
Ministry of Rural Development

# SPECIFICATIONS FOR RURAL ROADS

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# FOREWORD

The connectivity of the rural hinterland through good quality all-weather roads provide access to opportunities and services which plays a key role in the socio-economic development of the area. Therefore, as a part of a poverty reduction strategy, Pradhan Mantri Gram Sadak Yojana (PMGSY) was launched on the 25th December 2000 as a fully Central Govt. funded scheme. The programme aims at connecting every habitation that has population more than 500 (250 in case of hill States, Desert areas and Tribal areas). Rural Roads being a State subject, the implementation of the programme is the responsibility of the State Governments.

Learning from past experiences of road construction, the new initiative has focused on delivery of a quality product by meticulous attention to the technical aspects, which inter-alia include development and standardization of specifications, cost effective design, efficient procurement and strict quality control of works.

As a first step of the technical intervention, the Indian Roads Congress (IRC) published the Rural Roads Manual (IRC:SP:20-2002). Subsequently, the National Rural Roads Development Agency (NRRDA), constituted for the purpose of providing management support to the Ministry of Rural Development for implementation of the programme, developed a Standard Bidding Document and a Quality Control Handbook and established a three-tier quality monitoring mechanism to enforce the new system.

During the implementation of the programme, it was noticed that different States were adopting different sets of specifications, which sometimes, were not in conformity to the specifications prescribed in Rural Roads Manual. It was, therefore, felt necessary that a Standard Specification, which normally forms the part of Agreement with the Contractor should be developed for rural roads. The Indian Roads Congress was requested to take up this task. The preparation of the specifications was done by a group of experts under the aegis of IRC and a Peer Review Committee comprising of another set of experts headed by Director, CRRI was set up to review the contents. The draft was further subjected to review by senior and knowledgeable field Engineers from the selected States. The resulting document, entitled 'Specifications for Rural Roads', is the outcome of the efforts by the representatives of all the agencies connected with Rural Roads.

This document will be extensively used by all the Engineers, Contractors

and others involved in the construction of Rural Roads under Pradhan Mantri Gram Sadak Yojana. Its utility will be enhanced, if these Specifications are applied to all the Rural Roads constructed and maintained in the Country by the States. I need not stress that of the 2.5 million km or so of road length in this Country, nearly 80 per cent is in the Rural Roads Sector and barring earthen tracks created under employment programmes, the remaining roads are subjected to some form of engineering intervention for which Specifications contained in the document can be effectively utilized.

I wish to place on record the efforts made by the Experts, Scientists of CRRI and the Officers of NRRDA for bringing out the document in the present form. I also thank the Indian Roads Congress for undertaking the assignment and bringing out this publication.

(S. Vijay Kumar)
(Director General, NRRDA)
Joint Secretary
Govt. of India
Ministry of Rural Development

New Delhi
August 2004



# PREFACE

Construction of quality roads requires concerted actions on many fronts. But the task is made easier, if a concise, clearly worded specification is available on the basis of which the construction authority could design, award and supervise the works. A precise specification is also valuable to the contractors, as it gives them a clear understanding of the materials and of process of construction. It also brings out uniformity of approach and ease for construction.

Considering the requirement of implementation of the Pradhan Mantri Gram Sadak Yojana (PMGSY) spreading to the far-flung areas in the country, on the request of National Rural Roads Development Agency (NRRDA) under the Ministry of Rural Development, Government of India, the Indian Roads Congress (IRC) in March 2003 undertook the task of preparing detailed Specifications for PMGSY works.

A Working Group comprising of senior and experienced professionals in various fields of roads and bridges was constituted by IRC as below:

| | |
|---|---|
| Shri S.C. Sharma | *Group Leader* |
| Shri S.K. Kaistha | *Member* |
| Shri Jai Prakash | *Member* |
| Dr. N.B. Lal | *Member* |
| Shri R.K. Jain | *Member* |
| Shri H.K. Sharma | *Member* |
| Shri S.C. Kakkar | *Coordinator* |

This Working Group prepared the draft specifications for various items of work considered most appropriate for the construction of rural roads in the country. Guidance was taken from the Ministry of Road Transport & Highways Specifications for Road & Bridge Works-2001, IRC:SP:20-2002 'Rural Roads Manual', IRC, BIS and international codes of practices.

A Peer Review Committee comprising of the following reviewed various Sections of the document in a series of meetings:

| | |
|---|---|
| Prof. P.K. Sikdar, Director, CRRI | *Chairman* |
| Shri Prabha Kant Katare, Jt. Director, NRRDA | *Member-Secretary* |

*MEMBERS*

Dr. Ashok Kumar, Rural Roads Specialist, World Bank
Prof. C.E.G. Justo, Emeritus Fellow, Bangalore University
Shri C.V. Kand, Chief Engineer (Retd.) Madhya Pradesh PWD
Shri D.P. Gupta, Director General (Retd.) MORTH
Shri N.V. Merani, Principal Secretary (Retd.) Maharashtra, PWD

Shri P.K. Lauria, Secretary (Retd.) Rajasthan PWD
Shri V.V. Gulati, Chief Engineer (Retd.) Uttaranchal PWD
Prof. B.P. Chandrasekhar, Director (Technical), NRRDA
Shri H.K. Shrivastava, Director (Projects), NRRDA
Shri S. Baliga, Director (Projects), NRRDA
Head, Flexible Pavement Dn., CRRI
Head, Bridges Dn., CRRI
Head, Geotechnical Dn., CRRI

*SPECIAL INVITEE*

Shri G. Sharan, Secretary, IRC upto September, 2003
Shri R.S. Sharma, Secretary, IRC from November, 2003

Suggestions of the Peer Review Committee members and officers of NRRDA on the draft specifications, Section wise, were incorporated and draft document of complete specifications was compiled and printed. Copies of draft document were sent to NRRDA. Subsequently, a two-day's Workshop was organized by NRRDA on the 7th and 8th June, 2004 wherein apart from Peer Review Committee members, officers of NRRDA and representatives of user State Government departments, IRC officials and Working Group members actively participated. Based on the suggestions made in the Workshop, the draft specifications were further modified and a Section on 'Maintenance' besides some additional Clauses were prepared and added appropriately.

Shri G.S. Khinda, Consultant, IRC provided help in preparing the Section on 'Maintenance'. Shri M.V.B. Rao, Dr. P.K. Jain and Shri Satander Kumar of CRRI provided help and guidance in preparing the Specifications pertaining to structures, flexible pavements and rigid pavements respectively. Shri S.C. Kakkar, Under Secretary, IRC coordinated the secretarial work in the IRC.

While drafting the Specifications, every effort has been made to bring out the best current practices. However, road design and construction technology is continuously progressing forward. Future developments in research and construction practices will undoubtedly make it necessary to update the Specifications. Moreover, experience with the use of the Specifications made through out the Country may throw up the need for certain amendments. Suggestions for the improvement of the Specifications will thus be most welcome from all quarters.

(R.S. Sharma)
Secretary
Indian Roads Congress

New Delhi
August 2004



## CONTENTS

## ABBREVIATIONS

| | | |
|---|---|---|
| BOQ | = | Bill of Quantities |
| CBR | = | Callifornia Bearing Ratio |
| CD | = | Cross-Drainage |
| CRMB | = | Crumb Rubber Modified Bitumen |
| cu.m | = | Cubic metre |
| g | = | Gram |
| GBFS | = | Ganulated Blast Furnace Slag |
| GSB | = | Granular Sub-Base |
| GTS | = | Grand Triangulation Survey |
| h | = | Hour |
| kg | = | Kilogram |
| km | = | Kilometre |
| kN | = | Kilo Newton |
| l | = | Liter |
| m | = | Metre |
| MB | = | Modified Binder |
| ml | = | Millilitre |
| mm | = | Millimetre |
| MORD | = | Ministry of Rural Development |
| MORTH | = | Ministry of Road Transport & Highways |
| MPa | = | Mega Pascal |
| MPM | = | Modified Penetration Macadam |
| MS | = | Medium Setting |
| NRRDA | = | National Rural Roads Development Agency |
| OMC | = | Optimum Moisture Content |
| PMB | = | Polymer Modified Bitumen |
| RMB | = | Rubber Modified Bitumen |
| sq.m | = | Square metre |
| SS | = | Slow Setting |
| UCS | = | Unconfined Compressive Strength |
| WBM | = | Water Bound Macadam |
| WMM | = | Wet Mix Macadam |





# 100

# General

## 101. INTRODUCTION

These Specifications shall apply to all such rural road and bridge works as are required to be executed under the contract or otherwise directed by the Engineer-in-Charge (hereinafter referred to as 'the Engineer'). In every case, the work shall be carried out to the satisfaction of the Engineer and conform to the location, lines, dimension, grades and cross-sections shown on the drawings or as indicated by the Engineer.

The quality of work and materials shall comply with the requirements setforth in the succeeding Sections. Where the drawings and specifications describe a portion of the work in only general terms, and not in complete details, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer are to be fully complied with. The Specifications for most of the items of work are based on the current Indian Roads Congress Specifications and Codes of Practice and MoRT&H Specifications for Road & Bridge Works.

A list of Indian Roads Congress Specifications and Codes of Practice which have been made use of in the preparation of these Specifications is given at ***Appendix-1***.

## 102. DEFINITIONS

The words like Contract, Contractor, Engineer (synonymous with Engineer-in-Charge), Drawings, Government, Department, Works and Work site used in these Specifications, shall be considered to have the meaning as understood from the definitions of these terms intended in the general conditions of contract.

The abbreviations IRC, IS, BS, and ASTM shall be considered to have the following meaning:

| | | |
|---|---|---|
| IRC | : | Indian Roads Congress. |
| IS | : | Indian Standards published by the Bureau of Indian Standards (erstwhile Indian Standards Institution). |
| BS | : | British Standards of the British Standards Institution. |
| ASTM | : | American Standard of the American Society for Testing and Materials. |

## 103. TESTS AND SIEVE DESIGNATIONS

The tests and testing procedure referred to in the specifications shall coform to the relevant IS, BS or ASTM standards as indicated at appropriate places in the respective specifications.

A list of these standards with their full title and the year of publication applicable is included at ***Appendix-2***.

The sieve designations referred to in the specifications correspond to those specified in IS:460 (Parts 1 and 2).

The various elements in the cross-section of road referred to in these Specifications are shown in Fig. 100.1 and 100.2

## 104. SCOPE OF WORK

**104.1.** The work to be carried out under the contract, shall consist of the various items as generally described in the tender documents and bill of quantities. The work shall be carried out to these specifications unless specified otherwise.

**104.2.** The works to be performed shall also include all general works preparatory to construction of roads, bridges, canal crossings, drainage and protection works and all other related works. The works shall include work of any kind necessary for the due and satisfactory construction and completion of the works to the intent and meaning of the drawings and these specifications and further drawings and orders that may be issued by the Engineer from time-to-time. The scope of work shall include compliance by the Contractor with all General Conditions of Contract, whether specifically mentioned or not in the various clauses of these specifications, all materials, apparatus, plant, equipment, tools, fuel, water, strutting, timbering, transport, offices, stores, workshop, staff, labour and provision of proper and sufficient protective works, diversions, temporary fencing, lighting for the safety of the public and protection of the works and adjoining land, first-aid equipment, sanitary accommodation of the staff and workmen, the effecting and maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or the other charges arising out of the erection of works and the regular clearance of rubbish, reinstatement and clearing up of the site as required on completion.

**104.3.** The Contractor shall take all necessary actions to build in quality assurance in the planning and execution of works. The quality





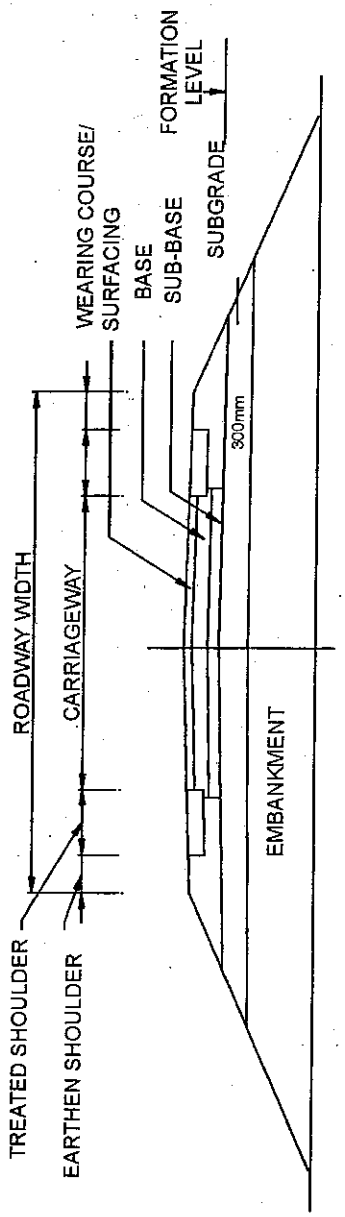



**Fig. 100.1.** Terms used in the Specifications to describe road cross-section elements with a flexible pavement

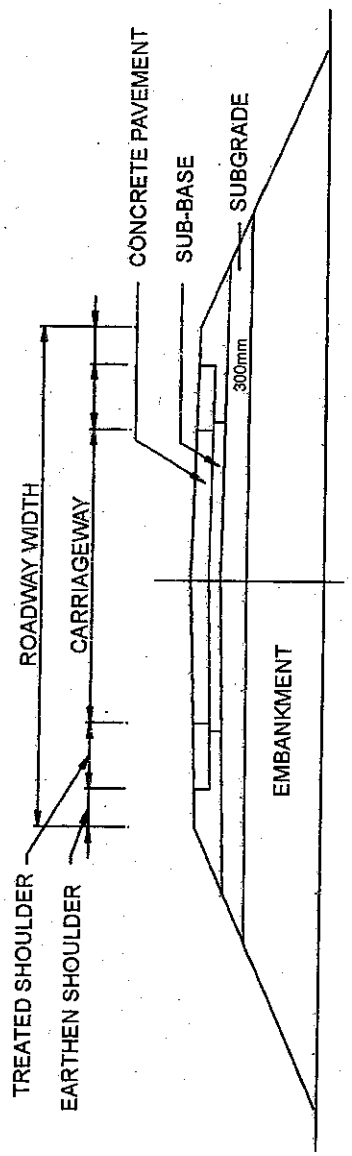



**Fig. 100.2.** Terms used in the Specifications to describe road cross-section elements with a cement concrete pavement





assurance shall cover all stages of work including setting out, selection of materials, construction method, equipment and plant, deployment of personnel and supervisory staff, quality control, testing, etc. and shall be deemed to be covered in the scope of work.

**104.4.** The Contractor shall furnish at least 15 days in advance his programme of commencement of item of work, the method of working, he intends to adopt for various items of works, such as, construction for embankment, cutting, sub-base, base, surfacing, culverts, bridges protection works, hill cutting, retaining wall, breast wall side drains and such other items for which the Engineer demands the submission of the method of working. He shall provide information regarding the details of the method of working, and equipment he proposes to employ and satisfy the Engineer about the adequacy and safety of the same. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor shall, however, rest on the Contractor, irrespective of any approval given by the Engineer. The Contractor shall submit a work schedule before the commencement of project for the approval of the Engineer.

## 105. CONSTRUCTION EQUIPMENT

In addition to the general conditions indicated in the contract documents, the following conditions regarding use of equipment in works shall be satisfied:

(a) All equipment provided, shall be of the proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Engineer.

(b) All the plant and equipment to be deployed in the work shall be got approved from the Engineer. The Contractor may be required to give a trial run of the equipment before commencement of the work if directed by the Engineer.

(c) No equipment or personnel shall be removed from site of work without permission of the Engineer.

(d) Any material or equipment not meeting the approval of the Engineer, shall be removed from the site forthwith.

## 106. CONTRACT DRAWINGS

**106.1.** The contract drawings provided for tendering purpose with the tender documents shall be used as a reference only. The Contractor should visualize the nature and type of work contemplated and to ensure that the

rates and prices quoted by him in the bill of quantities take due consideration of the complexities of work involved during actual execution/construction.

**106.2.** Drawings on the basis of which actual execution of the work is to proceed, shall be furnished free of cost to the Contractor by the Engineer progressively according to the work programme submitted by the Contractor and accepted by the Engineer. Drawings for the particular activity shall be issued to the Contractor at least 30 days in advance of the scheduled date of the start of the activity.

**106.3.** The tendered rates/prices for the work shall be deemed to include the cost of preparation, supply and delivery of all necessary drawings, prints, tracings and negatives, which the Contractor is required to provide in accordance with the contract.

**106.4.** Examination and/or approval by the Engineer, of any drawings or other documents submitted by the Contractor shall not relieve the Contractor of his responsibilities or liabilities under the contract.

## 107. SITE INFORMATION

**107.1.** The information about the site of work and site conditions in the tender documents is given in good faith for guidance only but the Contractor shall satisfy himself regarding all aspects of site conditions.

**107.2.** The location of the works and the general site particulars are as generally shown on the site plan/index plan enclosed with the tender documents.

**107.3.** Whereas the right of way to the bridge sites/road works shall be provided to the Contractor by the Engineer, the Contractor shall have to make his own arrangements for the land required by him for site offices, labour camps, stores, etc.

**107.4.** The quarry charts given in the tender documents indicate the location of quarries and the sources from which naturally occurring materials are available, for guidance of the Contractor. The leads indicated in the said charts are only approximate. It is assumed that the Contractor has inspected the quarries, borrow areas, etc. before quoting his rates for the work to assess the availability of constructional materials in required quantity and quality.





## 108. SETTING OUT

**108.1.** The Contractor shall establish working bench marks, tied with the reference Bench mark in the area, soon after taking possession of the site. The Reference Bench mark for the area shall be as indicated in the contract documents and the value of the same shall be obtained by the Contractor from the Engineer. The working bench marks shall be at the rate of four per km and also at or near all drainage structures and bridges. The working bench marks/levels shall be got approved from the Engineer. Checks must be made on these bench marks once every month and adjustments, if any, got agreed with the Engineer and recorded. An upto date record of all bench marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Engineer for his record.

In the hilly areas, each and every reference pillar, made by the Department and handed over by the Engineer to the Contractor, shall work as a bench mark for hill cutting width as well as for level of hill cutting. It shall be the Contractor's responsibility to safe guard the reference pillars during construction. In case any pillar is damaged, the Contractor shall immediately inform the Engineer. The Engineer shall restore the pillar at the cost of the Contractor as per conditions of contract.

**108.2.** The lines and levels of formation, side slopes, carriageway, shoulders and drainage works shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and cross-sections are obtained, everywhere.

**108.3.** In order to facilitate the setting out of the works, the centre-line of the carriageway of road shall be accurately established by the Contractor and got approved by the Engineer. It must then be accurately referenced in a manner satisfactory to the Engineer, every 50 m intervals in plain and rolling terrain and 20 m interval in hilly terrain with a closer spacing of 10 m on sharp curves, 5 m on hair pin bends or as directed by the Engineer, with marker pegs and chainage boards set in or near the fence line, and a schedule of reference dimentions shall be prepared and supplied by the Contractor to the Engineer. These markers shall be maintained until the works reach finished formation level and are accepted by the Engineer.

**108.4.** On construction reaching the formation level stage, the centre-line shall again be set out by the Contractor and, when approved by the

Engineer, shall be accurately referenced in a manner satisfactory to the Engineer, by marker pegs set at the outer limits of the formation.

No reference peg or marker shall be moved or withdrawn without the approval of the Engineer and no earthwork or structural work shall be commenced until the centre has been referenced.

**108.5.** The Contractor shall be the sole responsible party for safeguarding all survey monuments, bench marks, reference pillars, beacons, etc. The Engineer will provide the Contractor with the data necessary for the setting out of the centre-line. All dimensions and levels shown on the drawings or mentioned in documents forming part of or issued under the contract, shall be verified by the Contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions or levels. In connection with the staking out of the centre-line, the Contractor shall survey the terrain along the road and shall submit to the Engineer, for his approval, a profile along the road centre-line and cross-sections at intervals as required by the Engineer.

**108.6.** After obtaining approval of the Engineer, work on earthwork can commence and the profile and cross-section shall form the basis for measurements and payment. The Contractor is responsible for checking that all the basic traverse points are in place at the commencement of the contract and if any are missing or appear to have been disturbed, the Contractor shall make arrangements to re-establish these points. A 'Survey File' containing the necessary data will be made available for this purpose. If, in the opinion of the Engineer, design modifications of the centre-line or grade are advisable, the Engineer will issue detailed instructions to the Contractor and the Contractor shall perform the modifications in the field, as required and modify the ground levels on the cross-section accordingly as many times as required. There will be no separate payment for any survey work performed by the Contractor. The cost of these services shall be considered as being included in the cost of the items of work in the bill of quantities of the contract.

### 108.7. Measurement for Payment

The work of setting out shall be provided as a separate payable item in the bill of quantities and shall be measured in linear metre or in items of unit specified in the BOQ.





### 108.8. Rate

The Contract unit rate for the item of setting out shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, construction and establishing bench marks, reference pillars and their safeguarding, and all incidentals necessary to complete the work.

## 109. PUBLIC UTILITIES

**109.1.** Drawings scheduling the affected services like water pipes, sewers, electric lines, cables etc., owned by the various authorities including Public Undertaking and local authorities included in the contract documents shall be verified by the Contractor for the accuracy of the information prior to the commencement of any work.

The Contractor's programme must take into account the period of notice and duration of diversionary works of each body and allow for any affect of these services and alterations upon the works and for arranging regular meetings with the various bodies at the commencement of the contract and throughout the period of the works in order to maintain the required coordination.

**109.2.** No clearance or alterations to the utility shall be carried out unless specially ordered by the Engineer.

**109.3.** Any services affected by the works shall be temporarily supported by the Contractor who shall also take all measures reasonably required by the various bodies to protect their services and property during the progress of the works.

**109.4.** The Contractor may be required to carry out certain works for and on behalf of the various bodies and he shall also provide, with the prior approval of the Engineer, such assistance to the various bodies as may be authorised by the Engineer.

**109.5.** The work of temporarily supporting and protecting the public utility services during execution of the works shall be deemed to be part of the contract and no extra payment shall be made for the same.

**109.6.** The Contractor may be required to carry out the removal or shifting of certain services/utilities on specific orders from the Engineer, for which payment shall be made to him. Such works shall be taken up by

the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.

## 110. PRECAUTIONS FOR SAFEGUARDING THE ENVIRONMENT

### 110.1. General

The Contractor shall take all precautions for safeguarding the environment during the course of the construction of the works. He shall abide by all laws and rules and regulations in force governing pollution and environment or wild life protection that are applicable in the area where the works are situated.

### 110.2. Borrowpits for Embankment Construction

The stipulations in Clause 301.3.4.1 shall govern.

### 110.3. Quarry Operations

The Contractor shall obtain materials from quarries only after the consent of the Mining/Forest Department or other concerned authorities is obtained. The quarry operations shall be undertaken within the purview of the rules and regulations in force.

### 110.4. Control of Soil Erosion, Sedimentation and Water Pollution

The Contractor shall carry out the works in such a manner that soil erosion is fully controlled and sedimentation and pollution of natural water courses, ponds, tanks and reservoirs is avoided. The stipulations in Clause 308 shall govern.

### 110.5. Pollution from Construction Plants and Equipment

The contractor shall take every precaution to reduce the levels of noise, vibration, dust and emissions from his plant and shall be fully responsible for any claims for damages caused to the owners of property, fields and residences in the vicinity. Necessary approval from the concerned authorities will be attained by the Contractor for locating Plants and Equipment.

### 110.6. Substances Hazardous to Health

The Contractor shall not use or generate any materials in the works which are hazardous to the health of persons, animals or vegetation. Where it is necessary to use some substances which can cause injury to the health





of workers, the Contractor shall provide protective clothing or appliances like masks, shoes to his workers.

**110.7.** Any structural damage caused to the existing roads by the Contractor's construction equipment shall be made good without any extra cost.

**110.8.** The road side and surrounding shall be kept clean and clear of all dust, mud or other extraneous materials from the works. Any temporary housings of labour engaged in works shall be provided away from road side.

## 111. ARRANGEMENT FOR TRAFFIC DURING CONSTRUCTION

### 111.1. General

The Contractor shall at all times carry out work on the road in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing road, the Contractor shall, in accordance with the directives of the Engineer, provide and maintain, during execution of the work, a passage for traffic either along a part of the existing carriageway under improvement, or along a temporary diversion constructed close to the road. Such temporary road or drainage works shall be safe for passage of normal traffic. The Contractor shall take prior approval of the Engineer regarding traffic arrangements during construction.

### 111.2. Traffic Safety and Control

The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the road under improvement. Before taking up any construction, arrangements for the diversion of traffic on the road shall be made in consultation with the Engineer.

The barricades erected on either side of the carriageway shall be of design to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise.

At the points where traffic is to deviate from its normal path (Whether on temporary diversion or part width of the carriageway) the channel for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device as per the directions of the Engineer. At night, the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-way traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns/lights.

On both sides, suitable regulatory/warning signs, as approved by the Engineer, shall be installed for the guidance of road users. On each approach, at least two signs shall be put-up, one close to the point where transition of carriageway begins and the other 100 m away. The signs shall be of approved design and of reflectory type, if so directed by the Engineer.

### 111.3. Maintenance of Diversions and Traffic Control Devices

Signs, lights, barriers and other traffic control devices, as well as the riding surface of diversions shall be maintained in a satisfactory condition till such time they are required as directed by the Engineer. The temporary travelled way shall be kept free of dust by frequent applications of water, if necessary.

### 111.4. Measurements for Payment and Rate

All arrangements for traffic during construction including provision of treated shoulder including their maintenance, dismantling and clearing debris, where necessary, shall be considered as incidental to the works and shall be the Contractor's responsibility.

The construction of temporary diversion including temporary cross-drainage structures shall be measured in linear metre and the unit contract rate shall be inclusive of full compensation for construction (including supply of material, labour, tools, etc.) maintenance, final dismantling, and disposal.





## 112. GENERAL RULES FOR THE MEASUREMENT OF WORKS FOR PAYMENTS

### 112.1. General

All measurements shall be made in metric system. Different items of work shall be measured in accordance with the procedures setforth in the relevant Sections, read in conjunction with the general conditions of contract.

All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits:

| | | |
|---|---|---|
| (1) | Length and breadth | 10 mm |
| (2) | Height, depth or thickness of earthwork, subgrade, sub-bases, bases, surfacing and structural members | 5 mm |
| (3) | Areas | 0.01 sq.m |
| (4) | Cubic content | 0.01 cu.m |

In recording dimensions of work, the sequence of length, width and height or depth or thickness shall be followed.

### 112.2. Measurements of Lead for Materials

Where lead is specified in the contract for construction materials, the same shall be measured as described hereunder.

Lead shall be measured over the shortest practical route and not the one actually taken and the decision of the Engineer in this regard shall be taken as final. Distances upto and including 100 m shall be measured in units of 50 m, exceeding 100 m but not exceeding 1 km in units of 100 m and exceeding 1 km in units of 500 m, the half and greater than half of the units shall be reckoned as one and less than half of the units ignored. In this regard, the source of the material shall be divided into suitable blocks and for each block the distance from the centre of the block to the centre of placing pertaining to that block shall be taken as the lead distance.

### 112.3. Measurement of Pavement Thickness for Payment on Volume Basis

The finished thickness of sub-base, base, and bituminous course to be paid on volume basis shall be computed in the following manner:

Levels shall be taken before and after construction, at grid point of

10 m centre-to-centre longitudinally in straight reaches and 5 m at curves. Normally, on the two-lane roads, the levels shall be taken at four positions transversely, at 0.75 m and 2.75 m from either edge of the carriageway; and on single-lane roads these shall be taken at two positions transversely, being at 1.25 m from either edge of the carriageway.

Suitable reference for the transverse grid lines shall be left in the form of embedded bricks on either ends or by other means, so that it is possible to locate the grid points for level measurements after each successive course is laid.

For pavement courses laid only over widening portions, at least one line of levels shall be taken on each strip of widening, or more depending on the width of widening, as decided by the Engineer.

Notwithstanding the above, the measurements may be taken at closer intervals also if so desired by the Engineer, the need for which may arise particularly in the case of estimation of the volume of the material for profile corrective course (levelling course).

The average thickness of the pavement course in any area shall be the arithmetical mean of the difference of levels before and after construction of all the grid points falling in that area, provided that the thickness of finished work shall be limited to those shown on the drawings or approved by the Engineer in writing.

As supplement to level measurements, the Engineer shall have the option to take cores/make holes to check the depth of construction.

### 112.4. Checking of Pavement Thickness for Payment on Area Basis

Where payment for any bituminous course as per Section 500 is allowed to be made on area basis, the Engineer may have its thickness checked with the help of a suitable penetration gauge at regular intervals or other means as he may decide.

## 113. SCOPE OF RATES FOR DIFFERENT ITEMS OF WORK

**113.1.** For item rate contracts, the contract unit rates for different items of work shall be payable in full for completing the work to the requirements of the Specifications including full compensation for all the operations detailed in the relevant Sections of these Specifications under "Rates". In





the absence of any directions to the contrary, the rates are to be considered as the full inclusive rates for finished work covering all labour, materials, wastage, temporary work, plant, equipment, overhead charges and profit as well as the general liabilities, obligations, insurance and risks arising out of General Conditions of Contract.

**113.2.** The item rates quoted by the Contractor shall, unless otherwise specified, also include compliance with/supply of the following:

(i) General works, such as, setting out, clearance of site before setting out and clearance of works after completion;

(ii) A detailed programme for the construction and completion of the work;

(iii) Samples of various materials proposed to be used on the Work for conducting tests thereon as required as per the provisions of the Contract;

(iv) Design of mixes as per the relevant Clauses of the Specifications giving proportions of ingredients, sources of aggregates and binder along with accompanying trial mixes as per the relevant Clauses of these Specifications to be submitted to the Engineer for his approval before use on the works; for concrete works nominal mixes producing desired strength could be used for CD Works. Design mixes are provided for pavement works;

(v) Detailed design calculations and drawings for all Temporary Works (such as, formwork, staging, centering; specialized constructional handling and launching equipment and the like);

(vi) Testing of various finished items and materials including bitumen, cement, concrete, bearings as required under these Specifications and furnishing test reports/certificates;

(vii) All temporary works, formwork and false work;

(viii) Establishing and running a laboratory with facilities for testing for various items of works as specified in Section 900 and other relevant Clauses, where there is no separate item in the Bill of Quantities for establishing and running a laboratory;

(ix) Cost of in-built provision for Quality Assurance; and

(x) Cost of safeguarding the environment.

## 114. METHODOLOGY AND SEQUENCE OF WORK

Prior to start of the construction activities at site, the Contractor shall, within a period as per Contract Agreement after the date of the Letter of Acceptance, submit to the Engineer for approval, the detailed construction

methodology including mechanical equipment proposed to be used, sequence of various activities and schedule from start to end of the project. Programme relating to pavement and shoulder construction shall be an integrated activity to be done simultaneously in a coordinated manner. The methodology and the sequence shall be so planned as to provide proper safety, drainage and free flow of traffic.

## 115. APPROVAL OF MATERIALS

Approval of all sources of material for work shall be obtained in writing from the Engineer before their use on the project.

## 116. SUPPLY OF QUARRY SAMPLES

Raw and processed samples of the mineral aggregates from the approved quarry shall be submitted by the Contractor at no extra cost.

## 117. USE OF SURFACES BY CONSTRUCTION TRAFFIC

Ordinarily, no construction traffic shall be allowed on pavement under construction unless authorised by the Engineer. Even in that case the load and intensity of construction traffic should be so regulated that no damage is caused to the sub-grade or pavement layers already constructed. Where necessary, service roads shall be constructed for this purpose and the same shall be considered as incidental to the work.

## 118. SUPPLY OF COLOUR RECORD PHOTOGRAPHS AND ALBUMS

### 118.1. Scope

The work covers the supply of photographs, negatives and albums to serve as a permanent record of various stages/facets of the work needed for an authentic documentation as approved by the Engineer.

### 118.2. Description

The Contractor shall arrange to take colour photographs at various stages/facets of the work including interesting and novel features of the work as desired by the Engineer. The photographs shall be of acceptable quality and they shall be taken by a professionally competent photographer with a camera having the facility to record the date of photographs taken in the prints and negative. The Contractor shall supply two colour prints of





each of the photographs taken to the standard postcard size mounted in albums of acceptable quality. Also the negative in 35 mm size shall be supplied for each photograph. Each photograph in the album shall be suitably captioned.

Alternatively the photographs may be taken in a digital camera and may be recorded in a Compact Disc.

### 118.3. Measurements for Payment

Supply of two copies of colour record photographs mounted in the albums and the negative/compact disc thereof shall be measured in number of record photographs supplied.

Supply of additional prints of colour record photographs shall be measured in number of additional prints supplied.

### 118.4. Rate

The rate for the supply of record photographs shall include the cost of taking the photographs, developing and obtaining colour prints, cost of album, mounting of photographs and captioning the same, etc.

The rate of additional colour prints shall similarly include all costs incurred.

The photographs and materials including negatives shall form a part of the records of the Department and the prints of the same cannot be supplied to anybody else or published without the written permission of the Department.

## 119. FIELD LABORATORY

### 119.1. Scope

The work covers the provision and maintenance of an adequately equipped field laboratory as required for site control on the quality of materials and the works.

### 119.2. Description

The Contractor shall arrange to provide adequately equipped field laboratory constructed as shown in drawings. The field laboratory shall preferably be located adjacent to the site office of the Engineer and provided with amenities like water supply, electric supply, etc.

### 119.3. Laboratory Equipment

**119.3.1.** The following items of laboratory equipment or as directed by the Engineer shall be provided in the field laboratory.

| | | |
|---|---|---|
| (i) | Post Hole Auger with extension | One set |
| (ii) | Digging tools like pick axe, shovel, hammer, chisel, etc. | One set |
| (iii) | IS Sieves with lid and pan (90 mm, 80 mm, 63 mm, 53 mm, 45 mm, 37.5 mm, 26.5 mm, 19 mm, 13.2 mm, 11.2 mm, 9.5 mm, 4.75 mm, 2.8 mm, 5.6 mm, 3.35 mm, 2.36 mm, 600 micron, 425 micron, 300 micron, 150 micron, 180 micron, 90 micron and 75 micron) | One set |
| (iv) | Standard Proctor Density Test Apparatus with rammer | One set |
| (v) | Sand Pouring Cylinder with tray complete for field density test | One set |
| (vi) | Core Cutter (100 mm dia.), 100 mm/150 mm height complete with dolly and hammer | One set |
| (vii) | Speedy moisture meter complete with chemicals | One set |
| (viii) | Straight Edges | Two nos. |
| (ix) | Digital Thermometers | Three nos. |
| (x) | Liquid Limit and plastic limit testing apparatus complete with Water bottle and glass wares | One set |
| (xi) | Gas burner, sand bath | One set |
| (xii) | Camber Board | Two nos. |
| (xiii) | Electronic/digital balance 1 kg with the least count of 0.01 gm | One no. |
| (xiv) | Electronic/digital balance 5 kg | One no. |
| (xv) | Pan balance with weight Box, 5 kg | One no. |
| (xvi) | Oven (ambient to 200°C) | One no. |
| (xvii) | Water bath (ambient to 100°C) | One no. |
| (xviii) | Bitumen extraction apparatus | One no. |
| (xix) | Penetratin apparatus (Bitumen) | One no. |
| (xx) | Enamelled tray | Six nos. |





| | | |
|---|---|---|
| (xxi) | Measuring tape, spatula, glassware, porcelain dish, pestle mortar | One set |
| (xxii) | Trays for measurement of tack coat quantity | Three nos. |
| (xxiii) | Slump cone | Two nos. |
| (xxiv) | Cube moulds (150 mm x 150 mm) | Twelve nos. |

### 119.3.2. Rate

The cost of setting up laboratory including services, essential supplies, like, water, electricity, sanitary services and their maintenance and cost of all equipment, tools, materials, labour and incidentals to perform tests and other operation of quality control according to the Specification requirements shall be deemed to be incidental to the work and no extra payment shall be made for the same.

# 200

# Site Clearance

# 201. CLEARING AND GRUBBING

## 201.1. Scope

Clearing and grubbing shall be performed less than one month in advance of earthwork operations and shall consist of cutting, trimming, removing and disposing of all materials such as trees, tree branches, bushes, shrubs, stumps roots, grass, weeds, anthills, jungle top organic soil not exceeding 150 mm in thickness, rubbish, loose stones, boulders, etc. which are undesirable and unsuitable for use in the works, from the designated area of road land, embankment slopes, drains, cross-drainage structures and such other areas as specified on the drawings or from areas as directed by the Engineer. It shall include grubbing, necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, removal and disposal of cleared materials in accordance with the requirements of these Specifications.

Reclearing of the site of any vegetation, grass shrubs before commencement of work shall be carried out as directed by the Engineer and shall be incidental to the work of clearing and grubbing.

## 201.2. Preservation of Property/Amenities

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the road which are not to be disturbed shall be protected from injury or damage by providing and installing suitable safeguards as shown in the drawing or as approved by the Engineer.

During clearing and grubbing the Contractor shall take all adequate precautions for preservation of all vegetation adjacent to road land against soil erosion, water pollution, etc. and where required, shall undertake additional works to that effect. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc. and the schedule for carrying out additional work where required.

## 201.3. Conservation of Top–soil

The top-soil removed during clearing and grubbing of site, if suitable for re-use shall be transported, conserved and stacked as directed by the Engineer. This shall be incidental to the work.

### 201.4. Methods, Tools and Equipments

Only such methods, tools and equipment as are approved by the Engineer shall be adopted for the work. If the area has thick vegetation/ roots/trees, a crawler or dozer shall be used for clearance purposes. All trees, stumps, etc. falling within excavation and fill line shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for re-use in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these clearing limits trees and stumps required to be removed shall be cut down to 500 mm below ground level so that these do not present an unsightly appearance.

All branches of trees extending above the roadway shall be cut or trimmed so as to provide a clear height of 5 m above the road surface and shoulders.

All excavations below the general ground level arising out of the removal of trees, stumps etc. shall be filled with material conforming to prescribed requirements and compacted to specified density, given by the Engineer.

### 201.5. Removal of Ant-hills

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed by excavating to a suitable depth as directed by the Engineer. The excavated ant-hills material shall be carted away from the site. Cavities in the ground due to removal of ant-hills shall be filled with approved material and compacted to specified densities, as directed by the Engineer.

### 201.6. Disposal of Materials

All materials including trees, stumps, etc. arising from clearing and grubbing operations shall be the property of Government and shall be disposed off by the Contractor as here-in-after provided or as directed by the Engineer.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the Engineer. Stacking





of stumps, boulders, stones etc. shall be done at specified spots with all lifts and upto a lead of 1000 m.

All products of clearing and grubbing which cannot be used or auctioned shall be cleared away from the roadside in a manner as directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for embankment, subgrade and road construction or cause undesirable environmental conditions.

### 201.7. Measurements for Payment

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be incidental to embankment construction and the rates quoted for the embankment construction shall be inclusive of it.

Cutting of trees upto 300 mm in girth including removal of stumps and roots, and cutting/trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps of trees upto 300 mm girth left over after trees have been cut by any other agency of the Contractor or Government shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots of trees of girth above 300 mm and backfilling to required compaction and removal of stems and roots of trees of girth above 300 mm diameter left over after trees have been cut by any other agency or the government shall be measured in terms of number according to the sizes given below:

(i) Above 300 mm to 600 mm

(ii) Above 600 mm to 900 mm

(iii) Above 900 mm to 1800 mm

(iv) Above 1800 mm to 2700 mm

(v) Above 2700 mm to 4500 mm

(vi) Above 4500 mm

For this purpose, the girth shall be measured at a height of 1 m above ground or at the top of the stump, if the height of the stump is less than 1 m from the ground.

Where the proposed work site passes through dense forest area, clearing and grubbing including cutting of trees of all girths and removal of their roots and stumps, etc. for construction of road embankment, drains and cross-drainage structures shall be measured on area basis.

### 201.8. Acceptance

Acceptance of clearing and grubbing shall be based on visual inspection of the work for compliance with the above specifications to the satisfaction of the Engineer.

### 201.9. Rate

**201.9.1.** The Contract unit rates for the various items of clearing and grubbing shall be paid/payable in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps and roots of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency of the Contractor or Government, excavation and backfilling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

**201.9.2.** The Contract unit rate for cutting (including removal of stumps and roots) of trees of girth above 300 mm and removal of stems and roots of trees of girth above 300 mm left over after trees have been cut by any other agency or the government shall include excavation and backfilling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m as directed by the Engineer.

**201.9.3.** Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

## 202. DISMANTLING CULVERTS, SMALL BRIDGES, PAVEMENTS AND OTHER STRUCTURES

### 202.1. Scope

This work shall consist of removing, as hereinafter setforth, existing culverts, bridges, pavement, kerbs and other structures, like, railings,





fences, utility services, manholes, catch basins, inlets etc., which are in place but interfere with the new construction or are not suitable to remain in place. It shall include salvaging and disposing of the resulting materials and backfilling the resulting trenches and pits.

Existing culverts, bridges, pavement and other structures which are within the road land and which are designated for removal, shall be removed upto the limits and extent specified in the drawings or as directed by the Engineer.

Dismantling and removal operations shall be carried out preferably with locally available tools and equipments and in such a manner as to leave undisturbed adjacent pavement, structures and any other work to be left in place. Use of specialized tools and equipments by the agency shall be incidental to this item.

All operations necessary for the removal of any existing structure which endanger new construction shall be completed prior to the start of new work.

### 202.2. Dismantling Culverts and Small Bridges

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures or utilities nearby.

Unless otherwise specified, the superstructure portion of culverts/ bridges shall be entirely removed and other parts removed below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlying or adjacent material, if required in connection with the dismantling of the structures, shall be incidental to this item.

Where existing culverts/bridges are to be widened/strengthened or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as are necessary for execution of work shown in drawings to provide a proper connection to the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grade without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are

to be left in place so as to project into the new work as dowels or ties are not damaged during removal of concrete and protected against rusting or corrosion.

Pipe culverts shall be carefully removed in such a manner as to avoid damage to the pipes.

Steel structures shall be carefully dismantled in such a manner as to avoid damage to members thereof, if the structure is to be removed in a condition suitable for re-erection as specified in the drawings or directed by the Engineer. All members shall be match marked with white lead paint by the Contractor before dismantling. All loose parts like pins, nuts, loose plates, etc. shall be securely wired to adjacent members or packed in boxes with proper markings for the ease of identification at the time of re-erection of the structure at later stage.

Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber as is designated by the Engineer to be salvaged after joint inspection by the Engineer and the Contractor or their authorized representatives.

### 202.3. Dismantling Pavement and Other Structures

In removing pavements, kerbs, gutters, and other structures, like, railings, fences, manholes, catch basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

Concrete pavements, base courses in carriageway and shoulders, etc. designated for removal shall be broken to pieces and stock piled at designated locations or as directed by the Engineer, if the material is to be used later or otherwise, the Contractor shall arrange for disposal as stipulated in Clause 202.5.

### 202.4. Backfilling

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density conforming to these specifications, or as directed by the Engineer.





### 202.5. Disposal of Materials

All materials, obtained by dismantling, shall be the property of Government. Unless otherwise specified, materials having any salvage value shall be placed in neat stacks of like materials within the right-of-way, as directed by the Engineer with all lifts and upto a lead of 1000 m.

Pipe of culverts which are removed shall be cleaned and neatly piled on the right-of-way at spots designated by the Engineer with all lifts and lead upto 1000 m.

Structural steel removed from old structures shall, unless otherwise specified be stored in a neat and presentable manner in blocks at locations suitable for loading.

Timber or lumber salvaged from old structures shall have all nails and bolts removed therefrom and shall be stored in neat piles in locations suitable for loading in the right-of-way.

All materials obtained from dismantling operations which cannot be used or auctioned shall be disposed off as directed by the Engineer with all lifts and upto a lead of 1000 m.

### 202.6. Acceptance

Acceptance of dismantling and removal of salvaged material shall be based on visual inspection of the work and backfilling and compaction shall comply the tests specified for such work in these Specifications.

### 202.7. Measurements for Payment

The work of dismantling structures shall be paid for in units indicated below by taking measurements before and after, as applicable:

| | | |
|---|---|---|
| (i) | Dismantling brick/stone masonry/concrete (Plain and reinforced) | cu.m |
| (ii) | Dismantling flexible and cement concrete pavement | cu.m |
| (iii) | Dismantling steel structures | tonne |
| (iv) | Dismantling pipes, guard rails, kerbs, gutters and fencing | linear m |
| (v) | Utility services | Nos./linear m |

### 202.8. Rate

The Contract unit rates for the various items of dismantling including utility services shall be paid in full for carrying out the required operations including all labour, materials, tools, equipment, safeguards and incidental expenditure for the satisfactory completion of the work. These rates will also include excavation and backfilling where necessary to the required compaction and for handling, salvaging, piling, and disposing of the dismantled materials within all lifts and upto a lead of 1000 m.





# 300

# Earthworks

## 301. EMBANKMENT CONSTRUCTION

### 301.1. Scope

This Specification shall apply to the construction of embankments and miscellaneous backfills with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments and miscellaneous backfills shall be constructed in accordance with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 301.2. Definition of Earthwork Materials

**301.2.1. Topsoil** : Topsoil is a soil which, on visual examination, can be seen to be capable of supporting plant growth.

**301.2.2. Suitable fill material** : Suitable material shall comprise all that which is acceptable in accordance with the Contract for use in the Works and which is capable of being compacted in the manner specified in this Specification to form a stable fill having side slopes indicated in the Drawings.

**301.2.3. Unsuitable fill material** : Unsuitable material for embankment construction shall include the following, unless accepted by the Engineer:

(i) Materials from swamps, marshes and bogs;

(ii) Peat, log, stump and perishable material; any soil that classifies as OL, OI, OH or Pt in accordance with IS:1498;

(iii) Material susceptible to spontaneous combustion;

(iv) Materials with salts resulting in leaching in the embankment, such as salt-infested soils with pH>8.5 (sodic soils), when tested as per IS:2720 Part 26;

(v) Clays having liquid limit exceeding 70 and plasticity index exceeding 45. Expansive clays with 'Free Swelling Index' exceeding 50 per cent when tested as per IS:2720 Part 40;

(vi) Materials in a frozen condition;

(vii) Fill materials with a soluble sulphate content exceeding 1.9 gm of sulphate (expressed as $SO_3$) per litre, if deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works;

(viii)Materials with a total sulphate content (expressed as $SO_3$) exceeding 0.5 per cent by mass, if deposited within 500 mm, or other distance described in the Contract, of metallic items forming part of the Permanent Works.

## 301.3. Physical Requirements of Embankment Materials

**301.3.1.** The materials used in embankments and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment. The types of materials considered unsuitable for use in embankment shall be as detailed in Clause 301.2.3.

**301.3.2.** The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment. However, the Engineer may, at his discretion, permit the use of material coarser than this also, if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

**301.3.3.** For embankments upto 3 m height, and not subjected to flooding, any fill material which yields a maximum laboratory dry unit weight of less than 14.4 kN/m$^3$, when tested as per IS:2720 Part 7, shall be considered unsuitable. Any fill material for embankments exceeding 3 metres height or embankments of any height, subject to long periods of inundation, which yields a maximum laboratory dry unit weight of less than 15.2 kN/m$^3$, when tested as per IS:2720 Part 7, shall be considered unsuitable. The above density requirements are not applicable to light-weight fill materials like flyash, etc.

**301.3.4. General requirements** : The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract. The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

**301.3.4.1. Borrow pits** : Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall comply with the following requirements :

(a) **Location and Shape** : Borrow pits shall be rectangular in shape with one





side parallel to the centreline of the road. If on road land, they shall be dug as near the road boundary as possible. In any case, no borrow pits shall be dug within a distance equal to the height of the embankment, subject to a minimum of 1.5 m, from the toe of the final section of the road embankment, after making due allowance for future development.

Borrow pits shall not be dug continuously. Ridges of not less than 8 m width shall be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage.

(b) **Depth** : The depth of borrow pits shall be so regulated that :

(i) The bottom of the pits do not cut an imaginary line having a slope of 1:4 projected from the edge of the final section of the road embankment; the maximum depth in any case being limited to 1 m.

(ii) The bed level of the pits shall slope down progressively towards the nearest cross drain, if any, and shall not be lower than the bed of the cross drain.

(iii) Where the pits are on temporarily arranged cultivable land, the depth shall not exceed 450 mm. The topsoil to a depth of 150 mm shall be stripped and stacked aside. Thereafter, soil may be dug to a further depth not exceeding 300 mm. The topsoil shall then be spread back on the land.

(c) **Special cases**

(i) In areas of high water table, yielding suitable borrow material, the borrow pits shall take the form of deep narrow continuous ditches, connected with natural drainage, so as to conserve as much land as possible.

(ii) Borrow pits shall not be dug within 800 m of towns or villages. If unavoidable, they shall not exceed 300 mm in depth and shall be drained.

(iii) Where the road embankment is used as a flood bank, as far as possible, earth shall be borrowed only from the river side. The inner edge of any borrow pit shall not be less than 15 m from the toe of the bank. Where borrowing earth from the landside cannot be avoided, a berm at least 25 m wide shall be left between the borrow pit and the toe of the bank.

The toe of the bank on the rear side shall have a cover of 750 mm to 1.25 m over the saturation line drawn at a slope of 1 in 6 from the high flood level on the river side.

**301.3.4.2.** The Contractor shall, at least 7 working days before commencement of compaction work, submit the following to the Engineer

for approval :

(i) Soil classification test data

(ii) The values of maximum dry density and optimum moisture content obtained in accordance with IS:2720 (Part 7) for each of the fill materials he intends to use.

(iii) A graph of density plotted against moisture content from which each of the values in (ii) above of maximum dry density and optimum moisture content were determined.

(iv) CBR tests conducted on samples at specified density as per IS:2720 (Part 7) and for soaked and unsoaked conditions, for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction. In the body of the embankment, the degree of compaction shall be as given in Tables 300.1 and 300.2, except for expansive clay soils, having free swelling index below permissible limits, where it shall be 90 per cent of the maximum laboratory dry density as per IS:2720 (Part 7).

**TABLE 300.1 : EMBANKMENTS UPTO 3 m – SOIL COMPACTION**

| Material with Max. Lab. Dry Unit Weight kN/m³ | Min. Field Compaction *(%) |
|---|---|
| Less than 14.4 | Unsuitable |
| 14.4 or more | 97 |

* When tested in accordance with IS:2720 (Part 7)

**TABLE 300.2 : EMBANKMENTS OVER 3 m – SOIL COMPACTION**

| Material with Max. Lab. Dry Unit Weight kN/m³ | Min. Field Compaction *(%) |
|---|---|
| Less than 15.2 | Unsuitable |
| 15.2 or more | 97 |

* When tested in accordance with IS:2720 (Part 7)

## 301.4. Preparing Foundation for Embankment

**301.4.1.** The foundation for embankment construction shall be prepared as under, after removing the topsoil/unsuitable material :

(a) **Embankment less than 1 m high over natural ground** : The preparation of foundation shall consist in completely breaking-up the cleared ground surface to a minimum depth of 150 mm by ploughing or scarifying. The ground surface shall then be compacted according to Clause 301.5.5.

(b) **Embankment less than 0.5 m high over an existing black-topped or gravel road surface** : An existing gravel road shall be scarified to a minimum depth of 150 mm. In case of existing black-topped roads, the black-topping shall be removed and the pavement shall be scarified to a depth of 150 mm. All particles shall be reduced to a maximum size of 50 mm to produce a uniform material. The surface shall then be compacted according to Clause 301.5.5.

(c) **Embankment over ground not capable of supporting equipment** : Successive loads of embankment material shall be spread in a uniformly distributed layer to construct the lower portion of the embankment. The layer thickness shall be limited to the minimum depth necessary to support the equipment.

(d) **Embankment on an existing slope steeper than 1:4** : Horizontal benches shall be cut in the existing slope to a sufficient width to accommodate placement and compaction operations and equipment. As the embankment is placed and compacted in layers, the slope shall be benched, beginning each bench at the intersection of the original ground and the vertical cut of the previous bench.

## 301.5. Construction Operations

**301.5.1. Setting out** : After the site has been cleared as per Clause 201, the limits of embankment shall be marked by fixing batter pegs and marking the toe lines on both sides at regular intervals as guides before commencing the earthwork. The embankment shall be built sufficiently wider than the design dimension so that the surplus material at the edges (which does not receive the same degree of compaction as the rest of the embankment) may be trimmed ensuring that the remaining material is compacted to the desired density and in position specified and conforms to the specified side slopes.

**301.5.2. Dewatering** : If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer, it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer, and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

**301.5.3. Stripping of topsoil** : The topsoil from all areas of cutting and from all areas to be covered by embankment shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where revegetation is desired.

**301.5.4. Spreading and moisture control**

**301.5.4.1.** Suitable embankment material shall be spread in successive layers of uniform thickness over the entire width of embankment. The depth of each layer of filling shall suit the compaction plant and the compaction procedure approved by the Engineer. The thickness of layer shall be as specified in Clause 301.5.5.

Where materials of appreciably different characteristics are to be deposited in embankments, such materials shall be spread in separate layers, each layer composed of only one type of material.

**301.5.4.2.** Layers shall be placed, at such cross-falls as will shed storm water and prevent ponding.

**301.5.4.3.** Each layer shall be finished by a suitable tractor-towed appliance or manually, using camber board and compacted as per Clause 301.5.5. Successive layers shall not be placed until the layer under consideration has been thoroughly compacted to the specified requirements as in Tables 300.1 and 300.2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

**301.5.4.4.** Work on compaction of materials in embankment shall only be carried out when the material has a moisture content within ± 2 per cent of OMC. Clay soils shall be compacted on the wet side of the optimum. The Contractor shall, if required, adjust the moisture content of material spread without extra charge. Should the material be too dry, the required amount of water shall be applied uniformly by a trailer mounted water bowser and thoroughly mixed in the soil by blading, discing or harrowing until a uniform and satisfactory moisture content is obtained through the depth of the layer. Should the material be too wet, it shall be aerated by blading, discing or harrowing until the moisture content is satisfactory. The Contractor shall conserve the moisture content of material excavated when this is close to the optimum moisture content and such material shall not be stockpiled or double handled, but shall be spread and compacted





without delay. Allowance shall be made for evaporation, for instance in excessively hot weather, by the addition of extra moisture so that compaction may be carried out satisfactorily.

**301.5.5. Compaction** : Only the compaction equipment approved by the Engineer shall be employed to compact the different types of materials encountered during construction. If the compacted layer thickness is not to exceed 150 mm, static smooth-wheeled rollers of 80 to 100 kN static weight can be used. However, for higher compacted layer thicknesses upto 200 mm, vibratory rollers of 80 to 100 kN static weight shall be used. The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval. Rolling shall begin at the edge of the fill and progress towards the centre line, overlapping on successive trips by about one half the width of the roller unit. On superelevated curves, rolling shall begin at the low side and progress towards the high side.

Each layer of the material shall be thoroughly compacted to the densities specified in Tables 300.1 and 300.2 for embankments upto 3 m height and above 3 m height respectively.

The degree of compaction shall be measured in each layer, as laid down in Clause 1803.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

When density measurements reveal any soft areas, further compaction shall be carried out as directed by the Engineer. If inspite of that, the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements to the satisfaction of the Engineer.

**301.5.5.1. Repairs of damages caused by rain/spillage of water :** When damages to embankment are caused by rain or otherwise, the soil in the affected portion shall be removed in such areas as directed by the Engineer before the next layer is laid and compacted. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages shall be carried out by the Contractor at his own cost including arrangement of machinery/ equipment for the purpose.

**301.5.6. Embankment around structures** : To avoid interference with the construction of abutments, wing walls or return walls of culvert/ bridge structures, the Contractor shall, at points to be determined by the Engineer, suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

### 301.6. Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders/verge/roadbed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerance described in Clause 1802. Both the upper and lower ends of the side slopes shall be rounded-off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier (Clause 301.5.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the





growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being 100 to 150 mm. Where directed, the slopes shall be turfed.

### 301.7. Earthwork for Widening Existing Road Embankment

When an existing embankment and/or subgrade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches may be utilised in the widening of the embankment/subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

When the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers/plate compactors/power rammers or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

### 301.8. Earthwork over Existing Road Surface

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

(i) If the existing road surface is of granular or bituminous type and lies within 1 m of the new subgrade level, the same shall be scarified to a depth of 50 mm or more if specified, so as to provide ample bond between the old and new material ensuring that at least 300 mm portion below the top of new subgrade level is compacted to the desired density.

(ii) If the existing road surface is of cement concrete type and lies within 1 m of the new subgrade level, the same shall be removed completely.

(iii) If the level difference between the existing road surface and the new formation level is more than 1 m, the existing surface shall be permitted to stay in place without any modification.

### 301.9. Settlement Period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wingwall, retaining wall, footings etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the Contract or as directed by the Engineer.

### 301.10. Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

### 301.11. Surface Finish and Quality Control of Work

Control on the quality of materials and works shall be exercised in accordance with Clause 1803.

### 301.12. Measurements for Payment

Earth embankment construction shall be measured separately by taking cross-sections at intervals in the original position before the work starts and after its completion and computing the volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum of suitable material brought to site, from road and drainage excavation, forms one cum of compacted fill and all bulking or shrinkage shall be ignored.

Stripping of topsoil to the specified depth including storing and reapplication shall be measured in square metres.

Work involving loosening and recompacting of ground supporting embankment shall be measured in cubic metres.

Removal of unsuitable material at embankment foundation and replacement with suitable material shall be measured in cubic metres.

Scarifying existing granular/bituminous road surface shall be measured in square metres.





Dismantling and removal of existing cement concrete pavement shall be measured as per Clause 202.

Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cubic metres.

Setting out shall be measured in linear metres (refer Clause 108).

### 301.13. Rate

**301.13.1.** The Contract unit rates for the items of embankment construction shall be payment in full for carrying out the required operations including full compensation for :

(i) Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided otherwise in the Contract;

(ii) Compacting ground supporting embankment except where removal and replacement of suitable material or loosening and recompacting is involved;

(iii) Scarifying or cutting continuous horizontal benches 300 mm wide on side slopes of existing embankment and subgrade as applicable;

(iv) Cost of watering or drying of material in borrow areas and/or embankment during construction as required;

(v) Spreading in layers, bringing to appropriate moisture content and compacting to Specification requirements;

(vi) Shaping and dressing top and slopes of the embankment including rounding of corners;

(vii) Restricted working at sites of structures;

(viii) Working on narrow width of embankment;

(ix) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the Contract;

(x) All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications;

(xi) Dewatering; and

(xii) Keeping the embankment/completed formation free of water.

**301.13.2.** In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the Contract for construction of embankment shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

**301.13.3.** The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts, but leads upto 1000 m or as otherwise specified.

**301.13.4.** The Contract unit rate for loosening and recompacting the loosened materials shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

**301.13.5.** The Contract unit rate for items of removal of unsuitable material and replacement with suitable material shall be as per Clause 301.12.

**301.13.6.** The Contract unit rate for scarifying existing granular/ bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. This will also comprise of handling, salvaging, stacking and disposing of the dismantled materials within all lifts and upto a lead of 1000 m or as otherwise specified.

**301.13.7.** The Contract unit rate for providing and laying material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to the Specifications.

**301.13.8.** The cost of testing shall be borne by the Contractor.

## 302. EARTHWORK IN CUTTING

### 302.1. Scope

The work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and waterways in accordance with the requirements of these Specifications and





the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. It shall include earthwork in excavation in ordinary soil, soft rock, hard rock or soil mixed with boulders to achieve designed formation width including hauling and stacking of material useful for construction at suitable sites and safe disposal of unsuitable cut materials in specified manner, trimming, filling of unevenness, blindage and finishing of the road to specified dimensions or as directed by the Engineer for smooth riding.

### 302.2. Classification of Excavated Material

**302.2.1. Classification** : All materials involved in excavation shall be classified by the Engineer as under :

(a) Soil

(b) Ordinary Rock (not requiring blasting)

(c) Hard Rock (requiring blasting)

(d) Hard Rock (blasting prohibited)

(e) Marshy Soil

Further details pertaining to the above Classification are provided at ***Annexure-300.1***.

**302.2.2.** The classification of excavated material shall be decided by the Engineer and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification until blasting is clearly necessary in the opinion of the Engineer.

### 302.3. Construction Operations

**302.3.1.** After site clearance, the limits of excavation shall be set out to lines, curves, slopes, gradients and cross-sections as shown on the drawings as per directions of the Engineer. This shall be achieved by constructing job pillars, level pillars, reference pillars, cross-section points, back-cutting lines (back of formation) and reference lines 1.5 m away from formation lines on hill and valley sides.

In case of hill roads, the actual area to be cleared shall be marked on ground with reference to the trace-cut. The trace-cut shall be about one

metre wide track, cut along the selected alignment to facilitate access to the area for inspection and survey. It may not be possible to cut a trace where the pegged route traverses through unapproachable area and may, therefore, be detoured at such locations by cutting the trace either along the top or bottom periphery of these areas. Reference line (hill side edge) shall be marked on ground at 1.5 m above the edge of proposed back-cutting line of formation width and valley side reference line shall be marked at 1.5 m below the trace cut (formation) level.

**302.3.2. Stripping and storing topsoil** : When so directed by the Engineer, the topsoil (defined as per Clause 301.2.1) existing over the sites of excavation shall be stripped to specified depths and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs, etc. shall be removed along with their roots, with approval of the Engineer.

**302.3.3. Excavation – General** : All excavations shall be carried out in conformity with the directions as given below and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as decided upon beforehand.

While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion and water pollution, etc. and take appropriate drainage measures to keep the site free of water.

The excavation shall be done manually or mechanically using angle dozers (Tracked dozers using angle dozing blades) based on various relevant factors. If done by mechanical means, the work is commenced generally using dozers started at trace-cut level cutting sideways into the hill side. Two-stage construction, i.e., first making 2.5 m track and then widening, shall be done if light vehicle communication is to be established as an urgent requirement. In other cases single stage construction shall be done.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the specified levels/ dimensions on the drawings shall be made good at the cost of the





Contractor with suitable material of characteristics similar to that removed and compacted to the requirements of Clause 301.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when, boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place. Compensatory afforestation cost for damage to trees shall be paid to Forest Department as per relevant Act.

**302.3.3.1. Damage to property caused by excavation and safe disposal of debris** : The excavated debris shall be saved from falling on the side slopes down below the formation to avoid damage to private or Govt. property and damage and erosion of hill slopes and damage of trees. Checkwalls shall be made by the Contractor for this purpose at his own cost.

All excavated material shall be disposed of to safe places by the Contractor as directed by the Engineer. Stacking of debris etc. along any roadside shall not be permitted.

**302.3.3.2. Construction of cross-drainage works and side drains**: Cross-Drainage works like scuppers or small culverts 1 to 2 m span and side drains, shall be constructed along the formation cutting work and will be included in the formation cutting contract with least interference of existing drainage and additional locations for extra drainage required to control the damage of road surface by surface runoff as per drawings or as directed by the Engineer.

**302.3.4. Methods, tools and equipment** : Only such methods, tools and equipment as approved by the Engineer shall be adopted/used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

**302.3.5. Rock excavation** : Rock, when encountered in road excavation, shall be removed upto the formation level or as otherwise indicated on the

drawings. Where, however, unstable shales or other unsuitable materials are encountered at the formation level, these shall be excavated to the extent of 500 mm below the formation level or as otherwise specified. In all cases, the excavation operations shall be so carried out that at no point on cut formation, the rock protrudes above the specified levels. Rocks and large boulders which are likely to cause differential settlement and also local drainage problems should be removed to the extent of 500 mm below the formation level in full formation width including drains and cut through the side drains.

Where excavation is done to levels lower than those specified, the excess excavation shall be made good to the satisfaction of the Engineer.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when pierced by a crowbar shall be removed.

Where blasting is to be resorted to, the same shall be carried out to Clause 304 and all precautions indicated therein observed.

Where presplitting is prescribed to be done for the establishment of a specified slope in rock excavation, the same shall be carried out to Clause 304.

**302.3.6. Excavation in marshy soil** : The excavation of soils from marshes/ swamps shall be carried out as per the programme approved by the Engineer.

Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of backfilling. The method and sequence of excavating and backfilling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits called for on the drawings or as staked by the Engineer, and to the bottom of the marsh/firm support or levels as indicated on the Drawings.

**302.3.7. Excavation of road shoulders for widening of pavement or providing treated shoulders** : In works involving widening of existing pavements or providing treated shoulders, unless otherwise specified, the shoulders shall be removed to their full width and to levels shown on drawings or as indicated by the Engineer. While doing so, care shall be taken to see that no portion of the existing pavement designated for





retention is loosened or disturbed. If the existing pavement gets disturbed or loosened, it shall be dismantled and cut to a regular shape with sides vertical and the disturbed/loosened portion removed completely and relaid as directed by the Engineer, at the cost of the Contractor.

**302.3.8. Excavation for surface drains** : Where the Contract provides for construction of surface/sub-surface drains to Clause 307, excavation for these shall be carried out in proper sequence with other works as approved by the Engineer.

**302.3.9. Slides/slips/subsidence** : If slips, slides or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of the Contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction. If finished slopes slide into the roadway subsequently, such slides shall be removed and paid for at the Contract rate for the class of excavation involved, provided the slides are not due to any negligence on the part of the Contractor. The classification of the debris material from the slips, slides, etc. shall conform to its condition at the time of removal and payment made accordingly, regardless of its condition earlier.

**302.3.10. Drainage of excavated portion** : If water is met within the excavations due to springs, seepage from ponded water, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to discharge the drained water into suitable outlets as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/ restore to the original condition at his own cost or compensate for the damage.

**302.3.11. Disposal of excavated materials** : All the excavated materials shall be the property of the Employer. The material obtained from the excavation of roadway, shoulders, drains, cross-drainage works, etc. shall be used for filling-up of (i) roadway embankment (ii) the existing pits in the right-of-way and (iii) for landscaping of the road as directed by the Engineer, including levelling and spreading with all lifts and lead upto 1000 m and no extra payment shall be made for the same.

All hard materials, such as hard moorum, rubble, etc. not intended for

use as above shall be stacked neatly on specified land as directed by the Engineer with all lifts and lead upto 1000 m.

Unsuitable and surplus material not intended for use within the lead specified above shall also, if necessary, be transported with all lifts and lead beyond initial 1000 m, disposed of or used as directed by the Engineer.

**302.3.12. Backfilling** : Backfilling of masonry/concrete/hume pipe drain excavation shall be done with approved material after concrete/ masonry/hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and/or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be refilled to the original surface making due allowance for settlement, in layers generally not exceeding 150 mm compacted thickness to the required density, using suitable compaction equipment such as mechanical tamper, rammer or plate compactor as directed by the Engineer.

### 302.4. Plying of Construction Traffic

Construction traffic shall not use the cut formation and finished subgrade without the prior permission of the Engineer. Any damage arising out of such use shall be made good by the Contractor at his own expense.

### 302.5. Preservation of Roadside Drains and Structures

The Contractor shall undertake all reasonable precautions for the protection and preservation of any or all existing roadside trees, drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which, in the opinion of the Engineer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect, shall be got approved from the Engineer. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition at his expense. If the Contractor fails to do so, within the required time as directed by the Engineer or if, in the opinion of the Engineer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Engineer shall arrange the replacement/restoration directly through any other agency at the risk and cost of the Contractor after issuing a prior notice to the effect.





### 302.6. Preparation of Cut Formation

The cut formation, which serves as a subgrade, shall be prepared to receive the sub-base/base course as directed by the Engineer.

Where the material in the subgrade (that is within 300 mm from the lowest level of the pavement) has a density less than 100 per cent of Maximum Dry Density as per IS:2720 (Part 7), the same shall be loosened to a depth of 500 mm and compacted in layers in accordance with the requirements of Clause 301.5.5. Any unsuitable material (defined as per Clause 301.2.3) encountered in the subgrade level shall be removed as directed by the Engineer and replaced with suitable material and compacted in accordance with Clause 301.5.5.

In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular base material as directed by the Engineer, laid and compacted in accordance with the respective Specifications for these materials. The unsuitable material shall be disposed of in accordance with Clause 302.3.11. After satisfying the density requirements, the cut formation shall be prepared to receive the sub-base/base course in accordance with Clause 303 to receive the sub-base/base course.

### 302.7. Finishing Operations

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces.

When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock (hard or soft) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in Clause 1802.

Where directed, the topsoil removed earlier and conserved (Clauses 301.5.3 and 302.3.2 shall be spread over cut slopes, where feasible, berms and other disturbed areas. Slopes may be roughened and moistened slightly, prior to the application of topsoil, in order to provide satisfactory bond. The depth of topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 100 mm.

### 302.8. Measurements for Payment

Excavation for roadway shall be measured by taking cross-sections at suitable intervals in the original position before the work starts and after its completion and computing the volumes in cubic metres by the method of average end areas for each class of material encountered. Where it is not feasible to compute volumes by this method because of erratic location of isolated deposits, the volumes shall be computed by other accepted methods.

At the option of the Engineer, the Contractor shall leave depth indicators during excavations of such shape and size and in such positions as directed so as to indicate the original ground level as accurately as possible. The Contractor shall see that these remain intact till the final measurements are taken.

For rock excavation, the overburden shall be removed first so that necessary cross-sections could be taken for measurement. Where cross-sectional measurements could not be taken due to irregular configuration or where the rock is admixed with other classes of materials, the volumes shall be computed on the basis of stacks of excavated rubble after making 35 per cent deduction therefrom. When volumes are calculated in this manner for excavated material other than rock, deduction made will be to the extent of 16 per cent of stacked volumes.

Works involved in the preparation of cut formation shall be measured in units indicated below :

| | |
|---|---|
| (i) Loosening and recompacting the loosened material at subgrade | cu.m |
| (ii) Loosening and removal of unsuitable material and replacing with a suitable material and compacting to required density | cu.m |
| (iii) Preparing rocky subgrade | sq.m |
| (iv) Stripping including storing and reapplication of topsoil | cu.m |
| (v) Disposal of surplus material beyond initial 1000 m lead | cu.m |
| (vi) Setting out | linear m |

### 302.9. Rate

**302.9.1.** The Contract unit rates for the items of roadway and drain excavation shall be payment in full for carrying out the operations required





for the individual items including full compensation for :

(i) transporting the excavated materials and depositing the same on sites of embankments, spoil banks or stacking as directed within all lifts and lead upto 1000 m or as otherwise specified;

(ii) trimming bottoms and slopes of excavation;

(iii) dewatering;

(iv) keeping the work free of water; and

(v) all labour, materials, tools, equipment, safety measures, testing and incidentals necessary to complete the work to Specifications.

Provided, however, where presplitting is prescribed to achieve a specified slope in rock excavation, the same shall be paid for vide Clause 304.3.4.

**302.9.2.** The Contract unit rate for loosening and recompacting the loosened materials at subgrade shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

**302.9.3.** Clauses 301.10 and 302.9.1 shall apply as regards Contract unit rate for item of removal of unsuitable material and replacement with suitable material respectively.

**302.9.4.** The Contract unit rate for item of preparing rocky subgrade as per Clause 302.6 shall be full compensation for providing, laying and compacting granular base material for correcting surface irregularities including all materials, labour and incidentals necessary to complete the work and all leads and lifts.

**302.9.5.** The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts, but leads upto 1000 m, or as otherwise specified.

**302.9.6.** The contract unit rate for disposal of surplus earth from roadway and drain excavation shall be full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the initial lead of 1000 m, or as otherwise specified.

## 303. SUBGRADE CONSTRUCTION

### 303.1. Scope

These Specifications shall apply to the construction of subgrades, in embankments as well as in cut formations, with approved material obtained from roadway and drain excavation, borrow pits or other sources. All subgrades shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Also included are the subgrades improved by way of treatment with lime/ cement as additives.

### 303.2. Definition of Subgrade

Subgrade can be defined as a compacted layer, generally of naturally occurring local soil, assumed to be 300 mm in thickness, just beneath the pavement crust, providing a suitable foundation for the pavement. The subgrade in embankment is compacted in two layers usually to a higher standard than the deeper part of the embankment. In cuttings, the cut formation, which serves as the subgrade, is treated similarly to provide a suitable foundation for the pavement. Where the naturally occurring local subgrade soils have poor engineering properties and low strength in terms of CBR, for example in Black Cotton soil areas, improved subgrades are provided by way of lime/cement treatment or by mechanical stabilisation and other similar techniques.

### 303.3. Materials and General Requirements for Subgrades in Embankment

**303.3.1. Physical requirements** : The materials used for subgrades in embankment shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. The materials considered unsuitable for use in embankments are listed in Clause 301.2.3.

**303.3.2.** Where an expansive clay with acceptable 'free swelling index' value is used as a fill material in embankment, the subgrade and top 500 mm portion of the embankment just below the subgrade shall be non-expansive in nature.

**303.3.3.** The size of the coarse material in the mixture or earth shall ordinarily not exceed 50 mm when placed in the subgrade. However, the Engineer may, at his discretion, permit the use of material coarser than this





also, if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

**303.3.4.** For use in the subgrade, any fill material which yields a maximum laboratory dry unit weight of less than 16.5 kN/m$^3$ when tested as per IS:2720 (Part 7) shall be considered unsuitable.

### 303.3.5. General requirements

**303.3.5.1.** The work shall be so planned that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

**303.3.5.2.** For preparation of foundation Clause 301.4.1 shall apply

**303.3.5.3.** For submission of documents to the Engineer, Clause 301.3.4.2 shall apply except that on the basis of Dry density – Moisture content-CBR relationships for each of the fill materials, the Contractor shall submit to the Engineer, the fill material he intends to use in the subgrade, which should satisfy the design subgrade CBR requirement. For the subgrade, the degree of compaction shall be at least 100 per cent of the maximum laboratory dry density as per IS:2720 (Part 7).

### 303.4. Materials and General Requirements for Subgrades in Cutting

If the road is in full cutting, the roadbed and subgrade shall be in the cut hill formation. If the road is in part-cutting and part filling, the fill shall be generally formed by placing the cut soil itself. In both cases, in the top 500 mm portion of road formation, suitable materials as mentioned in Clause 303.3 shall be used.

### 303.5. Construction Operations

**303.5.1.** For setting out, dewatering and stripping of top soil, Clauses 301.5.1 to 301.5.3 shall apply.

**303.5.2. Compacting ground supporting embankment/subgrade:** Where necessary, the original ground shall be levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve a minimum dry density corresponding to 100 per cent degree of compaction as per IS:2720 (Part 7).

In case where the difference between the subgrade level (top of the subgrade on which the pavement rests) and ground level is less than 0.3m and the ground does not have the needed 100 per cent relative compaction with respect to IS:2720 (Part 7), the ground shall be loosened upto a level 0.3 m below the subgrade level, watered and compacted in layers in accordance with Clause 303.5 to not less than 100 per cent of the dry density as per IS:2720 (Part 7).

Where so directed by the Engineer, any unsuitable material in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction. Embankment or subgrade work shall not proceed until the foundation for embankment/ subgrade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments, especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the types of unsuitable materials listed in Clause 301.2.3, at least 300 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

**303.5.3. Improved subgrade construction** : In case of weak subgrade soils, like, some varieties of highly plastic Black Cotton soils yielding very low soaked CBR values, the subgrades shall be improved in their strength (CBR) values and in their workability characteristics by treatment with additives like lime/lime+cement, etc. For the construction of such improved subgrades, Clauses 403 and 404 shall apply.

**303.5.3.1. Improved subgrade construction in snow bound areas**: Repeated freezing and thawing tends the soluble salts to move up due to capillary action, which causes hardening of bitumen due to chemical action of salts. Also, due to change in volume on freezing and thawing, the salts breakup the pavement in cold regions. Wherever salt concentrations in excess of 0.2 per cent are met with, a capillary cut-off in the form of a 100 mm compacted layer of coarse sand shall be provided in the subgrade to check the upward movement of the moisture from below.

### 303.6. Compaction

**303.6.1.** For compaction, Clause 301.5.5 shall apply except that each





layer of the material in the subgrade shall be thoroughly compacted to at least 100 per cent of Maximum Dry Density as per IS:2720 (Part 7).

### 303.7. Drainage

The surface of the embankment/subgrade at all times during construction shall be maintained at such a cross-fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

### 303.8. Preparation of Cut Formation

The cut formation, which serves as a subgrade, shall be prepared, as per Clause 302.6, to receive the sub-base course as directed by the Engineer.

### 303.9. Subgrade Strength

**303.9.1.** It shall be ensured, prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of the design CBR.

**303.9.2.** Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on undisturbed samples cut out from the compacted subgrade in CBR mould fitted with cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

**303.9.3.** Where the subgrade soil does not possess the requisite engineering properties of a suitable material (Clause 301.2.2) and yields very low CBR values as for example in case of Black Cotton soils, the subgrade soil properties need to be improved by stabilisation techniques using stabilizers such as lime or lime plus cement. Clauses 403 and 404 shall apply in this regard. In such cases, the subgrade strength shall be determined from improved subgrade soil samples in terms of CBR or UCS values, as may be relevant.

### 303.10. Measurements for Payment

**303.10.1.** In case of subgrade in embankment, Clause 301.10 shall apply except that the work will be restricted to 300 mm depth below the finished formation level.

**303.10.2.** In case of subgrades in cut formation, Clause 302.8 shall apply.

### 303.11. Rate

**303.11.1.** In case of subgrades in embankment, Clause 301.11 shall apply except that the work will be restricted to 300 mm depth below the finished formation level.

**303.11.2.** In case of subgrades in cut formation, the rate shall be included in the rate for Earthwork in Cutting (Clause 302.9) and shall not be paid separately.

## 304. ROCK CUTTING

### 304.1. Scope

This Specification provides detailed guidelines on various aspects of blasting operations involved in rock cutting. It also covers 'presplitting', defined as the establishment of a specified excavation slope in rock by the controlled use of explosives and blasting accessories in properly aligned and spaced drill holes. The presplitting technique shall be used for forming rock excavation slopes at locations shown on the plans or as otherwise decided by the Engineer.

### 304.2. Guidelines on Blasting Operations

**304.2.1. General** : Blasting shall be carried out in a manner that completes the excavation to the lines indicated in drawings, with the least disturbance to adjacent material. It shall be done only with the written permission of the Engineer. All the statutory laws, regulations, rules, etc. pertaining to the acquisition, transport, storage, handling and use of explosive shall be strictly followed. A Note on the Safety Aspects is given at ***Annexure-300.2.***

The Contractor may adopt any method or methods of blasting consistent with the safety and job requirements. Prior to starting any phase of the operation, the Contractor shall provide information describing pertinent blasting procedures, dimensions and notes.

The magazine for the storage of explosives shall be built to the designs and specifications of the Explosives Department concerned and located at the approved site. No unauthorized person shall be admitted into the magazine which, when not in use, shall be kept securely locked. No





matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be hung in the lobby of the magazine:

(a) A copy of the relevant rules regarding safe storage both in English and in the language with which the workers concerned are familiar.

(b) A statement of up-to-date stock in the magazine.

(c) A certificate showing the last date of testing of the lightning conductor.

(d) A notice that smoking is strictly prohibited.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided to the satisfaction of the Engineer and in general not closer than 300 m from the road or from any building or camping area or place of human occupancy. In addition to these, the Contractor shall also observe the following instructions and any further additional instructions which may be given by the Engineer and shall be responsible for damage to property and any accident which may occur to workmen or the public on account of any operations connected with the storage, handling or use of explosives and blasting. The Engineer shall frequently check the Contractor's compliance with these precautions.

**304.2.2. Materials, tools and equipment** : All the materials, tools and equipment used for blasting operations shall be of approved type. The Engineer may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a length being cut as will permit sufficient time to the firer to reach safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators, fuses, etc. shall be fresh and not damaged due to dampness, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed from the site immediately.

**304.2.3. Personnel** : The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

**304.2.4. Blasting operations** : The blasting shall be carried out

during fixed hours of the day, preferably during the mid-day luncheon hour or at the close of the work as ordered in writing by the Engineer. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury. In advance of any blasting work within 50 m of any railway track or structures, the Contractor shall notify the concerned Railway Authority of the location, date, time and approximate duration of such blasting operations.

Red danger flags shall be displayed prominently in all directions during the blasting operations. The flags shall be planted 200 m from the blasting site in all directions. People, except those who actually light the fuse, shall be prohibited from entering this area, and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning siren being sounded for the purpose.

The charge holes shall be drilled to required depths and at suitable places. Blasting should be as light as possible, consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping material which shall be tamped lightly but firmly.

When blasting is done with dynamite and other high explosives, dynamite cartridges shall be prepared by inserting the square cut end of a fuse into the detonator and finishing it with nippers at the open end, the detonator gently pushed into the primer leaving 1/3rd of the copper tube exposed outside. The paper of the cartridge shall then be closed up and securely bound with wire or twine. The primer shall be housed into the explosive. Boreholes shall be of such size that the cartridge can easily go down. The holes shall be cleared of all debris and explosive inserted. The space of about 200 mm above the charge shall then be gently filled with





dry clay, pressed home and the rest of the tamping formed of any convenient material gently packed with a wooden rammer.

At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a siren in a recognised manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man-in-charge only. The man-in-charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the work site.

After blasting operations, the Contractor shall compact the loose residual material below subgrade and replace the material removed below subgrade with suitable material.

**304.2.5. Misfire** : In case of misfire, the following procedure shall be observed:

(i) Sufficient time shall be allowed to account for the delayed blast. The man-in-charge shall inspect all the charges and determine the missed charge.

(ii) If it is the blasting powder charge, it shall be completely flooded with water. A new hole shall be drilled at about 450 mm from the old hole and fired. This should blast the old charge. Should it not blast the old charge, the procedure shall be repeated till the old charge is blasted.

(iii) In case of charges of gelignite, dynamite, etc., the man-in-charge shall gently remove the tamping and the primer with the detonator. A fresh detonator and primer shall then be used to blast the charge. Alternatively, the hole may be cleared of 300 mm of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled 150 mm away and parallel to it. This hole shall then be charged and fired when the misfired hole should explode at the same time. The man-in-charge shall at once report to the Contractor's office and the Engineer all cases of misfire, the cause of the same and what steps were taken in connection therewith.

If a misfire has been found to be due to defective detonator or dynamite, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer for inspection to ascertain whether all the remaining materials in the box are also defective.

**304.2.6. Account** : A careful and day-to-day account of the explosive

shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer at all times.

### 304.3. Presplitting Rock Excavation Slopes

**304.3.1. Construction operations** : Prior to starting operations for presplitting, the Contractor shall furnish the Engineer a plan outlining the position of all drill holes, depth of drilling, type of explosives to be used, loading pattern and sequence of firing. The drilling and blasting plan is for record purposes only and will not absolve the Contractor of his responsibility for using proper drilling and blasting procedures. Controlled blasting shall begin with a short test section of a length approved by the Engineer. The test section shall be presplit, production drilled and blasted and sufficient material excavated whereby the Engineer can determine if the Contractor's methods have produced an acceptable slope.

All overburden soil and weathered rock along the top of the excavation for a distance of about 5 to 15 m beyond the drilling limits, or to the end of the excavation, as decided by the Engineer shall be removed before drilling the presplitting holes. Particular care and attention shall be directed to the beginning and end of excavations to ensure complete removal of all overburden soil and weathered rock and to expose fresh rock to an elevation equal to the bottom of the adjacent lift of the presplitting holes being drilled.

Slope holes for presplitting shall be drilled along the line of the planned slope within the specified tolerances. The drill holes shall be not less than 60 mm nor more than 75 mm in diameter. Drilling operations shall be controlled by the use of proper equipment and technique to ensure that no hole shall deviate from the plane of the planned slope by more than 300 mm nor shall any hole deviate from being parallel to an adjacent hole by more than two-third of the planned horizontal spacing between holes.

The length of presplit holes shall not exceed 900 mm on centres and shall be adjusted to result in a uniform shear face between holes.

Auxiliary drill holes along the presplit line, not loaded or stemmed, may be ordered by the Engineer. Except for spacing, auxiliary drill holes shall conform to the provisions for presplit holes.

The line of production holes shall be placed inside the presplit lines in such a manner as to avoid damage to the presplit face.





If necessary, to reduce shatter and overbreak of the presplit surface, the first line of the production holes shall be drilled parallel to the slope line at the top of the cut and at each bench level thereafter.

Any blasting technique, which results in damage to the presplit surface, shall be immediately discontinued.

No portion of any production hole shall be drilled within 2.5 m of a presplit plane except as approved by the Engineer. The bottom of the production holes shall not be lower than the bottom of the presplit holes.

A maximum offset of 600 mm will be permitted for a construction working bench at the bottom of each lift for use in drilling the next lower presplitting pattern. The drilling operations shall be adjusted to compensate for drift of previous levels and for the offset at the start of new levels to maintain the specified slope plane.

The maximum diameter of explosives used in presplit holes shall not be greater than one-half the diameter of the presplit hole.

Only standard cartridge explosives prepared and packaged by explosive manufacturing firms shall be used in presplit holes. These shall be fired as recommended by the manufacturer. Ammonium nitrate composition blasting agents will not be permitted in presplitting operations.

Stemming may be required to achieve a satisfactory presplit face. Stemming material shall be dry free-running material all of which passes 11.2 mm sieve and 90 per cent of which is retained on 2.80 mm sieve. Stemmed presplit holes shall be completely filled to the collar.

All charges in each presplitting pattern shall be detonated simultaneously.

**304.3.2. Tolerances** : The presplit face shall not deviate more than 300 mm from the plane passing through adjacent drill holes, except where the character of the rock is such that, as determined by the Engineer, irregularities are unavoidable. When completed, the average plane of the slopes shall conform to the slopes indicated on the plans and no point on the completed slopes shall vary from the designated slopes by more than 300 mm. These tolerances shall be measured perpendicular to the plane of the slope. In no case shall any portion of the slope encroach on the side drains.

As long as equally satisfactory presplit slopes are obtained, then either the slope face may be presplit before drilling for production blasting or presplitting the slope face and production blasting may be done at the same time, provided that the presplitting drill holes are fired with zero delay and the production holes are delayed starting at the row of holes farthest from the slope and progressing in steps to the row of holes nearest the presplit line, which row shall be delayed at least 50 milliseconds. In either case, the presplitting holes shall extend either to the end of the excavation or for a distance of not less than 15 m beyond the limits of the production holes to be detonated.

**304.3.3. Measurements for payment** : The area of presplitting to be paid for will be measured as square metres of acceptable presplit slope surface.

**304.3.4. Rate** : The Contract unit rate for presplitting work shall be payment in full for carrying out the required operations for obtaining acceptable presplit slope surfaces. The quantity of rock excavated through the production/presplit holes shall be paid for as per Clause 302.9.1.

## 305. EXCAVATION FOR STRUCTURES

### 305.1. Scope

This work consists of excavating for the construction of foundations for cross-drainage structures, retaining walls, headwalls and other similar structures, in accordance with the requirements of these Specifications and the lines and dimensions shown on the drawings or as directed by the Engineer. The work shall include construction of the necessary sheeting, bracing, shoring, draining and pumping, removal of all logs, stumps and other deleterious matter and obstructions necessary for placing the foundations, trimming bottoms of excavations, backfilling and clearing up the site.

### 305.2. Classification of Excavation

The classification of all materials involved in excavation shall be as per Clause 302.2.2.1 and ***Annexure-300.1***.

### 305.3. Construction Operations

**305.3.1. Setting out** : The site shall be cleared as per Clause 201 and the limits of excavation shall be set out true to lines, curves and slopes to Clause 108.





**305.3.2. Width of excavation** : The width of excavation shall be the width of the lowest step of the footing and where the nature of soil permits, the sides shall be left vertical. However, if the nature of soils or depth of the trench and season do not permit vertical sides, the Contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

**305.3.3. Depth of excavation** : The depth of excavation shall be as shown on the drawings, unless the type of material encountered is such as to require changes in which case the depth shall be as ordered by the Engineer. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1:2 from the bottom of the excavation.

**305.3.4. Blasting operations** : Where blasting is to be resorted to, the same shall be carried out in accordance with Clause 304 and all precautions as given therein shall be observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris, etc. shall be taken to prevent any damage.

**305.3.5. Dewatering** : Where water is met with in excavation due to stream flow, seepage, rain or other reasons, the Contractor shall take adequate measures such as pumping, constructing diversion channels, bunds and other necessary works to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the works. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

**305.3.6. Foundation preparation** : The bottom of the foundation shall be levelled both longitudinally and transversally or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In case the excavation has been made deeper than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation at the cost of the Contractor; ordinary filling shall not be used for the purpose.

When rock or other hard rock stratum is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams and crevices shall be cleaned and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete (1:3:6 nominal mix) upto the top level of rock. If the depth of fill required is more than 1.5 m above the top of the footing, filling upto 1.5 m above top of the footing shall be done with lean concrete (1:3:6 nominal mix) followed by boulders grouted with cement.

**305.3.7. Slips/slip-outs** : If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

**305.3.8. Public safety** : Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS:3764.

**305.3.9. Backfilling** : Backfilling shall be done with approved material after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface in layers not exceeding 150 mm compacted thickness. The compaction shall be done with the help of suitable equipment such as mechanical tamper, rammer, plate vibrator, etc. after necessary watering, so as to achieve a density not less than the field density before excavation.

**305.3.10. Disposal of surplus excavated materials** : Clause 302.3.11 shall apply.





## 305.4. Measurements for Payment

Excavation for structures shall be measured in cubic metres for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer. Excavation over increased width, cutting of slopes, shoring, shuttering and planking shall be deemed as convenience for the Contractor in executing the work and shall not be measured and paid for separately.

Preparation of rock foundation shall be measured in square metres. Foundation sealing, dewatering, including pumping shall be deemed to be incidental to the work unless separate provision is made for in the Contract. In the latter case, payment shall be on lumpsum basis as provided in the Bill of Quantities.

## 305.5. Rate

**305.5.1.** The Contract unit rate for the items of excavation for structures shall be payment in full for carrying out the required operations including full compensation for :

(i) setting out;

(ii) construction of necessary sheeting, shoring and bracing and their subsequent removal;

(iii) removal of all logs, stumps, grubs and other deleterious matter and obstructions, for placing the foundation including trimming of bottoms of excavations;

(iv) foundation sealing, dewatering including pumping, when no separate provision for it is made in the Contract;

(v) backfilling, clearing up the site and disposal of all surplus material within all lifts and leads upto 1000 m or as otherwise specified; and

(vi) all labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specifications.

**305.5.2.** The Contract unit rate for preparation of rock foundation shall be full compensation for cutting, trimming and cleaning the foundation surface and filling/sealing of all seams with cement grout or mortar including all materials, labour and incidentals required for completing the work.

**305.5.3.** The Contract unit rate for transporting materials from the excavation for structures shall be full compensation for all labour, equipment,

tools and incidentals necessary on account of the additional haul or transportation involved beyond the initial lead of 1000 m.

## 306. FLYASH EMBANKMENT CONSTRUCTION

### 306.1. Scope

This Specification shall apply to the construction of flyash embankments, with an appropriate soil cover, in accordance with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 306.2. Materials for Construction

The materials to be used in flyash embankment construction namely flyash and soil in the soil cover, shall be characterized to determine their physical and engineering characteristics and the test results made available to the Engineer for approval.

**306.2.1. Flyash** : The following information on the flyash to be used in embankment construction shall be made available for the Engineer's approval :

(i) Particle size analysis of the material as per wet sieve analysis

(ii) Maximum Dry Density and Optimum Moisture Content as per IS:2720 (Part 7) alongwith the graph of dry density plotted against moisture content for this test, which shall form the basis for compaction.

**306.2.2. Soil** : The soil to be used as soil cover to the flyash embankment shall satisfy all the requirements of a suitable material for embankment construction as per Clause 301.3.

### 306.3. Preparing Foundation for Embankment

Clause 301.4 shall apply.

### 306.4. Construction Operations

**306.4.1. Setting out** : Clause 301.5.1 shall apply.

**306.4.2. Dewatering** : Clause 301.5.2 shall apply.

**306.4.3. Stripping of topsoil** : Clause 301.5.3 shall apply.





**306.4.4. Handling flyash** : The flyash from hoppers or silos shall be conditioned with water at the power plant to prevent dusting enroute and causing environmental pollution. Flyash shall be delivered to the site in covered dump trucks to minimize loss of moisture and dusting. Stockpiling of flyash at the construction site shall be avoided. In case temporary stockpiling at site becomes inevitable, precautions shall be taken to prevent dusting by spraying water on stockpiles at regular intervals or the surface of the flyash stockpile shall be covered with tarpaulins or a thin layer of soil or other granular material not subject to dusting, as directed by the Engineer. Traffic movements shall be restricted to those areas which are kept moist, to prevent the dust nuisance.

### 306.4.5. Spreading, moisture control and compaction

**306.4.5.1. Spreading** : The side soil cover, of required width shall be provided, along with the flyash core, and mechanically compacted as the embankment progresses upwards; the addition of side cover subsequent to the construction of the flyash core shall not be permitted. The fill material shall preferably be spread by mechanical means, finished by the motor grader, so as to achieve the specified slope and grade. For small jobs, manual methods may be permitted by the Engineer. When compaction is to be carried out using a static roller of 80 to 100 kN weight, the loose layer thickness shall not exceed 200 mm. However, where vibratory rollers of dead weight 80 to 100 kN are to be used, loose layer thickness upto 400 mm can be adopted if site trials show satisfactory compaction. For small vibratory rollers of 10 to 15 kN dead weight, the loose layer thickness shall be 100-150 mm, while for medium weight vibratory rollers, with dead weights in the range 60 to 80 kN, the loose layer thickness shall be about 250 mm.

The cover soil and flyash shall be laid simultaneously before compaction, to ensure confinement of flyash. Clods in cover soil shall be broken to have a maximum size of 50 mm.

**306.4.5.2. Moisture control** : The moisture content of the fill material shall be checked at the site of placement prior to the commencement of compaction. Normally, the moisture content of flyash laid for compaction shall be within ± 2 per cent of the Optimum Moisture Content when determined as per IS:2720 (Part 7). However, the moisture content limits can be varied by the Engineer, depending on the weather conditions prevailing at the site, provided specified compaction is achieved as

determined by actual site trials. Moisture content of the cover soil shall be maintained at its Optimum Moisture Content.

Where water is required to be added to the fill material, it shall be sprinkled from a Water Bowser fitted with a sprinkler capable of applying water uniformly without flooding. The water shall be mixed thoroughly by blading, discing or harrowing or by manual means as directed by the Engineer, until uniform moisture content is obtained throughout the depth of the layer. If the material delivered to the construction site is too wet, it shall be dried by aeration and exposure to the sun, till it is acceptable for compaction.

**306.4.5.3. Compaction** : Flyash shall be compacted using static or vibratory rollers, as directed by the Engineer. Regardless of the equipment, flyash must be compacted as early as possible after spreading. The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. Each layer of flyash shall be thoroughly compacted to the specified density. When vibratory roller is adopted for compaction, two passes without vibration followed by 5 to 8 passes with vibration shall normally be sufficient to compact each layer.

The compaction of flyash core and earth cover on the sides shall proceed simultaneously. Each compacted layer shall be finished parallel to the final cross-section of the embankment. The end product specifications for the construction of flyash embankments shall be as under:

- Minimum dry density after compaction as percentage of maimum dry density determined as per IS:2720 (Part 7) 98 per cent
- Minimum dry density after compaction when used in bridge abutments for embankment length equal to 1.5 times the height of the embankment 100 per cent

Subsequent layers shall be placed only after the finished layer has been tested for its density requirements. The Contractor shall maintain a record of all such tests. When density measurements reveal any soft areas in the embankment, further compaction shall be carried out as directed by the Engineer. Inspite of that, if the specified degree of compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, moisture content brought to permissible limits and recompacted to the required density. The embankment shall be constructed





evenly over full width and the Contractor shall control and direct construction plant or other vehicular traffic uniformly across the width. Damage by the construction plant or other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as it had before it was damaged. Whenever embankment construction is to be taken-up against the face of natural slope or sloping earth works face including embankments, cuttings and excavations which are steeper than 1:4, such faces shall be benched immediately before placing the subsequent fill.

### 306.5. Soil Subgrade

On the top of the flyash embankment, at least 500 mm thick earth embankment shall be provided out of which top 300 mm thick shall be subgrade as per Clause 303 of these Specifications.

### 306.6. Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, verges and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the drawing or as directed by the Engineer. Both upper and lower ends of side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain. For the provision of turfing, topsoil shall be sufficient to sustain plant growth, the usual thickness being around 100 mm. Slopes shall be roughened and moistened slightly before the application of topsoil in order to provide satisfactory bond. Embankments in flood prone areas shall be protected by stone pitching.

### 306.7. Settlement Period

Clause 301.7 shall apply.

### 306.8. Plying of Traffic

Clause 301.8 shall apply.

### 306.9. Surface Finish and Quality Control of Work

Clause 301.9 shall apply.

### 306.10. Measurements for Payment

All provisions of Clause 301.10 shall apply.

### 306.11. Rate

All provisions of Clause 301.11 shall apply and include provision of soil cover.

## 307. SURFACE DRAINS

### 307.1. Scope

This work shall consist of constructing surface drains in accordance with the requirements of these specifications and to the lines, grades, dimensions and other particulars shown on the drawings or as directed by the Engineer. Schedule of work shall be so arranged that the drains are completed in proper sequence with road works to ensure that no excavation of the completed road works is necessary subsequently or any damage is caused to these works due to lack of drainage.

### 307.2. Surface Drains

Surface drains shall be excavated to the specified lines, grades, levels and dimensions to the requirements of Clause 302. The excavated material shall be removed from the area adjoining the drains and if found suitable, utilised in embankment/subgrade construction. All unusable material shall be disposed of as directed.

The excavated bed and sides of the drains shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes.

Where so indicated, drains shall be turfed or lined with suitable materials in accordance with details shown on the drawings.

All works on drain construction shall be planned and executed in proper sequence with other works as approved by the Engineer, with a view to ensuring adequate drainage for the area and minimizing erosion/ sedimentation.

### 307.3. Measurements for Payment

Measurement for surface drains shall be per running metre length of the drain. Disposal of surplus material beyond 1000 m shall be measured in cubic metres.

### 307.4. Rate

The Contract unit rates for surface drains shall be payment in full for





all items, such as, excavation, dressing the sides and bottom; providing lining, turfing, pitching, masonry, concrete and plastering, etc. including full compensation for all materials, labour, tools and other incidentals to complete the work as shown on the drawings with all leads and lifts except for removal of unsuitable material for which the lead shall be 1000 m. Provision of inlets, outlets, etc. whenever required shall be incidental to construction of drain. The Contract unit rate for disposal of surplus and unsuitable material beyond the initial 1000 m lead shall be in accordance with Clause 305.5.3.

## 308. SOIL EROSION AND SEDIMENTATION CONTROL

### 308.1. Scope

This work shall consist of measures as shown on plans or as directed by the Engineer to control soil erosion, sedimentation and water pollution, through use of berms, mulches, grasses, slope drains and other devices.

### 308.2. Materials

All materials shall meet commercial grade standards and shall be approved by the Engineer before being used in the work.

### 308.3. Construction Operations

Prior to the start of the relevant construction, the Contractor shall submit to the Engineer for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/subgrade construction, cross-drainage structures, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion/sedimentation control on borrow pits and his plan for disposal of materials. Work shall not be started until the erosion/ sedimentation control schedules and methods of operations for the applicable construction have been approved by the Engineer.

The surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations shall be limited to the extent practicable. The Contractor may be directed to provide immediate permanent or temporary erosion and sedimentation control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other water courses, lakes, reservoirs, etc. Such work may involve the construction of temporary berms, slope drains and use of

temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Cut and fill slopes shall be seeded and turfed as required on the plans.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion and pollution control measures will be used to control the phenomenon of erosion and pollution that may develop during normal construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the project.

Under no conditions shall a large surface area of erodible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the Engineer.

The Engineer may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion/ sedimentation control measures shall be taken immediately to the extent feasible and justified.

In the event temporary erosion, sedimentation and pollution control measures become necessary due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work as scheduled or ordered by the Engineer, these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the Engineer.

Temporary erosion, sedimentation and pollution control may include construction work outside the right-of-way where such work is necessary as a result of road construction such as borrow pit operations.

The temporary erosion, sedimentation and pollution control features installed by the Contractor shall be acceptably maintained by him till these are needed, unless otherwise agreed by the Engineer.





### 308.4. Measurements for Payment

The soil erosion, sedimentation and pollution control works shall be measured in terms of units specified in the Bill of Quantities for the respective items.

### 308.5. Rate

The Contract unit rate for different items of soil erosion, sedimentation and pollution control works shall be payment in full for carrying out all required operations including full compensation for all labour, tools, equipment and incidentals to complete the works to the Specifications.

## 309. TURFING WITH SODS

### 309.1. Scope

This work shall consist of furnishing and laying of the live sod of perennial turf forming grass on embankment slopes, verges (earthen shoulders) or other locations shown on the drawings or as directed by the Engineer. Unless otherwise specified, the work shall be taken up as soon as possible following construction of the embankment, provided the season is favourable for establishment of the sod.

### 309.2. Materials

The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be used, and shall be practically free from weeds or other undesirable matter. At the time the sod is cut, the grass on the sod shall have a length of approximately 50 mm and the sod shall have been freed of debris.

Thickness of the sod shall be as uniform as possible, with some 50-80 mm or so of soil covering the grass roots depending on the nature of the sod, so that practically all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width, not less than about 250 mm x 300 mm in size but not so large that it is inconvenient to handle and transport these without damage. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality and prevent the dropping of the soil in handling.

### 309.3. Construction Operations

**309.3.1. Preparation of the earth bed** : The area to be sodded shall have been previously constructed to the required slope and cross-section. Soil on the area shall be loosened, freed of all stones larger than 50 mm size, sticks, stumps and any undesirable foreign matter, and brought to a reasonably fine granular texture to a depth of not less than 25 mm for receiving the sod.

Where required, topsoil shall be spread over the slopes. Prior to placing the topsoil, the slopes shall be scarified to a depth which, after settlement, will provide the required nominal depth shown on the plans. Spreading shall not be done when the ground is excessively wet.

Following soil preparation and top soiling, where required, fertilizer and ground limestone when specified shall be spread uniformly at the rate indicated on the plans. After spreading, the materials are incorporated in the soil by discing or other means to the depths shown on the plans.

**309.3.2. Placing the sods** : The prepared sod bed shall be moistened to the loosened depth, if not already sufficiently moist, and the sod shall be placed thereon within approximately 24 hours after the same had been cut. Each sod strip shall be laid edge to edge and such that the joints caused by abutting ends are staggered. Every strip, after it is snugly placed against the strips already in position, shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil.

On side slopes steeper than 2 (horizontal) to 1 (vertical), the laying of sods shall be started from bottom upwards. At points where water may flow over a sodded area, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth placed over this followed by its thorough compaction.

**309.3.3. Staking the sods** : Where the side slope is 2 (horizontal) to 1 (vertical) or steeper and the distance along the slope is more than 2 m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000 mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

**309.3.4. Top dressing** : After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign





material. Thereafter, a thin layer of topsoil shall be scattered over the surface of top dressing and the area thoroughly moistened by sprinkling with water.

**309.3.5. Watering and maintenance** : The sods shall be watered by the Contractor for a period of at least four weeks after laying. Watering shall be so done as to avoid erosion and prevent damage to sodded areas by wheels of water tanks.

The Contractor shall erect necessary warning signs and barriers, repair or replace sodded areas failing to show uniform growth of grass or damaged by his operations and shall otherwise maintain the sod at his cost until final acceptance.

### 309.4. Measurements for Payment

Turfing with sods shall be measured as finished work in square metres.

### 309.5. Rate

The Contract unit rate for turfing with sods shall mean payment in full for carrying out all the required operations explained above including compensation for

(i) furnishing all the materials to be incorporated in the Works with all leads and lifts; and

(ii) all labour, tools, equipments and incidentals to complete the work in accordance with these Specifications.

The Contract unit rate for application of topsoil shall be as per Clause 302.9.5.

## 310. SEEDING AND MULCHING

### 310.1. Scope

This shall consist of preparing slopes, placing topsoil, furnishing all seeds, commercial or organic fertilizers and mulching materials, providing jute netting and placing and incorporating the same on embankment slopes or other locations designated by the Engineer or shown in the Contract documents.

### 310.2. Materials

(a) **Seeds**: The seeds shall be of approved quality and type suitable for the soil on which these are to be applied, and shall have acceptable purity and

germination to requirements set down by the Engineer.

Fertilizer shall consist of standard commercial materials and conform to the grade specified. Organic manure shall be fully putrefied organic matter, such as, cow dung.

Mulching materials shall consist of straw, hay, wood shavings or sawdust, and shall be delivered dry. They shall be reasonably free of weed seed and such foreign materials as may detract from their effectiveness as a mulch or be injurious to the plant growth.

(b) **Topsoil**: Topsoil shall not be obtained from an area known to have noxious weeds growing in it. If treated with herbicides or sterilents, it shall be got tested by appropriate agricultural authority to determine the residual in the soil. Topsoil shall not contain less than 2 per cent and more than 12 per cent organic matter.

(c) **Bituminous Emulsion**: A suitable grade of bituminous cutback or emulsion used as a tie down for mulch shall be as described in the Contract document or as desired by the Engineer. Emulsified bitumen shall not contain any solvent or diluting agent toxic to plant life.

(d) **Netting**: Jute netting shall be undyed jute yarn woven into a uniform open weave with approximate 25 mm square openings.

Geonetting shall be made of uniformly extruded rectangular mesh having mesh opening of 20 mm x 20 mm. The colour may be black or green. It shall weigh not less than 3.8 kg per 1000 sq.m.

## 310.3. Seeding Operations

**310.3.1. Seed-bed preparation** : The area to be seeded shall be brought to the required slope and cross-section by filling, reshaping eroded areas and refinishing slopes, medians, etc. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans, unless otherwise approved by the Engineer. The seed-bed preparation shall consist of eliminating all live plants by suitable means using agricultural implements. All stones 150 mm in smallest dimension and larger shall be removed. The soil shall be excavated on the contour to a depth of 100 mm. All clods larger than 25 mm in diameter shall be crushed and packed. Where necessary, water shall then be applied. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be by slope compactor, cleated tractor or similar equipment approved by the Engineer. Equipment shall be so designed and constructed as to produce a uniform rough textured surface ready for seeding and mulching and which will bond the topsoil to the underlying material. The entire area





shall be covered by a minimum of 4 passes or 2 round trips of the roller or approved equipment.

**310.3.2. Fertilizer application** : Fertilizer to the required quantities shall be spread and thoroughly incorporated into the soil surface as a part of the seed-bed preparation.

**310.3.3. Planting of seeds** : All seeds shall be planted uniformly at the approved rate. Immediately after sowing, the area shall be raked, dragged or otherwise treated so as to cover the seeds to a depth of 6 mm.

The operation of seed sowing shall not be performed when the ground is muddy or when the soil or weather conditions would otherwise prevent proper soil preparation and subsequent operations.

**310.3.4. Soil moisture and watering requirements** : Soil-moisture shall exist throughout the zone from 25 mm to at least 125 mm below the surface at the time of planting.

Watering of the seeded areas shall be carried out as determined by the Engineer.

## 310.4. Mulching, Applying Bituminous Emulsion and Jute Netting/Geonetting

Within 24 hours of seeding, mulching material mixed with organic manure shall be placed so as to form a continuous, unbroken cover of approximate uniform thickness of 25 mm using an acceptable mechanical blower. Mulching material shall be held in place and made resistant to being blown away by suitable means approved by the Engineer. When called for in the Contract documents, mulch material shall be anchored in place with bituminous emulsion applied at the rate of 2300 litres per hectare. Any mulch disturbed or displaced following application shall be removed, reseeded and remulched as specified. Jute netting/Geonetting shall be unrolled and placed parallel to the flow of water immediately following the bringing, to finished grade, the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they shall overlap a minimum of 100 mm. Jute netting/Geonetting shall be held in place by approved wire staples, pins, spikes or wooden stakes driven vertically into the soil.

### 310.5. Maintenance

The Contractor shall maintain all seeded and mulched areas until final acceptance. Maintenance shall include protection of traffic by approved warning signs or barricades and repairing any areas damaged following the seeding and mulching operations. If mulched areas become damaged, the area shall be reshaped and then seeded and mulched again as originally specified.

### 310.6. Measurements for Payment

Seeding and mulching shall be measured as finished work in square metres.

### 310.7. Rate

The Contract unit rate for seeding and mulching shall be payment in full for carrying out all the required operations including full compensation for all materials, labour, tools and incidentals.





*Annexure-300.1*

## CLASSIFICATION OF EXCAVATED MATERIAL

**(a) Soil**

This shall comprise topsoil, turf, sand, silt, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick, shade and/or shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having dimension in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

**(b) Ordinary Rock (not requiring blasting)**

This shall include:

(i) rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone, etc. which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting;

(ii) macadam surfaces such as water bound and bitumen/tar bound; soling of roads, paths, etc. and hard core; compact moorum or stabilised soil requiring grafting tool or pick or both and shovel, closely applied; gravel and cobble stone having maximum dimension in any one direction between 75 mm and 300 mm;

(iii) lime concrete, stone masonry in lime mortar and brick in lime/cement mortar below ground level, reinforced cement concrete which may be broken-up with crow bars or picks and stone masonry in cement mortar below ground level; and

(iv) boulders which do not require blasting having maximum dimension in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

**(c) Hard Rock (requiring blasting)**

This shall comprise :

(i) any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required;

(ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

(iii) boulders requiring blasting.

**(d) Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

**(e) Marshy Soil**

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.





*Annexure-300.2*

## A NOTE ON SAFETY ASPECTS IN BLASTING
(Clause 304 : Rock Cutting)

Safety in blasting is mostly commonsense with a knowledge of the dangers associated with explosives if misused. Explosives have a wide variety of uses and the development of an accident-free routine is complicated by the large number of wide-spread centres of use.

Because of the large potential energy content of explosives and the damage which can result from an accidental detonation, the need for caution in their use must be obvious. The majority of high explosives require a severe shock before detonating and consequently can be handled with care. Detonators are most susceptible to accidental initiation from shock or fire although this tendency has been reduced in recent years. Fire will probably cause detonators to explode and high explosive to burn and possibly explode.

### 1. SUPERVISION

With any safety programme both training and supervision are vital. The training should impart a knowledge of the various explosives and accessories, their use in practice and the routine to be adopted for their safe use. Supervision must follow training to ensure that correct procedures are used and safety requirements are strictly enforced. A suitably trained shot-firer must be employed for all blasting.

### 2. PRECAUTIONS

This will briefly outline the fundamental requirements for the use of explosives.

#### 2.1. Storage

This is important not only from the aspect of safety to the general public but also to prevent deterioration of the materials due to heat, cold or moisture. Explosives must be stored in approved magazines which must be securely locked except when removing or replacing stocks. Amongst the storage requirements are :

2.1.1. A magazine keeper must be appointed and he is responsible for the upkeep and control of the magazine and contents.

2.1.2. A magazine book must be kept in the magazine to enable a check to be made on the issue and receipt of high explosives and detonators.

2.1.3. High explosives and detonators are not to be stored together.

2.1.4. The magazine must be kept clean, dry and cool inside and the area for 10 m around must be cleared of vegetation and rubbish at all times. The magazines must be efficiently marked.

2.1.5. All explosives not being used must be kept in a magazine. Many accidents have resulted from unauthorized people (including children) picking-up and misusing explosives. Explosives (including detonators) are not to be carried in clothing or left lying about camp sites, job sites or in vehicles.

2.1.6. Ammonium nitrate does not have to be stored in a magazine but it must be protected from heat and moisture.

2.1.7. For the storage of high explosive like Ammonium Nitrate + Fuel Oil (AN/FO), when required, permission must be obtained from the Chief Inspector of Explosives.

## 2.2. Transport

The transport of explosives between the magazine and the job site is a necessary part of most excavation work and must be carried out in a safe manner.

2.2.1. The vehicle must be in sound working condition and effectively marked.

2.2.2. A fire extinguisher (in good working order) must be carried.

2.2.3. High explosives and detonators are not to be carried in the same receptacle.

2.2.4. No smoking is allowed.

When transporting explosives around the job site the following requirements are necessary.

2.2.5. Detonators and high explosive must be carried in separate receptacles suitably marked.





2.2.6. Any excess explosives are to be replaced in their respective magazines (in the case of AN/FO it is to be destroyed if permission for storage has not been obtained).

2.2.7. Explosives must not be stored or charged within 15 m of drilling and at all times it is advisable to remove all drilling equipment from the site before commencing charging.

## 2.3. Use

2.3.1. No smoking is allowed while handling or using explosives. This applies particularly to the AN/FO blasting agents which are susceptible to fire.

2.3.2. In safety fuse work a suitable crimping tool must be used when attaching the detonator to the fuse. The fuse must be inspected to ensure that it is not damaged or deteriorated. Capped fuses (i.e., safety fuse plus detonator) should be coated with grease as a water-proofing agent.

Safety fuse should be ignited with a fuse igniter and a minimum length of 2 m used for primary blasting and 1.5 m for secondary blasting (or "popping"). In the event of a misfire with safety fuse one hour must elapse before any person can enter the firing area.

2.3.3. With electric firing the wired circuit must be tested for faulty connections, earthed or broken wires. This is done with a circuit tester. Any connections put down the hole must be covered with insulating tape to prevent current leakage.

Exploders must be tested before use to ensure that they can provide adequate current for the circuit. A fusion tester is used for the condenser type of exploder and a rheostat tester for the plunger type.

Electric firing circuits must not be wired up during thunderstorms or near to radio transmitters (including two-way radio sets). In the event of a misfire with electric detonators 15 minutes must elapse before any person can enter the firing area.

2.3.4. Detonating fuse is an explosive but is relatively safe in handling and storage. It must be cut with a sharp instrument.

2.3.5. AN/FO blasting agents are powerful explosives but are usually safe and easy to use. They are susceptible to fire or water and their use in wet holes will probably produce misfires.

2.3.6. After holes are charged, access to the area should be properly restricted and certainly no member of the public should be allowed near the holes.

2.3.7. Hard hats must be worn by all personnel associated with the blasting.

2.3.8. An acoustic warning device (e.g., a siren) should be used specifically as a warning for blasting.

2.3.9. Suitable signs should be placed where they can be readily seen by anybody approaching.

## 2.4. Misfires

Misfires are apt to be both dangerous and expensive.

They can usually be avoided by adequate testing and care but there is still the possibility of an unexplained failure. In the event of a misfire, no person shall be allowed into the firing area for :

1 hour for safety fuse firings

15 minutes for electric firings

10 minutes for detonating fuse

In the treatment of misfire :

2.4.1. No high explosive is to be removed from the misfired hole (If AN/FO is used it can be desensitised with water and then removed).

2.4.2. A misfired hole must not be redrilled. A new hole may be positioned at least 1 m from the misfired hole or for a deep hole.

2.4.3. In refiring a misfired hole a check must be made to ensure that there is adequate burden otherwise excess flyrock may result.





2.4.4. In cleaning up broken rock, after a misfire has been treated, undetonated explosives or detonators must be sought and removed if located. (Accidents have resulted from explosives passing through crushing plants).

## 2.5. Disposal

After a long period of time most explosives tend to deteriorate (particularly in a hot, moist climate). This deterioration is noticeable on cartridges by the exudation of Nitro-Glycerine. Those explosives with a high ammonium nitrate content, tended to absorb moisture easily and this results in reduction of sensitivity and usefulness. Bulk ammonium nitrate (as used in AN/FO) is subject to degradation under the effect of heat and can be reduced to a fine powder form reducing the sensitivity to detonation.

If an explosive has deteriorated, then effective disposal must be carried out. The disposal must be complete to ensure that no high explosives or detonators can be found by the general public.

Generally explosives are destroyed by controlled burning, detonation in a safe place or in the case of ammonium nitrate, with copious quantities of water.

# 400

# Granular Sub-Bases, Bases & Surfacings

## 401. GRANULAR SUB-BASE

### 401.1. Scope

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base here-in-after) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 401.2. Materials

**401.2.1.** The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, brick metal, kankar or combination thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 400.1. The grading to be adopted for a project shall be as specified in the Contract.

**TABLE 400.1 : GRADING FOR GRANULAR SUB-BASE MATERIALS**

| IS Sieve Designation | Per cent by Weight Passing the IS Sieve | | |
|---|---|---|---|
| | Grading I | Grading II | Grading III |
| 75.0 mm | 100 | – | – |
| 53.0 mm | – | 100 | – |
| 26.5 mm | 55-75 | 50-80 | 100 |
| 9.50 mm | – | – | – |
| 4.75 mm | 10-30 | 15-35 | 25-45 |
| 2.36 mm | – | – | – |
| 0.425 mm | – | – | – |
| 0.075 mm | <10 | <10 | <10 |

Notes : (1) The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS:2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

(2) On clayey subgrades, the per cent passing IS Sieve 0.075 mm shall not exceed 5.

The Wet Aggregate Impact Value (IS:5640) shall not exceed 50.

Where locally available moorums are used in the Granular Subbase, it

shall be ensured through adequate tests on representative samples, that all the requirements set out in this Clause are satisfied.

### 401.3. Strength of Sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base shall have a minimum Soaked CBR value of 20*.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the "quality" of materials, as may be necessary.

### 401.4. Construction Operations

**401.4.1. Preparation of subgrade** : Immediately, prior to the laying of sub-base, the subgrade already finished to Clause 303 shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

The sequence of construction operations shall be such that the construction of granular subbase layer shall match the construction of the adjoining layer in the shoulders, as per Clause 407.4.1.

**401.4.2. Spreading and compacting** : The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of suitable tractor-towed appliances, for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method or by an approved mixing plant.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The

* In case the sub-base material of the requisite soaked CBR value is not available within economical leads, the sub-base material meeting any of the prescribed gradings and other requirements with a soaked CBR value of not less than 15 can be permitted with the approval of the competent authority.





equipment used for mix-in-place construction shall be a tractor-towed rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS:2720 (Part 7). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means, like, tractor-towed disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and superelevation and shall commence at the edges and progress towards the centre for portions having crossfall on both sides.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked, with the help of templates and straight edge, and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is atleast 100 per cent of the maximum dry density for the material determined as per IS:2720 (Part 7). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

### 401.5. Aggregate Plugs

When the granular sub-base is extended over the full formation, as shown on the drawings, the exposed edges shall be protected with suitable aggregate plugs, 200 to 300 mm wide, as specified on the drawings.

### 401.6. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 401.7. Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 401.8. Measurements for Payment

Granular sub-base shall be measured as finished work in position in cubic metres.

The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

### 401.9. Rate

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for :

(i) making arrangements for traffic to Clause 111 except for initial treatment to verges, shoulders and construction of diversions;

(ii) furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;

(iii) all labour, tools, equipment and incidentals to complete the work to the Specifications;

(iv) carrying out the work in part widths of road where directed; and

(v) carrying out the required tests for quality control.





## 402. GRAVEL/SOIL-AGGREGATE BASE AND SURFACE COURSE

### 402.1. Scope

This work shall consist of laying and compacting well-graded gravel/soil-aggregate material in one or more layers as base or surface course as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 402.2. Definition

Gravel/Soil-Aggregate is a mix of stone, sand and fine-sized particles used as base or surfacing on a road.

### 402.3. Materials

**402.3.1.** The material to be used for the work shall be natural gravel, crushed stone, crushed gravel, crushed slag, moorum, sand or combination thereof depending on the grading required. The material shall be free from organic or other deleterious constituents and conform to the gradings given in Table 400.2 for base course and in Table 400.3 for surface course.

### 402.3.2. Physical requirements

(a) When crushed stone/gravel/slag is used, the material shall conform to the following requirements :

- Wet Aggregate Impact Value (IS:5640) not to exceed 40 and 30 when used in base and surfacing respectively.
- Flakiness Index (IS:2386 (Part 1) not to exceed 25 and 20 per cent, when used in base and surfacing respectively.
- In high rainfall areas, coastal areas and where local soils are salt-infested, if the water absorption value of the coarse aggregate is greater than 2 per cent, the Soundness Test shall be carried out on the material delivered to the site as per IS:2386 (Part 5).

(i) Loss with Sodium Sulphate, 5 cycles : 12 per cent maximum

(ii) Loss with Magnesium Sulphate, 5 cycles : 18 per cent maximum

- If crushed slag is used, Clause 405.2.5 shall apply.
- If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have atleast two fractured faces.

(b) The needed gradation shall be obtained by crushing, screening and blending processes as necessary.

(c) Fine aggregate material passing 4.75 mm sieve shall consist of natural or crushed sand and fine mineral particles.

**402.3.3. Base gravel/soil-aggregate** : In addition to the physical requirements in Clause 402.3.2 above, the gradation shall conform to the requirements given in Table 400.2, the Liquid Limit when determined according to IS:2720 (Part 5), shall not exceed 25 and the PI shall not exceed 6.

**TABLE 400.2 : GRADING REQUIREMENTS FOR BASE COURSE**

| Sieve Size | Per cent by Mass Passing IS Sieve Grading Designation | | |
|---|---|---|---|
| | A | B | C |
| 53 mm | 100 | | |
| 37.5 mm | 97-100 | 100 | |
| 26.5 mm | | 97-100 | 100 |
| 19 mm | 67-81 | | 97-100 |
| 9.5 mm | | 56-70 | 67-79 |
| 4.75 mm | 33-47 | 39-53 | 47-59 |
| 425 µm | 10-19 | 12-21 | 12-21 |
| 75 µm | 4.0-8.0 | 4.0-8.0 | 4.0-8.0 |

**402.3.4. Surface course gravel/soil-aggregate** : In addition to the physical requirements in Clause 402.3.2 above, the gradation and plasticity index (PI) shall conform to the requirements given in Table 400.3.

**TABLE 400.3 : GRADING REQUIREMENTS FOR SURFACE COURSE**

| IS Sieve | Per cent by Mass Passing Designated Sieve |
|---|---|
| 26.5 mm | 100 |
| 19 mm | 97-100 |
| 4.75 mm | 41-71 |
| 425 µm | 12-28 |
| 75 µm | 9-16 |
| Plasticity Index | 4-10 |





## 402.4. Construction Operations

**402.4.1. Preparation of surface** : The surface of the subgrade/sub-base/base, as the case may be, to receive the Gravel/soil-Aggregate course shall be prepared to the specified lines and crossfall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained, if necessary by sprinkling water. Any irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course) to Clause 501 of these Specifications.

**402.4.2. Spreading and compacting** : The Gravel/Soil-Aggregate material of grading specified in the Contract shall be spread on the prepared surface with the help of a grader of adequate capacity, for maintaining the required slope and grade during the operation or other means as approved by the Engineer. When the Gravel/Soil-Aggregate material consists of combination of materials mentioned in Clause 402.3.1, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a tractor-towed Rotavator or similar approved equipment capable of mixing the materials to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish the suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck/ trailer mounted water bowser, suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is within 2 per cent of the optimum moisture content corresponding to IS:2720 (Part 7). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means, like, tractor-towed disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth-wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm, the compaction shall be done with the help of a vibratory roller of

minimum 80 to 100 kN static weight. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and superelevation and shall commence at the edges and progress towards the centre for portions having crossfall on both sides.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 100 per cent of the maximum dry density for the material determined as per IS:2720 (Part 7). The surface of any layer of material on completion of compaction shall be well closed, free from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

### 402.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 402.6. Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 402.7. Measurements for Payment

Gravel/Soil-Aggregate base/surface course as the case may be, shall be measured as finished work in position in cubic metres.

### 402.8. Rate

The Contract unit rate for the Gravel/Soil-Aggregate base/surface course shall be payment in full for carrying out the required operations including full compensation for all the components listed in Clause 401.9 (i) to (v).





## 403. LIME TREATED SOIL FOR IMPROVED SUBGRADE/SUB-BASE

### 403.0. General Guidelines

Lime treatment is generally adopted for silty clays and clayey soils, including Black Cotton soils. Reduction in plasticity index and development of strength in lime-soil mixes depends on the type of clay and its quantity in the soil. The lime shall have purity of not less than 70 per cent by weight of quicklime (CaO) when tested in accordance with IS:1514. By way of general guidelines, the lime content requirements for different types of soils are as under:

| Soil Type | Required Lime Content |
|---|---|
| Alluvial Soils and Moorums (PI : 10-15) | 3 per cent |
| Clays/B.C Soils of Medium Plasticity (PI : 15-30) | 3-5 per cent |
| Highly Expansive Clays (PI : over 30) | 5-6 per cent |

Mix design should be worked out to decide the optimum quantity of lime to be added to obtain the required test value.

As a modifier, the quantity of lime can be determined for reducing the PI of a high PI soil to a value less than 10 and for increasing the CBR to the required value. As a stabiliser, the quantity of lime has to be worked out to attain the needed strength of the mix in terms of a 7-day Unconfined Compressive Strength (UCS) value.

It is only on the basis of mix design, carried out on representative samples of soil, as well as lime to be used, that the required quantity of lime is to be specified.

Pulverization of soil clods to the required degree and mixing of pulverized soil with lime can be accomplished by using tractor-towed implements, like, disc harrows or rotavator. A static 80 to 100 kN smooth-wheeled roller and tractor-towed water bowser are generally adequate for compaction. Curing for 7-days by covering the compacted layer with wet gunny bags, moist straw or sand periodically sprinkled with water, is an important part of the construction process.

### 403.1. Scope

This work shall consist of laying and compacting an improved subgrade/ lower sub-base of soil treated with lime on prepared subgrade in accordance

with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Lime treatment is generally effective for soils which contain a relatively high percentage of clay and silty clay.

### 403.2. Materials

**403.2.1. Soil** : Except when otherwise specified, the soil used for lime treatment shall be the local clayey soil having a plasticity index greater than 10.

**403.2.2. Lime** : Lime for lime-soil stabilisation work shall be commercial dry lime slaked at site or pre-slaked lime delivered to the site in suitable packing. Unless otherwise permitted by the Engineer, the lime shall have purity of not less than 70 per cent by weight of Quick-lime (CaO) when tested in accordance with IS:1514. Lime shall be properly stored to avoid prolonged exposure to the atmosphere and consequent carbonation which would reduce its binding properties. Slaked lime supplied in airtight bags shall not be stored for more than 3 months.

**403.2.3. Quantity of lime in stabilised mix** : Quantity of lime to be added as percentage by weight of the dry soil shall be as specified in the Contract. The quantity of lime used shall be related to its calcium oxide content which shall be specified. Where the lime of different calcium oxide content is to be used, its quantity shall be suitably adjusted to the approval of the Engineer so that equivalent calcium oxide is incorporated in the work. The mix design shall be done to arrive at the appropriate quantity of lime to be added, having due regard to the purity of lime, the type of soil, the moisture-density relationship, and the design CBR/Unconfined Compressive Strength (UCS) value specified in the Contract. The laboratory CBR/UCS value shall be at least 1.5 times the minimum field value of CBR/UCS stipulated in the Contract.

**403.2.4. Water** : The water to be used for lime stabilisation shall be clean and free from injurious substances. Potable water shall be preferred.

### 403.3. Construction Operations

**403.3.1. Weather limitations** : Lime-soil stabilisation shall not be done when the air temperature in the shade is less than 10°C.

**403.3.2. Degree of pulverisation** : For lime stabilisation, the soil before addition of stabiliser, shall be pulverised using agricultural





implements, like, tractor-towed disc harrows and rotavators to the extent that it passes the requirements set out in Table 400.4, as explained at *Annexure-400.1*.

**TABLE 400.4 : SOIL PULVERISATION REQUIREMENTS FOR LIME STABILISATION**

| IS Sieve Designation | Minimum per cent by Weight Passing the IS Sieve |
|---|---|
| 26.5 mm | 100 |
| 5.6 mm | 80 |

**403.3.3. Equipment for construction** : Stabilised soil sub-base shall be constructed by mix-in-place method of construction or as otherwise approved by the Engineer. Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs.

The equipment used for mix-in-place construction shall be a tractor-towed rotavator or similar approved equipment capable of pulverizing and mixing the soil with additive and water to specified degree to the full thickness of the layer being processed, and of achieving the desired degree of mixing and uniformity of the stabilised material. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for work.

The thickness of any layer to be stabilised shall be not less than 100 mm when compacted. The maximum thickness shall be 200 mm, provided the plant used is accepted by the Engineer.

**403.3.4. Mix-in-place method of construction** : Before deploying the equipment, the soil after it is made free of undesirable vegetation or other deleterious matter shall be spread uniformly on the prepared subgrade in a quantity sufficient to achieve the desired compacted thickness of the stabilised layer. Where single-pass equipment is to be employed, the soil shall be lightly rolled at the discretion of the Engineer.

The equipment used shall either be of single-pass or multiple pass type. The mixes shall be equipped with an appropriate device for controlling the depth of processing and the mixing blades shall be maintained or reset periodically so that the correct depth of mixing is obtained at all times.

With single-pass equipment, the forward speed of the machine shall be so selected in relation to the rotor speed that the required degree of mixing, pulverisation and depth of processing is obtained. In multiple pass processing, the prepared subgrade shall be pulverised to the required depth with successive passes of the equipment and the moisture content adjusted to be within prescribed limits. The blending or stabilizing material shall then be spread uniformly and mixing continued with successive passes until the required depth and uniformity of processing have been obtained. Appropriate tractor-towed equipment, approved by the Engineer, are suitable for performing various operations in the construction process, like, pulverization of soil clods by tractor-towed disc harrows and mixing of soil with stabilizer by tractor-towed Rotavator.

**403.3.5. Construction with manual means** : Where manual mixing is permitted, the soil from borrow areas shall first be freed of all vegetation and other deleterious matter and placed on the prepared subgrade. The soil shall then be pulverised by means of crow-bars, pick axes or other means approved by the Engineer.

Water in requisite quantities may be sprinkled on the soil for aiding pulverisation. On the pulverised soil, the blending material(s) in requisite quantities shall be spread uniformly and mixed thoroughly by working with spades or other similar implements till the whole mass is uniform. After adjusting the moisture content to be within the limits mentioned later, the mixed material shall be levelled upto the required thickness so that it is ready to be rolled.

**403.3.6. Addition of lime** : Lime may be mixed with the prepared material either in slurry form or dry state at the option of the Contractor with the approval of the Engineer.

Dry lime shall be prevented from blowing by adding water to the lime or other suitable means selected by the Contractor, with the approval of the Engineer.

The tops of windrowed material may be flattened or slightly trenched to receive the lime. The distance to which lime may be spread upon the prepared material ahead of the mixing operation shall be determined by the Engineer.

No traffic other than the mixing equipment shall be allowed to pass over the spread lime until after completion of mixing.





Mixing or remixing operations, regardless of equipment used, shall continue until the material is free of any white streaks or pockets of lime and the mixture is uniform.

Non-uniformity of colour reaction, when the treated material is tested with the standard phenolphthalein alcohol indicator, shall be considered evidence of inadequate mixing.

**403.3.7. Moisture content for compaction** : The moisture content at compaction checked vide IS:2720 (Part 2) shall be within 2 per cent of the optimum moisture content corresponding to IS:2720 (Part 7).

**403.3.8. Rolling** : Immediately after spreading, grading and levelling of the mixed material, compaction shall be carried out with 80-100 kN static weight smooth-wheeled roller or other roller approved by the Engineer. Rolling shall begin at the edges and progress towards the centre on straight portions. On superelevated curves the rolling shall proceed from the inner to the outer edge. Compaction shall continue until the density achieved is atleast 100 per cent of the maximum dry density of the material as per IS:2720 (Part 7). The suitability of a particular compaction equipment and number of passes required may be verified on a test strip. Ideally, not more than 60 minutes shall elapse between the start of moist mixing and start of compaction process. Care shall be taken to see that compaction is completed within 3 hours of mixing or such shorter period as may be necessary during dry weather.

During rolling, it shall be ensured that the roller does not bear directly on hardened or partially hardened treated material previously laid other than what may be necessary for achieving the specified compaction at the joint. The final surface shall be well closed, free from movement under compaction planes, ridges, cracks or loose material. All loose or segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

**403.3.9. Curing**

Curing of the compacted layer shall be carried out for a minimum period of 7-days by spreading moist straw/wet gunny bags or sand and sprinkling water periodically. Curing by ponding of water shall not be permitted to avoid leaching of lime. After the curing period is over, subsequent pavement layers shall be laid as early as possible to prevent the surface from drying out. No traffic shall be allowed to ply during the curing period, unless permitted by the Engineer.

### 403.4. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 403.5. Strength

When lime is used for improving the subgrade, the soil-lime mix shall be tested for its CBR value. When lime stabilised soil is used in a sub-base, it shall be tested for unconfined compressive strength (UCS) at 7-days. In case of variation from the design CBR/UCS, in-situ value being lower, the pavement design shall be reviewed based on the actual CBR/UCS values. The extra pavement thickness needed on account of lower CBR/UCS value shall be constructed by the Contractor at his own cost.

### 403.6. Arrangements of Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 403.7. Measurements for Payment

Stabilised soil sub-base shall be measured as finished work in position in cubic metres.

### 403.8. Rate

The Contract unit rate for lime stabilised soil sub-base shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v).

## 404. CEMENT TREATED SOIL SUB-BASE/BASE

### 404.0. General Guidelines

Soil stabilisation with cement as a stabiliser is resorted to for soils which do not respond to lime treatment and where comparatively higher and faster development of strength and durability characteristics are needed, especially for waterlogged and high rainfall areas. Granular and sandy soils are most suitable for cement stabilisation. By way of broad guidelines,





the requirements of cement content for different soil types are as under:

| Soil Type | Required Cement Content |
|---|---|
| Sands/Sandy Soils/Soil-Gravels | 3-5 per cent |
| Silts/Silty Clays of Low PI (<15) | 4-8 per cent |
| Clays/Black Cotton Soils | 8-15 per cent |

For heavy clays/black cotton soils (PI more than 30), the clay is treated with lime in the first stage to reduce plasticity and to facilitate pulverization. In the second stage, the resulting soil is stabilised with cement.

Mix Design should be worked out to specify the amount of cement to be added to obtain the required strength in terms of 7-day Unconfined Compressive Strength (UCS) and/or durability test under alternate wet-dry conditions. Pulverisation of soil clods, mixing of pulverised soil with the required amount of cement, compaction and curing of the compacted layer are important construction operations, as in the construction of lime treated soil subbase.

### 404.1. Scope

This work shall consist of laying and compacting a sub-base/base course of soil treated with cement on prepared subgrade/sub-base, in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 404.2. Materials

**404.2.1. Material to be stabilised** : The material used for cement treatment shall be soil including sand and gravel, laterite, kankar, brick aggregate, crushed rock, slag or flyash or any combination of these. For use in a sub-base course, the material shall have a grading shown in Table 400.5; it shall have a uniformity coefficient ($C_u$)* not less than 5, capable of producing a well closed surface finish. For use in a base course, the material shall be sufficiently well graded to ensure a well-closed surface finish and have a grading within the range given in Table 400.5. If the material passing 425 micron sieve is plastic, it shall have a liquid limit not

* $C_u = D_{60}/D_{10}$ where $D_{60}$ denotes the soil particle size such that 60 per cent of the particles are smaller than that size. Similarly, $D_{10}$ denotes the soil particle size such that 10 per cent of the particles are smaller than that size.

greater than 45 per cent and a plasticity index not greater than 20 per cent determined in accordance with IS:2720 (Part 5).

**404.2.2. Cement** : Cement for cement stabilisation shall comply with the requirements of IS:269, 455 or 1489.

**404.2.3. Lime** : If needed for pre-treatment of highly clayey soils (PI more than 30), Clause 403.2.2 shall apply.

**TABLE 400.5 : GRADING LIMITS OF MATERIAL FOR STABILISATION WITH CEMENT**

| IS Sieve | Percentage by Weight Passing | |
|---|---|---|
| | Sub-base Finer than | Base Within the Range |
| 53.0 mm | 100 | 100 |
| 37.5 mm | 95 | 95-100 |
| 19.0 mm | 45 | 45-100 |
| 9.5 mm | 35 | 35-100 |
| 4.75 mm | 25 | 25-100 |
| 600 micron | 8 | 8-65 |
| 300 micron | 5 | 5-40 |
| 75 micron | 0 | 0-10 |

**404.2.4. Quantity of cement in stabilised mix** : The quantity of cement to be added as per cent by weight of the dry soil shall be specified in the Contract. Also, if lime is used as pre-treatment for highly clayey soils, the quantity as per cent by weight of dry soil shall be specified in the Contract. The mix design shall be done on the basis of 7-days unconfined compressive strength. While carrying out mix design, it must be ensured that the samples of soil and cement used are indeed representative of these materials actually to be used at the site.

**404.2.5. Water** : The water to be used for cement stabilisation shall be clean and free from injurious substances. Potable water shall be preferred.

**404.2.6. Minimum compressive strength** : A minimum laboratory 7-day compressive strength of 2.76 MPa is required for use in base





courses, whereas, in sub-base courses, a minimum laboratory 7-day compressive strength of 1.7 MPa is adequate.

### 404.3. Construction Operations

**404.3.1. Weather limitations** : Stabilisation shall not be done when the air temperature in the shade is less than 10°C.

**404.3.2. Degree of pulverisation** : For stabilisation, the soil before addition of stabiliser, shall be pulverised, where necessary, to the extent that it passes the requirements as set out in Table 400.6, explained at *Annexure-400.1*.

**TABLE 400.6 : SOIL PULVERISATION REQUIREMENTS FOR CEMENT STABILISATION**

| IS Sieve Designation | Minimum per cent by Weight Passing the IS Sieve |
|---|---|
| 26.5 mm | 100 |
| 5.6 mm | 80 |

**404.3.3.** Clauses 403.3.3 to 403.3.5 shall apply as regards spreading and mixing the stabiliser except that cement or lime plus cement as the case may be, shall be used as the stabilizing materials.

**404.3.4. Moisture content for compaction** : The moisture content at compaction checked vide IS:2720 (Part 2) shall be within 2 per cent of the optimum moisture content corresponding to IS:2720 (Part 7).

**404.3.5. Rolling** : Clause 403.3.8 shall apply except that care shall be taken to see that the compaction of cement stabilised materials is completed within two hours of its mixing or such shorter period as may be found necessary in dry weather.

**404.3.6. Curing** : Clause 403.3.9 shall apply.

### 404.4. Surface Finish and Quality Control of Works

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 404.5. Strength

Cement treated soil sub-base/base shall be tested for the unconfined compressive strength value at 7-days, actually obtained in situ. In case of variation from the design UCS, in-situ value being on lower side, prior to proceeding with laying of base/surface course on it, the pavement design shall be reviewed for the actual UCS value. The extra pavement thickness needed on account of lower UCS shall be constructed by the Contractor at his own cost.

### 404.6. Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 404.7. Measurements for Payment

The cement treated soil sub-base/base shall be measured as finished work in position in cubic metres.

### 404.8. Rate

The Contract unit rate for cement treated soil sub-base/base with pre-treatment with lime if required shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v).

## 405. WATER BOUND MACADAM SUB-BASE/BASE/SURFACING

### 405.1. Scope

**405.1.1.** This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary, and water laid on a properly prepared subgrade/sub-base/base or existing pavement, as the case may be and finished in accordance with the requirements of these Specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

### 405.2. Materials

**405.2.1. Coarse aggregates** : Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates, such as, kankar and laterite of





suitable quality. Materials obtained from rocks, such as, Phyllites, Shales or Slates, etc. shall not be permitted in WBM construction. Materials other than crushed or broken stone and crushed slag shall be used in sub-base courses only. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400.7. The type and size range of the aggregate shall be specified in the Contract or shall be as specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 per cent, the Soundness test shall be carried out on the material delivered to site as per IS:2386 (Part 5).

**TABLE 400.7 : PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE/ SURFACING COURSES**

| Test | Sub-base | Base | Surfacing |
|---|---|---|---|
| Aggregate Impact Test (IS:2386 Part 4 or IS:5640) | Less than 50 | Less than 40 | Less than 30 |
| Flakiness Index Test (IS:2386 Part 1) | Less than 30 | Less than 25 | Less than 20 |
| Soundness Test (IS:2386 Part 1) | | | |
| – Loss with Sodium Sulphate | Less than 12% | Less than 12% | Less than 12% |
| – Loss with Magnesium Sulphate | Less than 18% | Less than 18 % | Less than 18% |

**405.2.2.** Aggregates, like brick bats, kankar, laterite, etc. which get softened in presence of water shall be tested for Aggregate Impact Value under wet conditions in accordance with IS:5640.

**405.2.3.** The requirement of flakiness Index shall be enforced only in the case of crushed or broken stone and crushed slag.

**405.2.4. Crushed or broken stone** : The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

**405.2.5. Crushed slag** : Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in

quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials.

**405.2.6. Overburnt (Jhama) brick aggregates** : Jhama brick aggregates shall be made from overburnt bricks or brick ballast and be free from dust and other objectionable and deleterious materials.

**405.2.7. Grading requirement of coarse aggregates** : The coarse aggregates shall conform to one of the Gradings given in Table 400.8 as specified, provided, however, the use of Grading No.1 shall be restricted to sub-base courses only.

**TABLE 400.8 : GRADING REQUIREMENTS OF COARSE AGGREGATES**

| Grading No. | Size Range | IS Sieve Designation | Per cent by Weight Passing |
|---|---|---|---|
| (1) | 90 mm to 45 mm | 125 mm | 100 |
| | | 90 mm | 90-100 |
| | | 63 mm | 25-60 |
| | | 45 mm | 0-15 |
| | | 22.4 mm | 0-5 |
| (2) | 63 mm to 45 mm | 90 mm | 100 |
| | | 63 mm | 90-100 |
| | | 53 mm | 25-75 |
| | | 45 mm | 0-15 |
| | | 22.4 mm | 0-5 |
| (3) | 53 mm to 22.4 mm | 63 mm | 100 |
| | | 53 mm | 95-100 |
| | | 45 mm | 65-90 |
| | | 22.4 mm | 0-10 |
| | | 11.2 mm | 0-5 |

Note : The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other Gradings, i.e., 2 & 3, it shall be 75 mm.

**405.2.8. Screenings** : Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where economic considerations so warrant, predominantly non-plastic material (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent. The Screenings shall not contain any of the undesirable





constituents listed in Clause 301.2.3 which would render it unsuitable as a fill material.

Screenings shall conform to the grading set forth in Table 400.9. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in Table 400.10. The Table also gives the quantities of materials (loose) required for 10 $m^2$ for sub-base compacted thickness of 100/75 mm.

**TABLE 400.9 : GRADING FOR SCREENINGS**

| Grading Classification | Size of Screenings | IS Sieve Designation | Per cent by Weight Passing the IS Sieve |
|---|---|---|---|
| A | 13.2 mm | 13.2 mm | 100 |
| | | 11.2 mm | 95-100 |
| | | 5.6 mm | 15-35 |
| | | 180 micron | 0-10 |
| B | 11.2 mm | 11.2 mm | 100 |
| | | 5.6 mm | 90-100 |
| | | 180 micron | 15-35 |

The use of screenings shall be omitted in the case of soft aggregates, such as, brick metal, kankar, laterite, etc. as they are likely to get crushed to a certain extent under rollers.

**405.2.9. Binding material** : Binding material to be used for water bound macadam as a filler material meant for preventing ravelling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 for sub-base/base course and 4 to 10 for surfacing course as determined in accordance with IS:2720 (Part 5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 $m^3/10m^2$ and 0.08-0.10$m^3/10m^2$ for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction, etc.

Application of binding materials may not be necessary when the screenings used are of crushable type.

**TABLE 400.10 : APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS REQUIRED FOR 100/ 75 mm COMPACTED THICKNESS OF WATER BOUND MACADAM (WBM) SUB-BASE/BASE/SURFACING COURSE FOR 10m² AREA**

| Classification | Size Range | Compacted Thickness | Loose Quantity | Stone Screenings | | Crushable Screenings such as moorum or gravel | |
|---|---|---|---|---|---|---|---|
| | | | | Grading Classification & Size | For WBM Sub-base/ Base Course (Loose Quantity) | Properties | Loose Quantity |
| | $m^2$ | mm | $m^3$ | | $m^3$ | | $m^3$ |
| Grading 1 | 90 to 45 | 100 | 1.21 to 1.43 | Type A 13.2 | 0.27 to 0.30 | LL<20; PI<6 Percent passing 0.075 mm<10 | 0.30 to 0.32 |
| Grading 2 | 63 to 45 | 75 | 0.91 to 1.07 | Type A 13.2 | 0.12 to 0.15 | -do- | 0.22 to 0.24 |
| Grading 2 | 63 to 45 | 75 | 0.91 to 1.07 | Type B 11.2 | 0.20 to 0.22 | -do- | -do- |
| Grading 3 | 53 to 22.4 | 75 | 0.91 to 1.07 | Type B 11.2 | 0.18 to 0.21 | -do- | -do- |

### 405.3. Construction Operations

**405.3.1. Preparation of base** : The surface of the subgrade/sub-base/ base to receive the water bound macadam course shall be prepared to the specified lines and crossfall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base/base/surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course).

Laying water bound macadam course over an existing bituminous layer shall be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it.

**405.3.2. Inverted choke** : Where the WBM layer is to be laid over the subgrade and the subgrade soil is fine-grained, it is advisable to lay 100





mm intervening layer of screening or coarse sand on top of the fine-grained soil.

**405.3.3. Provision of lateral confinement of aggregates** : While constructing water bound macadam, arrangement shall be made for the lateral confinement of the aggregates. This shall be done by laying materials in adjoining shoulders along with that of water bound macadam layer and following the sequence of operations described in Clause 407.4.1.

**405.3.4. Spreading coarse aggregates** : The coarse aggregates shall be spread uniformly and evenly upon the prepared subgrade/ sub-base/ base to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3, as specified in Clause 405.2.5. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved drawings.

The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

**405.3.5. Rolling** : Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of 80 to 100 kN static weight. The type of roller to be used shall be approved by the Engineer based on trial run.

Except on superelevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move

inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates, like, brick metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired crossfall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

Material which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses, in accordance with the procedure given in Clause 407.4.1.

**405.3.6. Application of screenings** : After the coarse aggregate has been rolled to Clause 405.3.4, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would





prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

**405.3.7. Sprinkling of water and grouting** : After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

In case of lime treated soil sub-base, construction of water bound macadam on top of it can cause excessive water to flow down to the lime treated sub-base before it has picked up enough strength (is still "green") and thus cause damage to the sub-base layer. The laying of water bound macadam layer in such cases shall be done after the sub-base attains adequate strength, as directed by the Engineer.

**405.3.8. Application of binding material** : After the application of screenings in accordance with Clauses 405.3.5 and 405.3.6 the binding material where it is required to be used (Clause 405.2.7) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

**405.3.9. Setting and drying** : After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled.

No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

### 405.4. Surface Finish and Quality Control of Work

**405.4.1.** The surface finish of construction shall conform to the requirements of Clause 1802.

**405.4.2.** Control on the quality of material and works shall be exercised by the Engineer in accordance with Section 1800.

**405.4.3.** The water bound macadam work shall not be carried out when the atmospheric temperature is less than 0°C in the shade.

**405.4.4. Reconstruction of defective macadam** : The finished surface of water bound macadam shall conform to the tolerance of surface regularity as prescribed in Clause 1802. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to subgrade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and recompacted. In no case shall depressions be filled up with screenings or binding material.

### 405.5. Arrangement for Traffic

During the period of construction, the arrangement of traffic shall be done as per Clause 111.

### 405.6. Measurements for Payment

Water bound macadam shall be measured as finished work in position in cubic metres.

### 405.7. Rate

The Contract unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v) including arrangements of water used in the work as approved by the Engineer.





## 406. WET MIX MACADAM BASE

### 406.1. Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-base/base of existing pavement as the case may be, in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the base course may be adopted upto 200 mm upon approval of the Engineer.

### 406.2. Materials

#### 406.2.1. Aggregates

**406.2.1.1. Physical Requirements** : Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravels/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements setforth in Table 400.11.

**TABLE 400.11 : PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB-BASE/BASE COURSES**

| Test | Test Method | Requirements |
|---|---|---|
| 1. Aggregate Impact Value | IS:2386 (Part 4) or IS:5640 | 40 per cent (Max) |
| 2. Flakiness Index | IS:2386 (Part 1) | 25 per cent (Max) |

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part 5).

**406.2.1.2. Grading requirements** : The aggregates shall conform to the grading given in Table 400.12.

TABLE 400.12 : GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

| IS Sieve Designation | Minimum per cent by Weight Passing the IS Sieve |
|---|---|
| 53.00 mm | 100 |
| 45.00 mm | 95-100 |
| 26.50 mm | – |
| 22.40 mm | 60-80 |
| 11.20 mm | 40-60 |
| 4.75 mm | 25-40 |
| 2.36 mm | 15-30 |
| 600 micron | 8-22 |
| 75 micron | 0-8 |

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

**406.3. Construction Operations**

**406.3.1. Preparation of base** : Clause 405.3.1 shall apply.

**406.3.2. Provision of lateral confinement of aggregates** : While constructing wet mix macadam, arrangement shall be made for the lateral confinement of the wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 407.4.1.

**406.3.3. Preparation of mix** : Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/ positive mixing arrangement like pugmil or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with





IS:2720 (Part 7) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

**406.3.4. Spreading of mix** : Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/ sub-base as the case may be, in required quantities. In no case should these be dumped in heaps, directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface.

The paver finisher shall be self-propelled, having the following features:

(i) Loading hoppers and suitable distribution mechanism

(ii) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.

(iii) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of large and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

**406.3.5. Compaction** : After the mix has been laid to the required thickness, grade and crossfall/camber, the same shall be uniformly compacted, to the full depth with suitable roller.

If the thickness of single compacted layer does not exceed 100mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100

kN or equivalent capacity roller. The speed of the roller shall not exceed 5 km per hour.

In portions having unidirectional cross fall/superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre, parallel to the centre line of the road uniformly overlapping each of the preceding tracks by at lest one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with 3 m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 100 per cent of the maximum dry density for the material as determined by the method outlined in IS:2720 (Part 7).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.





**406.3.6. Setting and drying** : After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

### 406.4. Opening to Traffic

Preferably no-vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

### 406.5. Surface Finish and Quality Control of Work

**406.5.1. Surface evenness** : The surface finish of construction shall conform to the requirements of Clause 1802.

**406.5.2. Quality control** : Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 406.6. Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to subgrade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompacted in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

### 406.7. Arrangement for Traffic

During the period of construction, arrangement of traffic shall be done as per Clause 111.

### 406.8. Measurements for Payment

Wet mix macadam shall be measured as finished work in position in cubic metres.

### 406.9. Rate

The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9.

## 407. SHOULDER CONSTRUCTION

### 407.1. Scope

The work shall consist of constructing shoulder (hard/earthen with brick or stone block edging) on either side of the pavement, in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 407.2. Materials

Shoulder on either side of the road may be of selected earth/granular material conforming to the requirements of Clause 401/quarry waste.

Where hard shoulders are not provided, the pavement shall be provided with brick/ stone block edgings as shown in the drawings. The bricks shall conform to Clause 602.4 of these Specifications. Stone blocks shall conform to Clause 702.4 of these Specifications and shall be of size 225 mm x 110 mm x 75 mm.

### 407.3. Size of Shoulders

Shoulder (earthen/hard) dimensions shall be as shown on the drawings or as directed by the Engineer.

### 407.4. Construction Operations

**407.4.1.** The sequence of operations shall be such that the construction of shoulders is done in layers, each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in hard and earthen shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The adjacent layers having same material shall be laid and compacted together.

In all cases where hard shoulders have to be provided along side of existing carriageway, the existing shoulders shall be excavated in full width and to the required depth as per Clause 302. Under no circumstances, box cutting shall be done for construction of shoulders.

Compaction requirement of earthen shoulder shall be at least 100 per cent of Maximum Dry Density as per IS:2720 (Part 7).





During all stages of shoulder (earthen) construction, the required crossfall shall be maintained to drain off surface water.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the under-layers of shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned.

**407.4.2. Brick/stone block edging** : The bricks/stone blocks shall be laid on edge, with the length parallel to the transverse direction of the road. These shall be laid on a bed of 25 mm sand, set carefully, rolled into position by a light roller and made flush with the finished level of the pavement.

### 407.5. Surface Finish and Quality Control of Works

The surface finish of construction shall conform to the requirements of Clause 1802. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 407.6. Measurements for Payment

Shoulder (hard/earthen) construction shall be measured as finished work in position as below:

(i) For excavation in cubic metres

(ii) For earthwork/granular fill in cubic metres

(iii) For brick/stone block edging in cubic metres

### 407.7. Rate

The Contract unit rate for shoulder (hard/earthen with brick or stone block edging) shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v) as applicable. The rate for brick/stone block edging shall include the cost of sand cushion.

## 408. LOCAL MATERIALS FOR ROAD CONSTRUCTION

### 408.1. Scope

This Specification covers the use of local materials as such or after their processing, for road construction in areas where quality materials are not available within economical leads. It includes the laying and compacting of such low cost materials in one or more layers as subbase, base or

surface course as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 408.2. Definition

Low cost materials for road construction are the locally available soils and low-grade/marginal aggregates with requisite engineering properties which are both suitable and economical for incorporation (as such or after processing, as may be needed) in the pavement crust of low volume roads, in lieu of the conventionally used high quality road materials.

### 408.3. Materials

**408.3.1.** The quality and quantity of various sources of different types of soils and low-grade/marginal aggregates locally available, shall be established through scientifically carried out soils and materials surveys as per the procedures laid down in IRC:SP:20.

**408.3.2. Material characterization and usage** : The manner of using the locally available low-grade/ marginal aggregates shall be as per Table 400.13. The different types of soil stabilisation techniques appropriate for

**TABLE 400.13 : MANNER OF USING LOW-GRADE AGGREGATES IN RURAL ROAD PAVEMENTS**

| Sl. No. | State of Occurrence of Material | Manner of Using in Pavement Crust | Test/Quality Requirements |
|---|---|---|---|
| (1) | In block or large discrete particles, such as Kankar, Laterite, Dhandla, etc. | As water bound macadam without screenings/filler in accordance with IRC:19, after breaking the material into required sizes. | Wet Aggregate Impact Value (IS:5640) not to exceed 50, 40 and 30 when used in sub-base, base and surfacing respectively. |
| (2) | Graded form without appreciable amount of soil, such as naturally occurring gravels. | Directly as a granular layer for sub-base/base or surfacing. | PI should be 4-10 when used as surfacing and shall not exceed 6 when used in lower courses. Evaluated for strength by soaked CBR. |
| (3) | As discrete particles mixed with appreciable amount of soil such as soil-gravel mixtures, quarry wastes, etc. | Directly as soil-gravel mix for sub-base, base or surfacing. | The material shall be well-graded and the PI restricted as for Sl. No.2. Evaluated for strength by soaked CBR. |





different types of locally available soils shall be as given in Table 400.14.

**TABLE 400.14 : REQUIREMENTS OF SOIL STABILISATION TECHNIQUES**

| Sl. No. | Soil Stabilisation Technique | Applicability to Different Soil Types |
|---|---|---|
| (1) | Mechanical Stabilisation | Sands, moorums/gravels having missing fractions and clayey soils. |
| (2) | Lime Stabilisation | Medium and heavy clays having PI > 10 and containing atleast 15 per cent of material finer than 425 micron. A soil whose 7-day unconfined compressive strength increases by atleast 0.3 MN/m$^2$ with lime treatment is suitable. |
| (3) | Cement Stabilisation | Granular soils with organic content not greater than 2 per cent or deleterious salts (sulphates and carbonates) not greater than 0.2 per cent are suitable. Plasticity Product (product of PI and per cent passing 425 micron sieve) should be less than 250 and uniformity coefficient >5. |
| (4) | Lime-Flyash Stabilisation | Soils of medium plasticity (PI 5-20) and clayey soils not reactive to lime. |
| (5) | Two-Stage (Lime-Cement) Stabilisation | Heavy clays with PI ≥ 30. |

### 408.4. Construction Operations

#### 408.4.1. Use of low-grade aggregates

(i) As water bound macadam : Clause 405.3 shall apply

(ii) As granular layer for sub-base : Clause 401.4 shall apply

(iii) As soil-gravel mix for sub-base, base or surfacing : Clause 402.4 shall apply

#### 408.4.2. Use of stabilised soil

(i) Mechanical Stabilisation : Clause 401.4 shall apply

(ii) Lime Stabilisation : Clause 403.3 shall apply

(iii) Cement Stabilisation : Clause 404.3 shall apply

(iv) Lime-Flyash Stabilisation : Clause 409.5 shall apply

(v) Two-stage (Lime-Cement) Stabilisation : Clause 404.3 shall apply

### 408.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 408.6. Strength

When lime stabilisation is adopted, Clause 403.5 shall apply. In case of Cement, Two-stage (Lime-Cement) and Lime-Flyash, Clauses 404.5 and 409.9 shall apply.

### 408.7. Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 408.8. Measurements for Payment

The sub-base/base/surface course, as the case may be, constructed with low cost materials shall be measured as finished work in position in cubic metres.

### 408.9. Rate

The Contract unit rate for sub-base/base/surface course constructed with low cost materials shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v).

## 409. LIME-FLYASH STABILISED SOIL SUB-BASE

### 409.1. Scope

This work shall consist of laying and compacting Lime-flyash Stabilised Soil Sub-base on prepared subgrade in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.





### 409.2. Definition

Lime-flyash stabilised soil is a mixture of soil and flyash, when stabilised with lime.

### 409.3. Materials

**409.3.1. Flyash** : Flyash may be either from anthracitic coal or lignitic coal. The Flyash to be used in lime-flyash stabilisation of soil shall conform to the requirements given in Tables 400.15 and 400.16.

**TABLE 400.15 : CHEMICAL REQUIREMENTS FOR FLYASH AS A POZZOLANA**

| Sl. No. | Characteristics | Requirements for Flyash | | |
|---|---|---|---|---|
| | | Anthracitic Flyash | Lignitic Flyash | Method of Test |
| (1) | $SiO_2+Al_2O_3+Fe_2O_3$ in per cent by mass, Min | 70 | 50 | IS:1727 |
| (2) | $SiO_2$ in per cent by mass, Min | 35 | 25 | IS:1727 |
| (3) | MgO in per cent by mass, Max | 5.0 | 5.0 | IS:1727 |
| (4) | $SO_3$ in per cent by mass, Max | 2.75 | 3.5 | IS:1727 |
| (5) | Available alkalies as $Na_2O$ in per cent by mass, Max | 1.5 | 1.5 | IS:4032 |
| (6) | Total chlorides in per cent by mass, Max | 0.05 | 0.05 | IS:1727 |
| (7) | Loss on ignition in per cent by mass, Max | 5.0 | 5.0 | IS:1727 |

**TABLE 400.16 : PHYSICAL REQUIREMENTS FOR FLYASH AS A POZZOLANA**

| Sl.No. | Characteristics | Requirement |
|---|---|---|
| (1) | Fineness – specific surface in $m^2/kg$ by Blaine's permeability test, Min | 250 |
| (2) | Particles retained on 45 micron IS sieve, Max | 40 |
| (3) | Lime reactivity in $N/mm^2$, Min | 3.5 |
| (4) | Soundness by autoclave test-expansion of specimen in per cent, max | 0.8 |
| (5) | Soundness by Lechatelier method – expansion in mm, Max | 10 |

**409.3.2. Lime** : The lime to be used for lime-flyash soil stabilisation shall be quick lime, which has been pre-slaked at site and shall be used within 7-days. Slaked lime supplied in airtight bags shall not be stored for more than 3 months. The lime shall have a purity of not less 70 per cent by weight of CaO, when tested as per IS:1514.

**409.3.3. Soil** : The soil shall have a plasticity index between 4 and 20; however, this technique may also be applied to soil with plasticity index more than 20, provided strength tests on lime-flyash soil mixes show favourable results. The ideal proportion of particles smaller than 425 micron sieve shall be between 15 and 25 per cent by dry weight of the soil-lime-flyash mixture.

**409.3.4. Water** : Water for mixing and curing shall be clean and free from injurious salts, organic matter and other deleterious matter. Potable water shall be considered satisfactory.

### 409.4. Mix Proportion

The mix proportion shall be designed to obtain minimum unconfined compressive strength of 1.5 MPa after 28 days of moist curing. The component of soil in the lime-flyash-soil mix can be omitted, provided the specified minimum strength requirement is achieved.

### 409.5. Construction Operations

**409.5.1. Preparation of subgrade** : The subgrade over which the lime-flyash soil layer is to be laid shall be shaped to the desired profile and checked for line, grade and cross-section. All irregularities beyond the permitted tolerance shall be corrected and the surface prepared by light sprinkling with water and rolling with 80 to 100 kN static weight smooth-wheeled roller. Soft and yielding spots, ruts etc if present shall be rectified and backfilled with suitable material and rolled until firm.

**409.5.2. Weather limitations** : Lime-flyash soil stabilisation shall not be done when air temperature in the shade is less than 10°C.

**409.5.3. Mixing method** : Lime and flyash shall preferably be mixed by weigh batching; however, when unavoidable, volume batching can be resorted to. The mix-in-place method shall be adopted, which requires distribution of flyash and lime evenly over the work area, subsequent addition of moisture and mixing with a mobile mixing plant.





If permitted by the Engineer, manual mixing my be adopted. Soil shall be free from all vegetation and other deleterious matter and pulverised to conform to the requirements given in Table 400.17, as explained at *Annexure-400.1*.

**TABLE 400.17 : SOIL PULVERIZATION REQUIREMENTS FOR LIME-FLYASH STABILISATION**

| IS Sieve | Percent weight of Soil Passing IS Sieve |
|---|---|
| 26.5 mm | 100 |
| 5.6 mm | 80 |

**409.5.4. Spreading and moisture control** : First, the soil shall be spread uniformly on the prepared subgrade, the thickness of uncompacted layer being about 25 to 35 per cent more than the specified compacted thickness, determined through field trials. Lime and flyash shall be spread ahead of mixing, taking care to prevent raising of dust. A tractor-towed rotavator or any similar equipment shall be used for mixing. Mixing shall be continued with successive passes until the required uniformity of mixing has been obtained. The specified moisture content prior to compaction shall be the optimum moisture content (OMC)+2 per cent, to compensate for the loss of moisture during spreading. If it is necessary to adjust the moisture content of the mix, water shall be added uniformly and in a controlled manner using a Water Bowser fitted with a sprinkler. Water shall then be uniformly mixed, with the soil-lime-flyash mix by discing or harrowing using tractor-towed disc harrows or similar equipment.

Where manual mixing is adopted, soil free from organic matter, is scarified or brought from the identified borrow areas and pulverised using crow bars, pickaxes etc., to meet the specifications given in Table 400.17. Water in requisite quantities may be sprinkled on soil to aid pulverisation. On the pulverised soil, lime and flyash shall be spread uniformly and mixed thoroughly by working with spades or other implements to get a uniform mix. After adjusting the moisture content to be within the limits specified, the mixed material shall be spread upto the required thickness.

**409.5.5. Compaction** : Immediately after spreading, grading and levelling of the mixed material, compaction shall be carried out with 80-100 kN static weight smooth-wheeled roller or other roller approved by the Engineer. Rolling shall begin at the edges and progress towards the centre on straight portions. On superelevated curves the rolling shall proceed

from the inner to the outer edge. Compaction shall continue until the density achieved is atleast 100 per cent of the maximum dry density of the material as per IS:2720 (Part 7). The suitability of a particular compaction equipment and number of passes required may be verified on a test strip. Ideally not more than 60 minutes shall elapse between the start of moist mixing and start of compaction process. Care shall be taken to see that compaction is completed within 3 hours of mixing or such shorter period as may be necessary during dry weather.

During rolling, it shall be ensured that the roller does not bear directly on hardened or partially hardened treated material previously laid other than what may be necessary for achieving the specified compaction at the joint. The final surface shall be well closed, free from movement under compaction planes, ridges, cracks or loose material. All loose or segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

### 409.6. Curing

Curing of the compacted layer shall be carried out for a minimum period of 7-days by spreading moist straw/wet gunny bags or sand and sprinkling water periodically. Curing by ponding of water shall not be permitted to avoid leaching of lime. After the curing period is over, subsequent pavement layers shall be laid as early as possible to prevent the surface from drying out. No traffic shall be allowed to ply during the curing period, unless permitted by the Engineer.

### 409.7. Construction Joint

At the end of the day's work, a transverse construction joint for full depth shall be made by chamfering at an angle of 30°.

### 409.8. Surface finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 409.9. Strength

The Lime-flyash stabilised soil sub-base shall be tested for unconfined compressive strength (UCS) at 7-days. In case of variation from the design





UCS, insitu value being lower, the pavement design shall be reviewed based on the actual UCS values. The extra pavement thickness needed on account of lower UCS value shall be constructed by the Contractor at his own cost.

### 409.10. Arrangement of Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 409.11. Measurements for Payment

Lime-flyash stabilised soil subbase shall be measured as finished work in position in cubic metres.

### 409.12. Rate

The Contract unit rate for lime-flyash stabilised soil subbase shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v).

## 410. INDUSTRIAL WASTES FOR ROAD CONSTRUCTION

### 410.1. Scope

This Specification covers the techniques for incorporating (i) Flyash (waste material from Thermal Power Stations) in road embankments, subbase/base courses and (ii) Slags (waste materials from Iron and Steel industries) in sub-base, base or surface course as necessary, according to lines, grades and cross-sections drawn on the drawings or as directed by the Engineer.

### 410.2. Definition

Industrial Wastes for purposes of this Specification may be defined as waste materials having requisite engineering properties for use in rural road works in the vicinity of the industries/plants producing these waste materials.

### 410.3. Materials

#### 410.3.1. Flyash

**410.3.1.1. Use in flyash embankment construction** : While the quality of flyash varies a great deal from plant to plant, typical geotechnical

properties of flyash are given in Table 400.18. The information on flyash required by the Engineer for flyash embankment construction shall be as covered in Clause 306.2.1.

**TABLE 400.18 : TYPICAL GEOTECHNICAL PROPERTIES OF FLYASH**

| Parameter | Normal Range |
|---|---|
| Specific Gravity | 1.90-2.55 |
| Plasticity | Non-Plastic |
| Maximum Dry Density (gm/cc) | 0.9-1.60 |
| Optimum Moisture Content (%) | 38.0-18.0 |
| Cohesion ($kN/m^2$) | Negligible |
| Angle of internal Friction (j) | 30°-40° |
| Coefficient of Consolidation $C_v$ ($cm^2/sec$) | $1.7x10^{-5}$–$2.0x10^{-3}$ |
| Compression Index $C_c$ | 0.05-0.40 |
| Permeability (cm/sec) | $8x10^{-6}$–$7x10^{-4}$ |
| Particle Size Distribution (% of materials) | |
| Clay size fraction (less than 0.002 mm) | 1-10 |
| Silt size fraction (0.075 to 0.002 mm) | 8-85 |
| Sand size fraction (4.75 to 0.075 mm) | 7-90 |
| Gravel size fraction (80 to 4.75 mm) | 0-10 |
| Coefficient of Uniformity | 3-11 |

**410.3.1.2. Use in lime-flyash stabilised soil sub-base/base** : The chemical and physical requirements for flyash as a pozzolana are given in Tables 400.15 and 400.16 in Clause 409.3.1.

**410.3.1.3. Use in lime-flyash bound macadam** : The filler used shall be a mixture of flyash, lime and soil/moorum. The flyash shall conform to the requirements given in Tables 400.15 and 400.16 of Clause 409.3.1. Typical proportions of dry lime, flyash and soil/moorum in the filler are 1:2:9 (by weight).

### 410.3.2. Slag

Slag can be used as pavement material in a variety of forms. It can be





used as a base or subbase material. The broad types of slag are :

(i) Blast furnace slag

(ii) Granulated blast furnace slag (GBFS)

(iii) Steel slag

Some varieties of steel slag could be found lacking in stability in the presence of water owing to the hydration of calcium oxide. However, if such steel slags are left for weathering in stockpiles for sufficiently long period of time, these could be rendered suitable for use in road construction works.

Some of the typical test results conducted on slag materials are shown in Table 400.19.

**TABLE 400.19 : TEST RESULTS SHOWING PHYSICAL CHARACTERISTICS OF BLAST FURNACE SLAG AND STEEL SLAG**

| Physical Properties | Test Method | Blast Furnace | Steel Slag Slag |
|---|---|---|---|
| Aggregate impact value (%) | IS:2386 (Part 4) | 18-24 | 8-11 |
| Aggregate crushing value (%) | IS:2386 (Part 4) | 24-26 | 15-18 |
| Los Angeles abrasion value (%) | IS:2386 (Part 4) | 28-32 | 9-10 |
| Water absorption (%) | IS:2386 (Part 3) | 1.5-2.5 | 1-1.4 |
| Specific gravity ($kg/m^3$) | IS:2386 (Part 3) | 2650 | 3220 |

Air-cooled blast furnace slag and weathered steel slag can be used as coarse aggregate for the construction of sub-base and base courses. Granulated blast furnace slag, which is a pozzolanic material, can be stabilised using lime and used for construction of stabilised layers and lime-GBFS base/sub-base. GBFS can also be used in place of granular sub-base provided it meets the CBR requirements.

## 410.4. Construction Operations

### 410.4.1. Use of Flyash

(i) In flyash embankment construction : Clause 306.4 shall apply

(ii) In Lime-flyash stabilised soil sub-base/base : Clause 409.5 shall apply

(iii) In Lime-flyash bound macadam : Clause 405.3 shall apply except that the filler material shall be a mixture of lime, flyash and soil/ moorum (1:2:9)

### 410.4.2. Use of Crushed Slag

(i) In Soil-Aggregate Base/Surface : Clause 402.4 shall apply

(ii) In WBM construction : Clause 405.3 shall apply

(iii) In Cement Bound Granular Material : Clause 404.3 shall apply

### 410.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 410.6. Strength

In case of lime-flyash stabilised soil, Clause 409.9 shall apply. In case of Cement Bound Granular Material, Clause 404.5 shall apply.

### 410.7. Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 410.8. Measurements for Payment

For the flyash embankment construction, Clause 306.10 shall apply. The subbase/base/surface course, as the case may be, incorporating industrial wastes shall be measured as finished work in position in cubic metres.

### 410.9. Rate

For flyash embankment construction Clause 306.11 shall apply. The Contract unit rate for construction of sub-base/base/surface course incorporating industrial wastes shall be payment in full for carrying out the required operations including full compensation for all components in Clause 401.9 (i) to (v).





## 411. CRUSHER-RUN MACADAM BASE

### 411.1. Scope

This work shall consist of furnishing, placing and compacting crushed stone aggregate base course constructed in accordance with the requirements set forth in this Specification and in conformity with the lines, grades, thicknesses and cross-sections shown on the plans or as directed by the Engineer.

### 411.2. Materials

The material to be used for the work shall be crushed rock. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/ shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. It shall be free from any organic matter and other deleterious substances and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base. The aggregate shall conform to the grading and quality requirements shown in Tables 400.20 and 400.21.

**TABLE 400.20 : AGGREGATE GRADING REQUIREMENTS**

| Sieve Size | Per cent Passing b Weight | |
|---|---|---|
| | 53 mm Max. Size | 37.5 mm Max. Size |
| 63 mm | 100 | |
| 45 mm | 87-100 | 100 |
| 22.4 mm | 50-85 | 90-100 |
| 5.6 mm | 25-45 | 35-55 |
| 600 micron | 10-25 | 10-30 |
| 75 micron | 2-9 | 2-9 |

At the option of the Contractor, the grading for either 53 mm maximum size or 37.5 mm maximum size shall be used, except that once a grading is selected, it shall not be changed without the Engineer's approval.

### 411.3. Construction Operations

**411.3.1. Preparation of sub-base/subgrade** : Any ruts, deformations or soft yielding places which occur in the sub-base or subgrade shall be

TABLE 400.21 : PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR CRUSHER-RUN MACADAM BASE

| | Test | Test Method | Requirement |
|---|---|---|---|
| (1) | Aggregate Impact Value | IS:2386 (Part 4) or IS:5640 | 30 maximum |
| (2) | Flakiness Index | IS:2386 (Part 1) | 25 maximum |
| (3) | Water Absorption* | IS:2386 (Part 3) | 2 per cent maximum |
| (4) | Liquid Limit of Material Passing 425 micron | IS:2720 (Part 5) | Not more than 25 |
| (5) | Plasticity Index of Material Passing 425 micron | IS:2720 (Part 5) | Not more than 6 |

*If the water absorption is more than 2 per cent, soundness test shall be carried out as per IS:2386 (Part 5)

corrected and compacted to the required density before the aggregate base course is placed thereon.

**411.3.2. Spreading, watering, mixing and compaction** : The aggregate shall be uniformly deposited on the approved sub-base/ subgrade by means of the hauling vehicle with or without spreading devices. Aggregate will be distributed over the surface to the depth specified on the plans or as directed by the Engineer.

After the base course material has been deposited, it shall be thoroughly blade-mixed to full depth of the layer by alternately blading the entire layer to the centre and back to the edges of the road. It shall then be spread and finished to the required cross-section by means of suitable tractor-towed appliances.

Water shall be applied prior to and during all blading and processing operations to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall be applied in sufficient amounts during construction to assist in compaction.

Compaction shall commence immediately after the spreading operation. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN or equivalent





capacity roller. The speed of the roller shall not exceed 5 km per hour. Each layer of material shall be compacted to not less than 100 per cent of the maximum dry density as determined by IS:2720 (Part 7).

### 411.4. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

### 411.5. Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

### 411.6. Measurements for Payment

Crusher-run macadam base shall be measured as finished work in position in cubic metres.

### 411.7. Rate

The Contract unit rate for crusher run macadam base shall be payment in full for carrying out the required operations including full compensation for items as in Clause 401.9 (i) to (v).

## 412. BRICK SOLING

### 412.1. Scope

This work shall consist of laying brick soling layer on prepared subgrade in accordance with the requirements of these Specifications. The bricks shall be laid in one or more layers as soling according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

### 412.2. Materials

Burnt clay bricks shall conform to the requirements of IS:1077, except that the minimum compressive strength, when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. The brick shall have smooth rectangular faces with sharp

corners and emit a clear ringing sound when struck. The size may be according to the local practice with a tolerance of ± 5 per cent.

### 412.3. Setting Out

The edges of the soling shall be marked out with reference to the centre line by means of string and stakes. The lines shall be correctly ranged.

### 412.4. Preparation of Surface

The subgrade, to receive the brick soling shall be prepared to the required grade and camber and cleaned of all dust, dirt and other extraneous matter. Any ruts or soft yielding spots that may have appeared due to improper drainage or other reasons shall be corrected and rolled until firm, to the satisfaction of the Engineer.

### 412.5. Provision of Lateral Confinement

The side shoulders shall be constructed in advance to a thickness corresponding to the brick soling layer. The inside edges of the shoulders shall be trimmed vertical and any spillage over the included area removed. Alternatively, mud walls may be constructed to provide lateral confinements. Any excavation into the finished formation shall not be permitted. The compacted surface shall be scarified and levelled to proper camber and grade before laying the brick soling layer.

### 412.6. Laying

Bricks shall be set close to each other in herring bone bond or in header and stretcher bond laid on edge or flat in layer(s) as specified. The bricks shall be hand laid with no joint exceeding 10 mm in thickness.

### 412.7. Spreading Sand

After arranging the bricks in the specified pattern, sand or earth, free from clay with a Plasticity Index not exceeding 6 shall be spread over the surface to a thickness of about 25 mm so that the joints may be filled up by the sand working in. Sand shall be allowed to remain as a protective covering to the soling till such time as a subsequent pavement layer is laid over the soling. No traffic shall be allowed and the soling lightly rammed so that the sand works into the interstices.





### 412.8. Surface Evenness

The finished surface shall be checked for the longitudinal and cross profiles.

The maximum allowable difference between the brick soling surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line, at points decided by the Engineer shall be 10 mm.

### 412.9. Measurements for Payment

Laying of brick soling shall be measured in square metres of the area covered. Making of any mud walls shall be considered incidental to the work and no extra payment shall be made for it.

### 412.10. Rate

The contract unit rate for brick soling shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v).

## 413. STONE SET PAVEMENT

### 413.1. General

A Stone Set Pavement is best suited to areas with slow moving vehicles and low volume traffic, where good quality stones are locally available and craftsmen with knowledge of stone paving are available.

### 413.2. Scope

This Specification shall apply to the construction of Stone Set Pavement with a total pavement crust comprising of 100 mm compacted Granular Sub-base, 75 mm compacted Water Bound Macadam (Grade II) Base and 150 mm thick hammer-dressed Stone sets paved on a bedding sand layer over the WBM Base. This work shall be finished in accordance with the requirements of these Specifications and in conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

### 413.3. Materials

For the Granular Sub-base, Clause 401.2 shall apply. For the Water Bound Macadam (Grade II) Base, Clause 405.2 shall apply.

Stone sets shall be rectangular in shape, 250 mm to 300 mm long, 150 mm to 200 mm wide and 150 mm deep, with tolerance plus or minus 12 mm. The Stone sets shall be hard with an Aggregate Impact Value not more than 30 (IS:2386 Part 4), Polished Stone Value not less than 55 (BS 812 Part 114) and Water Absorption not more than 2 per cent (IS:2386 Part 3). The types of Stones normally used are Granite, Basalt, Sandstone and Limestone. Sedimentary stone shall in no case be used. The Stone sets shall be hammer dressed on top to the extent that maximum depression of the dressed surface from a straight edge applied across any part of the surface for testing does not exceed 20 mm. The dressing on the sides shall be similarly carried out, so as to obtain a mortar joint not exceeding 20 mm in width.

### 413.4. Construction Operations

For the preparation of subgrade and construction of 100 mm thick compacted Granular Sub-base, Clause 401.4 shall apply.

For the construction of 75 mm thick compacted Water Bound Macadam (Grade II) Base, Clause 405.3 shall apply.

The hammer-dressed stones are laid in the herringbone or stretcher bond pattern with the rows running either across or at 45° to the axis of the road. The stones are compacted into the properly graded coarse bedding sand over the WBM base, bounded by edgestones, using suitable compacting devices. The compacted thickness of bedding sand shall be 40 mm. The joint gaps are filled with fine sand, stone dust, or sand-cement mortar. Joints can also be sealed with hot sand-bitumen mix. In case of application of sand-cement mortar for filing joints, moist curing for minimum one week has to be ensured. Stone set shall be laid in sections not exceeding 12 m in length, with longitudinal axis of the stone sets parallel to the length of the road. Edgestones shall be 350 mm to 400 mm long, 150 mm to 200 mm wide and depth not less than 350 mm, laid with their longitudinal axis parallel to the length of the road.

### 413.5. Surface Evenness

The surface finish of construction shall conform to the requirements of Clause 1802.

### 413.6. Measurements for Payment

The measurements for payment in respect of Granular Sub-base and





the Water Bound Macadam Base shall be as per Clauses 401.8 and 405.6 respectively. The stone-sett paving shall be measured as finished work in position in square metres.

### 413.7. Rate

The Contract unit rate for the Stone-Sett Pavement shall be payment in full for carrying out the required operations including full compensation for all the components listed in Clause 401.9 (i) to (v).

*Annexure-400.1*

**(Clauses 403.3.2, 404.3.2 and 409.5.3)**

## METHOD OF SIEVING FOR WET SOILS TO DETERMINE THE DEGREE OF PULVERISATION

1. A sample of pulverised soil approximately 1 kg in weight should be taken and weighed ($W_1$).

2. It should be spread on the sieve and shaken gently, care being taken to break the lump of soils as little as possible. Weight of soil retained on the sieve should be recorded ($W_2$). Lumps of finer soils in the retained material should be broken until all the individual particles finer than the aperture size of the sieve are separated.

3. The soil should again be placed on the sieve and shaken until sieving is complete. The retained material should be weighed ($W_3$).

4. Weight of soil by per cent passing the sieve can than be calculated from the expression:

$$\frac{(W_1 - W_2) \times 100}{(W_1 - W_3)}$$





# 500

# Bituminous Construction

## 501. PREPARATION OF SURFACE

### 501.1. Scope

This work shall consist of preparing an existing granular or black-topped surface in advance of laying a bituminous course. The work shall be performed on such widths and lengths as shown on the drawings or as instructed by the Engineer. The existing surface shall be firm and clean, and treated with Primer or Tack Coat as shown on the drawings or as otherwise stated in the Contract.

### 501.2. Preparation of Surface

**501.2.1. Preparing existing granular surface :** Where the existing surface is granular, all loose materials shall be removed and the surface lightly watered, where the profile corrective course to be provided as a separate layer is also granular. The surface finish of all granular layers on which bituminous works are to be placed shall be free from dust. All such layers must be capable of being swept, after the removal of any non-integral loose material, by means of a mechanical broom, without shedding significant quantities of material and dust removed by air jet, or other means approved by the Engineer.

After cleaning, the surface shall be correct to line, level and cross-slope, within the tolerances specified for base course.

Where the profile corrective course of bituminous material is to be laid over the existing granular surface, the latter shall, after removal of all loose material, be primed in accordance with Clause 502.

**501.2.2. Scarifying existing bituminous surface :** Where specified or shown on the drawings, the existing bituminous layer in the specified width shall be removed with care and without causing undue disturbance to the underlying layer, by a suitable method approved by the Engineer. After removal of all loose and disintegrated material, the underlying layers which might have been disturbed, shall be suitably removed and compacted to line, level and cross-slope. After supplementing the base material as necessary with suitable fresh stone aggregates, the compacted finished surface shall be primed in accordance with Clause 502. Reusable material shall be stacked as directed by the Engineer within 1000 m of their origin.

**501.2.3. Preparing existing bituminous surface** : Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed as outlined in Clauses 501.2.3.1 and 501.2.3.2.

### 501.2.3.1. Filling potholes and patch repairs:

**(a) Preparation of the area for pothole and patch repair**

Pothole and patch repair area shall be inspected and all loose material removed. The area shall be cut/ trimmed with hand tools suitable for the purpose, such that the defective material responsible for the failure is all removed and such that the excavation is of a rectangular shape. The edges of the excavation shall be cut vertically. The area shall be thoroughly cleaned with brush, compressed air or any appropriate method approved by the Engineer to remove all dust and loose particles. Layers below the level of the bituminous construction shall be replaced using material of equivalent specification to the original construction, which shall particularly include the standards of compaction. The area of bituminous construction shall be tacked or primed, preferably with an emulsion depending upon whether the lower area is bituminous or granular in nature. The sides, however, are to be painted with tack coat material using a hand brush/ sprayer. The prime coat and tack coat shall conform to Clauses 502 and 503 of these Specifications respectively.

**(b) Backfilling operation**

The mixture to be used in bituminous patching shall be either a hot mix or cold mix in accordance with the appropriate Clauses of these Specifications. Mixing shall be done in a plant of suitable capacity. The bituminous mixture shall be placed in layers of thickness not more than 100 mm (loose) and shall be compacted in layers with roller/plate compactor/hand roller/rammer to the compaction standards defined in the appropriate Clauses of these Specifications. While placing the final layer, the mix shall be spread slightly proud of the surface so that after rolling, the surface shall be flush with the adjoining surface. If the area is large, the spreading and levelling shall be done using hand shovels and wooden edges. Where required, a seal coat shall be applied as per Clause 510. During the process of compaction, the surface levels shall be checked using a 3 m straight edge.

### 501.2.3.2. Crack sealing

**(a) Fine cracks less than 3 mm in width**

Sealing of fine cracks shall be done by applying Fog Seal. Fog Seal is a very light application of low viscosity Slow Setting Emulsion, for sealing cracks less than 3 mm in width. The surface on which the fog spray is to be applied shall be thoroughly cleaned with compressed air, scrubbers, etc. The cracks shall be cleaned with a pressure air jet to remove all dirt, dust, etc. The fog spray shall be applied at a rate 0.5-1.0 litres/m$^2$ of the specified quantity of emulsion, using equipment such as pressure tank,





flexible hose and spray bar or lance. For sites at sub-zero temperature, crack sealing by Medium Curing Cutback as per IS:217 shall be permissible.

**(b) Wide cracks**

For wider cracks, in excess of an average of 3 mm in width, the application of emulsion may be preceded by an application of crusher dust or other fine material acceptable to the Engineer. The bituminous emulsion for use in crack sealing shall be of a low viscosity Slow Setting type (SS grade). For sites at sub-zero temperature, the use of Medium Curing Cutback as per IS:217 shall be permissible. Dust for crack filling when used, shall be crusher dust or some other fine material, approved by the Engineer, passing 4.75 mm sieve. Dust or other suitable fine material shall be placed in the cracks before the application of binder and the cracks filled to a level approximately 5 mm below road surface level. The surface of the road shall be swept clear of dust prior to the application of binder. Binder shall be poured into the cracks, taking care to minimize spillage. If spillage onto the road surface does occur, dust shall be applied to the excess bitumen until it is blotted up.

Where wide cracks occur in isolated areas, these shall be cut and patched as per Clause 501.2.3.1.

## 501.3. Profile Corrective Course

Where specified, a Profile Corrective Course shall be provided prior to laying of bituminous surfacing.

**501.3.1.** The profile corrective course is essentially a levelling course laid to varying thickness as shown on the drawings for correcting the existing pavement profile which has either lost its shape or has to be given a new shape to meet the requirement of specified lines, grades and cross-sections. It shall be differentiated from the strengthening course or other type of structural pavement course needed as a remedial measure against inherent deficient and/ or distressed pavement. It is meant to remove the irregularity in the existing road profile only.

**501.3.2.** Over an existing bituminous surface, prepared as per para 501.2.3, the Profile Corrective Course shall be of premixed bituminous material conforming to Clause 508. Where the existing surface is granular in nature, prepared as per Clause 501.2.1, or where the old bituminous layer has been scarified as per Clause 501.2.2 and the required thickness of Profile Corrective Course is over 40mm, the Profile Corrective Course shall be with WBM (G3) material. If, however, the required thickness

of the Profile Corrective Course is less than 40mm, the Profile Corrective Course shall be premixed bituminous material conforming to Clause 508.

### 501.3.3. Laying the profile corrective course

**501.3.3.1. On granular base** : After preparing the granular surface as in Clauses 501.2.1 and 501.2.2, the profile corrective course with material as per Clause 501.3.2 shall be laid and compacted to the requirement of the particular Specification. Where a bituminous profile corrective course is to be laid over a primed granular surface, a tack coat conforming to Clause 503 shall be applied prior to laying the profile corrective course.

**501.3.3.2. On bituminous surface** : The existing bituminous surface shall be prepared as per Clause 501.2.3 and after applying a tack coat conforming to Clause 503, the bituminous profile corrective course shall be laid and compacted to the requirement of the particular Specification.

**501.3.3.3. Correction of short sags or depressions** : In specific situation of short sags or depressions in the pavement, it may become necessary to provide corrective course in the form of flat wedges. Normally, layers in maximum thickness of each layer at any point shall not be more than 100mm. In placing multiple lifts, the lift of shortest length (at the lowest portion of the sag/depression) shall be provided first, with successive lifts extending over and fully covering underneath layer, precluding development of a series of joints on the surfaces, as illustrated in Fig. 500.1.

**501.3.3.4. Correction for camber/superelevation** : For camber correction or correction of superelevation of the existing carriageway, the method as shown in Fig. 500.2 shall be adopted depending on the profile of the existing carriageway.

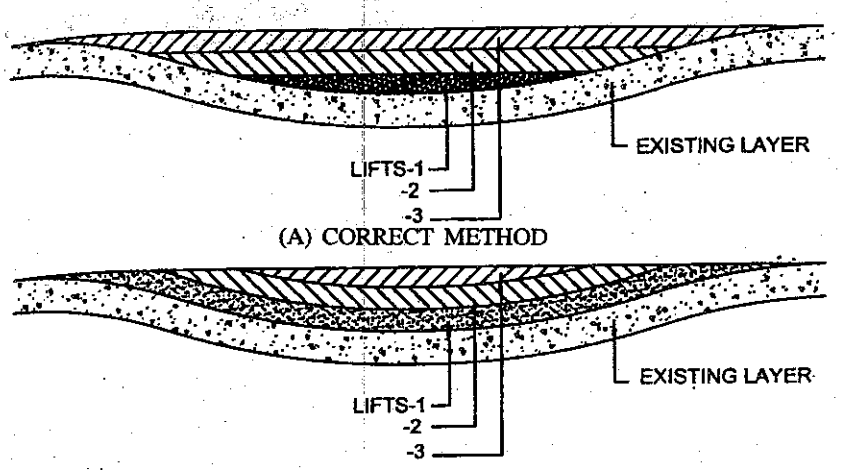
**501.3.3.5. Covering the profile corrective course** : Work of Profile Corrective Course shall be so planned that it shall be covered by the designed base/wearing course at the earliest, before opening to regular traffic.

### 501.4. Surface Finish and Quality Control of Work

Relevant provisions of Section 1800 shall be exercised by the Engineer.








*Note:* Profile corrective course material to be in accordance with the lift thickness.

**Fig. 500.1.** Methods for providing corrective course for short sages and depressions

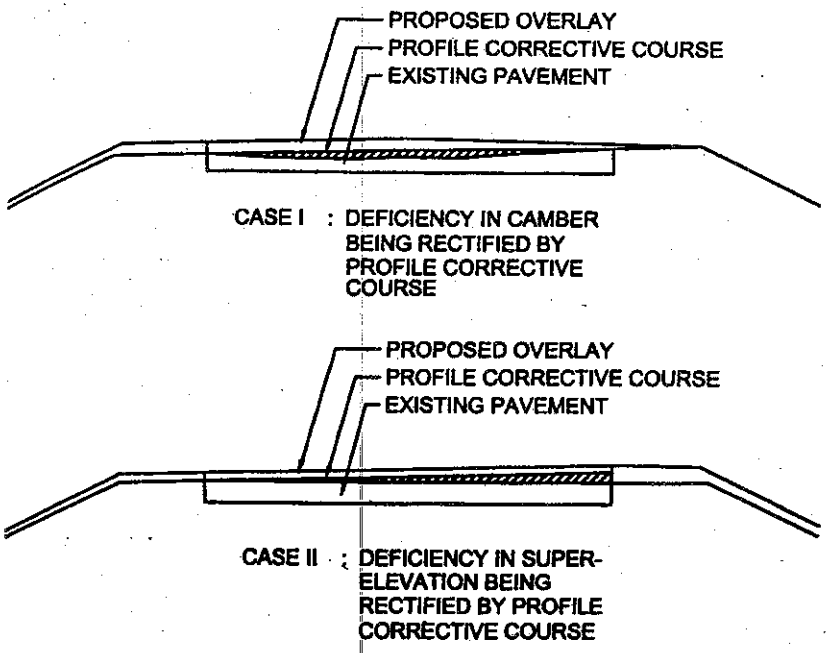



**Fig. 500.2.** Correction of camber or superelevation

### 501.5. Arrangement for Traffic

During the construction operations, arrangement of traffic shall be done to Clause 111.

### 501.6. Environmental Protection

Detailed Guidelines on the Protection of the Environment are provided at ***Annexure-500.1.***

### 501.7. Measurements for Payment

**501.7.1.** The work of filling potholes shall be measured separately and paid for in square metres.

The work of sealing cracks by applying fog seal shall be measured in square metres, and paid separately. The work of filling cracks larger than 3mm width shall be measured and paid for on a linear metre/square metre basis as specified in the Contract.

**501.7.2.** Scarifying existing bituminous surface shall be measured in square metres.

**501.7.3.** Prime coat shall be measured as per Clause 502.7 of these Specifications.

**501.7.4.** Tack coat shall be measured as per Clause 503.7 of these Specifications.

**501.7.5.** Profile Corrective Course shall be measured as volume compacted in position in cubic metres or in tonnage as specified in the contract. The volume shall be worked out by plotting the exact profile of Profile Corrective Course as built up at site and superimposed on the existing pavement profile.

### 501.8. Rate

**501.8.1.** Contract unit rate for scarifying of existing bituminous surfaces including repairing/resetting disturbed underlying layer and also removing and stacking reusable/unusable materials shall include cost of all labour, supply of materials needed for repair/resetting, hire charges of tools and plant and transportation of scarified materials with all lifts and upto a lead of 1000 m.





**501.8.2.** The contract unit rate for filling of potholes and patch repair shall be payment in full for :

(i) furnishing all materials required

(ii) all works involved including excavation, trimming, backfilling with any non-bituminous layers required, tacking, priming with emulsion or cutback and backfilling with bituminous materials

(iii) all labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

**501.8.3.** The contract unit rate for application of fog seal shall be payment in full for :

(i) supplying of fog seal material and all the operations for applying it; and

(ii) all labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

**501.8.4.** The contract unit rate for crack filling shall be payment in full for :

(i) supplying all necessary materials for the work and applying them; and

(ii) all labour, tools, equipment and all incidentals necessary to complete the work in accordance with the Specifications.

**501.8.5.** The contract unit rate for Profile Corrective Course shall be payment in full for carrying out the required operations including full compensation for :

(i) Making arrangements for traffic to Clause 111;

(ii) Providing all materials to be incorporated in the work including any royalties, fees, rents (where applicable) and all leads and lifts;

(iii) Preparation of the exposed surface/existing surface including all cleaning operations;

(iv) All labour, tools, equipment, testing for quality control and incidentals necessary to complete the work to the Specifications;

(v) Mixing, transporting, laying and compacting the bituminous mix as specified; and

(vi) Carrying out the work in part widths of road where directed by the Engineer.

## 502. PRIME COAT OVER GRANULAR BASE

### 502.1. Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

### 502.2. Materials

**502.2.1. Primer** : The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC:16. These are :

(i) Surfaces of low porosity; such as wet mix macadam and water bound macadam;

(ii) Surfaces of medium porosity; such as cement stabilised soil base; and

(iii) Surfaces of high porosity; such as, a gravel/soil-aggregate base.

**502.2.2. Primer viscosity** : The type and viscosity of the primer shall comply with the requirements of IS:8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in Table 500.1.

**TABLE 500.1 : REQUIREMENTS OF VISCOSITY AND QUANTITY OF LIQUID BITUMINOUS MATERIALS FOR PRIMING**

| Porosity | Type of Surface | Kinematic Viscosity of Primer at 60°C (Centistokes) | Saybolt Furol Viscosity at 60°C (Seconds) | Quantity per 10 sqm (kg) |
|---|---|---|---|---|
| Low | WBM/WMM | 30-60 | 14-28 | 7-10 |
| Medium | Stabilized Base | 70-140 | 33-66 | 9-12 |
| High | Gravel Base | 250-500 | 117-234 | 12-15 |

**502.2.3. Choice of primer** : The primer shall be Slow Setting Bitumen Emulsion Grade SS-1, complying with IS:8887 or as specified in the Contract or as directed by the Engineer. The use of medium curing cutback as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications.

### 502.3. Weather and Seasonal Limitations

Bituminous primer shall not be applied to a wet surface (see Clause





502.4.2) or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present.

### 502.4. Construction

**502.4.1. Equipment** : The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips shall be permitted with a pressure hand sprayer. Use of a hand held perforated cannister shall, however, not be permitted.

**502.4.2. Preparation of road surface** : The surface to be primed shall be prepared in accordance with Clause 501. Immediately prior to applying the primer, the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

**502.4.3. Application of bituminous primer** : The bituminous primer shall be sprayed/distributed uniformly over the dry surface, prepared as per Clause 502.4.2, using self-propelled or towed sprayer, capable of supplying primer at specified rates and temperature so as to provide a uniformly unbroken spread of primer. If the surface to be primed is so dry or dusty as to cause freckling of bituminous material, it shall be lightly and uniformly sprinkled with water immediately prior to priming; however, the bituminous material shall not be applied till such time as no surface water is visible. The primer shall be applied at the rate as specified in Table 500.1.

Temperature of application of a primer need only be high enough to permit the primer to be effectively sprayed through the jets of the spray bar and to cover the granular base surface uniformly in the desired quantity. For a bituminous emulsion primer, the range of spraying temperature shall be 20°C to 60°C and for cutback 50°C-80°C if Medium Curing grade is used.

The primer coat shall be applied only on the topmost water bound macadam or any granular layer, over which the bituminous base course/ wearing course is to be laid.

**502.4.4. Curing of primer and opening to traffic** : A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

**502.4.5. Tack coat** : Over the primed surface, a tack coat should be applied in accordance with Clause 503.

### 502.5. Quality Control of Work

For control of the quality of materials supplied and the works carried out, the relevant provision of Section 1800 shall apply.

### 502.6. Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### 502.7. Measurements for Payment

Prime coat shall be measured in terms of surface area of application in square metres.

### 502.8. Rate

The contract unit rate for prime coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.9 (i) to (v) and as applicable to the work specified in these Specifications.

## 503. TACK COAT

### 503.1. Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or instructed by the Engineer.





### 503.2. Materials

**503.2.1. Binder** : The binder used for tack coat shall be Rapid Setting Bitumen Emulsion Grade RS-1 complying with IS:8887 or as specified in the Contract. The use of cutback bitumen (Medium Curing grade) as per IS:217 shall be restricted only for sites at sub-zero temperature or for emergency applications as directed by the Engineer.

### 503.3. Weather and Seasonal Limitations

Bituminous material shall not be applied to a wet surface or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

### 503.4. Construction

**503.4.1. Equipment** : The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be permitted with a pressure hand sprayer, or as directed by the Engineer.

**503.4.2. Preparation of base** : The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of Clause 501. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, or by other means as directed by the Engineer.

**503.4.3. Application of binder** : The binder shall be sprayed on the base at the rate specified in Table 500.2. The normal range of spraying temperature for a bituminous emulsion shall be 20°C–60°C and for a cutback 50°C-80°C if Medium curing grade is used. It shall be the responsibility of the Contractor to carefully handle the inflammable bituminous cutback material so as to safeguard against any fire mishap. The binder shall be applied uniformly with the aid of either self-propelled or towed bitumen pressure sprayer capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen. Work should be planned so that no more than the necessary tack coat for the day's operation is placed on the surface.

TABLE 500.2 : RATE OF APPLICATION OF TACK COAT

| Type of Surface | Quantity of Bituminous Emulsion in kg per square metre area |
|---|---|
| (i) Normal bituminous surfaces | 0.20 to 0.25 |
| (ii) Dry and hungry bituminous surfaces | 0.25 to 0.30 |
| (iii) Granular surfaces treated with primer | 0.25 to 0.30 |
| (iv) Cement Concrete Pavement | 0.30 to 0.35 |

**503.4.4. Curing of tack coat** : The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat.

### 503.5. Quality Control of Work

For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### 503.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### 503.7. Measurements for Payment

Tack coat shall be measured in terms of surface area of application in square metres.

### 503.8. Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components listed in Clause 401.9 (i) to (v) and as applicable to the work specified in these Specifications.

## 504. BITUMINOUS MACADAM

### 504.1. Scope

This work shall consist of construction in a single course having 50 mm to 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of these Specifications.





### 504.2. Materials

**504.2.1. Bitumen** : The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS:73, or Modified Bitumen conforming to Clause 512 or as directed by the Engineer. Further guidelines on the choice of bitumen depending on the maximum and minimum annual temperatures ($T_{max}$ and $T_{min}$) in the area are given at ***Annexure-500.2.***

**504.2.2. Aggregates** : The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where the Contractor's selected source of aggregate have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with approved anti-stripping agents, as per the manufacturer's recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping.

The aggregates shall satisfy the physical requirements set forth in Table 500.3.

Where crushed gravel is proposed for use as aggregate, not less than

TABLE 500.3 : PHYSICAL REQUIREMENTS FOR AGGREGATES FOR BITUMINOUS MACADAM

| Property | Test | Specification |
|---|---|---|
| Particle shape | Flakiness Index[1] | Max. 25 per cent |
| Strength | Aggregate Impact Value [2] | Max. 30 per cent |
| Durability | Soundness [3]<br>Sodium Sulphate<br>Magnesium Sulphate | <br>Max. 12 per cent<br>Max. 18 per cent |
| Water Absorption | Water absorption [4] | Max. 2 per cent |
| Stripping | Coating and stripping of bitumen aggregate mixtures [5] | Min. retained coating 95 per cent |

Notes : 1. IS:2386 Part 1
2. IS:2386 Part 4*
3. IS:2386 Part 5
4. IS:2386 Part 3
5. IS:6241

* Aggregates may satisfy requirements or either of these two tests.

90 per cent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Fine aggregates shall consist of crushed material, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter.

**504.2.3. Aggregate grading and binder content** : When tested in accordance with IS:2386 (Part 1) (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in Table 500.4. The type and quantity of bitumen are also indicated in Table 500.4.

**TABLE 500.4 : COMPOSITION OF BITUMINOUS MACADAM**

| IS Sieve (mm) | Cumulative Per cent Passing by Weight of Total Aggregate |
|---|---|
| 26.5 | 100 |
| 19 | 90-100 |
| 13.2 | 56-88 |
| 4.75 | 16-36 |
| 2.36 | 4-19 |
| 0.3 | 2-10 |
| 0.075 | 0-5 |
| *Bitumen content, % by weight of total mixture | 3.3-3.5 |
| Bitumen Penetration Grade | 35 to 90 |

* For conditions in cooler areas of India or where the per cent passing 0.075 mm sieve is on the higher side of the range, appropriate bitumen contents may be upto 0.5 per cent higher, subject to the approval of the Engineer.

The binder content shall be within a tolerance of ± 0.3 per cent by weight of total mixture when individual specimens are taken for quality control tests in accordance with the provisions of Section 1800.

### 504.3. Construction Operations

**504.3.1. Weather and seasonal limitations** : Laying of bituminous mixtures shall not be carried out when the air temperature at the surface over which it is to be laid is below 10°C or when the wind speed at any





temperature exceeds 40 km/hr at 2m height unless specifically approved by the Engineer. Laying shall be suspended while free-standing water is present on the surface to be covered, or during rain, fog and dust storms. After rain, the surface shall be left to dry before laying shall start.

**504.3.2. Preparation of the base** : The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clause 501, as appropriate, and a prime coat, on granular base shall be applied in accordance with Clause 502 where specified, or as directed by the Engineer.

**504.3.3. Tack coat** : A tack coat in accordance with Clause 503 shall be applied as specified in the Contract or as directed by the Engineer.

**504.3.4. Preparation and transportation of mix** : Bituminous Macadam shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table 500.7 of these Specifications; the difference in temperature between the binder and aggregate should at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time. A batch type or continuous type or a spot mixer may be used for preparation of mix as decided by the Engineer. If a continuous mixing plant is to be used for mixing, the Contractor must demonstrate by laboratory analysis that cold feed combined grading is within permissible grading limits and binder content is in compliance to job mix formula. The maximum permitted variation in binder content shall be 0.3 per cent.

Bituminous Macadam shall be transported in clean insulated vehicles and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicles to prevent sticking and to facilitate discharge of the material. Any tipper causing excessive segregation of materials by its spring suspension or other contributing factors or that which shows undue delay shall be removed from the work until such conditions are corrected.

**504.3.5. Spreading** : Except in areas where a mechanical paver cannot access, premixed bituminous macadam shall be spread, levelled, and tamped by an approved self-propelled paving machine. As soon as

possible, after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver and its method of operation, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and levelled with suitable hand tools by experienced staff and compacted to the satisfaction of the Engineer.

However, in restricted locations and in narrow widths where the available plant cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix.

**504.3.6. Compaction** : After the spreading of mix, rolling shall be done by 80 to 100 kN static weight rollers or other approved equipment. Rolling shall start as soon as possible after the material has been spread deploying a set of rollers as the rolling is to be completed in limited time frame. The roller shall move at a speed not more than 5 km/hr. Rolling shall be done with care to avoid unduly roughening of the pavement surface.

Rolling shall commence at the edges and progress towards the centre longitudinally except that on superelevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centreline of the pavement.

The initial or break-down rolling shall be done with 80 to 100 kN static weight rollers, as soon as it is possible to roll the mix without cracking the surface or having the mix pick up on the roller wheels. The second or intermediate rolling shall follow the break-down rolling with vibratory roller of 80 to 100 kN static weight or a suitable pneumatic tyred roller as closely as possible to the paver and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while material is still workable, as per the temperatures given in Table 500.5. The joints and edges shall be rolled with a 80 to 100 kN static weight roller.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or





adding mix material. The rolling shall then be continued till there is no crushing of aggregates and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. The roller wheel shall be kept damp if necessary to avoid bituminous material from sticking to the wheels and being picked up. In no case shall fuel, lubricating oil be used for this purpose, nor excessive water poured on the wheels. The initial wetting of the roller wheels should be done outside the compaction area.

Rolling operations shall be completed in every respect before the temperature of the mix falls below the rolling temperature given in Table 500.5.

**TABLE 500.5 : MANUFACTURING AND ROLLING TEMPERATURES**

| Bitumen Penetration | Bitumen Mixing (°C) | Aggregate Mixing (°C) | Mixed Material (°C) | Laying (°C) | Rolling (°C) |
|---|---|---|---|---|---|
| 35 | 160-170 | 160-175 | 170 maximum | 140 minimum | 110 minimum |
| 65 | 150-165 | 150-170 | 165 maximum | 130 minimum | 100 minimum |
| 90 | 140-160 | 140-165 | 155 maximum | 130 minimum | 100 minimum |

Roller(s) shall not stand on newly laid material while there is a risk that surface will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it, as per Clause 504.3.7.

Where Modified Bitumen is used, the manufacturing and rolling temperatures shall be as per Clause 512.4.2.

**504.3.7. Joints** : For single-lane road construction, only transverse joints are made, while for double-lane road construction, longitudinal joints have also to be made in addition to transverse joints. While forming joints, it is necessary that the premixed material shall be fully compacted and the joint made flush by cutting back the exposed joint for a distance equal to the specified layer thickness, to a vertical face, discarding all loosened material. The vertical face shall be coated completely with 80/100 penetration grade hot bitumen, or cold-applied bitumen, or polymer modified adhesive bitumen tape with a minimum thickness of 2mm, before the adjacent width is laid.

### 504.4. Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of Clause 1802. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### 504.5. Protection of the Layer

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay on account of the construction procedure adopted by the Contractor, the course shall be covered by a seal coat to the requirement of Clause 509 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

### 504.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### 504.7. Measurements for Payment

The work shall be measured as finished work in cubic metres or by weight in metric tonnes as provided in the Contract.

### 504.8. Rate

The contract unit rate for the work shall be payment in full for carrying out the required operations including full compensation for :

(i) Making arrangements for traffic to Clause 111 except for initial treatment to verges, shoulders and construction of diversions;

(ii) Preparation of base;

(iii) Providing all materials to be incorporated in the work including arrangement for stockyards, all royalties, fees, rents where necessary and all leads and lifts;

(iv) Mixing, transporting, laying and compacting the mix, as specified;

(v) All labour, tools, equipment, plant including laying trials, if directed by the Engineer, installation of hot mix plant, power supply units and all machineries, incidental to complete the work to the Specifications;

(vi) Carrying out the work in part widths of the road where directed;

(vii) Carrying out all tests for control of quality;





(viii) The rate shall cover the provision of bitumen at 3.4 per cent of weight of total mix, with the provision that the variation of quantity of bitumen will be assessed and the payment adjusted as per the rate of bitumen quoted; and

(ix) The rates for premixed material shall include for all wastage in cutting of joints, etc.

## 505. BUILT-UP SPRAY GROUT

### 505.1. Scope

This work shall consist of a two-layer composite construction of compacted crushed coarse aggregates with application of bituminous binder after each layer, and with key aggregates placed on top of the second layer, in accordance with the requirements of these Specifications, to serve as a base course and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The thickness of the course shall be 75 mm.

### 505.2. Materials

**505.2.1. Bitumen** : Clause 504.2.1 shall apply. Where permitted by the Engineer, an appropriate grade of emulsion complying with IS:8887 may be used.

**505.2.2. Aggregates** : The coarse aggregate shall conform to Clause 504.2.2.

The aggregate shall satisfy the physical requirements set out in Table 500.3. The coarse and key aggregates for built-up spray grout shall conform to the grading given in Table 500.6.

**TABLE 500.6 : GRADING REQUIREMENTS FOR COARSE AND KEY AGGREGATES FOR BUILT-UP SPRAY GROUT**

| IS Sieve Designation (mm) | Cumulative per cent by weight of total aggregate passing | |
|---|---|---|
| | Coarse Aggregate | Key Aggregate |
| 53.0 | 100 | – |
| 26.5 | 40-75 | – |
| 22.4 | – | 100 |
| 13.2 | 0-20 | 40-75 |
| 5.6 | – | 0-20 |
| 2.8 | 0-5 | 0-5 |

### 505.3. Construction Operations

**505.3.1. Weather and seasonal limitations** : The provisions of Clause 504.3.1 shall apply.

**505.3.2. Equipment** : A mechanical broom, compressor, self-propelled or trailed bitumen heater/distributor and 80 to 100 kN smooth steel-wheeled roller are required.

**505.3.3. Preparation of base** : The base on which the built-up spray grout course is to be laid shall be prepared, shaped and compacted to the specified lines, grades and cross-sections in accordance with Clause 501. A prime coat shall be applied in accordance with Clause 502 with approved primer as directed by the Engineer.

**505.3.4. Tack coat** : A tack coat shall be applied in accordance with the procedure described in Clause 503, as directed by the Engineer.

**505.3.5. Spreading and rolling coarse aggregates for the first layer** : Immediately after the application of primer/tack coat, the clean, dry and dust free coarse aggregates shall be spread uniformly and evenly, by mechanical means or as directed by the Engineer, at the rate of 0.5 cu.m. per 10 sq.m. area.

Immediately after spreading of the aggregates, the entire surface shall be rolled with an 80 to 100 kN static weight roller. Rolling shall commence at the edges and progress towards the centre except in superelevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass.

The surface of the layer shall be carefully checked, after rolling, with a template and straight edge and shall be within the tolerances specified, and any deficiencies corrected by reworking and recompacting the layer.

Care shall be taken not to over-compact the layer.

**505.3.6. Application of binder-first spray** : The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the aggregate at the rate of 15 kg per 10 sq.m (measured in terms of residual bitumen content) at a uniform rate of spray by mechanical sprayers capable of spraying bitumen uniformly at the





specified rates and temperatures. Excessive deposits of binder caused by stopping or starting of the sprayers or through leakage or for any other reason shall be removed and made good.

**505.3.7. Spreading and rolling of coarse aggregate for the second Layer** : Immediately after the first application of the binder, the second layer of coarse aggregates shall be spread and rolled in accordance with the procedure detailed in Clause 505.3.5.

**505.3.8. Application of binder-second spray** : The second aggregate layer shall then be sprayed with binder at the rate of 15 kg per 10 sq.m (measured in terms of residual bitumen content) in accordance with Clause 505.3.6.

**505.3.9. Application of key aggregate** : Immediately after the second application of binder, key aggregates shall be spread uniformly and evenly, preferably by mechanical means, at the rate of 0.13 cu.m. per 10 sq.m so as to cover the surface completely. The key aggregate shall be clean, dry and free from dust and deleterious matter. If necessary, the surface shall be swept to ensure uniform application of the key aggregates. The entire surface shall then be rolled with an 80 to 100 kN smooth wheel steel roller in accordance with Clause 505.3.5. While rolling is in progress, additional key aggregates, where required, shall be spread by hand. Rolling shall continue until the entire course is thoroughly compacted and the key aggregates are firmly in position.

### 505.4. Surface Finish and Quality Control

The surface finish of construction shall conform to the requirements of Clause 1802. All materials shall comply with the requirements of the relevant provisions in Section 1800 of the Specifications.

### 505.5. Final Surfacing

The built-up-spray-grout shall be provided with final surfacing within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 510 before it is open to traffic. Where the seal coat is required as a result of the method selected by the Contractor for performing this operation, then it shall be considered incidental to the work and shall not be paid for separately.

### 505.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### 505.7. Measurements for Payment

Built-up spray grout shall be measured as finished work in square metres.

### 505.8. Rate

The contract unit rate for built-up spray grout shall be payment in full for carrying out the required operations as specified. The rate shall include for components listed in Clause 504.8, as applicable to the work specified in these Specifications.

## 506. MODIFIED PENETRATION MACADAM*

### 506.1. Scope

The work shall consist of construction of one or more layers of compacted coarse aggregates with alternate applications of bituminous

* This Specification is based on Appendix 8.4 of IRC:SP:20, which had to be totally relied upon, in the absence of any other reference available for the Specification. However, the more important points that emerge from Appendix 8.4 of IRC:SP:20 include the following:

(i) it does not specify any grading for aggregates

(ii) it does not specify any tack coat on a WBM surface, not even priming of the WBM surface

(iii) the specified quantity of bitumen is less than half the quantity specified for Penetration Macadam

(iv) over a black-topped surface, the specified quantity of bitumen for tack coat is not in conformity with MoRT&H Specifications

(v) the application temperature of binder has been specified as 177°C -191°C, which is on the higher side

(vi) only S-35 and S-65 grades of bitumen are specified

Some of the modifications made in this Clause are :

(i) a wider range of penetration grade bitumen, viz., S-35 to S-90 has been provided for

(ii) prime coat and tack coat quantities are specified according to Clause 502 and 503 respectively

(iii) a more practical range of application temperature of bitumen, i.e., 160°C-180°C has been specified.





binder and key aggregates in accordance with the requirements of these Specifications to be used as a base course on roads, subject to the requirements of the overall pavement design, in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Thickness of an individual course shall be 50 mm or 75 mm.

### 506.2. Materials

**506.2.1. Bitumen** : The binder shall be paving bitumen of penetration grade within the range of S-35 to S-90 as per Indian Standards Specifications IS:73 for "Paving Bitumen". The actual grade of bitumen to be used shall be as specified or as directed by the Engineer.

**506.2.2. Aggregates** : The aggregates shall satisfy the physical requirements set out in Clause 504.2.2 and the Table 500.3. The coarse and key aggregates shall be 40 mm size hand-broken metal and 12 mm size stone chips respectively. Upto 30 per cent of the total quantity of 40 mm size metal may comprise 40 mm crusher broken metal.

**506.2.3. Quantities of materials** : The quantities of materials used for this work shall be as specified in Tables 500.7 and 500.8.

### 506.3. Construction Operations

**506.3.1. Weather and seasonal limitations** : The provisions of Clause 504.3.1 shall apply.

**506.3.2. Equipment** : A mechanical broom, compressor, self propelled or trailed bitumen heater/distributor, mechanical aggregate spreader and 80 to 100 kN static weight roller or vibrating roller are required for the preparation of Modified Penetration Macadam (MPM).

**506.3.3. Preparation of the base** : The base on which the Modified Penetration Macadam course is to be laid shall be prepared, shaped and compacted to the specified lines, grades and sections to Clauses 501 and 1802 as appropriate, or as directed by the Engineer. A prime coat, where specified, shall be applied over the granular base in accordance with Clause 502 or as directed by the Engineer. A tack coat as per Clause 503 shall be applied.

**506.3.4. Spreading and compaction** : The coarse aggregate comprising 40 mm size metal shall be spread evenly at the specified rate of 9 cu.m. or 6 cu.m. per 100 sq.m. of area so as to form a layer (for 75

**TABLE 500.7: RATE OF APPLICATION OF AGGREGATES FOR 10 sq.m AREA**

| Description | Thickness of Modified Penetration Macadam Layer | | | |
|---|---|---|---|---|
| | 75 mm | | 50 mm | |
| | On Bituminous Surface (cum) | On WBM Surface (cum) | On Bituminous Surface (cum) | On WBM Surface (cum) |
| (a) 40 mm size hand broken metal | 0.9 | 0.9 | 0.6 | 0.6 |
| (b) 12 mm size stone chips | 0.18 | 0.18 | 0.18 | 0.18 |

**TABLE 500.8 : RATE OF APPLICATION OF BITUMEN FOR 10 sq.m AREA**

| Description | Thickness of Modified Penetration Macadam Layer | | | |
|---|---|---|---|---|
| | 75 mm | | 50 mm | |
| | On Bituminous Surface (cum) | On WBM Surface (cum) | On Bituminous Surface (cum) | On WBM Surface (cum) |
| (a) Bitumen for grouting | 20 | 20 | 17.5 | 17.5 |
| (b) Tack coat | As per Clause 503 | | | |

mm and 50 mm MPM respectively) over the width of road with correct camber/superelevation as required. Any foreign matter, organic matter, dust, grass etc shall be removed immediately. The sections shall be checked with camber board and straight edge batten, etc. Any irregularities shall be made good by adding aggregates in case of depressions and removing aggregates from high spots checked with camber board and straight edge batten, etc.

The surface of 40 mm metal layer, after bringing it to necessary grades and sections, shall be rolled with the use of 80 to 100 kN static weight roller. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portion, where it shall





progress from the lower to upper edge, parallel to the centre line of pavement. When the roller has passed over the whole area, any high spots or depressions, which become apparent, shall be corrected by removing or adding aggregates.

Rolling shall then be continued till the entire surface has been rolled to desired compaction such that there is no crushing of aggregates and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass.

**506.3.5. Application of bitumen** : Bitumen of paving grade S-35 to S-90 supplied for the work, shall be heated to a temperature of 160°C to 180°C, depending on the grade of bitumen in a bitumen boiler and this temperature shall be maintained at the time of actual application. The hot bitumen shall be applied through a pressure sprayer on road surface uniformly at the rate of 200 kg per 100 sq.m or 175 kg per 100 sq.m as the case may be. The road surface shall be divided into suitable rectangles marked by chalk so as to ensure correct rate of application of the bitumen.

**506.3.6. Key aggregates** : On completion of bitumen application, 12 mm size key aggregate shall be spread immediately at a uniform rate of 1.8 cu.m. or 1.2 cu.m. per 100 sq.m. Brooms shall be used to ensure even distribution of key aggregate.

**506.3.7. Final compaction** : Immediately after spraying of bitumen and spreading of key aggregates, the surface shall be rolled with a 80 to 100 kN static weight roller to obtain full compaction and to force the blindage of key aggregates into the intersections of the coarse aggregates. The rolling shall continue till the bituminous surface hardens and key aggregates stop moving under power roller.

### 506.4. Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of Clause 1802. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### 506.5. Final Surfacing

The Modified Penetration Macadam layer shall be provided with final surfacing within a maximum of forty eight hours. If there is to be any delay, the MPM layer shall be covered by a seal coat to the requirements

of Clause 510 before it is open to traffic. Where the seal coat is required as a result of the method selected by the Contractor for performing this operation, then it shall be considered incidental to the work and shall not be paid for separately.

### 506.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### 506.7. Measurements for Payment

The Modified Penetration Macadam layer shall be measured as finished work in square metres.

### 506.8. Rate

The contract unit rate for Modified Penetration Macadam layer shall be payment in full for carrying out the required operations as specified. The rate shall include for components listed in Clause 504.8 as applicable to the work specified in these Specifications.

## 507. SURFACE DRESSING

### 507.1. Scope

This work shall consist of the application of one coat or two coats of surface dressing, each coat consisting of a layer of bituminous binder sprayed on a previously prepared base, followed by a cover of stone chips rolled in to form a wearing course to the requirements of these Specifications.

### 507.2. Materials

**507.2.1. Binder** : The type of binder to be used will be stated in the Contract documents and shall comply with one of the following:

| | |
|---|---|
| Modified Bitumen | IRC:SP:53 |
| Paving Bitumen | IS:73 |
| Bitumen Emulsion | IS:8887 |

Paving Bitumen shall be a suitable Penetration grade S-65/90, or as appropriate to the region, traffic and climatic conditions as directed by the Engineer. Emulsions shall be Rapid Setting Cationic type of bitumen emulsions.





**507.2.2. Aggregates** : The chips shall conform to the requirements of Clause 504.2.2, except that their water absorption shall be restricted to a maximum of 1 per cent. The chips shall be single sized, clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter and conforming to one of the gradings given in Table 500.9.

**TABLE 500.9 : GRADING REQUIREMENTS FOR CHIPS FOR SURFACE DRESSING**

| IS Sieve Designation mm | Cumulative per cent by weight of total aggregate passing for the following nominal sizes (mm) | | |
|---|---|---|---|
| | 13.2 | 9.5 | 6.3 |
| 19.0 | 100 | - | - |
| 13.2 | 85-100 | 100 | - |
| 9.5 | 0-40 | 85-100 | 100 |
| 6.3 | 0-7 | 0-35 | 85-100 |
| 4.75 | - | 0-10 | - |
| 3.35 | - | - | 0-35 |
| 2.36 | 0-2 | 0-2 | 0-10 |
| 0.60 | - | - | 0-2 |
| 0.075 | 0-1.5 | 0-1.5 | 0-1.5 |
| Minimum 65% by weight of aggregate | Passing 13.2 mm, retained 9.5 mm | Passing 9.5 mm, retained 6.3 mm | Passing 6.3 mm, retained 3.35 mm |

The size of stone chips shall depend on the hardness of the existing surface and the volume of traffic. Guidelines for selecting the nominal size of stone chips are given at ***Annexure-500.3***. For average conditions, the nominal size of stone chips shall be in accordance with Table 500.10.

**507.2.3. Rates of spread of binder and chippings** : The rates of spread of binder and stone chippings shall be determined by adopting the procedure detailed in IRC:SP:20 (Rural Roads Manual), for different sets of conditions pertaining to traffic level, types of chippings, existing surface and climate etc. Average values obtained for normal conditions are given in Table 500.11. The average values given in Table 500.11 shall be taken for the purpose of pricing the Bill of Quantities.

**TABLE 500.10 : SIZE REQUIREMENTS OF STONE CHIPS FOR SURFACE DRESSING**

| Type of Construction | Nominal Size of Stone Chips | Specification |
|---|---|---|
| Single coat surface dressing or the first coat of two-coat surface dressing | 13.2 mm | 100 per cent passing IS sieve 22.4 mm size and retained on IS sieve 11.2 mm size |
| Second coat of two-coat surface dressing (also used as a renewal coat) | 9.5 mm | 100 per cent passing IS sieve 11.2 mm and retained on IS sieve 5.6 mm size |

**TABLE 500.11 : NOMINAL RATES OF SPREAD FOR BINDER AND CHIPPINGS**

| Nominal (cum/m²) | Binder (penetration Chipping Size (mm) | Bitumen Emulsion grade bitumen) Kg/m² | Chips (kg/m²) |
|---|---|---|---|
| 13.2 | 1.0 | 1.5 | 0.010 |
| 9.5 | 0.9 | 1.4 | 0.008 |
| 6.3 | 0.75 | 1.1 | 0.004 |

**507.2.4. Anti-stripping agent** : Where the proposed aggregate fails to pass the stripping test, then an approved adhesion agent may be added to the binder in accordance with the manufacturer's instructions. The effectiveness of the proposed anti-stripping agent must be demonstrated by the Contractor, before approval by the Engineer.

**507.2.5. Pre-coated chips** : As an alternative to the use of an adhesion agent, the chips may be pre-coated before they are spread except when the sprayed binder film is a bitumen emulsion. Pre-coating the chips may be carried out as under.

Mixing stone chips with 0.75 to 1.0 per cent of paving bitumen by weight of chips in a suitable mixer, the chips being heated to 160°C and the bitumen to its application temperature. The pre-coated chips shall be allowed to cure for at least one week or until they become non sticky and can be spread easily.





## 507.3. Construction Operations

**507.3.1. Weather and seasonal limitations** : Clause 504.3.1 shall apply.

**507.3.2. Preparation of base** : The base on which the surface dressing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with Clause 501 or as directed by the Engineer. Prime coat, where needed, shall be provided as per Clause 502 or as directed by the Engineer. Where the existing surface shows signs of fatting up, the excess bitumen shall be removed by burning off, or manually, as specified in the contract or as directed by the Engineer. The bituminous surface to be dressed shall be thoroughly cleaned either by using a mechanical broom and/or compressed air, or any other approved equipment/method as specified in the Contract or directed by the Engineer. The prepared surface shall be dust free, clean and dry (except in the case of cationic emulsion where the surface shall be damp).

**507.3.3. Application of binder** : The spraying of a uniform thin film of binder as per the rates of spread of binder given in Table 500.11, shall be provided by a Bitumen Distributor, fitted with a spray bar, the type of Distributor depending on the type of binder used, as directed by the Engineer. The application temperature for the grade of binder used shall be as given in Table 500.12 and the rate of spray as given in Clause 507.2.3. Where Modified Bitumen is used, the application temperatures shall be as per Clause 512.4.2. When bitumen emulsion is used as the binder, it shall be sprayed/distributed uniformly over the prepared base, using self-propelled or towed sprayer, capable of supplying the binder at specified rates so as to provide a uniformly unbroken spread of binder.

**TABLE 500.12 : SPRAYING TEMPERATURES FOR BINDERS**

| Binder Grades | Whirling Spray Jets | | Slot Jets | |
|---|---|---|---|---|
| | Min °C | Max °C | Min °C | Max °C |
| Penetration grades 80/100 | 180 | 200 | 165 | 175 |
| 180/200 | 170 | 190 | 155 | 165 |

**507.3.4. Application of stone chips** : A mechanically operated Chip Spreader of an approved type shall be used for the uniform spread of chippings as per the rates given in Table 500.11. Careful application by other approved method may be permitted with the approval of the

Engineer.

Immediately after application of the binder, clean, dry chips (in the case of emulsion binder the chippings may be damp) shall be spread uniformly on the surface so as to cover the surface completely with a single layer of chips.

Synchronized spreading of binder and stone chips using modern truck-mounted machine with bituminous sprayer and chip spreader shall be preferred, especially for large projects.

**507.3.5. Rolling** : Rolling of the chips shall be carried out by 60 to 80 kN static weight roller, preferably by a pneumatic tyred roller in accordance with Clause 504.3.6. Rolling shall commence at the edges and progress towards the centre, except in superelevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

**507.3.6. Application of second coat of surface dressing** : Where surface dressing in two coats is specified, the second coat should not be applied until the first coat has been open to traffic for 2 or 3 weeks. The surface on which the second coat is laid must be clean and free of dust. The construction operations for the second coat shall be the same as described in Clauses 507.3.3 to 507.3.5.

### 507.4. Opening to Traffic

Traffic shall not be permitted to run on any newly surface dressed area until the following day. In special circumstances, however, the Engineer may allow the road to be opened to traffic immediately after rolling, but in such cases, traffic speed shall be limited to 20 km per hour until the following day.

### 507.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802. For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.





### 507.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with provisions of Clause 111.

### 507.7. Measurements for Payment

Each coat of surface dressing shall be measured as finished work, for the area instructed to be covered, in square metres.

### 507.8. Rate

The Contract unit rate for surface dressing, based on the notional rates of spread for binder and each size of chippings given in Clause 507.2.3, shall be adjusted, plus or minus, for the difference between the notional rates of spread and the actual rates of spread approved by the Engineer. The adjusted rate shall be payment in full for carrying out the required operations including full compensation for components listed in Clause 504.8, as applicable to the work specified in these Specifications.

## 508. 20 mm THICK PREMIX CARPET

### 508.1. Open-graded Premix Surfacing using Bitumen

**508.1.1. Scope** : This work shall consist of the preparation, laying and compaction of a premix surfacing material of 20 mm thickness composed of small-sized aggregate premixed with a bituminous binder on a previously prepared base, in accordance with the requirements of these Specifications, to serve as a wearing course.

### 508.1.2. Materials

**508.1.2.1. Binder** : The binder shall be a penetration grade bitumen of a suitable grade S-65/90 as specified in the Contract, or as directed by the Engineer, and satisfying the requirements of IS:73. Where Modified Binder is specified, Clause 511 shall apply.

**508.1.2.2. Aggregate** : The aggregate shall conform to Clause 504.2.2 except that the water absorption shall be limited to a maximum of 1 per cent.

**508.1.2.3. Proportioning of materials** : The materials shall be proportioned in accordance with Table 500.13.

**TABLE 500.13 : QUANTITIES OF MATERIALS REQUIRED FOR 10 m² OF ROAD SURFACE FOR 20 MM THICK PREMIX CARPET USING PENETRATION BITUMEN OR CUTBACK**

| | |
|---|---|
| **Aggregate** | |
| (a) Nominal Stone size 13.2 mm (passing 22.4 mm sieve and retained on 11.2 mm sieve) | 0.18 m³ |
| (b) Nominal Stone size 11.2 mm (passing 13.2 mm sieve and retained on 5.6 mm sieve) | 0.09 m³ |
| **Total** | **0.27 m³** |
| **Binder** (quantities in terms of straight run bitumen) | |
| (a) For 0.18 m³ of 13.2 mm nominal size stone at 52 kg bitumen per m³ | 9.5 kg |
| (b) For 0.09 m³ of 11.2 mm nominal size stone at 56 kg bitumen per m³ | 5.1 kg |
| **Total** | **14.6 kg** |

### 508.1.3. Construction operations

**508.1.3.1. Weather and seasonal limitations** : Clause 504.3.1 shall apply.

**508.1.3.2. Preparation of surface** : The underlying surface on which the bituminous surfacing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross-section in accordance with Clause 501. A prime coat where needed shall be applied in accordance with Clause 502 as directed by the Engineer.

**508.1.3.3. Tack coat** : A tack coat complying with Clause 503, shall be applied over the base preparatory to laying of the surfacing.

**508.1.3.4. Preparation of premix** : Hot mix plant of appropriate capacity and type shall be used for the preparation of the mix. The hot mix plant shall have separate dryer arrangement for aggregate.

For small jobs, mixers of approved type shall be permitted for mixing the aggregates with bituminous binder with the approval of the Engineer.

The temperature of the binder at the time of mixing shall be in the range of 150°C to 163°C and that of the aggregate in the range of 155°C





to 163°C provided that the difference in temperature between the binder and aggregate at no time exceeds 14°C. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly and the discharge temperature of mix shall be between 130°C and 160°C. When Modified Bitumen is used, the application temperature shall be as per Clause 512.4.2.

The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or hand barrows. The vehicles employed for transportation shall be clean and the mix being transported covered in transit if so directed by the Engineer.

For further guidance, refer to Appendix 8.5 of IRC:SP:20-2002 : Rural Roads Manual.

**508.1.3.5. Spreading and rolling :** The pre-mixed material shall be spread by suitable means to the desired thickness, grades and cross-fall (camber) making due allowance for any extra quantity required to fill-up depressions, if any. The cross-fall should be checked by means of camber boards and irregularities levelled out. Excessive use of blades of rakes should be avoided. As soon as sufficient length of bituminous material has been laid, rolling shall commence with 80 to 100 kN static weight roller, or other approved equipment. Rolling shall begin at the edge and progress towards the centre longitudinally, except that on superelevated and uni-directional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions, which become apparent, shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled and all the roller marks eliminated. In each pass of the roller, the preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels. In no case shall fuel/lubricating oil be used for this purpose. Excess use of water for this purpose shall also be avoided.

Rollers shall not stand on newly laid material. Rolling operations shall be completed in every respect before the temperature of the mix falls below 100°C. Joints along and transverse to the surfacing laid and compacted earlier shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with thin coat of appropriate binder before the new mix is placed against it.

**508.1.3.6. Seal coat :** A seal coat conforming to Clause 510 of the type specified in the Contract shall be applied to the surface immediately after laying the surfacing.

**508.1.4. Opening to traffic** : No traffic shall be allowed on the road until the seal coat has been laid. After the seal coat is laid, the road may be opened to traffic according to Clause 510.4.

**508.1.5. Surface finish and quality control of work** : The surface finish of construction shall conform to the requirements of Clause 1802. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

**508.1.6. Arrangements for traffic** : During the period of construction, arrangement of traffic shall be made in accordance with the provision of Clause 111.

**508.1.7. Measurements for payment** : Open graded premix surfacing shall be measured as finished work, for the area instructed to be covered, in square metres. The area will be the net area covered, and all allowances for wastage and cutting of joints shall be deemed to be included in the rate.

**508.1.8. Rate** : The contract unit rate for open-graded premix surfacing shall be payment in full for carrying out the required operations including full compensation for components listed in Clause 504.8, as applicable to the work specified in these Specifications.

### 508.2. 20 mm Premix Carpet Using Bitumen Emulsion

**508.2.1. Scope** : This work shall consist of the preparation, laying and compaction of an open graded premix surfacing of 20 mm thickness composed of small-sized aggregate premixed with a cationic bitumen emulsion on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course.

#### 508.2.2. Materials

**508.2.2.1. Binder** : The binder for premix wearing course shall be bitumen emulsion of Medium Setting (MS) grade complying with IS:8887 and having a bitumen content 65 per cent minimum by weight. For liquid seal coat RS grade of bitumen emulsion shall be used. Where expressly specified in the Contract, MS Grade emulsion shall be used or otherwise directed by the Engineer. Slow Setting (SS) grade bitumen Emulsion shall be used for premix seal coat.





**508.2.2.2. Aggregate** : The requirements of Clause 508.1.2.2 shall apply.

**508.2.3. Proportioning of materials** : The materials shall be proportioned as per quantities given in Table 500.14.

**TABLE 500.14 : QUANTITIES OF MATERIALS REQUIRED FOR 10m² OF ROAD SURFACE FOR 20 mm THICK PREMIX CARPET USING CATIONIC BITUMEN EMULSION**

| | |
|---|---|
| **Aggregate** | |
| (a) Nominal Stone size 13.2 mm (passing 22.4 mm sieve and retained on 11.2 mm sieve) | 0.18 $m^3$ |
| (b) Nominal Stone size 11.2 mm (passing 13.2 mm sieve and retained on 5.6 mm sieve) | 0.09 $m^3$ |
| **Total** | **0.27 $m^3$** |
| **Cationic Bitumen Emulsion** | |
| (a) For 0.18 $m^3$ of 13.2 mm nominal size stone at 78 kg cationic bitumen emulsion per $m^3$ | 14 kg |
| (b) For 0.09 $m^3$ of 11.2 mm nominal size stone at 84 kg cationic bitumen emulsion per $m^3$ | 7.5 kg |
| **Total** | **21.5 kg** |

#### 508.2.4. Construction operations

**508.2.4.1. Weather and seasonal limitations** : Clause 504.3.1 shall apply except that the minimum air temperature for laying shall be 10°C. Cationic bitumen emulsion shall not normally be stored below 0°C.

**508.2.4.2. Preparation of surface** : The underlying surface on which the premix surfacing is to be laid shall be prepared, in accordance with the requirements of Clause 504.3.2 for a newly primed surface.

**508.2.4.3. Preparation of binder** : Before opening, the bitumen emulsion drum shall be rolled at slow speed, to and fro, at least 5 times, for a distance of about 10 m., to distribute any storage sedimentation.

**508.2.4.4. Tack coat** : A tack coat complying with Clause 503, shall be applied over the surface preparatory to laying of the surfacing where specified in the Contract, or directed by the Engineer.

**508.2.4.5. Preparation of premix** : Premixing of bitumen emulsion and aggregates can be carried out in a suitable mixer such as cold mixing

plant as per IS:5435 (Revised) or concrete mixer or by pay-loaders in exceptional cases where approved by the Engineer.

When using concrete mixer for preparing the premix, 0.135 cu.m (0.09 cu.m of 13.2 mm size and 0.045 cu.m of 11.2 mm size) of aggregates per batch shall be used which quantity will cover 5 sq.m of road surface with 20 mm average thickness.

The aggregates required for one batch shall be prepared adjacent to the mixer.

First the coarse aggregate of 13.2 mm size shall be placed into the mixer followed by 5 to 6.5 kg of bitumen emulsion and then the 11.2 mm size aggregate shall be added, followed by 5 to 6.5 kg of bitumen emulsion. After the materials have been mixed thoroughly, the mix shall be immediately transported to the laying site in suitable vehicles. Too much mixing shall be avoided.

For small jobs, like maintenance works, manual mixing by shovels are permitted with the approval of the Engineer.

**508.2.4.6. Spreading and rolling :** The premixed bitumen emulsion and aggregates shall be spread within 10 minutes of applying the tack coat. All levelling, raking, etc. should be completed within 20 minutes of the time of mixing.

The mix should be spread uniformly to the desired thickness, grades and crossfall (camber) making due allowance for any extra quantity required to fill up depressions, if any. The crossfall shall be checked by means of camber boards and irregularities levelled out. Too much raking is to be avoided.

The rolling shall start immediately after laying the premix. An 80 to 100 kN static weight roller shall be used, unless other compaction methods are approved by the Engineer, based on the results of laying trials, if necessary. While rolling, wheels of roller should be clean and kept moist to prevent the premix from adhering to the wheels. In no case shall fuel/ lubricating oil be used for this purpose. Use of water for this purpose shall be strictly limited to an absolute minimum.

Rolling shall commence at the edges and progress towards the centre longitudinally except in the case of superelevated and uni-directional cambered sections where rolling shall be carried out from the lower edge towards the higher edge, parallel to the centre line of the road.





After one pass of roller over the whole area, depressions or uncovered spots shall be corrected by adding premix material. Rolling shall be continued until the entire surface has been rolled to maximum compaction and all the roller marks eliminated. In each pass of the roller the preceding track shall be overlapped uniformly by at least 1/3 width. Roller(s) shall not stand on newly laid material. Joints both longitudinal and transverse to the road sections laid and compacted earlier, shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of binder before the new mix is placed against it.

**508.2.4.7. Seal coat** : A seal coat, conforming to Clause 510 as specified in the Contract, shall be applied 4 to 6 hours after laying the premix carpet.

**508.2.5. Opening to traffic** : Traffic should not be allowed over the premix surface with or without seal coat, for 6 to 8 hours after rolling. In case of single lane roads, traffic shall be allowed onto the surface once it has reached ambient temperature, but speed must be rigorously restricted to not more than 16 km per hour. If any premix material is picked up by vehicle tyres, the spot shall be filled up by new mix. If traffic conditions permit, the road shall not be opened until a full 24 hours after laying.

**508.2.6. Surface finish and quality control :** The surface finish of construction shall conform to the requirements of Clause 1802.

For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

**508.2.7. Arrangements for traffic** : During the period of construction, arrangements of traffic shall be made in accordance with the provisions of Clause 111.

**508.2.8. Measurements for payment** : Open graded premix carpet shall be measured as finished work, for the area specified to be covered in the Contract. The area will be the net area covered, and all allowances for wastage and cutting of joints shall be deemed to be included in the rate.

**508.2.9. Rate** : The contract unit rate for premix carpet and seal coat shall be payment in full for carrying out the required operations including full compensation for components listed in Clause 504.8, as applicable to the work specified in these Specifications.

## 509. MIX SEAL SURFACING

### 509.1. Scope

**509.1.1.** This work shall consist of the preparation, laying and compaction of mix seal surfacing material of 20 mm thickness composed of graded aggregates premixed with a bituminous binder on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course. No Mix Seal Surfacing layer shall, however, be placed directly over WBM base.

**509.1.2.** Mix Seal surfacing shall be of Type A or Type B as specified in the Contract documents.

### 509.2. Materials

**509.2.1. Binder** : The provisions of Clause 508.1.2.1 shall apply.

**509.2.2. Coarse aggregates** : The provisions of Clause 508.1.2.2 shall apply.

**509.2.3. Fine aggregates** : The fine aggregates shall consist of crushed rock, quarry sands, natural gravel/sand or a mixture of both. These shall be clean, hard, durable, un-coated, mineral particles, dry and free from injurious, soft or flaky particles and organic or deleterious substances.

**509.2.4. Aggregate gradation** : The coarse and fine aggregates shall be so graded or combined as to conform to one or the other gradings shown in Table 500.15 as specified in the contract.

**TABLE 500.15 : AGGREGATE GRADATION**

| IS Sieve Designation (mm) | Cumulative per cent by weight of Total Aggregate Passing | |
|---|---|---|
| | Type A | Type B |
| 13.2 mm | - | 100 |
| 11.2 mm | 100 | 88-100 |
| 5.6 mm | 52-88 | 31-52 |
| 2.8 mm | 14-38 | 5-25 |
| 0.090 mm | 0-5 | 0-5 |





**509.2.5. Proportioning of materials** : The total quantity of aggregates used for Type A or B close-graded premix surfacing shall be 0.27 cu.m per 10 sq.m area. The quantity of binder used for premixing in terms of straight-run bitumen shall be 22 kg and 19 kg per 10 sq.m area for Type A and Type B surfacing respectively.

### 509.3. Construction Operations

The provisions of Clauses 508.1.3.1 to 508.1.3.5 shall apply, except that the laying of Mix Seal Surfacing shall be carried out by a mechanical paver.

### 509.4. Opening to Traffic

Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. Excessive traffic speeds should not be permitted.

### 509.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802. For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### 509.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be in accordance with the provisions of Clause 111.

### 509.7. Measurements for Payment

Mix Seal surfacing, Type A or B shall be measured as finished work, for the area specified to be covered, in square metres at a specified thickness. The area shall be the net area covered, and all allowances for wastage and cutting of joints shall be deemed to be included in the rate.

### 509.8. Rate

The contract unit rate for Mix Seal Surfacing, Type A or B shall be payment in full for carrying out the required operations including full compensation for components listed in Clause 504.8, as applicable to the work specified in these Specifications.

## 510. SEAL COAT

### 510.1. Scope

**510.1.1.** This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and cross fall (camber).

**510.1.2.** Seal coat shall be of any of the three types specified below :-

**Type A :** Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chips.

**Type B :** Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

**Type C :** Premixed seal coat comprising of an application of 6.7 mm size stone chips premixed with bituminous binder.

### 510.2. Materials

**510.2.1. Binder** : The requirements of Clauses 508.1.2.1 and 508.2.2.1 shall apply. The required quantities of binder shall be as given in Table 500.16.

**TABLE 500.16 : REQUIRED QUANTITIES OF BINDER**

| Type of Seal Coat | Per 10 m² Area | |
|---|---|---|
| | Bitumen (kg) | Bituminous Emulsion (kg) |
| Type A : Liquid Seal Coat | 9.8 | 12 to 14 |
| Type B : Premix Seal Coat | 6.8 | 10 to 12 |
| Type C : Premixed Seal Coat using stone chips of 6.7 mm size | 4.5% by weight of total mixture | 9 to 11 |

**510.2.2. Stone chips for Type A Seal Coat** : The stone chips shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They should be free of soft or disintegrated stone, organic or other deleterious matter. Stone chips shall be 6.7 mm size defined as 100 per cent passing through 11.2 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10





sq.m area. The chips shall satisfy the quality requirements in Table 500.3 except that the upper limit for water absorption value shall be 1 per cent.

**510.2.3. Aggregate for Type B Seal Coat** : The aggregate shall be sand or grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cu.m per 10 sq.m area.

**510.2.4. Stone chips for Type C Seal Coat** : The stone chips shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. The stone chips shall be free of soft or disintegrated stone, organic or other deleterious matter and shall be of 6.7 mm size defined as 100 per cent passing through 9.5 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chips shall satisfy the quality requirements in Table 500.3 except that the upper limit for water absorption value shall be 1 per cent.

### 510.3. Construction Operations

**510.3.1. Weather and seasonal limitations** : The requirements of Clause 504.3.1 shall apply.

**510.3.2. Preparation of surface** : The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other extraneous matter.

**510.3.3. Construction of Type A Seal Coat:**

**(a) Bitumen as the Binder**

Bitumen shall be heated to 150°C to 163°C and sprayed at the rate specified on the dry surface in a uniform manner with a self-propelled or towed mechanical sprayer as approved by the Engineer. Immediately after the application of binder, stone chips, which shall be clean and dry, shall be spread uniformly at the rate specified on the surface preferably by means of self-propelled or towed mechanical grit spreader so as to cover the surface completely. If necessary, the surface shall be brushed to ensure uniform spread of chips. Immediately after the application of the cover material, the entire surface shall be rolled with an 80 to 100 kN static weight roller, 80 to 100 kN static weight vibratory roller, or other

equipment approved by the Engineer after laying trials if required. Rolling shall commence at the edges and progress towards the centre except in superelevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

**(b) Bituminous Emulsion as the Binder**

When a bitumen emulsion is used as binder, it shall be sprayed uniformly on the prepared base by mechanical sprayers. An emulsion tank of 30 litre capacity pressurized by compressed air from a hand pump and a 12 mm flexible pipe with a spray nozzle is a simple and efficient arrangement for spraying. Immediately after spraying of bituminous emulsion, aggregate shall be spread uniformly and evenly by mechanical means to cover the surface completely and evenly. Any oversize aggregate if observed, shall be removed. Immediately after the application of cover material, the surface shall be rolled adopting the same procedure as described above at (a) with bitumen as the binder.

### 510.3.4. Construction of Type B Seal Coat:

**(a) Bitumen as the Binder**

A mixer of appropriate capacity and type approved by the Engineer shall be used for preparation of the mixed material. The plant shall have separate dryer arrangements for heating aggregate. The binder shall be heated in boilers of suitable design, approved by the Engineer to the temperature appropriate to the grade of bitumen or as directed by the Engineer. The aggregates shall be dry and suitably heated to a temperature between 150°C and 165°C or as directed by the Engineer before these components are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued until the latter are thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as a sufficient length has been covered with the premixed material, the surface shall be rolled with an 80 to 100 kN static weight roller. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

**(b) Bituminous Emulsion as the Binder**

When bitumen emulsion is used as the binder, premixing with aggregates





shall be done in a suitable mixer such as cold mixing plant as per IS:5435 or concrete mixer or by shovels in exceptional cases for small jobs with the approval of the Engineer. However, for large works, continuous mixing operation can be done either in batch or continuous mixer units suitable for emulsion mixes. For small jobs, when mechanical mixer is not available, manual mixing of bitumen emulsion and aggregates may be resorted to, with the approval of the Engineer. The premixed cationic bituminous emulsion and aggregates shall be spread within ten minutes of applying the tack coat. The mix is easily workable for about 20 minutes after mixing and hence all levelling, raking, etc. shall be completed within this time. The rolling by an 80 to 100 kN static weight roller shall start at least half an hour after laying the premix and in no case the commencement of rolling delayed beyond four hours after laying. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

**510.3.5. Construction of Type C Seal Coat using stone chips of 6.7 mm size:** The provisions of Clauses 508.1.3.4 and 508.1.3.5 shall apply for preparation of premix, spreading and rolling. A smooth uniform closed surface shall be ensured at completion of rolling operation.

### 510.4. Opening to Traffic

In the case of Type B and C seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. In the case of Type A seal coat, traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases traffic speed shall be rigorously limited to 16 km per hour until the following day.

### 510.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 1802.

For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### 510.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### 510.7. Measurements for Payment

Seal coat, Type A, B or C, shall be measured as finished work, over the area specified to be covered, in square metre. Alternatively, Type 'C' seal coat can also be measured as finished work in cu.m or by weight in metric tonnes as provided in the Contract.

### 510.8. Rate

The contract unit rate for seal coat Type A, B and C shall be payment in full for carrying out the required operations including full compensation for components listed in Clause 504.8, as applicable to the work specified in these Specifications.

## 511. SUPPLY OF STONE AGGREGATES FOR PAVEMENT COURSES

### 511.1. Scope

This Specification Clause shall apply to the supply of stone aggregates only. The work shall consist only of collection, transportation and stacking the stone aggregates for use in pavement courses. The actual work of laying the pavement courses shall, however, be governed by the individual Specification Clause for the actual work, given elsewhere in this Specification. The size and quantities of the aggregates to be supplied shall be so selected by the Engineer that the grading requirements set forth in the individual Specification Clauses for the pavement courses, for which the supply is intended, are satisfied.

All the materials shall be procured from approved sources and shall conform to the physical requirements, specified in the respective Specification Clauses for the individual items given elsewhere in this Specification.

### 511.2. Sizes of Stone Aggregates

The stone aggregates shall be designated by their nominal sizes in the Contract and shall conform to the requirements shown in Table 500.17.

### 511.3. Stacking

(1) **Coarse Aggregates**

Only the aggregates satisfying the Specification requirements shall be conveyed to the roadside and stacked. Each size of aggregate shall be





**TABLE 500.17 : SIZE REQUIREMENTS FOR COARSE STONE AGGREGATES**

| Sl. No. | Nominal size of aggregate | Designation of sieve through which the aggregates shall wholly pass | Designation of sieve on which the aggregates shall be wholly retained |
|---|---|---|---|
| (i) | 75 mm | 106 mm | 63 mm |
| (ii) | 63 mm | 90 mm | 53 mm |
| (iii) | 45 mm | 53 mm | 26.5 mm |
| (iv) | 26.5 mm | 45 mm | 22.4 mm |
| (v) | 22.4 mm | 26.5 mm | 13.2 mm |
| (vi) | 13.2 mm | 22.4 mm | 11.2 mm |
| (vii) | 11.2 mm | 13.2 mm | 6.7 mm |
| (viii) | 6.3 mm | 11.2 mm | 2.8 mm |

stacked separately. Likewise, materials obtained from different quarry sources shall be stacked separately and in such a manner that there is no contamination of one source with another.

(2) **Fine Aggregates** : As stated in the individual relevant Specification Clauses.

The aggregates shall be stacked entirely clear of the roadway on even, clear hard ground, or on a platform prepared in advance for the purpose by the Contractor at his own cost and in a manner that allows correct and ready measurement. If the stockpile is placed on ground where the scraping action of the loader can contaminate the material with underlying soil, then the stockpile shall be rejected by the Engineer. Materials shall not be stacked in locations liable to inundation or flooding.

The dimensions of the stockpiles and their locations shall be approved by the Engineer. Where the material is improperly stacked, the Engineer shall direct complete re-stacking of the materials in an approved manner at the Contractor's cost.

### 511.4. Quality Control of Materials

The Engineer shall exercise control over the quality of the materials so as to ascertain their conformity with the Specification requirements, by carrying out tests for the specified properties.

For both coarse and fine aggregates, atleast one test shall be carried out for each specified property per 50 $m^3$ of stone aggregates.

Materials shall only be brought to site from a previously tested and approved source, and any materials not conforming to the requirements of the Specification shall be rejected by the Engineer and removed from the work site.

### 511.5. Measurements for Payment

Coarse and fine aggregates supplied to the site shall be paid for in cubic metres. The actual volume of the aggregates to be paid for shall be computed after deducting the specified percentages in Table 500.18, from the volume computed by stack measurements, to allow for bulking.

**TABLE 500.18 : PER CENT REDUCTION IN VOLUME OF AGGREGATES**

| Sl. No. | Nominal size of aggregates | Percentage reduction in volume computed by stack measurements to arrive at the volume to be paid for |
|---|---|---|
| (1) | 75 mm and 63 mm | 12.5 |
| (2) | 45 mm and 26.5 mm | 10.0 |
| (3) | 22.4 mm, 13.2 mm, 11.2 mm and 6.3 mm | 5.0 |
| (4) | Fine aggregates | 5.0 |

Unless otherwise directed by the Engineer, measurements shall not be taken until sufficient materials for use on the road have been collected and stacked. Immediately after measurement, the stacks shall be marked by white wash or other means as directed by the Engineer.

### 511.6. Rate

The contract unit rates for different sizes of coarse and fine aggregates shall be payment in full for collecting, conveying and stacking or storing at the site including full compensation for :

(a) all royalties, rents where necessary;

(b) all leads and lifts;

(c) all labour, tools, equipment and incidentals to complete the work to the Specifications; and

(d) all necessary testing of material, both initial, to approve the source, and regular control testing thereafter.





## 512. MODIFIED BITUMEN

### 512.1. Scope

Modified bitumen comprises a base binder, to which is added either Natural Rubber, Crumb Rubber or Synthetic Rubbers or Synthetic Polymers. The purpose is to achieve a high performance binder with improved properties, particularly at extremes of temperature.

### 512.2. Materials

**512.2.1. Base binder** : The base binder into which the modifier is incorporated shall conform to IS:73. The choice of grade shall be such that it is compatible with the modifier and, when mixed, shall have the properties described in Clause 512.3.

**512.2.2. Modifier** : The modifier shall be a natural rubber, crumb rubber or any other polymer which is compatible with the base binder and which allows the properties given in Clause 512.3 to be achieved. For further details, IRC:SP:53-2002 may be referred to. The modifier, in the required quantity shall be blended at the refinery or at the site plant capable of producing modified binder.

**512.2.3. Modified bitumen** : Modified Bitumen from Refinery sources shall be used for road work. Proprietary products where used shall comply with the requirements of these Specifications. ***Annexure-500.4*** gives the criteria for selecting the type and grade of modified bitumen based on atmospheric temperature.

### 512.3. Modified Bitumen Properties and Testing

The properties of the modified bitumen shall be as given in Tables 500.19 to 500.22 according to the requirements of the Contract.

### 512.4. Handling of Modified Bitumen

**512.4.1.** The modified bitumen shall be supplied hot in tankers or if supplied in drums shall be agitated in melted condition with suitable device for achieving homogeneity. Tests for penetration, softening point, separation and elastic recovery shall be conducted for a lot of 10 tonne Rubber/ Polymer Modified Bitumen.

**512.4.2.** The temperature of mixing and rolling shall be slightly higher than conventional bituminous mixes. The broad range of viscosity

**TABLE 500.19 : REQUIREMENTS OF POLYMER MODIFIED BINDERS (PMB) (ELASTOMERIC THERMOPLASTIC BASED)**

| Designation | Grade and Requirements | | | Method Test |
|---|---|---|---|---|
| | PMB 120 | PMB 70 | PMB 40 | |
| Penetration at 25°C, 0.1mm, 100g, 5 sec | 90 to 150 | 50 to 90 | 30 to 50 | IS:1203-1978 |
| Softening Point (R&B), °C, Minimum | 50 | 55 | 60 | IS:1205-1978 |
| Ductility at 27°C, cm | +75 | +60 | +50 | IS:1208-1978 |
| Fraass Breaking Point, °C, Maximum* | –24 | –18 | –12 | IS:9381-1978 |
| Flash point, by COC, °C, Minimum | 220 | 220 | 220 | IS:1209-1978 |
| Elastic recovery of Half Thread in Ductilometer at 15°C, %, Minimum | 75 | 75 | 75 | ** |
| Separation, Difference in Softening Point, R&B, °C, Maximum | 3 | 3 | 3 | ** |
| Viscosity at 150°C, Poise | 1-3 | 2-6 | 3-9 | IS:1206-1978 |
| *Thin Film Oven Test, TFOT on Residue (IS:9382-1992)* | | | | |
| Loss in weight, %, Maximum | 1.0 | 1.0 | 1.0 | IS:9382-1982 |
| Increase in Softening Point, °C, Maximum | 7 | 6 | 5 | IS:1205-1978 |
| Reduction in Penetration at 25°C, %, Maximum | 35 | 35 | 35 | IS:1203-1978 |
| Elastic Recovery of Half Thread in Ductilometer at 25°C, %, Minimum | 50 | 50 | 50 | ** |

* Relevant to snow bound cold climate areas

** Test Procedure outlined in IRC:SP:53-2002





**TABLE 500.20 : REQUIREMENTS OF POLYMER MODIFIED BINDERS (PMB) (PLASTOMERIC THERMOPLASTIC BASED)**

| Designation | Grade and Requirements | | | Method Test |
|---|---|---|---|---|
| | PMB 120 | PMB 70 | PMB 40 | |
| Penetration at 25°C, 0.1mm, 100g, 5 sec | 90 to 150 | 50 to 90 | 30 to 50 | IS:1203-1978 |
| Softening Point (R&B), °C, Minimum | 50 | 55 | 60 | IS:1205-1978 |
| Ductility at 27°C, cm | +50 | +40 | +30 | IS:1208-1978 |
| Fraass Breaking Point, °C, Maximum* | –20 | –16 | –12 | IS:9381-1978 |
| Flash point, by COC, °C, Minimum | 220 | 220 | 220 | IS:1209-1978 |
| Elastic recovery of Half Thread in Ductilometer at 15°C, %, Minimum | 50 | 50 | 50 | ** |
| Separation, Difference in Softening Point, R&B, °C, Maximum | 3 | 3 | 3 | ** |
| Viscosity at 150°C, Poise | 1-3 | 2-6 | 3-9 | IS:1206-1978 |
| *Thin Film Oven Test, TFOT on Residue (IS:9382-1992)* | | | | |
| Loss in weight, %, Maximum | 1.0 | 1.0 | 1.0 | IS:9382-1982 |
| Increase in Softening Point, °C, Maximum | 7 | 6 | 5 | IS:1205-1978 |
| Reduction in Penetration of Residue, at 25°C, %, Maximum | 35 | 35 | 35 | IS:1203-1978 |
| Elastic Recovery of Half Thread in Ductilometer at 25°C, %, Minimum | 35 | 35 | 35 | ** |

* Relevant to snow bound cold climate areas

** Test Procedure outlined in IRC:SP.53-2002

**TABLE 500.21 : REQUIREMENTS OF NATURAL RUBBER MODIFIED BINDERS (NRMB)**

| Designation | Grade and Requirements | | | Method Test |
|---|---|---|---|---|
| | NRMB 120 | NRMB 70 | NRMB 40 | |
| Penetration at 25°C, 0.1mm, 100g, 5 sec | 90 to 150 | 50 to 90 | 30 to 50 | IS:1203-1978 |
| Softening Point (R&B), °C, Minimum | 50 | 55 | 60 | IS:1205-1978 |
| Ductility at 27°C, cm | +75 | +60 | +50 | IS:1208-1978 |
| Fraass Breaking Point, °C, Maximum* | –20 | –16 | –12 | IS:9381-1978 |
| Elastic recovery of Half Thread in Ductilometer at 15°C, %, Minimum | 50 | 40 | 30 | ** |
| Flash point, by COC, °C, Minimum | 220 | 220 | 220 | IS:1206-1978 |
| Separation, Difference in Softening Point, R&B, °C, Maximum | 4 | 4 | 4 | ** |
| *Thin Film Oven Test, TFOT on Residue (IS:9382-1992)* | | | | |
| Penetration at 25°C, 0.1mm, 100g, 5 sec., Minimum, % of Original | 60 | 60 | 60 | IS:1203-1978 |
| Increase in Softening Point, (R&B), °C, Maximum | 7 | 6 | 5 | IS:1205-1978 |
| Elastic Recovery of Half Thread in Ductilometer at 25°C, %, Minimum | 35 | 30 | 25 | ** |

* Relevant to snow bound cold climate areas

** Test Procedure outlined in IRC:SP:53-2002





**TABLE 500.22 : REQUIREMENTS OF CRUMB RUBBER MODIFIED BINDERS (CRMB)**

| Designation | Grade and Requirements | | | Method Test |
|---|---|---|---|---|
| | CRMB 50 | CRMB 55 | CRMB 60 | |
| Penetration at 25°C, 0.1mm, 100g, 5 sec | < 70 | < 60 | < 50 | IS:1203-1978 |
| Softening Point (R&B), °C, Minimum | 50 | 55 | 60 | IS:1205-1978 |
| Elastic recovery of Half Thread in Ductilometer at 15°C, %, Minimum | 50 | 50 | 50 | * |
| Flash point, by COC, °C, Minimum | 220 | 220 | 220 | IS:1206-1978 |
| Separation, Difference in Softening Point, R&B, °C, Maximum | 4 | 4 | 4 | * |
| *Thin Film Oven Test, TFOT on Residue (IS:9382-1992)* | | | | |
| Penetration at 25°C, 0.1mm, 100g, 5 sec., Minimum, % of Original | 60 | 60 | 60 | IS:1203-1978 |
| Increase in Softening Point, (R&B), °C, Maximum | 7 | 6 | 5 | IS:1205-1978 |
| Elastic Recovery of Half Thread in Ductilometer at 25°C, %, Minimum | 35 | 35 | 35 | * |

* Test Procedure outlined in IRC:SP:53-2002

and temperature at different stages is given in Table 500.23. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per advice of supplier or test data of viscosity of modified bitumen at different temperatures.

**512.4.3.** Multiple heating of modified bitumen shall be avoided to retain its premium properties.

**TABLE 500.23 : BROAD RANGE OF VISCOSITY AND TEMPERATURE REQUIREMENTS FOR MODIFIED BINDERS**

| Stage of Work | Viscosity (Poise) | Indicated Temperature (°C) |
|---|---|---|
| Binder at mixing | Maximum 2 | 165-185 |
| Mix at mixing plant | Maximum 4 | 140-160 |
| Mix at laying site | Maximum 5 | 130-150 |
| Rolling at laying site | 10-1000 | 115-135 |

**512.4.4.** In case of Natural Rubber Modified Bitumen, the material shall be supplied at 130°C-150°C and used within 24 hours of its filling.

**512.4.5.** Manufacturer of proprietary products shall be responsible to provide full details to user for special precautions needed for their products at site or may depute their technical personnel, if required.

### 512.5. Controls

The Specifications for various items of road works using Polymer/ Rubber Modified Bitumen are the same as those for penetration grade bitumen except those for any special conditions which the manufacturer of PMB/RMB or supplier of additive may indicate in the technical literature of the product. The other controls during mixing and laying shall be the same as specified in the relevant IRC codes of practice.

### 512.6. Measurements for Payment

Modified binder supplied for the Contract shall be paid for in tonnes.

### 512.7. Rate

The contract rate for modified binder shall be as per contract agreement.





*Annexure-500.1*

**(Clause 501.6)**

## PROTECTION OF THE ENVIRONMENT

### 1. General

1.1. This section of the Specification sets out limitations on the Contractor's activities specifically intended to protect the environment.

1.2. The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on site or off-site are carried out in conformity with statutory and regulatory environmental requirements including those prescribed elsewhere in this document.

1.3. The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.

1.4. In the event of any spoil, debris, waste or any deleterious substance from the Site being deposited on any adjacent land, the Contractor shall immediately remove all such material and restore the affected area to its original state to the satisfaction of the Engineer.

### 2. Water Quality

2.1. The Contractor shall prevent any interference with the supply to or abstraction from, and prevent any pollution of, water resources (including underground percolating water) as a result of the execution of the works.

2.2. Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall to specially-constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.

2.3. All water and other liquid waste products arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.

2.4. The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.

2.5. The Contractor shall at all times ensure that all existing stream courses and drains within, and adjacent to, the Site are kept safe and free from any debris and any materials arising from the Works.

2.6. The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution as a result of the execution of the Works.

**3. Air Quality**

3.1. The Contractor shall devise and arrange methods of working to minimise dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimise adverse impacts on air quality.

3.2. The Contractor shall utilise effective water sprays during delivery manufacture, processing and handling of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather. Stockpiles of friable materials or debris shall be dampened prior to their movement, except where this is contrary to the specification.

3.3. Any vehicle with an open load-carrying area used for transporting potentially dust producing material shall have properly fitting side and tail boards. Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tail boards.

3.4. In the event that the Contractor is permitted to use gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the Engineer, necessary. Such measures may include spraying the road surface with water at regular intervals

**4. Noise**

4.1. The Contractor shall consider noise as an environmental constraint in his planning and execution of the works.





4.2. The Contractor shall take all necessary measures so that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimise the noise emission during construction works.

**5. Control of Wastes**

5.1. The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No uncontrolled deposition or dumping shall be permitted. Wastes to be controlled shall include, but shall not be limited to, all forms of fuel and engine oils, all types of bitumen, cement, surplus aggregates, gravels, bituminous mixtures, etc. The Contractor shall make specific provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.

**6. Emergency Response**

6.1. The Contractor shall plan and provide for remedial measures to be implemented in the event of occurrence of emergencies such as spillages of oil or bitumen or chemicals.

6.2. The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.

**7. Measurement**

7.1. No separate measurement shall be made in respect of compliance by the Contractor with the provisions of this section of the Specifications. The Contractor shall be deemed to have made allowance for such compliance with these provisions in the preparation of his prices for items of work included in the Bills of Quantities and full compensation for such compliance will be deemed to be covered by them.

*Annexure-500.2*

(Clause 504.2)

## CHOICE OF BITUMEN TYPE AND GRADE BASED ON MAXIMUM AND MINIMUM ANNUAL TEMPERATURES

Recommendations for the Selection of Penetration Binder

| $T_{max}$ * ⟶ <br> $T_{min}$ ** ↓ | < 20°C | 20°C to 30°C | 30°C to 40°C | 40°C to 50°C |
|---|---|---|---|---|
| **–10°C to 0°C** | 80/100 | 80/100 | MB *** | MB *** |
| **0°C to 10°C** | 80/100 | 80/100 | 60/70 | 60/70 or MB *** |
| **10°C to 20°C** | 80/100 | 80/100 | 60/70 | 60/70 |
| **> 20°C** | – | 80/100 | 60/70 | 30/40 |

* Highest monthly average maximum temperature

** Lowest monthly average minimum temperature

*** Modified Binder, as per Clause 512





*Annexure-500.3*

(Clause 507.2.2)

## RECOMMENDED NOMINAL SIZES OF STONE CHIPPINGS (Millimetres)

| Type of Surface | Approximate Number of Commercial Vehicles with a Laden weight Greater than 3.0 tonnes Currently Carried per day in the Lane Under Consideration | | |
|---|---|---|---|
| | **200-1000** | **20-200** | **Less than 20** |
| Very Hard | 6 | 6 | 6 |
| Hard | 10 | 6 | 6 |
| Normal | 10 | 10 | 6 |
| Soft | 13 | 13 | 10 |

Note : The size of stone chippings is related to the mid-point of each lane traffic category. Light traffic conditions may make the next smaller size of stone more appropriate.

The assessment of hardness of the existing road surface shall be made on the basis of judgment with the help of the definitions given below :

| Category of Surface | Definition |
|---|---|
| Very Hard | Surfaces, such as concrete, or very lean bituminous structures with dry stony surfaces, into which negligible penetration of chippings will occur even under the heaviest traffic. |
| Hard | Surfaces into which chippings will penetrate only slightly under heavy traffic. |
| Normal | Surfaces into which chippings will penetrate moderately under medium and heavy traffic. |
| Soft | Surfaces into which chippings will penetrate considerably under medium and heavy traffic. |

In selecting the nominal size of chipping for two-coat surface dressings, the size of chippings for the first layer shall be selected on the basis of the hardness of the existing surface and the traffic category as indicated above. The nominal size of chipping selected for the second layer shall then be about half the nominal size of that of the first layer to promote good interlock between the layers.

*Annexure-500.4*

**(Clause 512.2.3)**

## SELECTION OF THE TYPE AND GRADE OF MODIFIED BITUMEN (BASED ON ATMOSPHERIC TEMPERATURE)

Selection Criteria for PMB and RMB based on Atmospheric Temperature

| **Maximum Atmospheric Temperature °C** | | **< 30** | **30 to 40** | **> 40** |
|---|---|---|---|---|
| **Minimum Atmospheric Temperature °C** | < –15 | PMB-120 * RMB-50 ** | PMB-70 RMB-55 | PMB-70 RMB-60 |
| | – 15 to 15 | PMB-120 RMB-55 | PMB-70 RMB-55 | PMB-40 RMB-60 |
| | > 15 | PMB-70 RMB-55 | PMB-40 RMB-60 | PMB-40 RMB-60 |

* PMB : Polymer Modified Bitumen

** RMB : Rubber Modified Bitumen





# 600

# Brick Work for Structures

## 601. SCOPE

The work shall consist of construction of structures with bricks jointed together by cement mortar or cement-lime mortar in specified proportions in accordance with the provisions laid down in this Section, IRC:40 and details shown on the drawings or as approved by the Engineer.

## 602. MATERIALS

### 602.1. General

All materials to be used in the work shall be in conformity with the requirements laid down in this Section.

The Contractor shall notify the Engineer of his proposed sources of materials prior to delivery. If it is found after tests that proposed sources of supply do not produce uniform and satisfactory products at any time of execution, the Contractor shall provide acceptable materials conforming to the specifications from other sources at his own cost.

Samples required for approvals must be supplied well in advance, at least 48 hours or minimum time required for carrying out the relevant tests and according approvals. Delay in submission of samples shall not be acceptable as a reason for delay in completion of the works/extension of time for completion. Cost of sampling/testing of materials including imported materials in the laboratories approved by the Engineer, shall be borne by the Contractor.

All materials shall be stored at proper places so as to prevent their deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the works. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used in the work and shall be removed from site by the Contractor at his cost.

All materials, even though stored in an approved manner shall be subjected to acceptance test prior to their immediate use.

### 602.2. Cement

**602.2.1.** Cement to be used in the work shall be any of the following types with the prior approval of the Engineer:

(i) Ordinary Portland Cement, 33 Grade conforming to IS:269

(ii) Portland Blast Furnace Slag Cement conforming to IS:455

(iii) Portland Pozzolana Cement (flyash based) conforming to IS:1489-Part-I

(iv) Portland Pozzolana Cement (calcined clay based) conforming to IS:1489-Part-II

(v) Sulphate resistance Portland Cement conforming to IS:12330

Substitution of ordinary portland cement of 33 Grade by ordinary portland cement of a higher grade (Grade 43 or 53) shall not be permitted.

Mixing of blast furnace slag with ordinary portland cement at site shall not be permitted.

Different types of cement shall not be mixed together.

Notwithstanding BIS marking or test certificates, the cement shall be got tested for the following main properties before incorporation in the work. At least one set of three tests shall be conducted for each consignment:

(i) Fineness-IS:4031(Parts 1, 2 & 15)

(ii) Setting Time-IS:4031(Part 5)

(iii) Soundness-IS:4031(Part 3)

(iv) Compressive Strength-IS:4031(Part 6)

Cement brought to work site shall not be more than 6 weeks old from the date of its production. Cement more than 3 months old shall invariably be tested to ascertain that it satisfies the acceptability requirements and its fitness for the work.

For any type of cement, initial setting time shall not be less than 30 minutes and final setting time shall not be more than 600 minutes.

Sulphate resistance Portland Cement, IS:12330 shall be used only where the masonry structure is likely to be affected by the presence of sulphates in surrounding soil or in ground water in large concentration {greater than 0.2 per cent in soil substrata or 300 ppm (0.03 per cent) in ground water}.

**602.2.2. Storage of cement** : Cement in bags shall be stored on wooden platforms minimum 200 mm above the floor level and minimum 600 mm above the ground level whichever is higher, in perfectly dry and watertight sheds. The cement shall be stacked not more than eight bags high. Cement bags shall be stacked at least 450 mm clear off the walls





and the space between the consecutive two rows shall not be less than 600 mm.

Different types of cement shall be stacked and stored separately.

Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received.

Storage of cement at the work site shall be at the Contractor's cost and risk. Any damage occurring to the cement due to faulty storage or negligence on his part shall be the liability of the Contractor.

The Contractor shall keep proper records on site in respect of type of cement, lot No., date of manufacture, manufacturer's certificate regarding quality with respect to the requirements of BIS, i.e., test results conforming the main properties like fineness, setting time, soundness, compressive strength of cement used in various components of structure.

### 602.3. Lime

**602.3.1.** Lime when used as a part of composite mortar (Cement-lime mortar) shall conform to the specifications of type A and B of IS:712.

Use of Quick lime shall not be permitted.

**602.3.2. Storage of lime** : Lime shall be stored in weatherproof sheds. Lime which has been damaged by rain, moisture or air slaking shall not be used in the works. Hydrated lime shall be stored in the same manner as cement and period of storage shall not be more than one month.

### 602.4. Bricks

**602.4.1.** First class bricks to be used in the works shall be any one of the following types with the prior approval of the Engineer:

(a) **Burnt clay bricks**: Shall conform to the requirements of IS:1077 except that the minimum compressive strength of any individual brick, when tested as per IS:3495, shall not be less than the value specified in the drawings or 7 MPa whichever is more. The size shall be according to the local practice with tolerance of $\pm$ 5 per cent. The bricks shall be free from cracks, organic matter and flaws and nodules of free lime. The brick shall have rectangular faces with sharp corners and emit a clear ringing sound when struck.

(b) **Clay Flyash bricks**: Shall conform to the requirements of IS:13757. The minimum compressive strength of any individual brick when tested as

per IS:3495, shall not be less than the value specified in the drawings or 7 MPa whichever is more. The size shall be according to the local practice with tolerance of ± 5 per cent. The bricks shall be free from cracks, organic matter and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp corners and emit a clear ringing sound when struck.

Flyash shall conform to grade 1 or 2 of IS:3812.

Bricks of 190 mm x 90 mm x 90 mm or 230 mm x 110 mm x 70 mm shall be preferred.

The bricks shall be subjected to the dimensional tolerance, water absorption, efflorescence and compressive tests before their use in the work and meet the requirements specified in IS:1077. The permissible values for compressive strength, water absorption and efflorescence are given below:

| | | |
|---|---|---|
| (i) | Minimum compressive strength of any individual brick for burnt clay/clay flyash bricks | Not less than the value specified in the drawings or 7 MPa whichever is more. |
| (ii) | Water absorption | Upto 20 per cent by weight when tested in accordance with IS:3495 (Part 2). |
| (iii) | Efflorescence | 'Moderate' upto 50 per cent of exposed area of the brick covered with a thin deposit of salt but unaccompanied by powdering or flaking of surface when tested in accordance with IS:3495 (Part 3) |

**602.4.2. Storage of bricks** : The bricks shall not be dumped at site but shall be stacked in regular tiers as they are unloaded, to minimize breakage and defacement. The supply of bricks shall be so arranged that, as far as possible, at least two days requirements of bricks are available at site at any time. Bricks selected for use in different situations or different types shall be stacked separately.

### 602.5. Sand/Stone Dust/Marble Dust

**602.5.1.** Sand/stone dust/marble dust shall consist of hard, durable, clean particles of natural sand, crushed gravel, crushed marble or suitable combination thereof. This shall not contain dust lumps, soft or flaky





particles, mica and other harmful materials in such quantities as would reduce the strength or durability of mortar.

Stone dust/marble dust shall conform to the requirements of IS:383 and sand shall conform to the requirements of IS:2116.

**602.5.2. Storage of sand/stone dust/marble dust** : Sand/stone dust/ marble dust, etc. shall be stored at proper places so as to prevent contamination of foreign material due to wind, etc. When these materials are placed directly on the ground (which shall be hard, free draining, free from deleterious matter and denuded of vegetation), they shall not be removed from stockpile within 300 mm of the ground. The bottom 300 mm of stockpile shall be used only after thorough cleaning of the material. These materials shall be deposited at the mixing site not less than 8 hours before use and shall have been tested and approved by the Engineer.

### 602.6. Water

Water shall be clean and percentage of deleterious materials in it shall not be more than permissible limit and provisions of Clause 802.5 of these Specifications shall be followed. Potable water is considered fit for use.

## 603. MORTAR

Mortar in general shall conform to IS:2250 and shall be mixed in the specified proportions given on the drawings. The mix shall be clean and free from materials, like, acids, alkali, organic matter or other deleterious substances.

For Cement Mortar, cement shall be proportioned only by weight, taking cement bag weighing 50 kg as 0.035 cu.m (unit weight as 1.44 tonne per cu.m) and other ingredients shall be proportioned by weight and converted into volume boxes. Based on the requirements at site, box size corresponding to one cement bag or half bag shall be adopted to avoid any error in proportioning. Sand shall be measured after making due allowance for bulking. Inner dimensions of box may be 300 mm x 300 mm x 390 mm corresponding to one cement bag or 300 mm x 300 mm x 200 mm corresponding to half bag of cement.

All mortar shall be mixed with a minimum quantity of water to produce desired workability consistent with maximum density of mortar. The mixing shall preferably be done in a mechanical mixer operated manually or by power. Hand mixing of mortar, can be resorted to, with the

specific permission by Engineer in case of isolated culverts in remote areas where use of mechanical mixer is considered not feasible. Hand mixing operation shall be carried out on a clean watertight platform. The ingredients in specified proportions shall be first mixed dry by being turned over and over, backwards and forwards, several times till a mix of uniform colour is obtained. Thereafter minimum quantity of water shall be added to bring the mortar to the consistency of a workable stiff paste. The mortar shall be mixed for at least two minutes after addition of water.

For cement-lime mortar, cement, lime and sand shall be mixed in specified proportions. Cement shall be taken by weight (50 kg as 0.035 cu.m) and lime and sand by weight by using volume boxes of suitable sizes.

Lime in ground form and sand shall thoroughly be mixed before mixing the same with cement. Immediately before use, specified proportion of cement shall be added to a small quantity of mortar and thoroughly mixed to achieve uniform distribution of cement.

Mortar shall be mixed in such quantity as required for immediate use. As a general guide, not more than half bag of cement shall be mixed at a time if one mason is engaged at site and not more than one bag of cement in case two masons are engaged. The mix which has developed initial set shall not be used in the works. In case the mortar has stiffened during initial setting time (30 minutes for ordinary portland cement) because of evaporation of water, the same shall be re-tempered by adding water as frequently as needed to restore the requisite consistency but this re-tempering shall not be permitted after 30 minutes of mixing.

The cement mortar unused for more than 30 minutes after addition of water shall be rejected and removed from site.

Cement mortar gauged with lime shall be used within two hours of mixing of lime and within 30 minutes of mixing of cement.

Necessary tests to determine compressive strength of the mortar, consistency of the mortar and its water retentivity shall be carried out in accordance with IS:2250. The frequency of testing shall be one cube for every 2 cu.m of mortar prepared subject to a minimum of 3 cubes for a day's work.

The masonry work shall be in cement mortar or cement-lime mortar as specified in the drawings.





## 604. SOAKING OF BRICKS

All bricks shall be thoroughly soaked in water for a minimum period of one hour before use. Soaked bricks shall be removed from the tank sufficiently in advance so that they are skin dry at the time of actual laying. Such soaked bricks shall be stacked on a clean place where these are not in contact with dirt, earth, etc.

## 605. LAYING OF BRICKS

All brickwork shall be laid in English Bond, even and true to line, in accordance with the drawing or as directed by the Engineer, plumb or specified batter and level. All joints shall be accurately laid. Joints in the successive courses of the brick work shall be broken and the length of lap between the joint of the stretcher course with the header course shall not be less than one fourth of the length of the brick. The bricks used on the face and all angles forming the junction of any two walls shall be whole bricks of uniform size and rectangular faces. Brickbats or cut bricks shall not be used except to obtain dimensions of different courses for specified bond or shape.

All bricks shall be laid with frogs up, if any, on a full bed of mortar. In case of top layer without proper coping, the frogs shall be filled with mortar before placing the bricks with frogs down in position. When laying, bricks shall be slightly pressed so that the mortar gets into all the surface pores of bricks to ensure proper adhesion. All head and side joints shall be completely filled by applying sufficient mortar to bricks already in place and on bricks to be placed. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left.

The brickwork shall be built in uniform layers. Corners and other advanced work shall be raked back. Brick work shall be done true to plumb or in specified batter. During construction, no part of brick work shall rise more than one metre above the general construction level, to avoid unequal settlement and improper jointing. Where this is not possible, the work shall be raked back accordingly to the bond (and not toothed) at an angle not steeper than 45 degrees with prior approval of Engineer. Toothing may be permitted as an alternative to raking back in case future extension is contemplated.

The masonry work shall not be started earlier than 48 hours of casting of foundation block. Before laying bricks in foundation over foundation

block, the top surface of the foundation block shall be thoroughly hacked, cleaned, wetted and a layer of not less than 12 mm of mortar shall be spread to prepare the surface on which the bricks will be laid. Immediately thereafter, the first course of bricks shall be laid. In case of masonry works resting on rock, the surface of the rock shall be thoroughly cleaned and levelling course of concrete of M10 grade with minimum average thickness of 150 mm shall be provided before putting the layer of mortar.

## 606. BRICK MASONRY ARCH*

Construction of brick masonry in arches wherever permitted shall in general conform to IS:2118. A full scale shape of arch shall be laid on a levelled platform near the construction site and size of brick and mortar thickness marked. Alternate brick shall be placed length wise and width wise in outer rings of arch. Remaining bricks in the inner part of the arch shall be placed to have uniform length. The courses shall be as shown in the drawings. Beds shall be properly adjusted to bring them to radial planes. Radial joints shall be in planes parallel to the transverse axis of the arch. The intrados face shall be dressed sufficiently to permit the bricks to rest properly on the centering. The bricks of the spandrel wall at their junctions with the extrados of the arch shall be cut to fit in the curvature of the arch.

Laying of arches shall commence from both ends towards the crown and the work shall be carried out systematically about the crown. Bricks shall be laid in full mortar beds with tightly filled joints. Each brick shall be first fitted dry before it is finally laid into mortar and fixed in its bed.

The masonry work shall be done in not leaner than 1:4 cement mortar. Flyash bricks can be permitted in place of burnt bricks provided their crushing strength is not less than the value specified on the drawings.

## 607. JOINTS

The thickness of joints shall not exceed 10 mm. All joints on exposed faces shall be tooled to give concave finish. In the case of arches, the thickness of joints shall not be less than 5 mm and shall not be more than 15 mm.

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(* In Seismic Zones – IV and V, brick masonry arch bridges having span more than 6 m, shall not be constructed)





## 608. JOINTING OLD AND NEW MASONRY WORK

When fresh masonry is to be placed against masonry that is partially or entirely set or existing surface of structure, the exposed joining surface of the set masonry shall be cleaned of all loose material, roughened and wetted with cement slurry as directed by the Engineer so as to effect the best possible bond with the new work.

In case of vertical and inclined joints, the proper bond shall be obtained by interlocking the bricks. Any portion of the brickwork that has been completed shall remain undisturbed until thoroughly set. In case of sharp corners, a flat cutback of 100 mm shall be provided so as to have proper and bonded laying of bricks.

## 609. CURING

All brickwork shall be properly marked indicating the date of construction for keeping a watch for proper curing. Green work shall be protected from rain by suitable covering. Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day. Watering may be done carefully so as not to disturb or wash out the green mortar. In case of cement-lime mortar, curing shall commence two days after laying of masonry and shall continue for seven days.

During hot weather, all finished or partly completed work shall be covered or wetted in such a manner as to prevent rapid drying of brick work. Watering and curing shall be maintained at the close of the day's work or for other period of cessation of works. The work with mortar which has become dry, white or powdery due to neglect of curing shall be pulled down and rebuilt as directed by the Engineer. If any stain appears on the surface during watering, the same shall be removed.

## 610. SCAFFOLDING

The scaffolding shall be sound, and safe to withstand all dead, live and impact loads likely to come upon it. The scaffolding shall be provided to allow easy approach to each part of the work.

Where plastering, pointing or any other finishing has been indicated for the brick work, single scaffolding shall be provided unless otherwise specified. In single scaffolding, one end of the put-logs/pole shall rest in

the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in masonry under one metre in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good by brick work and surface finishing as specified.

Where the brick work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

The Contractor shall get the scaffolding approved from the Engineer. However, the approval by the Engineer shall not relieve the Contractor from the responsibility for its safety.

## 611. CENTERING

The centering required for proper implementation of arch work shall conform to the requirements specified in these specifications and IRC:87. The centering of arches resting on soils shall be preloaded with full designed dead load and observed for minimum 24 hours before its approval. The Contractor shall get the design, procedure for erection, stripping and other construction details approved from the Engineer. The approval by the Engineer shall however, not relieve the Contractor from the responsibility for its safety.

Wedges shall be struck in pairs from the crown outwards to the springing line loosening them gradually without shock to the arch. Not more than half the wedges shall be removed in seven days and centering shall not be struck before filling the haunch portions to half the rise incase of circular arch and 1/3 rise in segmental arch but not before 21-days of completing the masonry work. In case of multiple arch spans, centering shall not be struck and stripped before the construction of adjoining arch. However, it is preferable to keep one or two arches undisturbed between the arch last built and the arch being stripped off.

All the formwork shall be cleaned and made good as directed by the Engineer before reuse.

## 612. CONDITION OF EQUIPMENT

All equipment used for mixing or containers used for transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.





## 613. FINISHING OF SURFACES

### 613.1. General

All brick work shall be finished in a workmanlike manner with the thickness of joints and manner of striking or tooling as described in these specifications or as shown on the drawings.

The surfaces shall be finished by 'jointing' or 'pointing' or by 'plastering', as shown on the drawings.

For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm, while the mortar is still green. The raked joints shall be wire brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.

The mortar for finishing shall be prepared as per Clause 603.

### 613.2. Jointing

In jointing, the face of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work. The faces of brick work shall be cleaned to remove any splashes of mortar during the course of raising the brick work.

### 613.3. Pointing

Pointing shall be carried out using mortar of proportion shown on the drawings but not leaner than 1:3 by volume of cement and sand. The mortar shall be filled and pressed in to the raked out joints before giving the required finish. The pointing shall be finished to proper type given on the drawings. If type of pointing is not mentioned on the drawings, the same shall be ruled pointing. For ruled pointing, after the mortar has been filled and pressed into the joints and finished off level with the edges of the bricks, it shall, while still green, be ruled along the centre with a half round tool of suitable width or as specified by the Engineer. The superfluous mortar shall then be taken off from the edges of the lines and the surface of masonry shall be cleaned of all mortar. The work shall conform to IS:2212. Pointing which projects beyond the face of the brickwork shall not be permitted.

### 613.4. Plastering

Plastering shall be done only when it is shown on the drawings.

Plastering shall be carried out using mortar of proportion shown on the drawings but not leaner than 1:4 by volume of cement and sand. Superficial plastering may be done, if necessary, only in structures situated in fast flowing channels or in severely aggressive environment. Plastering shall be started from top and worked down. All putlog holes shall be filled and made good by brick work in advance of the plastering while the scaffolding is being taken down. Wooden screeds 75 mm wide and of thickness equal to that of the plaster, shall be fixed vertically 2.5 m to 4 m apart to act as gauges and guides in applying the plaster. Before laying of plaster, the surface of brickwork shall be wetted. The mortar shall be laid on the wall between the screeds using the plaster's float and pressing the mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm or 75 mm at a time. Finally, the surface shall be finished off with a plaster's wooden float. Metal floats shall not be used.

When recommencing the plastering beyond the work suspended a week earlier, the edges of the old plaster shall be scraped, cleaned, and bonding agent applied before new plaster is applied to the adjacent areas.

No portion of the surface shall be left unfinished for patching up at a later period.

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as directed by the Engineer.

The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less that the specified thickness by more than 3 mm.

Any cracks which appear in the surface and all portions, which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and re-done as directed by the Engineer.

### 613.5. Curing of Finishes

All plastered work shall have the date of plastering marked on it for keeping a watch for proper curing. Curing shall be started as soon as the mortar of pointing/plastering has hardened sufficiently so as not to be damaged during curing. It shall be kept wet for a period of at least 7-days. During this period, it shall be suitably protected from all damages. Any surface with mortar which has become dry, white or powdery due to





neglect of curing shall be removed and rebuilt as directed by the Engineer. Any stain appearing during watering of surface shall be removed.

### 613.6. Scaffolding for Finishes

Provisions of Clause 610 of these Specifications shall be followed.

## 614. WEEP HOLES

Weep holes as shown on the drawings shall be provided in the masonry structures with height more than 2 m to drain moisture from the backfilling. Weep holes shall be provided with 100 mm dia AC pipes and shall extend through the full width of the masonry with slope of about 1 vertical to 20 horizontal towards the draining face.

The weep hole shall be suitably staggered and the spacing of weep holes shall not exceed 2 m in horizontal and 1 m vertical direction with the lowest one at about 150 mm above the low water level or bed level which ever is higher or as directed by the Engineer.

## 615. ARCHITECTURAL COPING FOR WING/RETURN/ PARAPET WALLS

This work shall consist of providing an architectural coping over the top of wing/return/parapet walls as per the drawings.

The minimum thickness of architectural concrete coping over the masonry shall be 150 mm. For pre-cast or cast in situ concrete coping, vertical construction joints at spacing of not more than 1.5 m shall be provided.

## 616. TOLERANCES & TESTS AND STANDARDS OF ACCEPTANCE

All work shall be done true to the lines and levels as shown on the drawings or as directed by the Engineer subject to the tolerances as indicated in these Specifications for different components of the structure.

All materials shall be tested in accordance with stipulations made in Clause 602 of these Specifications.

Sampling and testing of bricks shall be done in accordance with IS:5454 and IS:3495. The permissible values of tolerances are given below:

(i) Dimensions — Variation of ± 5 per cent in size.

| | |
|---|---|
| (ii) Compressive Strength of any individual brick for burnt clay/ clay flyash bricks with respect to the value specified in the drawings or 7 MPa whichever is more. | +2.5 MPa<br>No minus tolerance shall be permitted. |
| (iii) Water absorption | Upto 20 per cent by weight when tested in accordance with IS:3495 (Part 2). |
| (iv) Efflorescence | 'Moderate' upto 50 per cent of exposed area of the brick covered with a thin deposit of salt but unaccompanied by powdering or flaking of surface when tested in accordance with IS:3495 (Part 3) |

Mortar cubes shall be tested in accordance with IS:2250 for compressive strength, consistency and its water retentivity. The frequency of testing shall be one cube for every 2 cu.m. of mortar prepared subject to a minimum of 3 cubes for a day's work.

Thickness of joints shall not be more than 10 mm. In case of arches, the thickness of joints shall not be less than 5 mm nor more than 15 mm.

In case of plaster finish, the minimum surface thickness shall not be less than the specified thickness by more than 3 mm.

## 617. MEASUREMENTS FOR PAYMENT

All brick work shall be measured in cubic metres. Any extra work done by the Contractor over the specified dimensions shall be ignored.

In arches, the length of arch shall be measured as the mean length between the extrados and intrados.

The work of plastering and pointing shall be measured in sq.m. of the surface treated.

Architectural coping shall be measured in linear metres.

## 618. RATE

The contract unit rate for brick work shall include the cost of all labour, materials, tools and plant, scaffolding including centering if required





and other expenses incidental to the satisfactory completion of the work, sampling, testing and supervision as described in these Specifications.

The contract unit rate for plastering shall include the cost of all labour, materials, tools and plant, scaffolding including centering if required and all incidental expenses, sampling and testing and supervisions as described in these Specifications.

The contract unit rate for pointing shall include the cost of all labour, materials, tools and plant for erection and removal of scaffolding including centering if required and all incidental expenses to complete the pointing, i.e., raking out joints, cleaning, wetting, filling with mortar, trowelling, pointing and watering, sampling and testing and supervision as described in these Specifications.

The contract unit rate for architectural coping shall include cost of all labour, materials, tools and plant, sampling and testing and supervision as described in these Specifications.

700

# Stone Masonry for Structures

## 701. SCOPE

The work shall consist of construction of structures with stones jointed together by cement mortar or cement-lime mortar in specified proportions in accordance with the provisions laid down in this Section, IRC:40 and details shown on the drawings or as approved by the Engineer.

## 702. MATERIALS

### 702.1. General

All materials to be used in the work shall be in conformity with the requirements laid down in this Section.

The Contractor shall notify the Engineer of his proposed sources of materials and size of stones prior to delivery. If it is found after tests that proposed sources of supply do not produce uniform and satisfactory products at any time of execution, the Contractor shall provide acceptable materials conforming to the specifications from other sources at his own cost.

Samples required for approvals must be supplied well in advance, at least 48 hours or minimum time required for carrying out the relevant tests and according approvals. Delay in submission of samples shall not be acceptable as a reason for delay in completion of the works/ extension of time for completion. Cost of sampling/testing of materials including imported materials in the laboratories approved by the Engineer, shall be borne by the Contractor.

All materials shall be stored at proper places so as to prevent their deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the works. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used in the works and shall be removed from site by the Contractor at his cost.

All materials, even though stored in an approved manner shall be subjected to acceptance test prior to their immediate use.

### 702.2. Cement

Ordinary Portland Cement- 33 Grade or blended cement shall be used and shall conform to the Specifications given under Clause 602.2.

### 702.3. Lime

Lime when used as a part of composite mortar (cement-lime mortar) shall conform to the Specifications given under Clause 602.3.

### 702.4. Stone

Stone shall be hard, sound, free from cracks, decay, weathering, defects like cavities, flaws, sand holes, and patches of loose or soft materials or other similar defects that may adversely affect its strength or appearance and shall be from the approved quarry. Stone with round surfaces shall not be used. Stone used shall conform to the requirements of IS:1597 (Part 1).

The stones when immersed in water for 24 hours shall not absorb water more than 5 per cent of their weight when tested in accordance with IS:1124 and it shall not soften when rubbed by hand.

No stone shall be less in width than its height and width on base shall not be greater than three-fourth of the wall thickness nor less than 150 mm. For coursed rubble masonry, the length of any stone shall not exceed three times its height nor shall be less than twice its height. The size of the stone shall be such that it can be lifted and placed by hand.

### 702.5. Sand/Stone Dust/Marble Dust

Sand/stone dust/marble dust shall conform to Clause 602.5.

### 702.6. Water

Water shall be clean and percentage of deleterious materials in it shall not be more than permissible limit and provisions of Clause 802.5 of these Specifications shall be followed. Potable water is considered fit for use.

### 702.7. Mortar

Mortar used shall conform to Clause 603 except that the stone masonry work shall be in cement mortar not leaner than 1:5 above bed/ ground level and 1:4 below bed/ground level.

## 703. TYPE OF MASONRY

The type of masonry used for the structures shall be coursed rubble masonry (first or second sort). Random rubble masonry shall not be permitted except where allowed as per Clause 704.5.





The actual type of masonry to be used for different structural members shall be specified in the drawings.

## 704. CONSTRUCTION OPERATIONS

### 704.1. General Requirements

The dressing of stone shall be as specified for individual type of masonry work and it shall also conform to the requirements of IS:1597 and requirements for dressing of stones covered in IS:1129.

### 704.2. Laying

The masonry work shall be laid to lines, levels, dimensions as shown on the drawings. The height of each course shall be kept the same and every stone shall be fine tooled on all bed joints and faces full and true. It shall be carried up true to plumb or to specified batter.

Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar.

Stratified stones shall be laid on their natural beds. All bed joints shall be normal to the pressure upon them.

Outer layer of masonry shall be laid first. Location of headers (bond stones) shall then be fixed and headers laid.

Stones in the hearting shall be laid on their broadest face for a better opportunity to fill the spaces between stones and each stone fixed in mortar.

Based on locally available size of stones of any dimension not less than 150 mm, the height of course of masonry shall be predetermined by the Engineer. They shall be of same height. The height of the course shall not be less than 160 mm. When there is to be variation in the height of courses, the larger courses shall be placed at lower levels with heights of courses decreasing gradually towards the top of the wall. Mortar shall be mixed thoroughly and the fluid mortar poured in the joints. Pouring of water on dry mortar on the course to fill the gaps between stones shall not be permitted. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar.

In tapered walls, the beds of the stones and the plans of courses shall

be at right angle to the batter. In case of piers with batter on both sides, the courses shall be horizontal.

The bed of masonry which is to receive the stone shall be cleaned, wetted and covered with layer of fresh mortar. All stones shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a wooden mallet immediately on placement and solidly embedded in mortar before it has set. Clean chips and spalls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. The quantity of mortar consumed shall be 0.25 to 0.30 cu.m. per cubic metre of stone masonry. The face stones shall be first fixed in position and then the stones in the hearting shall be placed and fixed in the mortar. Thereafter, all interstices shall be filled with stone chips laid in mortar.

Face works and hearting shall be brought up evenly but the top of each course shall not be levelled up by the use of flat chips.

Projections of any footing course or back of abutments/return/wing wall shall not exceed the half of the depth of the course.

Foundation masonry shall not be laid directly on rock. Concrete levelling course of minimum average thickness of 150 mm and of M10 grade shall be provided on the rock before laying the first course of stone masonry. The face stones of the first course shall be dressed to fit into rock snugly when pressed down in the mortar bedding of minimum thickness of 12 mm over the levelling course. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. Annular gap around the foundations shall be filled upto the top level of the rock with concrete grade not leaner than M10.

For sharp corners specially in skew bridges, through stones shall be used in order to avoid spalling of corners.

In case any stone already set in mortar is disturbed or the joint broken, it shall be taken out without disturbing the adjoining stones and joints, the stone shall be reset in fresh mortar after removing dry mortar and thoroughly cleaning the stones and joints. Sliding of stones on top of another freshly laid stones shall not be permitted.

Shaping and dressing shall be done before the stone is laid in the work. No dressing and hammering, which will loosen the masonry, shall





be allowed after it is once placed. All necessary chases for joggles, dowels and clamps shall be formed before hand.

Sufficient transverse bonds shall be provided by the use of bond stones or set of bond stones extending from the front to the back of the wall from outside to the interior and vice versa, overlapping each other by minimum 150 mm. Only rectangular shaped bond stones or headers shall be used. In case natural bond stones of requisite size are not available, precast concrete (M15) bond blocks of size as given in Table 700.1 shall be used. Cast in situ headers shall not be permitted.

**TABLE 700.1 : SIZE OF FACE STONES AND PRECAST CONCRETE BOND BLOCKS**

| Size | Height of course (mm) | Minimum acceptable size of face stones (mm) | Preferable size of face stones (mm) | Size of longer stones 1/3rd of total face stones (mm) | Size of precast concrete bond blocks (mm) |
|---|---|---|---|---|---|
| A | 160 | 150x150x200 | 150x180x225 | 150x180x300 | 150x180x450 |
| B | 180 | 170x170x210 | 170x210x255 | 170x210x340 | 170x210x500 |
| C | 220 | 190x190x225 | 190x225x280 | 190x225x380 | 190x225x600 |

At junctions of walls, the stones at each alternate course shall be carried into each of the respective walls so as to unite the work thoroughly.

Building up thin faces tied with occasional through stones and filling up the middle with small stuff or even dry packing shall not be permitted.

All quoin stones and the angles of the opening shall be made from selected stones, carefully squared and bedded and arranged to bond alternately long and short in both directions.

All vertical joints shall be truly vertical and staggered as far as possible. Distance between the nearer vertical joints of upper layer and lower shall not be less than half the height of the course.

All connected masonry in a structure shall be carried up nearly at one uniform level throughout but when breaks are unavoidable, the masonry shall be raked in sufficiently long steps to facilitate jointing of old and new work. The stepping of raking shall not be more than 45 degrees with the horizontal.

The face stones shall be hammer dressed on all beds and joints so as to give them approximately regular shape. The face stone shall tail into the work for not less than its height and at least one third of stones shall tail in the work for a length not less than twice of its height. The size of face stones for different preferred height of courses shall be as given in Table 700.1.

### 704.3. Coursed Rubble Masonry (First Sort)

**704.3.1. Dressing** : Face stones shall be hammer dressed on all beds and joints so as give them approximately rectangular shape. These shall be square on all joints and beds. The beds joints shall be chisel drafted for at least 30 mm back from the face and for at least 30 mm for the side joints. No portion of the dressed surface shall show a depth of gap more than 6 mm from straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints. The requirements regarding bushing shall be same as for random rubble masonry.

**704.3.2. Hearting stones** : The hearting or interior filling of the wall shall consist of flat bedded stone carefully laid on their proper beds in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 per cent of the quantity of masonry. While using chips, it shall be ensured that no hollow spaces are left anywhere in the masonry. This shall be ensured by filling the gaps with mortar and inserting chips in it.

**704.3.3. Bond stones** : The requirements regarding through or bond stones shall be same as random masonry but these shall be provided at 1.5 m to 1.8 m apart clear in every course.

**704.3.4. Quoin stones** : The quoins shall be of the same height of the course in which these occur and shall be formed of header stones not less than 450 mm in length. They shall be laid lengthwise alternately along each face, square in their beds which shall be fairly dressed to a depth of at least 100 mm.

**704.3.5. Face stones** : Face stones shall tail into the work for not less than their heights and at least one-third of the stones shall tail into the work for a length not less twice their height. These shall be laid headers and stretchers alternately.





**704.3.6. Laying** : The stones shall be laid on horizontal courses. All vertical joints shall be truly vertical and staggered as far as possible. Distance between the nearer vertical joints of upper layer and lower shall not be less than half the height of the course. The quoin stones rough chisel dressed to a depth of minimum 30 mm, shall be laid stretchers and headers alternately and shall be laid square on their beds, which shall be rough chisel dressed to a depth of atleast 30 mm.

**704.3.7. Joints** : The face joints shall not be more than 10 mm thick but shall be sufficiently thick to prevent stone to stone contact and shall be completely filled with mortar.

### 704.4. Coursed Rubble Masonry (Second Sort)

**704.4.1. General** : All the requirements are the same as for coursed rubble masonry (first sort) except that no portion of dressed surface joints shall show a depth of gap more than 10 mm from a straight edge placed on it and use of chips in hearting stone shall not exceed 15 per cent of the quantity of the stone masonry.

Adoption of coursed masonry (second sort) shall be restricted to culverts and wing/return walls of small bridges.

**704.4.2. Joints** : The face joints shall be uniform throughout and not be more than 20 mm thick but shall be sufficiently thick to prevent stone to stone contact and shall be completely filled with mortar.

### 704.5. Random Rubble Masonry

Random rubble masonry shall be adopted only in case of return/wing/ toe walls of heights less than 3 m.

**704.5.1. Dressing** : Stone shall be hammer dressed on the face, the sides and beds to enable it to come in proximity with the neighbouring stone. The bushing on the exposed face shall not be more than 40 mm.

**704.5.2. Insertion of chips** : Minimum quantity of chips and spall stones shall be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are left anywhere in the masonry. The chips shall not be used below hearting stones to bring these upto the level of face stones. Use of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 per cent of the quantity of stones masonry.

**704.5.3. Hearting stones** : The hearting or interior filling of wall face shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting shall be laid nearly level with facing and backing.

**704.5.4. Bond stones** : Bond stones are selected long stones, used to hold a wall together transversely. Through bond stones shall be provided in masonry upto 600 mm thickness and in case of masonry above 600 mm thickness, a set of two or more bond stones overlapping each other at least by 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous limestone and sandstones, etc.) the bond stone shall extend only about two-third into the wall, as through stones in such cases may give rise to penetration of dampness and therefore, for all thickness of such masonry, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Minimum one bond stone or a set of bond stones shall be provided for every 0.50 sq.m of the masonry surface.

**704.5.5. Quoin stones** : Quoin stones, i.e., the stones specially selected and neatly dressed for forming an internal angle in masonry work, shall not be less then 0.03 cu.m. in volume.

**704.5.6. Plum stones/Pin headers** : These stones are selected oblong stones embedded vertically in the interior of masonry to form a bond between successive courses. The plum stones embedded in the lower course shall extend to the minimum full height of the upper course and shall be provided at about 1000 mm intervals.

**704.5.7. Laying** : The masonry shall be laid with or without course as specified. The quoins shall be laid header and stretcher alternately. Every stone shall be fitted to the adjacent stone so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints, as much as possible, and to avoid long vertical lines of joints.

**704.5.8. Joints** : The face joints shall not be more than 20 mm thick, but shall be sufficiently thick to prevent stone-to-stone contact and shall be completely filled with mortar.





### 704.6. Dry Rubble Masonry for Retaining Walls

Dry rubble masonry shall be adopted only in case of breast/retaining walls/toe walls and other incidental works of heights upto 3 m which are not subjected to flood/stagnated water and with specific permission of the Engineer. The minimum base width of such walls shall not be less than the height of the wall.

This work shall conform to Clause 704.5 of Random Masonry except that:

(i) the masonry shall be dry without mortar;

(ii) the spaces between large stones shall be filled with spalls as tightly as possible; and

(iii) the foundations shall be excavated at right angles to the batter face and not horizontally. The beds of the stones shall be laid at right angles to the face batter.

### 704.7. Pointing

Pointing shall be provided only if specified in the drawings. Pointing if specified, shall be carried out using mortar not leaner than that used in bed courses or in proportion shown on the drawings. The pointing shall conform to Clause 613.3. The thickness of joints shall not exceed what is specified for each type of masonry. Pointing which projects beyond the face of stone masonry shall not be permitted.

### 704.8. Curing

Curing shall conform to Clauses 609 and 613.5.

## 705. SCAFFOLDING & CENTERING

Provisions of Clauses 610 and 611 shall be applicable for scaffolding and centering respectively.

## 706. STONE MASONRY ARCH*

A full scale shape of arch shall be laid on a levelled platform near the construction site and size of each stone and mortar thickness marked. The stones shall then be cut accordingly. In outer rings of arch the alternate

(*In seismic Zones-IV and V, stone masonry arch bridges having span more than 6 m, shall not be constructed.)

stone shall have long length and short length. Remaining stones in the inner part of the arch shall be placed to have as far as possible uniform length. The courses shall be as shown in the drawings. The drawing shall indicate the order in which voussoirs shall be placed. Voussoirs shall be full size throughout and shall have bond not less than their thickness. Beds shall be properly adjusted to bring them to radial planes. Radial joints shall be in planes parallel to the transverse axis of the arch. The intrados face shall be dressed sufficiently to permit the stones to rest properly on the centering. The stones of the spandrel wall at their junctions with the extrados of the arch shall be cut to fit in the curvature of the arch.

Laying of arches shall commence from both ends towards the crown and the work shall be carried out systematically, stones being placed in full mortar beds and joints grouted if required. Pinning by use of spalls or such material of any description shall not be permitted. Each stone shall be first fitted dry, in order that inaccuracies are found out and corrected by stone cutter before it is finally laid into mortar and fixed in its bed.

The masonry work shall be done in not leaner than 1:4 cement mortar.

## 707. JOINTING OLD AND NEW MASONRY WORK

For jointing old and new masonry, the specifications given under Clause 608 shall apply.

## 708. FINISHING OF SURFACES

All stone masonry work shall be finished in a workmanlike manner with the thickness of joints and manner of striking or tooling as described in these Specifications or as shown on the drawings.

The surfaces shall be finished by 'jointing' or 'pointing' as given on the drawings.

For a surface which is to be subsequently pointed, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.

The mortar for finishing shall be prepared as per Clause 603.

## 709. WEEP HOLES

Adequate number of weep holes at spacing not exceeding 2 m in





horizontal and 1 m in vertical direction suitably staggered shall be provided in the masonry structures with height more than 2 m to drain moisture from the backfilling. The lowest row of weep holes shall be provided at about 150 mm above the low water level or lowest ground level whichever is higher or as directed by the Engineer.

The weep holes shall be provided with 100 mm dia. AC pipes and shall extend through the full width of the masonry with slope of about 1 vertical to 20 horizontal towards the draining face. Alternatively, the height of weep holes shall be same as the height of the course in which they are formed and the size of the weep holes shall be not less than 80 mm x 150 mm. The sides and bottom of weep holes in the interior shall be made up with stones having fairly plain surface and the channel so formed slabbed over with stones not less than 150 mm thick and having bearing of not less than 150 mm on each side.

## 710. ARCHITECTURAL COPING FOR WING/RETURN/PARAPET WALLS

This work shall consist of providing an architectural coping over the top of wing/return/parapet walls as per the drawings.

The minimum thickness of architectural stone/concrete coping over the stone masonry shall be 150 mm. For pre-cast or cast-in-situ concrete coping, vertical joints at spacing of not more than 1.5 m shall be provided.

In case of stone masonry, the mortar used shall be cement sand mortar in 1:3 proportion and shall conform to Clause 603.

## 711. TOLERANCES AND TESTS AND STANDARDS OF ACCEPTANCE

All work shall be done true to the lines and levels as shown on the drawings or as directed by the Engineer subject to the tolerances as specified in these Specifications for different components of structure.

All materials shall be tested in accordance with stipulations made in Clause 702 of these Specifications.

Water absorption in the stones shall not be more than 5 per cent of their weight when tested in accordance with IS:1124.

Mortar cubes shall be tested in accordance with IS:2250 for compressive strength, consistency and its water retentivity. The frequency of testing

shall be one cube for every 2 cu.m of mortar prepared subject to a minimum of 3 cubes for a day's work.

### 712. MEASUREMENTS FOR PAYMENT

All stone work shall be measured in cubic metres. Any extra work done by the Contractor over the specified dimensions shall be ignored.

In arches, the length of arch shall be measured as the mean length between the extrados and intrados.

The work of pointing shall be measured in sq.m. of the surface treated.

Architectural coping shall be measured in linear metres.

### 713. RATE

The contract unit rate for stone masonry work shall include the cost of all labour, materials, tools and plant, scaffolding including centering if required, sampling, testing, supervision and other expenses incidental to the satisfactory completion of the work as described in these Specifications.

The contract unit rate for work shall also include full compensation for using dressed stones on faces of walls with batter.

The contract unit rate for pointing shall include cost of all labour, materials, tools and plants for erection and removal of scaffolding including centering if required, and all incidental expenses to complete the pointing, i.e., raking out joints, cleaning, wetting, filling with mortar, trowelling, pointing and watering, sampling and testing and supervision as described in these Specifications.

The contract unit rate for architectural coping shall include cost of all labour, materials, tools and plant, sampling and testing and supervision as described in these Specifications.





# 800

# Concrete for Structures

## 801. SCOPE

These Specifications cover the requirements of cement concrete for use in various components of structures. The work shall consist of supplying and placing of concrete using all materials in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Engineer.

## 802. MATERIALS

### 802.1. General

All materials to be used in the work shall be in conformity with the requirements laid down in this Section.

The Contractor shall notify the Engineer of his proposed sources of materials prior to delivery. If it is found that proposed sources of supply do not produce uniform and satisfactory products at any time of execution, the Contractor shall provide acceptable materials conforming to the specifications from other sources at his own cost.

Samples required for approvals must be supplied well in advance, at least 48 hours or minimum time required for carrying out the relevant tests and according approvals. Delay in submission of samples shall not be acceptable as a reason for delay in completion of the works/extension of time for completion. Cost of sampling/testing of materials including imported materials in the laboratories approved by the Engineer, shall be borne by the Contractor.

If any special material, not covered in these Specifications is required to be used, it shall conform to relevant Indian Standards if there are any, or to the requirements specified in contact documents.

All materials shall be stored at proper places so as to prevent their deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the works. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used in the works and removed from site by the Contractor at his cost. Such materials shall not be made acceptable by any modifications.

All materials, eventhough stored in an approved manner shall be subjected to acceptance test prior to their immediate use.

## 802.2. Cement

**802.2.1.** Cement to be used in the works shall be any of the following types with the prior approval of the Engineer:

(i) Ordinary Portland Cement, 33 Grade conforming to IS:269

(ii) Ordinary Portland Cement, 43 Grade conforming to IS:8112

(iii) Rapid hardening Portland Cement conforming to IS:8041

(iv) Portland Pozzolana Cement conforming to IS:1489 (Part 1)

(v) Portland Blast Furnace Slag Cement conforming to IS:455

(vi) Sulphate resistance Portland Cement conforming to IS:12330

Ordinary portland cement 43 grade shall be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, ordinary portland cement 43 grade shall be used with a certain caution as high early strengths of cement in the 1 to 28-days range can be achieved by finer grinding and higher constituent ratio of Tricalcium Silicate ($C_3S$) and Dicalcium Silicate ($C_2S$). In such cements, the further growth of strength beyond say 28-days may be much lower than that traditionally expected and shall require further tests to be carried out for 56 and 90-days to adjust the proportions from strength considerations. Therefore, no substitution of ordinary portland cement of 33 or 43 Grade by ordinary portland cement of a higher grade (Grade 43 or 53 as the case may be) shall be done without additional tests to prove that the quality and strength of concrete are satisfactory and specific approval of the Engineer.

Mixing of blast furnace slag with ordinary portland cement at site shall not be permitted.

Mixing of different types of cement in one lot of concrete shall not be permitted.

Not withstanding BIS marking or test certificates, the cement shall be got tested for the following main properties to ascertain that these properties meet the requirements as per BIS before incorporation in the work. At least one set of three tests shall be conducted for each consignment.

| | |
|---|---|
| (i) Fineness | IS:4031(Parts 1,2 & 15) |
| (ii) Setting Time | IS:4031(Part 5) |
| (iii) Soundness | IS:4031(Part 3) |
| (iv) Compressive Strength | IS:4031(Part 6) |





Total chloride content in cement shall not exceed 0.05 per cent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride ($SO_3$) shall in no case exceed 2.5 per cent and 3 per cent when tri-calcium aluminate per cent by mass is upto 5 and greater than 5 respectively.

For any type of cement, initial setting time shall not be less than 30 minutes and final setting time shall not be more than 600 minutes.

Cement brought to work site shall not be more than 6 weeks old from the date of its production. Cement more than 3 months old shall invariably be tested to ascertain that it satisfies the acceptability requirements and its suitability for the works.

Any cement including imported one, if found to have lower quality than certified by the manufacturer shall be debarred from use in the works.

For any type of cement, the cement content required to achieve the minimum specified strength shall not be more than 450 kg per cu.m of concrete.

Use of Portland Pozzolana Cement, IS:1489 (Part 1) shall be permitted only in plain concrete members and flyash or any other pozzolanic material shall not be used to replace part of cement or fine aggregates.

Sulphate Resistance Portland Cement, IS:12330 shall be used only where the structure is likely to be affected by the presence of sulphates in surrounding soil or in ground water in large concentration {greater than 0.2 per cent in soil substrata or 300 ppm (0.03 per cent) in ground water}.Tests to confirm actual values of sulphate concentration are essential if structure is located near sea coast, chemical factories, and sites where there are effluent discharges or soluble sulphate bearing ground water level is high.

Rapid Hardening Portland Cement, IS:8041 shall be used only for precast concrete products after specific approval of the Engineer.

**802.2.2. Storage of cement** : Cement in bags shall be stored on wooden platforms minimum 200 mm above the floor level and minimum 600 mm. above the ground level whichever is higher, in perfectly dry and watertight sheds. The cement shall be stacked not more than eight bags high and in a manner to facilitate their removal and use in the order in which they are received. Cement bags shall be stacked at least 450 mm clear off the walls and the space between the consecutive two rows shall not be less than 600 mm.

Different types of cement/each consignment shall be stacked and stored separately and cement shall be used in the sequence in which it is received at site.

Storage of cement at the work site shall be at the Contractor's cost and risk. Any damage occurring to the cement due to faulty storage or negligence on his part shall not be used in the work and removed from site by the Contractor without charge to the Employer.

The Contractor shall keep proper records on site in respect of type of cement, lot No., date of manufacture, manufacturer's certificate regarding quality with respect to the requirements of BIS, test results confirming the main properties like fineness, setting time, soundness, compressive strength of cement used for various components of structure.

### 802.3. Coarse Aggregates

**802.3.1.** Coarse aggregates (4.75 to 40 mm size) shall be clean, free from adherent coating, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials such as coal, lignite, mica, pyrite, shale, clay, organic impurities in such quantities as to reduce the strength and durability of the concrete, or attack the steel reinforcement. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity carried out as per IS:2386 (Parts 1 to 8).

Before the commencement of the works, at least three samples in accordance with the procedure laid down in IS:2430 shall be taken for each quarry source to ascertain the quality, suitability and fitness of the available material for use in the works.

The aggregate having more than 0.5 per cent of sulphate as $SO_3$ with water absorption more than 2 per cent of their own weight shall not be used.

The Contractor shall furnish the information specified in Appendix-A of IS:383.

The nominal sizes of graded coarse aggregate shall be 40, 20 or 12.5 mm as specified in the drawings.





The preferred nominal size of aggregate is 20 mm for reinforced concrete. Larger sizes up to 40 mm may be permitted in special cases when there is no restriction to flow of concrete in a section. If smaller sizes are required to be used for any member 10 mm and 12.5 mm may be used.

For plain concrete, the preferred nominal size of aggregate shall be between 20 and 40 mm.

Proportions of coarse aggregates shall be such as to produce a dense concrete of specified strength, which can be worked readily into position without segregation and without the use of excessive water content.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 per cent.

Coarse aggregate shall be either graded or single sized (ungraded) of different sizes to be blended at site to obtain the required grading as specified. Coarse aggregates, unless otherwise agreed by the Engineer in writing, shall be supplied in different sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when nominal size is 32 mm or more). The graded coarse aggregate shall satisfy the requirements given in Table 800.1.

**TABLE 800.1**

| IS Sieve Size | Per cent by Weight Passing the Sieve for Nominal Size of | | |
|---|---|---|---|
| | 40 mm | 20 mm | 12.5 mm |
| 63 mm | 100 | - | - |
| 40 mm | 95-100 | 100 | - |
| 20 mm | 30-70 | 95-100 | 100 |
| 12.5 mm | - | - | 90-100 |
| 10 mm | 10-35 | 25-55 | 40-85 |
| 4.75 mm | 0-5 | 0-10 | 0-10 |

**802.3.2. Storage of coarse aggregates** : The coarse aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of coarse aggregates shall be stored in separate stockpiles sufficiently away from each other to prevent intermixing of the materials at the edges of the stockpiles. The height of stockpile shall normally be not more than 120 cm unless otherwise permitted by the Engineer.

Coarse aggregates shall be stored at proper places so as to prevent contamination of foreign material due to wind, etc. When these materials are placed directly on the ground (which shall be hard, free draining, free from deleterious matter and denuded of vegetation), they shall not be removed from stockpile within 300 mm of the ground. The bottom 300 mm of stockpile shall be used only after thorough cleaning of the material. The aggregates which are not free from dirt shall be thoroughly washed and dried for at least 72 hours before using in the work.

Required quantities of coarse aggregates of different sizes shall be stock-piled preferably a day, before use and shall have been tested and approved by the Engineer.

### 802.4. Sand/Fine Aggregates

**802.4.1.** Sand/Fine aggregates of sizes 0.15 to 4.75 mm shall consist of natural sand or hard pieces of crushed stone or crushed gravel or combination thereof. They shall be clean and shall not contain lumps, soft or flaky materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of concrete or to attack the embedded steel. Fine aggregates having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity carried out as per IS:2386 (Parts 1 to 8). The fineness modulus of fine aggregate shall be between 2.0 to 3.5.

Before the commencement of the works, at least three samples as per IS:2430 shall be taken for each quarry source to ascertain the quality, suitability and fitness of the available material for use in the works.

Grading of aggregates shall be such as to produce a dense and workable concrete of specified strength without segregation and use of excessive water content. Sand/fine aggregate shall conform to the grading requirements given in Table 800.2.

**802.4.2. Storage of fine aggregates** : Fine aggregates shall be stored at proper places so as to prevent contamination of foreign material due to wind, etc. When these materials are placed directly on the ground (which shall be hard, free draining, free from deleterious matter and denuded of vegetation), they shall not be removed from stockpile within 300 mm of the ground. The bottom 300 mm of stockpile shall be used only after thorough cleaning of the material. The fine aggregates which are not free





TABLE 800.2

| IS Sieve Size | Per cent by Weight Passing the Sieve | | |
|---|---|---|---|
| | Zone I | Zone II | Zone III |
| 10 mm | 100 | 100 | 100 |
| 4.75 mm | 90-100 | 90-100 | 90-100 |
| 2.36 mm | 60-95 | 75-100 | 85-100 |
| 1.18 mm | 30-70 | 55-90 | 75-100 |
| 600 micron | 15-34 | 35-59 | 60-79 |
| 300 micron | 5-20 | 8-30 | 12-40 |
| 150 micron | 0-10 | 0-10 | 0-10 |

from dirt shall be thoroughly washed and dried for at least 72 hours before using in the works.

These materials shall be deposited at the mixing site not less than 8 hours before use and shall have been tested and approved by the Engineer.

### 802.5. Water

**802.5.1.** Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, salts, sugar, organic materials or other substances that may be harmful to concrete or steel. Potable water (with pH value between 6 and 8) is generally considered satisfactory for mixing and curing of concrete. The pH value of water proposed to be used shall not be less than 6. Water used for curing shall not produce any objectionable strain or unsightly deposit on concrete surface. Mixing and curing with sea water shall not be permitted. The following concentrations represent the maximum permissible values of harmful materials in water when tested in accordance with IS:3025:

(i) **Limits of Acidity** : To neutralise 100 ml sample of water, using phenolphthalein as an indicator, it shall not require more than 5 ml of 0.02 normal NaOH when tested in accordance with IS:3025 (Part 22).

(ii) **Limits of Alkalinity** : To neutralise 100 ml sample of water, using mixed indicator, it shall not require more than 25 ml of 0.02 normal $H_2SO_4$ when tested in accordance with IS:3025 (Part 23).

(iii) Permissible limits for solids, when tested in accordance with IS:3025, shall be as given in Table 800.3.

TABLE 800.3

| | Tested as per | Permissible limit (Maximum) |
|---|---|---|
| Organic | IS:3025 (Part 18) | 200 mg/litre |
| Inorganic | IS:3025 (Part 18) | 3000 mg/litre |
| Sulphates (as $SO_4$) | IS:3025 (Part 24) | 400 mg/litre |
| Chlorides(as cl) | IS:3025 (Part 32) | 2000 mg/litre (for plain concrete)<br>500 mg/litre (for reinforced concrete) |
| Suspended matter | IS:3025 (Part 17) | 2000 mg/litre |

Average 28-days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90 percent of the average of strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the procedure laid down in IS:516.

The initial setting time of test blocks with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by ± 30 minutes from the initial setting of control test blocks prepared with same cement and distilled water. The test blocks shall be prepared and tested as per IS:4031 (Part 5).

Water from each source shall be tested before the start of works, thereafter every three to four months and after each monsoon till the completion of the works or as directed by the Engineer.

**802.5.2. Storage of water** : Water shall be stored in containers covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow (depth less than 1 m), muddy or marshy surface shall not be permitted.

## 803. GRADES OF CONCRETE

The concrete shall be in grades designated as per Table 800.4, where the characteristic strength is defined as the strength of concrete below which not more than 5 per cent of the results are expected to fall.

The lowest grades of concrete and corresponding cement contents and water-cement ratios shall be maintained as given in Table 800.5.

The cement content shall be as low as possible but not less than





TABLE 800.4

| Grade designation | Specified characteristic compressive strength of 150 mm cubes at 28-days in MPa |
|---|---|
| M10* | 10 |
| M15 | 15 |
| M20 | 20 |
| M25 | 25 |
| M30 | 30 |

Note: In designation of concrete M refers to the mix and number to the specified characteristic compressive strength of 150 mm cubes at 28-days expressed in MPa.

* Lean concrete levelling course/foundation concrete for masonry work.

quantities specified above. In no case shall it exceed 450 kg/cu.m of concrete.

Concrete used in any structure shall be apart from its grade designation, specified either as "Design Mix" or "Nominal Mix".

Design mix concrete is that concrete for which the design of mix, i.e., the determination of the proportions of cement, aggregates and water is arrived at to have a target mean strength of concrete, is done, while "Nominal Mix" concrete is that concrete for which the proportions of materials are specified.

For all items of concrete "Design Mix" shall be preferred to "Nominal Mix" because of better quality and it requires less quantity of cement than the quantity required for nominal mix for a specified grade.

Nominal mix for grades higher than M20 is generally not recommended. However, as per policy decision taken for culverts and small bridges involving small quantity of concrete work, nominal mix of grades M20 and M25 may be used with adequate supervision and quality control measures. Nevertheless, it will be preferable to use design mix in place of nominal mix for concrete of M20 and higher grades.

**TABLE 800.5 (A): MINIMUM CEMENT CONTENT AND MAXIMUM WATER-CEMENT RATIO**

| Structural Member | Minimum cement content (kg/cu.m.) | | Maximum water-cement ratio | |
|---|---|---|---|---|
| | Conditions of Exposure | | Conditions of Exposure | |
| | Normal | Severe | Normal | Severe |
| (a) Plain Cement Concrete members (PCC members) | 250 | 310 | 0.50 | 0.45 |
| (b) Reinforced Cement Concrete members (RCC members) | 310 | 400 | 0.45 | 0.40 |

**TABLE 800.5 (B): MINIMUM STRENGTH OF CONCRETE**

| Structural Member | Conditions of Exposure | |
|---|---|---|
| | Normal | Severe |
| (a) Plain Cement Concrete members (PCC members) | M15 | M20 |
| (b) Reinforced Cement Concrete members (RCC members) | M20 | M25 |

Notes:

(i) The minimum cement content is based on 20 mm aggregate (nominal maximum size). For 40 mm and larger size aggregates, it may be reduced suitably but the reduction shall not be more than 10 per cent or 30 kg per cu.m whichever is lower. For 12.5 or 10 mm size aggregates, it shall be adjusted suitably but the increment shall not be less than 10 per cent or 40 kg per cu.m whichever is higher.

(ii) For underwater concreting and hand mixed concrete, the cement shall be increased by 10 per cent.

(iii) Severe conditions of exposure shall mean alternate wetting and drying due to sea spray, coastal environments, direct contact with liquid/solid aggressive chemicals, corrosive fumes, high rainfall, alternate wetting and drying combined with freezing, and buried in soil having corrosive effect.

(iv) Normal conditions of exposure shall mean other than those mentioned in (iii) above.

(v) Foundation concrete for masonry abutment, pier, return/wing/toe wall shall be M10 if laid in dry conditions and M15 in wet conditions.





The mix shall be designed by weigh batching. For ease of production at site, volumetric batching may also be permitted after making adjustments for bulking of aggregates by using appropriate size of boxes of half or full bag capacity and quantity of water adjusted for the surface water carried by the coarse and fine aggregates. The size of the boxes shall be large enough to eliminate error in proportioning of mix and which can be handled manually. The cement shall, however, be mixed by weight or number of full bags (weighing 50 kg).

## 804. PROPORTIONING OF CONCRETE

### 804.1. General

Prior to the start of construction, the Contractor shall design the mix in case of "Design Mix Concrete" or propose nominal mix in case of "Nominal Mix Concrete", and submit to the Engineer for approval, the proportions of the materials, including water reducing admixtures proposed to be used.

No material other than the essential ingredients, i.e., cement, aggregates and water, shall be used in the manufacture of concrete. The Engineer may however, permit the use of approved water reducing admixtures (with chloride contents not more than 0.2 per cent when tested in accordance with IS:6925), conforming to IS:9103 for imparting special characteristics to concrete, on satisfactory evidence that its use does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no harmful effect on reinforcement.

### 804.2. Requirements of Consistency

The mix proportion shall be selected to ensure the workability of the fresh concrete to surround and properly grip all reinforcement, required strength, durability and finish when hardened.

Maximum slump for different types of works when checked as per IS:516 shall be as given in Table 800.6 or as specified in the drawings.

### 804.3. Requirements of Design Mix Concrete

The design mix concrete, if adopted shall conform to the requirements regarding target mean strength, trial mixes, control of strength, etc. laid down in the "Specifications for Road and Bridge Works-2001" of Ministry of Road Transport & Highways.

TABLE 800.6

| | Type | Slump |
|---|---|---|
| (i) | Reinforced concrete structures with exposed inclined surface requiring low slump concrete to allow proper compaction and plain cement concrete members | 25 mm |
| (ii) | RCC structures with widely spaced reinforcement, e.g., solid columns, piers, abutments, footings, etc. | 40-50 mm |
| (iii) | RCC structures with fair degree of congestion of reinforcement e.g. piers/abutment caps, box culverts, members with thickness greater than 300 mm, etc. | 50-75 mm |
| (iv) | RCC structures with highly congested reinforcement, e.g., deck slabs, girders, box girders, members with thickness less than 300 mm, etc. | 75-125 mm |

### 804.4. Requirements of Nominal Mix Concrete

**804.4.1. General** : Nominal mix concrete shall generally be specified by grades of concrete.

Proportion of ingredients of concrete shall be by mass. Water shall either be measured by volume in calibrated tanks or weighed.

Where the weight of cement is determined by accepting the maker's weight per bag, a reasonable number of bags shall be weighed separately to check the net weight. The cement shall be measured by in terms of number of full bags to avoid error in proportioning.

Volume batching shall be permitted only after the accurate determination of bulk densities of coarse and fine aggregates proposed to be used in the works. Allowance for bulking shall be made in accordance with IS:2386 (Part 3). The mass volume relationship shall be checked frequently as necessary, the frequency being determined by the Engineer to ensure that the required grading is maintained.

It is important to keep the specified water-cement ratio constant and at its correct value. Moisture content in both fine and coarse aggregates shall therefore, be determined as per IS:2386 (Part 3) as frequently as possible. The frequency shall be as determined by the Engineer according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. Suitable adjustment shall also be made in the weights of aggregates to allow for





the variation in weight of aggregates due to variation in their moisture content.

In the absence of exact data, the amount of surface water may be estimated from the values given in Table 800.7 and volumetric proportions of fine, coarse aggregates and quantity of water to be mixed shall be accordingly modified.

TABLE 800.7 : SURFACE WATER CARRIED BY AGGREGATE

| Aggregate | Approximate quantity of surface water | |
|---|---|---|
| | Per cent by mass | Litres/cu.m |
| (i) Very wet sand | 7.5 | 120 |
| (ii) Moderately wet sand | 5.0 | 80 |
| (iii) Moist sand | 2.5 | 40 |
| (iv) Moist gravel or crushed rock* | 1.25-2.5 | 20-40 |

*Coarser the aggregate, less the water it will carry.

No substitutions in materials or change in the established proportions, except for adjustment due to moisture content in the ingredients and bulking shall be permitted without additional tests to prove that the quality and strength of concrete are satisfactory and approval by the Engineer.

**804.4.2. Proportions of materials** : Proportions of materials shall be in accordance with Table 800.8 unless otherwise specified.

The proportions in nominal mix for different grades of concrete, using ordinary cement Grade 43 shall not be leaner than the values given in Table 800.9.

## 805. EQUIPMENT

Unless specified otherwise in the Notice Inviting Tenders/contract documents/drawings, the equipment for production and compaction of concrete shall be as follows:

(a) For Production of Concrete:

Mechanical mixer (minimum one bag capacity) conforming to IS:1791 and IS:12119 fitted with water measuring device for culverts/small bridges with length less than 60 m and individual span less than

TABLE 800.8 : PROPORTIONS FOR NOMINAL MIX CONCRETE

| Grade of concrete | Total quantity (kg) of dry aggregate by mass per 50 kg of cement to be taken as the sum of the individual masses of fine and coarse aggregates | Proportion of fine aggregate to coarse aggregates (By mass) | Quantity of water per 50 kg of cement (max. litres) |
|---|---|---|---|
| M10 | 480 | Generally 1:2 subject to an upper limit of 1:1½ and a lower limit of 1:2½ | 34 |
| M15 | 330 | | 25 |
| M20 | 250 | | 25 |
| M25 | 180 | | 22 |

Notes: (i) The proportions of fine coarse aggregate shall be adjusted from upper limit to lower progressively as the grading of fine aggregates becomes finer and the maximum size of coarse aggregates becomes larger. Graded coarse aggregates shall be used.

(ii) The cement content of the mix shall be proportionately increased in case extra water is added from placement and compaction consideration to ensure that water-cement ratio as specified is not exceeded.

TABLE 800.9

| Grade of concrete | Nominal Mix |
|---|---|
| M10 | 1: 3: 6 |
| M15 | 1: 2½: 5 |
| M20 | 1: 2: 4 |
| M25 | 1: 1½: 3[@] |

Notes: (i) Mix proportions are by mass.

(ii) Since strength of a mix depends on the size and quality of aggregates actually used, the proportions shall be verified by testing of cubes before adoption of proportions at site.

[@] Approved quality of plasticizer @ 300 ml per 50 kg of cement or as per manufacturer's specifications may be added for M25 grade concrete, if required.





15 m. Mechanical mixer fitted with small load cell shall be preferred. However, for controlled concrete mix of M25 for superstructure, mechanical mixer of minimum 200 litres capacity having integral weigh batching facility (hydraulic/pneumatic type), automatic water measuring and dispensing device shall be used.

All measuring devices of equipment shall be maintained in a clean and serviceable condition. Its accuracy shall be checked over the range in use, when set up at each site and thereafter periodically as directed by the Engineer.

The accuracy of the measuring devices shall fall within the following limits:

| | |
|---|---|
| Measurement of Cement | ±3 per cent of quantity of cement in each batch. |
| Measurement of Water | ±3 per cent of quantity of water in each batch. |
| Measurement of Aggregate | ±3 per cent of quantity of aggregate in each batch. |
| Measurement of Admixture | ± 5 per cent of quantity of admixture in each batch. |

(b) For Compaction of Concrete:

| | |
|---|---|
| (i) Internal vibrators conforming to IS:2505 | 25 to 70 mm size |
| (ii) Form vibrators conforming to IS:4656 | minimum 500 watts |
| (iii) Screed vibrators conforming to IS:2506 | Full width of carriageway (upto two lanes) |

## 806. MIXING OF CONCRETE

For all works, concrete shall be mixed in a mechanical mixer complying with IS:1791 and IS:12119 fitted with water measuring device. The mixer and other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and a uniform colour and consistency of the entire mass is obtained. Further each individual particle of the coarse aggregate shall show complete coating of mortar containing its proportionate amount of cement. If there is segregation after unloading from the mixer, the concrete shall be remixed. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

Mixer which has been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Engineer, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregates. Mixing plant shall be thoroughly cleaned before changing from one type of cement or a grade of concrete to another.

Hand mixed concrete shall not be used in structural concrete. However, when hand mixing is permitted by the Engineer for small isolated culverts (upto 2 m span) in remote areas or for certain other reasons, 10 per cent extra cement shall be used and the cost of extra cement shall be borne by the Contractor. Graduated/measuring cans shall be used for measuring water. The mixing shall be done on a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine aggregates, which shall also be spread in layer of uniform thickness on the mixing platform. Dry fine aggregate/sand and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Measured quantity of water shall then be added gradually and the mass turned over till a mortar of required consistency is obtained. Measured quantity of coarse aggregates shall then be placed on the mixing platform and wetted, mortar added and the entire mass turned and re-turned until all particles of the coarse aggregates are fully covered with mortar and the mixture obtained is of uniform colour and required consistency. The quantity of total water added shall not exceed the maximum value given in Table 800.8.

During hot weather, the aggregates and water shall be cooled before mixing while in cold weather, the aggregates and water shall be heated before mixing so that the temperature of the concrete at the time of placing in position is within permissible limits (5°C to 40°C). The methods of cooling or heating of aggregates and water shall be as approved by the Engineer. Cement shall not be heated under any circumstances.

## 807. TRANSPORTING, PLACING AND COMPACTION OF CONCRETE

After mixing, concrete shall be transported to the formwork as quickly as possible. The method and arrangement of transporting and placing concrete shall be approved by the Engineer. Concrete shall be so transported





and placed that no contamination, segregation or loss of its constituent materials or ingress of foreign matter or water takes place and the required workability is also maintained.

During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods as approved by the Engineer to reduce the loss of water by evaporation shall also be adopted.

All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete.

No concrete shall be placed in any part of the structure until the approval of the Engineer has been obtained.

If concreting is not started within 48 hours of the approval being given, the Contractor shall take fresh approval from the Engineer. Concreting then shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

Concrete when deposited shall have a temperature of not less than 5°C and not more than 40°C. It shall be compacted before the initial setting of the concrete but not later than 30 minutes of its discharge from the mixer.

Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not more than 300 mm in other cases.

The method of placing of concrete shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcements or form work.

The concrete shall not be dropped freely into place from a height exceeding 1.5 m.

Concrete shall be thoroughly compacted by vibrations using internal (needle) vibrators of suitable size or form vibrators during placing and worked around the reinforcement, embedded fixture and into corners of the form work to produce a dense homogeneous void free mass having the required surface finish.

Needle vibrators have generally radius of action of about four times it's diameter. The internal vibrators used for compacting the fresh concrete shall be inserted vertically to the full depth of layer being placed and ordinarily shall also penetrate the layer below for a few centimetres. The vibrator shall be kept in place until air bubbles stop coming out from the surface, the coarse aggregate particles get fully embedded, surface becomes level and a thin film of paste appears along the head of the vibrator. The internal vibrator shall be withdrawn slowly so that the hole left by it in the concrete gets closed without entrapping any air. The vibrator has to be reinserted in case the hole does not get filled up. The vibrators shall be inserted in orderly manner and the distance between insertions shall be about one and a half times the radius of the area visibly affected by vibration. The vibration shall be applied continuously during the placing of each batch of concrete. Vibrations by direct contact of vibrators with reinforcement during compaction shall be avoided. Vibrators shall not be used to move the concrete. Over vibration shall be avoided to minimize the risk of segregation and forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface defects. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.

Mechanical vibrators used shall comply with IS:2505, IS:2506, IS:2514 and IS:4656.

## 808. CONCRETING UNDER WATER

When it is necessary to deposit concrete under water, the concrete shall not be permitted to fall freely through water. The method, equipment, materials and proportions of the mix to be used shall be got approved from the Engineer before any work is started.

Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall be not less than 16°C and not more than 40°C.

Concrete shall contain 10 per cent more cement than that required for the same mix placed in the dry. The materials shall be so proportioned as to produce a concrete having a slump of not less than 100 mm, and not more than 180 mm. when tested as per IS:516.

Coffer-dams or forms shall be sufficiently tight to ensure still water conditions if practicable, and in any case to reduce the flow of water to less





than 3 m per minute through the space into which concrete is to be deposited. Coffer-dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping if required, shall not be done while concrete is being placed, or until 24 hours thereafter.

Concrete shall be deposited continuously until it has been brought to the required height. While depositing, the top surface shall always be kept as nearly level as possible. Drop bucket method or any other method approved by the Engineer may be used for depositing concrete under water.

Drop bottom bucket method: The top of the bucket shall be closed. The bottom doors shall move freely downward and outward when tripped. The bucket shall be filled completely and lowered slowly to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

To minimize the formation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

## 809. WORKING IN EXTREME WEATHER

Where concrete is to be deposited at or near freezing temperatures, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5°C and that the temperature after the concrete has been placed and compacted is maintained above 4°C until it has thoroughly hardened. When necessary, the concrete ingredients shall be heated before mixing but the cement shall not be heated artificially other than heat transmitted to it from other ingredients of the concrete. Generally heating of the mixing water alone may be sufficient for this purpose. The temperature of water shall not however be more than 65°C. The concrete shall be carefully protected after placing.

Salt or other chemicals shall not be used to prevent water from freezing. No frozen material or materials containing ice shall be used. All concrete damaged by frost shall be removed. It is recommended that concrete exposed to freezing weather shall have entrained air and water cement ratio shall not be more than 0.60.

When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40°C while

placing. This shall be achieved by stacking aggregates under the shade and keeping them moist, using cold water, reducing the time between mixing and placing to the minimum, cooling form work by sprinkling water, starting curing before concrete dries out and restricting concreting, as far as possible, to early mornings and late evenings. When ice is used to cool mixing water, it will be considered a part of the water for the purpose of working out the water-cement ratio in the mix.

## 810. PROTECTION & CURING

Concreting operations shall not be started until adequate arrangements for proper curing of concrete have been made by the Contractor.

Curing is the process for preventing the loss of moisture from the concrete. The prevention of moisture loss from the concrete is particularly important if the water-cement ratio is low.

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

(a) Premature drying out due to Sun heat and wind.

(b) High internal thermal gradients.

(c) Leaching out by rain and flowing water.

(d) Rapid cooling during the first few days after placing.

(e) Low temperature or frost.

(f) Vibrations and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

### 810.1. Water Curing

Water for curing shall conform to Clause 802.5. Sea water shall not be used. After one or two hours of concreting, the concrete shall be protected from quick drying by covering with moist gunny bags, canvas, Hessian or similar material as approved by the Engineer. After 24 hours, all exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacks, canvas, Hessian, or similar materials and shall be kept constantly wet for a period of not less than fourteen days from the date of placing of concrete.

### 810.2. Curing Compounds

Curing compounds shall only be permitted in special circumstances





and with specific approval of the Engineer. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist, cured and no curing compound shall be permitted in locations where concrete surfaces are required to be bonded together.

Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking.

Masonry work over the foundation concrete shall not be started earlier than 48 hours of its laying but the curing of concrete shall be continued for minimum period of 14-days.

## 811. FINISHING

Immediately on removal of forms, the concrete shall be examined by the Engineer before any defects are made good.

All exposed bars or bolts passing through the reinforced cement concrete member and used for shuttering or any other purpose shall be cut inside the reinforced cement concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes be closed by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in of all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

The portion of concrete, which is porous or honey combed or its placing has been interrupted without providing proper construction joint or construction tolerances have not been met or reinforcement has been displaced to an extent detrimental to structural safety shall be rejected, removed and replaced as per the directions of the Engineer.

Surface defects of minor nature shall be rectified as directed by the Engineer.

## 812. CONSTRUCTION JOINTS

Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings. The joints, if provided shall be in a direction perpendicular to the axis of the member.

Concreting shall be carried out continuously upto the construction joints, the location and details of which shall be as shown on the drawings or as determined by the Engineer.

For a vertical construction joints, a stooping board shall be fixed previously at the pre-determined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or bulging when concrete is compacted against it. Concreting shall be continued right up to the board. The board shall not be removed before the expiry of 24 hours after the concreting.

Before resuming work at any construction joint when concrete has not yet fully hardened, all laitance shall be removed by scrubbing the wet surface with stiff wire or bristle brushes, care being taken to avoid dislodgement of any particle of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed, and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness, and shall be well rammed against old work, particular attention being paid to corners and close spots.

When work has to be resumed on a surface which has hardened, it shall be thoroughly hacked without dislodgement of coarse aggregates, cleaned to remove loose material, debris and accumulated dust /rubbish etc, wetted and covered with a layer of neat cement grout. The neat cement grout shall be followed by a 10 mm thick layer of cement mortar mixed in the same proportion as that of cement and sand in concrete and concreting resumed immediately thereafter. The first batch of concrete





shall be rammed against the old work to avoid formation of any pockets, particular attention being paid to corners and close spots.

## 813. USE OF PLUMS IN ORDINARY CONCRETE

Stone plums shall not be used unless specified on the drawings.

Plums shall not be used in reinforced concrete or concrete laid under water.

The quantity of plums shall not exceed 15 per cent by volume of the concrete.

If round plums are stacked, volume of plums shall be assumed as 60 per cent of total volume and 40 per cent as voids. This criteria shall be used to measure volume of plums.

The size of plums shall be from 160 to 300 mm. The maximum dimension of the stones or plums shall not exceed 1/3rd the least dimension of the member.

All plums shall be hard, durable, clean and free from soft materials or loose pieces or deleterious substance in them and shall not have sharp corners.

First layer of concrete of the specified mix shall be laid to a thickness of the maximum size of plums proposed to be used. The plums shall then be evenly distributed laid while the top portion of this concrete is still green but sufficiently stiff to prevent complete submergence of the plums under their own weight. These plums shall be about half embedded in the concrete and the remaining part exposed so as to from a key with the next layer of concrete.

While placing the plums, care shall be taken to see that the clear distance between any two plums is not less than either the width or thickness of either of the plums. The distance from plums to the outer surface shall not be less than width of the plum subject to minimum of 150mm.

If plums of stratified stone are used, they shall be laid on their natural bed. Stones with concave faces shall be laid with the concave upwards.

The thickness of the next and successive layer of concrete shall be at least twice that of the largest plums.

## 814. TOLERANCES

Tolerances for dimensions/shape of various components shall be as specified in these Specifications or shown on the drawings or as directed by the Engineer.

## 815. TESTS AND STANDARDS OF ACCEPTANCE

### 815.1. General

Concrete work shall conform to the surface finish and tolerance for different components of the structure as specified in these Specifications or as shown on drawings or as directed by the Engineer.

Random sampling and lot by lot acceptance inspection shall be made for the 28-days cube strength of concrete.

Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before the start of work. The delimitation of lots shall be determined by the following:

(i) No individual lot shall be more than 30 cu.m in volume;

(ii) At least one cube forming an item of the sample representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day; even if quantity is less than 1 cu.m.

(iii) Different grades of mixing of concrete shall be divided into separate lots;

(iv) Concrete of one lot shall be used in the same identifiable member of the cross drainage work.

### 815.2. Sampling and Testing

(i) Concrete for making three test cubes shall be taken from a batch of concrete at point of discharge from the mixer in accordance with the procedures laid down in IS:1199.

(ii) A random sampling procedure to ensure that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cube shall be adopted. The sampling shall be spread over the entire period of concreting covering all mixing units.

(iii) 150 mm cubes shall be made, cured and tested at 28-days age for compressive strength conforming to IS:516. The 28-days test strength result for each cube shall form an item of the sample representing a lot.





### 815.3. Test Specimens and Sample Strength

Three test specimens shall be made from each sample for testing at 28-days. Additional set of specimens shall be made to determine the strength of concrete at 7-days or for removal of formwork or any other purpose if directed by the Engineer.

The test strength of the sample shall be the average of the strength of three cubes. The individual variation in test strength shall not exceed ± 15 per cent of the average test strength.

### 815.4. Frequency

The minimum frequency of sampling of concrete of each grade shall be as given in Table 800.10.

**TABLE 800.10**

| Quantity of concrete in work (in cu.m) | No. of Samples |
|---|---|
| 1-5 | 1 |
| 6-15 | 2 |
| 16-30 | 3 |
| 31-50 | 4 |

At least one sample shall be taken for each shift of work.

### 815.5. Acceptance Creteria

All materials shall comply with the requirements of quality and fitness for the works as specified in Clause 802.

Acceptance decision shall be taken lot by lot and samples of different lots shall not be clubbed for the purpose of acceptance. Test strength result of each cube shall form an item of the sample representing a lot.

The concrete shall be deemed to comply with strength requirements when both the following conditions are satisfied:

(i) The mean strength of any group of four consecutive samples shall exceed the specified characteristic compressive strength by 3 MPa.

(ii) The strength of any sample shall not be less than the specified compressive strength minus 3 MPa.

The quantity of concrete represented by the test results shall include the batches from which first and last samples were taken, together with all intervening batches.

Total water soluble sulphate ($SO_3$) content of concrete shall not exceed 4 per cent by mass of cement used in the mix.

Total chloride content in concrete expressed as chloride-ion shall not exceed 0.30 per cent by mass of cement used under moderate conditions of exposure and 0.20 per cent under severe conditions of exposure.

If the concrete is not able to meet any of the standards of acceptance as specified, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The investigations shall be carried out at Contractor's cost. If the results of the investigations adequately prove that the structure meets the required criteria for safety during service, the Engineer may accept the concrete as sub-standard work provided the actual average strength of sample is not less than 85 per cent of the specified strength of the concrete. In case any additional work is required to be done for such acceptance and to bring the structure to the required level for safety during service, the same shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable after investigations, the Contractor shall remove the rejected concrete and replace the same with new concrete.

## 816. MEASUREMENTS FOR PAYMENT

The cement concrete shall be measured in cubic metres. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously and the beam as the portion below the slab.

## 817. RATE

The contract unit rate for concrete shall include the cost of all materials, labour, tools and plant and equipment required for mixing, transporting, placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all other incidental expenses, sampling, testing, quality assurance, supervision for producing concrete of specified strength to complete the structure or its components as shown on the drawings and these Specifications. The contract unit rate shall also include the cost of making, providing, fixing





and removing of all form work required for completion of concrete work as per Section 900 of these Specifications.

The Contractor shall pay a discount over the contract unit rate as determined by the Engineer in case concrete is acceptable as substandard work.

For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under:

$$\text{Per cent reduction} = \frac{(\text{Specified Strength} - \text{Observed Strength}) \times 100}{\text{Specified Strength}}$$

# 900

# Formwork and Surface Finish for Structures

## 901. SCOPE

Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IRC:87 "Guidelines for Design and Erection of Falsework for Road Bridges" and these Specifications.

## 902. MATERIALS

**902.1.** All materials shall comply with the requirements of Clause 3.2 of IRC:87. Materials and components used for formwork shall be examined for damage or excessive deterioration before use/re-use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of spilts.

**902.2.** Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Other materials conforming to the requirements of IRC:87 are also permitted to be used with prior approval of the Engineer.

## 903. DESIGN OF FORMWORK

**903.1.** The Contractor shall furnish the design and drawing of complete formwork (i.e., the forms as well as their supports) for approval of the Engineer before any erection is taken up. If proprietary system of formwork is used the Contractor shall furnish detailed information as per Appendix-1 of Clause 4.9 of IRC:87 to the Engineer for approval.

Notwithstanding any approval or review of drawing and design of formwork by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

**903.2.** The design of the formwork shall conform to provisions of IRC:87. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection.

**903.3.** Form panels for abutments, piers and return walls shall not be less than 1 mt in height and adjusted at the top level only.

**903.4.** If steel built up columns are used as supports and are placed on concrete bed, the columns will be fixed to concrete bedding by suitably designed steel plates which shall be bolted to concrete block. These columns shall be extended by bolting flats or angles and not by welding steel bars out side.

Timber planks may be used to make up height difference upto 50 mm by using only single plank. For difference in height more than 50 mm and upto 200 mm, timber block upto 200 mm thick may be used. Height difference more than 200 mm shall not be permitted. Diagonal/cross bracings shall be with the same size of angles used for columns.

## 904. CONSTRUCTION OPERATIONS

**904.1.** Forms for concrete shall be made of metal or timber suitably aligned and be of substantial and rigid construction, true to shape and dimensions shown on the drawings. Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plain surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may spoil the surface of concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete.

**904.2.** Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hard-wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.

**904.3.** Suitable camber shall be provided in horizontal members of structure to counteract the effects of any deflection so that the deflection of members in formwork is limited by the tolerances specified in permanent works. The formwork shall be so fixed as to provide for such camber. The camber shall generally be equal to 1/500 of span.

**904.4.** Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections.





## 905. FORMED SURFACES AND FINISH

The formwork shall be lined with a proven material, following manufacturer's recommendations and approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so joined and fixed to its backing as not to impart any blemishes. It shall be of the same type for the construction of any particular component of structure. The contractor shall make good any imperfections in the resulting finish by approved material or rubbing with carborendum stone/grinder. No cement grouting or cement mortar plastering of the exposed concrete surfaces shall be permissible. Internal ties and embedded metal parts will be allowed only with prior specific approval of the Engineer.

## 906. PREPARATION OF FORMWORK BEFORE CONCRETING

**906.1.** The inside surfaces of forms shall, except in the case of permanent form work, be coated with a release agent supplied by approved manufacturer or of an approved material by the former to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement. Different release agents shall not be used in formwork for concrete which will be visible in the finished works. The stains caused by lubricants shall be removed by grinding with carborendum stone. (Burnt mobile oil shall not be used as a lubricant).

**906.2.** The formwork shall be constructed with designed precamber to the soffit to allow for deflection of the formwork to ensure that levels of soffit of permanent structure shall conform to those shown in the drawing. The calculated deflection of unsupported areas of form faces shall not exceed 3 mm or 0.003 of the span whichever is least.

**906.3.** Formwork shall be tight enough to prevent escape of cement slurry during compaction with vibrators. Laminated tar paper or similar sealants shall be used as per manufacturer's recommendations.

**906.4.** All forms shall be thoroughly cleaned immediately before concreting.

**906.5.** Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork and coat of release agent. However, such inspection shall not

relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

**906.6.** Where field operations are controlled by strength tests of concrete, the removal of the load-supporting or soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subjected at the time of striking props including the effect of any further addition of loads. When field operations are not controlled by strength tests of concrete, the vertical forms of beams, columns and walls may be removed after 2-days. The props of beams may be removed after 21-days.

## 907. WORKMANSHIP

**907.1.** The formwork shall be robust and strong and the joints shall be leak-proof.

**907.2.** Balli of diameter less than 100 mm for height not more than 4 m without any joint in ballies may also be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Bracing should be of minimum 75 mm dia ballies. Staging shall be provided with designed base plate resting on firm strata.

**907.3.** The number of joints in the formwork shall be kept to a minimum by using large size panels. The design shall provide for proper "soldiers" to facilitate alignment. All joints shall be leak proof and must be properly sealed by using PVC JOINT sealing tapes, foam rubber or PVC T-section to prevent leakage from green concrete.

**907.4.** Clamps of adequate strength shall be used to hold the forms together. Where use of nails is unavoidable minimum number of double headed nails shall be used and these shall be left projecting so that they can be withdrawn easily.

**907.5.** Chamfers or fillets of minimum size of 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, beveled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as shown in drawings or as directed by the Engineer.

**907.6.** Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.





**907.7.** The formwork shall be so made as to produce a finished concrete true to shape, line and levels and dimensions as shown on the drawings, subject to the tolerances specified in respective sections of these Specifications.

**907.8.** Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plain surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

**907.9.** Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.

**907.10.** The formwork and plates in contact with concrete shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating machine oils shall be prohibited for use as coating.

**907.11.** No centring and shuttering shall be kept on soft or filled up earth.

## 908. REMOVAL OF FORMWORK

**908.1.** The scheme for removal of formwork (i.e., de-shuttering and decentering) shall be planned in advance and furnished to the Engineer for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Engineer.

**908.2.** While fixing the time for removal of formwork, due consideration shall be given to the local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. The period shall be suitably increased in case of temperatures lower than 23°C and for any other conditions tending to delay the setting of concrete.

**908.3.** The formwork shall be so removed as not to cause any damage to concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually, to avoid any shock or vibration.

**908.4.** Where not specifically approved, the time of removal of formwork (when ordinary Portland Cement is used without any admixtures at an ambient temperatures exceeding 10°C) shall be as under:

| | | |
|---|---|---|
| (a) | Walls, piers, abutments, columns and vertical faces of structural members | : 12 to 48 hours as shall be decided by the Engineer. |
| (b) | Soffits of slabs (with props left under) | : 3 days |
| (c) | Props (left under slabs) | : 14 days |
| (d) | Soffit of girders (with props left under) | : 7 days |
| (e) | Props (left under girders) | : 21 days |

**908.5.** Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

**908.6.** Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with cement mortar (1:3). No permanently embedded metal part shall have less than 25 mm cover to the finished concrete surface.

## 909. RE-USE OF FORMWORK

**909.1.** When formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before being used again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning.

Before re-use of forms, the following actions shall be taken :

(i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.

(ii) The form surfaces shall be evenly and thinly coated with release agent. The vertical surface shall be treated before horizontal surface and any excess release agent properly wiped out.

(iii) The release agent shall not come in contact with reinforcement or hardened concrete.

**909.2.** All bent steel props shall be straightened before re-use. The maximum deviation from straightness is 1/600 of the length. The maximum





permissible axial loads in used props shall be reduced by minimum 10 per cent after each reuse depending upon their condition. The condition of the timber components plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

## 910. PRECAUTIONS

(i) The forms may be removed at the earliest opportunity subject to the minimum time for removal of forms at props retained in position.

(ii) Where necessary, formwork shall be so arranged that the soffit form, properly supported on props only can be retained in position for such period as may be required by maturing conditions.

(iii) Any cut-outs or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of formwork ensuring watertight joints. Steel bars fixed in concrete to erect forms should be cut after removal of forms and end finished with mortar or non-corrosive paint.

(iv) Provision shall be made for safe access on to and about the formwork at the levels as required.

(v) Close watch shall be maintained to check for settlement of formwork during concreting. Any settlement of formwork during concerting shall be promptly rectified.

(vi) Water used for curing should not be allowed to stagnate near the base plate supporting the staging and should be properly drained.

## 911. TOLERANCES

Formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerances given below :

| | | |
|---|---|---|
| (a) | Deviations from the specified dimensions of cross section of columns, beams | + 12 mm<br>- 6 mm |
| (b) | Deviations from dimensions of footings/open foundations | |
| | (i) Dimensions in plan | + 50 mm<br>- 12 mm |
| | (ii) Eccentricity in plan 0.02 times the width of the footings in the direction of deviation but not more than 50 mm | |
| | (iii) Thickness | |
| | ± 0.05 times the specified thickness | |

Note : Tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels.

## 912. MEASUREMENTS FOR PAYMENT

**912.1.** Where it is specifically stipulated in the contract that the formwork shall be paid for separately, the measurement for formwork shall be taken in square metres of the area of concrete surface, which is in contact with formwork.

**912.2.** Where it is not specifically stated in the contract or description of the item of work that formwork shall be paid for separately, the rate of the Reinforced Cement Concrete items shall be deemed to include the cost of all formwork.

## 913. RATE

The unit rate of the plain concrete or reinforced concrete as defined in respective sections including box-sections shall be deemed to cover the costs of all formwork, including cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this section including properly supporting the members until the concrete is cured, set and hardened as required.

Where the contract unit rate for formwork is specifically provided as a separate item, it shall include the cost of all materials, labour, tools and plant required for design construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured, set and hardened as required.





# 1000

# Steel Reinforcement

## 1001. SCOPE

This work shall consist of furnishing and placing uncoated mild steel or high strength deformed reinforcement bars of the shape and dimensions shown on the drawings and conforming to this Section or as approved by the Engineer.

## 1002. MATERIALS

### 1002.1. General

Reinforcements may be either mild steel or high strength deformed bars as specified on the drawings.

For plain and reinforced cement concrete (PCC and RCC) works, reinforcement steel shall consist of any of the following grades of reinforcing bars as specified on the drawings:

| Grade Designation | Bar Type conforming to governing BIS Specifications | Characteristic Strength $f_y$ MPa | Elastic Modulus GPa |
|---|---|---|---|
| Fe 240* | IS:432 Part 1 Mild Steel | 240 | 200 |
| Fe 415 | IS:1786 High Yield Strength Deformed Bars (HYSD) or Thermo-mechanically treated (TMT) bars | 415 | 200 |

* Mild steel shall not be permitted in any structural member except as mesh reinforcement and dowels in Cement Concrete Pavements.

Other grades of bars conforming to IS:432, IS:1786 and re-rolled steel shall not be permitted. All reinforcing steel must be procured from original manufacturers or their authorised agent for use in works.

Reinforcing steel of same type and grade shall be used as main reinforcement in a structural member. However, simultaneous use of two different types of same grade of steel for main and secondary reinforcement respectively may be permitted.

All reinforcement shall be free from loose mill scales, loose rust and coats of paints, oil, mud or any other substances which may destroy or reduce bond.

Only new steel shall be delivered to the site. The pitch of ribs shall

neither be less than 8 times bar diameter nor more than 12 times diameter of the bar.

Every bundle of bars shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Ends of bars having excessive deformation shall be rejected. Cracked ends of bars shall be discarded.

### 1002.2. Storage

Reinforcement bars, when delivered on the works, shall be stored on blocks, racks or platforms, or other supports about 300 mm to 450 mm above the surface of the ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification. The reinforcement shall be protected from any mechanical injury and deterioration by exposure.

## 1003. PROTECTION OF REINFORCEMENT

Reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using suitable method, before use.

Portions of reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete, with a brush coat of neat cement mixed with water to the consistency of a thick paint. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete.

On completion of works, the steel bars used to support formwork and projecting out shall be cut inside the reinforced cement member, to a depth of at least 50 mm below the surface and resulting hole shall be closed by cement mortar.

## 1004. BENDING OF REINFORCEMENT

Bar bending schedule if not shown on the drawings, shall be prepared/ approved by the Engineer before commencement of work.

Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.





Reinforcement shall be bent and fixed in accordance with procedure specified in IS:2502.

Bars shall be bent cold to the specified shape and dimensions as directed by the Engineer using a proper bar bender, operated by hand or power to obtain the correct radii of bends and shape.

Bars shall not be bent or straightened in a manner that will damage the parent material.

Bars bent during transportation or handling shall be straightened before being used on the works and shall not be heated to facilitate straightening. However, high strength deformed bars bent with diameter less than 6 times the diameters of the bar shall not be re-bent or straightened and used in the works.

## 1005. PLACING OF REINFORCEMENT

The reinforcement as per bar bending schedule shown on the drawings or as prepared/approved by the Engineer shall be fabricated as directed by the Engineer. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when concreting schedule for the member has been finalised and the member is otherwise ready for placing of concrete. Prolonged gap between assembling of reinforcement and casting of concrete which may result in rust formation on the surface shall not be permitted.

Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with minimum one mm diameter annealed binding wire, conforming to IS:280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during the placing of concrete, or vibration.

Tack welding of cross bars for assembly of reinforcement shall not be permitted.

Bars shall be kept in position usually by the following methods:

(a) In case of beam and slab construction, industrially produced polymer cover blocks (wherever adaptable) or concrete cover blocks of thickness equal to the specified cover shall be placed between the bars and form work. The polymer cover blocks shall be permitted subject to satisfactory evidence that the polymer composition is not harmful to concrete and

reinforcement. In case of concrete cover blocks, the strength shall be same as that of the concrete of the member.

(b) In case of projected steel from substructure or foundation, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed upto a level just below their location.

(c) Layers of reinforcement shall be separated by spacer bars at a maximum spacing of 1 m. The minimum diameter of spacer bars shall be equal to next higher size of main reinforcement. Horizontal reinforcement shall not be allowed to sag between supports.

(d) Necessary stays, blocks, metal chairs, spacers, or other subsidiary reinforcement at a maximum spacing of 1 m shall be provided to maintain the specified nominal cover to the steel reinforcement and to fix all reinforcement firmly in its correct position.

(e) All devices used for positioning of reinforcement shall be of non-corrodible material. Use of pebbles, broken stone, metal pipe, brick or wooden blocks, etc. as devices for positioning reinforcement shall not be permitted.

Rough handling, shock loading prior to embedment, dropping of reinforcement from a height shall be avoided.

Reinforcing bars which are to be bent aside at construction joints and afterwards bent back into original positions, the radius of the bend at any time shall not be less than six times bar diameters in case of high strength deformed steel bars upto 12 mm and four times bar diameter in case of mild steel bars upto 16 mm diameter. Care shall also be taken when bending back the bars, to ensure that the concrete around the bar is not damaged beyond the bend.

Reinforcement shall be placed and tied in such a way that satisfactory placement and good compaction of concrete all around in the components is possible by immersion vibrators and without segregation of concrete mix.

Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed.

Placing and fixing of reinforcement shall be inspected and approved by the Engineer before concrete is deposited.





## 1006. BAR SPLICES

All reinforcement shall be furnished in full lengths as indicated on the drawings. No splicing of bars, except where shown on the drawings, shall be permitted without the specific approval of the Engineer. The location and lengths of splice shall be as shown on the drawings.

The Engineer shall ensure that lapped splices are staggered in accordance with the provisions made in IRC:21 and located at points, along the span where stresses are low. Splices in flexural members shall not be permitted at sections where the bending moment is more than 50 per cent of the moment of resistance. Not more than 25 per cent of bars in case of mild steel (Fe 240) and not more than 50 per cent of the bars in case of High Yield Strength Deformed (HYSD) bars or TMT bars (Fe 415) shall be spliced at a section. However, 33 per cent is the preferred value for HYSD/TMT bars.

Where practicable, the minimum spacing between overlapped bars shall be kept 25 mm or 1¼ times the maximum size of coarse aggregate, whichever is greater. If it is not feasible, overlapping bars shall preferably be grouped in the vertical plane and there shall not be more than three bars in contact. The minimum horizontal and vertical distance between such group and adjacent group or bar as specified on the drawings shall be maintained. The lapped bars shall be bound with annealed steel binding wire, not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface.

The Engineer may, however, approve suitable adjustments in the locations of the splices to accommodate the available lengths of bars provided that the requirements of lap length and other stipulations of IRC:21 and as shown on the drawings are complied with.

## 1007. WELDING

Splicing by welding of reinforcement shall be permitted only if detailed on the drawings or specified in the contract documents.

Site welding shall not be permitted unless the Engineer is satisfied about the adequacy of facilities, equipment, process, consumables, qualified operators, welding procedure to produce and maintain uniform quality at par that attainable in shop welding.

Welding of deformed bars conforming to IS:1786 shall in general be

prohibited except in special situations in accordance with stipulations made in IRC:21.

Welding of mild steel reinforcing bars conforming to IS:432, if proposed by the Contractor, shall be permitted by the Engineer.

The method of welding shall conform to IS:2751 and IS:9417 and to any supplemental specifications specified in the contract documents to the satisfaction of the Engineer.

Bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before carrying out welding.

Welding shall be carried out by metal arc welding process. Oxy-acetylene welding shall not be permitted. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., shall be strictly observed.

All bars shall be butt welded except for bars with diameter less than 20 mm which shall be lap welded. Single-V or Double-V butt joints shall generally be used. Single bevel or double bevel butt joints shall be used for vertical bars.

Welded joints shall be located well away from the bends and not less than twice the bar diameter from a bend.

Joint welding procedures which are to be adopted shall invariably be established by a procedure specification.

All welders and welding operators to be employed shall have to be qualified by the tests prescribed in IS:2751.

M.S. electrodes used for welding shall conform to IS:814.

Weld shall develop an ultimate strength equal to or greater than that of the bars to be connected.

The welds shall be staggered so that at any section not more than 20 per cent of bars are welded.

Inspection of welds shall conform to IS:822. Welded pieces of reinforcement shall be tested. The number of specimens and frequency of testing shall be as directed by the Engineer.





Joints with weld defects detected by visual inspection or dimensional inspection shall not be accepted.

## 1008. SUBSTITUTION OF BAR SIZES

In order to accommodate the available size of bars, use of bar sizes other than those shown on the drawings, may be permitted by the Engineer provided that;

(i) substituted reinforcing bars are of same type and grade as shown on the drawings.

(ii) reinforcement proposed to be actually used shall have a minimum area equivalent to the original at each section of the member.

(iii) various stipulations of IRC:21 or shown on the drawings are not violated and special attention is paid to the requirements regarding limitations of bar sizes, spacing of bars, bond stress, cover and cracks.

## 1009. TOLERANCES

Unless otherwise shown on the drawings or specified by the Engineer, the reinforcement shall be placed within the following tolerances:

| | | |
|---|---|---|
| (a) | Members with effective depth less than 200 mm | ±10 mm |
| (b) | Members with effective depth more than 200 mm | ±15 mm |
| (c) | Cover | +10 mm |

No minus tolerance shall be permitted for cover.

## 1010. TESTING AND ACCEPTANCE

The material shall be tested in accordance with relevant BIS specifications and necessary tests certificates shall be furnished.

In case of small jobs and culverts, the Engineer may accept the material on the basis of manufacturer's certificate. In case of doubt regarding quality, the material shall be tested in accordance with relevant BIS specifications.

All tests required as per codal stipulations and directed by the Engineer shall be got carried out by the Contractor at his own cost.

The fabrication, furnishing and placing of reinforcement shall be in accordance with this Section and shall be checked and accepted by the Engineer.

### 1011. MEASUREMENTS FOR PAYMENT

Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in works, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of IS:1732. Wastage, over laps, couplings and welded joints, if any, spacer bars, chairs, stays, hangers, concrete/PVC cover blocks and annealed steel wire or other material for binding and satisfactory placing of reinforcement cage shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

### 1012. RATE

The contract unit rate for reinforcement shall cover the cost of materials, transporting, storing, cleaning of reinforcement bars, straightening, fabricating, bending, placing, binding and fixing in position as shown on the drawings as per this Section and as directed by the Engineer, including all labour, equipment, supplies, incidentals, sampling, testing and supervision.





# 1100

# Pipe Culverts

## 1101. SCOPE

This work shall consist of furnishing and installing reinforced cement concrete pipes of the type, diameter and length required at the locations shown on the drawings or as directed by the Engineer and in accordance with the requirements of this Section.

## 1102. GENERAL

Humps or dips in the vertical profile of the road at the location of pipe culverts shall be avoided.

Pipes of less than 500 mm internal diameter used for irrigation water crossings/channels shall be considered as buried conduits and not culverts. The size, type and other details of conduits shall be got approved from the concerned department before the start of the work.

It is not economical to provide high headwalls to retain deep overfill. In such cases, the length of the pipe culvert shall be suitably increased and side slope flattened in full multiple of available pipe length (generally 2.5 m or 3 m) so that the road embankment with its natural slopes, is accommodated without high retaining headwalls and cutting of pipes is avoided.

The wearing surface of the road shall generally be carried over the pipe culvert unless specified otherwise on the drawings or directed by the Engineer.

## 1103. MATERIALS

Reinforced concrete pipes for culverts shall be of NP-3 or NP-4 type conforming to the requirements of IS:458 as specified in the drawings. The internal diameter of reinforced concrete pipes shall not be less than 900 mm except in exceptional situations where it may be 600 mm or 750 mm.

Buried conduits used for irrigation purposes shall consist of reinforced concrete pipes of the size (generally 300 to 500 mm internal diameter) and type (either NP-3 or NP-4) as approved by the concerned department and as specified on the drawings.

All materials used in brick masonry work for pipe culvert shall conform to Clause 602.

All materials used in stone masonry work for pipe culvert shall conform to Clause 702.

All materials used in concrete work for pipe culvert shall conform to Clause 802.

Steel reinforcement for concrete work for the pipe culvert shall conform to Clause 1002.

Each consignment of cement concrete pipes shall be inspected, tested, if necessary, and approved by the Engineer either at the place of manufacture or at the site before their incorporation in the works.

## 1104. EXCAVATION FOR PIPE

The foundation bed of pipe culverts shall be excavated true to the lines and grades shown on the drawings or as directed by the Engineer. The pipes shall be placed in shallow excavation of the natural ground or in open trenches cut in existing embankment, taken down to levels as shown on the drawings.

In case of embankments of heights of fill more than 3 m above the bed level or three times the external diameter of the pipe, the embankment shall first be constructed to the level above the top of the pipe equal to the external diameter of the pipe and the width on either side of the pipe shall not be less than five times the diameter of the pipe. After the construction of embankment, a trench shall be excavated and the pipe shall be laid.

The pipe shall be placed where the ground for the foundation is reasonably firm. If spongy, soft or other unstable material is met with at the location of the pipe culvert; such unsuitable material shall be removed to such depth, width and length as directed by the Engineer. The excavation shall then the backfilled with approved granular material which shall be properly shaped and thoroughly compacted upto the specified level.

The width of trench in the embankment on either side of the pipe shall be one-fourth of the diameter of the pipe subject to minimum of 150 mm and shall not be more than one third diameter of the pipe. The sides of the trench shall be as nearly vertical as possible.

Where rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in this area be





removed and the space filled with approved earth, free from stones or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Trenches shall be kept free from water until the pipes are installed and the joints have hardened.

## 1105. BEDDING FOR PIPE

The bedding surface shall provide a firm foundation of uniform density throughout the length of the culvert, shall conform to the specified levels and grade, and shall be of either of the following two types as specified on the drawings:

### (i) Type A (Concrete Cradle) bedding

Type A bedding shall be provided for the size of pipes of 900 mm internal diameter or more and height of fill more than 4 metres above the pipe.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded in a cradle constructed of concrete having a mix not leaner than M 15 or as specified on the drawings, conforming to Section 800. The shape and dimensions of the cradle shall be as indicated on the drawings. The pipes shall be laid in accordance with the requirements of IS:783 on the concrete bedding before the concrete has set.

### (ii) Type B (First Class) bedding

Type B bedding shall be adopted for a height of filling of less than 4 m above the pipe.

Under type B bedding, the pipe shall be evenly bedded on a continuous layer of well compacted sand, moorum or approved granular material, shaped concentrically to fit the lower part of the pipe exterior for minimum 10 per cent of its overall height or as otherwise shown on the drawings. The bedding material shall be well graded sand or other granular material passing 5.6 mm sieve suitably compacted/rammed. The compacted thickness of the bedding layer shall not be less than 75 mm or as specified on the drawings.

In case of expansive soils, like, black cotton soil, which have very low bearing capacity, a layer of sand/moorum or non-expansive material shall be provided under the bedding. The thickness of the sand layer bedding

shall be as specified on the drawings or as directed by the Engineer subject to the minimum thickness of 450 mm.

## 1106. LAYING OF PIPE

No pipe shall be laid in position until the foundation has been approved by the Engineer.

Where two or more pipes are to be laid adjacent of each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

If the pipes are laid in two layers, the minimum horizontal and diagonal distance between pipes shall be same as specified above and the centres of pipes shall form vertices of equilateral triangles.

The pipes shall generally be laid as per IS:783.

The arrangement for lifting, loading and unloading concrete pipes from factory/yard and at site shall be such that the pipes do not suffer any undue structural strain or any damage due to fall or impact.

In manual unloading of pipes from the trucks, pipes shall be rolled down on a pair of skids hooked on to the trucks, and the movement shall be controlled with a rope passing round the pipes, back to a rail or station, etc. The pipes shall be placed as near to the edge of the trench as possible and as safety permits to avoid possible damage during re-transportation.

The arrangement for lowering the pipe in the bed shall be got approved by the Engineer. It may either be with tripod pulley arrangement or simply by manual labour with the help of ropes or by chain blocks, etc. in a manner that the pipe is placed in the proper position without damage. Hooks shall not be used in the ends of the pipe to lift or lower down as this procedure is likely to damage joint surfaces.

The longitudinal slope of the pipe shall not be flatter than bed slope subject to minimum of 1 in 1000 in plains. In case of culverts in hilly areas the longitudinal slope of the pipe shall be according to bed slope but not steeper than 1 in 30* unless otherwise specified on the drawings or directed by the Engineer.

(*Normally, a slope of 1 in 100 shall be considered as good slope)





The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The invert of the pipe shall be minimum 150 mm below the average bed level. In case of use of pipes with bell-mouth, the belled end shall face upstream. The pipes shall be fitted and matched so that when laid in work, they form a culvert with a smooth uniform invert.

Any pipe found defective or damaged during laying shall not be used in the works and shall be removed at the cost of the Contractor.

## 1107. JOINTING

The pipes shall be jointed either by collar joints or by flush joint. The width of the collars shall be 150 to 200 mm. The collars shall be of reinforced cement concrete of the same strength as that of the pipes to be jointed. Caulking space shall be between 13 mm and 20 mm according to the diameter of the pipes. The collar shall be so placed that its centre coincides with the joints and even annular space is left between the collar and the pipe. Caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons.

Flush joint shall be either internal flush joint or external flush joint. The ends of the pipes shall be specially shaped to form a self centering joint with a jointing space 13 mm wide. The jointing space shall be filled with cement mortar (1 cement to 2 sand), mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed.

For jointing pipe lines, the recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The rings shall be thoroughly compressed by a suitable method.

All joints shall be made with care so that interior surface in smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.

## 1108. BACKFILLING

Trenches shall be backfilled immediately after the pipe have been laid and the jointing material has hardened. The backfill soil shall be clean, free

from boulders, large roots, clay lumps retained on 75 mm sieve, stones retained on 26.5 mm sieve and excessive amounts of sods or other vegetable matter and shall be approved by the Engineer.

Backfilling upto 300 mm above the top of the pipe shall be carefully done and the soil thoroughly rammed, tamped or vibrated in layers not exceeding 150 mm, particular care being taken to thoroughly consolidate the materials under the haunches of the pipe using light mechanical tamping equipment.

Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur. The earthwork between the pipes shall be compacted thoroughly by hand compacting tools. Normally, granular material shall be used for the purpose. Care shall be exercised during compaction to prevent damage to pipes.

When it is not possible to provide the minimum specified cushion over the pipe, the pipe shall be encased in M10 concrete with cover of minimum 100 mm or as directed by the Engineer. The minimum cushion shall be measured at the edge of the roadway.

## 1109. HEADWALLS AND OTHER ANCILLARY WORKS

Headwalls, wings walls, aprons and other connected works shall be constructed in accordance with the details shown on the drawings or as directed by the Engineer.

Brick masonry work in the pipe culvert shall conform to Section 600.

Stone masonry work in the pipe culvert shall conform to Section 700.

Concrete work in the pipe culvert shall conform to Section 800.

Steel reinforcement work in the pipe culvert shall conform to Section 1000.

Apron, pitching of slopes, flooring and curtain/cut off walls shall conform to Section 1300.

## 1110. OPENING TO TRAFFIC

No traffic shall be permitted to move over the pipe unless height of earth filling above the top of the pipe line is at least 600 mm or as specified on the drawings.





## 1111. MEASUREMENTS FOR PAYMENT

R.C.C. Pipe culverts shall be measured along their centre between the inlet and outlet ends in metres.

Selected granular material and cement concrete for pipe bedding shall be measured as laid in cubic metres.

Ancillary works, like, headwalls, etc. shall be measured as provided for under the respective Sections of these Specifications.

## 1112. RATE

The contract unit rate for the pipe shall include the cost of pipe including loading, unloading, hauling, handling, storing, laying in position and jointing complete and all incidental costs to complete the work as per these Specifications.

Excavation, bedding, backfilling, concrete and masonry shall be paid for separately, as provided under the respective Sections.

# 1200

# R.C.C. Slab Culverts and Minor Bridges

## 1201. GENERAL GUIDELINES

Certain general guidelines as detailed below are given to aid and facilitate appropriate use of specifications given in this Section:

(i) These Specifications provide for foundations placed in open excavations (open type of foundations) only as other types of foundations like raft, wells or piles are not anticipated in cross – drainage works and minor bridges in rural road works. If such types of foundations are specified in drawings, the work shall be carried out in accordance with relevant clauses of "Ministry of Road Transport & Highways–Specifications for Road and Bridge Works".

(ii) The sections of piers, abutments, wing walls/return walls shall conform to Plates 7.02 to 7.05 of IRC:SP:20 "Rural Roads Manual"

(iii) Design and details of RCC solid slabs for spans 1.5 m to 15 m having overall width of 6.0 m, 6.4 m and 7.5 m shall conform to Plates 7.7 to 7.16 of IRC:SP:20 "Rural Roads Manual"

(iv) Design and Details of RCC box cell bridges shall conform to Plates Nos. 7.18 & 7.19 of IRC:SP:20 "Rural Roads Manual"

(v) Unless otherwise specified in the drawings or directed by the Engineer, concrete Grade of M25 and H.Y.S.D. reinforcement conforming to IS:1786 shall be used for superstructure.

(vi) For minor bridges having individual span upto 10 m and R.C.C. slab culverts (length upto 6 m), filler joints comprising 25 mm thick premoulded filler or burried joints shall be provided.

(vii) Elastomeric slab seal or/compression seal expansion joints shall be provided for minor bridges having multiple spans with individual span more than 10 m.

(viii) Concrete wearing coat over minor bridges and culverts shall only be provided if specified in the drawing. The grade of cement concrete wearing coat shall be M30 (Design Mix Only)

(ix) Specifications for scuppers and other similar types of structural forms shall be as per prevailing regional/local practices and conforming to local bodies/State PWDs specifications, rates, etc.

(x) Plain cement concrete structures shall be provided with minimum skin reinforcement of 2.5 kg/m$^2$ on all exposed surfaces in both horizonal and vertical directions. The spacing of skin reinforcing bars in each direction shall not be more than 200 mm c/c.

(xi) For minor bridges having overall length of 30 m and above, a method statement for construction indicating the following shall be submitted by

the Contractor for approval of the Engineer well in advance of the commencement of work for each component of the bridge :

(a) Sources of materials

(b) Design, erection and removal of formwork

(c) The proportions of ingredients in case of nominal mix concrete or design mix concrete,

(d) Production, transportation, laying and curing of concrete

(e) Design, procurement and installation of expansion joints, drainage spouts and railings.

(f) Personnel employed for execution and supervision

(g) Tests and sampling procedures for materials

(h) Equipment details

(i) Necessary arrangement for execution under water wherever necessary

(j) Any other point.

(xii) Steps shall be provided adjacent to CD/bridge works from approaches to facilitate inspection of the structure.

(xiii) Elastomeric expansions joints conforming to these Specifications shall be used where requisite expertise for their installation is available with contractors executing RCC bridge works. Alternatively filler joints conforming to these specifications may be adopted.

## 1202. MATERIALS

Materials for the construction of various components of culverts and minor bridges shall conform to relevant provisions of these Specifications as listed below :

| | | |
|---|---|---|
| (i) | Bricks | Clause 602.4 |
| (ii) | Stones | Clause 702.4 |
| (iii) | Cement | Clause 602.2/702.2/802.2 |
| (iv) | Coarse aggregates | Clause 802.3 |
| (v) | Sand | Clause 602.5/802.4 |
| (vi) | Water | Clause 802.5 |
| (vii) | Steel reinforcement | Clause 1002 |
| (viii) | Structural steel | Clause 505 of IRC:24 |





For any other material not covered in these Specifications, relevant I.S. codes or in case of proprietary products, manufacturer's literature shall be referred and got approved from the Engineer prior to its use.

## 1203. FOUNDATIONS

### 1203.1 Scope

The work shall cover furnishing and providing plain cement concrete foundations placed in open excavation in accordance with the drawings and these Specifications or as directed by the Engineer.

### 1203.2 Depth of Foundation

**In soils** : The minimum depth of foundation shall be upto stratum having the specified bearing capacity shown on the drawing but shall not be less than 2 m below the scour level where no bed protection is provided or 1.5 m below the protected bed level unless otherwise specified in the drawings.

**In rocks** : The minimum embedment of foundation into the rock below shall be as follows:

| | | |
|---|---|---|
| (a) | Hard rocks with ultimate crushing strength of 10 MPa | 500 mm |
| (b) | All other types like soft rock/erodible rocks, etc. | 1200 mm |

In case of sloping rock profile, the surface on which the foundation shall rest be made levelled by properly benching the rock face/profile. Where the levels of foundations of returns can be kept higher than those of abutments, stepping of foundations may be resorted to with difference in level not more than 1.5 m and length not less than 3 m. A vertical joint shall be kept at each change of foundation level.

### 1203.3. Thickness of Footing

Footing shall be of plain cement concrete in M15 grade. The thickness of footing shall be 300 mm unless otherwise specified on drawing. A minimum offset of 150 mm shall be provided for the base of substructure.

### 1203.4. Workmanship

**1203.4.1. Preparation of foundations** : Excavation for laying the foundation shall be carried out in accordance with Clause 302 of these Specifications.

In the event of excavation having been made deeper than that shown on the drawing or as directed by the Engineer, the extra depth, shall be made up with M15 concrete at the cost of the Contractor and shall be considered as incidental work. Special care shall be taken not to disturb the bearing surface. Open foundations shall be constructed in dry conditions and the Contractor shall provide for adequate dewatering arrangements to the satisfaction of the Engineer without extra cost.

**1203.4.2. Setting out** : The plan dimensions of the foundation shall be set out at the bottom of foundation trench and checked with respect to original reference line and axis. It shall be ensured that at no point the bearing surface is higher than the founding level shown on the drawing or as directed by the Engineer.

**1203.4.3. Construction** : Before laying of foundation concrete layer, the earth surface shall be cleaned of all loose material and wetted. Care shall be taken to avoid muddy surface. If any portion of the surface has been spoiled by over-wetting, the same shall be removed. For foundation concrete, side formwork conforming to Section 900 of these Specifications before laying of concrete shall be provided to the required thickness. No construction joint shall be provided in the concrete footing.

Before laying foundation concrete rock surface shall be cleaned of all loose material and lightly moistened. Foundation concrete of required dimensions and shape shall be laid continuously upto the location of construction joint shown on the drawing or as directed by the Engineer.

The concrete surface shall be finished smooth with a trowel. Curing of concrete shall be done as per Clause 810 of there Specifications.

Dewatering, where necessary for laying of concrete, shall be carried out adopting any one of the following procedures or any other method approved by the Engineer :

(i) A pit or trench deeper than the foundation level as necessary may be dug beyond the foundation pit during construction so that the water level is kept below the foundation level.

(ii) Water table is depressed by well point system or other methods.

(iii) Use of steel/concrete caissons or sheet piling for creating an enclosure for the foundations, which can subsequently be dewatered.

Before backfilling is commenced, loose sand laid on foundation shall be removed and dispersed as directed by the Engineer.





All spaces excavated and not occupied by the foundation or other permanent works shall be refilled with earth upto surface of surrounding ground in accordance with Section 300. In case of excavation in rock, the annular space around foundation shall be filled with M15 concrete upto the top of rock.

The protective works, where provided shall be completed before the floods so that the foundation does not get undermined.

**1203.4.4. Tests and standards of acceptance** : The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to the Specifications and shall meet the prescribed standards of acceptance.

No point of the bearing surface on which concrete footing is to be laid shall be higher than the founding level shown on the drawing or as ordered by the Engineer. Levels of the bearing surface on which concrete footing is laid shall be taken at intervals of not more than 3 m center to center, subject to a minimum of nine levels on the surface.

**1203.4.5. Tolerances**

| | | |
|---|---|---|
| (a) | Variation in dimensions | : + 50 mm<br>– 10 mm |
| (b) | Misplacement from specified position in plan | : 15 mm |
| (c) | Surface irregularities measured with 3 m straight edge | : 5 mm |
| (d) | Variation of levels at the top | : ± 25 mm |

**1203.4.6. Measurements for payment** : Excavation in foundation shall be measured in accordance with Section 300 of these Specifications based on the actual dimensions at site.

Concrete shall be measured in cubic metres in accordance with Section 800 of these Specifications based on the actual quantity used in the work at site.

Reinforcement steel shall be measured in tonnes in accordance with Section 1000 of these Specifications based on quantity ordered by the Engineer and/or as shown on the drawings.

**1203.4.7. Rate** : The contract unit rates for excavation in foundation,

concrete in foundation shall include all works as given in respective Sections of these Specifications and cover all incidental items for furnishing and providing open foundation as mentioned in this Section.

## 1204. SUB-STRUCTURE

### 1204.1. Scope

The work shall cover furnishing and providing of brick or stone masonry or cement concrete sub-structure in accordance with the drawings and as per these Specifications.

### 1204.2. Materials

Materials shall conform to Clause 1202 of these Specifications.

### 1204.3. Piers, Abutments, Wing Walls and Return Walls

**1204.3.1.** Piers, abutments and wing/return walls shall be in brick masonry or Coursed Rubble (C.R.) stone masonry or plain or reinforced cement concrete as shown in the drawings. In case, the height of wing walls and return walls is less than 3 m, random rubble masonry in accordance with Section 700 of these Specifications may be adopted.

**1204.3.2.** Brick masonry shall conform to Section 600 of these Specifications.

**1204.3.3.** C.R. stone masonry shall conform to Section 700 of these Specifications.

**1204.3.4.** Plain cement concrete shall conform to Section 800, reinforcement to Section 1000 and formwork to Section 900 of these Specifications.

**1204.3.5.** In case of concrete piers, the number of horizontal construction joints shall be kept minimum. Construction joints shall be avoided in splash zones. No vertical construction joint shall be provided. The work shall conform strictly to the drawings.

**1204.3.6.** The surface of foundation shall be scrapped with wire brush and all loose materials removed and thoroughly wetted before commencing masonry or concrete work.

**1204.3.7.** In case of solid (non-spill through type) abutments, weep holes as shown on the drawings, shall be provided.





**1204.3.8.** The backfill behind solid abutments, wings and return walls shall conform to the specifications given in Appendix-6 of Clause 710.1.4 of IRC:78. The filter material shall be well packed to a thickness of not less than 600 mm with smaller size towards the soil and bigger size towards the wall and provided over the entire surface behind abutments, wings or return walls to the full height.

Filter materials need not be provided in case of spill through type abutments.

**1204.3.9.** The surface finish shall be smooth, except the earth face of abutments which shall be rough finished.

**1204.3.10.** Vertical expansion gap of 20 mm shall be provided between abutments and wing walls. In addition such gaps shall be provided at every 10 m intervals or as shown in the drawings.

**1204.3.11.** Coping for wing wall/return walls shall be in plain cement concrete as shown on the drawing. The measurement for coping shall be in linear metres.

The concrete unit rate for coping shall include cost of all labour, materials, tools and plants, formwork, etc. in accordance with these Specifications.

### 1204.4. Pier Cap and Abutment Cap

**1204.4.1.** Pier and abutment caps shall be in reinforced cement concrete as shown on the drawings.

**1204.4.2.** Concrete, formwork and reinforcement shall conform to Sections 800, 900 and 1000 of these Specifications.

**1204.4.3.** The locations and levels of pier cap/abutment cap/pedestals shall be checked carefully to ensure alignment in accordance with the drawings of the bridge.

**1204.4.4.** The surface of cap shall be finished smooth. For slab bridges surface of pier and abutment caps and pedestals shall be cast horizontal.

**1204.4.5. R.C.C. dirt wall** : Formwork, reinforcement and concrete in RCC dirt wall shall conform to relevant Sections of these Specifications.

The finish of the surface on the earth side shall be rough while the front face shall be smooth finished.

### 1204.6. Tests and Standards of Acceptance

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

### 1204.7. Tolerances in Concrete Elements

| | | |
|---|---|---|
| (a) | Variation in cross–sectional dimensions mm | : + 10 mm, -5 |
| (b) | Misplacement from specified position in plan | : 10 mm |
| (c) | Variation of levels at the top | : ± 10 mm |
| (d) | Variations of reduced levels of bearing areas | : ± 5 mm |
| (e) | Variations from plumb over full height | : ± 10 mm |
| (f) | Surface irregularities measured with 3 m straight edge | : 5 mm |
| (g) | Bearing areas | : 3 mm |

### 1204.8. Measurements for Payment

Masonry in sub-structure shall be measured in cubic metres in accordance with Sections 600 or 700 of these Specifications based on the quantities ordered or as shown on the drawings.

Concrete in sub-structure shall be measured in cubic metres in accordance with Section 800 of these specifications based on the quantity ordered or as shown on the drawings. No deduction shall be made for weep holes.

Steel in concrete of sub-structures shall be measured in tonnes, in accordance with Section 1000 of these Specifications based on the quantity ordered or as shown on the drawings.

### 1204.9. Rate

The contract unit rates for masonry, concrete and reinforcement shall include all works as given in respective sections of these Specifications and cover all incidental items for furnishing and providing substructure as mentioned in this Section. The rate for backfill behind abutment, wing walls and returns shall be as given as per Section 1300 of these Specifications.





## 1205. SUPERSTRUCTURE

### 1205.1. Scope

The work shall cover furnishing and providing of reinforced concrete slab or Box cell type or composite section with steel beam and reinforced concrete slab type or stone/brick masonry arch type superstructure in accordance with the drawings as per these Specifications or as directed by the Engineer.

### 1205.2. Materials

Materials shall conform to Sections 800 & 1000 for Reinforced Cement Concrete Section 600 for masonry, Section 700 for stone masonry and Clause 505 of IRC:24 for structural steel. Nominal mix or design mix concrete of grade specified in the drawing shall be used.

### 1205.3. Workmanship

**1205.3.1.** Dimensions, lines and level shall be set out and checked with respect to permanent reference lines and permanent bench marks so that the final product is in accordance with the drawings or as directed by the Engineer.

**1205.3.2.** The work shall conform to the following sections besides stipulations in this section with regard to specific type of construction :

| | | |
|---|---|---|
| (i) | Formwork | Section 900 |
| (ii) | Steel Reinforcement | Section 1000 |
| (iii) | Structural Concrete | Section 800 |
| (iv) | Structural steel | IRC:24 |

### 1205.4. Reinforced Concrete Solid Slabs

Where adjacent span of slab has already been cast, the expansion joint and filler board shall be placed abutting the already cast span which shall form the shutter on that side of the new span to be cast, whole of the slab shall be cast with reinforcement embedded for road kerb and railings. No other construction joint shall be allowed except with the written permission of the Engineer.

Where wearing coat is required to be provided, after the deck slab has been cast, the surface of the slab shall be finished rough, but true to lines

and levels as shown on the drawings, before the concrete has hardened. The areas of construction joints shall be treated in the prescribed manner.

Curing shall be carried out as per Clause 810 of the Specifications.

### 1205.5. R.C.C. Box Cell

**1205.5.1.** Box Cell shall be in cement concrete M-25 (nominal mix) and type and grade of reinforcement shall be as specified on the drawings.

**1205.5.2.** The box section shall be constructed with a maximum of one construction joint located in the web below the fillet between the deck slab and web.

**1205.5.3.** The concreting operation shall be carried out continuously upto the construction joint. The concrete surface at the joint of the box shall be brushed with a stiff brush after casting while the concrete is still fresh and it has slightly hardened.

**1205.5.4.** Before new concrete is poured, the surface of the already cast concrete shall be prepared as under :

(a) For hardened concrete, the surface shall be thoroughly cleaned to remove debris and made rough.

(b) For partially hardened concrete, the surface shall be treated by wire brush followed by air jet.

(c) The old surface shall be soaked with water without leaving puddles immediately before starting concreting to prevent the absorption of water from newly poured concrete.

(d) New concrete shall be thoroughly compacted in the region of the joint.

**1205.5.5.** Concrete shall be produced in a power driven mechanical mixer of capacity not less than 200 litres. A second mixer may also be used for continuous concreting where required.

**1205.5.6.** Proper compaction of concrete shall be ensured by the use of screed or form vibrators for concrete in top slab of the box. For webs needle vibrators of appropriate specifications shall be used to ensure proper compaction.

**1205.5.7.** Pressure relief pipes of 100 mm diameter shall be provided as shown on drawing. Area 500 mm x 500 mm below pressure relief pipe shall be provided in the form of inverted filter as per Clause 1302 of these Specifications.





**1205.5.8.** The bearing surface of the box cell shall be prepared in accordance with Clause 1203.4 of these Specifications before laying M10 grade cement concrete leveling course.

**1205.5.9.** Cut–of walls, protective apron shall be as shown in drawing and according to Section 1300 of these Specifications.

**1205.5.10.** Plain cement concrete parapet (400 mm thick) shall be provided in accordance with Clause 1208.4 of these Specifications.

**1205.5.11.** Top of the R.C.C. raft (i.e., bottom of the box cell) shall be kept 300 mm below the lowest bed level.

### 1205.6. Composite Type

**1205.6.1.** Composite type of superstructure for bridges comprising longitudinal steel girders with R.C.C. solid slab as decking shall be provided for only simply supported bridges.

**1205.6.2.** Shear connectors between the steel girder and reinforced concrete deck shall be provided to ensure composite action of girders and R.C.C slab as shown on drawing or as directed by the Engineer.

**1205.6.3.** No traffic shall be permitted on the bridge having composite type of superstructure prior to 28-days of concreting the deck for effective composite action.

**1205.6.4.** 150 mm x 150 mm haunches shall be provided between top of steel girder and soffit of slab. The sides of haunches shall be located outside a line drawn at 45° from the outside edge of the base of the connectors.

**1205.6.5.** Design of composite section of steel beams and R.C. slab and shear connectors shall conform to IRC:22 and IRC:24.

**1205.6.6.** All structural steel components of the composite type superstructure shall be protected against corrosion by :

(i) a minimum of three coats of paints, or

(ii) a metal coating followed by two coats of paint.

The painting and protective coating shall be done in accordance with IS:1477 Code of Practice for Painting of Ferrous Metals in Buildings, and allied finishes.

**1205.6.7.** Steel surfaces to be painted shall be prepared in a thorough manner by the process of grit and sand blasting. Primary coat shall be applied as soon as practicable after cleaning.

**1205.6.8.** Damaged or deteriorated paint surfaces of steel components shall first be made good with the same type of coat before erection.

### 1205.7. Tolerances

| | | |
|---|---|---|
| (a) | Variations in overall depth or width | : ± 5 mm |
| (b) | Variation in overall length and length between bearings | : shall not exceed ± 10 mm or ± 0.1 per cent of the span length, whichever is lesser |
| (c) | Permissible surface irregularities when measured with a 3 m straight edge or template | : 5 mm |

### 1205.8. Tests and Standards of Acceptance

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed Standards of acceptance.

### 1205.9. Measurements for Payment

Concrete in superstructure shall be measured in cubic metres in accordance with Section 800 of these Specifications based on the actual quantity used in work at site.

Steel reinforcement in superstructure shall be measured in accordance with Section 1000 of these Specifications based on the actual quantity used in work at site.

Structural steel in composite type superstructure shall be measured in tonnes on the net weight of steel beams computed on the basis of nominal weight of materials.

The weight of rolled beams shall be determined from the dimensions shown on the drawings taking unit weight as 78.4 kN per cu.m.





Weight of protective coatings shall not be included.

Steel in shear connectors shall be measured in tonnes as per Section 1000 of these Specifications.

### 1205.10. Rate

The contract unit rates for concrete, steel reinforcement and structural steel shall include all works as given in respective Sections of these Specifications and cover all incidental items for furnishing and providing superstructure as mentioned in this Section.

## 1206. WEARING COAT

### 1206.1. Bituminous Wearing Coat

Bituminous wearing coat shall comprise of 20 mm thick premix carpet with seal coat on culverts having earth cushions and pavement carried over such culverts. On minor bridges and culverts having no earth cushion, 40 mm thick Bituminous Maccadam (BM) covered with 20 mm thick premix carpet and seal coat shall be used.

### 1206.2. Premix Carpet Wearing Coat

Specifications for BM, premix carpet and seal coat in wearing coat shall conform to Section 500 of these Specifications.

### 1206.3. Cement Concrete Wearing Coat

Cement concrete wearing coat may be provided in case of isolated bridges, submersible structures, causeways and dips, etc. It shall not be laid monolithic with the deck.

The thickness of wearing coat shall be 75 mm. The minimum grade of concrete shall be M30 with water cement ratio of 0.4 or as specified on the drawings.

In case where cement concrete pavement is provided, the same shall be carried over the hume pipe or box culverts.

Curing of wearing coat earlier than what is generally required may be resorted to so as to avoid formation of shrinkage cracks in hot weather.

All carriageway and footpath surfaces shall have non-skid characteristics.

The cross slope in the deck shall be kept as 2.5 per cent for decks, level in longitudinal profile.

### 1206.4. Measurements for Payment

Bituminous wearing coat shall be measured in square metres in accordance with Clause 508 of these Specifications. Cement concrete wearing coat shall be measured in cubic metres in accordance with Clause 816 of these Specifications.

### 1206.5. Rate

The contract unit rate for wearing coat shall include the cost of all labour, material, tools and plant and other cost necessary for completion of the work as per these Specifications.

## 1207. BEARINGS AND EXPANSION JOINTS

Bearings and expansion joints shall be provided as specified on the drawings.

### 1207.1. Bearings

Only elastomeric bearings shall be provided for R.C.C. slab bridges of span length more than 10 m conforming to MoRT&H Specifications and IRC:83 (Part III).

The surface on which elastomeric bearings are to be placed shall be wood float finished to a level plan which shall not vary more than 1.5 mm from straight edge placed in any direction across the area.

### 1207.2. Expansion Joints

This work shall consist of fabrication and placing of expansion joints as indicated on the drawing and conforming to these Specifications or as directed by the Engineer.

#### 1207.2.1. General

(a) The expansion joints shall be designed and duly got approved by the Engineer. It shall cater for expected movement of the structure at the joints and provide smooth riding surface. It shall also be easy for inspection, maintenance and replacement.

(b) Expansion joints shall be robust, durable, water–tight and replaceable. Site fabricated expansion joints shall be prohibited. Expansion joints shall be obtained by the Engineer either directly or through the Contractor from approved manufacturers or their authorised agents and be of proven type.

(c) Vehicular traffic shall not be allowed over expansion joints after its construction for such period as may be determined by the Engineer.





(d) Proprietary type deck joints offered by the Contractor in lieu of the type specified shall comply in all respects with the manufacturer's specifications and meet the required range of movements and rotations and be fit for the purpose of ensuring satisfactory long term performance in the bridge.

Where alternative type proprietary deck joints are proposed by the Contractor, the following information shall be provided:

(i) Name and location of the proposed manufacturer.

(ii) Dimensions and general details of the joint including material specifications, holding down bolt or anchorage details and installation procedures.

(iii) Evidence of satisfactory performance under similar environmental conditions of similar joints being produced by the manufacturer.

Any acceptance of alternative types will be at the sole discretion of the Engineer.

Such deck joints shall be installed in accordance with the manufacturer's recommendation and to the general requirements of this Specification.

Expansion joint shall be provided for the width of the bridge and shall follow the profile of carriageway besides the kerb and the footway and facia, if provided. The type of expansion joint for the latter may be made different from that used for the carriageway expansion joint.

#### 1207.2.2. Filler joints

(a) The components of this type of joint shall be at least 2 mm thick corrugated copper plate placed slightly below the wearing coat, 20 mm thick compressible fibre board to protect the edges, 20 mm thick pre-moulded joint filler filling the gap upto the top level of the wearing coat, sealed with a joint sealing compound.

(b) The material used for filling expansion joint shall be bitumen impregnated felt, polysulphide elastomer or any other suitable material, as specified on the drawings. Impregnated felt shall conform to the requirements of IS:1838, and shall be got approved from the Engineer. The joint filler shall consist of large pieces and assembly of small pieces to make up the required size shall be avoided.

(c) Expansion joint materials shall be handled with care and stored under cover by the Contractor to prevent damage.

(d) Any damage occurring after delivery shall be made good to the satisfaction of the Engineer and at the expense of the Contractor.

(e) Joint gaps shall be constructed as shown on the drawings. Surfaces of joint grooves shall be thoroughly cleaned with a wire brush to removed all loose materials and dirt and debris, then washed or jetted out.

(f) Pre-moulded expansion joint filler shall not be placed in position until immediately prior to the placing of the abutting material. If the two adjacent surfaces of the joint are to be placed at different times, this type of joint filler shall not be placed until the second face is about to be placed.

(g) Sealants shall be installed in accordance with the manufacturer's recommendations and all appropriate requirements of joint face priming.

(h) Sealants shall be finished approximately 3 mm below the upper surfaces of the joint.

(i) Joint materials spilt or splashed onto finished surfaces of the bridge during joint filling operations shall be removed and the surfaces made good to the Engineer's approval.

(j) No joint shall be sealed until inspected by the Engineer and approval is given to proceed with the work.

### 1207.2.3. Burried joint

(a) This joint shall consist of continuously laid bituminous/asphaltic surfacing over the joint gap bridged by a steel plate resting freely over the top surface of the deck concrete.

(b) The width of the joint gap shall be kept as 20 mm.

(c) The steel plate shall conform to weldable structural steel as per IS:2062. The plate shall be 20 mm thick and 200 mm wide. The plate shall be made of minimum number of pieces (not exceeding two pieces per traffic lane width) welded together to form the required length.

(d) 8 mm dia, 100 mm long nails, spaced at 300 mm centres along the centre line of the plate shall be welded to the bottom surface of the steel plate to protrude vertically into the joint gap in order to prevent dislodging of the plate.

(e) The plate and the nails shall be protected against corrosion by galvanising or any other approved anti-corrosive coating with a minimum thickness of 100 micron. These shall be completely free of oil, rust, loose paint or other similar material before application of anti-corrosive coating.

(f) The concrete surface shall be free from any loose material and cleared of any grease, oil, paint, etc. and the surface shall be sand blasted, clean of all laitance and level true, prior to placement of the steel plate.





(g) The plate shall be placed symmetrical to the centre line of the joint and it shall be ensured that the plate does not get displaced from its positoin while laying the wearing course.

(h) Any temporary bolts or other fixtures which prevent relative movement of the adjacent parts of the joint shall be removed as soon as the concrete has set sufficiently to hold the expansion plates in their positions. In any case, temporary bolt or other fittings shall be removed within 6 hours of placing concrete unless otherwise directed by the Engineer.

(i) Care shall be taken to prevent damage to expansion joint plates or its coating. If any damage occurs, the plates and coatings shall be restored by the Contractor to the satisfaction of the Engineer.

**1207.2.4. Compression seal joint** : Compression seal joint shall consist of steel armoured nosing at two edges of the joint gap suitably anchored to the deck concrete and a preformed chloroprene elastomer or closed cell foam joint sealer compressed and fixed into the joint gap with special adhesive binder.

**(a) Materials:**

(i) **Steel nosing :** The steel nosing shall be of angle section 1SA 100 mm x 100 mm conforming to weldable structural steel as per IS:2062. The thickness of legs shall not be less than 12 mm. The top face of the angle shall be provided with bleeder holes of 12 mm diameter spaced at maximum 100 mm centres so as to ensure that there are no voids in the concrete beneath the angle.

(ii) **Anchorage:** The anchorage steel shall conform to IS:2062 or equivalent.

The steel nosing shall be anchored to the deck by reinforcing bars, headed studs or bolts or anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or anchor loops, this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12 mm. Total cross- sectional area of bars, studs or bolts on each side of the joint shall not be less than 1600 sq.mm per m length of the joint and the centre-to-centre spacing shall not exceed 250 mm. The ultimate resistance of anchorages shall not be less than 500 kN per m in any direction.

(iii) **Corrossion Protection :** All steel section shall be protected against corrosion by hot dip galvanising or any other approved anti-

corrosive coating with a minimum thickness of 100 micron.

(iv) **Joint Seal :**

(1) The sealing element shall be a preformed continuous chloroprene or closed cell foam seal with high tear strength, insensitive to soil, gasoline and ozone. It shall have high resistance to aging and ensure water tightness. The seal should be vulcanised in a single operation for the full length of the joint required for carriageway, kerbs and footpaths, if any. The seal shall cater for a horizontal movement upto 40 mm and vertical movement of 3 mm.

(2) The physical properties of chloroprene/closed cell foam sealing element shall conform to the following :

**Chloroprene Seal** : Shall be preformed extruded multiweb cellular section of chloroprene of such a shape as to promote self removal of foreign material during normal service operations. Chloroprene of joint seal shall conform to Clause 915.1 of IRC:83 (Part-II) and satisfy the properties stipulated in Table 1200.1 except in respect of the working movement range of the sealing element which shall be as specified in Clause 1207.2.4(a)(iv)(1) of these Specifications.

**Closed Cell Foam Seal** : Shall be of preformed non-extruded; non-cellular section made from low density closed cell, cross linked ethylene vinyl acetate, polyethylene copolymer that is physically blown using nitrogen. The material shall possess properties, as indicated in Table 1200.2.

(v) **Lubricant-cum-Adhesive** : The type and application of material used in bonding the preformed joint seal to the steel nosing and concrete shall be as recommended by the manufacturer/supplier of the seal system.

**(b) Handling and Storage:**

(1) The expansion joint materials shall be handled with care and stored under cover.

(2) All joint material and assemblies shall be protected from damage and assemblies shall be supported to maintain true shape and alingment during transportation and storage.

**(c) Installation:**

(1) The expansion joint shall be installed by the manufacturer/supplier or their authorised representative, who will ensure compliance of installation procedure and instructions.





**TABLE 1200.1 : STRIP SEAL ELEMENT SPECIFICATIONS**

Sealing element is made of chloroprene and must be a extruded section. The working movement range of the sealing element shall be at 70 mm.

| PROPERTY | SPECIFIED VALUE |
|---|---|
| Hardness* | |
| DIN 53505 | 63 ± 5 Shore A |
| ASTM D 2240 (Modified) | 55 ± 5 Shore A |
| Tensile Strength* | |
| DIN 53504 | Min. 11 MPa |
| ASTM D 412 | Min. 13.8 MPa |
| Elongation at fracture* | |
| DIN 53504 | Min. 350 per cent |
| ASTM D 412 | Min. 250 per cent |
| Tear Propagation Strength | |
| Longitudinal | Min. 10 N/mm |
| Transverse | Min. 10 N/mm |
| Shock Elasticity | Min. 25 per cent |
| Abrasion | Min. 220 cu.m |
| Residual Compressive Strain (22 h/70°C/30 per cent strain) | Max 28 per cent |
| Ageing in hot air (14-days/70°C) | |
| Change in hardness | Max + 7 Shore A |
| Change in tensile strength | Max -20 per cent |
| Change in elongation at fracture | Max -20 per cent |
| Ageing in ozone (24 h/50 pphm/25°C/20 per cent elongation) | No cracks |
| Swelling behaviour in Oil (168h/25°C) ASTM Oil No.1 | |
| Volume Change | Max. + 5 per cent |
| Change in hardness | Max. - 10 Shore A |
| ASTM Oil No.3 | |
| Volume Change | Max. + 25 per cent |
| Change in hardness | Max. - 20 Shore A |
| Cold Hardening Point | Max. - 35°C |

* Only one set of specifications, viz., ASTM or DIN shall be followed depending on the source of supply.

**TABLE 1200.2: CLOSED CELL FOAM SEAL SPECIFICATIONS**

| | Property | Specified Value |
|---|---|---|
| (i) | Density | 417-513 N per cu.m. |
| (ii) | Compression Set on 25 mm (ASTM D 3575) for 22 hours at | 50 per cent compression samples 23°C, 2 hour recovery; 13 per cent set. |
| (iii) | Working temperature | -70 to + 70°C. |
| (iv) | Water absorption (total immersion for 3 months) | 0.09766 N per sq.m (ASTM D 3575) |
| (v) | Tensile strength | 0.8 MPa |
| (vi) | Elongation at break | 195 ± 20 per cent (ASTM D 3575) |

(2) The dimension of the joint recess and the width of the gap shall conform to the approved drawing.

(3) Anchoring steel shall be welded to the main reinforcement in the deck maintaining the level and alignment of the joint.

(4) Concreting of pocket/recess shall be done with great care using proper mix conforming to same grade as that of the deck concrete but not less than M30 grade in any case. The water-cement ratio shall not be more than 0.40. If needed, suitable admixtures may be used to achieve the workability. The width of pocket shall not be less than 300 mm on either side of the joint. Care shall also be taken to ensure efficient bonding between already cast/existing deck concrete and the concrete in the joint recess.

(5) At the time of installation, joint shall be clean and dry and free from spalls and irregularities which might impair a proper joint seal.

(6) Concrete or metal surfaces shall be clean, free of rust, laitance, oil, dirt, dust or other deleterious materials.

(7) The lubricant-cum-adhesive shall be applied to both faces of the joint and joint seal prior to installation in accordance with the manufacturer's instructions.

(8) The joint seal shall be compressed to the specified thickness for the rated joint opening and ambient temperature at the time of installation which shall be between +5 to +35°C.





(9) The joint seal shall be installed without damage to the seal. Loose fitting or open joints shall not be permitted.

**(d) Acceptance Criteria :**

(1) All steel elements shall be furnished with corrosion protection system.

(2) For the joint seal the acceptance test shall conform to the requirements stipulated in Clause 1207.2.4(a)(iv). The manufacturer/ supplier of this type of joint shall produce a test certificate to this effect conducted in a recognised laboratory in India or abroad.

(3) Prior to acceptance 25 per cent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25 mm above the highest point of deck. The width of ponding shall be atleast 50 mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25 mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

**(e) Tests and Standards of Acceptance:**

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria. The manufacturer/supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance

## 1207.2.5. Elastomeric slab seal expansion joint

### 1207.2.5.1. Materials

(a) Steel inserts shall conform to IS:2062. Use of any other materials like fibre-glass or similar material shall not be permitted.

(b) Elastomer for elastomeric slab unit (ESU) shall conform to Clause 915.1 of IRC:83 (Part II), compounded to give hardness IRHD 60 ± 5, subject to the following additional stipulations :

(i) Chloroprene (CR) only shall be used in the manufacture of elastomeric expansion joints. No reclaimed/natural rubber or vulcanized wastes shall be used.

(ii) The chloroprene material used in the manufacture of elastomeric (expansion joints) shall be Neoprene WRT, Bayprene 110, Skyprene B5 or Denka S-40V.

(iii) Chloroprene content of the compound shall not be lower than 60 per cent by weight. The ash content not exceed 5 per cent (as per tests conducted in accordance with ASTM D-297 for (i) and (ii) above.

(iv) EPDM and other similar candidate elastomers for expansion joints shall not be permitted.

(c) Elastomeric plugs

(d) Spacer bars, marked with center to center distance of fixing holes.

(e) Fixing bolts and nuts made of stainless steel.

(f) Anchor bars comprising hooked anchor stiffeners welded with lower steel inserts and sinusoidal anchor bars welded with horizontal leg of the edge steel inserts. The elaborate anchoring arrangement of steel inserts shall be permanently welded/tied with the steel reinforcement.

### 1207.2.5.2. Fabrication

(a) Steel inserts shall be grit blasted and provided with epoxy paint

(b) Edges of reinforcing steel sections shall be rounded.

(c) Expansion joints shall be fully moulded to the required size in one single vulcanizing operation including the encasing layers as integral and homogenous part.

(d) Tolerances of fabrication shall be as follows :

(i) Plan dimension $> \pm 5$ mm

(ii) Total height $> \pm 3$ mm

### 1207.2.5.3. Supply and handling

(i) The Contractor shall supply all steel–reinforced elastomeric expansion joints including bolts, nuts, sealant, plugs and all other accessories for the effective installation of the joints including angled jointing sections for kerbs.

(ii) Expansion joint material shall be handled with care and stored under cover by the Contractor to prevent damage. Any damage occurring after delivery shall be made good at the expense of the Contractor to the satisfaction of the Engineer.

**1207.2.5.4. Installation** : Expansion joints shall be installed as per approved drawing. Steel inserts, spacer bars, concreting of pockets, fixing





of elastomer slab unit and presetting etc. shall be done as per the following :

(a) **Steel Inserts**

(i) Deck casting shall be done leaving pockets or recess for steel inserts and anchors of the expansion joint as per drawing.

(ii) Steel inserts shall be lowered at the appropriate location inside the pocket.

(iii) The top of the insert shall be flush with the finished level of wearing course maintaining the camber.

(iv) Spacer bars, duly set appropriately to the month of installation, shall be fitted under proper supervision.

(v) Anchor rods shall be tied/welded with the existing deck main reinforcement, maintaining level and alignment.

(vi) Welding between anchor rods and deck reinforcement is preferable. If welding is not possible, strong steel tie wires shall be used for fastening, under proper supervision.

(b) **Spacer Bar**

(i) Spacer bars shall be used to ensure proper positioning of bolts and also leveling of the steel inserts during fixing of the same with the deck reinforcement and casting second stage concreting in the pocket thereafter.

(ii) The second stage concreting operation shall preferably be started within 24 hours of fixing the steel inserts. In such cases, spacer bars should be removed just after concreting is finished. If there is a substantial time lag between fixing of inserts and concreting, then any one of the following methods shall be adopted, depending on the support condition:

(a) For simply supported bridge resting on simple elastomeric bearings, (with no dowel pins), insert shall be placed in position with spacer bars at every alternate joints. Such joints shall be called restrained joints hereafter. In other words, inserts shall not be fixed simultaneously at two ends of one span. If the above condition is satisfied, inserts with spacer bars shall be kept in position for a substantially longer period at such restrained joints. Spacer bars shall be removed after concreting of such restrained joints and inserts placed in position with spacer bars at the other unrestrained joints thereafter.

(b) For bridges resting on other than elastomeric bearings (including bearings with dowel pins at one end), after placing and aligning the inserts and securing the same, the spacer bars shall be removed. Concreting shall be done with great care so that inserts are not dislocated or distorted.

(iii) While removing the spacer bars after concreting, one must take care to see that the concrete is not damaged during withdrawal of spacer bar. If the spacer bar happens to be snugly fitted, it shall not be pulled by any means; it shall be gas cut in two pieces and then removed.

(c) **Concreting of Pockets**

(i) Concreting of pocket shall be done with great care using proper mix conforming to grade similar to that of the deck casting besides ensuring efficient bonding between deck and steel insert. Also proper care shall be given for ensuring efficient bonding with the already cast concrete.

(ii) Needle vibrators shall be used. Care shall be taken so that the position of steel insert is not disturbed during vibration.

(iii) Spacer bar shall be removed within an appropriate time before the joint is required to permit movement.

(d) **Fixing of Elastomeric Slab Unit (ESU)**

(i) Special jig shall be used to preset the ESU during installation.

(ii) ESU (mounted on the jig, if preset) shall be lowered to position.

(iii) The line and level on the ESU shall be adjusted.

(iv) ESU shall be removed and coated with special adhesive

(v) ESU shall be placed in position again, ensuring waterproof joining at required faces.

(vi) ESU shall be tightened with stainless steel nuts and the lock washers in position.

(vii) Special sealant shall be poured inside the plug holes.

(viii) The elastomeric plugs shall be pressed in position after applying adhesive on the appropriate surface.

(ix) ESU shall be fitted in position after completion of wearing course. While completing this part of the wearing course, adequate care shall be taken to ensure a waterproof joining with the already existing wearing course.





(e) **Pre-setting**

(i) The main purpose of presetting of the steel inserts at the time of its installation is to ensure as closely as possible the condition that in the long run at the mean average annual temperature, the ESU remains at its nominal state.

(ii) Major factors responsible for changing the longitudinal length of the bridge superstructure are indicated below :

(a) Temperature variation from annual mean.

(b) Changes due to shrinkage of concrete

(c) Deformation of superstructure and substructure, if any.

Resultant changes in expansion gap due to first factor can occur in both directions from any pre-selected mean position whereas changes due to shrinkage are unidirectional such that the expansion gap continuously increases with passage of time.

The steel insert unit of expansion joint can be fixed in any month of the year. As stated earlier, the expansion gap between bridge superstructure may vary from time to time, hence the initial fixing distance between fixing points will obviously depend on the month of installation of steel insert. The c/c distance between stainless steel fixing of bolts as indicated in the drawing can be taken as only nominal. The same shall be modified by pre-setting depending on the difference between the mean temperature of the month of fixing of steel insert and the annual average temperature.

**1207.2.5.5. Acceptance test** : As per Clause 918.7 of IRC:83 (Part II), necessary quality control certification by the manufacturer in regard to properties of Elastomer and steel will be furnished.

For severe environment, ozone resistance test as per Clause 915.2.3 of IRC:83 (Part II), shall be carried out for elastomer.

The properties of the elastomer shall conform to Table 1 of Clause 915.2 of IRC:83 (Part II). The acceptance testing for elastomer material shall conform to Clauses 918.4.1.2, 918.4.1.3 and 918.4.2 of IRC:83 (Part II).

The fabricated expansion joint shall be subjected to the following acceptance tests :

(i) Routine test. Each expansion joint shall be tested for at least 100 cycles for a test movement which shall be 10 per cent more than the design expansion/contraction movement.

(ii) In addition to routine test, one out of every 20 expansion joints shall be subjected to the test movement for 4000 cycles.

The lot shall be rejected if the elastomer material shows signs of fatigue or permanent set or distress in the test. The test piece shall not be used in the bridge.

(iii) The type test for abrasion resistance shall be carried out for one joint out of every 20 nos. as per IS:3400 (Part : 3) and the standard deviation shall be within ± 20 per cent.

N.B. The manufacturer shall preferably have in-house testing facility. Otherwise, the testing shall be got done by him at his expense at any testing establishment selected by the Engineer. A manufacturer who cannot carry out the acceptance test shall not be entitled to supply elastomeric slab seal joint.

**1207.2.6. Measurements for payment** : The expansion joint shall be measured in running metres. For filled joints, the rate per running metres shall include the cost of sealant for the depth provided in this drawing.

**1207.2.7. Rate** : The contract unit rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as per these specifications in the case of Bridge Contractor supplying the expansion joint. If the manufacturer supplies the expansion joint directly to the Engineer, the cost of installation, handling and fixing shall be borne by the Contractor.

## 1208. RAILINGS/PARAPETS

### 1208.1. General

(a) Bridge railing includes the portion of the structure erected on and above the kerb for the protection of pedestrians and traffic

(b) Railings shall not be constructed until the centering for falsework for the span has been released and the span is self-supporting.

(c) The type of railing shall be carefully erected true to line and grade. Posts shall be vertical with a tolerance not to exceed 6 mm in 3 m. The pockets left for posts shall be filled up with cement mortar.

(d) The type of railing to be constructed shall be as shown on the drawing

(e) Care shall be exercised in assembling expansion joints in the railings to ensure that they function properly.



(f) The design of bridge railings shall be such which is amenable to quick repairs.

(g) Railing materials, particularly metal railings, shall be handled and stored with care, so that the material and parts are kept clean and free from damage. Railing materials shall be stored above the ground on platforms, skids, or other supports and kept free from grease, dirt and other contaminants.

Any material which is lost, stolen or damaged after delivery shall be replaced or repaired by the Contractor. Methods of storage, etc. or repairs shall not damage the material or protective coating.

### 1208.2. Metal Railings

All pipes and steel elements used for railings shall be mild steel conforming to IS:1239 and shall be galvanized.

All complete steel rail elements, pipe terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanized or painted with an approved paint.

If galvanized, all elements of the railings shall be free from abrasions, rough or sharp edges, and shall not be kinked, twisted or bent. If straightening is necessary, it shall be done by methods approved by the Engineer.

Damaged galvanized surfaces, edges of holes and ends of steel, railing cut after galvanizing shall be cleaned and re-galvanised.

The railing shall be carefully adjusted prior to fixing in place to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

Unless otherwise specified on the drawings, metal railing shall be given one shop coat of paint and three coats of paint after erection if sections are not galvanized.

Railings shall not follow any irregularity in the alignment of the deck. When shown on the drawings, the rail elements shall be curved before erection.

### 1208.3. Cast-in-Situ Concrete Railings

The portion of the railing or parapet which is to be cast in place shall

be constructed in accordance with the requirements for structural concrete in Section 800 and reinforcement shall conform to Section 1000 of these Specifications.

Forms shall either be of single width boards or shall be lined with suitable material duly approved by the Engineer. Form joints in plane surfaces will not be permitted.

All mouldings, panel work and bevel strips shall be constructed according to the details, shown on the drawings. All corners in the finished work shall be true, sharp and clean-cut and shall be free from cracks, spalls or other defects. Casting of posts shall be done in single pour.

### 1208.4. Parapets

Plain cement concrete M15 grade or brick or stone masonry parapets as shown on drawing shall be provided on R.C.C. slab culverts or minor bridges having overall length not exceeding 30 m. Minimum thickness of masonry parapets shall be 400 mm.

### 1208.5. Measurements for Payment

Measurements for railings and parapets shall be in running metres.

### 1208.6. Rate

The contract unit rate for railings and parapets shall include the cost of all labour, material, tools and plants, formwork required for completing the work as per these Specifications.

## 1209. DRAINAGE SPOUTS

**1209.1.** This work shall consist of furnishing and fixing in position drainage spouts and drainage pipe for bridge deck. The transverse drainage of bridge deck shall be ensured by means of a suitable camber in the carriageway surface. The down spouts shall be of not less than 100 mm in diameter and shall be of corrosive resistant material such as galvanised steel with suitable clean-out fixtures. These shall be rigid and adequately fixed to the deck. The spacing of drainage spouts shall not exceed 10 m. The details of flow drains shall be such as to prevent discharge of drainage water against any portion of the structure. Over hanging portions of concrete members of deck shall be provided preferably with drip heads.





### 1209.2. Placement

The galvanized assembly shall be given two coats of bituminous painting before placement. The whole assembly shall be placed in true position, lines and levels as shown in the drawing with necessary cut-out in the shuttering for deck slab and held in place firmly. Where the reinforcement of the deck are required to be cut, equivalent reinforcements shall be placed at the corners of the assembly.

### 1209.3. Finishing

After setting of the deck slab concrete, the shrinkage cracks around the assembly shall be totally sealed with polysulphide sealant or bituminous sealant as per IS:1834 and the excess sealant trimmed to receive the wearing coat. After the wearing coat is completed, similar sealant shall be finished to cover at least 50 mm on the wearing coat surface all around the drainage assembly.

### 1209.4. Measurements for Payment

Drainage spouts shall be measured in numbers.

### 1209.5. Rate

The contract unit rate for each drainage spout shall include the cost of all labour, materials, tools and plant required for completing the work as per these Specifications. It shall also include the cost of providing flow drain pipe with all fixtures upto the point of ground drains where shown on the drawing.

## 1210. BED PROTECTION

Bed Protection shall be provided as shown on drawing and conforming to Section 1300 of these Specifications.

## 1211. APPROACH SLAB

### 1211.1. General

**1211.1.1.** No approach slabs shall be provided on culverts/or minor bridges as abutments are designed for 1.2 m height of live load surcharge. The road pavement shall be continued in the full formation width between wing walls.

**1211.1.2.** Where reinforced concrete approach slab has been specified

and shown on the drawings, the same may be provided as per details given thereon covering the entire width of roadway between wing walls/returns. Minimum length of approach slab shall be 3.5 m and minimum thickness 300 mm. The base for the approach slab shall be 150 mm thick in M10 concrete grade.

**1211.1.3.** The reinforcement in approach slab shall consist of 12 mm diameter steel bars at 150 mm c/c in both directions at top and bottom. The cement concrete and reinforcement shall conform to Section 800 of these Specifications.

### 1211.2. Tests and Materials of Acceptance

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed Standards of acceptance.

### 1211.3. Measurements for Payment

The measurement for approach slab and its base shall be measured separately in cubic metres.

### 1211.4. Rate

The contract unit rate for approach shall include the cost of all materials, labour, tools and plant, formwork and other cost necessary for the satisfactory completion of the work as per these Specifications. It shall include the cost of steel unless otherwise specified. The rate for base shall also include preparation of surface and its consolidation.



Protection Works and Drainage

# 1300

# Protection Works and Drainage

## 1301. APRON

### 1301.1. Scope

This work shall consist of laying boulders of the required size directly or in wire crates where the required size stones are not available, on the bed of rivers or streams, nallahs, etc. for protection against scour beyond curtain wall and shall be 600 mm thick unless otherwise specified on drawing or as directed by the Engineer.

### 1301.2. General

**1301.2.1.** Where the required size of boulders are not available, economically cement concrete blocks with M15 nominal mix or stone in wire creates shall be used in place of isolated stones of equivalent weight.

**1301.2.2.** The stones used in apron shall be sound, hard, durable and fairly regular in shape weighing not less than 25 kg each. Stone subject to marked deterioration by water or weather shall not be used.

**1301.2.3.** The surface on which the apron is to be laid shall be levelled and prepared for the length and width as shown on the drawings. In case the surface on which apron is to be laid is below the low water level, the ground level may be raised upto low water level by dumping earth, moorum, boulders or stones or brick bats and the apron laid thereon. The quantity of stone required in the apron shall be reworked out by taking the toe of pitching at higher level.

**1301.2.4.** Flexible Apron shall be provided beyond curtain walls for a minimum distance of 3 m on upstream side and 6 m on down stream side unless otherwise specified on drawing or as directed by the Engineer. Generally, the length of apron shall not be less than two times the depth of the curtain wall.

**1301.2.5.** The work of floor protection, like, flooring, cut-off walls and apron shall be completed along with foundations of C.D. work/bridge and well before the on set of monsoon. The superstructure of bridge shall be done only on completing floor protection works.

### 1301.3. Laying Boulder Apron

**1301.3.1.** The size and weight of stone should conform to Table 1300.1 given below. In no case any fragment shall weigh less than 25 kg.

The specific gravity of stones shall be as high as possible and it shall not be less than 2.65.

**TABLE 1300.1**

| Mean Design Velocity m/sec. | Minimum size and weight of stone | |
|---|---|---|
| | Diameter (mm) | Weight (kg) |
| Upto 2.0 | 220 | 25 |
| 2.5 | 300 | 40 |
| 3.0 | 380 | 76 |
| 3.5 | 510 | 184 |
| 4.0 | 670 | 417 |

**1301.3.2.** To ensure regular and orderly disposition of the full intended quantity of stone in the apron, template crosswalls in dry masonry shall be built about a meter thick and to the full height of the specified thickness of the apron at intervals of 30 m all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.

### 1301.4. Laying Wire Crates and Mattresses in the Apron

**1301.4.1.** Wire Crates shall be made from hot dipped galvanized mild steel wire of diameter not less than 4 mm in annealed condition conforming to IS:280. The galvanizing coating shall be heavy coating for soft condition conforming to IS:4826.

**1301.4.2.** The mesh of the crate shall not be more than 150 mm.

**1301.4.3.** Wire crates built in-situ, shall not be larger than 7.5 m x 3 m x 0.6 m, nor smaller than 2 m x 1 m x 0.3 m. Sides of large crates shall be securely stayed at intervals of not more than 1.5 m to prevent bulging.

**1301.4.4.** For deep or inaccessible situations, wire crates can be made smaller size of 2 m x 1 m x 0.3 m.

**1301.4.5.** The netting shall be made by fixing a row of spikes on a beam at a spacing equal to the mesh. The beam must be a little longer than the width of netting required. The wire is to be cut to lengths about three times the length of the net required. Each piece





shall be bent at the middle around one of the spikes and the weaving commenced from one corner.

**1301.4.6.** A double twist shall be given at each intersection. This twisting shall be carefully done by means of a strong iron bar, five and half turns being given to the bar at each splice.

**1301.4.7.** The bottom and two ends of the crate or mattresses shall be made at one time. The other two sides shall be made separately and shall be secured to the bottom and the ends by twisting adjacent wires together. The top shall be made separately and shall be fixed in the same manner as the sides after the crates or mattress have been filled.

**1301.4.8.** Wherever possible, crates shall be placed in position before filling with boulders. The crates shall be filled by carefully hand packing the boulders as tightly as possible and not by merely throwing in stones or boulders.

## 1302. PITCHING ON SLOPES

### 1302.1. Scope

The work shall consist of covering the slopes of guide banks/walls, training works and road embankment with stone, boulders or bricks over a layer of granular material called filter.

### 1302.2. Pitching

**1302.2.1.** The thickness of pitching shall be minimum 225 mm or as indicated on the drawings. The stone shall be sound, hard and fairly regular in shape.

**1302.2.2.** Quarry stone shall be used. Round boulders shall not be allowed. The stone subject to marked deterioration by water or weather shall not be accepted. No stone, weighing less than 25 kg shall be used. The size and weight of stones shall be as given in Table 1300.2 The sizes of spalls shall be minimum 25 mm and shall be suitable to fill the voids in the pitching.

**1302.2.3.** Where the required size stones are not economically available, cement concrete blocks in M15 grade or stones in wire crates may be used in place of isolated stones of equivalent weight.

TABLE 1300.2

| Mean Design velocity m/sec. | Minimum size and weight of stone | | | |
|---|---|---|---|---|
| | Slope 2 :1 | | Slope 3:1 | |
| | Diameter (mm) | Weight (kg) | Diameter (mm) | Weight (kg) |
| Upto 2.0 | 220 | 25 | 220 | 25 |
| 2.5 | 300 | 40 | 300 | 40 |
| 3.0 | 300 | 40 | 300 | 40 |
| 3.5 | 350 | 59 | 300 | 40 |
| 4.0 | 450 | 126 | 350 | 59 |

### 1302.3. Filter Media

**1302.3.1.** To drain off the seepage water and to prevent erosion of the base material, one or more layers of graded materials, commonly known as a filter medium, shall be provided underneath the pitching. The material for the filter shall consist of sand gravel, stone or coarse sand.

The gradation of the filter material shall satisfy the following requirements :

(i) $\frac{D_{15} \text{ of filter}}{D_{85} \text{ of base material}} < 5$

(ii) $4 > \frac{D_{15} \text{ of filter}}{D_{15} \text{ of base material}} < 20$

(iii) $\frac{D_{50} \text{ of filter material}}{D_{50} \text{ of base material}} < 25$

(iv) The grain size curve of the filter should be roughly parallel to that of the base material.

**Notes :** (1) Filter design may not be required if embankment consists of CH soil or CH soils with liquid limit greater than 30 which are resistant to surface erosion. In this case, if a layer of material is used as bedding for pitching, it shall be well graded and its $D_{85}$ size shall be at least twice the maximum void size in pitching.

(2) In the foregoing $D_{15}$ means the size of that sieve which allows 15 per cent by weight of the filter material to pass through it and similar is the meaning of $D_{50}$ and $D_{85}$.

(3) The filter shall be compacted to a firm condition.





**1302.3.2.** The thickness of filter may generally be 150 mm unless otherwise shown on drawing or directed by the Engineer.

### 1302.4. Construction Operations

**1302.4.1.** Before laying the pitching, the sides of banks shall be trimmed to the required slope and profile put up by means of line and pegs at intervals of 3 m to ensure regular straight work and an uniform slope throughout. Depressions shall be filled and thoroughly compacted.

**1302.4.2.** The filter granular material shall be laid over the prepared base and compacted to the thickness specified on the drawings.

**1302.4.3.** The lowest course of pitching shall be started from the toe wall and built up in courses upwards. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Section 700 in case of dry rubble pitching and shall be in brick wall in cement mortar 1:4 in case of brick pitching conforming to Section 600 of these Specifications.

**1302.4.4.** The stone pitching shall commence in a trench below the toe of the slope. Stone shall be placed by derrick or by hand to the required length, thickness and depth conforming to the drawings. Stones shall be set normal to the slope, and placed so that the largest dimension is perpendicular to the face of the slope, unless such dimension is greater than the specified thickness of pitching. The largest stones shall be placed in the bottom courses and for use a headers for subsequent courses.

**1302.4.5.** When full depth of pitching can be formed with a single stone, the stones shall be laid breaking joints and all interstices between adjacent stones shall be filled in with spalls of the proper size and wedged in with hammers to ensure tight packing.

**1302.4.6.** When two or more layers of stones are to be laid to obtain the design thickness of pitching, dry masonry shall be used and stones shall be well bonded. To ensure regular and orderly disposition of the full intended quantity of stone as shown, template crosswalls in dry masonry shall be built about a metre wide and to the full height of the specified thickness at 10 m intervals and all along the length and width of the pitching. Within these walls the stones shall be hand packed as specified.

**1302.4.7.** Where bricks are to be used, the same shall be laid on the prepared based in one or more layers as specified. When more than one

layer is to be adopted, adjacent layers shall be properly bonded by means of a sufficient number of pin headers, extending from one layer to the other. The bond used in laying shall be as directed by the Engineer.

### 1302.5. Toe Protection

**1302.5.1.** This work shall consist of constructing a toe wall, retaining/ breast wall or close bamboo walling at the junction of embankment slope and general ground level to protect the embankment from damages.

**1302.5.2.** Where embankment is provided with slope pitching conforming to Clause 1302.2 and launching apron conforming to Clause 1301 of these Specifications, toe wall shall be provided at the junction of slope pitching and launching apron so as to protect the slope pitching from falling. The toe wall shall be in dry rubble masonry conforming to Clause 704.6 of these Specifications.

**1302.5.3.** Retaining wall/breast wall as toe protection shall be conforming to Clause 1604 of these Specifications.

**1302.5.4.** Close bamboo walling shall consist of bamboo, eucalyptus. Sal or other locally available bullahs/ballies having 65 mm to 75 mm diameter. The required diameter of bullahs/ballies of bamboo shall be checked at a distance of 1.2 m from the wider end of the diameter of the bamboo/bullah. The bullahs/ballies shall be painted with coal tar in the entire length.

The length of bamboo bullah/ballies shall preferably be not less than 1.2 m and not more than 3 m and these shall be driven about the half length in the ground at close interval of 150 mm c/c. The bamboo bullah/ballies, thus driven in the ground shall have minimum of three stout horizontal half split bamboo runner/stays at equal spacing. The horizontal stays/runners shall be adequately fixed with nails.

The exposed surface of bamboo walling shall be lined with sheets made from cut drums properly fixed with nails.

The bullahs shall be fitted with iron cap on wider diameter ring to facilitate their driving. The bullah should be placed and hoisted at the required position and driven with the help of iron monkey weighing 800 kg to 1000 kg attached with a jute or steel rope and moving through a guiding rod. The rope shall be passing through a pulley fitted at the top of the tripod stand and hammering done by pulling and releasing the rope





manually. After completion of driving of the bullah/balli, the iron cap shall be removed.

## 1303. RUBBLE STONE/BRICK FLOORING OVER CEMENT CONCRETE BEDDING

### 1303.1. Scope

This work shall consist of constructing rubble stone/brick flooring in cement mortar laid over a cement concrete bedding. The rigid flooring shall be provided under the bridge culverts and extend for a distance of at least 1.5 m on upstream side and 3 m on downstream side unless otherwise specified on drawing or directed by the Engineer.

### 1303.2. Construction Operations

**1303.2.1.** Excavation for laying foundation of bed protection shall be carried out as per these Specification under the supervision of the Engineer. Before laying the concrete bedding, the excavated trench shall be thoroughly inspected by the Engineer-in-Charge to ensure :

(a) There are no loose pockets, unfilled depressions left in the trench

(b) The soil at the founding level is properly compacted to the line and level

(c) All concrete and other elements are laid in the dry bed.

**1303.2.2.** 150 mm thick cement concrete M10 grade shall then be laid in accordance with provisions given in Section 800 of these Specifications. The surface of the concrete shall not be given a smooth finish. The paving work shall be embedded in green concrete.

**1303.2.3.** Where rubble stone is specified as flooring it shall be done with flat stones 150 mm thick. The stones shall be bedded on a 25 mm thick layer of cement mortar 1:5. Spalls shall be used to fill the voids. The joints shall then be filled with 1:3 cement mortar and finished neat. The stone shall break joints and the joints shall not exceed 20 mm in thickness.

**1303.2.4.** Where bricks are to be used, the flooring shall be done with 150 mm thick brick on edge. Each layer of brick shall be bedded on 25 mm thick 1:5 cement mortar and the joints filled in with 1:3 cement mortar. The joints shall not exceed 10 mm in thickness.

**1303.2.5.** The top of the flooring shall be kept 300 mm below the lowest bed level. The flooring shall extend upto the line connecting the end of splayed wing walls on either side of the bridge.

### 1303.3. Dry Rubble/Brick Flooring

**1303.3.1.** This work shall consist of constructing dry rubble stone/ brick flooring at cross-drainage works where the flow is insignificant (less than 1.5 m/sec) and no significant scour is expected.

**1303.3.2.** The base for the flooring shall be prepared to the levels and slopes shown on drawing and compacted with hand rammers or other means to have an even bedding.

**1303.3.3.** Where rubble stone is specified, the minimum thickness of flooring shall be 150 mm and made with one flat stone only. The stones shall be laid closely breaking joints and all joints shall be filled with spalls of the proper size and wedged in with rammers to ensure tight packing.

**1303.3.4.** Where brick is the material to be used, the same shall be laid closely on the prepared base in one or more layers as shown on drawing and the bond used shall be as directed by the Engineer.

**1303.3.5.** The top of the flooring shall be kept 300 mm below the lowest bed level.

## 1304. CURTAIN WALL

The flooring shall be enclosed by curtain walls in Cement Concrete M10 grade or stone/brick masonry in cement mortar 1:4 and taken to a depth of atleast 1.5 m on the u/s side and 2 m on d/s side below the floor level. The flooring shall be continued over the top width of curtain wall. The depth of curtain wall shall not be less than normal scour depth.

## 1305. CHUTE DRAINS

### 1305.1. Scope

The work shall consist of providing chute drains across the embankment slopes in approaches of bridges and on horizontal curves connected at the toe of the embankment with parallel open drains discharging into a nearby nallah or cross drainage work as shown on drawing or as directed by the Engineer.





### 1305.2. Materials

The materials for chute drain/open drain at toe of embankment shall comprise as under :

(i) Brick masonry conforming to Section 600 of these Specifications.

(ii) Coursed Rubble Stone masonry conforming to Section 700 of these Specifications.

(iii) Plain Cement Concrete (M15 grade) conforming to Section 800 of these Specifications.

**1305.3.** Chute drains shall be provided in sections of road in embankment (embankment height more than 8 m) at minimum 10 m intervals.

**1305.4.** The sections of the road where chute drains are provided shall have prescribed camber on carriageway and shoulders. Concrete kerb and channel in such sections are provided to guide the road surface discharge through chute drains.

**1305.5.** Chute drains of rectangular or trapezoidal sections may be adopted. For guidance reference may be made to Fig. 3 of IRC:SP:42 "Guidelines on Road Drainage".

**1305.6.** For hydraulic design of chute drains or open toe drain, Section 11 of IRC:SP:42 "Guidelines on Road Drainage" may be referred.

**1305.7.** The open drain at the toe of embankment shall be located as far as possible away from the imaginary slope line of 4H : IV or alternatively the open drain is lined with stone/brick masonry or concrete.

## 1306. ROADSIDE DRAINS

The side drains shall be constructed in accordance with the requirements of Clause 307 of these Specifications, to the lines, grades dimensions and other particulars shown on the drawings.

The schedule of work shall be so arranged that the drains are completed in proper sequence with the road works to ensure that the no excavation of the completed road works is necessary subsequently or any damage is caused to these works due to lack of drainage

## 1307. HILLSIDE DRAINS

The hillside drains shall be constructed in accordance with the requirements of Clause 1606.1 of these Specifications, to the lines, grades dimensions and other particulars shown on the drawings.

## 1308. CATCH WATER/INTERCEPTING DRAINS

Catch Water/Intercepting drains shall be provided on hill slopes to intercept water flowing from upper reaches and guide such flow into culverts. These shall be of trapezoidal shape and lined. The drains shall be constructed in accordance with the requirements of Clause 1606.2 of these Specifications, true to the specified lines, grades, levels and dimensions as shown on the drawings.

## 1309. MEASUREMENTS FOR PAYMENT

**1309.1.** The protection works shall be measured as setforth below. If directed by the Engineer for measurement, the materials may have to be stacked at site before laying and nothing extra will be paid to the Contractor for this stacking.

**1309.2.** Preparation of the base and earthwork in excavation for protection works shall be incidental to the work and shall not be measured separately.

**1309.3.** The boulders and wire crates in apron shall be measured in cubic metres.

**1309.4.** The filter and stone pitching shall be measured separately in cubic metres.

**1309.5.** Bamboo/Eucalyptus/Sal Walling comptete shall be measured in running linear metres.

**1309.6.** Rubble stone/brick flooring and cement concrete bedding shall be measured in cubic metres for each class of material.

**1309.7.** Dry stone/brick flooring shall be measured in square metres for one or two layers as shown on drawings.

**1309.8.** Curtain walls shall be measured in cubic metres.

**1309.9.** Chute drains and open drains shall be measured in linear metres.





**1309.10.** Surface drains shall be measured as per Clause 307.3 of these Specifications.

**1309.11.** Hillside drains shall be measured as per Clause 1606.1.4.

**1309.12.** Catch-water/Intercepting drains shall be measured as per Clause 1606.2.4.

## 1310. RATE

**1310.1.** The contract unit rate for 1 cu.m of finished work of apron shall include the cost of all material, labour, tools and plants for completing the work according to above Specifications.

**1310.2.** The contract unit rate for 1 cu.m of filter or stone pitching on slopes shall include the cost of preparing the bases, putting to the profiles, laying and compacting the filter and stone pitching of dry rubble/brick revetment for embankment slopes to the specified thickness, lines, curves, slopes and levels and all labour and materials as well as tools and plant required for the work.

**1310.3.** The contract unit rate for bamboo/bullah walling shall include the cost of all material, labour, tools, plants and incidentals for completing the work as per Specifications and as shown in the drawings.

**1310.4.** The contract unit rate for rubble stone/brick flooring shall include the cost of all material, labour and tools and plant for completing the work as per the above specifications and as shown on the drawings.

**1310.5.** The contract unit rate for concrete in footing of curtain walls shall include cost of all materials, labour, tools and plants for completing the work as per specifications and as shown on the drawings.

**1310.6.** The contract unit rate for brick/stone masonry in cut of walls shall include cost of all materials, labour tools and plains for completing the work as per specifications and as shown on the drawings.

**1310.7.** The contract unit rate for chute drains and open drains shall include cost of all materials, labour, tools and plants for completing the work as per specifications and as shown on the drawings.

**1310.8.** The contract unit rate for surface drains shall be as per provisions of Clause 307.4.

**1310.9.** The contract unit rate for hillside drain shall be as per provisions of Clause 1606.1.5.

**1310.10.** The contract unit rate for Catch-water/Intercepting drains shall be as per provisions of Clause 1606.2.5.





# 1400

# Cement Concrete Causeway

# 1401. FLUSH CAUSEWAY

## 1401.0. General Guidelines

For designs and construction of flush causeways, guidelines given in Rural Roads Manual of IRC or prevailing practice in the State may be followed. Some salient requirements are given below for guidance:

(1) Flush causeway is a paved dip built to cross a shallow water-course.

(2) The top level of the pavement/flooring of the causeway shall be as that of the bed of the water-course.

(3) The top outer width of causeways shall be equal to roadway width.

(4) The approaches of causeways shall be without banking.

(5) The up-stream and down-stream cut-off walls of the flush causeway shall cover the whole bed-width of the water course or upto 3 m in continuation or at right angle to the causeway.

(6) Cut-off walls shall be in CR masonry in cement mortar 1:4/1:5 or 1:3:6 cement concrete and taken sufficiently deep to avoid exposure due to scouring.

Unless rock is met with at higher level the depth of foundation for cut-off walls may be 1.5 m on up-stream side and 2 m on the down-stream side.

(7) Aprons of suitable width and thickness shall be provided on the up-stream and down-stream sides.

(8) Cement concrete pavement shall be provided on the causeway for its full width and length.

(9) The work of causeway, its approaches and protective works including apron, pitching, etc. shall be so planned and undertaken that all the works are completed before onset of monsoon.

The following pavement composition shall be adopted unless specified otherwise:

(1) 200 mm thick compacted moorum/gravel/crushed stone

(2) 150 mm thick WBM

(3) 200 mm thick cement concrete slab of M30 grade.

## 1401.1. Scope

This work shall consist of construction of flush causeway as shown on

the drawings and in accordance with the requirements of these Specifications or as directed by the Engineer.

### 1401.2. Materials

The materials for construction of various components of flush causeway shall conform to relevant provisions of these Specifications as listed below:

| | |
|---|---|
| (1) Bricks | Clause 602 |
| (2) Stones | Clause 702.4 |
| (3) Cement | Clause 602.2/702.2/802.5@ |
| (4) Sand | Clause 802.5/802.4@ |
| (5) Water | Clause 802.5 |
| (6) Steel | Clause 1002 |

@as the case may be

For any other material not covered in these Specifications, relevant IS codes shall be referred and got approved from the Engineer, prior to its use.

### 1401.3. Cut-off Walls

**1401.3.1.** The cut-off walls shall be constructed true to the lines and grades shown on the drawings or as ordered by the Engineer.

**1401.3.2.** Excavation for laying the foundation shall be carried out in accordance with Clause 305 of these Specifications. Open foundation shall be constructed in dry conditions and the Contractor shall provide for adequate dewatering arrangements to the satisfaction of the Engineer, without extra cost.

**1401.3.3. Foundation concrete for cut-off walls :** Footing shall be of plain cement concrete in M15 grade (1:2$^1/_2$:5 nominal mix) on a levelling course of 100 mm of lean concrete (M10). The thickness of footing shall be 150 mm unless specified otherwise on the drawings. A minimum offset of 150 mm shall be provided for the base of cut-off wall.

Laying of foundation concrete shall be done in accordance with Clause 1203.4.3 of these Specifications.

**1401.3.4.** Cut-off walls shall be of brick masonry or stone masonry or plain cement concrete as shown on the drawings.





Brick masonry shall conform to the requirements of Section 600 of these Specifications.

Stone masonry shall conform to the requirements of Section 700 of these Specifications.

Plain cement concrete shall conform to the requirements of Section 800 of these Specifications.

Formwork shall conform to the requirements of Section 900 of these Specifications.

**1401.3.5.** The surface of foundation concrete shall be scrapped with wire brush and all loose material removed and thoroughly wetted before commencing masonry or concrete work.

Coping for cut-off walls shall be in plain cement concrete, as shown on the drawings or directed by the Engineer.

### 1401.4. Pavement Construction

**1401.4.1. Preparation of sub-grade** : The preparation of sub-grade for laying pavement courses shall conform to the requirements of Clause 303 of these Specifications.

**1401.4.2. Sub-base and base** : The sub-base and base shall conform to the requirements of Section 400 of these Specifications.

**1401.4.3. Cement concrete slab** : The minimum thickness of plain cement concrete slab shall be 200 mm and minimum grade of concrete shall be M30 or as specified in the drawings.

The base of cement concrete of M15 shall conform to the requirements of Clause 1501.6 of these Specifications.

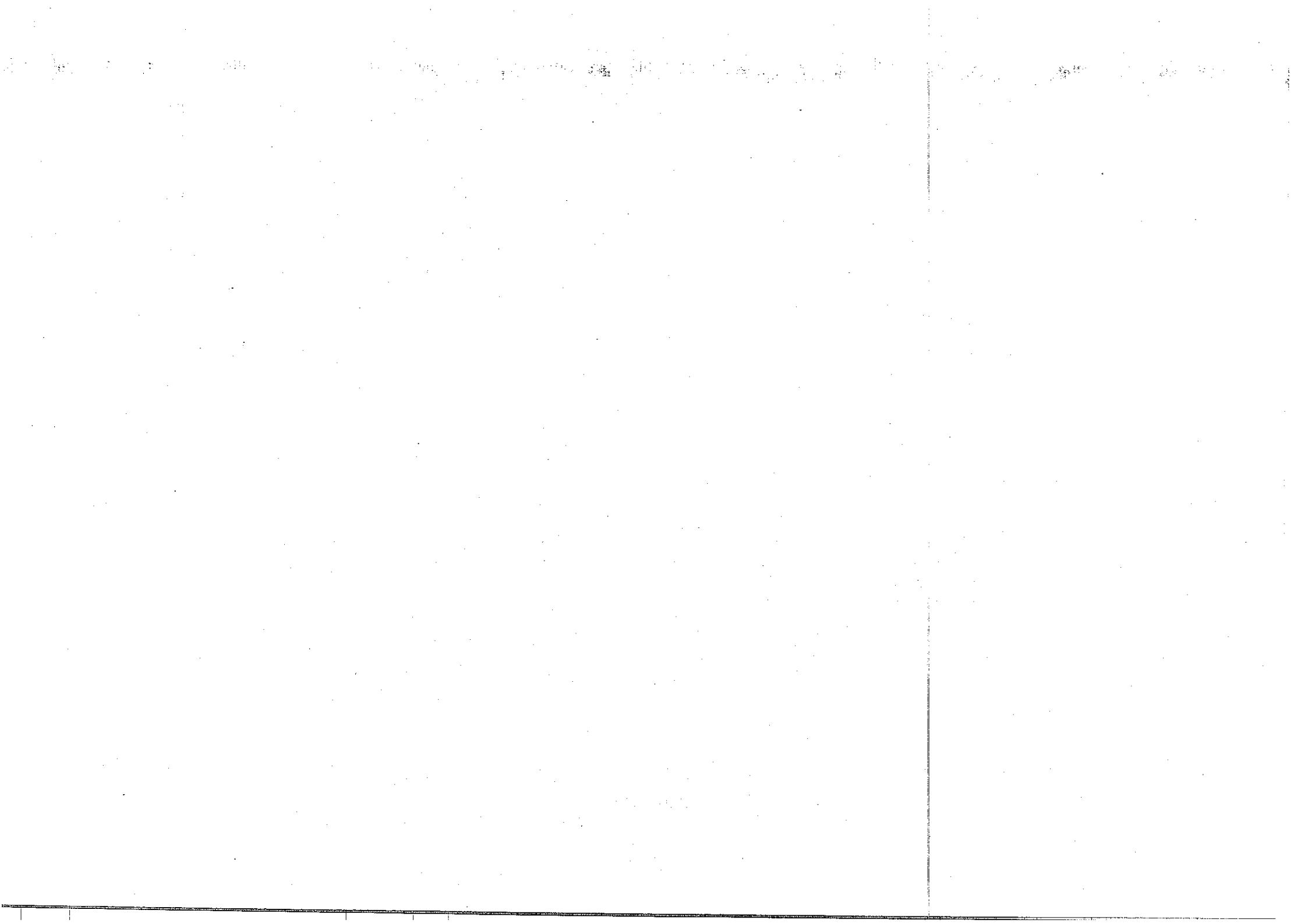
The pavement shall be provided with proper cross slope of 2.5 per cent, sloping down towards downstream side.

### 1401.5. Apron

The work of apron shall conform to the requirements of Clause 1301 of these Specifications.

### 1401.6. Guide Posts/Stones

The guide posts/stones shall be of reinforced cement concrete of M25



grade or as specified on the drawings or as directed by the Engineer. Stones can be used wherever available in place of R.C.C. The size of stone shall be 225 mm x 225 mm x 300 mm (above road level) and spaced 1200 mm.

The guide post/stone shall be 250 mm diameter and of height as specified on the drawings and embedded full depth in concrete pavement as indicated on the drawings.

The R.C.C. post/stone shall be painted with alternate black and white bends with ordinary paint conforming to IS:164 or as directed by the Engineer.

### 1401.7. Construction Joints

Construction joint in C.C. pavements shall be spaced 4-6 m apart. The joints shall be sealed with polysulphide as per manufacture's specifications.

### 1401.8. Arrangements for Traffic

During the period of construction the arrangement for traffic shall be done as per Clause 111 of these Specifications.

### 1401.9. Opening to Traffic

Traffic shall be permitted to cross the causeway only when the concrete has been cured for 28-days after sealing of construction joints.

### 1401.10. Measurements for Payment

The earthwork in excavation for cut-off walls and pavement construction shall be measured in cubic meters upto record decimal for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer, in accordance with Section 300 of these Specifications.

The concrete in footing, brick masonry, stone masonry, apron and pitching work shall be measured in cubic metres, limited to the dimensions shown on the drawings or as directed by the Engineer, in accordance with the Sections 800, 600, 700 and 1300 of these Specifications, respectively.

The sub-base and base courses shall be measured as finished work in position in cubic metres as per Clause 401.8 of these Specifications.

The concrete pavement shall be measured in cubic metres of concrete





placed and limited to specified thickness shown on the drawings or as directed by the Engineer, in accordance with Clause 1501.26 of these Specifications.

Guide posts/stones fixed at site shall be measured in numbers.

Measurement in respect of sealant shall be in cubic millimetres.

### 1401.11. Rate

The Contract unit rate for earthwork in excavation, concrete for footing, masonry for cut-off walls, apron, pitching and guide posts/stones shall include all works including finishing of concrete and providing open foundation as per this Section.

The Contract unit rate for sub-base and base course shall be payment in full for carrying out the required operations including full compensation for items in accordance with Clause 401.9 of these Specifications.

The Contract unit rate for concrete pavement shall include the cost of all labour, material, tools and plant and other cost necessary for completion of the work as per Clause 1501.27 of these Specifications.

The Contract unit rate for guide posts/stones shall be payment in full compensation for furnishing all labour, material, tools, equipment for preparing, supplying, fixing, painting and all other incidental costs to complete the work in accordance with these Specifications.

## 1402. VENTED PIPE CAUSEWAY

### 1402.1. Scope

This work shall consist of furnishing and providing vented causeway including furnishing and installing reinforced cement concrete pipes of the type, diameter and length required at the locations shown on the drawings or as ordered by the Engineer and in accordance with the requirements of this Section.

### 1402.2. General

For design and construction of vented pipe causeway, guidelines given in Rural Roads Manual or prevailing practice in the State may be followed. Some salient requirements are given in ***Annexure-1400.1.***

### 1402.3. Materials

Material for construction of various components of vented pipe causeway shall conform to relevant provisions of these Specifications as listed below:

| | | |
|---|---|---|
| (i) | Bricks | Clause 602.4 |
| (ii) | Stones | Clause 702.4 |
| (iii) | Cement | Clause 602.2/702.2/802.2@ |
| (iv) | Coarse aggregate | Clause 802.3 |
| (v) | Sand | Clause 602.5/802.4@ |
| (vi) | Water | Clause 802.5 |
| (vii) | Steel | Section 1000 |
| (viii) | R.C.C. Pipe NP 3 | Clause 1100 |

@as the case may be

### 1402.4. Excavation for Pipe

The excavation for pipe causeway shall be in accordance with the requirements of Clause 1104 of these Specifications.

### 1402.5. Bedding for Pipe

The bedding for pipes shall be in accordance with the requirements of Clause 1105 of these Specifications.

### 1402.6. Laying of Pipes

The laying of pipes shall be in accordance with the requirements of Clause 1106 of these Specifications.

### 1402.7. Jointing of Pipes

The jointing of pipes shall be in accordance with requirements of Clause 1107 of these Specifications.

### 1402.8. Back-Fillings

The back-filling shall be in accordance with the requirements of Clause 1108 of these Specifications.

### 1402.9. Head Walls and Other Ancillary Works

**1402.9.1.** The head walls shall be constructed true to lines and grades shown on the drawings or as ordered by the Engineer.





**1402.9.2. Excavation** : Excavation for foundation of bed of head walls shall be in accordance with the requirements of Clause 305 of these Specifications.

**1402.9.3. Foundation concrete for head-walls** : Foundation concrete for head-walls shall be in accordance with the requirements of Clause 1401.3.3 of these Specifications.

Laying of foundation concrete shall be in accordance with the requirements of Clause 1203.4.3 of these Specifications.

### 1402.10. Cement Concrete Pavement

Cement concrete pavement shall be in accordance with the requirements of Clause 1401.4 of these Specifications.

### 1402.11. Guide Posts/Stones

The guide posts/stone shall be in accordance with the requirements of Clause 1401.6 of these Specifications.

### 1402.12. Apron

The work of apron shall conform to Clause 1301 of these Specifications.

### 1402.13. Pitching of Slope

The work shall be carried out in accordance with the requirements of Clause 1302 of these Specifications.

### 1402.14. Opening to Traffic

Traffic shall be permitted on the causeway only after the concrete slab has been laid and cured for 28-days.

### 1402.15. Measurements for Payment

Providing, furnishing and laying of pipes shall be measured in accordance with Clause 1111 of these Specifications.

Earthwork in excavation, concrete footing, brick masonry, stone masonry, sub-base, base, concrete pavement, apron, pitching and guard posts shall be measured in accordance with Clause 1401.10 of these Specifications.

### 1402.16. Rate

The Contract unit rate for the pipes shall be as per Clause 1112 of these Specifications.

The Contract rates for excavation, concrete footing, masonry, sub-base, base, concrete pavement, apron, pitching, and guide posts shall be in accordance with Clause 1401.11 of these Specifications.

## 1403. SUBMERSIBLE BRIDGE

### 1403.1. Scope

The work shall consist of construction of various components of submersible bridge at the location as shown on the drawings and in accordance with the requirement of these Specifications or as directed by the Engineer.

### 1403.2. General

For design and construction of submersible bridges, guidelines given in IRC:SP:20-Rural Roads Manual, instructions issued by the Ministry of Rural Development, Govt. of India or prevailing practice in the State duly approved by the competent authority shall be followed.

General Guidelines for the selection, design and construction of submersible bridges are given in ***Annexure-1400.2.***

### 1403.3. Materials

Materials for construction of various components of submersible bridge shall conform to relevant provisions of Clause 1202 of these Specifications.

The stainless steel bars for anchoring superstructure with substructure shall be austenite Chromium-Nickel steel, possessing rust, acid and heat resisting properties, generally as per IS:6603. Mechanical properties/Grade for such stainless steel bars shall be as specified on the drawings or as directed by Engineer but not inferior to mild steel bars (Fe 240) as per IS:432-Part 1.

### 1403.4. Foundations

The work of foundations shall conform to relevant provisions of Clause 1203 of these Specifications.





### 1403.5. Substructure

**1403.5.1.** The work of various components of substructure shall conform to the relevant provisions of Clause 1204 of these Specifications and following additional provisions.

**1403.5.2.** The masonry substructure shall not be permitted if the height above foundations is more than 7 m.

**1403.5.3.** Dry rubble masonry (Clause 704.6) shall not be permitted in retaining walls/breast walls, if required, in approaches of submersible bridges.

**1403.5.4.** Pier cap including raised portion/stopper (thrust) wall, abutment cap and pedestals shall be given streamline shape as shown on the drawings or as directed by the Engineer.

**1403.5.5.** The locations and levels of pier cap/abutment cap, pedestals, anchorage arrangements (between superstructure and pedestal/pier cap/ abutment cap), side bearing pad between superstructure and raised portion of pier cap (thrust wall) and stainless steel rods in pedestal/bearings shall be carefully checked to ensure alignment in accordance with the drawings.

### 1403.6. Superstructure

**1403.6.1.** The work of reinforced concrete slab/box type superstructure or series of box cell type or stone/brick masonry arch type structures shall conform to the relevant provisions of Clause 1205 of these Specifications.

**1403.6.2.** Stone/brick masonry arch bridges having individual span more than 15 m shall not be permitted.

**1403.6.3.** In seismic zones IV & V, brick/stone masonry arch bridges with spans more than 6 m shall not be permitted.

**1403.6.4.** Composite type of superstructure comprising of steel girders with RCC solid slab as decking shall not be permitted.

**1403.6.5.** Superstructure shall be given streamline shape as shown on the drawings or as directed by the Engineer.

**1403.6.6.** Corners of all submerged elements shall have 40 mm x 40 mm chamfers, if not streamlined.

**1403.6.7.** Vent holes in reinforced deck slab/box type superstructure with vent holes in deck as well as in soffit slab and web, series of box cell type structures, and spandrels of arches to reduce the uplift pressure during submergence shall be provided as shown on the drawings or as directed by the Engineer.

Vent holes shall be provided with 100 mm diameter PVC pipes. Minimum three number of vent holes per span in both directions or as shown on the drawings or as directed by the Engineer shall be provided.

**1403.6.8.** The area of vent holes shall not be deducted while computing the quantity of concrete in superstructure and this item shall be treated as incidental to the item of concrete in superstructure.

### 1403.7. Wearing Coat

**1403.7.1.** Only cement concrete wearing coat shall be provided and it shall not be laid monolithic with the deck.

The thickness of wearing coat shall be 75 mm. The minimum grade of concrete shall be M30 and water-cement ratio shall not be more than 0.4 or as specified on the drawings.

The reinforcement shall consist of 8 mm diameter bars @ 200 mm centers reducing to 100 mm centers in both the directions over a strip of 300 mm near the expansion joint. Reinforcement shall be placed at the center of the wearing coat.

Wearing coat shall be discontinued at expansion joint locations. Joint fillers shall extend upto the top of wearing coat.

Curing of wearing coat earlier than what is generally required shall be resorted to so as to avoid formation of shrinkage cracks in hot weather.

All carriageway and footpath surfaces shall have non-skid characteristics.

One-way 2.5 per cent cross slope towards downstream side shall be provided on the deck slab.

#### 1403.7.2. Measurements for Payment

Cement concrete wearing coat shall be measured in cubic metres in accordance with Clause 816 of these Specifications.





#### 1403.7.3. Rate

The contract unit rate for wearing coat shall include the cost of all labour, material, tools and plant and other cost necessary for completion of the work as per these Specifications. Any deficiency in compressive strength of concrete shall not be accepted as substandard work.

### 1403.8. Bearings, Expansion Joints & Anchorage System

**1403.8.1.** Elastomeric bearings, if specified on the drawings, shall conform to Clause 1207.1 of these Specifications.

**1403.8.2.** Use of metallic bearings shall not be permitted.

**1403.8.3.** Open type or filler joint with appropriate nose protection may be permitted by the Engineer.

**1403.8.4.** The work of supplying, handling and installation of bearings and expansion joints shall be as specified on the drawings or as approved by the Engineer and shall conform to Clause 1207 of these Specifications.

**1403.8.5.** The anchorage arrangement for anchoring superstructure with substructure shall conform to the typical details shown in Plate No.7.22 or 7.23 of IRC:SP:20 or as specified on the drawings in accordance with these Specifications or as directed by the Engineer.

**1403.8.6. Measurements for payment for anchorage arrangement:** The anchorage arrangement shall be measured in numbers.

**1403.8.7. Rate for anchorage arrangement :** The contract unit rate for anchorage arrangement as shown on the drawings shall include the cost of all labour, materials, tools and plants, incidentals, quality assurance and supervision required for completing the work in accordance with these Specifications or as directed by the Engineer.

### 1403.9. Railings

#### 1403.9.1. General

(a) The railing shall be metal railing of collapsible or removable type or tubular railing as specified on the drawings. Fixed type railings consisting of R.C.C. vertical posts and R.C.C./Tubular horizontal members or solid parapet type or post and chain type railing shall not be permitted.

(b) Collapsible railing shall be used where it is necessary to put up the railings immediately when the bridge is opened to traffic after a submerging

flood has receded. The design of these railings shall be such as to ensure that they fit well in their grooves and are not liable to be dislodged by floods.

(c) Removable type railings shall be adopted when there is no danger to the traffic using the bridge for short period without railings. The design of these railing shall be such as to ensure that the various members are interchangeable and can be easily removed and refitted.

(d) Collapsible or removable railings shall be strong enough to resist same forces as applicable for railings or parapets on high level bridges. The arrangement shall be such as to ensure that the railings do not collapse on carriageway side.

(e) Guide posts/stones shall not be permitted in bridge portion and their use shall be restricted to the approach portion of the bridge.

(f) The design of bridge railings shall be such, which is amenable to quick removable, erection and repairs.

(g) Railing materials, particularly metal railings, shall be handled and stored with care, so that the material and parts are kept clean and free from damage. Railing materials shall be stored above the ground on platforms, skids, other supports and kept free from grease, dirt and other contamination. Any material which is lost, stolen or damaged after delivery shall be replaced or repaired by the Contractor. Methods of storage, etc. or repairs shall not damage the material or protective coating.

**1403.9.2. Metal collapsible/removable railing:** Metal collapsible/ removable type railing shall conform to relevant provisions of Clause 1208.2 of these Specifications. Tubular steel railing shall conform to Clause 1706 of these Specifications.

### 1403.10. Kerbs

Continuous kerb on deck shall not be permitted. The kerb shall be discontinuous with 300 mm wide gap at 1.8 m center to center (i.e., 1.5 m continuous length) on both sides. The gaps provided in kerbs shall be opposite to each other to permit free flow of flood waters.

The outer face of the kerb shall be given streamline shape as shown on the drawings or as directed by the Engineer.

Construction of kerb including pockets for fixing railings shall conform to the provisions of Sections 800 and 1000 of these Specifications.





**1403.10.2.** Concrete and Steel Reinforcement in kerb shall be measured in accordance with Sections 800 and 1000 of these Specifications.

**1403.10.3.** Contract unit rates for concrete and steel reinforcement (untensioned) shall include all works as given in respective Sections of these Specifications, painting of kerbs as per IRC:35, making proper pockets in kerbs for fixing of railings and all incidental items for furnishing and providing kerbs as shown on drawings in accordance with these Specifications or as directed by the Engineer.

### 1403.11. Warning/Cautionary Signs

**1403.11.1.** Advance warning/cautionary signs giving the information about the nearness of submersible bridge, speed limit, and depth of water at ordinary flood level, length of submergence of road to the user shall be installed.

Advance warning-cum-informatory signs shall be located at about 200 m from the start of submerged portion of approach road/bridge 'SLOW DOWN SUBMERSIBLE BRIDGE 200 m AHEAD' and second sign at about 50 m from the starting point of submersible bridge 'DEAD SLOW SUBMERSIBLE BRIDGE 50 m AHEAD. NOT SAFE FOR VEHICULAR TRAFFIC TO CROSS WHEN FLOOD WATER OVERTOPS BRIDGE DECK'

**1403.11.2.** Advance warning/cautionary signs shall be in English as well as in local language and shall conform to the provisions of Clause 1701 of these Specifications.

### 1403.12. Flood Gauges

**1403.12.1.** Flood gauges as per IRC:67 at about 15 m interval shall be installed on submerged section of approaches and submersible bridge to indicate to road users the height of the flood above road level/bridge deck.

**1403.12.2.** Flood gauges shall conform to the provisions of Clause 1701 of these Specifications.

**1403.13.** Approaches, vented causeways, drainage spouts, approach slab, protection and drainage works shall conform to the relevant provisions of following Clauses of these Specifications:

| Item of work | Section/Clause |
|---|---|
| i) Embankment construction/ Earthwork in cutting | 300 |

| | | |
|---|---|---|
| ii) | Vented pipe causeway in approaches | 1402 |
| iii) | Vented box cell or arch type causeway | 1205.5, 600/ 700/ 800 1000 (as applicable) |
| iv) | Pavement construction | 1401.4. |
| v) | Drainage spouts | 1209 |
| vi) | Approach slab | 1211 |

### 1403.14. Protection and Drainage work

**1403.14.1.** Protection and drainage works shall conform to Section 1300 of these Specifications.

**1403.14.2.** A wall perpendicular to the returns shall be provided at both ends of the bridge for a length of about 3 m, so that water coming through side drains, etc. does not undermine the abutment and return walls. Pucca drains along submersible approaches and protection around abutment shall be as per Plate Nos.7.20 and 7.21 of IRC:SP:20.

**1403.14.3.** The upstream and downstream cut-off walls in case of the submersible bridge with bed protection shall cover the whole bed-width of the water course or upto 3 m in continuation or at right angle to the submersible bridge as per site requirements.

**1403.14.4.** Cut-off walls shall be taken sufficiently deep to avoid exposure due to scouring. Unless rock is met with at higher level, the minimum depth of foundation for cut-off walls below bed floor protection level shall be 1.5 m on upstream side and 2 m on the downstream side.

**1403.14.5.** Cement concrete or stone pavement as specified on the drawings or as approved by the Engineer for full roadway width shall be provided on the portion of approaches likely to be submerged during floods.





*Annexure-1400.1*

**(Clause 1202.2)**

## Some Salient Requirements for Design and Construction of Vented Pipe Causeways

(1) Vented pipe causeway is a cross drainage structure provided with a few pipe openings keeping the raised road top level to the barest minimum.

(2) The outer width of the vented pipe causeway shall be equal to road way width.

(3) The up-stream and down-stream head-walls of the vented pipe causeway shall cover the whole bed-width of the water-course.

(4) A cushion of lean concrete (M15) at least 150 mm (upto bottom of C.C. slab) or earth cushion as shown on the drawings, over the pipe shall be provided. The minimum depth of cushion above pipe excluding road crust shall be 0.45 m.

(5) Cement concrete pavement should be provided on the vented pipe causeway for its full width and length.

Unless otherwise specified, the pavement shall comprise:

(i) 200 mm thick compacted moorum/gravel/crushed stone

(ii) 150 mm thick W.B.M.

(iii) 200 mm thick cement concrete slab of M30 grade.

(6) The work of vented pipe causeway, its approaches and protective works including apron, pitching, etc. shall be so planned and undertaken that all the works are completed before the onset of monsoon.

(7) Humps and dips in the vertical profile of the road at the location of vented pipe causeway shall be avoided.

(8) The cutting of pipes shall be avoided by selecting length of vent in multiple of available length of the pipe (generally 2.5 m or 3 m).

(9) Installation of pipes under existing bridges and culverts shall be avoided.

*Annexure-1400.2*

(Clause 1400.3)

## GENERAL GUIDELINES FOR SELECTION, DESIGN & CONSTRUCTION OF SUBMERSIBLE BRIDGES

1. Cross drainage structures having total length less than 30 m with individual span of 10 m or less may be designed/constructed as high level structures.
2. Construction of submersible bridges shall be avoided as far as possible on roads which are likely to be upgraded in near future (say within 15 years or so) or serving as link roads to important road network, like, National Highways, State Highways, industrial areas or foodgrain markets/Mandis dealing with perishable agricultural produce, etc.
3. Construction of submersible bridge shall be considered only if its cost including cost of approaches is less than 70 per cent of the cost of high level bridge including approaches.
4. Submersible bridges shall not be constructed over the streams having velocity more than 6 m/sec.
5. Submersible bridges shall be adopted at sites where linear waterway at ordinary flood level (OFL) is not more than 70 per cent of the linear waterway at high flood level (HFL) and HFL is considerably higher than OFL.
6. Since the cost of construction and performance of submersible bridge depends upon the correct assessment of ordinary flood level (i.e., flood level of annual frequency), number of interruption caused to traffic and its duration at a time, these parameters shall be judicially fixed.

   After completion of facility, the interruptions caused to traffic due to submergence shall not be more than 6 times in a year with period not exceeding 24 hours at a time if no alternative access road is available.
7. Carriageway of submersible bridges shall not be less than 5.5 m with overall width as 6 m in hilly terrain or 6.6 m with overall width of 7.5 m in plain/ruling terrain.

   The soffit of deck slab shall be fixed above the affluxed OFL.





   In case HFL is of rare occurrence and flood level of frequency of more than 10 years is not very much higher than OFL, the bearings shall be kept above this flood level plus afflux and bridge having specified clearance above OFL.
8. Humps and dips in the vertical profile shall be avoided and gradient in approaches shall generally be kept 1:20 but shall not be steeper than 1:15.

   Submersible bridge shall be constructed at least 100 m away from the most suitable site for high level bridge so that it serves as diversion during construction of high level bridge at a later date.

   The site of submersible bridge shall preferably be such that rock is available for foundation.
9. Annular space in the rock between the foundation and rock shall be filled with concrete of minimum grade M15.
10. Raft foundations or multiple box type structure shall be adopted only for the streams having low velocity.
11. If the flood velocity is more than 4m/sec, the superstructure shall be suitably anchored to pier cap. Guidance for working out details of anchorage may be taken from the typical details shown in Plate Nos.7.22 and 7.23 of IRC:SP:20.
12. The sections given in Plates Nos.7.02 to 7.06 of IRC:SP:20 for substructure shall not be applicable for adoption in case of submersible bridges. The structural adequacy of these sections shall be investigated for submerged condition.
13. Properly designed stoppers in ease water portion shall be provided to avoid sliding of superstructure in transverse direction and for typical details Plate No.7.23 of IRC:SP:20 may be referred.
14. Superstructure and substructure, pier cap (as per typical details given in Plate No.7.25 of IRC:SP:20) shall be given streamline shape on upstream and/or downstream side. R.C.C. solid or box cell type superstructure with stream line shape shall be preferred.

    Composite section with steel beam and reinforced concrete slab type superstructure shall not be adopted for submersible bridges.
15. Suitable number of adequate size of vent holes shall be provided in the deck slab or in deck as well as soffit slab and webs of box

to provide stability during floods.

16. Inside depth of box type superstructure shall not be less than 1.5 m for easy inspection and maintenance purposes.

17. Removable/collapsible type railings shall be provided on submersible bridges. Use of guide posts/stones shall not be permitted in bridge portion and their use shall be restricted to approach portion of the bridge.

    Submersible bridges shall be provided discontinuous kerb.

18. Approaches of submersible bridges shall preferably be in cutting. In filling, height of embankment shall not be more than 3 m. Return walls shall be provided in embankment portion.

19. The approaches in spill sections/khadir width/terrace bank which get submerged during OFL shall be provided with suitably designed protection work. Alternatively, suitably designed vented causeway in combination with submersible bridge shall be provided in approach portion.

20. Cement concrete pavement shall be provided on the approaches likely to get submerged during floods, for its full roadway width. Unless otherwise specified, the composition of pavement beyond approach slabs (if provided) shall be:

    (i) 200 mm thick compacted moorum/gravel/crushed stone

    (ii) 150 mm thick WBM

    (iii) 200 mm thick cement concrete slab of M30 grade.

21. Suitably designed flexible aprons of suitable width and length in combination of suitably designed cut off walls shall be provided on the upstream and downstream sides of bed protection.

22. Cautionary/warning road signs indicating the nearness of submersible bridge and speed limit, etc. shall be installed on both sides of the bridge.

23. The work of following components shall be planned in such a way that following components are completed well before onset of monsoons:

    (a) Individual foundation

    (b) Individual substructure





    (c) Individual superstructure span along with anchoring and thrust block

    (d) Approaches and protection work, i.e., flooring, apron, pitching, drainage system, etc.

24. General Guidelines at S.No.i, v, vi, vii, viii, x, xi and xii under Clause 1201 of these Specifications are applicable for submersible bridges also.

25. For some items of work not covered in these Specifications or 'Ministry of Road Transport & Highways Specifications for Road and Bridge Works, and specified on the drawings or require to be executed at site, the same shall be carried out in accordance with prevalent practice in the region/State and conforming to local/ State P.W.D. specifications, rates, etc. and approved by the Engineer.

# 1500

# Cement Concrete Pavements

Cement concrete pavements shall be recommended very selectively and restricted to be built in special cases only, where drainage of surface water is an acute problem, such as, in built-up areas or other isolated stretches. These pavements can also be used where other engineering conditions justify their use.

## 1501. PLAIN CEMENT CONCRETE PAVEMENT

### 1501.1. Scope

**1501.1.1.** The work shall consist of construction of unreinforced, plain cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross sections shown on the drawings. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations in connection with the work, as approved by the Engineer. Semi mechanized method of construction shall be acceptable.

**1501.1.2.** The design details, viz., thickness of pavement slab, grade of concrete, joint details, etc. shall be as shown on the drawings.

### 1501.2. Materials

**1501.2.1. Source of materials** : The Contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance and the approval of the Engineer for the same shall be obtained at least 30-days before the scheduled commencement of the trial work. If the Contractor later proposes to obtain materials from a different source, he shall notify the Engineer for his approval, at least 30-days before such materials are to be used with relevant test data.

**1501.2.2. Cement** : Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer.

(i) Ordinary Portland Cement, 33 Grade, IS:269

(ii) Ordinary Portland Cement, 43 Grade IS:8112

(iii) Ordinary Portland Pozzolana Cement, IS:1489

(iv) Portland Blast Furnace Slag Cement IS:455

(v) Ordinary Portland Cement (OPC), 53 grade (IS:12269) is to be used only when a part of cement is replaced by flyash.

**1501.2.2.1.** If the soil around has soluble salts like sulphates in excess of 0.5 per cent, by weight of soil, the cement used shall be sulphate resistant and shall conform to IS:12330.

**1501.2.2.2.** Cement shall be obtained in bags or in bulk form if bulk storage containers are available. The cement shall be subjected to acceptance tests prior to its use.

**1501.2.3. Admixture**

**1501.2.3.1.** Chemical admixture conforming to IS:6925 and IS:9103 shall be permitted to improve workability of the concrete.

**1501.2.3.2.** Mineral admixture : Flyash when used shall conform to IS:3812.

**1501.2.4. Aggregates** : Aggregates for pavement concrete shall be natural material complying with IS:383 but with a Los Angeles Abrasion Test result not more than 35 per cent or wet Aggregate Impact Value (AIV) not more than 30 per cent. The limits of deleterious materials shall not exceed the requirements set out in IS:383. The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalies in the cement. The total chlorides content expressed as chloride ion content shall be not more than 0.06 per cent by weight and total sulphate content expressed as sulphuric anhydride ($SO_3$) shall not exceed 0.25 per cent by weight.

**1501.2.4.1. Coarse aggregates** : Coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The aggregate shall not have flakiness index more than 35 per cent. The maximum size of coarse aggregates shall not exceed 25 mm for pavement concrete. No aggregate which has water absorption more than 5 per cent shall be used in the concrete mix. Where the water absorption is more than 3 per cent, the aggregates shall be tested for soundness in accordance with IS:2386 (Part 5). After 5 cycles of testing, the loss in weight of aggregate shall not be more than 12 per cent if sodium sulphate solution is used, or 18 per cent if magnesium sulphate solution is used.





**1501.2.4.1.1.** Dumping and stacking of aggregates shall be done in an approved manner. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching as directed by the Engineer.

**1501.2.4.2. Fine aggregates** : The fine aggregates shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS:383. Fine aggregates shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter.

**1501.2.4.2.1.** The fine aggregate shall not contain deleterious substances more than the following limits:

| | |
|---|---|
| Clay lumps | 4 per cent |
| Coal and lignite | 1 per cent |
| Material passing IS Sieve No.75 micron | 4 per cent in natural sand<br>15 per cent in crushed sand |

**1501.2.4.3. Aggregate gradation** : The coarse and fine aggregates shall be blended so that the material after blending conforms to Table 1500.1:

**TABLE 1500.1 : AGGREGATES GRADATION FOR CONCRETE**

| Sieve Designation | Percentage Passing the Sieve by Weight |
|---|---|
| 26.5 | 100 |
| 19.0 | 80-100 |
| 9.5 | 55-80 |
| 4.75 | 35-60 |
| 600 micron | 10-35 |
| 75 micron | 0-8 |

**1501.2.5. Dowel bars :** Plain steel bars as per IS:432 (Part 1) having minimum yield strength 240 N/mm$^2$ shall be used as dowel bars.

**1501.2.6. Water:** Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter

or other substances harmful to the finished concrete. It shall meet the requirement stipulated in Clause 802.5 of these Specifications.

**1501.2.7. Premoulded joint filler** : Bitumen impregnated filler board/ pre-moulded synthetic joint filler board for expansion joints which are provided at abutting structures, like, bridges and culverts, shall be of 20 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirement of IS:1838. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. Holes to accommodate dowel bars, if used, shall be accurately bored or punched out to give a sliding fit on the dowel bars.

**1501.2.8. Joint sealing compound** : The joint sealing compound shall be of hot poured sealing compound type having flexibility, resistance to age hardening and durability conforming to IS:1834.

**1501.2.9. Storage of materials** : All materials shall be stored in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for the work, as described in Clause 802.1.

**1501.2.9.1. Storage of cement** : Cement shall be stored at site in accordance with Clause 802.2.2 of these Specifications.

### 1501.3. Mix-Design

**1501.3.1.** After approval by the Engineer of all the materials to be used in the concrete, the Contractor shall submit the mix design based on weighed proportions of all ingredients for the approval of the Engineer. The mix design shall be submitted at least 30 days prior to the paving of trial length and the design shall be based on laboratory trial mixes using the approved materials and method as per IS:10262 or on the basis of any other rational method agreed to by the Engineer. Guidance in this regard may also be obtained from IS:SP:23 "Handbook on Concrete Mixes", and IRC:44. The mix design shall be based on the flexural strength of concrete. The strength of concrete shall be as specified in the Contract drawings. Where there are no facilities for testing beam samples for determining flexural strength, the mix-design may be carried out using equivalent





compressive strength value. The co-relation between flexural strength and compressive strength may be adopted, as below:

$f_f = 0.7 \sqrt{f_{ck}}$ $f_f$ = flexural strength, N/mm².

$f_{ck}$ = characteristic compressive cube strength N/mm².

**1501.3.2.** The Contractor shall carry out laboratory trials of design mixes with the materials from the approved sources to be used. Trial mixes shall be made in presence of the Engineer or his representative and the design mix shall be subject to the approval of the Engineer. These shall be repeated, if necessary, until the proportions that will produce a concrete which complies in all respects with this Specification, and conforms to the requirements of the design/drawings.

**1501.3.2.1.** The proportions determined as a result of the laboratory trial may be adjusted if necessary during the construction of the trial length, with the approval of the Engineer.

**1501.3.2.2.** Any change in the source of materials or mix proportions proposed by the Contractor during the course of work shall be assessed for suitability by making laboratory trial mixes and shall be subject to the approval of the Engineer.

**1501.3.3. Cement content:** The cement content shall not be more than 425 kg nor less than 310 kg per cu.m of concrete. If this minimum cement content is not sufficient to produce in the field, concrete of the strength specified in the drawings/design, it shall be increased as necessary with out any additional payment to the Contractor. If flyash is used to replace a part of cement in the concrete mix, the cement content shall not be less than 250 kg per cu.m.

**1501.3.4. Concrete strength** : The concrete mix shall be of minimum M30 grade and its design shall be based on the flexural strength of concrete. The target average strength for the mix design shall be obtained from the following relationship:

$$S = S^1 + Za^* \nabla$$

Where

S = target average flexural strength, at 28 days, in MPa

$S^1$ = characteristic flexural strength, at 28 days, in MPa.

Za = normal variate, for rural roads the tolerance level of 1 in 20 is recommended, for which Za=1.65.

$\nabla$ = Standard Deviation in MPa

The value of $\sigma$ is expected standard deviation of field test samples in MPa.

**1501.3.5.** The characteristic flexural strength of concrete shall be as specified in the contract drawings. The characteristic flexural strength at 28-days shall not be less than 3.8 MPa.

### 1501.4. Workability

The workability of the concrete shall be measured at the point of placing with slump cone test as per IS:1199. It shall be adequate for the concrete to be fully compacted and finished without undue flow. A slump value of 30 ± 10 mm is reasonable for paving work but will be adjusted depending upon the site requirement, ambient temperature, wind velocity and relative humidity. Chemical admixtures/plasticizer as per IS:9103 may be used if needed to achieve the workability, without affecting the strength and other properties of concrete. The maximum water cement ratio shall be 0.50. The water content per batch of concrete should be maintained constant including suitable allowances to be made for free moisture and absorption by aggregates during storage.

### 1501.5. Subgrade

The subgrade shall conform to the grades and cross-sections shown on the drawings and shall be uniformly compacted to the design strength in accordance with the Specifications stipulated in the Contract. All vegetable and extraneous matter shall be removed from subgrade. The sub-base shall not be laid on a subgrade softened by rain after its final preparation; surface trenches and soft spots, if any, must be properly back-filled and compacted to avoid any weak or soft spot. As far as possible, the construction traffic shall be avoided on the prepared subgrade. A day before placing of the sub-base, the subgrade surface shall be lightly sprinkled with water and rolled with one or two passes of a 80 to 100 kN static or vibrating roller after a lapse of 2-3 hours in order to stabilise loose surface. If Engineer feels it necessary, another fine spray of water may be applied just before placing sub-base.

### 1501.6. Sub-base

**1501.6.1.** The cement concrete pavement shall be laid over Granular Sub-Base (GSB) or water bound macadam (WBM) Gr. 3 (53-22.4 mm) or lime treated soil of thickness varying from 75 mm to 150 mm depending upon the volume and type of traffic. Where the sub-base soil is stabilized,





the 4 days soaked CBR after 3 days curing shall not be less than 20. The thickness and composition of sub-base shall be as specified in the drawings. It shall meet the requirement of Section 400 of these Specifications. Near the bridge or culvert an additional layer of 200 mm thick non-plastic GSB over the subgrade, shall be provided in full panel length and full carriage way width. It shall be compacted with plate vibrator for adequate compaction near the abutment.

### 1501.7. Separation Membrane

A separation membrane shall be used between the concrete slab and sub-base. Separation membrane shall be impermeable plastic sheet 125 microns thick laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all extraneous materials.

### 1501.8. Joints

**1501.8.1.** The location and type of joints shall be as shown in the drawings. Joints shall be constructed depending upon their functional requirement as detailed in the following paragraphs.

**1501.8.1.1.** The location of the joints should be transferred from drawings, accurately at the surface of sub-base and marked on either side with red paint. Saw cutting of joints of pavement slab as per stipulated dimensions should be done when concrete is neither too soft nor too hard. Sawing operations could start as early as possible depending upon the season. The initial saw cutting and subsequent widening of groove shall be done with the help of saw cutting machine with diamond studded blade. The thickness of blade shall match the width of groove as far as possible.

**1501.8.2. Transverse joints** : Transverse joints shall be contraction, construction and expansion joints constructed at the spacing described in the drawings. Transverse joints shall be straight along the intended line of joints which is the straight line transverse to the longitudinal axis of the carriageway. Except at road junctions or roundabouts where the position shall be as described in the drawings, transverse joints on each side of the longitudinal joints, if provided, shall be in line with each other and of the same type and width.

**1501.8.3. Contraction joints** : The Contraction joint shall consist of a mechanically sawn joint groove 3 mm to 5 mm wide and upto 1/4 to 1/3 depth of the slab as shown on the drawings. The sawn joints shall be

cut as soon as the concrete has undergone initial hardening and is strong enough to bear the weight of crew and the cutting machine. These joints shall be subsequently widened to 10 mm width and depth of 20 mm by appropriate saw to house the sealant. These joints shall be spaced 2.5 m - 3.75 m as per sketch in Fig. 1500.1. However, the length of panel (in direction of traffic) shall not be less than the width of panel.

**1501.8.4. Construction joints** : Construction joints shall be placed when concerting is completed after a day's work or is suspended for more than 30 minutes. Construction joint shall be provided at the location of contraction joint. The joint shall be a butt joint. Steel bulkhead shall be used to retain the concrete while surface is finished. The joint shall be widened to 10 mm width and 20 mm depth by saw cutting to house the joint sealing material. No emergency joint shall be allowed in less than 2 m distance of any preceding or succeeding joint position.

**1501.8.5. Expansion joints** : These shall be provided only near the bridges and slab culverts. The expansion joint shall consist of a bitumen impregnated joint/premoulded synthetic joint filler board about 20 mm thick complying with IS:1838 and dowel bars complying with Clause 1501.9 as specified in the drawings. The dowel bars shall be passing through the holes in the board. The filler board shall be positioned vertically along the line of the joint within the tolerances detailed in Clause 1501.2.7. The adjacent slabs shall thus be completely separated from each other by providing the joint filler board.

**1501.8.6. Longitudinal joints** : The longitudinal joints shall be provided for two-lane road or where ever shown on the drawings. For a single-lane road a longitudinal joint is not needed. The concreting in the entire width shall be done in one go and the longitudinal joint shall be saw-cut. It shall be 3-5 mm wide and of depth equal to 1/3rd the depth of the slab ± 5 mm. The joint shall be subsequently widened to a groove of 6 mm to 8 mm width and 12 mm to 15 mm depth and sealed with hot poured sealant as per Clause 1501.22 of these specifications. Before sealant is poured a baker thread of non-combustible material such as jute thread/narial rope shall be pressed into the widened groove so as to leave unfilled depth of 8 mm to 10 mm from the top of the slab. This shall be filled with hot poured sealant as per IS:1834 upto 2 mm ± 1 mm below the surface.

### 1501.9. Dowel bars

Dowel bars shall be mild steel bars of 25 mm diameter and in accordance with Clause 1501.2.5 with details/dimensions as indicated in the drawings and free from oil, dirt, loose rust or scale. These shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. Normally, these shall be 500 mm long and spaced at about 250 mm centre-to-centre or as shown on drawings.

**1501.9.1.** Unless shown otherwise on the drawings dowel bars shall be positioned at mid depth of the slab within a tolerance of ± 20 mm. These shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given hereunder:

(i) All bars in a joint shall be within ± 5 mm in length of bar.

(ii) No bar shall differ in alignment from an adjoining bar by more than 5 mm in either the horizontal or vertical plane.

(iii) Cradles supporting dowel bar shall not extend across the line of joint, i.e., no supporting bar of the cradle assembly shall be continuous across the joint (Fig. 1500.1).

**1501.9.2.** Dowel bars shall be covered by a thin plastic sheath for half the length plus 50 mm for expansion joints. The sheath shall be tightly fitting on the dowel bar. The thickness of sheath shall not be more than 0.50 mm.

**1501.9.3.** For expansion joints, a closely fitting cap 100 mm long consisting of waterproofed cardboard or an approved synthetic material like PVC shall be placed over the sheathed end of each dowel bar. An expansion space at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar, by using compressible/sponge/thermacol. To block the entry of cement slurry between dowel bar and cap it may be taped.

### 1501.10. Side Forms

All side forms shall be of mild steel channels or fabricated plates with adjustable jacks at the back and of depth equal to the thickness of pavement or slightly less to accommodate the surface irregularities of the sub-base. The forms can be placed on series of steel packing plates or shims to take care of irregularity of sub-base. These shall be sufficiently robust and rigid to support the weight and pressure caused by paving

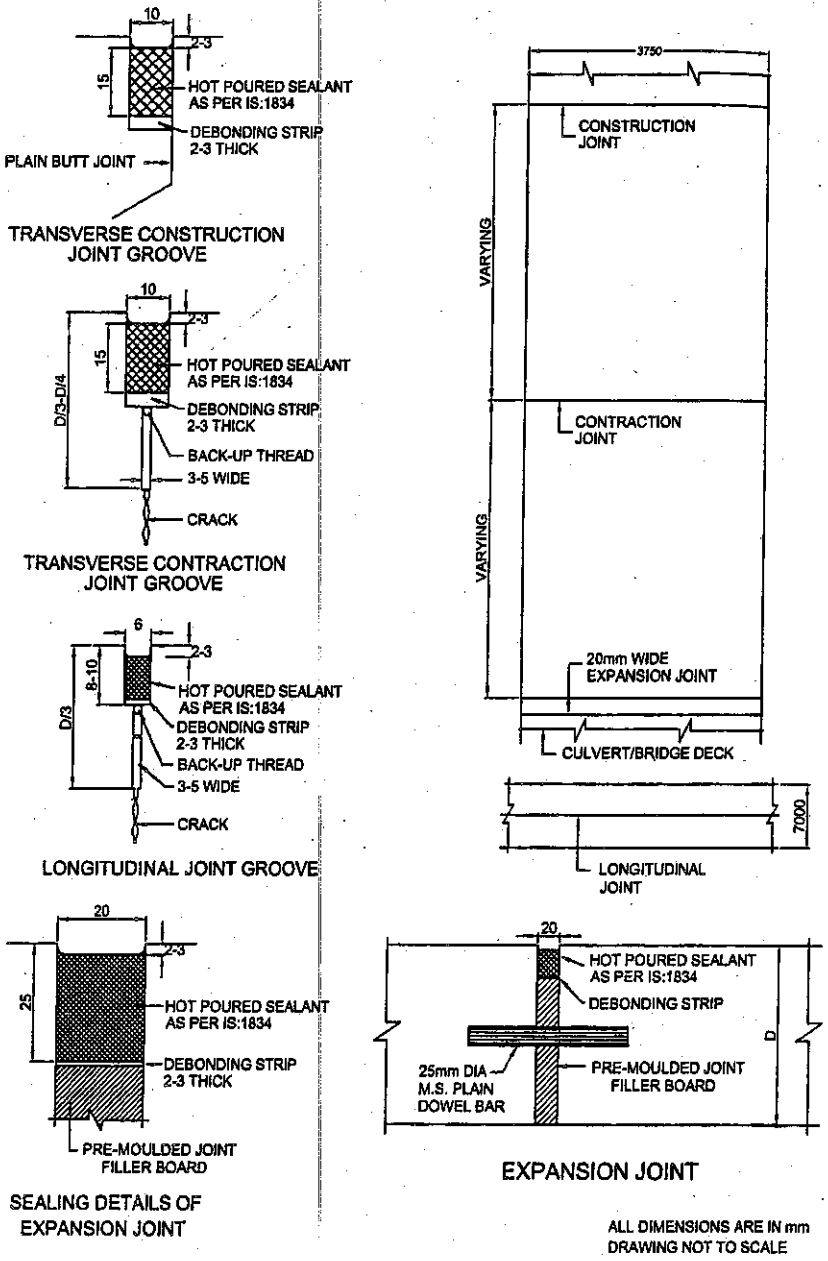



Fig. 1500.1. Joints in Cement Concrete Pavement (contd.)





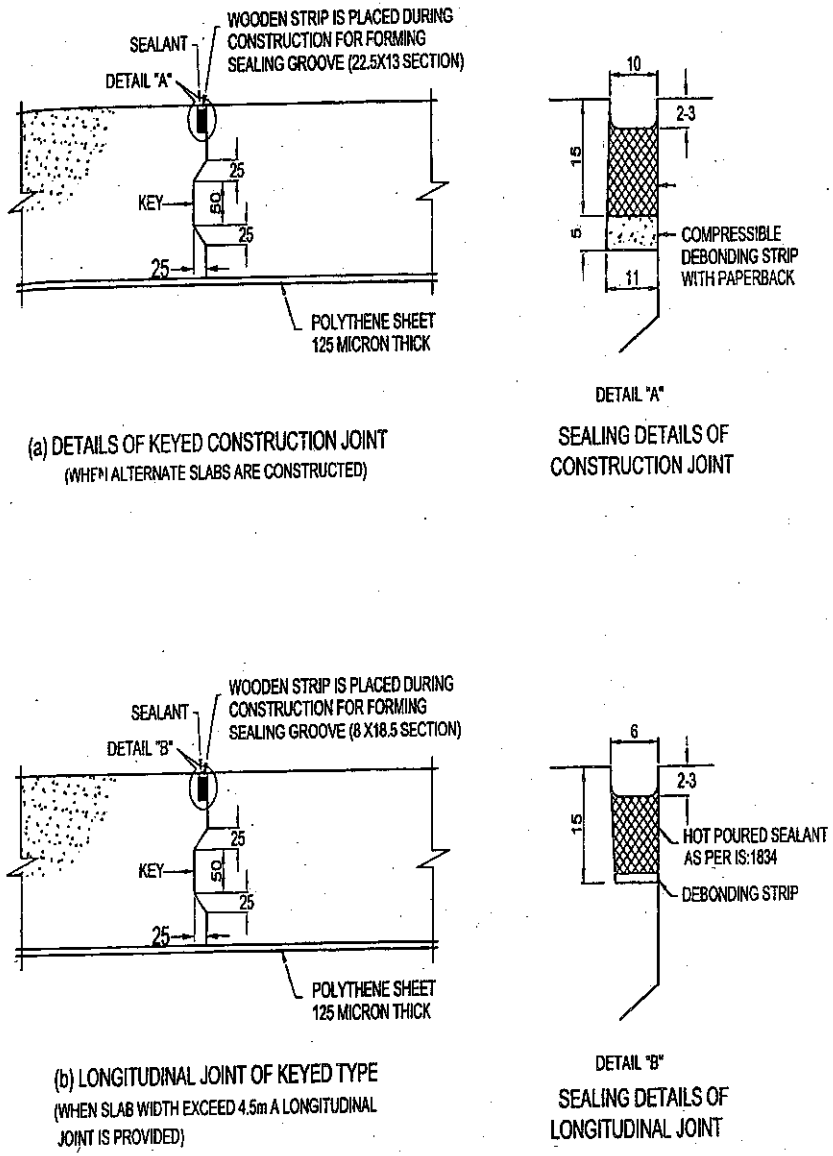



Fig. 1500.1. Joints in Cement Concrete Pavement

equipment. The forms shall be firmly secured in position by not less than 3 stakes/pins for each 2 m length in straight reach and 2 stakes in 1.5 m – 2 m length on curves so as to prevent movement in any direction. Forms shall be straight within a tolerance of 3 mm in 3 m and when in place, shall not settle in excess of 1.5 mm in 3 m while paving is being done. The surface of the forms exposed to concrete shall be cleaned and oiled immediately before each use. The forms shall be bedded on a continuous bed of low moisture content lean cement mortar or concrete and set to the line and levels shown on the drawings within tolerances ± 10 mm and ± 3 mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 3 mm. The forms shall be got inspected from the Engineer for his approval before 12 hours on the day before the construction of the slab and shall not be removed until at least 12 hours after concreting.

### 1501.11. Construction

**1501.11.1.** Construction methodology shall be submitted by the Contractor to the Engineer for his approval. The method statement shall list all the activities and steps to be undertaken and the details of the personnel and equipment to be deployed to accomplish the task. The type and capacity of mixer, weigh batcher, arrangements for measuring of water, the procedure to mix admixtures, hauling arrangement, curing and texturing, etc. shall be specified.

**1501.11.2. Plants, equipment and tools:** Semi-mechanised and labour oriented construction techniques will be permitted:

(i) Weigh batcher usually two-pan swing type

(ii) Two tilting type drum mixers of at least 0.2 cu.m. capacity. The number of mixers to be employed in a project shall be decided on the basis of the size of the project. One additional stand-by unit shall be kept at site.

(iii) Vibrating screeds of appropriate length so that the same can be supported on the side forms for tamping and compacting pavement surface. These are moved on the levelled side forms to achieve the required smoothness, grade and surface regularity. One screed vibrator shall have straight bottom for use on super-elevation and the other one will have specified parabolic camber.

(iv) A couple of needle vibrators, with one stand-by.

(v) Wooden tamper 100 mm x 100 mm size with mild steel shoe.





(vi) Concrete saw cutter for cutting contraction joints in a continuously constructed lane.

(vii) Hand held sprayer for applying liquid curing compound with at least 10-20 litres capacity container/tank to be used where no water is available for curing or where there is acute scarcity of water.

(viii) Texturing brooms/steel or fibre brush.

(ix) Straight edges of 3 m length and a master straight edge.

(x) Graduated wedge.

(xi) Appropriate tools for sealing joints as per IRC:57.

(xii) Fixed side forms measuring at least 100-150 m length.

(xiii) Stop-end and start-end made of steel or wooden section.

(xiv) Appropriate nos of wheel barrows and iron pans.

(xv) Adequate nos of spades, shovels and rakes.

(xvi) Drilling equipment for drilling hole in existing slab of bridge/culvert

(xvii) Pump to clean the holes/grooves of joints

(xviii) Epoxy gun for filling holes with epoxy, if any, expansion joints are needed near existing bridges/culverts.

(xix) Two sets of bulk head made of iron sheet in two halves with half diameter circular holes in each half to hold the dowel bars, and with adequate clamps to hold the assembly together.

**1501.11.3. Batching and mixing of materials** : All batching of materials shall be by weight. After determining the proportion of ingredients for the field mix, the fine aggregate and each separated size of coarse aggregate shall be proportioned by weight in an approved weigh-batching plant (usually two pan swing type) and placed into the hopper of the mixer along with the necessary quantity of cement. Cement shall be measured either by weight or by 50 kg bag. It would be necessary to sample-check the weight of the bags occasionally. All materials other than cement shall be calculated on the basis of one or more bags (full) of cement taking the bulk weight of cement as 1440 kg/cu.m. Water may be measured by volume. Volume batching of aggregates may be permitted as a special case in small projects, with the approval of the Engineer.

**1501.11.3.1.** If batching by volume is permitted, as a special case, separate measuring boxes shall be provided for the different aggregates. The boxes shall be of strong construction provided with handles for convenient lifting and loading into the mixer. They shall be of such size that it should be possible to measure out the requisite quantity and shall be capable of being lifted by two men. Each box shall be provided with a straight edge of required length for striking off after filling. If so directed by the Engineer, improved facilities, such as, tipping boxes of accurate capacity working on run-out rails arranged for direct delivery into the hopper of the mixer shall be provided by the Contractor. In volume batching, suitable allowance shall be made for the bulking of fine aggregate due to the presence of water. For this purpose, the bulking shall be determined as per relevant Indian Standard Specification.

### 1501.11.4. Production of concrete

**1501.11.4.1.** The concrete shall be produced near the site of placement using the concrete mixers of at least 0.2 cu.m. capacity each. The slump of concrete shall be in the range 30 mm ± 10 mm which shall be fine tuned according to the wind velocity, ambient temperature and natural water content in coarse and fine aggregates. The mixing time shall be about one minute. In case of paving on slopes and superelevated portion the slump will be slightly less.

**1501.11.4.2.** Readymix concrete conforming to the specified properties of strength and workability shall also be permitted.

**1501.11.4.3. Placing of concrete :** The concrete shall be placed between the formwork described hereinafter.

**1501.11.4.3.1.** The concrete shall be placed between the forms separated by a distance equal to the width of the carriage way. Concrete shall be placed in a continuous manner without any break/stoppage. The concrete shall be carried to the placement location in wheel barrows and shall be levelled with shovels and rakes. It shall be prodding the form work by about 25 per cent or as ascertained during field trial (Clause 1501.23) of the pavement thickness, to account for settlement during compaction. It shall be stopped at the end of day's work. It may also have to be stopped if paving remains suspended for more than ½ hour. In such a situation, stop end or bulk head will be used to retain the concrete and the joint shall be finished, as a construction joint.





**1501.11.4.3.2. Concreting of irregular area :** Some panels will have acute angles because of some site conditions. In such situation a bar-mat of 10 mm dia tor-steel bars at 150 mm centre-to-centre both ways shall be provided at 50 mm depth below the top of slab in the entire panel to avoid cracking of the acute angled slab.

**1501.11.4.3.3. Concreting around man-holes :** Around man-holes, or rectangular or square openings in the road, 12 mm thick Salitex or other premoulded board as per IS:1838 shall be placed before concreting. Such panels with 'openings' shall also have bar-mats of 10 mm dia tor steel in the entire surface 50 mm below the top of slab.

**1501.11.4.3.4. Paving near culverts and bridges**

(i) **Hume-pipe culverts :** The pavement slab shall be carried over the hume pipe culverts.

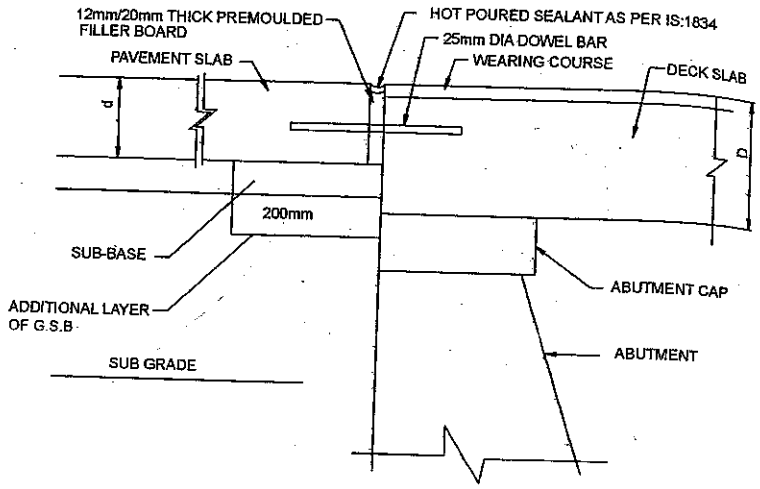
(ii) **New culvert/bridge :** The abutment cap shall be laid on full width of the abutment. The structural slab of culvert/bridge shall be extended over the full width of abutment cap (Fig. 1500.2). This shall be cast first and 25 mm dia dowel bars shall be embedded in it while casting, at 250 mm centre-to-centre or as shown on the drawings.

The exposed portion of dowel bar shall be covered with polythene sheathing. A 100 mm long PVC cap with 20-25 mm sponge placed at its closed end shall be put on the free end of the dowel bar. 12 mm thick, bitumen impregnated/premoulded synthetic filler board (IS:1838) in case of culvert and 20 mm thick board in case of bridge shall be inserted between the deck slab and pavement slab before the pavement slab is cast. Circular holes of adequate diameter shall be made in the filler board so that dowel bars pass through these holes.

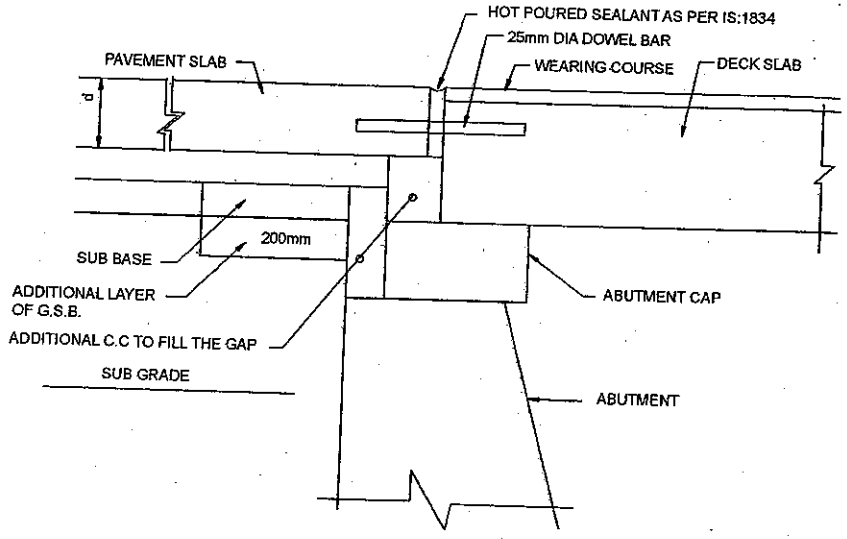
The filler board shall be of full pavement width and shall be in one length. Its width shall be 20 mm less than the thickness of pavement slab. This groove shall be subsequently filled with hot poured bituminous sealant after inserting a debonding strip/rope as per drawing. Similar treatment shall be provided at the other end of the culvert/bridge.

iii) **Existing slab culvert/bridge :** Expansion joint shall be provided at either end between the paving slab and culvert/bridge slab (Fig. 1500.2) as per Clause 1501.11.4.2.5. (ii) of these Specifications.

**1501.11.4.3.5.** Concreting in super-elevated portions/gradients exceeding 5 per cent, slump should not be more than 20 mm.




NEW CULVERT/BRIDGE




EXISTING CULVERT/BRIDGE

**Fig. 1500.2. Expansion Joints at Culvert/Bridge Approaches**





### 1501.12. Concreting During Monsoon Months

When concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulin or other water proof cloth shall be provided along the line of the work. Any time when it rains, all freshly laid concrete which had not been covered for curing purpose shall be adequately protected. Any concrete damaged by rain shall be removed and replaced.

### 1501.13. Concreting in Hot Weather

No concreting shall be done when the concrete temperature is above 30°C measured at the point of placing, and ambient temperature is more than 35°C. Besides, in adverse conditions, like, high temperature, low relative humidity, excessive wind velocity imminence of rains, etc. freshly laid concrete shall be adequately protected by tarpaulins.

### 1501.14. Concreting in Cold Whether

No concreting shall be done when the concrete temperature is below 5°C and the temperature is descending.

### 1501.15. Compaction of Concrete

The compaction of the pavement shall be accomplished by a vibrating screed supplemented by two internal vibrators. Vibrating screed shall be supplemented by portable needle vibrators. The vibrating screed shall rest on side forms. There will be two vibrating screeds. One shall be full width with straight bottom and other with bottom in specified parabolic camber. It shall be lowered vertically on to the concrete surface, evenly spread to the appropriate level above the base to provide the required surcharge for compaction; allowed to remain in position for a few seconds until compaction is complete, then lifted vertically and lowered on to the adjacent strip to uncompacted concrete. The amplitude of vibration of the screed shall not be less than 1.5 mm and the speed of travel not more than 0.6 m per minute. The screed shall again be taken slowly over the surface, sliding with its axis slightly tilted away from the direction of sliding and the operation repeated until the required dense, close knit surface is obtained. Immediately after the screeding has been completed and before the concrete has hardened, i.e., while the concrete is still in the plastic stage, the surface shall be inspected for irregularities with a profile checking template and any needed correction made by adding or removing concrete followed by further compaction and finishing. When the screed

vibrator goes out of order, the concreting shall be continued using wooden tamper at least upto next joint. The tamper may also supplement the screed vibrator if so warranted. The concrete shall be compacted within 100 minutes in summer, when temperature of concrete is between 25°C and 35°C and within 120 minutes when temperature of concrete is between 5°C and 25°C. The temperature of concrete shall be measured in wheel barrows just before placement of concrete.

### 1501.16. Floating

As soon as practicable after the concrete has been compacted, its surface shall be smoothened by longitudinal float operated from the work bridge. The float shall be worked with a sawing motion, while held in a floating position parallel to the carriageway centre line and passed gradually from one side of the pavement to the other. Movements ahead along the centre line of the carriageway shall be in successive advances of not more than one half the length of the float.

### 1501.17. Texturing

Just before the concrete becomes non-plastic, the surface shall be textured with an approved long handled steel or fibre brush conforming to the stipulations laid down in IRC:43. The brush shall be pulled gently over the surface of the pavement in transverse direction from one edge to other edge of pavement. Adjacent strokes shall be slightly overlapped. Texturing shall be perpendicular to the centre line of the pavement and so executed that the corrugations thus produced will be uniform in character and width, and about 1.5 mm deep. Texturing shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The textured surface shall be free from porous or rough spots, irregularities, depressions and small pockets, such as may be caused by accidentally disturbing the particles of coarse aggregates embedded near the surface. The texturing shall not be carried out when there is excessive bleeding water on the surface. The texture brush shall be cleaned to ensure that it is free from hardened cement paste/mortar.

### 1501.18. Curing

**1501.18.1.** After completion of the finishing operations, the surface of the pavements shall be entirely covered with wet hessian cloth (minimum of two layers), burlap or jute mats. The coverings used shall be of such





length (or width) that when laid, will extend at least 500 mm beyond the edges of the slab and shall be so placed that the entire surface and both the edges of the slab are completely covered. They shall be placed as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to their being placed, the coverings shall be thoroughly wetted with water and placed with the wettest side down. They shall be so weighed down as to cause them to remain in intimate contact with the surface covered. They shall be maintained fully wetted and in position for 24 hours after the concrete has been placed, or until the concrete is sufficiently hard to be walked upon without suffering any damage. To maintain the coverings wet, water shall be gently sprayed so as to avoid damage to the fresh concrete. The concrete slab shall not be kept exposed for a period of more than half an hour for saw cutting of joints. After saw-cutting of joints the surface shall be again covered and kept wet.

**1501.18.2.** Covering shall be placed from suitable wooden/steel bridges (IRC:43). Walking on freshly laid concrete to facilitate placing coverings will not be permitted.

**1501.18.3.** Upon the removal of the wet covering at the end of 24 hours, the slab shall be thoroughly wetted and then cured by ponding or sprinklers. Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal dykes of clay about 50 mm high, covered with a blanket of sandy soil free from stones, to prevent the drying up and cracking of clay. Before constructing clay dykes, the joints formed in concrete slabs shall be temporarily sealed with jute ropes, or synthetic back-up rods so that no foreign material, like, clay or sand enters the joint. The rest of the slab shall be covered with sufficient sandy soil so as to produce a blanket of earth not less than 40 mm thick after wetting. The earth covering shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 14 days and thoroughly wetted down during the morning of the 15th day. The sand shall not be removed and shall thereafter remain in place till 28 days from date of casting so that the concrete has attained the required strength. If at any time the earth covering is displaced, same shall be restored and wetted.

### 1501.19. Edging

After belting and/or texturing have been completed, but before the concrete has taken its initial set, the edges of the slab shall be carefully

finished so as to leave the pavement edges smooth and true to line. The floting, finishing and edging, etc. shall be done using a wooden/steel bridge with legs straddled apart so as not to touch the pavement.

### 1501.20. Joint Filling

After minimum 28 days of casting the pavement, joint groove at contraction joint which was 3-5 mm wide initially shall be widened to 10 mm width and to a depth of 18-20 mm for contraction/construction joint. For longitudinal joint it shall be 6-8 mm wide and shall be sealed as per Clause 1501.22 of these Specifications.

### 1501.21. Debonding Strip

A 12 mm diameter jute thread/narial rope or any similar material shall be forced to sit in the groove before applying the primer.

### 1501.22. Method of Sealing the Joints

**1501.22.1. Cleaning the joints** : All foreign materials, if any, in the joints shall be removed with a raker. The joints shall thereafter be cleaned with a coir brush. Their fine particles clinging to the concrete faces shall be removed either with the help of an air compressor or bicycle pump. The joints shall be cleaned and surface dried before the application of primer, so as to obtain good bond of the primer with the concrete and uniform coating of the primer thereon.

**1501.22.2. Primer application** : The cleaned joint is primed with a 20-25 mm wide painter's brush. While painting, light pressure shall be applied so that the primer penetrates into the pores of concrete. The primer shall be applied in the thinnest possible complete film and then left for some time till the primer feels "tacky". The sealing compound must not be applied till the primer feels "tacky". Depending upon the weather conditions, it may take upto 2 hours for the primer to feel "tacky" during the winter and rainy seasons. Soon after the primer is applied the joint is covered with 10 cm-15 cm wide paper strips so that no dust is deposited on the primer. The primer shall be as per specifications given by manufacturers.

**1501.22.3. Sealing compound application** : Before application, the compound shall be heated until it is fluid enough to pour easily into the joint. Rubberised compositions are particularly liable to be damaged by overheating, since rubber decomposes at temperature above about 180°C. If heating is done carelessly, the compound may be seriously damaged.





Care shall be taken to ensure that the compound is not heated above 200°C and temperature does not exceed 180°C for long periods (or other temperatures specified by the manufacture of the compound).

**1501.22.4. Pouring of sealing compound in the joint groove** : The hot sealing compound is taken out in the pouring kettle having a spout. It shall be poured into the joint opening in such a manner that the material does not spill over the exposed surface of the concrete. The pouring of the compound in the joint shall be started from the crown or the raised end of the slab. The other end(s) shall be blocked in order to prevent the sealing compound flowing out, and spill-over material shall be scraped off with a scraper, when the compound, though still warm, has somewhat hardened, but does not take any impression on being pressed with a finger. It may take about ½ hour for the compound to achieve this state of hardening. To prevent "tackiness" or "pick-up" under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if necessary.

**1501.22.4.1.** While the joints shall be filled to a depth of 2 mm ± 1 mm below the surface. This procedure will reduce the possibility of ingress of grit and other foreign matters into the sealing compound as well as dislodging of the hardened sealing compound under traffic.

### 1501.23. Trial length

**1501.23.1.** The Contractor shall demonstrate the materials, plant equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, off road for at least 30 m length. If the first trial is unsatisfactory, the Contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

**1501.23.2.** The trail length shall be constructed in two parts over a period comprising at least of two separate working days, with a minimum of 15 m on each day. In manual construction the trial length shall be constructed at a similar rate to that which is proposed for the main work.

**1501.23.3.** Transverse joints and longitudinal joints of each type that are proposed for concrete slabs in the main work shall be constructed and assessed in the trial length.

**1501.23.4.** Approval of the materials, plant, equipment and construction methods for main work shall be given when a trial length

complies with the Specification. The Contractor shall not proceed with normal working until the trial length has been approved.

### 1501.23.5. Acceptance criteria for trial length

**1501.23.5.1.** Four full depth cores of diameter at least 100 mm (2 cores for each day's work) at 28 days will be cut by core cutting machine. The core shall be tested as per IS:516. The crushing strength of cores with height to diameter ratios between 1 and 2 may be corrected to corresponding standard cylinder of height to diameter ratio of 2 by multiplying with the correction factor obtained from the following equation:

$$f = 0.11\ n + 0.78$$

Where

f = correction factor

n = height to diameter ratio

The concrete in the work represented by the core test shall be considered acceptable if the average equivalent cube strength of the cores is at least 85 per cent of the cube strength of the grade of concrete specified for corresponding age and no individual core has a strength less than 75 per cent.

**1501.23.5.2.** The trial length shall satisfy surface levels and regularity, and demonstrate that the joint-forming methodology is satisfactory. The hardened concrete shall be cut over 3 m width and reversed to inspect the bottom surface for any segregation taking place. The trial length shall be again constructed after making necessary changes in the gradation of the mix to eliminate segregation of the mix. It shall be ensured that the lower surface shall not have honey-combing and the aggregates shall not be held loosely at the edges.

**1501.24. Quality control and tolerances** : The quality control, tolerances for thickness, levels and strength shall conform to the requirements of Section 1800 of these Specifications.

### 1501.25. Opening to Traffic

No vehicular traffic including construction vehicles shall be allowed to run on the finished surface of a concrete pavement for the period as specified on the drawings and until the joints are permanently sealed.





### 1501.26. Acceptame Criteria for Cracked Concrete Slabs

(i) The length of single crack in any panel shall not be more than 750 mm, even though its depth is less than half of the slab depth.

(ii) The cumulative length of cracks with depth of crack less than half the depth of slab in a panel shall not be more than 1250 mm.

(iii) Slabs with cracks which are penetrating to more than half of the slab depth shall not be accepted.

### 1501.27. Measurements for Payment

Cement Concrete shall be measured in cubic metres. The volume to be paid for will be calculated on the basis of net plan area and thickness shown on the project drawings and adjusted for the deficiency in thickness. No additional payment shall be made for extra thickness of the slab.

### 1501.28. Rate

The Contract unit rate for the construction of the cement concrete pavement shall be for carrying out the operations required for the different items of the work as per these Specifications including full compensation for all labour, tools, plant, equipments, testing and incidentials to complete the work as per Specification, providing all materials to be incorporated in the work including all royalties, fees, storage, rents where necessary and all leads and lifts.

## 1502. ROLLER COMPACTED CONCRETE PAVEMENT

### 1502.1. Scope

**1502.1.1.** The work shall consist of construction of roller compacted cement concrete pavement on a coarse graded granular sub-base in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross sections shown on the drawings. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations in connection with the work, as approved by the Engineer. The pavement shall be constructed using semi mechanized, methods.

**1502.1.2.** Roller Compacted Concrete Pavement (RCCP) shall be laid as per design on granular sub-base of 75 to 100 mm thickness or as specified on the drawings and constructed to the requirements of the specification in accordance with Section 400 of these Specifications.

**1502.1.3.** The design parameters such as grade of concrete, details of joints if any, width, and thickness shall be as laid down in construction drawings. However, minimum compacted thickness of Roller Compacted Concrete as wearing course shall not be less than 200 mm.

### 1502.2. Materials

**1502.2.1. Source of materials** : The specifications as laid down in 1501.2.1 shall be followed.

**1502.2.2. Cement** : Cement shall conform to Clause 1501.2.2 of these Specifications, Pozzolana cement shall not be used when fly ash is used as part replacement of cement.

**1502.2.3. Flyash** : Flyash used for Roller Compacted Concrete (RCC) work may be either from anthracitic coal or lignite collected by electro-static precipitator. Bottom ash or pond ash shall not be used as replacement of cement. Flyash for RCC shall conform to Table 1500.2.

**1502.2.4. Aggregates** : The aggregates shall conform to Clause 1501.2.4 of these specifications.

**1502.2.4.1. Coarse aggregates** : The coarse aggregates shall conform to Clause 1501.2.4.1 of these Specifications.

After five cycles of testing for soundness as per IS:2386 (Part 5), the loss of weight of aggregate shall not exceed more than 12 per cent if sodium sulphate solution is used or 18 per cent if magnesium sulphate is used.

**1502.2.4.2. Fine aggregates** : Fine aggregates shall conform to Clause 1501.2.4.2. of these Specifications.

**1502.2.4.3. Blending of aggregates** : The coarse and fine aggregates shall be blended so that the material after blending shall conform to the grading given in Table 1500.3.

**1502.2.5. Water:** Water shall conform to Clause 1501.2.6 of these Specifications.

**1502.2.6. Storage of material** : Materials shall be stored in proper places so as to prevent their deterioration or contamination by foreign matter as per Clause 802.1. If the aggregates are dusty, the same will be washed on instructions of Engineer. The aggregates shall be subjected to





**TABLE 1500.2 : PHYSICAL REQUIREMENTS OF FLYASH AS CONCRETE ADMIXTURE AS PER IS:3812**

| S. No. | Characteristic | Requirement of Grade I Flyash |
|---|---|---|
| (1) | Fineness, specific surface area in $m^2/kg$ by Blaine's permeability test, minimum: | 320 |
| (2) | Particles retained on 45 micron IS sieve, per cent maximum: | 34 |
| (3) | Lime reactivity average compressive strength in $N/mm^2$: | 4.5 |
| (4) | Soundness by autoclave test expansion of specimen in per cent, maximum: | 0.8 |
| (5) | Drying shrinkage per cent, maximum | 0.15 |

Note:- Flyash shall be used in case of OPC.

**TABLE 1500.3 : AGGREGATES GRADATIONS FOR RCCP**

| Sieve Designation | Percentage passing the sieve by weight |
|---|---|
| 26.50 mm | 100 |
| 19.00 mm | 80-100 |
| 9.50 mm | 55-75 |
| 4.75 mm | 35-60 |
| 600 micron | 10-35 |
| 75 micron | 0-8 |

acceptance tests prior to their use. Cement bags shall not be placed directly on the floor and shall not touch the walls.

**1502.2.7. Storage of cement** : It shall conform to Clause 802.2.2 of these Specifications.

### 1502.3. Proportioning of Materials for the Mix

**1502.3.1. Without flyash** : Contractor shall submit the mix design based on weighed proportion of all ingredients for the approval by Engineer 30 days prior to the trial length paving. The mix shall be proportioned by weight of all ingredients such that the desired target mean

strength is achieved. The mix design shall be based on the flexural strength of concrete as per IRC:44. The moisture content shall be so selected that mix is dry enough to support the weight of a vibratory roller, and yet wet enough to permit adequate distribution of paste throughout the mass during mixing, laying and compaction operations. The water content may be in range of 5 to 7 per cent by weight of total weight of coarse aggregates plus fine aggregates plus cement, dry materials required for making concrete. Trial mixes may be made with water contents in the range of 5 to 7 per cent at 0.5 per cent intervals. The optimum moisture content which gives the maximum density shall be established. The exact moisture content requirement in the mix shall be established after making field trial construction. Using the moisture content so established, a set of six beams and six cubes shall be prepared for testing on the 3rd and 7th days. If the flexural strength achieved is lower than the desired strength, the trials should be repeated after increasing the cement content till the desired strength is achieved.

**1502.3.2. With flyash** : Flyash in Roller Compacted Concrete shall be used as 15-35 per cent as replacement of cement by weight. The flyash concrete shall have zero slump. The modified Proctor compaction test can be used for determining the optimum moisture content (OMC) for compaction. Rest of the specifications shall conform to Clause 1502.3.1. When Portland Pozzolana Cement flyash based, as per IS:1489 (Part 1) or any other blended cement is used, flyash may not be used as replacement of cement.

All other Clauses of these Specifications shall also apply.

**1502.3.3.** The water content shall be between 5 per cent to 7 per cent by weight of the total dry weight of coarse aggregate plus fine aggregate plus cement. The correct amount of water to be added in the mix, shall be adjusted during trial length construction to rollable consistency. While executing the job; and if transportation of mix by tippers is essential, then water content shall be kept upto 2 per cent higher than optimum moisture content to cater to evaporation losses, and to render the compaction of RCC more effective.

**1502.3.4. Cement content** : The minimum cement content in the Roller Compacted Concrete mix for pavement shall not be less than 310 kg per cu.m of concrete. If the designated or characteristic compressive strength of 30 MPa at 28 days is not achievable with the minimum





quantity of cement, the same shall be increased in suitable installments without any additional payment to Contractor. The maximum quantity of cement shall not exceed 425 kg per cu.m of concrete in case of roller compacted concrete. If flyash is used to replace a part of cement in the concrete mix, the cement content shall not be less than 250 kg per cu.m.

**1502.3.5. Design** : The mix design shall be based upon flexural strength which shall not be less than 3.5 MPa. The design mix shall be minimum of M 30 grade also.

**1502.3.6. Concrete strength** : Average compressive strength of each consecutive group of 5 cubes shall be not less then 30 MPa at 28 days. Considering the variations in field, the laboratory mix shall be designed for at least 1.25 times the required 28 days field strength (5.6.1 of IRC:SP:20). The flexural strength = $0.7 \sqrt{f_{ck}}$.

where $f_{ck}$ is characteristic compressive cube strength in MPa

**1502.4. Construction**

The construction of Roller Compacted Concrete Pavement shall be attained as laid down in these Specifications, overlaid on sub-base, duly compacted and finished.

**1502.4.1 Sub-base** : It shall conform to Clause 1501.6.1. of these Specifications.

**1502.4.2. Batching and mixing** : The specifications as laid down in Clauses 1501.11.3. and 1501.11.3.1. shall be followed. A weigh batcher (double bucket swing type) will be installed at site. The ingredients, i.e., coarse aggregates, flyash when used, sand and cement shall be weighed in weigh batcher. The mixing shall be done in concrete mixer, installed near the site of work or in any approved batching plant available near site. The Guidelines for Ready mixed concrete shall be taken from IS:4926. The mixer shall be minimum of full bag capacity (0.2 cum.) When sufficient confidence has been gained, volume batching may be permitted by the Engineer. The wooden or iron measuring boxes only shall be used to measure the ingredients by volume. Extra wooden strips (phatties) shall be added to measure the quantities of coarse and fine aggregate. However, in case of cement, only steel measuring box will be used. Similarly in case of water a permanent mark will be made on a suitable container to allow only the specified quantity of water.

In case of aggregates, the weighting accuracy shall be ± 2 per cent by weight and for cement flyash and water it shall be ± 1 per cent by volume.

**1502.4.2.1.** The loading sequence of ingredients shall be coarse aggregates, fine aggregates, cement and lastly water to be added into the mixer.

**1502.4.3. Production** : The concrete shall be produced near the site of placement using concrete mixers of at least 0.2 cu.m capacity. The concrete shall be 'Zero slump' concrete. The mixing time shall not be less than two minutes.

**1502.4.4. Transportation** : The mixed material shall be transported in wheel barrows or steel pans. For larger works it will be desirable to use tippers/transit mixers for transporting of mix. The tippers if used shall be covered with tarpaulin to avoid loss of moisture by evaporation.

**1502.4.4.1. Side forms** : The side forms shall be fixed as per Clause 1501.10 of these Specifications and shall be as per IRC:43.

**1502.4.5. Placing of roller compacted concrete** : The concrete shall be placed between the forms separated by distance equal to the width of carriageway in a continuous way without any break.

**1502.4.5.1. Placing by semi-mechanized tools** : At about every six metres, camber templates or unidirectional tapered templates having 2 per cent camber/slope shall be positioned. In between, thickness blocks with 25 per cent to 30 per cent ruffle shall be placed between the camber templates. The actual prodding shall be ascertained during field trial. The mix shall be placed with wheel barrows/steel pans with rotary motions and it shall be spread uniformly with the help of shovels and rakes. A wooden screed (wooden batten 125 mm x 50 mm and about 3 m long) shall be used in a sawing motion to level the mix before rolling. Any deficiency in thickness shall be made good. Once the loose Roller Compacted Concrete has been placed in first compartment, rolling shall commence immediately. Uniform spreading is very important from the consideration of getting uniformity in density, compaction and finally uniform designed thickness. The concreting shall be stopped only at the end of the days work. It may also have to be stopped if paving remains suspended for more than ½ hour. The concrete shall be tapered in ½ m length while stopping the paving. Before commencement of





paving on next day this half metre shall be cut straight and fresh concrete shall abutting the old concrete. Alternatively at the end of days work tapered wooden block head (at 30° angle) abutting vertically in the transverse direction may be placed to avoid wastage of half metre length of RCC. The exposed sides of pavement shall be finished with 1:4 cement sand mortar to prevent ingress of water from shoulders.

**1502.4.5.2. Placing by mechanical paver** : The placing of concrete by mechanical paver shall be permitted. The equipment shall be capable of laying the material in one layer in full width in an even manner without segregation so that after compaction, the total thickness is, as specified. The paver shall have high amplitude temping bars to give good initial compaction to the concrete. When paving is done by paver the pavement width shall be 300 mm extra on either side. In that case no side forms are needed.

**1502.4.6. Rolling and compacting** : The zero slump Concrete shall be rolled with a vibratory roller of 80 to 100 kN static weight as shown in Table 1500.4.

**1502.4.6.1.** At the end of rolling, no roller marks shall be visible. The rolling shall commence from lower edge(s) to centre/super elevated edge. The speed of roller shall not exceed 4 km per hour.

**TABLE 1500.4 : ROLLING SEQUENCE, NUMBER OF PASSES BASED ON TYPE OF ROLLER**

| S. No. | Type of roller Static | No. of passes | No. of vibrating passes | Remarks |
|---|---|---|---|---|
| (1) | Double drum tandem roller | (i) 2<br>(ii) Nil<br><br>(iii) 1-2 | Nil<br>4 - 6<br><br>Nil | Breakdown rolling<br>Vibratory rolling with amplitude 0.8-0.4 mm<br>Smoothening |
| | | | Or | |
| (2) | Single front drum steel roller with rear tyres of rubber | (i) 1<br>(ii) Nil<br><br>(iii) 1-2 | Nil<br>4 - 5<br><br>Nil | Breakdown rolling<br>Vibratory rolling with amplitude descending from 1.8 mm to 0.4 mm<br>Smoothening |

**1502.4.6.2.** If some hungry surface or honey combed concrete is visible after rolling, moist cement sand mortar 1:4 shall be broomed-in and one pass of roller in static mode shall be given.

**1502.4.6.3.** The in-situ-density by sand replacement method shall be checked and if the field density is less than 97 per cent density of trial length, additional passes of roller shall be given to achieve minimum 97 per cent of the density of trial length, without any delay.

**1502.4.6.4.** The surface unevenness shall be simultaneously checked with 3 m straight edge and high spots shall be raked open, extra material removed and recompacted. If the thickness is less, even then the area shall be raked open, extra material added and recompacted by roller without any delay. No roller marks, lines or loose material shall left out. Any attempt to make up the depressions by depositing, fine material should be curbed.

**1502.4.6.5.** When next day's work will commence the Roller Compacted Concrete in a width of 0.5 m from terminal end shall be either saw cut as a butt joint or on removing wooden form or bulk head. Voids, if any, shall be filled with 1:4 cement sand mortar. The cut material shall not be used in Roller Compacted Concrete and shall be thrown away. The initial about 2-3 m shall be compacted by running the roller in transverse direction so as to save the previous day's vertical end intact. After this roller shall work in usual longitudinal direction.

**1502.4.6.6.** The final time of rolling of the Roller Compacted Concrete shall not exceed 100 minutes from time of mixing water when the concrete temperature is between 25°C and 30°C. Similarly, it shall not exceed more than 120 minutes when the same is less than 25°C or equal to 25°C. No concerting shall be done when ambient temperature is less then 4°C and descending or more than 40°C. Chilled water or ice shall be added to mixing water to bring down the temperature of concrete upto 30°C in summer if needed. When ambient temperature is below 5°C or more than 40°C necessary precautions for laying and placing of concrete shall be as per IRC:15.

**1502.4.6.7. Paving near culverts/bridges:** The Roller Compacted Concrete shall be carried over the hume pipe culverts. In all other cases when slab culverts or bridges are provided or are existing it shall abutt the deck slab of the culvert or approach slab/deck slab of the bridge and a construction joint shall be formed in accordance with Clause 1502.5.1. Additional layer of 200 mm thick non plastic GSB shall be provided over





the sub-base in full panel length and full carriageway width as per drawings. Plate vibrator shall be used for adequate compaction near the abutment or at locations where roller cannot compact the layers efficiently.

### 1502.5. Joints

No longitudinal joint shall be provided as the width of carriage way is less than 4 m. Roller Compacted Concrete Pavement (RCCP) shall have only transverse contraction joints at 5 m centre-to-centre. These shall be saw-cut after 18-24 hours of laying. As the joints are filled after curing period is over, i.e., 14 days, to avoid infiltrates of foreign particles, i.e., aggregates or dust into the joints, flexible synthetic rope or jute rope may be placed in the empty joints. The width shall be 6-8 mm and depth 1/4$^{th}$ of Roller Compacted Concrete slab thickness. These shall be filled with hot poured sealing compound as per Clause 1501.22 of these Specifications and in accordance with IS:1834. The joint at the end of the days work or emergency joint due to stopping of work more than ½ hour shall be butt joint and sealed as above.

### 1502.6. Curing

Soon after the compaction is over depending upon the weather, wind velocity and humidity, curing shall start within one hour to two hours, after laying by covering the Roller Compacted Concrete Pavement with wet hessian in two-three layers for first 24 hours. After the first day's curing, small earthen rectangles/dykes about 50 mm high transversely and longitudinally shall be made and shall be filled with water for at least 14 more days. In case of flyash admixed concrete curing may be extended upto 16 days.

### 1502.7. Protection of Concrete

The freshly laid concrete shall be protected by means of suitable barricades to exclude traffic for 28 days at least.

### 1502.8. Trial Mix

Trial mixes of RCCP shall be prepared using cement aggregate ratio as constant and water content as 5 per cent, 5.5 per cent, 6 per cent, 6.5 per cent and 7 per cent of mix by weight. Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix in 150 mm cube moulds shall be done in three layers with vibrating hammer fitted with a square or oblong foot or through loaded

plate vibrator of size just smaller than 150 mm. After establishing optimum moisture by moisture density curve 6 no. cubes shall be cast at optimum moisture content, (OMC) and these shall be tested for strength after 3 days and 7 days of casting. If the compressive strength is less than specified strength the process shall be repeated by adding more cement.

### 1502.9. Trial Length

**1502.9.1.** The trial length shall be near the main road. For reasons of economy trial length may form part of driveway for buses near bus-que shelter or may be additional lane near bus stops or for parking. This shall be done after approval of the Engineer. No payment shall be made for trial length and its construction shall be incidental to the main work.

**1502.9.2.** The Contractor shall submit methodology and mix design report for carrying out the work 30 days before trial length is to be laid. The trial length shall be laid at least two weeks before the main pavement is to be constructed. The trial length shall be normally not less than 30m in length. It shall involve at least two working days so that treatment at end of day's work/ start of day's work is supervised. The trial length shall be rolled as per rolling sequence in Table 1500.5. If during compaction of trial length, waves appear on the top of rolled surface in front the roller the mix in that case shall be too harsh, the moisture content shall be varied and strength re-determined. Before production of mix, natural moisture content of aggregates should be determined on day to day basis so that designed moisture content could be used to prepare the mix.

**1502.9.3.** After rolling, the in-situ density of freshly laid Roller Compacted Concrete layer shall be checked by sand replacement method with 200 mm dia density hole. Three density holes shall be made along a diagonal which bisects the trial length taking care that no holes are made within 0.5 metre of edge from either side. The average density of these three- holes shall be taken as reference density and taken as 100 per cent. Later on the field density of regular work shall not be less than 97 per cent of this reference density.

**1502.9.4.** The trial length shall be cut over one metre length and reversed to inspect the condition of concrete at the bottom. It should not be segregated. The trial length which does not comply with specifications shall be removed and relaid. The main work shall start only after approval of trial length by the Engineer.

**1502.9.5.** Core density shall be taken after 28 days age of concrete.





The homogeneity of Roller Compacted Concrete layer shall also be assessed from the cores. A minimum of three cores shall be taken from each day's trial work. The average of three cores for the day shall be the core density for day's work.

The strength of cores shall be governed by Clause 1501.23.6.1 of these Specifications.

### 1502.10. Quality Control and Tolerances

The quality control, tolerances for thickness, levels and strength shall conform to the requirements of Section 1800 of these Specifications.

### 1502.11. Acceptance Criteria for Cracked Concrete Slabs

(i) The length of single crack in any panel shall not be more than 750 mm, eventhough its depth is less than half of the slab depth.

(ii) The cumulative length of cracks with depth of crack less than half the depth of slab in a panel shall not be more than 1250 mm.

(iii) Slabs with cracks which are penetrating to more than half of the slab depth shall not be accepted.

### 1502.12. Opening to Traffic

No commercial traffic, i.e., buses trucks and tractors with or without trolleys are to be allowed on Roller Compacted Concrete Pavement for a period as specified in the drawings and until the joints are sealed. However, very light construction traffic may be allowed at very slow speed (not more than 4 km per hour) with written permission of the Engineer only after 7 days of laying.

### 1502.13. Measurements for Payment

The unit of measurements for Roller Compacted Concrete Pavement shall be in cubic metres. This shall be based upon built-up area of cross-section and depth indicated therein. The extra width on either side, beyond approved cross-section shall be incidental to the item and shall not be measured and paid for.

### 1502.14. Rate

The unit rate payable for Roller Compacted Concrete Pavement shall be payment in full for carrying the work including labour, material, machinery working charges, curing, royalties, octroi and incidentals such as cost of running various tests and construction of trial length, etc. to deliver the product as per laid down Specifications.

## 1503. RECTANGULAR CONCRETE BLOCK PAVEMENT

### 1503.1. Scope

**1503.1.1.** The rectangular concrete block pavement (CBP) shall consist of a surface layer of appropriate-sized concrete block paved on a thin, compacted bedding sand layer of specified grading, which is spread over a properly profiled base course and is bounded by edge restraints. The joints shall be filled by fine sand of specified grading. The work shall include furnishing of all plant and equipment, material, and labour for manufacturing and laying concrete blocks in position and performing all other operations in connection with the work as approved by the Engineer. Only mechanized or semi-mechanized methods of manufacturing cement concrete blocks shall be acceptable.

**1503.1.2.** The design details, viz., dimensions of blocks, grade of cement concrete, joint details, patterns of laying and end restraints, etc. shall be as shown on the drawings. The thickness of block shall be not less than 150 mm and grade of concrete shall not be less than M30.

### 1503.2. Materials

**1503.2.1. Source of materials** : Clause 1501.2.1 of these Specifications shall be followed.

**1503.2.2. Cement** : Cement shall conform to Clause 1501.2.2. of these Specifications.

**1503.2.3. Aggregates** : The aggregates shall conform to Clause 1501.2.4.

**1503.2.3.1. Course aggregates** : The course aggregates for manufacture of blocks shall conform to Clauses 1501.2.4.1 and 1501.2.4.1.1 of these Specifications.

**1503.2.3.2. Fine aggregates** : The fine aggregates far manufacture of blocks shall conform to Clause 1501.2.4.2.

**1503.2.3.3. Admixtures** : Admixtures, if used for attaining required workability of concrete mix shall conform to IS:9103.

**1503.2.4. Water:** Water shall conform to Clause 1501.2.6 and Table 1500.2.

**1503.2.5. Aggregate gradation** : The aggregate gradation shall conform to Table 1500.1 of these Specifications.





**1503.2.6. Joint filling sand** : The joint filling sand shall be fine sand conforming to grading as per Table 1500.5.

**1503.2.7. Bedding sand** : It shall conform to grading specified in Table 1500.5.

**TABLE 1500.5 : RECOMMENDED GRADING FOR BEDDING AND JOINT FILLING SAND**

| IS Sieve Size (mm) | Per cent Passing | |
|---|---|---|
| | Bedding Sand | Joint Filling Sand |
| 10.00 | 100 | 100 |
| 4.75 | 90-100 | 95-100 |
| 2.36 | 75-100 | 95-100 |
| 1.18 | 55-90 | 90-100 |
| 0.60 | 35-59 | 80-100 |
| 0.30 | 8-30 | 15-50 |
| 0.15 | 0-10 | 0-15 |
| 0.075 | 0-3 | 0-5 |

**1503.2.8. Storage of materials** : This shall conform to Clause 802 of these Specifications.

**1503.2.8.1. Storage of cement** : It shall conform to Clause 802.2.2 of these Specifications.

### 1503.3. Size of Paving Blocks

The size of paving blocks and restraint blocks shall be 450 mm x 300mm x 150 mm and 300 mm x 300 mm x 150 mm (length × width × thickness) respectively. If any other size is adopted as per drawings or as per directions of the Engineer, the width to length ratio shall not be more than 1:2.

### 1503.4. Mix Design

**1503.4.1.** The concrete for block pavements shall have design mix of M 30 grade. The laboratory trials on the mix design shall be made by the Contractor and the mix design submitted to the Engineer for approval 30 days prior to the paving of trial length. The mix design shall be tested for characteristic strength in compression by 150 mm x 150 mm x 150 mm

cubes cured for 28 days. The design of concrete mix shall be as per guide lines given in IS:10262. The aggregates cement ratio shall normally be in the range of 3:1 to 6:1.

**1503.4.1.1.** The quantities of coarse or fine aggregates in gradation of the aggregates may be varied to achieve the minimum characteristic strength if necessary.

**1503.4.2. Cement content:** The cement content shall not be less than 310 kg/cu.m. nor shall it be more than 425 kg per cu.m. However, if the Contractor is not able to achieve the specified characteristic strength with 310 kg/cu.m. he shall not be paid any extra cost for using more cement.

**1503.4.3. Concrete strength**

The characteristic compressive strength of concrete shall not be less than 30 MPa.

**1503.5. Workability**

The total water content shall be between 5-7 per cent by weight of total dry materials (cement + sand + coarse aggregates). When blocks are manufactured using block making machine, the concrete shall be "Zero slump concrete". When concrete blocks are manufactured using vibrating table along with surface vibrator, the concrete slum may vary from 10-15 mm.

**1503.6. Manufacture and Curing of Blocks**

**1503.6.1.** The blocks shall preferably be manufactured with the help of block manufacturing machine. If the same is not available, the blocks shall be manufactured with the help of semi-mechanised means, i.e., vibrating table and a surface vibrator. Thorough vibration will be imparted for proper compaction. Tough plastic moulds or steel moulds shall be used for the purpose. The sides and bottom of moulds shall be oiled with shuttering oil prior to filling of mould. The moulds shall be removed at appropriate time varying from 12-24 hours of casting of blocks and then the blocks shall be cured in water tank for 28 days. The moulds shall be washed with water after each use and oiled before each re-use.

**1503.6.2. Buffer** : Extra number of blocks to the extent of 5 per cent shall be manufactured at the time of initially casting the blocks and shall be properly stored for replacement as and when needed.





**1503.7. Subgrade**

The subgrade shall conform to Clause 1501.5.1. of these Specifications and shall have camber of 3 per cent. When the soaked CBR of subgrade soil is less than 4 per cent, it shall be improved by cement/lime/mechanical stabilization as appropriate or 300 mm thick existing layer shall be replaced with soil of minimum CBR of 4 per cent, which ever is cost effective.

**1503.8. Sub-base**

The sub-base shall be 100 mm thick granular sub-base (GSB) conforming to Clause 401 of these Specifications or 100 mm thick WBM using Gr. 1 metal conforming to Clause 405 of these Specifications. In case the subgrade soil is clayey, the sub-base shall be extended over the full formation width for proper drainage.

**1503.9. Shoulders**

Earthen Shoulders of 1.5 m width on either side shall be prepared with camber of 4 per cent.

**1503.10. Base Course**

The base course shall be 75 mm thick WBM Gr. 2 or Gr. 3 conforming of Clause 405 of these Specifications. The base course shall be extended by at least 150 mm beyond edge blocks.

**1503.11. Bedding Sand**

Bedding sand conforming to grading given in Table 1500.6 shall be uniformally laid over the base course to a compacted thickness of 25 mm to 30 mm. It shall be profiled truly to the camber or unidirectional fall on superelevations, with the help of a screed. The screed can be guided to proper level by tensioned string lines set above the base course or by thickness blocks. The bedding sand shall have about 6 per cent moisture to facilitate its spreading and compaction. Screeding shall not be processed beyond about 1 metre ahead of the planned end of the block paving for the day. Sand shall be compacted with a hand rammer or plate compactor and level shall be re-adjusted, if needed, by using the screed.

**1503.12. Laying of Blocks**

The pattern for paving of blocks shall be either herringbone or

stretcher as shown in the sketch. In case sketcher pattern is used, staggered joints shall be ensured. The joint between any two stretcher shall be staggered by about half the length of the stretcher. The edge restraining blocks shall be made to stand vertically so that their outer/inner edge matches with the profile of block pavement. Control over alignment, laying pattern and joint width can be assisted by the use of chalked string lines set at about 5 m intervals.

**1503.12.1 Joints** : The width of joint shall be between 2 mm to 4 mm. On curves non-unifrom joint width may have to be resorted to. Cutting paving units for filling the paving gaps occurring against edge restraints, etc. shall be deferred until sufficient work has progressed to allow reasonably continuous operation. When space does not permit the use of cut piece of blocks, the use of premixed or dry packed concrete is recommended. After a section has been paved, compaction with a vibratory plate compactor shall be done in the following sequence of operations.

(i) The blocks shall be vibrated with three passes of a standard vibrating plate compactor of weight 0.9 kN, plate area not less than 0.3 square metres and capable of applying centrifugal force of 15 kN.

(ii) A thin layer of joint filling sand as per Clause 1503.2.6 shall be spread on the top of paved blocks and swept into joints using suitable brooms.

(iii) The sand shall be vibrated into the joints by moving the vibrating plate compactor and more sand shall be applied till the joints are well packed.

(iv) Excess sand from the top of block pavement shall be swept clean.

### 1503.13. Acceptance Criteria

Minimum six cubes per day's work (3 each for 7-day and 28-day strength) shall be cast, cured and tested as per IS:516.

The compressive strength shall not be less than $f_{ck}$ the design characteristic compressive strength.

### 1503.14. Trial Length

The Contractor shall lay a trial length of 30 m before proceeding with the main work. The same shall be got approved by the Engineer before proceeding with the regular pavement. The length shall be rectified/re-laid if, found deficient in Specifications. The procedure demonstrated in the laying of trial length shall be followed while laying the main pavement.





### 1503.15. Opening to Traffic

The pavement may be opened to traffic soon after completion of a stretch.

### 1503.16. Tolerance

**1503.16.1. Level tolerance** : The tolerance in surface levels shall be not more than ± 15 mm.

**1503.16.2. Surface regularity** : The maximum allowable difference between the road surface and underside of a 3 m straight edge when placed parallel or at right angles to the centre-line the road at points decided by the Engineer shall be as under:

| | |
|---|---|
| Longitudinal profile not more than | 12 mm |
| Cross profile not more than | 10 mm |

### 1503.17. Measurements for Payment

The measurement shall be in square metres measured from outer edge of restraint block to outer edge of restraint block across the whole width of pavement.

### 1503.18. Rate

The contract unit rate shall include cost of manufacture of blocks, including materials, cost of curing, stacking, transportation to site, laying of block, including supplying and applying bedding sand and joints filling sand including full compensation for labour, tools, plant, equipment, testing and all incidentals to the work complete as per Specifications including all royalties, taxes storage rents where ever necessary and all leads and lifts.

## 1504. INTERLOCKING CONCRETE BLOCK PAVEMENT

### 1504.1. Scope

Interlocking Concrete Block Pavement (ICBP) shall consist of a surface layer of appropriate sized concrete paving blocks paved and compacted over a thin bedding sand layer of specified grading, which is spread over a properly constructed and profiled base course and is

bounded by properly installed edge restraints. The joints shall be filled by fine sand of specified grading. The work shall include supplying laying and paving of blocks including all materials, labour and equipment and performing all operations in connection with the laying of ICBP as per these Specifications.

### 1504.2. Materials

**1504.2.1.** The Concrete Paving Block shall conform to the relevant IS standard.

**1504.2.2. Bedding sand** : Bedding sand shall conform to the grading given in Table 1500.6.

**1504.2.3. Joint filling sand** : Joint filling sand shall conform to grading given in Table 1500.6.

**TABLE 1500.6 : GRADINGS FOR BEDDING AND JOINT FILLING SAND**

| Is Sieve Size (mm) | Per cent Passing | |
|---|---|---|
| | For Bedding Sand | For Joint Filling Sand |
| 10.00 | 100 | 100 |
| 4.75 | 90-100 | 90-100 |
| 2.36 | 60-95 | 75-100 |
| 1.18 | 15-34 | 55-90 |
| 0.60 | 25-60 | 35-59 |
| 0.30 | 5-20 | 8-30 |
| 0.15 | 0-10 | 0-10 |
| 0.075 | 0-5 | 0-5 |

### 1504.3. Buffer

Buffer of specified quantity of paving blocks (of the same shape, size and thickness) required for normal maintenance of paved area as specified by the Engineer, shall be supplied and stored for replacement as and when needed. Normally this will be 5 per cent of the blocks used in the paved area.





### 1504.4. Block Thickness

For rural roads catering to heavy vehicles, the minimum thickness of paving blocks shall be 60 mm for traffic up to 100 vehicles per day, and 80 mm for projected traffic from 100 to 250 vehicles per day.

### 1504.5. Dimensions and Tolerances

The dimensions and tolerances of paving blocks shall conform to the Specifications given in Table 1500.7. Aspect ratio is the ratio of length to thickness of blocks. Chamfer is the bevelled edge, provided on the top surface of a block. Plan area is the horizontal area bounded by the vertical faces. Wearing surface area is the horizontal area bounded by the vertical faces, minus the area reduced due to the presence of chamfer.

**TABLE 1500.7 : DIMENSIONS AND TOLERANCES FOR PAVING BLOCKS**

| S. No. | Dimension | Recommended Values | Tolerance Limit |
|---|---|---|---|
| (1) | Width W | To be specified by Manufacturer | ± 2 mm |
| (2) | Length L | To be Specified by Manufacturer | ± 2 mm |
| (3) | Thickness T | 60 to 80 mm | ± 3 mm |
| (4) | Aspect Ratio L/T | Maximum : 4.0 | + 0.2 |
| (5) | Chamfer (Arris) | Minimum : 5 mm<br>Maximum: 7 mm | ± 1 mm |
| (6) | Plan Area | Maximum : 0.03 $m^2$ | + 0.001 $m^2$ |
| (7) | Wearing Face Area | Minimum 75 % of Plan Area | - 1% |
| (8) | Squareness | NIL | ± 2 mm |

### 1504.6. Compressive Strength

**1504.6.1.** The average 28 days compressive strength of 8 blocks shall be 30 MPa and strength of individual block shall not be less than 26 MPa.

**1504.6.2.** The 28 days compressive strength of paving blocks

tested as per relevant IS specification shall be determined as explained hereinafter.

**1504.6.2.1.** Compression testing machine of adequate capacity shall be used for testing of blocks. The steel bearing plates shall have a minimum thickness of 25 mm. The surface area of the bearing side of the plate should be such that no edge of the bearing plate is less than 10 mm from the outer edge of the paving block being tested.

**1504.6.2.2.** In case the testing surface of the paving block departs from a plain surface by more than 0.05 mm, capping using suitable materials shall be adopted for testing as per IS:516.

**1504.6.2.3.** The blocks shall be stored for 24 ± 4 hours in water maintained at a temperature of (20± 5)°C before testing. The dimensions and plan areas of the block shall be determined. The bearing plates of the testing machine shall be wiped clean. The specimen shall be clamped between the plates in such a way that the axes of the specimen are vertically aligned with those of the bearing plates.

**1504.6.2.4.** The load shall be applied without shock and increased continuously at a rate of 15± 3 N/mm²/minute until no greater load can be sustained by the specimen or delamination occurs. The maximum load applied to the specimen shall be noted.

**1504.6.2.5.** The apparent compressive strength of individual block shall be calculated by dividing the maximum load (N) by the plan area (mm²). The corrected compressive strength shall be calculated by multiplying the apparent compressive strength by the appropriate correction factor from Table 1500.8. The strength shall be expressed to the nearest 0.1 N/mm².

**TABLE 1500.8: CORRECTION FACTORS FOR THICKNESS AND CHAMFER OF PAVING BLOCK FOR CALCULATION OF COMPRESSIVE STRENGTH**

| Paving Block Thickness (mm) | Correction Factor for | |
|---|---|---|
| | Plain Block | Chamfered Block |
| 60 | 1.00 | 1.06 |
| 80 | 1.12 | 1.18 |





**1504.6.2.6. Water Absorption:** The water absorption being the average of five blocks shall be not more them 6 per cent by mass.

### 1504.7. Edge Blocks

The edge blocks shall have equivalent cube compressive strength not less than 30 MPa. The road kerbs provided on the edges of the road also serve the purpose of edge blocks. In case the end kerbs are not provided, 300 mm x 300 mm x 150 mm of M30 grade concrete edge blocks or other suitable size as per drawings or direction of the Engineer shall be provided.

### 1504.7.2. Subgrade

The Subgrade shall conform to Clause 1501.5.1 of these Specifications. The soaked CBR of subgrade soil shall not be less than 4 per cent.

### 1504.8. Sub-base

The sub-base shall be 100 mm thick granular layer conforming to Clause 401 or 100 mm thick WBM Gr.1 conforming to Clause 405 of these Specifications. In case the subgrade soil is clayey, the sub-base shall be extended over the full formation width for proper drainage.

### 1504.9. Base Course

A minimum 100 mm thick layer of granular/stabilized base course shall be provided. The base course layer shall be extended at least 300 mm beyond the edge restraints. The material shall conform to Clause 402 of these Specifications.

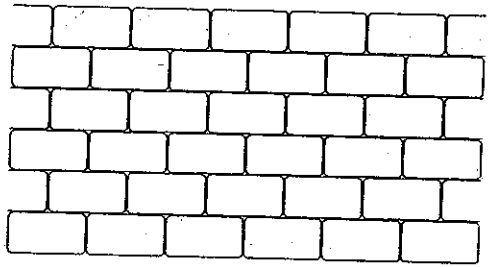
### 1504.10. Bedding Sand

Bedding sand conforming to Table 1500.6 shall be uniformly laid to a compacted thickness of 25 mm for 60 mm thick blocks and 30 mm for 80 mm thick blocks. Bedding sand shall be unloaded in small piles regularly placed over the base course and shall preferably have a moisture content of about 6 per cent which will facilitate its spreading and compaction. Bedding sand shall be screeded in a uniform layer over the base course. The screed can be guided to level by tensioned string lines set above the base course. At the time of screeding, the thickness of sand must allow for the amount by which it will be subsequently compacted which is normally about 25 per cent more than the compacted thickness. Screeding shall not proceed beyond about 1 m ahead of the planned end of block paving for the day. Sand shall preferably be compacted with a manual, fabricated

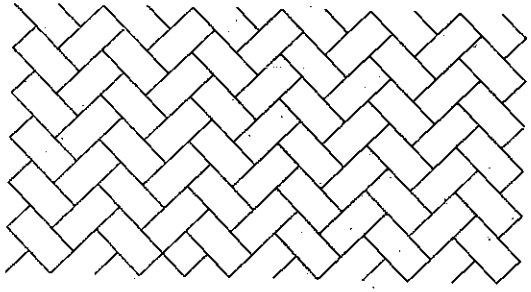
plate compactor and the level shall be readjusted using the screed. The surface profile of the screeded bedding sand shall match that required for the completed pavement.

### 1504.11. Paving Pattern

The pattern in which blocks are to be paved shall be decided in advance from the two choices or their derived forms available. These are the herringbone and stretcher patterns, as shown in Fig. 1500.3.



(a) STRETCHER OR RUNNING



(b) HERRINGBONE

**Fig. 1500.3. Basic Bonds**

**1504.11.1.** By and large, these patterns are the same as adopted for brick paving. All shapes of blocks are not amenable to the above paving patterns. For paving in trafficked areas, herringbone pattern shall be adopted for ensuring better performance. Paving shall commence and progress from one starting line only. Wherever possible, paving shall commence adjacent to or against edge restraint.





### 1504.12. Paving and Compaction of Blocks

Blocks shall be placed at the correct angle to the start line to achieve the final orientation of the laying pattern. For curved or unfavourably oriented edge restraints, a string line shall be established to permit fast, easy laying such that it is not required to force a block between the blocks already paved. Control over alignment, laying pattern and joint width can be assisted by the use of chalked string lines set at about 5 m intervals. Nominal joint width of 2 to 4 mm shall be maintained by holding the paving unit lightly against the face of the adjacent block and allowing it to slide into position. Cutting paving units for filling the paving gaps occurring against edge restraints etc. shall be deferred until sufficient work has progressed to allow reasonably continuous operation. When space does not permit the use of cut pieces of blocks, premixed or dry packed concrete shall be used. After a section has been paved, compaction shall be effected by using vibrating plate compactors in the following sequence of operations:

(i) Vibrate the blocks with 3 passes of the plate vibrator of adequate capacity.

(ii) Spread a thin layer of fine joint filing sand on top of the paved blocks and sweep it into the joints, using suitable brooms.

(iii) Vibrate the sand into the joints by making 3 passes of the compactor.

(iv) Sweep off the excess sand from top of blocks.

As a guide to the characteristics of typical vibrating plate compactors, standard compactors have a weight of 90 kg, a plate area of 0.3 $m^2$ and apply a centrifugal force of 1500 kg. Heavy duty compactors weigh between 300 to 600 kg, have a plate area of about 0.5 to 0.6 $m^2$ and apply a centrifugal force in the range of 2000-3000 kg. Use of heavy duty compactors is desirable for trafficked pavements

**1504.12.1. Trial length** : The contractor shall lay a trial length of 30 m and get it inspected and approved by the Engineer before proceeding with the regular paving work. The trial length shall be rectified/relaid if found deficient in any respect. The procedure demonstrated in the laying of trial length shall be followed while executing the main construction work.

### 1504.13. Opening to Traffic

The pavement can be opened to traffic as soon as the construction work is completed.

### 1504.14. Surface Tolerances

**1504.14.1. Transverse profile** : When measured by a camber template, the transverse profile shall not deviate by more than 10 mm from the design profile.

**1504.14.2. Longitudinal profile** : When measured by a 3 m straight edge, the longitudinal profile shall not deviate by more than 12 mm from the design profile.

### 1504.15. Acceptance Criteria

From each lot of 500 blocks, 5 blocks shall be selected at random for water absorption and compressive strength tests. In case the number of blocks in the lot is less than 500, a minimum 1 per cent of the blocks delivered to site shall be tested for water absorption and strength. The blocks shall be first tested for water absorption and these shall meet the requirement of Clause 1504.5.2.6 of these Specifications. The same five blocks (or minimum 1 per cent) shall be tested for strength and shall conform to the strength as per Clause 1504.5.1 of these Specifications.

The paved surface shall meet the tolerances for lines, levels, and grades etc. as given in Section 1800 of these Specifications.

### 1504.16. Measurements for Payment

The measurement of the paved area shall be in square metres measured from the inner edge of edge restraints on one side of the pavement to the inner edge of the edge restraints on the transverse side of the pavement. The measurement of the edge restraints shall be in number of units or in cubic metres.

### 1504.17. Rate

The contract unit rate shall include the cost of blocks, cost of stacking, transportation to site and paving including supply and application of bedding sand and joint filling sand. The rate shall include full compensation for labour, tools, plant, equipment, testing and all incidentals to the work, including all royalties, taxes, storage rents wherever necessary, and all leads and lifts.





# 1600

# Hill Road Construction

## 1601. SITE CLEARANCE

The work of site clearance shall conform to the requirements of Section 200 of these Specifications

## 1602. SETTING OUT

### 1602.1. Reference Pillars (Alignment) and Back-cutting Line

The reference pillars for alignment of the road shall be constructed by the Engineer at the project preparation stage. The reference pillars shall be located as shown in Fig. 1600.1(a). The valley side top edge of reference pillar shall be at ground level. The size of reference pillars shall be 200 mm x 200 mm in plan and 300 mm in height [Fig. 1600.1(b)]. These shall be in mud masonry, plastered with 1:6 cement-sand mortar. The top levels of reference pillars shall be tied down to the level of nearest available G.T.S. Bench Mark.

The reference pillars shall be at 20 m intervals. On sharp curves the interval shall be 10 m. On hair pin bends the location of reference pillars and spacings of 5 m shall be as shown in Fig. 1600.2.

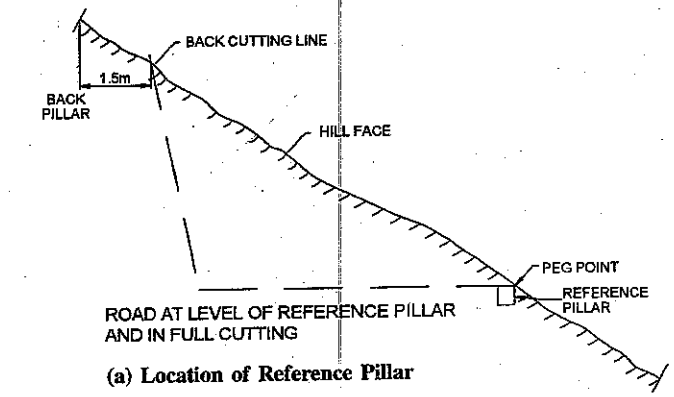
Back-cutting line shall be demarcated on the hill face by digging, taking into account the designed slope of hill-cutting. The accuracy of hill-cutting as per drawings shall be the responsibility of the Contractor irrespective of correctness of demarcation of back-cutting line at site and hill-cutting shall match with the drawings.

Recommended side slopes in hill-cutting shall preferably be following or as mentioned in the design:

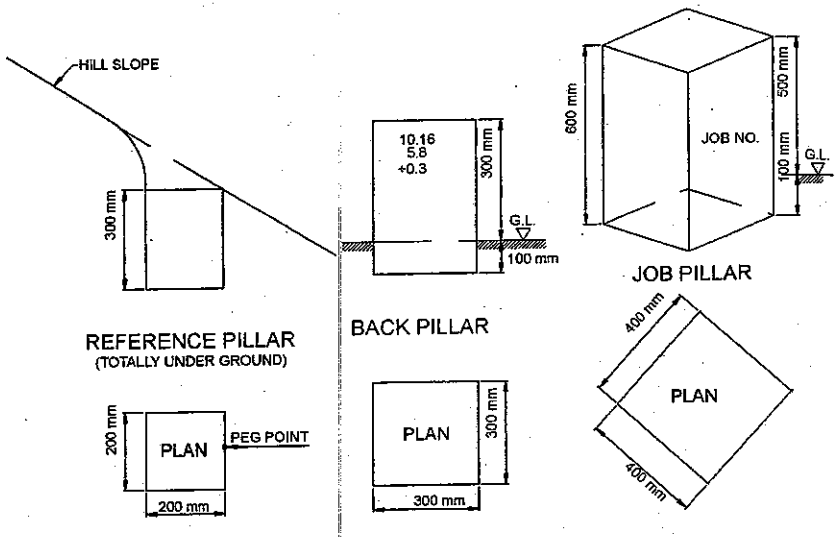
| | |
|---|---|
| Cutting in silty/gravel/sandy soil | 1 : 1 to ½ : 1 |
| Cutting in disintegrated rocks or conglomerate | ½ : 1 to ¼ : 1 |
| Cutting in soft rock/shale | ¼ : 1 to $\frac{1}{8}$ : 1 |
| Cutting in medium rock/sandstone/phyllite | $\frac{1}{12}$ : 1 to $\frac{1}{16}$ : 1 |
| Cutting in hard rocks/quartzite/granite | Nearly vertical |

### 1602.2. Demarcating Formation Edge

The reference pillars, constructed by the Engineer, shall be taken over by the Contractor. The valley side edge of reference pillar shall represent the peg point. The Contractor shall be responsible to safe guard and maintain the reference pillars till completion of the work.




(a) Location of Reference Pillar




(b) Reference Pillar (c) Back Pillar (d) Job Pillar

(NOT TO SCALE)

Fig. 1600.1.





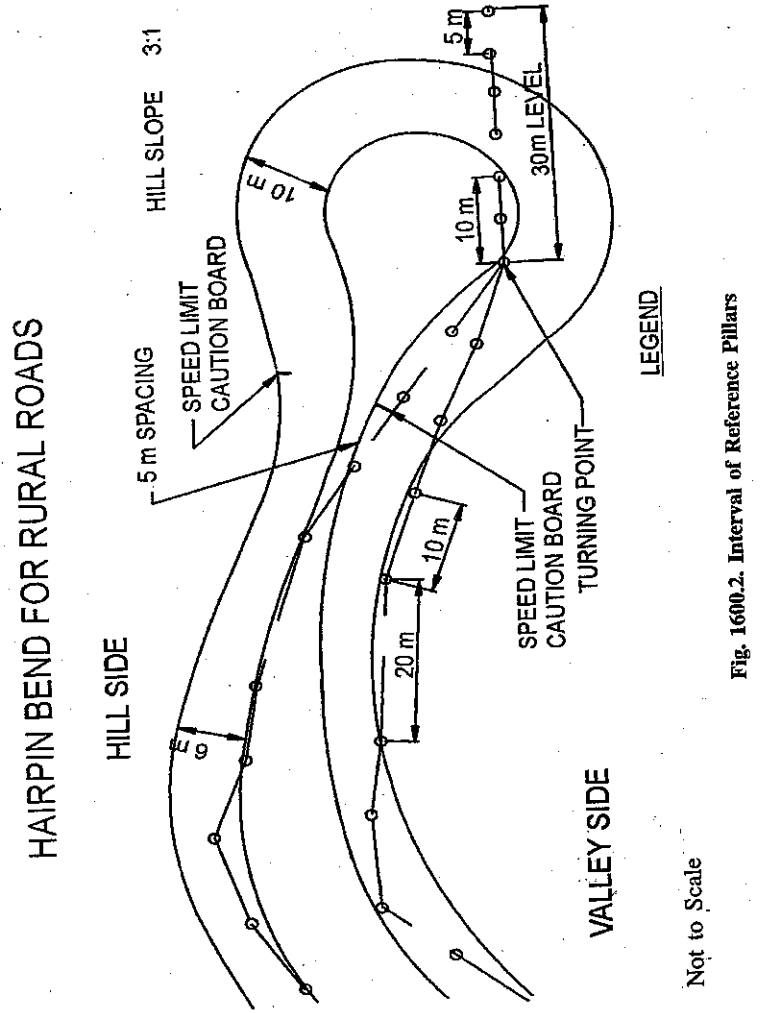



Fig. 1600.2. Interval of Reference Pillars

The Contractor shall verify the correctness of the traverse shown on the drawings with reference to reference pillars at site as shown in Fig. 1600.3. For setting out hair pin bend, the traverse will be continued for 30 m (at a uniform level) beyond the turning point as shown in Fig. 1600.2. In case of any discrepancy in length (measured parallel to road grade), direction and grade is found between two reference pillars beyond the tolerances noted below, the Contractor shall immediately inform the Engineer to do the needful.

Layout of hairpin bends shall be done at desired curves radii with due consideration to transition curves.

**Tolerances**

| | | |
|---|---|---|
| (1) | Length | ± 0.5 per cent |
| (2) | Direction | ± 20 minutes |
| (3) | Grade | ± 0.2 per cent |

The hill side edge of roadway (back cutting line) shall be accurately marked on the hill face, based on distances shown on the drawings, measured horizontally and accurately from reference pillars and accounting for the specified slope of hill cutting, to the satisfaction of the Engineer.

Where the road is in filling, the retaining wall shall be so constructed that its outside edge at top is accurately at a distance as shown on the drawing, measured from the reference pillar.

The roadway demarcation lines between consecutive reference pillars shall follow the curvature shown on the drawings, to the satisfaction of the Engineer.

**1602.2.1. Transferring the peg points from traverse line to centre line of the road :** It shall be ensured that the longitudinal section of the road shall be drawn along the centre line of the road. The distances between peg points on the centre line shall be transferred from corresponding peg points on the traverse, radially towards the centre line curve.

### 1602.3. Back Pillars

Back pillars shall be constructed by the Contractor in front of each reference pillar, as shown in Fig. 1600.1(c). The size of the back pillar shall be 300 mm x 300 mm in plan and 400 mm in height, of which 100 mm shall be below ground level. These pillars shall be located at about 1.5





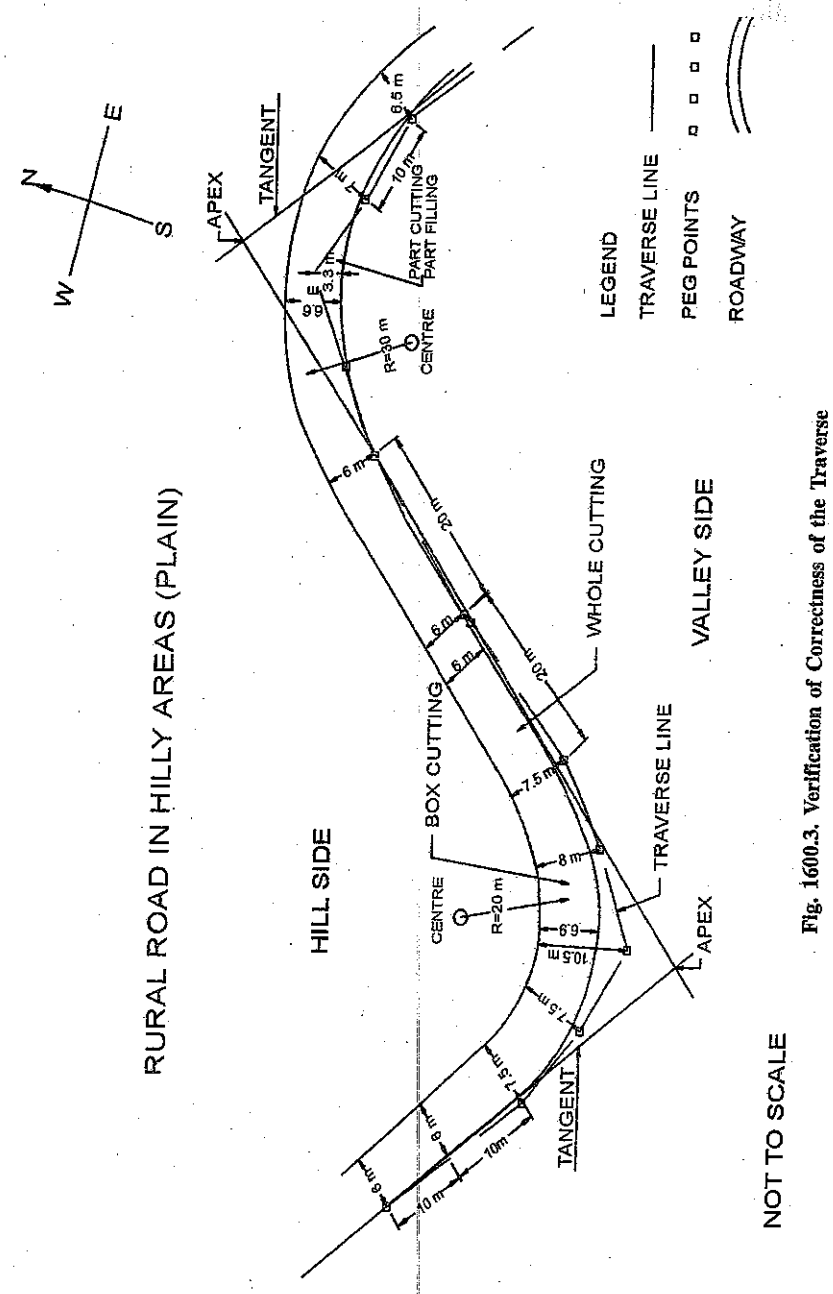



Fig. 1600.3. Verification of Correctness of the Traverse

m away towards hill side from the back-cutting line, and shall have the following information written on them in the order given below for proper execution of the work:

(1) Location of reference pillar in km.

(2) Distance of hill side edge at road level from reference pillar in m.

(3) Level of the road top at centre with reference to the level from level of the top of the reference pillar (above = (+), below (-), level (0) in m.

Back-cutting pillars shall be constructed about 1.5 m away (towards hill side) from back-cutting line, so that information written over there is easily visible during hill-cutting.

### 1602.4. Job Pillars

Job pillars shall be constructed by the Contractor at site at the two ends of the job indicating location and job number as shown in Fig. 1600.1(d). The size of job pillars shall be 400 mm x 400 mm in plan and 600 mm in height, of which 100 mm shall be below ground level. Job Numbers shall be written on these job pillars.

### 1602.5. Measurements for Payment

The work of setting out shall be measured in linear metres or length units specified in the bill of quantities.

### 1602.6. Rate

The Contract unit rate for the item of setting out shall be payment in full for carrying out the required operations including full compensation for all labour, material, tools, equipment, construction and establishing benchmarks, making back cutting lines, back pillars, job pillars and their safeguarding and incidentals necessary to complete the work.

## 1603. EARTHWORK

### 1603.1. Earthwork in Excavation

All earthwork in excavation, including rock excavation, shall be carried out true to lines, grades, side slopes, width, camber, super-elevation and levels as shown on the drawings or as directed by the Engineer, in conformity with the requirements of Clause 302 of these Specifications.

Identification of areas for proper disposal of debris and waste materials





shall be done before commencement of work. Safe disposal of materials shall be done as per direction and satisfaction of the Engineer. The Contractor shall arrange necessary construction equipment and adequate labour camps and camp equipage at his own cost. Prompt removal of debris shall also be ensured by the Contractor at his own cost.

Hill cutting shall be done in a manner so that deforestation comes to minimum so as to reduce the environmental imbalance. It shall be done in conformity with environment Management Plan after assessment of adverse impact on environment. Necessary mitigation measures shall be ensured before start of hill-cutting work.

**1603.1.1. Transferring designed widths, curves and grades to the ground** : At desired road level, the hill side hill-cutting edge shall be at a distance specified in the drawing as measured from outside edge of reference pillar. For sections in filling, the outside edge of retaining wall shall be located at a distance specified in the drawings and measured from the outside edge of the reference pillar, measured along road level. Construction shall proceed in such a manner so that curvature of hill side and valley side edges shall be same as per drawings. Formation level at centre line of the carriageway shall be as per levels as indicated on corresponding back-pillars, so that desired gradient is achieved.

Width of prescribed roadway for hilly terrain is inclusive of parapet and hillside drains. Extra widening at curves shall be provided as per drawings. On roads subjected to snowfall, width of roadway shall be increased by 1.5 m or as indicated in drawings at the design stage.

**1603.1.2. Extra widening at curves** : Extra widening at curves shall be done in accordance with Rural Roads Manual para 2.10.6. Sight distance shall be improved by batter benching which shall be done by benching the hill side above 1.20 m height from road level. This shall be executed if provided in design and drawings.

**1603.1.3. Passing places** : These shall be provided at the rate of 2 to 3 per km as per para 2.14 of Rural Roads Manual.

**1603.1.4. Hairpin bends** : These shall be provided, if unavoidable, as per design of circular curve with transition at each end in accordance with para 2.13 of Rural Roads Manual. These shall be located at stable and

easy hill-slopes and shall be avoided at inner curves to keep away from drainage problems. Full width of roadway shall be surfaced to avoid erosion. One cross drain shall be provided on upper arm of hairpin bend just before the bend, in order to minimize flow of water along the surfaced road and to reduce erosion.

### 1603.2. Rock Cutting

All work of rock cutting by blasting shall be carried out true to lines, grades, side slopes, width, camber, super-elevation and levels as shown on the drawings or as directed by the Engineer, in conformity with the requirements of Clause 304 of these specifications. The Contractor shall take all necessary precautions against soil erosion, damage to hill side, water pollution, etc. and to protect stability of hill side.

### 1603.3. Safeguarding Reference Pillars

Earthwork in excavation and rock cutting shall be carried out in such a way that the reference pillars are safeguarded to the maximum possible extent. The construction section for hill cutting shall be restricted to two chain length (40 m). The next chain length shall be taken up only when the work in first chain length is completed, in order to avoid the possibility of damage or dislocation of more than two reference pillars in one continuous length of two chains.

When due to excavation or rock blasting or any other reason a reference pillar is damaged or dislodged, the Contractor shall immediately inform the Engineer. The Engineer shall relocate the reference pillar with the help of alignment from adjoining intact pillars and at the cost of the Contractor.

The excavation or rock cutting work to be in operation in more than one stretch, sufficiently separated from each other, can be done with the approval of the Engineer.

Heavy rock-blasting shall be avoided and controlled blasting shall be resorted to by using shallow holes and low explosives charge. Blasting must be adequately supervised by technical personnel of the Contractor at site at his own cost. Selection of blasting holes shall be done so as to avoid large scale disturbance to the rock-face developing cleavage planes/cracks/opening of fissures, etc. Rock-cutting shall be done at appropriate angle so as to achieve the desired hill slope as specified in the drawings.





### 1603.4. Excavation for Structures

All excavation for structures, such as, culvert, hillside drains, catch water drains, retaining walls, breast walls shall be true to lines, grades, cross sections, shown on the drawings or as directed by the Engineer, in accordance with the requirements of Clause 305 of these Specifications.

**1603.4.1 Safe-disposal of debris** : Debris from excavation/blasting shall be disposed of systematically with due consideration to avoiding adverse effect on environment. It shall not be thrown haphazardly down the hill slopes as this is likely to trigger off land slides, heavy siltation, choking of water channels/streams and damage to agricultural land and private/govt. property. It shall be stacked at identified locations along road-side or away from it to the satisfaction of the Engineer as specified in the agreement. It shall be placed at such locations so that it does not get easily washed away during rains. It shall either be turfed or shall be provided with vegetative cover as per provisions of the contract agreement.

### 1603.5. Embankment Construction

Embankment construction including filling behind retaining walls, shall be carried out true to lines, grades, side slopes, widths, cambers, super-elevations and levels as shown on the drawings or as directed by the Engineer and in conformity with the requirements of Clause 301 of these Specifications.

### 1603.6. Useful Finds

Any finds, such as, relics of antiquity, coins, fossils or other articles of value, shall be promptly delivered to the Engineer, free of cost and shall remain the property of the Government.

### 1603.7. Preparation of Cut Formation

The cut formation which serves as a sub-grade, shall be prepared to receive the sub-base, base and pavement courses, in accordance with the requirements of Clause 302.6 of these Specifications.

### 1603.8. Cross Section and Road Profile

The Contractor shall be responsible for providing, formation width, curves, grades, grade compensation, cambe super-elevation as specified

in the Contract or shown on the drawings or as directed by the Engineer and upto the tolerances noted below:

| | | |
|---|---|---|
| (1) | Width of formation | (+) 5%, (-) 1% |
| (2) | Longitudinal grade | ± 5% of the specified grade |
| (3) | Grade compensation | ± 5% of the specified gradient |
| (4) | Super elevation | ± 5% of the specified superelvation |

**1603.8.1. Preparation of completion plan and verification of curve radius and gradient and rectification of defects** : Completion plan of the completed lengths shall be prepared and compared with the original drawings as enclosed with the agreement in regard to widths, curve radius, camber, super-elevation and the longitudinal gradient.

The defects so marked shall be rectified by the Contractor at his own cost and in case still some defects are left within permissible limits (as mentioned in agreement) the cost of the same shall be deducted from the Contractor as per conditions of the agreement. Suitable cost deduction clause shall be provided in the agreement in such a way that remaining work can be completed upto finished stage within the cost so deducted from the Contractor as per agreement conditions.

### 1603.9. Finishing Operations

The finishing operations shall be in accordance with the requirements of Clauses 301.6 and 302.7 of these Specifications.

No permanent construction shall be started over the cut or fill surface until and unless approved by the Engineer.

### 1603.10. Measurements for Payment

Measurements for payment of the works of Earthwork in Excavation, Rock Cutting, Excavation for structures and embankment construction shall be carried out in accordance with the requirements of Clauses 302.8, 304.3.3, 305.4 and 301.10 of these Specifications respectively.

### 603.11. Rate

The contract unit rates for earthwork in excavation, rock cutting, excavation for structures and embankment construction shall be in accordance with the requirements of Clauses 302.9, 304.3.4, 305.5 and 301.11 of these Specifications respectively.





## 1604. RETAINING WALLS/BREAST WALLS

Retaining/Breast walls for stability of valley side and hill side slopes shall be provided as per provision in the agreement and after the approval of the Engineer-in-charge.

### 1604.1. Earthwork

The earthwork for foundation shall conform to the requirements of Clause 305 of these Specifications. The depth of foundation shall be as shown on the drawing or as directed by the Engineer. The foundation bed shall have 3:1 (H:V) slope towards hill side.

For demarcation of foundation bed of retaining walls, the top width of wall section shall be laid out with the help of bamboos and strings. The strings shall be hung from bamboos according to the designed front and backslopes. In case of breast-walls, the outer edge of the wall, at road level, shall be the same as the hill side edge of roadway. In case of stable rocks, the foundation bed of retaining walls shall be stepped up with 150 mm depth in hard rock and 600 mm in soft rock.

### 1604.2. Materials

All materials used in stone masonry shall conform to the requirements of Clause 702 of these Specifications.

### 1604.3. Masonry work

The masonry of retaining/breast walls shall be of random rubble dry masonry conforming to Clause 704.6. of these Specifications or random rubble dry masonry with 1:6 cement masonry bands or with a course of cement concrete 1:4:8 throughout the section both in length-wise and breadth–wise direction of the wall or as shown on the drawings or as ordered by the Engineer. The bands shall be 0.6 m wide with clear space of 3 m between them, both horizontally and vertically.

The depth of foundation shall be as shown on the drawing or as directed by the Engineer and shall be safe from scour, frost and surface water. The foundation pit in front of wall shall be filled upto original ground level and well compacted. In case of retaining wall, the top course shall be horizontal and in case of breast wall, it shall be sloping down 2:1(H:V) towards valley side.

The masonry work shall start only after prepared foundation has been approved by the Engineer.

The top level of retaining wall shall match the adjoining shoulder edge with camber/super elevation and shall not be an obstruction to water flowing towards it.

### 1604.4. Bond Stones

The bond stones shall conform to the requirements of Clause 704.5.4 of these Specifications. The bond stones shall be provided in dry stone masonry. The spacing of the bond stones shall be 1 m horizontally and 0.5 m vertically.

### 1604.5. Back Fill

The back fill behind retaining wall /breast wall shall be done only after the masonry work of wall has been approved by the Engineer.

The backfill shall conform the requirement of Clause 301.5.6 of these Specifications.

The surface shall be filled with impervious material to prevent seepage of water behind the retaining wall. Back filling shall not be started until retaining wall has attained a suitable height to the satisfaction of the Engineer.

### 1604.6. Measurements for Payment

Stone masonry random rubble dry and random rubble in cement mortar shall be measured separately. Back fill shall be measured in cubic metres, on the basis of mean length, mean thickness and mean height. Any unauthorized work done by the Contractor shall be ignored. Bond stones shall not be measured separately.

### 1604.7. Rate

The contract unit rate for earthwork in excavation, stone masonry and back filling shall include the cost of all labour, material, tools and plants, scaffolding, sampling, testing, supervision and other expenses incidental to the satisfactory completion of the work as described here in above.

## 1605. PAVEMENT CONSTRUCTION

### 1605.1. Sub-grade Construction

The sub-grade construction shall conform to the requirement of Clause 303 of these Specifications.





### 1605.2. Granular sub-base and bases

The granular sub-base and base course construction shall be in accordance with the requirements of Section 400 of these Specifications.

### 1605.3. Bituminous Construction

The bituminous construction shall be in accordance with the requirements of Section 500 of these Specifications.

### 1605.4. Tolerances

The tolerances in the various courses of pavement shall conform to the relevant provisions of Clauses 1802.3 and 1802.4 of these Specifications.

### 1605.5. Measurements for Payment

The measurement shall conform to the requirements of Section 500 of these Specifications.

### 1605.6. Rate

The rate shall conform to the requirement for Section 500 of these Specifications.

## 1606. DRAINAGE

Appropriate system of drainage shall be provided depending upon site requirement. Initial studies shall be done regarding identification of any sediment traps and its effect on drainage. Adverse effect of nearby streams, lakes and ponds shall also be studied at design stage keeping in view that existing drainage facilities are not disturbed. Need for provision of catch water drain shall also be studied. Adequate drainage shall then be designed based on available hydrological data.

### 1606.1. Hill side Drain

Hill side Drain shall be of the shape as specified in the drawings and preferably of Kerb and Channel type (K.C. Drain) with normal flow and of trapezoidal shape in case of heavy flow of water.

**1606.1.1.** This work shall consist of constructing hill side drain in accordance with the requirements of these Specifications and true to lines, grades, dimensions and other particulars shown on the drawings or as

directed by the Engineer. Schedule of work shall be so arranged that the drain is completed in proper sequence with road works, to ensure that no excavation of completed works is necessary subsequently or any damage is caused to these works due to lack of drainage.

The depth of the Kerb and Channel drain shall be uniformly increased from 100 mm at start to 200 mm at the outfall near cross drainage structure. Lining of the K.C. drain shall be so located that thickness of lining towards hillside shall be outside the formation width. It shall be a part of shoulder towards road side.

The trapezoidal drain shall be designed as per anticipated volume of the discharge and shall also have guide posts of R.C.C. or stone masonry along the edge for safety of the traffic. Proper outfall design shall be ensured for efficient drainage.

**1606.1.2. Materials** : All materials for construction of hillside drain shall conform to relevant provisions of these specifications noted below:

| | | |
|---|---|---|
| (1) | Stone | Clause 702.4 |
| (2) | Cement | Clause 702.2 |
| (3) | Sand | Clause 602.5 |
| (4) | Water | Clause 802.5 |

**1606.1.3. Construction work** : The excavation in rock for hillside drain shall preferably be done along with hill side cutting for the sake of ease of construction. Earthwork in excavation for hill side drains shall be true to the specified lines, grades, levels and dimensions and in accordance with the requirements of Clauses 302 and 304 of these Specifications. The excavated materials shall be removed from the area adjoining the drain and if found suitable, utilized in sub-grade construction. All unsuitable material shall be disposed of as directed by the Engineer.

The excavated bed and sides of the drain shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes.

Where the sub-grade is erodible or when directed by the Engineer, the drain shall be lined with random masonry coursed with 1:5 cement sand mortar conforming to the requirements of Clause 704.6 of these Specifications or any other suitable material shown on the drawings of the size as shown in Fig. 1600.4 or as directed by the Engineer. Where lining of concrete is





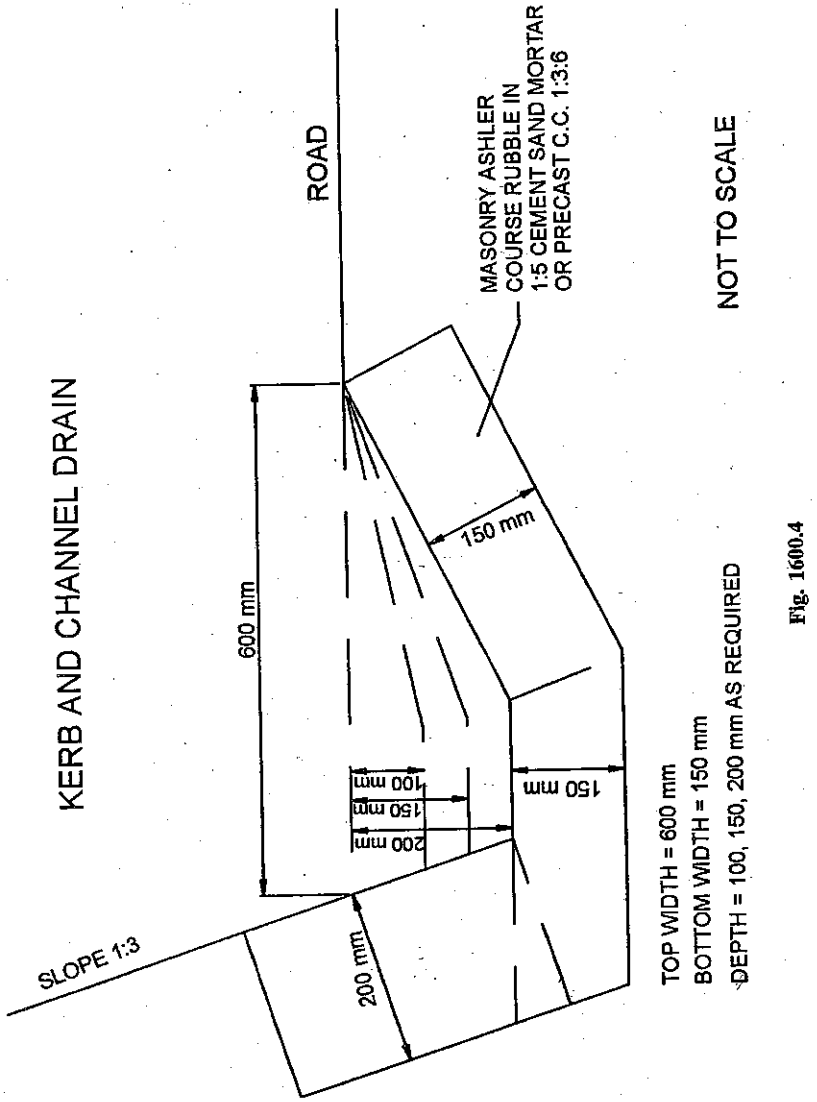



Fig. 1600.4

specified the concrete shall be of M15 grade (1:3:6 nominal mix) and of thickness 150 mm or as directed by the Engineer.

Where the drain is constructed in unerodible rocky strata the excavated surfaces shall be dressed as specified with M20 grade concrete (1:2:4 nominal mix).

The cement concrete/cement mortar lining shall be cured for at least 7 days before opening the drain.

**1606.1.4. Measurements for payment** : Measurement for hill side drains shall be as per running metre length of the drain. Disposal of surplus material beyond 1000 m shall be measured in cubic metres.

**1606.1.5. Rate**

The Contract unit rate for hill side drains shall be payment in full for all items, such as excavation, dressing the sides and bottom, providing lining, masonry, concrete, plastering, levelling course, including full compensation for all material, labour, tools and other incidentals to complete the work as shown on the drawings and with all leads upto 1000 m and all lifts, for removal of unsuitable material.

The Contract unit rate for disposal of surplus and unsuitable material beyond the initial lead of 1000 m shall be in accordance with Clause 305.5.3.

**1606.2. Catch Water/Intercepting Drain**

**1606.2.1.** Catch water/Intercepting Drain shall be provided on hill slopes to intercept water flowing from upper reaches to prevent it from entering slide/unstable areas. These drains shall be provided over stable slopes, outside periphery of slide, and unstable areas, as per drawings of the Contract. Surface-cum-trench drains may also be provided at critical locations where subsurface water needs to be intercepted.

Map for identification of unstable areas need to be prepared before taking up work.

These drains shall generally be of trapezoidal shape. The lining shall be of R.R. dry stone masonry as per design/drawing to the satisfaction of the Engineer. Where the strata is pervious the masonry shall be in cement sand mortar, preferably 1:6 or at least pointed with 1:6 cement sand mortar. The catch-water drains shall be located close to the periphery of the area to be protected and shall be located in stable areas.





**1606.2.2. Materials** : All materials for construction of catch water/ intercepting drain shall conform to relevant provisions of these Specifications noted below:

| | |
|---|---|
| (i) Stone | Clause 702.4 |
| (ii) Cement | Clause 602.2 |
| (iii) Sand | Clause 602.5 |
| (iv) Water | Clause 802.5 |

**1606.2.3. Construction** : The earthwork in excavation for catch water/intercepting drain shall be true to the specified lines, grades, levels and dimensions and in conformity to the requirements of Clause 302 and 304 of these Specifications. The excavated material shall be removed from the area adjoining the drain and if found suitable, utilized in sub-grade construction or filling work. All unsuitable material shall be disposed of as directed by the Engineer.

The excavated bed and sides of the drain shall be dressed to bring these to close conformity with the specified dimension, levels, and slopes.

The lining of the drain shall be cured for 7 days.

**1606.2.4. Measurements for payment** : Measurement for catch water/ intercepting drain shall be per running metre length of the drain. Disposal of surplus material shall be measured in cubic metres.

**1606.2.5. Rate** : The Contract unit rate for catch water/intercepting drains shall be payment in full for all items such as excavation, dressing the sides and bottom, providing masonry, concrete, pointing, plastering as specified, including full compensation for all material, labour, tools and other incidentals to complete the work as shown on the drawings and with all leads upto 1000 m and all lifts, for removal of unsuitable material.

**1606.3. Cement Concrete Causeways**

Flush Causeways and Vented Pipe Causeways shall be constructed conforming to the requirements of Section 1400 of these Specifications.

**1606.4. Pipe Culverts**

Pipe culvert shall be constructed conforming to the requirement of Section 1100 of these Specifications.

### 1606.5. Scupper

**1606.5.1.** Scupper is a cross drainage structure, provided on hill roads, made with locally available stone. This is constructed generally with dry stone masonry.

Design of dry stone scupper shall be as per plate 7.27 of Rural Roads Manual. Number of scuppers per km shall also be specified as per Rural roads Manual depending upon rainfall. When scuppers are constructed at inner curves top surface shall be in accordance with super-elevation.

In case, location of a scupper is likely to cause damage to a property or agricultural field, its location will be shifted by the Engineer.

**1606.5.2. Material :** Stone for scupper shall be hard, sound, free from decay, weathering, cavities, patches of loose or soft materials or other such defects that may adversely affect the strength of scupper. Stone with round surface shall not be used. The size of stone shall conform to the requirements of Clause 702.4. of these Specifications.

### 1606.5.3. Earthwork

**1606.5.3.1.** The earthwork in excavation for foundation of abutments, catch pit and flooring shall conform to the requirements of Clause 305 of these Specifications.

**1606.5.3.2.** Where stable rock is encountered, the rock shall be used as abutments, and breast walls in catch pits.

**1606.5.4. Construction** : The scupper shall be constructed as per details shown on the drawings.

The abutments, breast wall and Kharanja (stone on edge) shall be of random rubble dry stone masonry. The corbelling shall be of random rubble coursed dry stone masonry.

The cushion over corbelling shall be of thickness not less than 600 mm. The cushion shall be of hand packed stone, locally available or any other approved granular material compacted, conforming to the requirements of Clause 301.5.5 of these Specifications.

Where filled up soil or any other unsuitable strata is encountered, the whole structure shall be taken down to rest on suitable strata, as directed by the Engineer.





Generally, the scuppers shall have 1 m wide abutments until and unless specified differently in the drawings. The corbelling stone shall be provided preferably not less than 450 mm in length and not less than 150 mm wide and with a minimum thickness of 150 mm. There shall be 3 corbelling projections on each side with each projection being 150 mm preferably or as per design and drawings. Corbelling stones shall be collected in advance before the foundation excavation is permitted by the Engineer-in-Charge. These shall be hammer dressed.

**1606.5.4.1. Side retaining walls on both ends of scuppers:** Hill side and valley side retaining walls, i.e., on both ends of scuppers shall be with a batter of 1:3 (Horizontal : Vertical) towards outer-side. When the bed of water course is lower than the bed of scupper, the whole structure shall be taken down to firm base and thickness of cushion shall be increased accordingly.

**1606.5.4.2. Safe disposal of drainage water from scuppers :** It shall be ensured that water is disposed off safely from scuppers. It shall be led away from dwellings, fields, etc. to avoid damage. Drains leading to safe disposal points shall be lined if so required.

**1606.5.5. Measurements for payment** : The scupper shall be measured as complete work along its length (formation width of road) in metres. The catch pit shall not be measured separately.

**1606.5.6. Rate** : The Contract unit rate for scupper shall include the cost of complete work including catch pit and shall include full compensation for all labour, material, tools, equipment and other expenses incidental to the satisfactory completion of the work.

## 1607. PROTECTIVE WORKS

Protective works include retaining walls, breast walls, parapet walls, railings, edge stones, toe walls, check walls, river training structures, etc. which are required either for slope stabilization or safety against erosion in normal alignments or slope failure and erosion of toe for alignment along river banks. By hill-cutting, natural stability of hill slope gets disturbed. Soil movement may also cause instability of slopes. Their studies shall be done prior to road construction at design stage and appropriate structure shall be designed accordingly. Some structures are also needed to protect the public property which is disturbed due to road-construction.

**1607.1. Apron**

The work of apron shall be done in accordance with the requirements of Clause 1301 of these Specifications.

**1607.2. Pitching on Slopes**

The work of pitching on slopes shall be done in accordance with the requirements of Clause 1302 of these Specifications.

**1607.3. Rubble Stone/Brick Flooring over Cement Concrete Bedding**

The work of Rubble stone/Brick flooring over cement concrete flooring shall be done in accordance with the requirements of Clause 1303 of these Specifications.

**1607.4. Curtain Walls**

The work of curtain walls shall be done in accordance with the requirements of Clause 1304 of these Specifications.

**1607.5. Soil Erosion and Sedimentation Control**

The work of soil erosion and sedimentation control shall be done in accordance with the requirements of Clause 308 of these Specifications.

**1607.6. Bed Scouring**

The outside bed of a cross drainage structure or the outfall of a drain may be through a retaining wall and as such the water falls as a free fall which sometimes causes erosion of the toe of the wall at soft reaches. To check erosion at such points, one or a series of toe walls along with apron shall be constructed in order to break the water force and check scouring at the bed.

## 1608. SAFETY MEASURES

**1608.1. Traffic signs**

Traffic signs shall be provided in accordance with the requirements of Section 1701 of these Specifications.

**1608.2. Guide Posts**

The work shall consist of providing RCC guide posts of the size and shape and at locations as specified on the drawings.





**1608.2.1. Materials** : Materials for R.C.C. guide posts shall conform to relevant provisions of these Specifications as listed below:

| | | |
|---|---|---|
| (i) | Cement | Clause 802.2 |
| (ii) | Coarse Aggregate | Clause 802.3 |
| (iii) | Sand | Clause 802.4 |
| (iv) | Water | Clause 802.5 |
| (v) | Steel | Section 1000 |

**1608.2.2.** Guide Posts shall be of reinforced cement concrete of M 15 grade or as specified on the drawings or as directed by the Engineer.

The Guide Posts shall be 250 mm diameter and of height as specified on the drawings and embedded in concrete as indicated on the drawings.

The Guide Posts shall be white washed.

**1608.2.3. Measurements for payment** : The Guide posts and edge stones shall be measured in numbers.

**1608.2.4. Rate** : The Contract unit rate for Guide Posts shall be payment in full compensation for furnishing all labour, material, tools, equipment for preparing, supplying, fixing, white washing and all other incidental costs to complete the work.

**1608.2.5. Railings/Parapets** : The Railings/Parapets shall be provided in accordance with the requirements of Clause 1208 of these Specifications.

**1608.2.6. Edge Stones**

**1608.2.6.1.** Edge stones roughly dressed about 300 mm in height over the road level shall be provided on the valley side edge of formation as shown in Fig. 1600.5 or as shown on the drawings or as ordered by the Engineer, specially in areas prone to fog.

**1608.2.6.2.** Edge stones shall be of locally available rocks of sufficient length and white washed.

**1608.2.6.3.** Edge stones shall be measured in number.

**1608.3. Traffic Safety and Control**

**1608.3.1.** The Contractor shall take all necessary effective measures

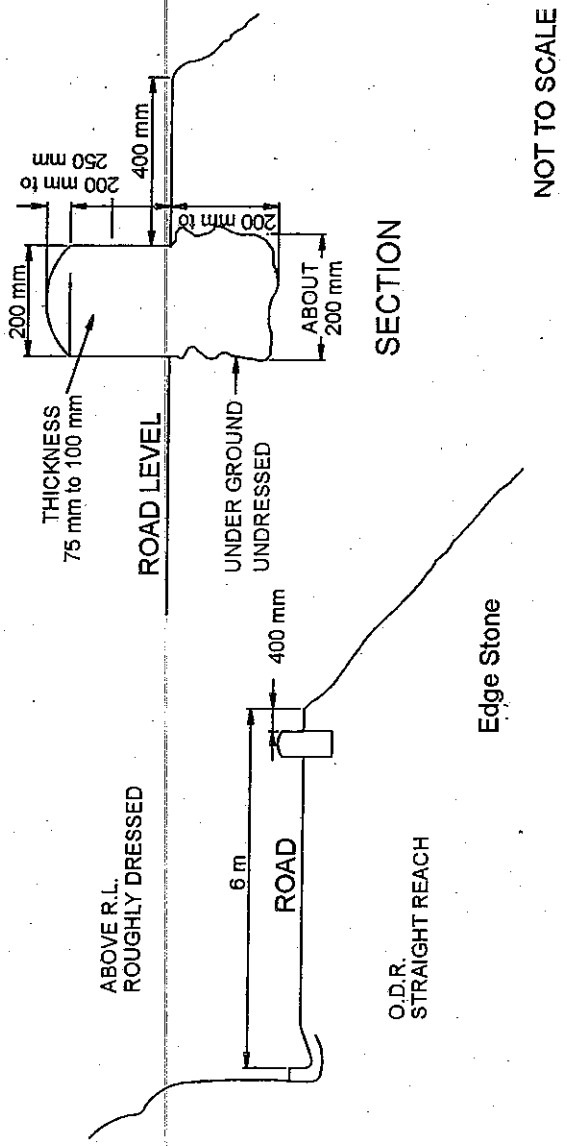



Fig. 1600.5.





for traffic safety and control in accordance to the requirements of Clause 111.2 of these Specifications.

### 1608.3.2. Precautions during blasting operations

**1608.3.2.1.** Blasting operations shall be carried out in accordance with the requirements of Clause 304 of these Specifications.

## 1609. PRECAUTIONS FOR SAFE GUARDING THE ENVIRONMENT

Precautions for safe guarding the environment shall conform to Clause 110 of these Specifications.

## 1610. HILL SLOPE PROTECTION

### 1610.1. Soil Erosion and Sedimentation Control

The Contractor shall take all necessary measures against soil erosion and sedimentation in conformity to the requirements of Clause 308 of these Specifications.

Cut-slopes shall be rendered stable in construction stage itself by cutting and ensuring appropriate hill cut slopes as specified in Clause 1602.1. Wherever necessary, cut/denuded slopes shall be treated with appropriate slope stabilization measures as provided in contract/agreement conditions.

**1610.1.1. Some aspects to be seen prior to hill-cutting** : Before start of hill road construction work, studies shall be done, such as, need for diversion, treatment of sensitive slopes and whether it shall be feasible to cut the disturbed hill slopes or some alternatives, like, bridges and tunnels shall be more stable, etc. Study of temporary erosion control measures between successive construction measures shall also be done and necessary mitigation measures may be adopted in the design. These studies shall be carried out in consultation with geological and forest department authorities. Identification of natural water courses shall also be done before hand because at certain locations, additional out burst of water from hill side drain may cause soil erosion. Toe-erosion near rivers and heavy flow of streams shall also be studied which causes subsidence of the hill road and necessary mitigation measurers shall be provided in the design.

### 1610.2. Turfing with Sods

**1610.2.1. Scope** : This work shall consist of furnishing and laying of the live sod of perennial turf forming grass on benched hill side slopes, embankment slopes, verges or other locations shown on the drawings or as directed by the Engineer. Unless otherwise specified, the work shall be taken up as soon as possible following construction of the embankment, provided the season is favorable for establishment of the sod. Pre-monsoon season is considered to be the best period for turfing with sods.

**1610.2.2. Materials** : The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be used, and shall be practically free from weeds or other undesirable matter. At the time the sod is cut, the grass on the sod shall have a length of approximately 50 mm and the sod shall have been freed of debris.

**1610.2.3.** Thickness of the sod shall be as uniform as possible, with some 50-80 mm or so of soil covering the grass roots depending on the nature of the sod, so that practically all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width, not less than about 250 mm x 300 mm in size but not so large that it is inconvenient to handle and transport these without damage. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality and prevent the dropping of the soil in handling.

### 1610.2.4. Construction Operations

**1610.2.4.1. Preparation of the earth bed:** The area to be sodded shall have been previously constructed to the required slope and cross section. Soil on the area shall be loosened, freed of all stones larger than 50 mm size, sticks, stumps and any undesirable foreign matter, and brought to a reasonably fine granular texture to a depth of not less than 25 mm for receiving the sod.

Where required, topsoil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be scarified to a depth which, after settlement, will provide the required nominal depth shown on the plans. Spreading shall not be done when the ground is excessively wet.





Following soil preparation and adding top soil, where required, fertilizer and ground limestone when specified shall be spread uniformly at the rate indicated on the plans. After spreading, the materials are incorporated in the soil by discing or other means to the depths shown on the plans.

**1610.2.4.2. Placing the sods:** The prepared sod bed shall be moistened to the loosened depth, if not already sufficiently moist, and the sod shall be placed thereon within approximately 24 hours after the same had been cut. Each sod strip shall be laid edge to edge and such that the joints caused by abutting ends are staggered. Every strip, after it is snugly placed against the strips already in position, shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil.

On side slopes steeper than 2 (horizontal) to 1 (vertical), the laying of sods shall be started from bottom upwards. At points where water may flow over the sodded area, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth placed over this followed by its thorough compaction.

**1610.2.4.3. Staking the sods:** Where the side slope is 2 (horizontal) to 1 (vertical) or steeper and the distance along the slope is more than 2 m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000 mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

**1610.2.4.4. Top dressing:** After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign materials. Thereafter, a thin layer of topsoil shall be scattered over the surface of top dressing and the area thoroughly moistened by sprinkling with water.

**1610.2.4.5. Watering and maintenance:** The sods shall be watered by the Contractor for a period of at least four weeks after laying. Watering shall be so done as to avoid erosion and prevent damage to sodded areas by wheels of water tanks.

The Contractor shall erect necessary warning signs and barriers, repair or replace sodded areas failing to show uniform growth of grass or damaged by his operations and shall otherwise maintain the sod at his cost until final acceptance.

**1610.2.5. Measurements for payment** : Turfing with sods shall be measured as finished work in square metres.

**1610.2.6. Rate :** The Contract unit rate for turfing with sods shall be payment in full for carrying out all the required operations explained above including compensation for:

(i) furnishing all the materials to be incorporated in works with all leads and lifts; and

(ii) all labour, tools, equipments and incidentals to complete the work in accordance with these Specifications.

The Contract unit rate of the items of stupping and storing top soil and of application of top soil shall include full compensation for all the necessary operations including all lifts, but lead of 1000 m.

### 1610.3. Seeding and Mulching

#### 1610.3.1. Scope

This shall consist of preparing slopes, placing topsoil, furnishing all seeds, commercial or organic fertilizers and mulching materials, providing jute netting and placing and incorporating the same on embankment slopes or other locations designed by the Engineer or shown in the Contract documents.

#### 1610.3.2. Materials

**A. Seeds:** The seeds shall be of approved quality and type suitable for the soil on which these are to be applied, and shall have acceptable purity and germination to requirements set down by the Engineer. Fertilizer shall consist of standard commercial material and conform to the grade specified. Organic manure shall be fully putrefied organic matter such as cow dung.

Mulching materials shall consist of straw, hay, wood shaving or sawdust, and shall be delivered dry. They shall be reasonably free of weed seed and such foreign materials as may detract from their effectiveness as a mulch or be injurious to the plant growth.

**B. Topsoil:** Topsoil shall not be obtained from an area known to have noxious weeds growing in it. If treated with herbicides or sterilents, it shall be got tested by appropriate agricultural authority to determine the residual in the soil. Topsoil shall not contain less than 2 per cent and more than 12 per cent organic matter.





**C. Bituminous Emulsion:** A suitable grade of bituminous cutback or emulsion used as a tie down for mulch shall be as described in the Contract document or as desired by the Engineer. Emulsified bitumen shall not contain any solvent or diluting agent toxic to plant life.

**D. Netting:** Jute netting shall be undyed jute yarn woven into a uniform open weave with approximate 25 mm square openings.

Geonetting shall be made of uniformly extruded rectangular mesh having mesh opening of 20 mm x 20 mm.

#### 1610.3.3. Seeding operations

**1610.3.3.1. Seed-bed preparation:** The area to be seeded shall be brought to the required slope and cross-section by filling, reshaping eroded areas and refinishing slopes, medians, etc. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans, unless otherwise approved by the Engineer. The seed-bed preparation shall consist of eliminating all live plants by suitable means using agricultural implements. All stones 150 mm in smallest dimension and larger shall be removed. The soil shall be excavated on the contour to a depth of 100 mm . All clods larger than 25 mm in diameter shall be crushed and packed. Where necessary, water shall then be applied. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be done by slope compactor, cleated tractor or similar equipment approved by the Engineer. Equipment shall be so designed as to produce a uniform rough textured surface ready for seeding and mulching and which will bond the topsoil to the underlying material. The entire area shall be compacted by a minimum of 4 passes or 2 round trips of the roller or approved equipment.

**1610.3.3.2. Fertilizer application:** Required quantity of fertilizer shall be spread and thoroughly incorporated into the soil surface as part of the seed-bed preparation.

**1610.3.3.3. Planting of seeds:** All seeds shall be planted uniformly at the approved rate immediately after sowing, the area shall be rake dragged or otherwise so as to cover the seeds to a depth of 6 mm.

The operation of seed sowing shall not be performed when the ground is muddy or when the soil or weather conditions would otherwise prevent proper soil preparation and subsequent operations.

**1610.3.3.4. Soil moisture and watering requirements:** Soil-moisture shall exist throughout the zone from 25 mm to atleast 125 mm below the surface at the time of planting.

Watering of the seeded areas shall be carried out as determined by the Engineer.

**1610.3.3.5. Applying, mulching bituminous emulsion and/or jute netting/geonetting** : Within 24 hours of seeding, mulching material mixed with organic manure shall be placed so as to form a continuous, unbroken cover of approximate uniform thickness of 25 mm using an acceptable mechanical blower. Mulching material shall be held in place and made resistant to being blown away by suitable means approved by the Engineer. When called for in the Contract documents, mulch material shall be anchored in place with bituminous emulsion applied at the rate of 2300 litres per hectare. Any mulch disturbed or displaced following application shall be removed, reseeded and remulched as specified. In case of treatment with Geogrids, Jute netting/Geonetting shall be unrolled and placed parallel to the flow of water immediately after bringing, the slope surface to finished grade, the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they shall have a minimum overlap of 100 mm. Jute netting/Geonetting shall be held in place by approved wire staples, pins, spikes or wooden stakes driven vertically into the soil. The upper and lower ends of the grids shall be secured by anchoring the ends into the trenches dug for this purpose and, after anchoring the ends, refilled with the same material.

**1610.3.3.6. Maintenance** : The Contractor shall maintain all seeded and mulched areas until final acceptance. Maintenance shall include protection of traffic by approved warning signs or barricades and repairing any areas damaged following the seeding and mulching operations. If mulched areas become damaged, the area shall be reshaped and then seeded and mulched again as originally specified.

**1610.3.3.7. Measurements for payment** : Seeding and mulching shall be measured as finished work in square metres.

**1610.3.3.8. Rate** : The Contract unit rate for seeding and mulching shall be payment in full for carrying out all the required operations including full compensation for all materials, labour, tools and incidentals.





## 1611. REMOVAL OF LANDSLIDES (SLIP-CLEARANCE)

### 1611.1. Scope

Due to land slides, along disturbed hill slopes the roadway width for traverse of traffic gets reduced specially during monsoons. Immediate removal of slips/debris from the road shall be done so as to make full width of road way available to traffic.

### 1611.2. Construction Operations

The debris shall be removed by manual labour (in case of small quantity) and by machinery (bull dozer, etc.) in case of large quantities. Since land slides on existing roads do not have any regular geometrical shape and types and size of debris also varies greatly, as such, the contract agreement for removal of road side debris shall be based on lump sum rate.

### 1611.3. Measurements of Quantity of Debris

This shall be measured before hand prior to its removal. For the purpose of departmental assessment of quantity, the debris shall be divided into several parts so that each part is somewhat of a regular geometrical shape. Quantity of such parts shall be computed on the basis of mean length, mean width and mean height. Where the slide mass is largely sloped, it shall be measured as maximum length at road level X maximum width at road level X maximum height from road level X factor 2/9.

### 1611.4. Rate

The payment shall be done on lump sum basis including labour, material, tools & plants, equipment for preparing smooth surface clear of the entire debris by achieving original surface and level of the existing road.

## 1612. CAUSEWAYS

### 1612.1. Scope

It is a low cost submersible structure with or without openings with paved dip over which stream water shall pass with short period of interruption to traffic during rainy season and is designed for streams with a velocity of less than 6 m per sec.

These can be flush, low level, or high level causeways depending on

type of construction. Length of causeway shall be sufficient to accommodate shock free vertical curves.

### 1612.2. Construction

It shall be done as per paras 7.1.1 to 7.1.5 of Rural Roads Manual. Necessary dip for causeway shall be provided in the longitudinal section at the design stage. Road top level above the bed shall be as low as possible. Headwall in elevation shall be of trapezoidal shape blending smoothly with the natural cross-section of the water course with desirable grade 1:30. In erosive area apron shall be provided for down stream protection as per Rural Roads Manual. The location of causeway shall be shifted upstream or downstream to achieve the desired design bed level and appropriate level of edges of causeway.





# 1700

# Traffic Signs, Markings and Other Road Appurtenances

## 1701. TRAFFIC SIGNS

### 1701.1. Scope

The work covers supplying and installing traffic signs conforming to IRC:67 complete in all respects in accordance with these Specifications and as approved by the Engineer.

### 1701.2. General

**1701.2.1.** The colour, configuration, size and location of all traffic signs for roads shall be in accordance with the Code of Practice for Road Signs, IRC:67, or as shown on the drawings. In the absence of any details or for any missing details, the same shall be provided as directed by the Engineer.

**1701.2.2.** The signs shall be semi-reflective, as shown on the drawings, fixed over mild steel sheeting duly stove enameled in white colour in front and grey colour on back, red engineering grade tape on borders and required message in non-reflective black sheeting of engineering grade tape as per Clause 1701.3.7 of these Specifications.

Road signs, in particular, the cautionary/warning signs and mandatory/ regulatory signs in the approaches of level crossings or narrow bridges may be reflectorised using luminous paints or other similar reflective material.

**1701.2.3.** It is desirable that cautionary/warning and mandatory signs are fabricated through process of screen printing. In case the facility is not locally available in the region of work, these signs and informatory signs may have inscription/message having cut letters of non-reflective black sheeting which shall be bonded well or the base sheeting as directed by the Engineer.

**1701.2.4.** The sizes and dimensions of different categories of signs shall be in accordance with IRC:67.

**1701.2.5.** Language of inscription and font for informatory signs shall be in accordance with IRC:67.

**1701.2.6.** The informatory signs shall have prescribed diamond type logo (600 mm x 600 mm) of Pradhan Mantri Gram Sadak Yojana on top of sign board as shown in Fig. 1700.1.

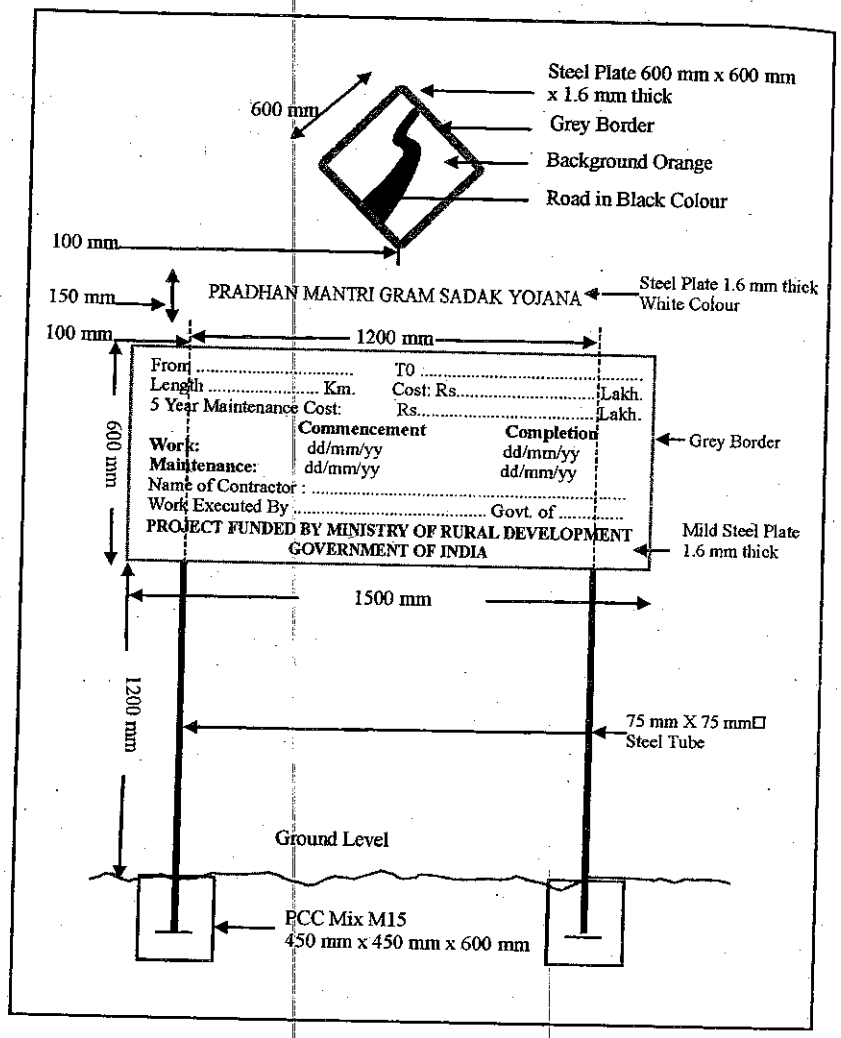



**Fig. 1700.1. Typical PMGSY Logo & Informatory Sign Board**





**1701.2.7. Typical PMGSY logo and informatory sign board :** The specifications and design of typical PMGSY Informatory Sign Board shall be as given in ***Annexure-1700.1*** of these Specifications duly approved by the Engineer.

### 1701.3. Materials

The various materials and fabrication of the traffic signs shall conform to the following requirements:-

**1701.3.1. Concrete** : Concrete for footing shall be of the grade shown on the Contract drawings or of minimum M15 grade conforming to Section 801 of these Specifications.

**1701.3.2. Reinforcing steel** : Reinforcing steel shall conform to the requirement of IS:1786 unless otherwise shown on the drawing.

**1701.3.3. Bolts, nuts, washers** : High strength bolts shall conform to IS:1367.

**1701.3.4. M.S. Sheets, Plates and supports** : Plates and support sections for the sign posts shall conform to IS:2062 or any other relevant IS Specifications.

**1701.3.5. Reflectorised paint** : Reflectorised paint shall conform to IS:5 or the manufacturer's specifications in case of proprietary product and as approved by the Engineer.

**1701.3.6. Non reflectiorised paint** : Non-reflectorised paint shall conform to IS:164 and as approved by the Engineer.

**1701.3.7. Engineering grade sheeting :** This sheeting shall be enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lens optical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM Standard) as indicated in Table 1700.1.

When totally wet, the sheeting shall not show less than 90 per cent of the values, of retro-reflection indicated in Table 1700.1. At the end of 5 years, the sheeting shall retain at least 50 per cent of its original retro-reflectance.

TABLE 1700.1 : ACCEPTABLE MINIMUM COEFFICIENT OF RETRO-REFLECTION FOR ENGINEERING GRADE SHEETING (CANDEL AS PER LUX PER SQUARE METRE)

| Observation angle in degree | Entrance angle in degree | White | Yellow | Orange | Green | Red | Blue |
|---|---|---|---|---|---|---|---|
| 0.2 | -4 | 70 | 50 | 25 | 9.0 | 14.5 | 4.0 |
| 0.2 | +30 | 30 | 22 | 7.0 | 3.5 | 6.0 | 1.7 |
| 0.5 | -4 | 30 | 25 | 13.5 | 4.5 | 7.5 | 2.0 |
| 0.5 | +30 | 15 | 13 | 4.0 | 2.2 | 3.0 | 0.8 |

**1701.3.8.** Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick. All others shall be at least 2 mm thick. The thickness of the sheet shall be related to the size of the sign board and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.

**1701.3.9.** In respect of sign sizes not covered by IRC:67, the structural details (thickness, etc.) shall be as per the approved drawings.

### 1701.4. Installation

**1701.4.1.** Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally signs with an area upto 0.9 sq.m can be mounted on a single post and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or Galvanised Iron (G.I.) posts and should be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

**1701.4.2.** All components of signs and supports, other than the reflective portion and G.I. posts shall be thoroughly de-scaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.

**1701.4.3.** The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced concrete or G.I. posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.





**1701.4.4.** Mild steel sheets of sign boards shall be stove enameled on both sides in furnace at required temperature, the lettering, borders shall be painted with ready mix synthetic enamel paint of superior quality in required shade and colour as specified.

### 1701.5. Measurements for Payment

The measurement of standard cautionary, mandatory and facility information signs shall be in numbers of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square metres.

### 1701.6. Rate

The Contract unit rate shall be payment in full for the cost of making the road sign including all materials and installing it at the site and incidentals to complete the work to the Specifications.

## 1702. ROAD MARKINGS

### 1702.1. Scope

The work covers providing road markings at site including supply of materials and carrying out the work in-accordance with IRC:35 and these Specifications.

### 1702.2. General

The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints IRC:35 and as specified in the drawings. No centreline marking shall be done on single-lane roads.

### 1702.3. Materials

Ordinary paints shall be used for road markings, conforming to IS:164. These shall have a wear resistance of at least 4 hours under accelerated laboratory test. Yellow colour (conforming to IS colour No. 356) as given in IS:164, white and black colours are the standard colours used for markings.

### 1702.4. Application

**1702.4.1.** Painting may be done by machine or by hand (preferably by machine). The Contractor shall maintain traffic control while painting

operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

**1702.4.2.** The finished lines shall be free from ruggedness on sides and ends and be in true plane with the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

### 1702.5. Measurements for Payment

The painted markings shall be measured in linear metres with no deductions for intermediate gaps as shown on the drawings.

In respect of markings, like, directional arrows and lettering, etc. the measurement shall be by numbers.

### 1702.6. Rate

The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, and carrying out the markings at site as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications.

## 1703. 200 m/KILOMETRE STONES

### 1703.1. Scope

The work covers the supply, painting, lettering and fixing of distance measurement stones and shall include:

(i) 200 metre stones

(ii) Kilometre stones

(iii) 5th kilometre stones

### 1703.2. Materials

The 200 m/kilometre stones may be made of local stones, concrete or any other material locally available and approved by the Engineer. The stones shall be bedded into the ground to a minimum grip of 600 mm with adequate plain cement concrete M10 grade foundations or as indicated in the drawings.

### 1703.3. Design

**1703.3.1.** The dimensions of the stones, size, arrangement of letters





and script shall be as per Plates 1 to 3 of and IRC:8 and IRC:26. The background colour shall be white with black letters and numerals for names of stations and distances. The semi-circular portion of km and 5th km stones of village roads shall have orange background with route numbers painted with black colour.

**1703.3.2.** Kilometre stones shall be located on left side of the road as one proceeds from the station from which the kilometre count starts and shall be fixed at right angles to the line of the carriageway.

**1703.3.3.** These shall be located on the edge of roadway beyond the shoulders, if necessary on specially erected platforms. In cut sections, these shall be fixed clear of the shoulders and drains as shown in Plate 6 of IRC:8.

**1703.3.4.** The inscription on Kilometre stones fixed shall be in Hindi in Devnagri script or the script of the recognized regional language at the discretion of the State Road Authority.

**1703.3.5.** Numerals on Kilometre stones shall be inscribed in the international form of Indian numerals. Local or Devnagri numerals shall not be permitted to be used.

**1703.3.6.** Letters and numerals on Kilometre stones shall be of the following size:

| | |
|---|---|
| Height of Letters for Place Name | 80 mm |
| Height of Numerals for Kilometerage | 130 mm |
| Height of Numerals for Route Numbers | 100 mm |

**1703.3.7.** Spacing between adjacent letters/numerals shall be as shown in Table 1 of IRC:8.

The other edge clearance should be as given below:

| | |
|---|---|
| Top | 50 mm |
| Bottom | 75 mm |
| Sides | 50 mm |
| Spacing between Lines | 50 mm |

### 1703.4. Measurements for Payment

The measurement will be in numbers of 200 m, kilometre and 5th kilometre, stones fixed at site.

### 1703.5. Rate

The Contract unit rate for 200 m/kilometre/5th kilometre stones shall be payment in full compensation for furnishing all labour, materials, tools, equipment and making the stones, painting and lettering and fixing at site and all other incidental costs necessary to complete the work to these Specifications.

## 1704. BOUNDARY STONES

### 1704.1. Scope

The work comprises of supplying and fixing boundary stones as per designs and Specifications given in IRC:25 and at locations indicated in the drawings or as directed by the Engineer.

### 1704.2. Measurements for Payment

The measurement shall be made in numbers of boundary stones fixed at site.

### 1704.3. Rate

The Contract unit rate for boundary stones shall be payment in full compensation for furnishing all labour, materials, tools, equipment for preparing, supplying and fixing and all other incidental costs necessary to complete the work to these Specifications.

## 1705. FENCING

### 1705.1. General

**1705.1.1. Scope** : The work comprises of fixing R.C.C. M15 grade concrete posts and providing barbed wire fencing including necessary stays and entry gates as shown in the drawing(s) or as directed by the Engineer.

**1705.1.2. Materials** : The R.C.C. posts shall be of size indicated in the drawings and embedded in concrete block to a depth not less than 600 mm below ground or as indicated in the drawings.

The barbed wire shall be of galvanized iron and shall conform to IS:278.

Entry gate(s) shall be made of tubular steel pipes conforming to IS:1239 or wooden plank as per the design shown in the drawing(s).





**1705.1.3. Measurements for payment** : The measurement shall be in running metres of fencing and in square metres for fencing including the entry gates.

**1705.1.4. Rate** : The Contract unit rate for fencing including entry gates shall be payment in full compensation for furnishing all labour, materials, tools, equipment for fabrication and fixing at site and all other incidental costs necessary to complete the work to these Specifications.

## 1706. RAILINGS

### 1706.1. Scope

The work shall consist of supplying, fixing and erecting tubular steel or R.C.C. railings as shown on the drawings or as directed by the Engineer.

### 1706.2. Materials

The railings shall be either of tubular steel conforming to IS:1239 or R.C.C. in M20 grade conforming to Section 800 of these Specification. The R.C.C. railings shall be painted white with ordinary paint conforming to IS:164 or white washed with minimum three coats, or as directed by the Engineer.

**1706.3.** The fabrication and painting of tubular steel railings except for the final coat shall be completed before dispatch to the site. Prior to the painting, all surfaces shall be grit blasted to the satisfaction of the Engineer and pickled. The priming coat of paint shall be applied as soon as the steel has dried and is still warm. The final three coats of paints shall be applied after erection of the railings.

### 1706.4. Measurements for Payment

The railings will be measured in linear metres from end to end along the face of the railings, including end and intermediate posts, with no deductions for gaps as shown on the drawings.

### 1706.5. Rate

The Contract unit rate for R.C.C. or tubular steel railings shall be payment in full compensation for furnishing all labour, materials, tools, equipment and plants required for fabrication, connection, oiling, painting, white washing, temporary erection, inspection, test and final erection at site and all other incidental costs necessary to complete the work to these Specifications.

*Annexure-1700.1*

## SPECIFICATIONS FOR PMGSY INFORMATORY SIGN BOARD

A typical design of PMGSY Informatory Sign Board is shown in Fig. 1700.1. The specification and installation details of the typical sign board are given below:

(i) The board will be a composite unit consisting of three M.S. Plates of 1.6 mm thickness (16 SWG). The top most plate will be in diamond shape of 600 mm x 600 mm size, welded over welded M.S. flat iron frame of 25 mm x 5 mm size on back on edges. The middle plate will be 1200 mm x 150 mm size welded over welded M.S. flat iron frame of 25 mm x 5 mm size on back on edges. The main lower most M.S. plate will be 1500 mm x 600 mm size, welded over welded M.S. angle iron frame of 25 mm x 25 mm x 5 mm size. Welding of all the sheets over angle and flat iron frame will be done neatly to have plain surface on one side. The angle iron frame of the lower most plate and flat iron frame of the middle plate will be welded to two nos. 75 mm x 75 mm (12 SWG) sheet tubes posts placed at 1125 mm apart centre to centre. The top of the middle plate will be flushed with the top of 75 mm dia medium steel tube posts and these posts will be embedded in cement concrete M15 grade blocks of 450 mm x 450 mm x 600 mm below ground level. The height of bottom of the lower most plate will be 1200 mm from normal ground level and the bottom of middle plate will be 100 mm above the top level of the lower most plate. The diamond shaped plate mounted over flat iron frame will be connected to middle plate by square steel section of 47 mm x 47 mm thickness 12 SWG having a spacing of 100 mm between the diamond shaped plate and middle plate and this square section will be welded to the bottom point of the diamond shaped plate.

(ii) All M.S. plates will be stove enameled on both sides in furnace at required temperature; the lettering and borders, etc. of middle and bottom plate, PMGSY logo on top plate and back of all steel plates will be painted with ready mixed synthetic enamel paints of superior quality in required shade and colour as specified. All the sections for frame and posts will be painted with primer and two coats of Epoxy paint. The steel tube below ground level will be painted with three coats of Epoxy paint. The design, painting and lettering will be done as per approved drawing.





# 1800

# Quality Control

## 1801. GENERAL

**1801.1.** Appropriate quality control shall be exercised on all materials to be used, all procedures adopted and all works executed in conformance to the requirements of these Specifications. A three-tier system of quality control and quality monitoring shall be adopted as under :

**1801.1.1.** At the first tier, the District Programme Implementation Unit (DPIU) which is the executing agency, has the primary responsibility to perform all mandatory quality control tests and ensure the reliability of the test results. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with the needed equipment (***Annexure-1800.1***) and provide adequately trained personnel to carry out all the required tests and quality control work as per Specifications and/or as directed by the Engineer. The Contractor shall carry out quality control tests on all materials and works to the stipulated frequency as detailed in Clause 1803. In the absence of clear indications about the method of testing and/or frequency of tests for any item, the instructions of the Engineer shall be followed.

**1801.1.2.** At the second tier, periodic inspections of works shall be carried out by the State Quality Control Units/Monitors, set up/engaged by the State Government, independent of the Executing Agency/Programme Implementation Units. There shall be a State Quality Control Coordinator (SQC) of the rank of Superintending Engineer or above to coordinate and supervise first tier quality control as well as to facilitate and coordinate the third tier quality control. The State Quality Monitors at the second tier of quality control shall inspect every work at least two times; the first inspection shall be during the execution of the work and the second, on completion of the work but not more than one month after completion. A monthly schedule for State Quality Monitors shall be drawn up by the State Quality Coordinator to ensure a systematic coverage.

**1801.1.3.** At the third tier, the National Quality Monitors (NQM), engaged directly by the National Rural Road Development Agency, shall carry out inspection of ten to twelve works spending about three days in every district. The role of NQMs shall be to provide guidance to undertake random checks, where required and suggest improvements in the working of the Executing Agency rather than exercising hardcore quality control.

**1801.2.** During the work on embankment, subgrade and pavement, the construction of subsequent layer shall be carried out after obtaining

permission of the Engineer. Similar permission from the Engineer shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

**1801.3.** The Contractor shall carry out any modifications in the procedure of work, if found necessary during inspections at any of the three tiers of quality control as outlined in Clauses 1801.1.1, 1801.1.2 and 1801.1.3 or as directed by the Engineer. Works falling short of quality shall be rectified/redone by the Contractor at his own cost, and defective work shall also be removed from the site of works by the Contractor at his own cost.

**1801.4.** The cost of laboratory building including services, essential supplies like water, electricity, sanitary services and their maintenance and cost of all equipment, tools, materials, labour and incidentals to perform tests and other operations of quality control according to the Specification requirements shall be deemed to be incidental to the work and no extra payment shall be made for the same.

**1801.5.** For testing of samples of soils/soil mixes, granular materials and mixes, bituminous materials and mixes, aggregates, cores, etc. samples in the required quantity and form shall be supplied to the Engineer by the Contractor at his own cost.

**1801.6.** For cement, bitumen, mild steel, and similar other materials where essential tests are to be carried out at the manufacturer's plant or at laboratories other than the site laboratory, the cost of samples, sampling, testing and furnishing of test certificates shall be borne by the Contractor. He shall also furnish the test certificates to the Engineer.

**1801.7.** For testing of cement concrete at site during construction, arrangements for supply of samples, testing and supply of test results shall be made by the Contractor as per the frequency and number of tests specified in the PMGSY Handbook on Quality Control: Road Works issued by the NRRDA, January, 2003 and relevant IS Codes or relevant clauses of these Specifications, the cost of which shall be borne by the Contractor.

**1801.8.** The method of sampling and testing of materials shall be as required by the PMGSY Handbook on Quality Control : Road Works, issued by the NRRDA, January, 2003. Where they are contradicting, the provision in these Specifications shall be followed. Where they are silent,





sound engineering practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contractor.

**1801.9.** The materials for embankment construction shall be got approved from the Engineer. The responsibility for arranging and obtaining the land for borrowing or exploitation in any other way shall rest with the Contractor, who shall ensure smooth and uninterrupted supply of materials in the required quantity during the construction period.

Similarly, the supply of aggregates for construction of road pavement shall be from quarries approved by the Engineer. Responsibility for arranging uninterrupted supply of materials from the source shall be that of the Contractor.

**1801.10.** All materials which the Engineer/his representative has determined as not conforming to the requirements of the contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials, which have been subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with any order of the Engineer/his representative, given under this Clause, the Engineer/his representative shall have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payments due to the Contractor.

## 1802. CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY

### 1802.1. General

All works performed shall conform to the lines, grades, cross-sections and dimensions shown on the drawings or as directed by the Engineer, subject to the permitted tolerances described hereinafter.

### 1802.2. Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centerline of the carriageway as shown on the drawings. The permitted tolerances for the edges of the carriageway and for the edges of the roadway and lower layers of pavement in plain and rolling terrains and in hilly terrain are given below :

| | Permitted Tolerances | |
|---|---|---|
| | *In Plain & Rolling Terrains* | *In Hilly Terrains* |
| Edges of carriageway | ± 20 mm | ± 30 mm |
| Edges of Roadway and lower layers of pavement | ± 30 mm | ± 50 mm |

### 1802.3. Surface Levels

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in Table 1800.1.

**TABLE 1800.1 : TOLERANCES IN SURFACE LEVELS**

| | |
|---|---|
| (1) Subgrade | + 20 mm<br>– 25 mm |
| (2) Sub-base | |
| (a) Flexible pavement | + 10 mm<br>– 20 mm |
| (b) Concrete pavement | + 6 mm<br>– 10 mm |
| [(b) lean concrete or rolled Concrete] | |
| (3) Base-course for flexible pavement | |
| (a) Bituminous course | + 6 mm<br>– 6 mm |
| (b) Other than bituminous | |
| (i) Machine laid | + 10 mm<br>– 10 mm |
| (ii) Manually laid | + 15 mm<br>– 15 mm |
| (4) Wearing course for flexible pavement | |
| (a) Machine laid | + 6 mm<br>– 6 mm |
| (b) Manually laid | + 10 mm<br>– 10 mm |
| (5) Cement concrete pavement | + 5 mm<br>– 6 mm* |

* This may not exceed –8 mm at 0-300 mm from the edges.





Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than 6 mm for flexible pavements and 5 mm for concrete pavements.

For checking compliance with the above requirement for subgrade, sub-base and base courses, measurements of the surface levels shall be taken on a grid of points placed at 10 m longitudinally and 2.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

For checking the compliance with the above requirement for bituminous wearing courses and concrete pavements, measurements of the surface levels shall be taken on a grid of points spaced at 6.25 m along the length and at 0.5 m from the edges and at the centre of the pavement. In any length of pavement, compliance shall be deemed to be met for the final road surface, only if the tolerance given above is satisfied for any point on the surface.

### 1802.4. Surface Regularity of Pavement Courses

The maximum allowable difference between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centreline of the road at points decided by the Engineer shall be as under:

| Type of Construction | Maximum Permissible Undulation Measured with 3m Straight Edge | |
|---|---|---|
| | Longitudinal Profile | Cross Profile |
| Subgrade | 20 mm | 15 mm |
| Granular Sub-base | 12 mm | 10 mm |
| Stabilized Soil Layer | 12 mm | 10 mm |
| W.B.M Grade I | 15 mm | 12 mm |
| W.B.M Grade II/Grade III | 12 mm | 8 mm |
| Wet Mix Macadam Base | 10 mm | 8 mm |
| Surface Dressing | 10 mm | 12 mm |
| Built-up Spray Grout | 12 mm | 8 mm |
| 20 mm Bituminous Premix Carpet | 8 mm | 8 mm |
| Bituminous Macadam | 12 mm | 8 mm |
| Mix Seal Surfacing | 8 mm | 8 mm |
| Cement Concrete | 6 mm | 6 mm |

### 1802.5. Rectification

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

(i) **Subgrade** : Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirement of Clause 303.

(ii) **Granular Sub-base** : Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401.

(iii) **Lime/Cement Stabilized Soil Sub-base** : For lime/cement treated materials where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. However, where the surface is low, the same shall be corrected as described hereinbelow.

For cement treated material, when the time elapsed between detection of irregularity and the time of mixing of the material is less than 2 hours, the surface shall be scarified to a depth of 50 mm supplemented with freshly mixed materials as necessary and recompacted to the relevant specification. When this time is more than 2 hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to Specification. This shall also apply to lime treated material except that the time criterion shall be 3 hours instead of 2 hours.

(iv) **Water Bound Macadam/Wet Mix Macadam Sub-base/Base** : Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 405. This shall also apply to wet mix macadam to Clause 406.

(v) **Bituminous Constructions** : For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recompacting to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3.5 m in width.





(vi) **Dry Lean Concrete Sub-base/Rolled Cement Concrete** : The defective length of the course shall be removed to full depth and replaced with material conforming to Section 1500, as applicable. The area treated shall be at least 3 m long, not less than 1 lane wide and extend to the full depth. Before relaying the course, the disturbed subgrade or layer below shall be corrected by levelling, watering and compaction.

(vii) **Cement Concrete Pavement** : The defective areas having surface irregularity exceeding the specified limits may be rectified by bump cutting or scabbling or grinding using approved equipment. When required by the Engineer, areas which have been reduced in level by the above operation(s) shall be retextured in an approved manner either by cutting grooves (5 mm deep) or roughening the surface by hacking the surface. If high areas in excess of 6 mm or low areas in excess of 3mm occur, exceeding the permitted numbers and if the Contractor cannot rectify, the slab shall be demolished and reconstructed at the Contractor's expense and in no case the area removed shall be less than the full width of the lane in which the irregularity occurs and full length of the slab.

If deemed necessary by the Engineer, any section of the slab which deviates from the specified levels and tolerances, shall be demolished and reconstructed at the Contractor's expense.

## 1803. QUALITY CONTROL TESTS DURING CONSTRUCTION

### 1803.1. General

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the preceding Clauses.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in Tables 1800.2 to 1800.7 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer.

### 1803.2. Tests on Earthwork, Subgrade, Granular Sub-base/Base/ Wearing Courses

**Borrow Material :** Grid the borrow area at 25 m c/c (or closer, if the variability is high) to full depth of proposed working. These pits should be logged and plotted for proper identification of suitable sources of material. The following tests on representative samples shall be carried out :

(a) Sand content (IS:2720 Part 4), one test per 4000 cu.m of soil

(b) Plasticity Test [IS:2720 (Part 5)] : Each type to be tested, one test per 4000 cu.m of soil

(c) Compaction Test [IS:2720 (Part 7)] : Each soil type to be tested, one test per 4000 cu.m of soil

(d) Deleterious Content Test [IS:2720 (Part 27)] : As and when required by the Engineer

(e) Natural Moisture Content Test [IS:2720 (Part 2)] One test for every 500 cu.m of soil

(f) CBR Test on materials to be incorporated in the Subgrade on soaked samples [IS : 2720 (Part 16)] : One CBR test for every 5000 cu.m atleast or closer as and when required by the Engineer.

**Tests on Earthwork, Subgrade, Granular Sub-base/Base/Wearing Courses** : The types of tests, their frequency and related acceptance criteria on Earthwork, Subgrade, Granular Sub-base/Base/Wearing courses shall be as given in Table 1800.2.

**TABLE 1800.2 : FREQUENCY OF TESTS FOR EARTHWORK, SUBGRADE, GRANULAR SUB-BASE/BASE/WEARING COURSES**

| Sl. No. | Type of Test | Frequency |
|---|---|---|
| (1) | **Earthwork** | |
| | (a) Placement moisture content (IS:2720 Part 2) | 1 in 250 cu.m for each layer, subject to a maximum of 4 tests per day |
| | (b) Degree of compaction (IS:2720 Part 28) | One set of the tests per 2000 m area comprising 5 to 6 measurements |
| | (c) CBR of subgrade on remoulded samples (IS:2720 Part 16) | As required |





| | | |
|---|---|---|
| (2) | **Granular Sub-base/Base/Wearing Courses (Other than WBM)** | |
| | (a) Gradation (IS:2720 Part 4) | 2 tests per 500 cu.m subject to a minimum of 2 tests per day |
| | (b) Atterberg's Limits (IS:2720 Part 5) | 2 tests per 500 cu.m subject to a minimum of 2 tests per day |
| | (c) Placement moisture content (IS:2720 Part 2) | 2 tests per 500 cu.m subject to a minimum two tests per day |
| | (d) Degree of compaction (IS:2720 Part 28) | One set of tests per 2000 sq.m comprising 5 to 6 measurements |
| | (e) CBR (IS:2720 Part 16) | 1 in 1000 cu.m |
| (3) | **Lime/Cement/Lime-GBFS/Lime-Flyash Stabilised Sub-base** | |
| | (a) Pulverisation of soil | Regularly |
| | (b) Purity of Lime (IS:1514) | 1 in 5 tonnes of lime or for each lot |
| | (c) Placement moisture content (IS:2720 Part 2) | 2 tests per 500 cu.m subject to minimum two tests per day |
| | (d) Degree of compaction (IS:2720 Part 28) | One set of tests per 2000 sq.m comprising 5 to 6 measurements subject to minimum two tests per day |
| | (e) CBR or Unconfined Compresive Strength test on a set of 3 specimens (IS:2720 Part 16) (IS:4332 Part 5) | 1 in 100 cu.m subject to a minimum one test per day |
| (4) | **WBM Courses** | |
| | (a) Aggregate Impact Value of Stone Aggregates (IS:2386 Part 4) | 1 in 250 cu.m or source |
| | (b) Grading of aggretates and screenings (IS:2386 Part 1) | 2 tests per 250 cu.m or per day |
| | (c) Flakiness Index (IS:2386 Part 1) | 1 in 250 cu.m or per day |
| | (d) Atterberg's Limits of binding material (IS:2720 Part 5) | 1 to 50 cu.m or per day |
| | (e) Water Absorption (IS:2386 Part 3) | 1 test per source |

(5) **Wet Mix Macadam**

| | |
|---|---|
| (a) Aggregate Impact Value (IS:2386 Part 4) | 1 in 200 cu.m of aggregate |
| (b) Grading (IS:2386 Part 1) | 1 in 100 cu.m of aggregate |
| (c) Flakiness Index (IS:2386 Part 1) | 1 in 200 cu.m of aggregate |
| (d) Atterberg's Limits of portion of aggregate passing 425 micron sieve (IS:2720 Part 5) | 1 in 100 cu.m of aggregate |
| (e) Density of compacted layer | 1 test per 500 sq.m |

N.B. : If the daily output is less than the unit suggested for frequency, at least one test (for each type of test) is to be performed daily on the completed work.

### 1803.3. Tests on Bituminous Construction

The tests and their minimum frequencies for the different types of bituminous works shall be as given in Tables 1800.3 to 1800.7.

**TABLE 1800.3 : FREQUENCY OF TESTS FOR PRIME COAT AND TACK COAT**

| Sl. No. | Test | Test Method | Frequency |
|---|---|---|---|
| (1) | Quality of binder | Viscosity, Residue on 600 micron sieve and Storage Stability Tests for Emulsions (IS:8887) Viscosity and Flash Point Tests for Cutbacks (IS:217) | One test per lot or per 10 tonnes |
| (2) | Temperature of binder for cutback, when used | Appendix - 10.6 of IRC:SP:20 | Regularly |
| (3) | Rate of spread of binder | Appendix - 10.7 of IRC:SP:20 | One test per 500 sq.m: not less than 2 tests per day |





**TABLE 1800.4 : FREQUENCY OF TESTS FOR BITUMINOUS MACADAM**

| Sl. No. | Test | Test Method | Frequency |
|---|---|---|---|
| (1) | Quality of binder | Penetration, Softening Point & Ductility Tests for Paving Bitumen (IS:73) Penetration, Softening Point and Elastic Recovery Tests for Modified Bitumen (IRC:SP:53) | One test per lot or per 10 tonnes |
| (2) | Temperature of binder | Appendix - 10.6 of | Regularly IRC:SP:20 |
| (3) | Aggregate impact value | IS:2386 (Part 4) | 1 test per 250 cu.m per source |
| (4) | Flakiness index | IS:2386 (Part 1) | 1 test per 250 cu.m per source |
| (5) | Stripping of aggregate | IS:6241-1971 | 1 set of 3 representative specimens per source |
| (6) | Water absorption | IS:2386 (Part 3) | 1 set of 3 representative specimens per source |
| (7) | Grading of aggregates | IS:2386 (Part 1) | 1 test per 100 cu.m or per day |
| (8) | Binder content | Appendix-10.8 of IRC:SP:20 | 2 tests per day per plant |
| (9) | Thickness | - | Regularly |
| (10) | Density of compacted layer | Appendix-10.9 of IRC:SP:20 | 1 test per 1000 sq.m or per day |

TABLE 1800.5 : FREQUENCY OF TESTS FOR BUILT-UP SPRAY GROUT/ MODIFIED PENETRATION MACADAM

| Sl. No. | Test | Test Method | Frequency |
|---|---|---|---|
| (1) | Quality of binder | Penetration, Softening Point & Ductility Tests for Paving Bitumen (IS:73) Penetration, Softening Point and Elastic Recovery Tests for Modified Bitumen (IRC:SP:53) | One test per lot or 10 tonnes |
| (2) | Temperature of binder | Appendix-10.6 of IRC:SP:20 | Regularly |
| (3) | Aggregate impact value | IS:2386 (Part 4) | 1 test per 250 cu.m per source |
| (4) | Flakiness index | IS:2386 (Part 1) | 1 test per 250 cu.m per source |
| (5) | Stripping of aggregate | IS:6241-1971 | 1 set of 3 representative specimens per source |
| (6) | Aggregate grading | IS:2386 (Part 1) | 1 test per 100 cu.m of aggregate |
| (7) | Water absorption | IS:2386 (Part 3) | 1 set of 3 representative specimens per source |
| (8) | Soundness of aggregate | IS:2386 (Part 5) | 1 test per source |
| (9) | Rate of spread of binder | Appendix-10.7 of IRC:SP:20 | 1 test per 1000 sq.m or per day |
| (10) | Rate of spread of aggregates | Appendix-10.10 of IRC:SP:20 | 1 test per 1000 sq.m or per day |





TABLE 1800.6 : FREQUENCY OF TESTS FOR SURFACE DRESSING/ SEAL COAT

| Sl. No. | Test | Test Method | Frequency |
|---|---|---|---|
| (1) | Quality of binder | Penetration, Softening Point & Ductility Tests for Paving Bitumen (IS:73) Penetration, Softening Point and Elastic Recovery Tests for Modified Bitumen (IRC:SP:53) Viscosity, Residue on 600 micron sieve and Storage Stability Tests for Emulsion (IS:8887) | One test per lot or 10 tonnes |
| (2) | Temperature of binder | Appendix-10.6 of IRC:SP:20 | Regularly |
| (3) | Aggregate impact value | IS:2386 (Part 4) | 1 test per 250 cu.m per source |
| (4) | Flakiness index | IS:2386 (Part 1) | 1 test per 250 cu.m per source |
| (5) | Grading of aggregates | IS:2386 (Part 1) | 1 test per 50 cu.m per source |
| (6) | Stripping of aggregate | IS:6241-1971 | 1 set of 3 representative specimens per source |
| (7) | Water absorption | IS:2386 (Part 3) | 1 set of 3 representative specimens per source |
| (8) | Soundness of Aggregates | IS:2386 (Part 5) | 1 test per source |
| (9) | Rate of spread of binder | Appendix-10.7 of IRC:SP:20 | 1 test per 1000 sq.m and not less than 2 tests per day |
| (10) | Rate of spread of aggregates | Appendix-10.10 of IRC:SP:20 | 1 test per 1000 sq.m and not less than 2 tests per day |

**TABLE 1800.7 : FREQUENCY OF TESTS FOR OPEN GRADED PREMIX SURFACING/MIX SEAL SURFACING**

| Sl. No. | Test | Test Method | Frequency |
|---|---|---|---|
| (1) | Quality of binder | Penetration, Softening Point & Ductility Tests for Paving Bitumen (IS:73)<br>Penetration, Softening Point and Elastic Recovery Tests for Modified Bitumen (IRC:SP:53)<br>Viscosity, Residue on 600 micron sieve and Storage Stability Tests for Emulsion (IS:8887) | One test per lot or 10 tonnes |
| (2) | Aggregate impact value | IS:2386 (Part 4) | 1 test per 250 cu.m per source |
| (3) | Flakiness index | IS:2386 (Part 1) | 1 test per 250 cu.m per source |
| (4) | Stripping of aggregate | IS:6241-1971 | 1 set of 3 representative specimens for each source |
| (5) | Water absorption | IS:2386 (Part 3) | 1 set of 3 representative specimens for each source |
| (6) | Grading of aggregates | IS:2386 (Part 1) | 1 test per 50 cu.m or per day |
| (7) | Soundness (magnesium and sodium sulphate) | IS:2386 (Part 5) | 1 test per source |
| (8) | Temperature of binder at application | Appendix-10.6 of IRC:SP:20 | Regularly |
| (9) | Binder content | Appendix-10.8 of IRC:SP:20 | 1 test per 500 cu.m or per day |
| (10) | Thickness | - | Regularly |





**1803.4.** Tests on Paving Quality Cement Concrete Road Construction

The tests and their minimum frequencies during cement concrete pavement construction are given at Table 1800.8.

**TABLE 1800.8 : FREQUENCY OF QUALITY CONTROL TESTS FOR PAVING QUALITY CEMENT CONCRETE PAVEMENT**

| | | | |
|---|---|---|---|
| (1) | **Levels and Alignment** | | |
| | (i) Level tolerance | | Clause 1802.3; to be checked for each day's work |
| | (ii) Surface Regularity (Transverse and Longitudinal) | | Regularly |
| | (iii) Width of pavement and position of paving edges | | Clause 1802.2; to be checked for each day's work |
| | (iv) Pavement thickness | | Regularly at grid points |
| | (v) Alignment of joints | | To be checked for each day's work |
| | (vi) Depth of Dowel Bars | | To be checked for each day's work |
| (2) | **Quality of Materials and Concrete** | | |
| | Control tests for materials and concrete shall be as under: | | |
| | (a) Cement | | |
| | Physical and chemical tests | IS:269<br>IS:455<br>IS:1489<br>IS:8112<br>IS:12269 | Once for each source of supply and occasionally when called for in case of long/improper storage. Besides, the Contractor also shall submit daily test data on cement released by the Manufacturer |
| | (b) Coarse and Fine aggregates | | |
| | (i) Gradation | IS:2386 (Part 1) | One test for each day's work. |
| | (ii) Deleterious constituents | IS:2386 (Part 2) | One test for each day's work |
| | (iii) Water absorption/ content | IS:2386 (Part 3) | Regularly as required subject to a minimum of one test a day for coarse aggregate & two tests |

| | | | |
|---|---|---|---|
| | | | a day for fine aggregate. This data shall be used for correcting the water demand of the mix on daily basis. |
| (c) | Coarse Aggregate | | |
| | (i) Aggregate Impact Test | IS:2386 (Part 4) | One test per source |
| | (ii) Soundness | IS:2386 (Part 5) | One test per source |
| | (iii) Alkali aggregate reactivity | IS:2386 (Part 7) | One test per source |
| (d) | Water Chemical Tests | IS:456 | Once for approval of source of supply, subsequently only in case of doubt. |
| (e) | Concrete | | |
| | (i) Strength of concrete | IS:516 | Minimum 6 cubes and 6 beams per day's work (3 each for 7 day and 28 day strength) |
| | (ii) Workability of fresh concrete-Slump Test | IS:1199 | One test per 3 cubm of concrete at paving site or one test for each dumper laid at plant site. |

### 1803.5. Tests on Roller Compacted Concrete Road Construction

The tests and their minimum frequencies during roller compacted concrete road construction shall be as given below:

(1) **Levels and Alignment**

Same as given at Sl. No.1 in Table 1800.8.

(2) **Quality of Materials and Concrete**

Same as given at Sl. No.2 in Table 1800.8 for :

(a) Cement

(b) Coarse and Fine Aggregates

(c) Coarse Aggregate and

(d) Water

For strength of concrete (IS:516), a minimum of 3 cubes and 3 beams





shall be cast for each 100 sq.m or part thereof, laid each day.

For Workability of fresh concrete (Slump Test), at least one test to be carried out per 3 cu.m of concrete at paving site or per day.

(3) **In-situ Density**

The dry density of the laid material shall be determined (IS:2720 Part 28) from three density holes for each 2000 sq.m or part thereof laid each day.

*Annexure-1800.1*

## List of Essential Equipment for Quality Control in Rural Road Construction Works

| | | |
|---|---|---|
| (i) | Post Hole Auger with extensions | One set |
| (ii) | Digging tools like pick axe, shovel, etc. | One set |
| (iii) | IS Sieves Nos. with lid and pan (90mm, 80mm, 63mm, 53mm, 45mm, 37.5mm, 26.5mm, 19mm, 13.2mm, 11.2mm, 9.5mm, 4.75mm, 2.8mm, 5.6mm, 3.35mm, 2.36mm, 600 micron, 425 micron, 300 micron, 150 micron, 180 micron, 90 micron and 75 micron) | One set |
| (iv) | Standard Proctor Density Test Apparatus with rammer | One set |
| (v) | Sand Pouring Cylinder with tray complete for field density test | One set |
| (vi) | Core Cutter (10cm dia.), 10cm/15cm height complete with dolly and hammer | One set |
| (vii) | Speedy moisture meter complete with chemicals | One set |
| (viii) | Straight Edges | Two nos. |
| (ix) | Digital Thermometers | Three nos. |
| (x) | Liquid Limit and plastic limit testing apparatus complete with Water bottle and glass wares | One set |
| (xi) | Gas burner, sand bath | One set |
| (xii) | Camber Board | Two nos. |
| (xiii) | Electronic/digital balance 1 kg with the least count of 0.01 gm | One no. |
| (xiv) | Electronic/digital balance 5 kg | One no. |
| (xv) | Pan balance with weight Box, 5 kg | One no. |
| (xvi) | Oven (ambient to 200°C) | One no. |
| (xvii) | Water bath (ambient to 100°C) | One no. |
| (xviii) | Bitumen extraction apparatus | One no. |
| (xix) | Penetration apparatus (Bitumen) | One no. |
| (xx) | Enamelled tray | Six nos. |
| (xxi) | Measuring tape, spatula, glassware, porcelain dish, pestle mortar | One set |
| (xxii) | Trays for measurement of tackcoat quantity | Three nos. |
| (xxiii) | Slump cone | Two nos. |



Maintenance

# 1900

# Maintenance

## 1901. GENERAL

The Specifications shall apply to all items of road maintenance works as required to be carried out under the Contract or as directed by the Engineer. The works shall be carried out in conformity with the relevant Specifications to the required level, grade and lines using approved materials. The works shall be carried out using light duty machinery or manual means provided the quality of the end product does not suffer. In execution of maintenance works, a reference is made to MORT&H "Manual for Maintenance of Roads" published by IRC and IRC:82 "Code of Practice for Maintenance for Bituminous Surfaces of Highways" for guidance and compliance wherever applicable. Wherever the Specification is not clear, good engineering practice shall be adopted in the construction to the satisfaction of the Engineer.

## 1902. RESTORATION OF RAIN CUTS

### 1902.1. Scope

The work shall consist of earthwork for restoration of rain cuts in the embankment and shoulders, using suitable material, and compacting the same.

### 1902.2. Materials

The material used for restoration of rain cuts shall consist of soil conforming to Clause 301.3.

### 1902.3. Construction Operation

The area affected by rain cuts shall be cleared of all loose soil and benched. The width of the benches shall be at least 300 mm and they shall extend continuously for a sufficient length. The height of the benches shall be in the range of 150-300 mm.

Fresh material shall be deposited in layers not exceeding 250 mm loose thickness and compacted so as to match with the benching at a moisture content close to the optimum. Compaction shall be carried out using suitable equipment such as plate compactors and rammers or by suitable implements handled manually. The finished work shall conform to alignment, levels and slopes as indicated in the drawing.

### 1902.4. Measurements for Payment

The earthwork for restoration of rain cuts shall be measured in cubic metres.

### 1902.5. Rate

The Contract rate for the item of earthwork for restoration of rain cuts shall be payment in full for carrying out the required operation including full compensation for:

(i) supply of material including all leads and lifts and the cost of arrangement of land;

(ii) setting out;

(iii) removal of loose material from the rain cuts;

(iv) benching of old earthwork; and

(v) compacting after adding required quantity of water.

## 1903. MAINTENANCE OF EARTHEN SHOULDER

### 1903.1. Scope

The work of maintenance of earthen shoulder shall include making up the irregularities/loss of material on shoulder to the design level/profile by adding fresh approved selected soil and compacting it with appropriate equipments or to strip excess soil from the shoulder surface as per the requirement of this Specification.

### 1903.2. Material

The material to be added to the shoulder, if required, shall be a select soil conforming to Clause 301.3.

### 1903.3. Construction Procedure

This work shall involve:

(i) making up of the earthen shoulder by adding extra soil and compacting the same; and/or

(ii) stripping a layer of soil to achieve the required grade and level.

Wherever extra earth is required to be added, the earthen shoulder, shall be stripped and loosened to receive fresh soil. The deficiency of thickness shall be made up in layers of loose thickness not exceeding 250 mm. Water shall be added, if required, to attain the optimum moisture content and the layer compacted by 80 to 100 kN smooth wheel roller, vibratory roller, hand roller, plate vibrator or hand rammer to obtain at least 97 per cent of the maximum dry density in accordance with IS:2720





(Part 7). The finished surface shall have the specified cross slope and line in accordance with the drawing. The side slopes shall be trimmed to the required slope with the help of grader or manual methods using hand tools.

Wherever the earth is required to be excavated from the shoulder, this shall be done either using equipment like grader or by manual means using hand tools. The resulting surface shall be uniform and have a field density of at least 97 per cent of maximum density obtained in accordance with IS:2720 (Part 7). If the surface is not uniformly compacted, it shall be excavated to a depth of 150 mm and the soil mixed with water if required and compacted at a moisture content close to the optimum to achieve 97 per cent of maximum density as stated above and making sure that the camber or crossfall as required is provided.

### 1903.4. Measurements for Payment

Maintenance of earthen shoulder shall be measured in square metres.

### 1903.5. Rate

The Contract unit rate for maintenance of earthen shoulder shall be payment in full compensation for:

(i) stripping, loosening of earthen shoulder soil and dressing it to proper profile before placement of extra select soil;

(ii) furnishing earth required for making up of shoulders including all leads and lifts, cost of land and compaction;

(iii) excavation of earth as required and disposal of the earth at the location approved; and

(iv) all tools, equipments and incidentals to complete the work in accordance with the above Specification.

## 1904. MAINTENANCE OF BITUMINOUS SURFACE ROAD

### 1904.1. General

The scope and type of maintenance work to be carried out shall be in accordance with the provisions of the Contract or as instructed by the Engineer.

In all instances it will have been necessary to identify the causes of defects in order to permit effective repair. Where investigation work into the causes of defects is included in the Contract it shall be carried out in accordance with the appropriate provisions of this Specification.

Maintenance treatments required under the Contract or instructed by the Engineer may include pot-hole and patch repair, surface dressing and 20 mm open graded premix carpet.

When the pavement to be maintained is intended to carry heavy volumes of traffic, the constructed materials (particularly patching) used in maintenance operations shall be of a standard not less than those specified for the original construction.

Traffic control during maintenance operations shall conform to the requirements of the Contract documents.

### 1904.2 Filling Pot-holes and Patch Repairs

**1904.2.1. Scope:** This work shall include repair of pot-holes and patching of all types of bituminous pavement.

The work shall include the removal of all failed material, in the pavement courses and, if necessary, below the pavement, until the root cause of the failure is removed; the trimming of the completed excavation to provide firm vertical faces; the replacement of material of at least as high a standard as that which was originally specified for the pavement layer; the application of tack coat on to the sides and bases of excavations prior to placing of any bituminous materials and the compaction, trimming and finishing of the surfaces of all patches to form a smooth continuous surface, level with the surrounding road.

**1904.2.2. Materials:** All materials used for the pot-hole and patch repair of bituminous surface and underlying layers shall be in accordance with this Specification and shall be of the same type as specified for the original construction like WBM grading No.3 or Bituminous Macadam covered with 20 mm Premix Carpet and Seal Coat. A mix superior to the one on the existing surface may also be used for repair work. An emulsified bitumen/modified bitumen mix compatible with the existing layer shall also be considered appropriate.

The bituminous mixture used for such patch repairs shall be in accordance with the appropriate Clause of these Specifications . Materials to be used for patching shall always be of the same type and standard of construction as, or better than, the material being patched at the same level of construction. Materials used for patching shall never be of lesser bearing capacity nor of a greater porosity than the adjacent previous constructions. Non-bituminous materials must not be used for patching bituminous





materials. Where modified binder is to be used, Clause 512 of these Specifications shall apply.

The grading of aggregates and bitumen content of the mix used for such patch repair shall be in accordance with Clause 501.

**1904.2.3. Preparation of the area for pot-hole and patch repair:** Each pot-hole and patch repair area shall be inspected and all loose material removed. The area shall be cut/trimmed either with jack hammers or with hand tools suitable for the purpose, such that the defective material responsible for the failure is all removed and such that the excavation is of a regular shape.

The edges of the excavation shall be cut vertically. The area shall be thoroughly cleaned with compressed air or any appropriate method approved by the Engineer to remove all dust and loose particles. Layers below the level of the bituminous construction shall be replaced using material of the equivalent specification to the original construction, which shall particularly include the specified standards of compaction. The area for bituminous construction shall be tacked or primed with cutback or emulsion depending upon whether the lower area is bituminous or granular in nature. The sides, however, are to be applied with hot tack coat material when hot mix is used for patch work or emulsion if cold mix is used. The prime coat and tack coat shall conform to Clauses 502 and 503 of these Specifications, respectively.

**1904.2.4. Backfilling operation:** The mixture to be used in bituminous patching shall be either a hot mix or a cold mix in accordance with the appropriate Clauses of these Specifications. Mixing shall be done in a plant of suitable capacity. The bituminous mixture shall be placed in layers of thickness not more than 100 mm (loose) and shall be compacted in layers with roller/plate compactor/hand roller/rammer to the compaction standards defined in the appropriate Clauses of these Specifications. While placing the final layer, the mix shall be spread slightly proud of the surface so that after rolling, the surface shall be flush with the adjoining surface. If the area is large, the spreading and levelling shall be done using hand shovels and wooden straight edges. During the process of compaction, the surface levels shall be checked using a 3 m straight edge and required camber or crossfall shall be maintained.

**1904.2.5. Measurements for payment:** Filling of pot-hole and patch repair work shall be measured in cubic metres and square metres respectively.

**1904.2.6. Rate:** The Contract unit rate for filling of pot-hole and patch repair shall be payment in full for:

(i) furnishing all materials required;

(ii) all works involved including excavation, trimming, back filling with any non-bituminous layers required, tacking, priming with cutback or emulsion and back filling with bituminous materials;

(iii) all labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1905. MAINTENANCE OF GRAVEL ROAD

### 1905.1. Scope

The work of routine maintenance of Gravel road shall include making up the loss of profile, rectifying corrugated surface, filling up of depressions, pot-holes, ruts and erosion gullies by adding fresh approved material and compacting it with appropriate equipment or to strip excess of material from the road surface as per the requirement of this Specification. It also includes the periodic maintenance measure of re-gravelling.

### 1905.2. Materials

The material to be added to the gravel road surface where required, shall be a select material conforming to Clause 402.

### 1905.3. Construction Procedure

**1905.3.1. Making up the loss of profile:** The accumulated material at the roadsides/shoulders shall be brought to the centre using an approved mechanical grader. The grader shall start from the edges of the road and work towards the centre. Where a suitable grader is not available at the site, the loose materials from the sides shall be collected and brought to the centre manually, if approved by the Engineer. The material thus collected shall be watered, if required, to bring the moisture content close to the optimum to facilitate compaction. Compaction with a power roller shall follow immediately as per Clause 402.4. Heavy grading shall not be allowed without the provision of additional surfacing material if the remaining thickness of gravel is less than 75 mm. The surface of a gravel road shall be improved by dragging with the use of a 'Drag' of approved design.

**1905.3.2. Rectifying corrugated surface:** Corrugated surface of a





gravel road shall be rectified by grading with a mechanical grader or by using a tractor-towed drag of approved design. The scrapped material shall be spread over the surface and compacted by a road roller after the needed quantity of water, where required, has been sprinkled to bring the moisture content close to the optimum to facilitate compaction, as per Clause 402.4.

**1905.3.3. Filling up local depressions, ruts, pot-holes and erosion gullies:** The repair work of filling up the local depressions, ruts, pot-holes and erosion gullies shall be carried out by replacing or adding new surface material of specified properties as per Clause 402 and compacting it. The affected area shall first be cleaned of all loose material, bringing it to a regular rectangular shape with the help of spades and pick axes and hand ramming the bottom surface. The area thus prepared shall be filled up with gravel of specified properties as per Clause 402, sprinkled with water, where required, to bring the moisture content close to the optimum and compacted as per Clause 402.4.

**1905.3.4. Regravelling:** Where regravelling is to be carried out as a periodic maintenance measure, additional gravel 25 mm to 75 mm in loose thickness, meeting the specifications as contained in Clause 402 shall be spread after scarifying the old surface. Water shall be sprinkled, if required, to bring the moisture content close to the optimum to facilitate compaction.

The loose gravel layer shall then be compacted by road roller as per Clause 402.4.

### 1905.4. Measurements for Payments

The routine maintenance works of making up the loss of profile, rectifying corrugated surface, filling up of depressions, potholes and erosion gullies, shall be measured in square metres. The periodic maintenance work of regravelling shall, however, be measured in cum.

### 1905.5. Rate

The Contract unit rate for routine maintenance of gravel road shall include:

(a) supply of gravel including all leads and lifts;

(b) removal of loose material from affected areas;

(c) compaction after adding required quantity of water.

The Contract unit rate for periodic maintenance by way of regravelling shall be as per Clause 402.8.

## 1906. MAINTENANCE OF WBM ROAD

### 1906.1. Scope

The work of maintenance of WBM road shall include filling up of pot-holes, ruts and rectifying corrugated surface, damaged edges and ravelling. It also includes the periodic maintenance measure of surface renewal.

### 1906.2. Materials

The materials to be added including coarse aggregate, screenings and binding material shall conform to Clause 405.

### 1906.3. Construction Procedure

**1906.3.1. Filling up pot-holes:** All loose material from a pot-hole shall be taken out upto the firm base. The sides of the hole shall be kept vertical and the affected area made into a regular rectangular shape. The cleared space shall then be filled with stone aggregate of same size as used in the original layer, keeping the surface slightly proud of the surrounding area. The screenings and binding material shall then be spread manually over the aggregate. The aggregate layer shall then be compacted by hand rammers. The stone aggregate layer shall be watered and the layer again compacted by hand rammers, followed by road roller.

**1906.3.2. Filling up ruts:** The rutted portion shall first be cleaned of all loose material and sprinkled with water. Scarification and removal of stones shall be done to an approximate rectangular section with flat bottom and vertical sides. The rectangular section thus prepared shall be filled with salvaged as also fresh aggregates and rolled with the addition of screenings, gravel and watering, finally providing a 6 mm sand layer.

**1906.3.3. Rectifying corrugated surface:** The excess blindage material deposited in ripples shall be immediately removed by dragging or brooming. If, however, corrugations have developed in the WBM course itself, a renewal layer shall be provided as per Clause 405, after carefully scarifying the corrugated surface.

**1906.3.4. Repairing damaged edges:** The damaged portions of the edges shall be removed and renewed with fresh material. Rolling of the edge and shoulder shall be carried out simultaneously and cross-profile of the shoulder remedied by grading.





**1906.3.5. Rectifying ravelled surface:** Where, ravelling is detected early by the presence of fine haircracks, the tendency for ravelling can be remedied by blending with a good binding material and watering the surface. If however, ravelling is quite prominent, the repair shall be carried out by resurfacing. Prior to resurfacing, the old surface shall be scarified, fresh material added and rolling of the surface carried out as per Clause 405 for new construction.

**1906.3.6. Periodic surface renewal:** Renewal of WBM surface shall be carried out by a layer of 75 mm thickness in accordance with Clause 405. The existing surface shall first be cleaned of all dust and caked mud by wire brushes and brooms. After moistening, the surface shall be scarified and the salvaged materials screened. Stable shoulders shall be formed by additional earthwork. The salvaged material together with fresh additional material, as required shall be spread and dry rolled with a power roller, followed by wet rolling. After application of screenings and spreading of binding material, rolling shall be carried out as per Clause 405. A 6 mm layer of coarse sand shall be spread and curing by light sprinkling of water shall be carried out for 2 to 3 days before opening to traffic.

### 1906.4. Measurements for Payment

The routine maintenance works comprising filling up of pot-holes, ruts and rectifying corrugated surface, damaged edges and ravelling shall be measured in square metres. The periodic maintenance work of surface renewal shall, however, be measured in cubic metres.

### 1906.5. Rate

The contract unit rate for routine maintenance of WBM road shall include:

(a) supply of materials for WBM, including all leads and lifts and the cost of arrangement of land;

(b) removal of loose material from affected areas;

(c) compaction after adding required quantity of water.

The Contract unit rate for periodic maintenance work of surface renewal with WBM shall be as per Clause 405.7.

## 1907. DRAINS

### 1907.1. Scope

The work shall consist of erosion repair, clearing, cleaning, reshaping,

regrading and deepening of side drains as well as catch water drains to ensure that drainage elements remain free of obstruction and retain their intended cross sections and grades.

### 1907.2. Maintenance Operation

The affected length of side drain or catch water drain shall be cleared of all debris, loose soil/silt and the same reshaped, regraded to the intended cross sections and grades with the excavated useful earth available from regrading or with suitable borrowed soil conforming to Clause 301.3.

### 1907.3. Measurements for Payment

The maintenance of drain and catch water drain shall be measured in running metres.

### 1907.4. Rate

The Contract unit rate for maintenance of drain shall be payment in full for:

i) all the labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1908. CULVERTS

### 1908.1. Scope

The work shall consist of routine activities of clearing, cleaning, erosion repair, repairs to cracks, parapet walls, protection works and invert.

### 1908.2. Materials

All materials used for the repairs to cracks, protection works, parapet walls shall be in accordance with the Specifications and shall be of the same type as specified for the original construction conforming to Sections 1100 and 1200 for Pipe and Slab Culverts respectively.

### 1908.3. Maintenance Procedure

This work shall involve:

(i) clearing and cleaning of debris, sand & silt from the culvert opening and catch water pit;

(ii) erosion repair;





(iii) repairs to cracks;

(iv) repairs to protection works.

The debris, sand and silt after removal from the culvert and catch water pit shall be dumped away from the water channel as directed by the Engineer.

### 1908.4. Measurement for Payment

The maintenance for the culverts shall be measured in number of Hume pipe or slab culverts.

### 1908.5. Rate

The Contract unit rate for maintenance of a culvert shall be payment in full for:

i) supplying of cement, sand and all operations to repair the cracks;

ii) resetting the existing disturbed boulders and supply of additional boulders for repair to protection works in U/S and D/S sides of the culverts;

iii) all the labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1909. CAUSEWAYS

### 1909.1. Scope

The work shall consist of routine activities of minor surface repair, replacing guide posts, repairing flood gauges and protection works.

### 1909.2. Materials

All materials used for the repairs to surface, flood gauges and protection works shall be in accordance with the Specifications and shall be of the same type as specified for the original construction conforming to Clause 1400.

### 1909.3 Maintenance Procedure

This work shall involve:

i) minor surface repair;

ii) replacing guide posts;

iii) repair of flood gauges;

iv) removal of debris and boulders from U/S and D/S of the causeway and using boulders in protection works;

The debris and surplus boulders after removal from the vicinity of the causeway shall be dumped away from the water channel as directed by the Engineer.

### 1909.4. Measurements for Payment

The maintenance of a causeway shall be measured in linear metres.

### 1909.5. Rate

The Contract unit rate for maintenance of a causeway shall be payment in full for:

(i) supplying of cement, sand, aggregates and all operations to repair the causeway surface and casting and installation of guide posts;

(ii) all the labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1910. ROAD SIGNS

### 1910.1. Scope

The work shall consist of cleaning and repainting of Mandatory/ Regulatory, Cautionary/Warning, Informatory signs, minor bridge and culvert nameplates as well as replacement of damaged or missing signs.

### 1910.2. Materials

The material for the repair/fabrication of signs shall be as per Clause 5 and for repainting as per Clause 7 of IRC:67.

### 1910.3. Repair Procedure

The signs along with the posts shall be maintained in proper position, kept clean and legible at all times. Damaged signs shall be replaced immediately. All signs shall be inspected at least twice a year both in day and night times and at least once a year in the rain. The authorities responsible for road signs should maintain a schedule of painting of the posts and signs periodically. Painting the signs (where applicable) may be undertaken after every two years. Special care shall be taken to see that weeds, shrubbery, mud, etc. are not allowed to obscure any sign.

### 1910.4. Measurements for Payment

The maintenance of each identical sign shall be calculated from the dimensions of work instructed in the Contract by the Engineer.





### 1910.5. Rate

The Contract unit rate for maintenance of a road sign shall be payment for:

(i) cleaning of road sign and post/posts with damp cloth;

(ii) removal of weeds, shrubbery, mud, etc. around the road sign posts;

(iii) repair of damaged signs or post and refixing of tilted signs;

(iv) repainting (where applicable) of back side of road signs with grey paint and road sign post/posts painted with alternate black and white horizontal stripes each not less than 100 mm wide.

(v) all labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1911. GUARD-RAILS AND PARAPET RAILS

### 1911.1. Scope

The work shall consist of prompt repair of damaged guard/parapet rails, cleaning and repainting regularly.

### 1911.2. Material

The material for repair and repainting shall be as per Clause 1706.2 of the Specifications.

### 1911.3. Repair Procedure

Guard-rails are provided to prevent vehicles from running over high embankment and parapet rails on bridges to safeguard pedestrians and vehicles. They should be repaired promptly if damaged and kept clean and repainted regularly so as to maintain their visibility at all times.

### 1911.4. Measurements for payment

The repair of guard-rail, parapet-rail and their maintenance by cleaning and repainting shall be paid by the linear metres.

### 1911.5. Rate

The Contract unit rate for repair/maintenance of Guard-rail and Parapet-rail shall be payment for:

(i) repair of Guard-rail and Parapet-rail to their original condition;

(ii) cleaning of Guard-rail and Parapet-rail with damp cloth and repainting, if required;

(iii) all the labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1912. 200-m AND KILOMETRE STONES

### 1912.1. Scope

The work shall consist of refixing of tilted stones, repairing with cement mortar, cleaning with damp cloth, repainting and lettering on 200-m, kilometre and 5th kilometre stones.

### 1912.2. Material

The material for repair of 200-m and kilometre stones shall be as per Clause 1703.2 of the Specifications. Repainting and lettering on stones shall be as per guidelines indicated in IRC:8 and IRC:26.

### 1912.3. Repair Procedure

The 200-m and kilometre stones shall be maintained in proper position and kept clean and legible at all times. Damaged as well as tilted stones shall be refixed or repaired/replaced immediately. Special care shall be taken to see that weeds, shrubbery, mud, etc. are not allowed to obscure any 200-m or kilometre stone.

### 1912.4. Measurements for Payment

The measurement shall be in numbers of 200-m, kilometre and 5th kilometre stones cleaned, repaired and repainted.

### 1912.5. Rate

The Contract unit rate for maintenance of 200-m, kilometer or 5th kilometer stone shall be payment for:

(i) cleaning of 200-m, kilometre and 5th kilometre stones;

(ii) removal of weeds, shrubbery and mud, etc.;

(iii) repair, repainting and lettering of 200-m and kilometre stones;

(iv) all labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.





## 1913. MAINTENANCE OF ROAD DELINEATORS

### 1913.1. Scope

The work shall consist of cleaning, repainting of Roadway Indicators, Hazard Markers, Object Markers and keeping ground around the delineators clean by cutting grass/bushes periodically so that visibility of the delineators is not affected as well as repair/replacement of damaged or missing delineators.

### 1913.2. Material

The material for repair/replacement of Roadway Indicators, Hazard Markers and Object Markers shall be as per Clauses 3, 4 and 5 respectively of IRC:79.

### 1913.3. Maintenance Procedure

Iron, wooden or concrete posts shall be repainted regularly. To remove dirt, the reflective unit should be scrubbed clean with soap/detergent and water periodically, especially after the rains. The ground around the delineators should be kept clean by cutting grass, weeds and bushes periodically so that visibility of the delineators is not affected.

### 1913.3. Measurements for Payment

The measurement shall be in numbers of Roadway Indicators, Hazard Markers and Object Markers cleaned and repaired.

### 1913.4. Rate

The Contract unit rate for maintenance of delineators shall be payment for:

(i) cleaning of delineators with damp cloth including washing round or rectangular reflectors with soap/detergent and water;

(ii) removal of weeds, shrubbery and mud, etc.;

(iii) repainting of black and white stripes 150 mm wide on Roadway Indicator posts;

(iv) all labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1914. CUTTING OF BRANCHES OF TREES, SHRUBS AND TRIMMING OF GRASS AND WEEDS

### 1914.1. Scope

The work shall consist of cutting of branches of trees, shrubs and trimming of grass and weeds from the Roadway or within the Road land as directed by the Engineer.

### 1914.2. Maintenance Procedure

All the branches of trees extending above the roadway shall be cut or trimmed so as to provide a clear height of 5 m above the road surface and shoulders as per Clause 201.4 of these Specifications. All shrubs, grass and weeds in the roadway or in the road land shall be trimmed and debris removed to a suitable location as directed by the Engineer to ensure unobstructed sight distance of adequate length to avoid unwarranted accidents.

### 1914.3. Measurements for Payment

The measurement for cutting of branches of trees and shrubs shall be in numbers and for trimming of grass and weeds in square metres.

### 1914.4. Rate

The Contract unit rate for cutting of branches of trees, shrubs and trimming of grass and weeds shall be payment for:

(i) cutting of branches of trees, shrubs and disposing of the wood and leaves, etc. to suitable locations as directed by the Engineer;

(ii) trimming of grass and weeds manually or with electric cutters and disposing of the grass and debris to suitable locations as directed by the Engineer;

(iii) all the labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

## 1915. WHITE WASHING OF PARAPET WALLS OF CD WORKS AND TREE TRUNKS

### 1915.1 Scope

The work shall consist of white washing of parapet walls of culverts, minor bridges and tree trunks.





### 1915.2. Maintenance Procedure

The parapet walls of culverts, minor bridges and tree trunks shall be cleaned of any scales, dirt or loose material and applied two coats of white wash using good unslaked lime.

### 1915.3. Measurements for Payment

The measurement for white washing of parapet walls of culverts, minor bridges and tree trunks shall be in square metres.

### 1915.4. Rate

The Contract unit rate for white washing of culverts, minor bridges and tree trunks shall be payment for:

(i) preparation of surface by cleaning, scraping scales, if any;

(ii) two coats of white washing;

(iii) all the labour, tools, equipment and incidentals to complete the work in accordance with the Specifications.

# Appendices

*Appendix-1*

## LIST OF IRC PUBLICATIONS REFERRED TO IN THE SPECIFICATIONS

| Number Designation | Title |
|---|---|
| | **(A) INDIAN ROADS CONGRESS** |
| IRC:8-1980 | Type Designs for Highway Kilometre Stones (Second Revision) |
| IRC:15-2002 | Standard Specification and Code of Practice for Construction of Concrete Roads (Third Revision) |
| IRC:16-1989 | Specification for Perming of Base Course with Bituminous Primers (First Revision) |
| IRC:19-1977 | Standard Specification and Code of Practice for Water Bound Macadam (Second Revision) |
| IRC:21-2000 | Standard Specifications and Code of Practice for Road Bridges, Section III – Cement Concrete (Plain and Reinforced) (Third Revision) |
| IRC:22-1986 | Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (First Revision) |
| IRC:24-2001 | Standard Specifications and Code of Practice for Road Bridges, Section V – Steel Road Bridges (Second Revision) |
| IRC:25-1967 | Type Designs for Boundary Stones |
| IRC:26-1967 | Type Designs for 200–Metre Stones |
| IRC:35-1977 | Code of Practice for Road Markings (with Paints) (First Revision) |
| IRC:40-2002 | Standard Specifications and Code of Practice for Road Bridges, Section IV – (Brick, Stone and Block Masonry) (Second Revision) |
| IRC:43-1972 | Recommended Practice for Tools, Equipment and Appliances for Concrete Pavement Construction |
| IRC:44-1976 | Tentative Guidelines for Cement Concrete Mix Design for Pavements (for Non-Air Entrained and Continuously Graded Concrete) (First Revision) |

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| IRC:57-1974 | Recommended Practice for Sealing of Joints in Concrete Pavements |
| IRC:67-2001 | Code of Practice for Road Signs (First Revision) |
| IRC:76-1979 | Tentative Guidelines for Structural Strength Evaluation of Rigid Assfield Pavement |
| IRC:77-1979 | Tentative Guidelines for Repair of Concrete Pavements Using Synthetic Resins |
| IRC:78-2000 | Standard Specifications and Code of Practice for Road Bridges, Section VII - Foundations & Substructure (Second Revision) |
| IRC:79-1981 | Recommended Practice for Road Delineators |
| IRC:82-1982 | Code of Practice for Maintenance of Bituminous Surfaces of Highways. |
| IRC:83-1999 (Part-II) | Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part II: Elastomeric Bearings |
| IRC:83-2002 (Part-III) | Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part III: POT, POT-CUM-PITE, PIN AND METALLIC GUIDE BEARINGS |
| IRC:87-1984 | Guidelines for the Design & Erection of False Work for Road Bridges |
| IRC:SP:20-2002 | Rural Roads Manual |
| IRC:SP:42-1994 | Guidelines on Road Drainage |
| IRC:SP:48-1998 | Hill Road Manual |
| IRC:SP:49-1998 | Guidelines for the Use of Dry Lean Concrete as Sub-base for Rigid Pavement |
| IRC:SP:53-2002 | Guidelines on Use of Polymer and Rubber Modified Bitumen in Road Construction (First Revision) |

**(B) MINISTRY OF ROAD TRANSPORT & HIGHWAYS**

Manual for Maintenance of Roads, 1983

Specifications for Road and Bridge Works, 2001 (Fourth Revision)

**(C) NATIONAL RURAL ROADS DEVELOPMENT AGENCY**

PMGSY Handbook on Quality Control: Road Works, January, 2003





*Appendix-2*

## LIST OF INDIAN AND FOREIGN STANDARDS REFERRED TO IN THE SPECIFICATIONS

| Number Designation | Title |
|---|---|
| | **(A) INDIAN STANDARDS** |
| IS:5-1994 | Colour for ready mixed paints and enamels (Fourth Revision) |
| IS:26-1992 | Tin Ingot – Specification (Fourth Revision) |
| IS:73-1992 | Paving Bitumen Specification (Second Revision) |
| IS:164-1981 | Ready mixed paints, brushing for road marking, to Indian Standard Colour No.356 Golden yellow, white and black |
| IS:217-1988 | Cutback bitumen specification (Second Revision) |
| IS:269-1989 | 33 grade ordinary portland cement (Fourth Revision) |
| IS:278-1978 | Galvanized steel barbed wire for fencing (Third Revision) |
| IS:280-1978 | Specification for galvanized steel barbed wire for fencing (Third Revision) |
| IS:383-1970 | Coarse and fine aggregates from natural sources for concrete (Second Revision) |
| IS:432 (Part I) 1982 | Mild steel and medium tensile steel bars (Third Revision) |
| IS:455-1989 | Portland stag cement (Fourth Revision) |
| IS:456-2000 | Code of practice for plain and reinforced concrete (Third Revision) |
| IS:458-1988 | Precast concrete pipes (with and without reinforcement) (Third Revision) |
| IS:460-1985 | Specification for test values (Third Revision) |
| (Part 1) | Wise cloth test sieves |
| (Part 2) | Perforated plate test sieves |

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| IS:513-1994 | Cold-rolled low carbon steel sheets and strips (Fourth Revision) |
| IS:516-1959 | Methods of test for strength of concrete |
| IS:712-1984 | Specification for building limes (Third Revision) |
| IS:736-1986 | Wrought aluminium and aluminium alloys, plates for general engineering purpose (Third Revision) |
| IS:783-1985 | Code of practice for laying of concrete pipes (First Revision) |
| IS:814-1991 | Covered electrodes for manual metal arc welding of carbon and carbon manganese steel (Fifth Revision) |
| IS:822-1970 | Code of procedure for inspection of welds |
| IS:1077-1992 | Common burnt clay building bricks (Fifth Revision) |
| IS:1124-1974 | Method of test for water absorption apparent specific gravity and porosity of natural building stone (First Revision) |
| IS:1129-1972 | Recommendation for dressing of natural building stones (First Revision) |
| IS:1199-1959 | Method of sampling and analysis of concrete |
| IS:1201 to 1220-1978 | Indian standard methods for testing tar and bituminous materials |
| IS:1203-1978 | Determination of penetration (First Revision) |
| IS:1205-1978 (Parts 1 & 2) | Determination of viscosity (First Revision) |
| IS:1206:(Part1)-1978 | Determination of viscosity: Part 1 Industrial viscosity – (See IS:1201 to IS:1220) |
| IS:1206:(Part2)-1978 | Determination of viscosity: Part 2 Absolute viscosity –(See IS:1201 to IS:1220) |
| IS:1206:(Part3)-1978 | Determination of viscosity: Part 3 Kinematic viscosity – (See IS:1201 to IS:1220) |





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| IS:1208-1978 | Determination of ductility (First Revision) |
| IS:1209-1978 | Determination of solubility in carbon disulphide or carbon tetrachlorate or trichoroethylene (First Revision) |
| IS:1239:(Part 1)-1990 | Mild steel tubes (Fifth Revision) |
| IS:1239:(Part 2)-1992 | Mild steel tubular and other wrought steel pipe fittings (Third revision) |
| IS:1367-1997 | Technical supply conditions for threaded steel fastners |
| IS:1477 (Parts 1 & 2) | Code of practice for painting of ferrous metals in buildings |
| IS:1489-1991 | Portland pozzolana cement |
| (Part 1) | Flyash based (Third Revision) |
| (Part 2) | Calcined clay based (Third Revision) |
| IS:1498-1970 | Classification and identification of soils for general engineering purpose (First Revision) |
| IS:1514-1990 | Methods of sampling and test for quick lime and hydrated lime (First Revision) |
| IS:1597:(Part 1)-1992 | Construction of stone masonry - code of practice - Part 1 - rubble stone masonry (First Revision) |
| IS:1727-1967 | Methods of test for pozzolanic material (First Revision) |
| IS:1732-1989 | Dimensions for round and square steel bars for structural and general engineering purpose (Second Revision) |
| IS:1786-1985 | High strength deformed steel bars and wires for concrete reinforcement (Third Revision) |
| IS:1791-1985 | General requirements for batch type concrete mixers (Second Revision) |
| IS:1834-1984 | Specification for hot applied sealing compounds for joints in concrete (First Revision) |

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| IS:1838 | Preformed filler for expansion joint in concrete pavement and structures (non-extruding and resilient type) |
| IS:2062-1999 | Steel for general structural purpose-specification (Fifth Revision) (Superseding IS:226) |
| IS:2116-1980 | Sand for masonry mortars (First Revision) |
| IS:2118-1980 | Code of practice for construction of Jack-Arch type of built-up floor or roof (First Revision) |
| IS:2212-1991 | Code of practice for brickwork (First Revision) |
| IS:2250-1981 | Code of practice for preparation and use of masonry mortars (First Revision) |
| IS:2286-1963 | Specification for Pantograph |
| IS:2386-1963 | Methods of test for aggregates for concrete |
| (Part 1) | Particle size and shape |
| (Part 2) | Estimation of deleterious materials and organic impurities |
| (Part 3) | Specific gravity, density, voids, absorption and bulking |
| (Part 4) | Mechanical properties |
| (Part 5) | Soundness |
| (Part 6) | Measuring mortar making properties of fine aggregates |
| (Part 7) | Alkali aggregate reactivity test |
| (Part 8) | Petrographic examination |
| IS:2430-1986 | Methods for aampling of aggregates for concrete (First Revision) |
| IS:2502-1963 | Code of practice for bending and fixing of bars for concrete reinforcement |
| IS:2505-1992 | Concrete vibrators – Immersion type – General requirements (Third Revision) |





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| IS:2506-1985 | General requirements for concrete vibrators, screed board type (First Revision) |
| IS:2514-1963 | Specification for concrete vibrating tables |
| IS:2629-1985 | Recommended practice for hot-dip galvanizing of iron and steel (First Revision) |
| IS:2720 | Methods of test for soils |
| (Part 2)-1973 | Determination of water content (Second Revision) |
| (Part 4)-1985 | Grain size analysis (Second Revision) |
| (Part 5)-1985 | Determination of liquid and plastic limits (Second Revision) |
| (Part 7)-1980 | Determination of moisture content/dry density relation using light compaction (Second Revision) |
| (Part 16)-1987 | Laboratory determination of CBR |
| (Part 26)-1987 | Determination of pH value (Second Revision) |
| (Part 27)-1977 | Determination of total soluble sulphates |
| (Part 28)-1974 | Determination of dry density of soils in-place by the sand replacement method |
| (Part 40)-1977 | Determination of free swell index of soils |
| IS:2751-1979 | Code of Practice for Welding of Mild Steel Plain and Deformed Bars for Reinforced Concrete Construction (First Revision) |
| (Part 16)-1987 | Laboratory determination of CBR (Second Revision) |
| (Part27)-1977 | Determination of total soluble sulphates (First Revision) |
| (Part 28)-1974 | Determination of dry density of soils in-place by the sand replacement method (First Revision) |
| (Part 40)-1977 | Determination of free swell index of soils |

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| IS:3025:(Part 17)-1984 | Methods of sampling and test (physical and chemical) for water and wastewater: Part 17 Non-filterable residue (total suspected solids) (First Revision) |
| IS:3025:(Part 18)-1984 | Methods of sampling and test (physical and chemical) for water and waste water- Part 18 Volatile and fixed residue (total filterable and non-filterable) (First Revision) |
| IS:3025:(Part 22)-1986 | Methods of sampling and test (physical and chemical) for water and waste water –Part 22 : Acidity (First Revision) |
| IS:3025: (Part 23)-1986 | Methods of sampling and test (physical and chemical) for water and waste water –Part 23: Alkalinity (First Revision) |
| IS:3025: (Part 24)-1956 | Methods of sampling and test (physical and chemical) for water and waste water –Part 24: Sulphates (First Revision) |
| IS:3025 (Part 32)-1988 | Methods of sampling and test (physical and chamical) for water and waste water - Part 32: Chloride (First Revision) |
| IS:3400 (Part 3)-1987 | Methods of test for vulcanized rubbers: Part 3 Abrasion resistance using a rotating cylindrical drum device (First Revision) |
| IS:3495: Part 1 to 4: 1992 | Methods of tests of burnt clay building bricks (Third Revision) |
| Part 1: | Determination of compressive strength |
| Part 2: | Determination of water absorption |
| Part 3: | Determination of efflorescence |
| Part 4: | Determination of warpage |
| IS:3764-1992 | Code of safety for excavation work (First Revision) |
| IS:3812:1981 | Specification for fly ash for use as pozzolana and admixture (First Revision) |





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| IS:3935:1966 | Code of practice for composite construction |
| IS:4031:(Part 1)-1996 | Methods of physical tests for hydraulic cement : Part 1 Determination of fineness by dry sieving (Second Revision) |
| IS:4031:(Part 2)-1999 | Methods of physical tests for hydraulic cement: Part 2 Determination of fineness by specific surface by Blaine air permeability method (Second Revision) |
| IS:4031:(Part 3)-1988 | Mathods of physical tests for hydraulic cement: Part 3 Determination of soundness (First Revision) |
| IS:4031:(Part 5)-1988 | Methods of physical tests for hydraulic cement: Part 5 Determination of initial and final setting times (First Revision) |
| IS:4031:(Part 6)-1988 | Methods of physical tests for hydraulic cement: Part 6 Determination of compressive strength of hydraulic cement (First Revision) |
| IS:4031:(Part 15)-1991 | Methods of physical test for hydraulic cement Part 15 Determination of false set |
| IS:4032-1985 | Methods of chemical analysis of hydraulic cement (First Revision) |
| IS:4082-1996 | Recommendations on stacking and storage of construction materials and components at site (Second Revision) |
| IS:4332 | Methods of test for stabilized soils |
| (Part 5)-1970 | Determination of unconfined compressive strength of stabilized |
| (Part 7)-1973 | Determination of cement content of cement stabilized soils |
| (Part 8)-1969 | Determination of lime content of lime stabilized soils |
| IS:4656-1968 | Specification for Form Vibration for Concrete |

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| IS:4826-1979 | Hot dipped galvanised coating on round steel wires (First Revision) |
| IS:4926-1976 | Specification for Ready Mixed Concrete (First Revision) |
| IS:5435-1987 | General requirements for cold asphalt macadam mixing plants (First Revision) |
| IS:5454-1978 | Methods of sampling of clay building bricks (First Revision) |
| IS:5640-1970 | Method for determining the aggregate impact value of soft coarse aggregate |
| IS:6241-1971 | Methods of test for determination of stripping value of road aggregates |
| IS:6603-2001 | Stainless steel bars and flats - specification (First Revision) |
| IS:6909-1990 | Supersulphated cement |
| IS:6925-1973 | Methods of test for determination of water MI concrete admixtures |
| IS:8041-1990 | Rapid hardening portland cement (Second Revision) |
| IS:8112-1989 | 43 grade ordinary portland cement (First Revision) |
| IS:8887-1995 | Bitumen emulsion for roads (cationic type)-specification (First Revision) |
| IS:9103-1999 | Admixtures for concrete (First Revision) |
| IS:9381-1979 | Methods of testing tar and bituminous materials: Determination of FRAASS breaking point of bitumen |
| IS:9382-1979 | Methods of testing tar and bituminous materials: Determination of effect of heat and air by thin film oven tests |





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| IS:9417-1989 | Recommendations for welding cold worked bars for reinforced concrete construction (First Revision) |
| IS:10262-1982 | Guidelines for concrete mix design |
| IS:12119-1987 | General requirements for pan mixers for concrete |
| 1S:12269-1987 | Specification for 53 grade ordinary portland cement |
| IS:12330-1988 | Specification for sulphate resisting portland cement |
| IS:13757-1993 | Specifications for burnt clay fly ash building bricks |
| IS:SP:23-1982 | Handbook on concrete mixes (based on Indian Standards) |

**(B) FOREIGN STANDARDS**

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| ASTM: D-297 | Tentatics methods of chemical analysis of rubber products |
| ASTM:D-395 | Compression test of vulcanised rubber |
| ASTM:D-412 | Tension testing of vulcanised rubber |
| ASTM:D-2240 | Indentation hardness of rubber and plastic by means of a ourometer |
| ASTM:D-3575 | |
| DIN:53504 | |
| DIN:53505 | |
| BS:812-1975 Part-114 | Testing aggregates method for determination of the polished stone value |