

# Detailed Specifications for Bridge / Culverts

**Brick Masonry**

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**Brick Masonry**

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**1301. DESCRIPTION**

This work shall consist of construction of structures with bricks jointed together by cement mortar in accordance with the details shown on the drawings or as approved by the Engineer.

**1302. MATERIALS**

All materials to be used in the work shall conform to the requirements laid down in Section 1000.

**1303. PERSONNEL**

Only trained personnel shall be employed for construction and supervision.

**1304. CEMENT MORTAR**

Cement and sand shall be mixed in specified proportions given in the drawings. Cement shall be proportioned by weight, taking the unit weight of cement as 1.44 tonne per cubic metre. Sand shall be proportioned by volume taking into account due allowance for bulking. All mortar shall be mixed with a minimum quantity of water to produce desired workability consistent with maximum density of mortar. The mix shall be clean and free from injurious type of soil / acid / alkali organic matter or deleterious substances.

The mixing shall preferably be done in a mechanical mixer operated manually or by power. Hand mixing can be resorted to as long as uniform density of the mix and its strength are assured subject to prior approval of the Engineer. Where permitted, specific permission is to be given by the Engineer. Hand mixing operation shall be carried out on a clean water-tight platform, where cement and sand shall be first mixed dry in the required proportion by being turned over and over, backwards and forwards several times till the mixture is of uniform colour. Thereafter, minimum quantity of water shall be added to bring the mortar to the consistency of a stiff paste. The mortar shall be mixed for at least two minutes after addition of water.

Mortar shall be mixed only in such quantity as required for immediate use. The mix which has developed initial set shall not be used. Initial set of mortar with ordinary Portland Cement shall normally be considered to have taken place in 30 minutes after mixing. In case the mortar has stiffened during initial setting time because of evaporation of water, the same can 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. Mortar unused for more than 30 minutes shall be rejected and removed from site of work.

**1305. SOAKING OF BRICKS**

All bricks shall be thoroughly soaked in a tank filled with water for a minimum period of one hour prior to being laid. 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 they are not contaminated with dirt, earth, etc.

**1306. JOINTS**

The thickness of joints shall not exceed 10 mm. All joints on exposed faces shall be tooled to give concave finish.

**1307. LAYING**

All brickwork shall be laid in an English bond, even and true to line, in accordance with the drawing or as directed by the Engineer, plumb and level and all joints accurately kept. Half and cut bricks shall not be used except when necessary to complete the bond. closer in such cases shall be cut to the required size and used near the ends of the walls. The bricks used at the face and also at all angles forming the junction of any two walls shall be selected whole bricks of uniform size, with true and rectangular faces.

All bricks shall be laid with frogs up on a full bed of mortar except in the case of tile bricks. Each brick shall be properly bedded and set in position by slightly pressing while laying, so that the mortar gets into all their surface pores to ensure proper adhesion. All head and side joints shall be completely filled by applying sufficient mortar to brick already placed and on brick to be placed. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left. No bats or cut bricks shall be used except to obtain dimensions of the different courses for specified bonds or wherever a desired shape so requires.

The brick work shall be built in uniform layers, and for this purpose wooden straight edge with graduations indicating thickness of each course including joint shall be used. corners and other advanced work shall be raked back. Brickwork shall be done true to plumb or in specified batter. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. During construction, no part of work shall rise more than one metre above the general construction level, to avoid unequal settlement and improper jointing. Where this is not possible in the opinion of the Engineer, the works shall be raked back according to the bond (and not toothed) at an angle not steeper than 45 degrees with prior approval of the Engineer. Toothing may also be permitted where future extension is contemplated.

Before laying bricks in foundation, the foundation slab shall be thoroughly hacked, swept clean and wetted. A layer of mortar not less than 12 mm thick shall be spread on the surface of the foundation slab and the first course of bricks shall be laid.

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### 1308. JOINTING OLD AND NEW WORK

Where fresh masonry is to join with masonry that is partially / entirely set, the exposed jointing surface of the set masonry shall be cleaned, roughened and wetted, so as to effect the best possible bond with the new work. All loose bricks and mortar or other material shall be removed.

In the case of vertical or inclined joints, it shall be further ensured that proper bond between the old and new masonry is 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 specially in skew bridges, a flat cutback of 100 mm shall be provided so as to have proper and bonded laying of bricks.

### 1309. CURING

Green work shall be protected from rain by suitable covering and shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period. 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.

During hot weather, all finished or partly completed work shall be covered or wetted in such a manner as will prevent rapid drying of the brickwork.

During the period of curing of brick work, it shall be suitably protected from all damages. At the close of day's work or for other period of cessation, watering and curing shall have to be maintained. Should the mortar perish i.e. become dry, white or powdery through neglect of curing, work shall be pulled down and rebuilt as directed by the Engineer. If any stains appear during watering, the same shall be removed from the face.

### 1310. SCAFFOLDING

The scaffolding shall be sound, strong and safe to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left 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. Scaffolding shall be got approved by the Engineer. However, the Contractor shall be responsible for its safety.

### 1311. EQUIPMENT

All tools and equipment used for mixing, transporting and laying of mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

### 1312. FINISHING OF SURFACES

#### 1312.1. General

All brickwork shall be finished in a workmanlike manner with the thickness of joints, manner of striking or tooling as described in these above specifications.

The surfaces can be finished by "jointing" or "pointing" or by "plastering" as given in 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 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 1304.

#### 1312.2. 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.

#### 1312.3. Pointing

Pointing shall be carried out using mortar not leaner than 1:3 by volume of cement and sand or as shown on the drawing. The mortar shall be filled and pressed into the raked joints before giving the required finish. The pointing shall be ruled type for which it shall, while still green, be ruled along the centre with half round tools of such width as may be specified by the Engineer. The super flush mortar shall then be taken off from the edges of the lines and the surface of the masonry shall be cleaned of all mortar. The work shall conform to IS:2212.

#### 1312.4. Plastering

Plastering shall be done where shown on the drawing. Superficial plastering may be done, if necessary, only in structures situated in fast flowing rivers or in severely aggressive environment.

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Plastering shall be started from top and worked down. All putlog holes shall be properly filled in advance of the plastering while the scaffolding is being taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 to 4 metres apart, to act as gauges and guides in applying the plaster. 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 to 75 mm at a time. Finally, the surface shall be finished off with a plasterer's wooden float. Metal floats shall not be used.

When recommencing the plastering beyond the work suspended earlier, the edges of the old plaster shall be scrapped, cleaned and wetted before 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 true to 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 than 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 in rectangular shape and re-done as directed by the Engineer.

### **1312.5. Curing of Finishes**

Curing shall be commenced as soon as the mortar used for finishing has hardened sufficiently 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.

### **1312.6. Scaffolding for Finishes**

Stage scaffolding shall be provided for the work. This shall be independent of the structure.

## **1313. ARCHITECTURAL COPING FOR WING / RETURN / PARAPET WALL**

This work shall consist of providing an Architectural coping for wing/return/parapet walls.

The material used shall be cement mortar 1:3 or as shown on the drawings prepared in accordance with Clause 1304.

The cement mortar shall be laid evenly to an average thickness of 15 mm to the full width of the top of the wall and in continuation a band of 15 mm thickness and 150 mm depth shall be made out of the mortar along the top outer face of the walls.

## **1314. ACCEPTANCE OF WORK**

All work shall be true to the lines and levels as indicated on the drawing or as directed by the Engineer, subject to tolerances as indicated in these specifications.

Mortar cubes shall be tested in accordance with IS:2250 for compressive strength, consistency of mortar and its water retentivity. The frequency of testing shall be one sample for every 2 cubic meters of mortar, subject to a minimum 3 samples for a day's work.

In case of plaster finish, the minimum surface thickness shall not be less than the specified thickness by more than 3mm.

## **1315. 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 metres of the surface treated.

Architectural coping shall be measured in linear metres.

## **1316. RATE**

The contract unit rate for brick work shall include the cost of all labour, materials, tools and plant, scaffolding and other expenses incidental to the satisfactory completion of the work, sampling, testing and supervision as described in these specifications and as shown on the drawings.

The contract unit rate for plastering shall include the cost of all labour, materials, tools and plant, scaffolding and all incidental expenses, sampling and testing and supervision as described in these specifications.

The contract unit rate for pointing shall include erecting and removal of scaffolding, all labour, materials, and equipment incidental to complete the pointing, 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.

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**Stone Masonry**

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**Stone Masonry**

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**1401. DESCRIPTION**

This work shall consist of the construction of structures with stones jointed together by cement mortar in accordance with the details shown on the drawings and these specifications or as approved by the Engineer.

**1402. MATERIALS**

All materials used in stone masonry shall conform to Section 1000 except cement mortar for stone masonry which shall conform to Clause 1304.

**1403. PERSONNEL**

Only trained personnel shall be employed for construction and supervision.

**1404. TYPE OF MASONRY**

The type of masonry used for structures shall be random masonry (coursed or uncoursed) or coursed rubble masonry (First son). However, for bridge work generally, course rubble stone masonry shall be used. The actual type of masonry used for different parts of structures shall be specified on the drawings.

For facing work, ashlar masonry shall be used where indicated on the drawings.

**1405. CONSTRUCTION OPERATIONS****1405.1. General Requirements**

The dressing of stone shall be as specified for individual type masonry work and it shall also conform to the general requirements of IS:1597 and requirement for dressing of stone covered in IS:1129. Other specific requirements are covered separately with respect to particular types of rubble stone work.

**1405.2. Laying**

1405.2.1. The masonry work shall be laid to lines, levels, curves and shapes as shown in the plan. The height in each course shall be kept same and every stone shall be fine tooled on all beds joints and face full and true. The exposed faces shall be gauged out, grooved, regulated and sunk or plain moulded as the case may be. The faces of each stone between the draft be left rough as the stone comes from quarry except where sacrificial layer is to be provided or plastering is resorted to due to aggressive environment.

1405.2.2. Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar.

Stratified stones must be laid on their natural beds. All bed joints shall be normal to the pressure upon them.

Stones in the hearting shall be laid on their broadest face that gives a better opportunity to fill the spaces between stones.

The courses of the masonry shall ordinarily be pre-determined. They shall generally be of the same height. When there is to be variation in the height of courses, the larger courses are to be placed at lower levels, heights of courses decreasing gradually towards the top of the wall. The practice of placing loose mortar on the course and pouring water on it to fill the gaps in stones is not acceptable. Mortar may be fluid mixed thoroughly and then poured in the joints. 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 planes of course should be at right angles to the batter. In case of bridge piers with batter on both sides, the course shall be horizontal.

The bed which is to receive the stone shall be cleaned, wetted and covered with a 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 bed wherever necessary to avoid thick beds or joints of mortar. When the foundation

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masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into rock snugly when pressed down in the mortar bedding over the rock. 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. For masonry works over rock, a levelling course of 100 mm thickness and in concrete M 15 shall be laid over rock and then stone masonry work shall be laid without foundation concrete block.

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.

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 joints broken, it shall be taken out without disturbing the adjoining stones and joints. Dry mortar and stones thoroughly cleaned from the joints and stones and the stones reset in fresh mortar. Attempt must never be made to slide one stone on top of another, freshly laid.

Shaping and dressing shall be done before the stone is laid in the work. No dressing and hammering, which will loosen the masonry, will be allowed after it is once placed. All necessary chases for joggles, dowels and clamps should be formed before hand.

Sufficient transverse bonds shall be provided by the use of bond stone extending from the front to the back of the wall and in case of thick wall from outside to the interior and vice versa. In the latter case, bond stones shall overlap each other in their arrangement.

In case headers are not available, precast headers of M 15 concrete shall be used. Cast-in-situ headers are not permitted.

Stones shall break joint on the face for at least half the height of the course and the bond shall be carefully maintained through-out.

In band work at all angle 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.

The practice of building up thin faces tied with occasional through stones and filling up the middle with small stuff or even dry packing is not acceptable.

All quoins and the angles of the opening shall be made from selected stones, carefully squared and bedded and arranged to bond alternately long and shon in both directions.

All vertical joints shall be truly vertical. Vertical joints shall be 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.

Only rectangular shaped bond stones or headers shall be used. Bond stones shall overlap each other by 150 mm or more.

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.

### **1405.3. Random Masonry (Uncoursed and Coursed)**

**1405.3.1. 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.

**1405.3.2. Insertion of chips :** Chips and spalls of stone may be used wherever necessary to avoid thick mortar beds or joints and it shall 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

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filling of interstices between the adjacent stones in hearting and they shall not exceed 20 per cent of the quantity of stone masonry .

**1405.3.3. Hearting stones :** The hearting or interior filling of the 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 should be laid nearly level with facing and backing.

**1405.3.4. Bond stones :** 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 thicknesses of such masonry, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. One bond stone or a set of bond stones shall be provided for every 0.50 sq. m. of the masonry surface.

**1405.3.5. Quoin stone :** Quoin stone i.e. stone specially selected and neatly dressed for forming an external angle in masonry work, shall not be less than 0.03 cubic metre in volume.

**1405.3.6. Plum stone :** The plum stones are selected long stones embedded vertically in the interior of the masonry to form a bond between successive courses and shall be provided at about 900 mm intervals.

**1405.3.7. Laying :** The masonry shall be laid with or without courses 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.

**1405.3.8. 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 .

#### **1405.4. Square Rubble-Coursed Rubble (First Sort)**

**1405.4.1. Dressing :** Face stones shall be hammer dressed on all beds and joints so as to give them rectangular shape. These shall be square on all joints and beds. The bed joints shall be chisel drafted for at least 80 mm back from the face and for at least 40 mm for the side joints. No portion of the dressed surface shall show a depth of gap more than 6 mm from the 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 the same as for random rubble masonry .

**1405.4.2. Hearting stones :** The hearting or interior filling of the wall face shall consist of flat bedded stone carefully laid, on prepared 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

**1405.4.3. Bond stones :** The requirements regarding through or bond stone shall be the same as for random rubble masonry, but these, shall be provided at 1.5 metre to 1.8 metre apart clear in every course.

**1405.4.4. Quoin stone :** 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 450mm 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.

**1405.4.5. Face stone :** 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 than twice their height. These shall be laid as headers and stretchers alternately.



**1405.4.6. Laying :** The stones shall be laid on horizontal courses and all vertical joints should be truly vertical. The quoin stones should be laid header and stretcher alternately and shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm.

**1405.4.7. 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.

#### **1405.5. Ashlar Masonry (Plain Ashlar)**

**1405.5.1. Dressing :** Every stone shall be cut to the required size and shape, chisel dressed on all beds and joints so as to be free from all bushing. Dressed surface shall not show a depth of gap of more than 3 mm from straight edge placed on it. The exposed faces and joints, 6 mm from the face shall be fine tooled so that a straight edge can be laid along the face of the stone in contact with every point. All visible angles and edges shall be true and square and free from chippings. The corner stones (quoins) shall be dressed square and corner shall be straight and vertical.

**1405.5.2. Bond stones :** 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 thicknesses of such masonry a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. One bond stone or a set of bond stones shall be 1.5 metres to 1.8 metres apart clear in every course.

**1405.5.3. Laying :** The face stone shall be laid header and stretcher alternately, the header being arranged to come as nearly as possible in the middle of stretchers above and below. Stones shall be laid in regular courses not less than 300 mm in height and all courses of the same height unless otherwise specified. No stone shall be less in width than its height or less in length than twice its height, unless otherwise specified.

**1405.5.4. Joints :** All joints shall be full of mortar. These shall not be less than 3 mm thick. Face joints shall be uniform throughout, and a uniform recess of 20 mm depth from face shall be left with the help of a stone plate during the progress of work.

#### **1405.6. Pointing**

Pointing shall be carried out using mortar not leaner than 3 by volume of cement and sand or as shown on the drawing. The mortar shall be filled and pressed into the raked out joints before giving the required finish. The pointing shall conform to Clause 1312.3 of the specification. The work shall conform to 15:2212. The thickness of joints shall not be less than 3 mm for Ashlar masonry. However, the maximum thickness of joints in different works shall be as follows:

Random Rubble	: 20 mm
Coursed Rubble	: 15 mm
Ashlar Masonry	: 5 mm

#### **1405.7. Curing**

Curing shall conform to Clauses 1309 and 1312.5

#### **1405.8. Scaffolding**

For scaffolding Clause 1310 shall apply.

#### **1405.9. Weep Holes**

Weep holes shall conform to Clause 2706.

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**1405.10. Jointing with Existing Structures**

For Jointing with existing structures, the specifications given under Clause 1308 shall apply.

**1406. ARCHITECTURAL COPING FOR WING/RETURN/ PARAPET WALLS**

Architectural coping for wing/return/parapet walls shall conform to Clause 1313.

**1407. TESTS AND STANDARD OF ACCEPTANCE**

All work shall be done to the lines and levels as indicated on the drawing or as directed by the Engineer subject to tolerances as specified in these specifications.

Mortar cubes shall be taken in accordance with IS:2250 for compressive strength, consistency of mortar and its water retentivity. The frequency of testing shall be one sample for every two cubic metres of mortar subject to a minimum 3 samples for a day's work.

**1408. MEASUREMENTS FOR PA YMENT**

Stone masonry shall be measured in cubic metres.

In arches, the length of arch shall be measured as the m length between the extrados and intrados.

The work of pointing shall be measured in square metres.

Architectural coping shall be measured in linear metres.

**1409. RATE**

The contract unit rate for stone masonry shall include the cost of all labour, materials, tools and plant, scaffolding, sampling and testing, supervision and other expenses incidental to the satisfactory completion of the work as described herein above.

The contract unit rate for pointing shall include erecting and removal of scaffolding, all labour, materials and equipment incidental to complete pointing, raking out joints, cleaning, wetting, filling with mortar, trowelling, pointing and watering, sampling and testing and supervision as described in these specifications.

The contract rate for architectural coping shall include the cost of all labour, materials, tools and plant, sampling and testing and supervision as described in these specifications.

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**Structural Concrete**

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**Structural Concrete**

**1701. DESCRIPTION**

The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these specifications and in conformity with the line, grades and dimensions, as shown on the drawings or as directed by the Engineer.

**1702. MATERIALS**

All materials shall conform to section 1000 of these specifications.

**1703. GRADES OF CONCRETE**

**1703.1** The grades of concrete shall be designated by the characteristic strength as given in Table 1700 - 1, Where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test result are expected to fall.

**TABLE 1700 - 1**

Grade Designation	Specified characteristic compressive strength of 150 mm cubes at 28 days in MPa
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40
M 45	45
M 50	50
M 55	55

**1703.2.** The lowest grades of concrete in bridges and corresponding minimum cement contents and water-cement ratios shall be maintained as indicated in table 1700-2 and 1700-3

**TABLE 1700-2 FOR BRIDGES WITH PRESTRESSED CONCRETE OR THOSE  
WITH INDIVIDUAL SPAN LENGTHS MORE THAN 30M OR  
THOSE THAT ARE BUILT WITH INNOVATIVE DESIGN /  
CONSTRUCTION**

**(A) MINIMUM CEMENT CONTENT AND MAXIMUM WATER CEMENT RATIO**

Structural Member	Min. cement content for all exposure conditions (kg/cu.m.)	Max. water cement ratio Exposure conditions	
		Normal	Severe
a) PCC member	360	0.45	0.45
b) RCC member	400	0.45	0.40
c) PSC members	400	0.40	0.40

**(B) MINIMUM STRENGTH OF CONCRETE**

Member	Conditions of Exposure	
	Moderate	Severe
a) PCC member	M 25	M 30
b) RCC member	M 35	M 40
c) PSC members	M 35	M 40

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**TABLE 1700-3. FOR BRIDGES OTHER THAN THOSE MENTIONED IN TABLE  
1700-2 AND FOR CULVERTS AND OTHER INCIDENTAL  
CONSTRUCTION**

**(A) MINIMUM CEMENT CONTENT AND MAXIMUM WATER CEMENT RATIO**

Structural Member	Min. cement content (Kg/cu.m.)		Max. water cement Ratio	
	Exposure conditions		Exposure conditions	
	Normal	Severe	Normal	Severe
a) PCC member	250	310	0.50	0.45
b) RCC member	310	400	0.45	0.40

**(B) MINIMUM STRENGTH OF CONCRETE**

Member	Conditions of Exposure	
	Moderate	Severe
a) PCC member	M 15	M 20
b) RCC member	M 20	M 25

Notes Applicable to Table 1700-2 and 1700-3

- (i) The minimum cement content is based on 20 mm aggregate (nominal max. size) for 40 mm and larger size aggregates, it may be reduced suitably but the reduction shall not be more than 10 per cent.
- (ii) For underwater concreting the cement content shall be increased by 10 per cent.
- (iii) Severe conditions of exposure shall mean alternate wetting and drying due to sea spray alternate wetting and drying combined with freezing and buried in soil having corrosive effect.
- (iv) Moderate conditions of exposure shall mean other than those mentioned in (iii) above.

The cement content shall be as low as possible but not less than the quantities specified above. In no case shall it exceed 540 kg/cu.m of concrete.

**1703.3** Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. "Design Mix" or "Nominal Mix" for all items of concrete, only "Design Mix" shall be used, except where "Nominal Mix" concrete is permitted as per drawing or by the Engineer "Nominal Mix"

may be permitted only for minor bridges and culverts or other incidental construction where strength requirements are up to M 20 only. "Nominal Mix" may also be permitted for non-structural concrete or for screed below open foundations.

**1703.4.** If the Contractor so elects, the Engineer may permit the use of higher grade concrete than that specified on the drawing, in which event the higher grade concrete shall meet the specifications applicable thereto without additional compensation.

**1704. PROPORTIONING OF CONCRETE**

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 materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may be used at the Contractor's option, subject to the approval of the Engineer. Other types of admixtures shall be prohibited, unless specifically permitted by the Engineer.

**1704.1. Requirements of Consistency**

The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency.

The optimum consistency for various types of structures shall be as indicated in Table 1700-4, or as directed by the Engineer. The slump of concrete shall be checked as per IS:516.

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TABLE 1700-4.

TYPE	SLUMP (mm)
I (a) Structures with exposed inclined surface requiring low slump concrete to allow proper compaction	25
(b) plain cement concrete	25
2. RCC structures with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40-50
3. RCC Structures with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts well curb, well cap, walls with thickness greater than 300 mm	50-75
4. RCC and PSC structures with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75-125
5. Underwater concreting through tremie e.g. bottom plug, cast-in-situ piling	100-200

**1704.2. Requirements for Designed Mixes****1704.2.1. Target mean strength**

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the "current margin".

(i) The current margin for a concrete mix shall be determined by the Contractor and - shall be taken as 1.64 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

(ii) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 1700.5:

TABLE 1700-5.

Concrete Grade	Current Margin (MPa)	Target Mean Strength (MPa)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58
M 50	13	63
M 55	14	69

The initial current margin given in the Table 1700-5 shall be used till sufficient data is available to determine the current margin as per sub-clause (i) above.

**1704.2.2. Trial mixes**

The Contractor shall give notice to enable the Engineer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved materials typical of those he proposes to use in

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the works, for all grades to the Engineer's satisfaction prior to commencement of concreting. The initial trial mixes shall generally be carried out in an established laboratory approved by the Engineer. In exceptional cases, the Engineer may permit, the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. In all cases complete testing of materials forming the constituents of proposed Design Mix shall have been carried out prior to making trial mixes.

Sampling and testing procedures shall be in accordance with these specifications.

When the site laboratory is utilised for preparing initial mix design, the concreting plant and means of transport employed to make the trial mixes shall be similar to that proposed to be used in the works.

Test cubes shall be taken from trial mixes as follows. For each mix, set of six cubes shall be made from each of three consecutive batches. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these specifications. The average strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

#### 1704.2.3. Control of strength of design mixes

##### a) Adjustment to Mix Proportions

Adjustments to mix proportions arrived at in the trial mixes shall be made subject to the Engineer's approval, in order to minimise the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

##### b) Change of Current

Margin When required by the Engineer, the Contractor shall recalculate the current margin in accordance with Clause 1704.2.1. The recalculated value shall be adopted as directed by the Engineer, and it shall become the current margin for concrete produced subsequently.

##### c) Additional Trial Mixes

During production, the Contractor shall carry out trial mixes and tests, if required by the Engineer, before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with sub-clause (a) above.

#### 1704.3. Requirements of Nominal Mix Concrete

Requirements for nominal mix concrete unless otherwise specified, shall be as detailed in Table 1700-6.

**TABLE 1700-6. PROPORTIONS FOR NOMINAL MIX CONCRETE**

Concrete Grade	Total Quantity of dry aggregate by mass per 50 kg of cement to be taken as the sum of individual masses of fine and coarse aggregates (kg)	Proportion of fine to Coarse aggregate (by mass)
M 15	350	Generally 1:2, subject to upper limit 1:1.5 and lower limit of 1:2.5
M 20	250	- do -

#### 1704.4. Additional Requirements

Concrete shall meet with any other requirements as specified on the drawing or as directed by the Engineer. Additional requirements shall also consist of the following overall limits of deleterious substances in concrete:

- a) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to values given below:
  - Prestressed Concrete : 0.1 per cent
  - Reinforced concrete exposed to chlorides in service : 0.2 per cent

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(e.g. structures located near sea coast)

- Other reinforced concrete construction : 0.3 per cent

b) The total sulphuric anhydride (SO<sub>3</sub>) content of all the constituents of concrete as a percentage of mass of cement in the mix shall be limited to 4 per cent

#### 1704.5. Suitability of Proposed Mix Proportions

The Contractor shall submit the following information for the Engineer's approval :

- a) Nature and source of each material
- b) Quantities of each material per cubic metre of fully compacted concrete
- c) Either of the following :
  - (i) appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement(s) as specified.
  - (ii) full details of tests on trial mixes.
- d) Statement giving the proposed mix proportions for nominal mix concrete.

Any change in the source of material or in the mix proportions shall be subject to the Engineer's prior approval.

#### 1705. ADMIXTURES

Use of admixtures such as superplasticisers for concrete may be made with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of anyone of his products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the project.

#### 1706. SIZE OF COARSE AGGREGATE

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be given as Table 1700-7.

TABLE 1700-7.

Components		Maximum Nominal Size of Coarse Aggregate (mm)
i)	RCC well curb	20
ii)	RCC/PCC well steining	40
iii)	Well cap or Pile Cap	40
	Solid type piers and abutments	40
iv)	RCC work in girders, slabs, wearing coat, kerb, approach slab, hollow piers and abutments, pier/abutment caps, piles	20
v)	PSC work	20
vi)	Any other item	As specified by Engineer

Maximum nominal size of aggregates shall also be restricted to the smaller of the following values ;

- a) 10 mm less than the minimum lateral clear distance between main reinforcements
- b) 10 mm less than the minimum clear cover to the reinforcements

The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

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**1707. EQUIPMENT**

Unless specified otherwise, equipment for production, transportation and compaction of concrete shall be as under :

## a) For Production of Concrete :

- i) For overall bridge length of less than 200 metres.-batch type concrete mixer diesel or electric operated, with a minimum size of 200 litres, automatic water measuring system and integral weigher (hydraulic/pneumatic type)
- ii) For overall bridge length of 200 metres or more -concrete batching and mixing plant fully automatic with minimum capacity of 15 cu.m. per hour,

All measuring devices of the 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 the quantity of cement in each batch
Measurement of Water	± 3 per cent of the quantity of water in each batch
Measurement of Aggregate	± 3 per cent of the quantity of aggregate in each batch
Measurement of Admixture	± 5 per cent of the quantity of admixture in each batch

## b) For Concrete Transportation

- i) Concrete dumpers  
minimum 2 tonnes capacity
- ii) Powered hojsts  
minimum 0,5 tonne capacity
- iii) Chutes
- iv) Buckets handled by cranes
- v) Transit truck mixer
- vi) Concrete pump
- vii) Concrete distributor booms
- viii) Belt conveyor
- ix) Cranes with skips
- x) Tremies

## c) For Compaction of Concrete :

- i) Internal vibrators  
size 25 mm to 70 mm
- ii) Form vibrators  
minimum 500 walls
- iii) Screed vibrators  
full width of carriageway (upto two lanes)

**1708. MIXING CONCRETE**

Concrete shall be mixed either in a concrete mixer or in a batching and mixing plant, as per these specifications. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall mixing be done for less than 2 minutes.

Mixers which have 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 aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

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### 1709. TRANSPORTING, PLACING AND COMPACTION OF CONCRETE

The method of transporting and placing concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position, so that no contamination, segregation or loss of its constituent materials takes place. Concrete shall not be freely dropped into place from a height exceeding 1.5 metres.

When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without the use of excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

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 24 hours of the approval being given, it shall have to be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the 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.

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 exceeding 300 mm in all other cases.

Concrete when deposited shall have a temperature of not less than 5 degrees Celsius, and not more than 40 degrees Celsius. It shall be compacted in its final position within 30 minutes of its discharge from the mixer, unless carried in properly designed agitators, operating continuously, when this time shall be within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimise the risk of 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 blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc shall be avoided. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and a half times the radius of the area visibly affected by vibration. 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:2502, IS:2506, IS:2514 and IS:4656.

**1711 & 1712 Deleted**

### 1710. 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, except with express approval of the Engineer. The joints shall be provided in a direction perpendicular to the member axis.

Location, preparation of surface and concreting of joints shall conform to the additional specifications given 1700/1.

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**1713 PROTECTION AND CURING**

Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor.

Curing and protection of concrete shall start immediately after compaction of the concrete to protect it from :

- a) Premature drying out particularly by solar radiation 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) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement

Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

**1713.1. Water Curing**

Water for curing shall be as specified in Section 1000.

Sea water shall not be used for curing. Sea water shall not come into contact with concrete members unless it has attained adequate strength.

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 no less than 14 days from the date of placing of concrete.

**1713.2. Steam Curing**

Where steam curing is adopted, it shall be ensured that it is done in a suitable enclosure to contain the live steam in order to minimise moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

The steam shall be at 100 per cent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete and the ambient air temperature shall increase at a rate not exceeding 5 degrees Celsius per hour until a maximum temperature of 60 degrees Celsius to 70 degrees Celsius is reached. The maximum temperature shall be maintained until the concrete has reached the desired strength.

When steam curing is discontinued, the ambient air temperature shall not drop at a rate exceeding 5 degrees Celsius per hour until a temperature of about 10 degrees Celsius above the temperature of the air to which the concrete will be exposed, has been reached.

The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

**1713.3. Curing Compounds**

Curing compounds shall only be permitted in special circumstances and will require 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 will 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

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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.

#### 1714. FINISHING

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with cement mortar. All fins caused by forms joints, all cavities produced by the removal of forms 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 all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

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.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good.

- a) The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance shall be rejected.
- b) Surface defect of a minor nature may be accepted. On acceptance of such work by the Engineer, the same shall be rectified as directed by the Engineer.

#### 1715. TOLERANCES

Tolerances for dimensions/shape of various components shall be as indicated in these specifications or shown on the drawings or as directed by the Engineer.

#### 1716. TESTS AND STANDARDS OF ACCEPTANCE

**1716.1.** Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components.

**1716.2.** Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cube strength of concrete.

**1716.2.1.** Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement 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.
- (iii) Different grades of mixes of concrete shall be divided into separate lots
- (iv) Concrete of a lot shall be used in the same identifiable component of the bridge

##### 1716.2.2. Sampling and testing

1. Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure laid down in IS: 1199.
2. 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 cubes shall be adopted.
3. 150 mm cubes shall be made, cured tested at the age of 28 days for compressive strength in accordance with IS:516. The 28-day test strength result for each cube shall form an item of the sample.

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**1716.2.3. Test specimen and sample strength :** Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than :t 15 per cent of the average.

**1716.2.4. Frequency :** The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 1700-8

TABLE 1700.8

Quantity of Concrete In work, m <sup>3</sup>	No: of samples
1 - 5	1
6 - 15	2
16 - 30	3
31 - 50	4
51 and above	4 plus one additional sample for each additional 50 m <sup>3</sup> or part thereof

At least one sample shall be taken from each shift of work.

#### 1716.2.5. Acceptance Criteria

##### Compressive Strength

When both the following conditions are met, the concrete complies with the specified compressive strength :

- The mean strength detennined from any group of four consecutive samples should exceed the specified characteristic compressive strength.
- Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

##### Chloride and Sulphate Content

The total chloride and sulphuric anhydride (SO<sub>3</sub>) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this section of the specifications.

#### 1716.3. Density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 per cent of the specified value.

#### 1716.4. Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 per cent f the specified value.

#### 1716.5. Permeability Test

The concrete should pass the following test if it is properly compacted and is not considered permeable.

- Prepare a cylindrical test specimen 150 mm dia and 160 mm high
- After 28 days of curing, the test specimen is fitted in a machine such that the specimen can be placed

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in water under pressure upto 7 bars. A typical machine is shown.11 in Appendix 1700/11.

(iii) At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.

(iv) After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.

(v) The water penetration in the broken core is to be measured with a scale and the depth of penetration assessed in mm (max. permissible limit 25 mm).

1716.6. If the concrete is not able to meet any of the standards of ceptance as prescribed, the effect of such deficiency on the structure Shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable after investigation, the Contractor shall remove the rejected concrete forthwith.

### 1717. MEASUREMENTS FOR PAYMENT

Structural concrete shall be measured in cubic metres. In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

### 1718. RATE

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and super-vision. Unless mentioned separately as an item in the Contract, the contract unit rate for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per Section 1500.

Where concrete is found to be acceptable as sub-standard work, the Contractor shall pay a discount over the contract unit rate, as decided by the Engineer. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate may be applied as under

$$\text{Per cent reduction} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

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**River Training work  
and Protection work**

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**2500**

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**River Training work  
and Protection work**

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## 2501 DESCRIPTION

River training and protection work shall include construction of guide bunds, guide walls, bank protection, flooring and approach embankment protection as required for ensuring safety of the bridge structure and its approaches against damage by flood/flowing water. Construction of various components shall conform to IRC:89 and these specifications or as directed by the Engineer.

## 2502. GUIDE BUND

2502.1. This work shall consist of construction of embankment of guide bund and provision of pitching/rivetment on slopes, apron, toe protection, curtain walls etc. as indicated on the drawing in accordance with these specifications or as approved by the Engineer.

The provisions given hereunder are applicable only to guide bunds for bridges across alluvial rivers. Guide bunds for bridges across submontane rivers shall call for supplemental specifications.

2502.2. The alignment and layout of guide bund shall be as indicated on the drawing or as approved by the Engineer. The construction of embankment for guide bund shall conform to provisions of Section 300 of these Specifications. Pitching, filter underneath pitching and turfing, apron, toe protection, curtain walls, etc., shall be as per these specifications.

2502.3. Guide bunds shall generally be made of locally available materials from the river bed preferably cohesionless materials. Trial pits shall be taken in borrow holes to examine suitability of soil for construction and also to decide the types of earth moving machinery to be arranged. The borrow pits should be sufficiently away from the location of the launching apron. No borrow pits should be dug on the river side of the guide bunds.

Construction of guide bund shall be taken in hand alongwith the construction of the bridge. Every effort shall be made to complete the work of the guide bund in one working season. Where there is any doubt about completion of the whole guide bund within one working season, suitable measures shall be planned and executed for protection of completed work. In such cases the construction of guide bund shall be started from abutment towards upstream.

2502.4. Construction of apron and pitching of the guide bunds shall generally conform to clause 2503 and 2504 of these Specifications. Sufficient length of pit along the guide bund shall be ready within one to two months of commencement of work so that the placing of stones in the apron and in the slope pitching can be commenced. As a guideline, earthwork should be completed within 80 per cent of working season and about 70 per cent working season shall be available for laying apron and pitching. No portion of the guide bund should be left below HFL before the onset of monsoon. Bottom of apron pit shall be as low as permitted by sub-soil water/lowest water level. Sufficient labour and appropriate earth moving machinery and trained staff shall be deployed in construction.

2502.5. The Contractor shall furnish his planning for approval of the Engineer regarding transport of stones from the quarries to the site of work taking into account the quantities of stone required to be transported every day, train/truck, etc., deployed, available ferry or boats and labour available for loading and unloading and for laying within the time frame for construction of guide bund. Adequate reserve of stones should be maintained for major works as decided by the Engineer. Reserve stones shall be stacked far away from the main channel of the river.

2502.6. Where the alignment of guide bund or the approach embankment crosses a branch channel of the river, the branch channel may be either diverted to the main channel of the river with the help of spurs, etc. or closed by a properly designed closing dyke or closure bund before taking up construction of guide bund.

## 2503. APRON

### 2503 1. General

This work shall consist of laying boulders directly or in wire crates on the bed of rivers for protection against scour.

Where the required size of boulders are not available economically, cement concrete blocks of equivalent weight

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shall be used. The grade of concrete shall be M 15 nominal mix. (This holds good for pitching on slopes and flooring also). Cement concrete blocks shall be preferred where practicable.

The stones used in apron shall be sound, hard, durable and fairly regular in shape. Stone subject to marked deterioration by water or weather shall not be used.

Quarry stones are preferable to round boulders as the latter roll off easily. Angular stones fit into each other better and have good interlocking characteristics.

Where the required size stones are not economically available, cement concrete blocks in M15 grade conforming to Section 1700 or stones in wire crates in combination may be used in place of isolated stones of equivalent weight. Cement concrete blocks will be preferred, wherever practicable.

### **2503.2. Laying Boulder Apron**

The size of stone should conform to clause 5.3.7.2 of IRC:89.

The size of stone shall be as large as possible. In no case any fragment shall weigh less than 40 kg. The specific gravity of stones shall be as high as possible and it shall not be less than 2.65.

To ensure regular and orderly disposition of the full intended quantity of stone in the apron, template cross walls in dry masonry shall be built about a metre thick and to the full height of the specified thickness of the apron at intervals of 30 metres all along the length and width of the apron. Within these walls, the stone then shall be hand packed.

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 and the apron laid thereon. The quantity of stone required in the apron shall be re-worked out by taking the toe of pitching at higher level.

### **2503.3. Laying Wire Crates and Mattresses in the Apron**

Wire crates shall be made from hot dipped galvanized mild steel wire of diameter not less than 4 mm in annealed condition having tensile strength of 300-450 MPa conforming to IS:280. The galvanizing coating shall be heavy coating for soft condition conforming to IS:4826.

The mesh of the crate shall not be more than 150 mm.

Wire crates for shallow or accessible situations shall be 3 metre x 1.5 metre X 1.25 metre in size. Where these have to be deposited and there is a chance of overturning, the crate shall be divided into 1.5 metre compartments by cross netting.

For deep or inaccessible situations, wire crates can be made smaller subject to the approval of the Engineer.

Wire crates built in-situ, shall not be larger than 7.5 metres X 3 metres x 0.6 metre, nor smaller than 2 metres x 1 metre x 0.3 metre. Sides of large crates shall be securely stayed at intervals of not more than 1.50 metres to prevent bulging.

The netting shall be made by fixing a row of spikes on abeam 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.

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.

The bottom and two ends of the crate or mattress 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.

Wherever possible, crates shall be placed in position before filling with boulders. The crates shall be filled by

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carefully hand-packing the boulders as tightly as possible and not by merely throwing in stones or boulders.

For laying of wire crates in aprons of bridges, two situations arise:

- i) Where the crates are to be laid in deep water and have to be dumped and then joined together.
- ii) Where depth of water is low or dry bed is available. In such cases, the crates can be laid at site.

## 2504. PITCHING / REVETMENT ON SLOPES

### 2504.1. Description

This work shall consist of covering the slopes of guide bunds, training works and road embankments with stone, boulders, cement concrete blocks or stones in wire crates over a layer of granular material called filter. While river side slopes are given this protection against river action, the rear slopes, not subjected to direct attack of the river, may be protected against ordinary wave splashing by 0.3-0.6 metre thick cover of clayey or silty earth and turfed.

### 2504.2. Pitching / Filter media

**2504.2.1. Pitching :** The pitching shall be provided as indicated in the drawings. The thickness and the shape of stone pitching shall be shown on the drawing.

The stone shall be sound, hard, durable and fairly regular in shape. Quarry stone should be used. Round boulders shall not be allowed. The stones subject to marked deterioration by water or weather shall not be accepted.

The size and weight of stone shall conform to clause 5.3.5.1 of IRC:89. No stone, weighing less than 40 kg shall, however, be used. The sizes of spalls shall be a minimum of 25 mm and shall be suitable to fill the voids in the pitching.

Where the required size stones are not economically available, cement concrete blocks in M15 grade conforming to Section 1700 or stones in wire crates may be used in place of isolated stones of equivalent weight. Cement concrete blocks will be preferred wherever practicable. Use of geosynthetics has been dealt with in Section 700.

**2504.2.2. Filter media :** The material for the filter shall consist of sand, gravel, stone or coarse sand. To prevent escape of the embankment material through the voids of the stone pitching / cement concrete blocks as well as to allow free movement of water without creating any uplift head on the pitching, one or more layers of graded materials, commonly known as a filter medium, shall be provided underneath the pitching.

The gradation of the filter material shall satisfy the following requirements :

Provision of a suitably designed filter is necessary under the slope pitching to prevent the escape of underlying embankment material through the voids of stone pitching/cement concrete blocks when subjected to the attack of flowing water and wave action, etc. In order to achieve this requirement, the filter may be provided in one or more layers satisfying the following criteria :

$$\begin{array}{rcl}
 & \frac{D_{15} \text{ (Filter)}}{D_{85} \text{ (Base)}} & < 5 \\
 4 < & \frac{D_{15} \text{ (Filter)}}{D_{15} \text{ (Base)}} & < 20 \\
 & \frac{D_{15} \text{ (Filter)}}{D_{15} \text{ (Base)}} & < 25
 \end{array}$$

Notes : 1. Filter design may not be required if embankment consists of CH or CH soils with liquid limit greater than 30, 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. If more than one filter layer is required, the same requirement as above shall be followed for each

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layer. The finer filter shall be considered as base material for selection of coarser filter.

4. The filter shall be compacted to a firm condition. The thickness of filter is generally of the order of 200 mm to 300 mm. Where filter is provided in two layers, thickness of each layer shall be 150 mm.

#### **2504.3. Construction Operations**

Before laying the pitching, the sides of banks shall be trimmed to the required slope and profiles put up by means of line and pegs at intervals of 3 metres to ensure regular straight work and a uniform slope throughout. Depressions shall be filled and thoroughly compacted.

The filter granular material shall be laid over the prepared base and suitably compacted to the thickness specified on the drawings.

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 Clause 1405.3, in case of dry rubble pitching and shall be in nominal mix cement concrete (M 15) conforming to Clause 1704.3 in case of cement concrete block pitching.

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 as headers for subsequent courses.

In hand placed pitching, the stone of flat stratified nature should be placed with the principal bedding plane normal to the slope. The pattern of laying shall be such that the joints are broken and voids are minimum by packing with spalls, wherever necessary, and the top surface is as smooth as possible.

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.

When two or more layers of stones must 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 cross walls in dry masonry shall be built about a metre wide and to the full height of the specified thickness at suitable intervals and all along the length and width of the pitching. Within these walls the stones shall be hand packed as specified.

#### **2504.4. Toe Protection**

In conformity with clause 5.3.7. of IRC:89, a toe wall shall be provided at the junction of slope pitching and launching apron of a guide bund so as to protect the slope pitching from falling even when the apron is not laid at low water level. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Clause 1405.3 in case of dry rubble pitching or pitching/ revetment with stones in wire crates and in nominal mix cement concrete (M 15) conforming to Clause 1704.3 in case cement concrete blocks have been used in pitching. For protection of toes of bank slopes terminating either in short aprons at bed levels or anchored in flooring / rocky bed, the provisions of clause 8.2.2 of IRC:89 may be complied with. The relevant specifications of the protective works for individual components will be followed.

### **2508. 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.

### **2509. MEASUREMENTS FOR PAYMENT**

The protection works shall be measured as set forth below. If directed by the Engineer for measurement, the

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materials may have to be stacked at site before laying and nothing extra will be paid to the Contractor for this stacking.

The earth work in construction of embankment for guide bund shall be measured in cubic metres unless otherwise specified

The boulders/cement concrete blocks and wire crates in apron shall be measured in cubic metres.

The filter and stone pitching shall be measured separately in cubic metres unless otherwise specified.

Rubble stone/cement concrete blocks, flooring and cement concrete bedding shall be measured in cubic metres for each class of material.

Preparation of base for laying the flooring shall be deemed incidental to the work.

For laying apron, excavation upto an average depth of 150 mm shall be deemed to be included in the main item and shall not be measured separately unless otherwise specified. Excavation more than 150 mm shall be measured in cubic metres as given in Clause 304.

### 2510. RATE

The contract unit rate for the construction of embankment for guide bund shall cover the cost of all materials including transportation, laying, compacting, all labour, tools, equipment, sampling and testing, supervision and all incidentals necessary for completing the work according to these specifications.

The contract unit rate for one cubic metre of finished work of apron shall include the cost of all material, labour, tools and plant for completing the work according to above specifications. Excavation upto an average depth of 150 mm shall also be deemed to included in the rate as dressing of the bed. Excavation beyond this depth shall be paid for separately unless otherwise specified.

The contract unit rate for one cubic metre of filter or stone/cement concrete block 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/cement concrete block rivetment 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.

The contract unit rate for rubble stone/cement concrete block flooring shall include the cost of all material, labour and tools and plant for completing the work as per these specifications.

**Expansion Joints**

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**2600**

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**Expansion Joints**

**2601. DESCRIPTION**

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.

**2602. GENERAL**

- a) The expansion joints shall be designed and duly got approved by the Engineer. It shall cater for expected movement and rotation 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 and be of proven type.
- c) For bridges with prestressed concrete superstructure, with individual span length more than 20 m or built with innovative design/construction elastomeric expansion joints of slab seal or strip seal type shall be provided.
- d) For slab type of bridges of spans less than 10 metres continuous surfacing may be provided across the expansion gaps, supported on a 20 mm thick Plate / placed and fixed at the level of the deck slab.
- e) For bridges other than those mentioned in (c) above with spans above 10 metres, an alternative specification of sliding steel plate joint or filled joints with copper plates may also be adopted if approved by the Engineer, apart from elastomeric expansion joint of slab seal or strip seal type.
- f) Vehicular traffic shall not be allowed over expansion joints after its construction for such period as may be determined by the Engineer.
- g) 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 recommendations and to the general requirements of this Specification.

No expansion joint shall be provided only for the width of the carriageway. It shall follow the profile including the kerb and the footway and fascia, if provided. The type of expansion joint for the latter may be made different from that used for the carriageway expansion joint.

**2603. REQUIREMENTS**

**2603.1.** The requirement criterion will be separately applicable for the expansion joint proper and the transition zone of attachment to the deck.

**2603.2.** There are two types of performance requirements for the expansion joint proper viz. from the necessity of the bridge and from the road users e.g. man, animal and vehicle.

**2603.3. Performance Requirement with Respect to Bridges**

The expansion joint shall :

- a) Withstand the imposed load including the impact load from live load and other sources.
- b) Allow expansion and contraction movement due to temperature, creep, shrinkage, prestressing and structural deformations.

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- c) Permit relative rotation in elevation and plan due to the causes as noted above
- d) Be waterproof. Bridge deck expansion joint seals play a critical role in preventing the degradation of the structural components of the bridge system. Without effective joint seals water passes through the bridge deck and works harmfully to corrode steel components and cause deterioration of the concrete. Rain water gathers various corroding additives from the atmosphere and also from the carriageway.
- e) Ensure sealing. In case bridge deck joints are not sealed, apart from loss of waterproofing, grit and other forms of road debris may enter the joint. Debris, when impacted with the joint can seriously restrict the movement instead of facilitating the same. In the case of proprietary joints being accepted for adoption, the sealing shall be as specified by them,
- f) Ensure long life by being resistant to corrosion
- g) Be easy to install,
- h) Be easy to maintain. Replaceability one of the basic expansion joint shall be criteria for selection of type of expansion joint,
- i) Be resistant to the materials likely to collect/spill over the deck in its normal service.

#### **2603.4. Performance Requirement with Respect to User**

The expansion joint shall :

- a) Provide smooth continuity at the top of the deck for riding comfort,
- b) Be of skid resistant surface,
- c) Be non-damaging to the rubber tyre,
- d) Make minimum noise during vehicular crossing,
- e) Ensure that animal paws and hooves should not get entangled where bridges are used by animal drawn traffic,
- f) Permit passing of bullock cart steel tyre for bridges where bullock carts ply
- g) Look good aesthetically.

#### **2603.5. Performance Requirement for Transition Zone**

It is the zone of connection of joint assembly and the adjoining deck. The expansion joint shall :

- a) Permit transfer of generated forces without distress, i.e., without getting uprooted. The purpose will not be served if the bonding is with the wearing coat only. Anchorage must be provided with the deck structural element,
- b) Ensure that surface in the transition zone stays undisturbed during long term service.

#### **2604. STEEL PLATE SLIDING EXPANSION JOINTS**

- a) In this type of buried joint, the wearing coat shall be made continuous over the joint. The other alternative shall be to keep a gap in the wearing coat which is filled up with a seal and filler, to be provided in extremely hot areas.
- b) Materials for steel plates shall conform to Section 1900. The exposed metallic components shall be galvanised or coated with approved anti-corrosive paint. The thickness shall be 20 mm or so for obtaining satisfactory performance.
- c) Plates shall be placed to the line, grade and expansion gap shown on the drawings with any adjustment required for temperature, particular care being taken with the top of the plates.
- d) Plates shall be firmly held in place during concreting by methods approved by the Engineer.
- e) Any temporary bolts or other fixings 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 correct positions. In any case, temporary bolts or other fittings shall be removed within 6 hours of placing concrete unless otherwise directed by the Engineer.
- f) Care shall be taken to prevent damage to expansion joint plates or its coating
- g) If any damage occurs, the plates and coatings shall be restored by the Contractor to the satisfaction of the Engineer.
- h) Plates shall be free of oil, rust, loose paint or other similar material before coating.

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**2605. 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, 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 remove 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 for 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.

**2606. ELASTOMERIC SLAB SEAL EXPANSION JOINT****2606.1. Materials**

- a) Steel inserts shall conform to IS:226. 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 $\pm$ 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 vulcanised 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 shall not exceed 5 per cent (as per tests conducted in accordance with ASTM) 0-297 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 centre to centre 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 arrangements of steel inserts shall be permanently welded/ tied with the steel reinforcement.

**2606.2. Fabrication**

- a) Steel inserts shall be grit blasted and provided with epoxy paint.

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- b) Edges of reinforcing steel sections shall be rounded.
- c) Expansion joints shall be fully moulded to the required size in one single vulcanising operation including the encasing layers as integral and homogeneous part.
- d) Tolerances of fabrication shall be as follows :
  - i) Plan dimension -  $\pm 5$  mm
  - ii) Total height -  $\pm 3$  mm

### 2606.3. 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.

### 2606.4. Installation

**2606.4.1.** 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 levelling of the steel inserts during fixing of the same with the deck reinforcement and casting second stage concreting in the pocket thereafter.
  - ii) The 2nd 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 anyone 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 ultimate 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 bar 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 fixed, it shall not be pulled by any means; it shall be gas cut in two pieces and then removed.

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## c) Concreting of Pocket

- 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 should 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 nut and lock washers position. Tightened nuts shall be locked with lock washers.
- vi) Special sealant shall be poured inside the plug holes.
- vii) The elastomeric plugs shall be pressed in position after applying adhesive on the appropriate surface.
- viii) 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 bridge superstructure are indicated below:
  - a) Temperature variation from annual mean.
  - b) Changes due to shrinkage of concrete.
  - c) Changes due to elastic shortening and creep of the prestressed bridge superstructure.
  - d) 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 creep and 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 presetting depending on :

- i) The difference between the mean temperature of the month steel insert and the annual average temperature.
- ii) The elapsed period between the casting and/or prestressing steel insert for calculating the remnant creep and shrinkage.

**2606.4.2. Special requirements for installation**

- i) Prior to construction of bridge deck area adjacent to the joint, the supplier shall provide detailed working drawings showing the location of all bolts, recesses and holes necessary for the installation of the joint. Reinforcing bars in superstructure shall be amended as required to ensure that there will be no interference in the installation of the joint.

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- ii) All bearing surfaces and recesses which are in contact with the joint assembly shall be checked with a straight edge to ensure flatness of profile.
- iii) No holes shall be drilled for fixing bolts within 7 days of concreting. Holes for the bolts shall be drilled to the size and depth shown on the drawings.
- iv) Sections of the jointing making the completed joint shall follow a straight line.
- v) The fixing bolts shall not be placed in a position until at least 4 weeks after stressing is completed in post-tensioned box or beam and slab structures. Prior to placing sections of jointing contact surfaces shall be cleaned to remove all grease, tar, paint, oil, mud or any other foreign material that may affect adhesion of the sealant.
- vi) Sealant shall only be applied to dry contact surfaces. Sufficient sealant shall be applied to the contact surfaces to cause extrusion of sealant when the jointing is fixed in position.
- vii) Final sealing of the finished expansion joint shall be completed immediately after completion of installation. All exposed ends, joints between units and other areas of possible leakage shall be filled with sealant. All voids between the sides of the jointing and concrete or plates shall be filled with sealant.
- viii) Bolt cavities shall be cleaned and plugged with neoprene cavity plugs. Prior to placing the plugs sufficient sealant shall be placed in the cavities to cause extrusion of the sealant by the plugs.
- ix) All excess sealant shall be removed from the jointing and adjacent areas.

#### 2606.5. Acceptance Test

**2606.5.1.** 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 I of clause 915.2 of IRC:83 (Part II). The acceptance testing for elastomer material shall conform to clause 918.4.1.2 of IRC:83 (part II) with additional criteria as stated in Clause 2005.

**2606.5.2.** 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  $\pm 20$  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.

### 2607. STRIP SEAL EXPANSION JOINT

#### 2607.1. Components

Strip seal expansion joint shall comprise the following items :

- a) Edge reams - This special claw leg profiled member shall be of extruded rolled steel section combining good weldability with notch toughness.
- b) Strip seal - This shall be of chloroprene with high tear strength, insensitive to oil, gasoline, and ozone. It shall have high resistance to aging. This component, provided to ensure water tightness, shall have bulbous shape of the part of the seal which is inserted into the groove, provided in the edge beam. The seal should be vulcanised in single operation for minimum full length of joint-
- c) Rigid Anchorage - This shall be welded to the edge beam at staggered distance.

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- d) Anchor loops-This shall be made of weldable steel connecting the rigid anchorage with deck reinforcement.

**2607.2. Material**

- a) Edge beams of this special section are at present being directly imported in India. The steel shall conform to steel grade Rst 37-2 of German Standard or equivalent
- b) chloroprene of strip seal shall conform to clause 915.1 of IRC: 83 (Part 11). The properties of chloroprene shall conform to Table 2600-1.
- c) Anchorage steel shall conform to IS:2062.
- d) Anchor loop shall conform to IS:2062.

**TABLE 2600-1. STRIP SEAL ELEMENT SPECIFICATION**

Sealing element is made of chloroprene and must be a extruded section. The working movement range of the sealing element shall be at least 80 mm with a maximum of 100 mm at right angles to the joint and  $\pm 40$  mm parallel to the joint.

PROPERTY	SPECIFIED VALUE
Hardness	63 $\pm 5$ Shore A
Tensile Strength	Min 11 MPa
Elongation at fracture	Min 350 percent
Tear Propagation Strength	
Longitudinal	Min 10 N/mm <sup>3</sup>
Transverse	Min 10 N/mm
Shock Elasticity	Min 25 percent
Abrasion	Min 220 mm <sup>3</sup>
Residual Compressive Strain (22 h/70 deg C 130 per cent strain)	Max 28 per cent
Ageing in hot air (14 days /70 deg C)	
Change in hardness	Max +5 Shore A
Change in tensile strength	Max-20 per cent
Change in elongation at fracture	Max -20 percent
Ageing in ozone (24 h/50pphm/25 deg C/20 per cent strain)	No Creacks
Swelling behaviour in Oil (116 h/25 per cent C)	ASTM. Oil no.
Volume Change	Max 5 per cent
Change in hardness	Max 10 Shore A
ASTM Oil no.3	
Volume Change	Max 25 percent
Change in hardness	Max 20 Shore A
Cold Hardening Point	Min - 35 deg C

**2607.3. Fabrication (Pre-installation)**

- a) Rolled steel profiles for edge beams shall be long enough to cater for a 2-lane carriageway. These shall be cut to size of actual requirements by means of a mitre box saw. Alignment of the cut-to-size steel profiles shall then be

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made in accordance with the actual bridge cross-section on work tables. For this purpose, the contour of bridge cross-section shall be sketched onto these tables. After the steel profiles are aligned, they will be chucked to the tables by means of screw clamps and tacked by arc welding.

- b) Anchor plates shall be cut to the required size by gas cutting. These shall be welded to the edge beams.
- c) Anchor loops shall be bent to the required shape and welded to anchor plates.
- d) The finally assembled joints shall then be clamped and transported to the work site.

#### 2607.4. Handling and Storage

- a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.
- b) The manufacturer shall supply either directly to the Engineer or to the Bridge Contractor all the materials of strip seal joints including sealants and all other accessories for the effective installation of the jointing.
- c) Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding by the Contractor to prevent damage. Any damage occurring after delivery shall be made good at the Bridge Contractor's expense to the satisfaction of the Engineer.

#### 2607.5. Installation

**2607.5.1.** The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is likely to be installed, the gap dimension shall be preset.

**2607.5.2.** Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surfaces of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.

**2607.5.3.** The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be tight.

**2607.5.4.** Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.

**2607.5.5.** The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be levelled and finally aligned and the anchor loops on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.

**2607.5.6.** High quality concrete shall then be filled into the recess. The packing concrete must feature low shrinkage and have the same strength as that of the superstructure, but in any case not less than M 35 grade. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets still in place shall be removed.

**2607.5.7.** Rolled up neoprene strip seal shall be cut into the required length and inserted between the edge beams by using a crow bar pushing the bulb of the seal into the steel grooves of the edge beams. A landing to a bead shall be formed in the thickened end of the edges of the seal which would force the thickened end against the steel beam due to wedge effect when the strip seal is buttoned in place.

**2607.5.8.** As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from site traffic. Expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.

**2607.5.9.** The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing/wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

#### Acceptance Test

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- i) All steel elements shall be finished with corrosion protection system.
  - ii) For neoprene seal, the acceptance test shall conform to the requirements stipulated in Table 2600-1. It shall also be stretch tested. If a manufacturer is to supply this type of joint, they will have to produce a test certificate accordingly conducted in a recognised laboratory, in India or abroad.
  - iii) In view of the importance of the built up edge beams, special investigation of fatigue strength of this section with anchorages to withstand 2 x 10' load change cycles without showing signs of damage, will be required. The supplier shall have to produce a test certificate in this regard, conducted in a recognised laboratory, in India or abroad.
  - iv) The manufacturer shall produce test certificates indicating that anchorage system had been tested in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic loading.
  - v) The manufacturer shall satisfy the Engineer that water tightness test for the type of joint has been carried out in a recognised laboratory to check the water tightness under a water pressure of 4 bars.
  - vi) As strip seal type of joint is specialised in nature, generally of the proprietary
- Type, the manufacturer shall be required to produce evidence of satisfactory performance of this type of joint

#### **2608. 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.

#### **2609. MEASUREMENTS FOR PAYMENT**

The expansion joint shall be measured in running metres. For filled joints, the rate per running metre shall include the cost of sealant for the depth provided in this drawing.

#### **2610. 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 Bridge Contractor.

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Wearing Coat and Appurtenances

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**Wearing Coat and  
Appurtenances**

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**2701. DESCRIPTION**

This work shall include wearing coat and bridge appurtenances such as railing, approach slab, drainage spouts, weep holes in conformity with details shown on the drawing and these specifications or as approved by the Engineer.

**2702. WEARING COAT****2702.1. Bituminous Wearing Coat**

Specifications for bituminous concrete/bitumen mastic in wearing coat shall conform to Section 500 except for the special requirements as stated hereinafter.

**2702.1.1.** Principles of bituminous wearing coat shall comprise the following :

- i) A layer of mastic asphalt, 6 mm thick after applying a prime coat over the top of the deck before the wearing coat is laid. The prime coat and the layer of mastic asphalt shall be laid as per Clauses 503 and 515 respectively.
- ii) 50 mm thick asphaltic concrete wearing coat in two layers of 25 mm each as per Clause 512. In case of high rainfall intensity areas, the thickness of mastic asphalt layer may be increased to 12 mm.

**2702.1.2.** For high traffic density, an alternative specification for wearing course comprising 40 mm bituminous concrete overlaid with 25 mm thick bitumen mastic layer can be adopted. The work shall be done in conformity with Section 500.

**2702.2. Cement Concrete Wearing Coat**

Cement concrete Wearing coat may be provided in case of isolated bridge construction or bridges located in remote areas. 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 M 30 with water cement ratio as 0.4.

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.

**2702.3.** For providing cross camber no variation in thickness of wearing coat shall be permitted.

**2703. RAILINGS****2703.1. 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 falsework for the span has been released and the span is self-supporting. For concrete with steel reinforcement, specifications of the items of controlled concrete and reinforcement mentioned under relevant sections of this specifications shall be applicable.
- 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 metres. The pockets left for posts shall be filled up with non-shrinkable mortar.
- d) The type of railing to be constructed shall be as shown on the drawings.
- e) Care shall be exercised in assembling expansion joints in the railings to ensure that they function properly.
- f) The bridge railings shall be 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 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 repair shall not damage the material or protective coating.

**2703.2. Metal Railings**

Materials, fabrication, transportation, erection and painting for bridge railings shall conform to the requirements of section 1900.

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All complete steel rail elements, pipe terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanised or painted with an approved paint.

If galvanised, all elements of the railing 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 galvanised surfaces, edges of holes and ends of steel railing cut after galvanising 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 galvanised.

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.

### **2703.3. 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 1700. The reinforcement shall conform to Section 1600.

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 pesnitted.

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

### **2703.4. Precast Concrete Railings**

Precast members for railings shall be of reinforced cement concrete and shall conform to the specifications given in Sections 1600 and 1700. The maximum size of the aggregate shall be limited to 12 mm and the concrete grade shall be M 30. The precast members shall be removed from the moulds as soon as practicable and shall be kept damp for a period of at least 10 days. During this period they shall be protected from sun and wind. Any precast member that becomes chipped, marred or cracked before or during the process of placing shall be rejected. Special care shall be taken to watch the surface of the cast-in-situ portion of the deck.

## **2704. APPROACH SLAB**

Reinforced concrete approach slab covering the entire width of the roadway shall be provided as per details given on the drawings or as approved by the Engineer. Minimum length of approach slab shall be 3.5 m and minimum thickness 300 mm.

The cement concrete and reinforcement shall conform to Sections 1700 and 1600 respectively. The base for the approach slab shall be as shown on the drawings or as directed by the Engineer.

## **2705. DRAINAGE SPOUTS**

2705.1. This work shall consist of furnishing and fixing in position of drainage spouts and drainage pipes for bridge decks.

Drainage along longitudinal direction shall be ensured by sufficient number of drainage fixtures embedded in the deck slab. The 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. The spacing of drainage spouts shall not exceed 10 m. The discharge from drainage spout shall be kept away from the deck structure. In case of viaducts in urban areas, the drainage spouts should be connected with suitably located pipelines to discharge the surface run-off to drains provided at ground level.

### **2705.2. Fabrication**

The drainage assembly shall be fabricated to the dimensions shown, on the drawings; all materials shall be corrosion resistant; steel components shall be of mild steel confo to IS:226. The drainage assembly shall be seam welded for water tightness and then hot-dip galvanised.

**2705.3. Placement**

The galvanised 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 reinforcements of the deck are required to be cut, equivalent reinforcements shall be placed at the corners of the assembly.

**2705.4. 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 round the drainage assembly.

**2706. WEEP HOLE**

Weep holes shall be provided in solid plain concrete/reinforced concrete, brick/stone masonry, abutment, wing wall and return walls as shown on the drawing or directed by the Engineer to drive moisture from the back filling. Weep holes shall be provided with 100 mm dia AC pipe for structures in plain/reinforced concrete or brick masonry. In case of stone masonry weep holes shall be 80 mm wide, 150 mm high or circular with 150mm diameter. Weep holes shall extend through the full width of concrete/masonry with slope of about 1 vertical:20 horizontal towards the draining face. The spacing of weep holes shall generally be 1m in either direction or as shown in the drawing with the lowest at about 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer.

**2707. 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.

**2708. MEASUREMENTS FOR PAYMENT**

The measurement for payment for wearing coat, railings and, approach slab shall be made as given below:

- i) Cement concrete wearing coat shall be measured in cubic metres. Asphaltic concrete wearing coat shall be measured in square metres.
- ii) Railings shall be measured in running metres.
- iii) Approach slab and its base shall be measured separately in cubic metres.
- iv) Drainage spouts shall be measured in numbers.
- v) Weep holes in concrete/brick masonry structure shall be measured in numbers. For structures in stone masonry, weep holes shall be deemed to be included in the item of stone masonry work and shall not be measured separately.

**2709. 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.

The contract unit rate of railings shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications.

The contract unit rate for approach slab shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications. The rate for base shall include cost of all labour, material, tools and plant required, including preparation of surface and consolidation complete in all respects.

The contract unit rate for each drainage spout shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications. It shall also include the cost of providing flow drain pipes with all fixtures upto the point of ground drains wherever shown on the drawings.

The contract unit rate for weep hole shall include the cost of all labour, material, tools and plant required for completing the work as per these specifications

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Pipe Culverts

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Pipe Culverts

### 2901. 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 ordered by the Engineer and in accordance with the requirements of these Specifications.

### 2902. MATERIALS

All materials used in the construction of pipe culverts shall conform to the requirements of Section 1000.

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.

### 2903. EXCAVATION FOR PIPE

The foundation bed for 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 embankments, taken down to levels as shown on the drawings. In case of high embankments where the height of fill is more than three times the external diameter of the pipe, the embankment shall first be built to an elevation above the top of the pipe equal to the external diameter of the pipe, and to width on each side of the pipe of not less than five times the diameter of pipe, after which a trench shall be excavated and the pipe shall be laid.

Where trenching is involved, its width on either side of the pipe shall be a minimum of 150mm or one-fourth of the diameter of the pipe whichever is more and shall not be more than one-third the diameter of the pipe. The sides of the trench shall be as nearly vertical as possible.

The pipe shall be placed where the ground for the foundation is reasonably firm. Installation of pipes under existing bridges or culverts shall be avoided as far as possible. When during excavation the material encountered is soft, spongy or other unstable soil, and unless other special construction methods are called for on the drawings or in special provisions, such unsuitable material shall be removed to such depth, width and length as directed by the Engineer. The excavation, shall then be back filled with approved granular material which shall be properly shaped and thoroughly compacted upto the specified level.

Where bed-rock or boulder strata are encountered, excavation shall be taken down to atleast 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 stone 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.

### 2904. 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 one of the following two types as specified on the drawings:

- (i) First Class bedding: Under first class bedding, the pipe shall be evenly bedded on a continuous layer of well compacted approved granular material, shaped concentrically to fit the lower part of the pipe exterior for atleast ten per cent of its overall height or as otherwise shown on the drawings. The bedding material shall be well graded sand or another granular material Passing 5.6 mm sieve suitably compacted/rammed. The compacted thickness of the bedding layer shall be as shown on the drawings and in no case shall it be less than 75 mm.
- (ii) Concrete cradle bedding: 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 conforming to Section 1700. The shape and dimensions of the cradle shall be as indicated on the drawings. The pipes shall be laid on the concrete bedding before the concrete has set.

### 2905. 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 to 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.

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, any damage due to fall or impact. The arrangement may be got approved by the Engineer.

Similarly, the arrangement for lowering the pipe in the bed shall be got approved by the Engineer. It may be with tripod-pulley arrangement or simply by manual labour in a manner that the pipe is placed in the proper position without damage.

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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. 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 be removed at the cost of the Contractor.

#### 2906. JOINTING

The pipes shall be jointed either by collar joint or by flush joint. In the former case, the collars shall be of RCC 150 to 200 mm wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm according to the diameter of the pipe. Caulking material shall be slightly wet mix of cement and sand in the ratio of 1 : 2 rammed with caulking irons. Before caulking, the collar shall be so placed that its centre coincides with the joint and an even annular space is left between the collar and the pipe.

Flush joint may be internal flush joint or external flush joint. In either case, 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 under light hydraulic pressure, 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 ring shall be thoroughly compressed by jacking or by any other suitable method.

All joints shall be made with care so that their interior surface is 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.

#### 2907. BACKFILLING

Trenches shall be backfilled immediately after the pipes have been laid and the jointing material has hardened. The backfill soil shall be clean, free from boulders, large roots, excessive amounts of sods or other vegetable matter, and lumps and shall be approved by the Engineer. Back filling 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. Approved pneumatic or light mechanical tamping equipment can be used.

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.

In case of high embankment, after filling the trench upto the top of the pipe in the above said manner, a loose fill of a depth equal to external diameter of the pipe shall be placed over the pipe before further layers are added and compacted.

#### 2908. HEADWALLS AND OTHER ANCILLARY WORKS

Headwalls, wing walls, aprons and other ancillary works shall be constructed in accordance with the details shown on the drawings or as directed by the Engineer. Masonry for the walls shall conform to Section 1300, 1400 or 1700 as applicable. Aprons shall conform to Section 2500.

#### 2909. OPENING TO TRAFFIC

No traffic shall be permitted to cross the pipe line unless height of filling above the top of the pipe line is atleast 600 mm.

#### 2910. MEASUREMENTS FOR PAYMENT

R.C.C. pipe culverts shall be measured along their centre between the inlet and outlet ends in linear 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

#### 2911. RATE

The Contract unit rate for the pipes shall include the cost of pipes including loading, unloading, hauling, handling, storing, laying in position and jointing complete and all incidental costs to complete the work as per these Specifications.

Ancillary works such as excavation including backfilling, concrete and masonry shall be paid for separately, as provided under the respective Clauses.

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