सत्यमेव जयते

# QUALITY ASSURANCE MANUAL

FOR

## CONSTRUCTION OF CONCRETE STRUCTURES
## (Bridges & Flyovers)

**CENTRAL PUBLIC WORKS DEPARTMENT**

GOVERMENT OF INDIA

1965 CPWD/2002-

# INDEX

# CHAPTER - 1

# INTRODUCTION



1965 CPWD/2002—2A

## INTRODUCTION

Central Public Works Department is a premier construction agency of the Govt. of India, which has been entrusted with the task of building several challenging projects all over the country. The Department had taken up the construction of no. of flyovers in Delhi with a specific view to reduce the construction time so as to minimize traffic disturbances usually faced during construction. Amongst the materials for construction of Flyover, cement concrete is being used widely world over. Four concrete flyovers using precast segmental technology were recently completed and on the basis of the experience gathered, it was decided to prepare a uniform and generalized Quality Assurance Manual (QAM) to be followed in the future flyover projects with specific reference to precast prestressed concrete using segmental technique.

This QAM has been prepared to complete the general procedures and guidelines to be followed by the construction supervision personnel in carrying out all aspects of the Construction Supervision tasks. This Manual mainly provides procedures for carrying out tasks related to inspections, testing and reporting. However, this manual does not deal with day-to-day technical requirements, nor does it provide solutions to technical problems, as the Specifications and other Contract Documents usually administer these technical issues.

The document is largely based on the norms set up by Indian Road Congress Publication IRC: SP : 47-1998. Since precast segmental flyovers fall into category of Innovative Technology, the manual has been based on Class Q-4 of the publication. A concept of Level of testing has been introduced in order to cover up levels of testing of materials and products depending upon various factors.

Every effort has been made to evolve this Manual so that adherence to its guidelines will result in efficient, safe and consistent supervision of the works in strict conformity with the Specifications and other Contract requirements. This has led to the basic framework of this Manual being based on construction supervision procedures consistent with standard international practices for construction of important flyover projects of this type, with specific guidelines and forms where appropriate, being generated based on standard practices in India in conformity with MORTH and IRC standards and guidelines. In all cases, however, it is important that all users of this Manual understand that the contract documents including the specifications are the controlling documents for the supervision of the construction.

Although the intention of this Manual is to provide efficient, safe, high quality construction, adherence to the adopted guidelines does not necessarily guarantee that these attributes are achieved. Therefore, the users are cautioned to exercise judgement based on good engineering practice in all cases rather than blind adherence to the adopted guidelines. This also points to the urgent need to periodically review and update relevant guidelines and procedures, and hence the Manual is to be seen as an evolving guide.

# CHAPTER - 2

# GUIDELINES FOR USING THE MANUAL

# GUIDELINES FOR USING THE MANUAL

This Quality Assurance Manual is a document, by use of which, the total quality of the construction of flyover will be managed as per the Q 4 standards of IRC: SP: 47. This publication of the Indian Roads Congress gives the guidelines for achieving the quality of construction of roads, flyovers and bridges and provisions of Q 4 system guides the suppliers and producers for achieving the end product with extra high quality assurance. As also mentioned in the Chapter 1 i.e. Introduction that while constructing costly structures for public use, it is desirable that the strong and durable structures needing minimum maintenance are constructed. Therefore, it is essential that during execution, the works be managed in such a manner that the best possible quality is achieved. Every agency, whosoever is involved in the construction, and in whatever capacity it may be, shall aim for achieving the best quality. This shall require the quality management planning in advance. Every activity during the construction is necessary to be planned and monitored closely. Further it is not only the planning and monitoring, but also the documentation of activities, which plays a very vital role in assuring and achieving the high quality standards.

This manual is divided into 10 chapters and this chapter elaborates the guidelines for the use of the manual. Chapter 3 to 8 guides the user regarding the testing of basic ingredients and site activities, while chapter 9 has coverage of method statements of activities commonly involved in the construction of a flyover. Chapter 10 covers the non-conforming products and procedure to be followed for deciding their acceptance or rejection.

## 2.1 Quality Assurance Plan (QAP) for Basic Construction Materials

Every construction activity starts with the use of basic materials which may be either in raw shape like earth, sand, stone aggregates, etc. or manufactured materials like cement, steel or bitumen or assembled for accessories like bearings or expansion joints. Materials to be procured at site for use in any site activity have been covered in Chapter 3. Efforts have been made to include each and every material that is required to be procured at site for the use in site activities like concreting work, raising embankments or laying wearing courses. Chapter 3 has been titled as **Quality Assurance Plan for Basic Construction Materials**. The chapter has been classified into different parts on the basis of the type of materials and their source. QAP includes the tests that every material has to undergo before it is accepted and approved for use in the work. QAP is given in 5 columns.

Column 1: It lists the name of the test that a material is essentially to undergo before accepting it as fit for use in the work. .

Column 2: It gives the frequency of the testing of materials. A material once approved is required to be tested periodically to ensure the uniformity in its quality and to ensure that the does not deteriorated after initial acceptance.

Column 3: Depending upon the type of material and its use in the structure, it is mandatory that some materials are repeatedly tested in the site laboratory and also independently tested from some outside approved reputed laboratory. Column 3 of QAP indicates the check level of the test, which is to be performed on the material.

First Level i.e. **Level 1** indicates the tests performed by the contractor before requesting the department for accepting the material. This test may be in the shape of Manufacturer's Test Certificate (MTC) on the basic tests at random conducted by the manufacturer or it may be the tests got conducted by the contractor at his own level before requesting the department for its approval.

Next Level i.e. **level 2** indicates the tests to be conducted by the department in order to ensure satisfaction regarding the suitability of the material in view of the test certificates submitted by the contractor. These testing may be at the site laboratory if the facilities could be created or got done by an outside laboratory if the facilities are not possible to create in the site laboratory. Depending upon whether the tests have been conducted at site laboratory or outside laboratory, Level 2 is classified in two categories i.e. Level 2A and Level 2B. **Level 2A** is for the tests conducted at site laboratory and **level 2B** is for the tests conducted **outside the site laboratory as necessary facilities could not be made available at** site.

There are some materials like cement and steel, which are more sensitive than other materials. For such sensitive materials, in order to have more confidence, it is always desired that such materials are got tested from an independent source. This level of testing the sensitive material from an independent source has been classified as **Level 3**. It is essential that such an independent source should be a well-reputed laboratory equipped with proper controls like temperature, humidity etc. essential for the specific material testing and also equipped with well-qualified staff, from whom an expert opinion can be obtained.

As per the above levels, the need of the level required for testing the material is given in this column.

Column 4: It gives the reference of the Bureau of Indian standard or Indian Roads Congress standard or some other equivalent recognised standards which the material is expected to meet. Also these standards depict the test procedure of the test to be performed.

Column 5: The acceptance standards of the materials are given in this column.

The materials shall be accepted for use on the work only after the testing of the material as per this Quality assurance plan.

## 2.2 Quality Assurance Plan (QAP) for site activities

Like the materials, various construction stages are also required to undergo testing/checking before the items are accepted and payments to the contractor released.. QAP for all these site activities is given in Chapter 4 of the manual and all the activities are detailed out in 4 columns.

Column 1: It lists the names of the test that every activity is essentially to be subjected before its acceptance.

Column 2: It gives the frequency of the testing of materials or the lot size for which testing is required to be done.

Column 3: It gives the reference of the Indian standard or other equivalent applicable standards which the item is expected to meet. Also these standards depict the test procedure of the test performed, which may be decided by the department.

Column 4: The acceptance standards are given in the column 4 of this QAP.

It is only after the completion of the testing of the items/site activities as per this Quality assurance plan that a particular work is accepted.

## 2.3 In House/On Site Testing Facilities

While Chapter 3 and 4 cover the QAP for the construction materials and the site activities, their testing facilities are covered under Chapter 5 and 6. For prestigious projects like flyovers and bridges, it is essential that in house testing laboratory is created so as to perform the tests which are comparatively easier to perform with simple setup or are required to be conducted very frequently. Often the nature of the test is such that immediate results are needed. Such facilities should be created in the site-testing laboratory. Details of all such tests are furnished under Chapter 5 of the manual. All the materials for in house testing are detailed in this chapter under 4 columns. Column 1 gives the details of the test to be performed in house i.e. site laboratory. Column 2 gives the size of the sample of each material to under go a test and the standard which gives the standard testing procedure is mentioned in next column 3. While testing the material, the readings during the testing are required to be recorded in a proper manner. In order to simplify the recording and to record every data essential to record, data sheets have been created. The formats of these data sheets are given in Chapter 8. For the sake of convenience, all the required facilities for conducting the test are furnished in column 4. At the end of the Chapter 5, all the facilities ad the standards essential to be provided in site laboratory are summed up and indicated in this Chapter.

## 2.4 Outside /Independent Testing Facilities

Since the total tests required to meet the Quality Assurance Plan given under Chapter 3 and 4 are large in number and require extensive equipment & personnel set up, all the testing facilities can not be provided at site. Moreover as per the QAP give under chapter 3, many test are to be done at level 3, which means testing by an independent agency. Many reputed Test Houses conduct these tests. For the sake of convenience of the users, some of the reputed test centres are given in Chapter 6 and information about the testing facilities available in these centres has been compiled as ready reckoner. It is furnished in tabulated form, which is quite convenient to consult and use. Wherever the required testing facility is available, it is shown in a tick mark (✓) against that test house and the test to be conducted.

## 2.5 Site Documents

During the currency of a project, it is essential to keep certain documents at site for making a permanent record of each and every item related to the project. Such items may include tests conducted at site, instructions issued to the contractor, record of drawings issued to the contractor, inventory of the material at site and so on. All such site documents play a vital role not only in assuring the quality of the work, but also in making the total management of the project comparatively easier. For the sake of the user, all these documents with a unique identification number have been listed under Chapter 7 of the manual with a format for each of them. The record of all such documents kept at site is to be stored in the Master Register of the Chapter 7.

## 2.6 Check Lists and Test Proformas

For the efficient execution of the work, it is essential to ensure that the work done at various stages is done as per the standard procedure. Omitting compliance of any check is likely to create troubles in accomplishing the activity with the desired quality standards.

Hence in order to ensure a proper follow up of the construction methodology, checks are conducted at all important stages. To control such tests, checklists are evolved and have been given under Chapter 8 for all the important items of the work. The site staff are required to fill up the relevant checklist while allowing the contractor to proceed with the operation of the particular work.

It is not only the execution of the item that the checklists are made use of, but also for the approval of the agency/suppliers for various sub contracts. The checklists have been separately formulated for this purpose and given in the same chapter.

Further, for the in house testing facilities as given under chapter 5, the formats for the data sheets for performing various tests are given in chapter 8 and all the test proformas/data sheets have to be given a unique identification number for proper record of all the tests results. All the formats of the test proformas are required to be docketed in a separate register titled as Check lists/Test Proformas Record for which a format has been given as a site document under Chapter 7.

## 2.7 Method Statements

Chapter 9 incorporates method statements for site activities. These statements are given for only guidance purpose. It is essential that the contractor submits his own method statement depending upon his setup and arrangement of the type of the machinery for each and every item before proceeding with its execution and gets it approved from the department. Generally for the specialised items like bearings, expansion joints, reinforced soil work, launching of segments, specialised agencies are engaged and depending upon their experience & way of working, the method statements can be given by those selected specialised agencies. However, some common items like Piling and its testing, Pile Caps, Bituminous Works, Installation of bearings and Expansion Joints, Embankment, WBM etc. have been covered in this chapter and it is desirable that the execution of each and every activity be started only after the method statement is approved and available with the site staff.

## 2.8 Non Conforming Products and Procedures

The last Chapter i.e. Chapter 10 covers the procedure to be adopted for the non-conforming products. While working at site, situation occurs when some particular item/product does not fulfil certain test standards, but the same is otherwise acceptable as it passes other alternative tests. On fulfillment of alternative test, such products are generally accepted at lesser rates than accepted in the contract. The procedure to be followed for accepting such products is agreement rates or reduced rates is well explained in this chapter.

The above guidelines are framed for the convenience of the site staff to follow the manual and make effective use of it. Once the various formulations of the manual are followed strictly, it is hoped that the end results shall be of a extra high quality as desired under Q4 system of IRC: SP: 47.

# CHAPTER - 3

## QUALITY ASSURANCE PLAN

for

## BASIC CONSTRUCTION MATERIALS

## Q.A.P for Basic Materials

The first step towards ensuring good quality construction is to get good quality basic materials required to be used in the construction activities. These materials may be raw materials like Aggregates, Sand, Earth or Water, processed materials like Cement, Bitumen, Geotextile, Sealant etc. or processed and assembled materials like Bearings and Expansion Joints. This shall also require prior approval of the source or supplier for the individual material or product as given under chapter 8.

In order to ensure that material used in construction is of high quality and meets the codal requirements of BIS, IRC or MOST as applicable, a series of tests have to be carried out at regular frequencies. The testing has to be done first at the level of the supplier / manufacturer or the contractor. This forms the first level check. The testing may be done jointly with the client or the client may do the testing independently in the site laboratory. This forms the second level check. The material is also got tested from reputed independent laboratories. This forms the third level check. This chapter gives the level of testing required for the various materials as well as the frequency of such testing.

Extensive testing of the basic materials shall ensure that only the best quality material is cleared for use on the work so that extra high quality construction can be done.



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# 3.1 Materials from Natural Resources

## 3.1.1 For Concrete Works

3.1.1.1 Coarse Aggregates
3.1.1.2 Fine Aggregate
3.1.1.3 Water

## 3.1.2 Aggregates for Road work (Non Bituminous Sub bases and Bases)

a) Granular Sub Base
b) Water Bound Macadam
c) Wet Mix Macadam

## 3.1.3 Aggregates for Road work (Bituminous Base and Surface Courses)

a) Bituminous Macadam
b) Dense Graded Bituminous Macadam
c) Bituminous Concrete
d) Mastic Asphalt

## 3.1.4 Earth for Embankment

## 3.1.5 Lime (for Bituminous Works)



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## 3.1.1 For Concrete Works

### 3.1.1.1 Coarse Aggregates

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards | | |
|---|---|---|---|---|---|---|
| 1) **Particle Size and Shape** | 1. At the beginning for approval of each source and change of source<br>2. Once in a week | 1<br><br><br><br>2A | IS: 383-1970<br>IS: 2386 (Part I)-1963 | | | |
| a) Sieve Analysis | | | | **Grading** | **IS Sieve Designation** | **Percentage passing (by Weight)** |
| | | | | **20 mm Nominal size** | 40 mm<br>20 mm<br>10 mm<br>4.75 mm | 100<br>85 – 100<br>0 – 20<br>0 – 5 |
| | | | | **12.5 mm Nominal size** | 20 mm<br>12.5 mm<br>10 mm<br>4.75 mm | 100<br>85 – 100<br>0 – 20<br>0 – 5 |
| b) Flakiness Index and Elongation Index | | | | 35 % Maximum value of combined Elongation and Flakiness Index | | |

| | | | | |
|---|---|---|---|---|
| 2) **Deleterious Materials** | 1. At the beginning for approval of each source and change of source<br>2. Once in 3 months | 1<br>2B | IS: 383-1970<br>IS: 2386 (Part II)-1963 | **Deleterious Material** — **Percentage by weight (maximum)**<br>1. Coal & lignite — 1<br>2. Clay Lumps — 1<br>3. Material finer than 75 micron IS Sieve — 3<br>4. Soft fragment — -<br>5. Shale — -<br>Total — 5 |
| 3) **Specific Gravity & Density** | 1. At the beginning for approval of each source and change of source<br>2. Once in a Fortnight | 1<br>2A | IS: 383-1970<br>IS: 2386 (Part III)-1963 | Test is required for maintaining uniformity of material brought from the source. |
| 4) **Mechanical Properties** | | | IS: 383-1970<br>IS: 2386 (Part IV)-1963 | |
| a) Aggregate Crushing Value | 1. At the beginning for approval of each source and change of source | 1 | | 45 % Maximum by Weight |
| b) Impact Value | 2. Once in a week | 2A | | 45 % Maximum by Weight |
| c) 10 percent Fines | 1. At the beginning for approval of each source and change of source | 1 | | 5T Minimum |
| d) Abrasion Value | 2. Once in a 3 months | 2B | | 50 % Maximum by Weight |

| | | | | |
|---|---|---|---|---|
| **5) Soundness** | 1. At the beginning for approval of each source and change of source<br>2. Once in a 3 months | 1<br><br><br><br>2B | IS: 383-1970<br>IS: 2386 (Part V)-1963 | Maximum Average Loss of Weight after 5 cycles<br><br>(i) tested with Sodium Sulphate - 12%<br>(ii) tested with Magnesium Sulphate - 18% |
| **6) Surface moisture content.** | 1. At the beginning for approval of each source and change of source<br>2. At every change of mix design<br>3. Every time making the concrete | 1<br><br><br><br>1/2A<br><br>2A | IS: 383-1970<br>IS: 2386 (Part III)-1963 | Test required to adjust the water content in the mix design before starting any concrete mixing. |
| **7) Alkali Reactivity.** | 1. At the beginning for approval of each source and change of source.<br>2. Once in 3 months | 1<br><br><br><br>2B | IS: 383-1970<br>IS: 2386 (Part VII)-1963 | Innocuous Aggregate. |
| **8) Petrographic Examination**<br><br>a) Trade Group<br>b) Petrological name & Description<br>c) Description of Bulk<br>d) Particle shape<br>e) Surface texture. | 1. At the beginning for approval of each source and change of source.<br>2. Once in 3 months | 1<br><br><br><br>2B | IS: 383-1970<br>IS: 2386 (Part VIII)-1963 | Information required for approval of source |

### 3.1.1.2 Fine Aggregates

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Particle Sizes** | 1. At the beginning for approval of each source and change of source<br>2. Once in a month | 1<br><br><br><br>2A | IS: 383-1970<br>IS: 2386 (Part I)-1963 | Fine Aggregate should be of grading from Zone-I to Zone-III as given below.<br><br>**IS Sieve Designation** / **Percent by weight passing for Zone-I / Zone-II / Zone-III**<br>**10 mm**: 100 / 100 / 100<br>**4.75 mm**: 90-100 / 90-100 / 90-100<br>**2.36 mm**: 60-95 / 75-100 / 85-100<br>**1.18 mm**: 30-70 / 55-90 / 75-100<br>**600 µ**: 15-34 / 35-59 / 60-79<br>**300 µ**: 5-20 / 8-30 / 12-40<br>**150 µ**: 0-10 / 0-10 / 0-10 |
| **2) Deleterious Materials** | 1. At the beginning for approval of each source and change of source<br>2. Once in a month | 1<br><br><br><br>2B | IS: 383-1970<br>IS: 2386 (Part II)-1963 | **Deleterious Material** / **Percentage by weight (maximum)**<br><br>1. Coal & lignite: 1<br>2. Clay Lumps: 1<br>3. Material finer than 75 micron IS Sieve: 3<br>4. Soft fragment: -<br>5. Shale: 1<br><br>Total (1 to 5 above): 5 |

| | | | | |
|---|---|---|---|---|
| **3) Silt Content** | 1. At the beginning for approval of each source and change of source<br>2. Once Daily | 1<br><br>2A | | Maximum 8 % or as specified in the tender |
| **4) Specific Gravity, & Density** | 1. At the beginning for approval of each source and change of source.<br>2. Once in 3 months | 1<br><br>2A | IS: 383-1970<br>IS: 2386 (Part III-1963 | Test is required for maintaining uniformity of material brought from the source. |
| **5) Water absorption** | 1. At the beginning for approval of each source and change of source.<br>2. Daily | 1<br><br>2A | IS: 383-1970<br>IS: 2386 (Part III)-1963 | Test required for adjusting the water content in the mix design before starting any concrete mixing. |
| **6) Soundness** | 1. At the beginning for approval of each source and change of source<br>2. Once in 3 months | 1<br><br>2B | IS: 383-1970<br>IS: 2386 (Part V)-1963 | Maximum Average Loss of Weight after 5 cycles<br><br>(i) tested with Sodium Sulphate - 10%<br>(ii) tested with Magnesium Sulphate - 15% |

### 3.1.1.3 Water

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Chemical Analysis** | 1. Once at beginning for approval of each source and change of source | 1 | IS: 456:2000 | |
| a) pH value | | | | Minimum 6 |
| b) Chlorides (as Cl) | 2. Once in 3 months | 2B | IS:3025(Part24) | 500mg/l |
| | 3. Chemical Tests daily in the site Laboratory with testing kits | 2A | | |
| c) Sulphates (as $SO_3$) | | | IS:3025(Part32) | 400mg/l |
| d) Neuterlisation with NaOH (with phenolphathalein as indicator) | | | IS:3025(Part22) | Maximum 5 ml of .02 normal NaOH to neutralise 100 ml of water |
| e) Neuterlisation with $H_2SO_4$ (with mixed indicator) | | | IS:3025(Part 23) | Maximum 25 ml of .02 normal $H_2SO_4$ to neutralise 100 ml of water |
| **2) Physical Analysis** | 1. Once at beginning for approval of each source and change of source | 1 | | |
| a) Suspended matter | 2. Once in 3 months | 2B | IS:3025(Part 17) | 2000 mg/l maximum |
| b) Organic matter | | | IS:3025(Part 18) | 200 mg/l maximum |
| c) Inorganic matter | | | IS:3025(Part 18) | 3000 mg/l maximum |

## 3.1.2 Aggregates for Road Work (Non Bituminous Sub base and base)

### (a) Granular Sub Base (GSB)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards | | | |
|---|---|---|---|---|---|---|---|
| **1) Grading for** | 1. At the beginning for approval of each source and change of source | 1 | IS: 383-1970<br>IS: 2386 (Part I)-1963 | | | | |
| a) Close-graded Granular Sub base material | 2. One test per 200 $m^3$ | 2B | | **IS Sieve Designation** | **Percentage Grading I** | **by Weight passing IS Sieve Grading II** | **Grading III** |
| | | | | 75.0 mm | 100 | - | - |
| | | | | 53.0 mm | 80-100 | 100 | - |
| | | | | 26.5 mm | 55-90 | 70-100 | 100 |
| | | | | 9.5 mm | 35-65 | 50-80 | 65-95 |
| | | | | 4.75 mm | 25-55 | 40-65 | 50-80 |
| | | | | 2.36 mm | 20-40 | 30-50 | 40-65 |
| | | | | 425 µ | 10-25 | 15-25 | 20-35 |
| | | | | 75 µ 3-10 | 3-10 | 3-10 | |
| b) Close-graded Granular Sub base material | | | | **IS Sieve Designation** | **Percentage Grading I** | **by Weight passing IS Sieve Grading II** | **Grading III** |
| | | | | 75.0 mm | 100 | - | - |
| | | | | 53.0 mm | - | 100 | - |
| | | | | 26.5 mm | 55-75 | 50-80 | 100 |
| | | | | 4.75 mm | 10-30 | 15-35 | 25-45 |
| | | | | 75 µ | < 10 | < 10 | < 10 |

| | | | | |
|---|---|---|---|---|
| **2) Deleterious Materials** | 1. At the beginning for approval of each source and change of source<br>2. Once in 3 months | 1<br><br>2B | IS: 383-1970<br>IS: 2386 (Part II)-1963 | Free from Organic and other deleterious constituents |
| **3) Water absorption** | 1. At the beginning for approval of each source and change of source<br>2. Once per 200 $m^3$ | 1<br><br>2A | IS: 383-1970<br>IS: 2386 (Part III)-1963 | 2 % Maximum |
| **4) 10 % Fines** | 1. At the beginning for approval of each source and change of source<br>2. Once in 3 months | 1<br><br>2B | BS : 812 (Part 111) | Minimum 5 T(for sample in soaked condition) |
| **5) Soundness** (Test is required if water absorption is greater than 2 %) | 1. At the beginning for approval of each source and change of source<br>2. Once in 3 months | 1<br><br>2B | IS: 383-1970<br>IS: 2386 (Part V)-1963 | Maximum Average Loss of Weight after 5 cycles<br><br>(i) tested with Sodium Sulphate - 12%<br>(ii) tested with Magnesium Sulphate - 18% |
| **6) Atterberg Limits for material passing 425 µ sieve**<br><br>a) Liquid Limit<br>b) Plasticity Index | 1. At the beginning for approval of each source and change of source<br>2. Once per 200 $m^3$ | 1<br><br>2B/2A | IS : 2720 (Part 5) | <br><br>Maximum 25 %<br>Maximum 6 % |

# (b) Water Bound Macadam (WBM)

<table>
<tr><th>Test</th><th>Frequency</th><th>Check Level</th><th>Ref. Codes</th><th>Acceptance Standards</th></tr>
<tr>
<td>1) Sieve Analysis</td>
<td>1. At the beginning for approval of each source and change of source<br>2. Once per 100 $m^3$ of aggregate</td>
<td>1<br><br><br><br>2A</td>
<td>IS: 383-1970<br>IS: 2386 (Part I)-1963</td>
<td>
<table>
<tr><th rowspan="2">IS Sieve Designation</th><th colspan="3">Percentage by Weight passing IS Sieve</th></tr>
<tr><th>90-45mm</th><th>63-45 mm</th><th>53-22.4 mm</th></tr>
<tr><td>125 mm</td><td>100</td><td>-</td><td>-</td></tr>
<tr><td>90 mm</td><td>90-100</td><td>100</td><td>-</td></tr>
<tr><td>63 mm</td><td>25-65</td><td>90-100</td><td>100</td></tr>
<tr><td>53 mm</td><td>-</td><td>65-90</td><td>95-100</td></tr>
<tr><td>45 mm</td><td>0-15</td><td>0-10</td><td>65-90</td></tr>
<tr><td>22.4 mm</td><td>0 –5</td><td>0-5</td><td>0-10</td></tr>
<tr><td>11.2 mm</td><td>–</td><td>–</td><td>0-5</td></tr>
</table>
<u>Screenings</u>
<table>
<tr><th rowspan="2">IS Sieve Designation</th><th colspan="2">Percentage by Weight passing IS Sieve</th></tr>
<tr><th>13.2 mm</th><th>11.2 mm</th></tr>
<tr><td>13.2 mm</td><td>100</td><td>-</td></tr>
<tr><td>11.2 mm</td><td>90-100</td><td>100</td></tr>
<tr><td>5.6 mm</td><td>15-35</td><td>90-100</td></tr>
<tr><td>180 µ</td><td>0–1 0</td><td>15-35</td></tr>
</table>
</td>
</tr>
<tr>
<td>2) Deleterious Materials</td>
<td>1. At the beginning for approval of each source and change of source<br>2. Once in a month</td>
<td>1<br><br><br><br>2B</td>
<td>IS: 383-1970<br>IS: 2386 (Part II)-1963</td>
<td>Material should be free from deleterious materials. Test is required for maintaining uniformity of material brought from the source.</td>
</tr>
</table>

| | | | | |
|---|---|---|---|---|
| **3) Water absorption** | 1. At the beginning for approval of each source and change of source<br>2. Once in a month | 1<br><br>2A | IS: 383-1970<br>IS: 2386 (Part III)-1963 | 2 % Maximum |
| **4) Mechanical Properties** | 1. At the beginning for approval of each source and change of source<br>2. Once per 200 $m^3$ of aggregate | 1<br><br>2A/2B | IS: 383-1970<br>IS: 2386 (Part IV)-1963 | |
| a) Aggregate Crushing Value | | | | 30 % Maximum by Weight |
| b) Impact Value | | | | 30 % Maximum by Weight |
| c) Los Angeles Abrasion Value | | | | 40 % Maximum by Weight |
| d) Combined Flakiness and Elongation Value | | | | 30 % Maximum by Weight |
| **5) Soundness (test to be conducted if water absorption is more than 2 %)** | 1. At the beginning for approval of each source and change of source<br>2. Once in a month, if required | 1<br><br>2B | IS: 383-1970<br>IS: 2386 (Part V)-1963 | Maximum Average Loss of Weight after 5 cycles<br>(i) tested with Sodium Sulphate - 12%<br>(ii) tested with Magnesium Sulphate - 18% |

| | | | | |
|---|---|---|---|---|
| **6) Plasticity Index of Binding Material** | 1. At the beginning for approval of each source and change of source<br>2. Once per 25 $m^3$ of binding material | 1<br><br><br><br>2A/2B | IS :2720 (Part 5) | Maximum 6 |
| **7) Atterberg Limits of Screenings**<br>a) Liquid Limit<br>b) Plasticity Index | 1. At the beginning for approval of each source and change of source<br>2. Once in a month | 1<br><br><br><br>2A/2B | IS :2720 (Part 5) | <br><br><br>Maximum 20<br>Maximum 6 |
| **8) Screening Material passing 75 µ sieve** | 1. At the beginning for approval of each source and change of source | 1<br><br><br>2A | IS: 383-1970<br>IS: 2386 (Part I)-1963 | Maximum 10 % |

## (c) Wet Mix Macadam (WMM)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards | |
|---|---|---|---|---|---|
| **1) Sieve Analysis** | 1. At the beginning for approval of each source and change of source | 1 | IS: 383-1970<br>IS: 2386 (Part I)-1963 | **IS Sieve Designation** | **Percentage by Weight passing IS Sieve** |
| | 2. Once per 100 $m^3$ of aggregate | 2A | | 53.0 mm | 100 |
| | | | | 45.0 mm | 95-100 |
| | | | | 22.4 mm | 60-80 |
| | | | | 11.2 mm | 40-60 |
| | | | | 4.75 mm | 25-40 |
| | | | | 2.36 mm | 15-30 |
| | | | | 600 μ | 9- 22 |
| | | | | 75 μ | 0-8 |
| **2) Deleterious Materials** | 1. At the beginning for approval of each source and change of source | 1 | IS: 383-1970<br>IS: 2386 (Part II)-1963 | Material should be free from deleterious materials. Test is required for maintaining uniformity of material brought from the source. | |
| | 2. Once in a month | 2B | | | |
| **3) Water absorption** | 1. At the beginning for approval of each source and change of source | 1 | IS: 383-1970<br>IS: 2386 (Part III)-1963 | 2 % Maximum | |
| | 2. Once every day | 2A | | | |

| | | | | |
|---|---|---|---|---|
| 4) **Mechanical Properties** | 1. At the beginning for approval of each source and change of source | 1 | IS: 383-1970<br>IS: 2386 (Part IV)-1963 | |
| a) Aggregate Crushing Value | 2. Once per 200 $m^3$ of aggregate | 2A/2B | | 30 % Maximum by Weight |
| b) Impact Value | | | | 30 % Maximum by Weight |
| c) Los Angeles Abrasion Value | | | | 40 % Maximum by Weight |
| d) Combined Flakiness and Elongation Value | | | | 30 % Maximum by Weight |
| 5) **Soundness** (test to be conducted if water absorption is more than 2 %) | 1. At the beginning for approval of each source and change of source<br>2. Once a month, if required | 1<br>2B | IS: 383-1970<br>IS: 2386 (Part V)-1963 | Maximum Average Loss of Weight after 5 cycles<br>(i) tested with Sodium Sulphate - 12%<br>(ii) tested with Magnesium Sulphate - 18% |
| 6) **Plasticity Index of Materials finer than 425 μ sieve** | 1. At the beginning for approval of each source and change of source<br>2. Once per 100 m3 of aggregates | 1<br>2A/2B | IS :2720 (Part 5) | Maximum 6 |

### 3.1.3 Aggregates for Road Work ( Bituminous Base and Surface Courses)

**(a) Bituminous Macadam (BM)**
**(b) Dense graded Bituminous Macadam (DBM)**
**(c) Bituminous Concrete (BC)**

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Sieve Analysis** | 1. At the beginning for approval of each source and change of source<br>2. Once per 25 $m^3$ of aggregate | 1<br>2A | IS: 383-1970<br>IS: 2386 (Part I)-1963 | Maximum 5 % passing 75 µ sieve |
| **2) Deleterious Materials** | 1. At the beginning for approval of each source and change of source<br>2. Once in a month | 1<br>2B | IS: 383-1970<br>IS: 2386 (Part II)-1963 | Material should be free from deleterious materials. Test is required for maintaining uniformity of material brought from the source. |
| **3) Water absorption** | 1. At the beginning for approval of each source and change of source<br>2. Once everyday | 1<br>2A | IS: 383-1970<br>IS: 2386 (Part III)-1963 | 2 % Maximum |

| | | | | |
|---|---|---|---|---|
| **4) Mechanical Properties**<br>a) Impact Value<br>b) Los Angeles Abrasion Value<br>c) Combined Flakiness and Elongation Value | 1. At the beginning for approval of each source and change of source<br>2. Once per 50 $m^3$ of aggregate | 1<br>2A/2B | IS: 383-1970<br>IS: 2386 (Part IV)-1963 | Maximum 30 % by weight for BM and 27 %for DBM and DAC<br>Maximum 40 % by Weight for BM and 35 % for DBM and DAC<br>30 % Maximum by Weight |
| **5) Soundness (test to be conducted if water absorption is more than 2 %)** | 1. At the beginning for approval of each source and change of source<br>2. Once a month, if required | 1<br>2B | IS :2720 (Part 5) | Maximum Average Loss of Weight after 5 cycles<br>(i) tested with Sodium Sulphate - 12%<br>(ii) tested with Magnesium Sulphate - 18% |
| **6) Stripping Test Bitumen Aggregate Mixtures** | 1. At the beginning for approval of each source and change of source<br>2. Once a month | 1<br>2B | IS : 6241 | Minimum retained coating 95 %when bitumen stripped |
| 7) **Retained Tensile Strength (test to be conducted if retained coating is less than 95 %)** | 1. At the beginning for approval of each source and change of source<br>2. Once a month | 1<br>2B | | Minimum 80 % |

## (d) Mastic Asphalt

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Sieve Analysis** | 1. At the beginning for approval of each source and change of source<br>2. Once per 25 $m^3$ of aggregate | 1<br><br>2A | IS: 383-1970<br>IS: 2386 (Part I)-1963 | **IS Sieve Designation** — **Percentage by Weight passing IS Sieve**<br>19.0 mm — 100<br>13.2 mm — 88-96<br>2.36 mm — 0-5 |
| 2) **Deleterious Materials** | 1. At the beginning for approval of each source and change of source<br>2. Once in a month | 1<br><br>2B | IS: 383-1970<br>IS: 2386 (Part II)-1963 | Material should be free from deleterious materials. Test is required for maintaining uniformity of material brought from the source. |
| 3) **Water absorption** | 1. At the beginning for approval of each source and change of source | 1 | IS: 383-1970<br>IS: 2386 (Part III)-1963 | 2 % Maximum |
| 4) **Mechanical Properties**<br>a) Impact Value<br>b) Los Angeles Abrasion Value<br>c) Combined Flakiness and Elongation Value | 1. At the beginning for approval of each source and change of source<br>2. Once per 50 $m^3$ of aggregate | 1<br><br>2A/2B | IS: 383-1970<br>IS: 2386 (Part IV)-1963 | <br>Maximum 30 % by weight<br>Maximum 40 % by Weight<br>30 % Maximum by Weight |



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| | | | | |
|---|---|---|---|---|
| **5) Soundness** (test to be conducted if water absorption is more than 2 %) | 1. At the beginning for approval of each source and change of source<br>2. Once a month, if required | 1<br><br>2B | IS :2720 (Part 5) | Maximum Average Loss of Weight after 5 cycles<br>(i) tested with Sodium Sulphate - 12%<br>(ii) tested with Magnesium Sulphate - 18% |
| **6) Stripping Test Bitumen Aggregate Mixtures** | 1. At the beginning for approval of each source and change of source<br>2. Once a month | 1<br><br>2B | IS :6241 | Minimum retained coating 95 %when bitumen stripped |
| **7) Retained Tensile Strength** (test to be conducted if retained coating is less than 95 % | 1. At the beginning for approval of each source and change of source<br>2. Once a month | 1<br><br>2B | | Minimum 80 % |

### 3.1.4 Earth

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Atterberg Limits** | 1. Once for each kind of soil. | 1 | IS: 2720 Part 5 | |
| a) Liquid limit<br>b) Plasticity Index | 2. Once at beginning of supply | 1 | | Maximum 70<br>Maximum 45 |
| | 3. 2 tests per $3000m^3$. | 2A/2B | | |
| 2) **Clay Content** | | | IS: 2720 Part 4 | Maximum 10% |
| 3) **Deleterious Content Test** | | | IS: 2720 Part 27 | Material should be free from swamp, marshes and bogs<br>It should not be Peat, log, sump and perishable material |
| 4) **Classification of Soil** | | | IS:1498 | Soil should not be classified as OL, OI, OH or Pt |
| 5) **CBR** | | | IS: 2720 Part 16 | Minimum4% (under fully soaked condition) |
| 6) **OMC and Maximum Dry Density** | | | IS: 2720 Part 8 | Determined to control water content for achieving maximum density |
| 7) **Density** | | | IS: 2720 Part 8 | 1.80 to 2.15 gm/cc |
| 8) **Grading** | | | IS: 2720 Part 4 | The size of coarse material should not exceed 75 mm in embankment and 50 mm in subgrade |
| 9) **Moisture Content** | 1. Once every 250 $m^3$ | 2A | IS: 2720 Part 2 | 7-15 % |

### 3.1.5 Lime

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1. **$CaC0_3$ content**<br>2. **Sieve Analysis** | 1. At the beginning for approval of each source and change of source | 1 | IS: 1195-1978 | 80% Minimum. |
| | 2. One Test for every 5MT of lime consumption. | 2B | | 100% though 75mm sieve. |

# 3.2 Steel / Iron

## 3.2.1 Reinforcement bars (CTD, TMT)
## 3.2.2 H- T. Strands
## 3.2.3 Cast Iron
## 3.2.4 Mild Steel

### 3.2.1 Reinforcement bars (CTD, TMT)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Chemical Tests** | 1. At the beginning for approval of each source and change of source | 1 | IS: 1786-1985 | |
| a) Carbon | | | | 0.30 maximum |
| b) Sulphur | | | | 0.06 maximum |
| c) Phosphorus | 2. Once for every lot | 2B | | 0.06 maximum |
| d) Sulphur + Phosphorus | 3. Once in 3 months | 3 | | 0.11 maximum |
| **2) Physical Test** | 1. At the beginning for approval of each source and change of source | 1 | | |
| a) Ultimate Tensile. Strength. | | | | 10% more than the actual 0.2% proof stress but not less 485 MPa |
| b) 0.2% Proof stress | 2. Once for every lot<br>3. Once in 3 months | 2A/2B<br>3 | | 415 MPa minimum |
| c) Percentage Elongation | | | | 14.5 minimum |
| d) Bend and Rebend Test | | | | To be satisfactory |
| e) Mass per meter run (Kg) | | | | 6.31 ± 3% for 32 mm dia , 4.830 ± 3% for 28 mm dia, 3% for 25 mm dia, 2.470 ± 3% for 20 mm dia<br>1. 580 ± 5% for 16 mm dia, 0.888 ± 5% for 12 mm dia |

### 3.2.2 H. T. Strands (Uncoated Stress relieved low relaxation seven ply strand)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Chemical Test** | 1. At the beginning for approval of each source and change of source | 1 | | |
| a) Sulphur | | | IS:228 (Part-3) -1987 | Not greater than 0.05% |
| b) Phosphorus | 2. Once for every lot | 3 | IS:228 (Part-9) – 1989 | Not greater than 0.05% |
| 2) **Dimension, Tolerance & Mass** | 1. At the beginning for approval of each source and change of source | 1 | IS:14268 - 1995 | |
| a) Tolerance in Diameter<br>b) Nominal area<br>c) Nominal Mass of strands | 2. Once for every lot | 2A/2B | | Nominal Dia. (mm) / Tolerance (mm) / Nominal Area of Strands ($mm^2$) / Nominal Mass of Strands (kg/Km)<br>12.7 / +0.66 -0.15 / 98.7 / 775<br>15.2 / +0.66 -0.15 / 140.0 / 1102 |
| d) Difference in dia of central course and surrounding wires | | | | Centre wire at least 1.5 percent greater in diameter than the surrounding wires. |
| e) Length of lay | | | | 12 to 16 times the nominal diameter. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3) **Physical Própertìes** | 1. At the beginning for approval of each source and change of source | 1 | IS:14268 - 1995 | Nominal Dia (mm) | Breaking Strength (kN) | 0.2% Proof load (kN) |
| a) Breaking Strength of strands | 2. Once for every lot | 3 | | 12.7<br>15.2 | 183.7<br>260.7 | 165.3<br>234.6 |
| b) 0.2% Poof load | | | | | | |
| c) Elongation | | | | Minimum 3.5 % on minimum gauge length of 600 mm | | |
| d) Modulus of Elasticity | | | | 18870 to 20910 Kg/sq mm | | |
| 4) **Relaxation Properties** | | | IS:14268 - 1995 | | | |
| a) 100 hours | 1. At the beginning for approval of each source and change of source<br>2. Once for every lot | 1<br>3 | | Relaxation Losses not more than 1.8% when loaded to 70% of specified minimum breaking load. | | |
| b) 1000 hours | 1. At the beginning for approval of each source and change of source<br>2. Once in a project for every source | 1<br>3 | | Relaxation Losses not more than 2.5% when loaded to 70% of specified minimum breaking load | | |

## 3.2.3 Cast Steel (For bearings grade 280-520W)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Chemical Tests** | 1. Once in the beginning for source<br>2. During execution depending upon the nature of use<br>3. Once in a project for every source | 1<br><br><br>3<br><br><br>3 | IS :1030 :1989 | C – 0.25% Maximum<br>Mn – 1.20<br>Si – 0.60<br>P - 0.0.10<br>S - 0.035<br>Ni - 0.40<br>Cr - 0.35<br>Cu - 0.40<br>Mo - 0.15<br>V - 0.05 |
| 2) **Physical Tests.**<br>a) Ultrasonic Tests<br>b) Magnetic Particle Examination<br>c) Liquid Penetration Examination<br>d) Radiographic Examination | | | | No deformations should be observed |

### 3.2.4 Mild Steel

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Chemical Composition** | 1. At the beginning for approval of each source and change of source<br>2. Once in a project for every source | 1<br><br><br><br>3 | IS:2062-1999 | Grade Designation C Mn S P Si Carbon equal value maximum<br>A Fe410WA 0.23 1.5 0.05 .05 .04 0.42<br>B Fe410WB 0.22 1.5 0.046 .045 .04 0.41<br>C Fe410WC 0.20 1.5 0.040 .04 .04 0.39<br><br>Nitrogen Content P 0.012%<br><br>Nb, V&Ti content (all or any) 0.2% |

### 3.2.5 Stainless Steel

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards | |
|---|---|---|---|---|---|
| **1) Chemical Tests.** | 1. At the beginning for approval of each source and change of source | 1 | IS-6911:1992 | | |
| a) Carbon | | | | C – 0.08% | Maximum ± 0.01 % |
| b) Silicon | | | | Si – 1% | Maximum ± 0.05 % |
| c) Manganese | 2. Once in a project for every source | 3 | | Mn – 2% | Maximum ± 0.04 % |
| d) Nickel | | | | Ni – 10% to 14% | Maximum ± 0.15 % |
| e) Chromium | | | | Cr – 16% to 18% | Maximum ± 0.20 % |
| f) Molybdenum | | | | Mo – 2% to 3% | Maximum ± 0.10 % |
| g) Sulphur | | | | S - 0.03% | Maximum ± 0.05 % |
| h) Phosphorus | | | | P – 0.045% | Maximum ± 0.01 % |
| **2) Mechanical Tests** | | | | | |
| a) Tensile Test | | | IS:1663:1972 | Minimum 440 MPa | |
| b) Yield Strength | | | IS:1608:1972 | Minimum 200 MPa | |
| c) Hardness Test | | | IS:1500:1983 | Brinell – maximum 192, Rockwell – Maximum 95 | |
| d) Elongation | | | IS:1501:1984<br>IS:1586:1988 | Minimum 40 % in 50 mm | |

### 3.2.6 Galvanising

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Mass of Zinc Coating** | One Test per lot | 3 | IS:6745-1972 | 400g/$m^2$ minimum total mass of Zinc (inside and outside) per surface area (inside and outside) of the coated surface. |
| 2) **Visual Test** | One Test per lot | 3 | IS:2629-1985 | The Zinc coating shall be free from imperfection like flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rurns rust stain, blister, white deposit etc. |
| 3) **Free Bore Test** | One Test per lot | 3 | IS:2633-1986 | A 230 mm long shall be passed through the tube to ensure a free bore.<br>Nominal bore of tube after galvanising — dia of rod<br>8mm — 4mm<br>10mm — 6mm<br>15mm — 11mm<br>20mm — 16mm<br>25mm — 21mm |
| 4) **Uniformity of Glavanised Coating** | One Test per lot | 3 | IS:4736-1986 | The galvanized coating shall with stand 4 one minute dips. |
| 5) **Adhesion Test** | One Test per lot | 3 | IS:2629-1985 | Galvanised tubes upto and including 50mm nominal bore when bent cold through $90^0$ round grooved, former having radius at the bottoms of groove equal to 8 times its outer dia shall not develop any crack in the coating. For tubes more than 50mm nominal bore, this shall be tested by pivoted hammer test. |

# 3.3 Chemicals

## 3.3.1 Cement
(a) OPC
(b) PSC

## 3.3.2 Plasticiser (Normal Superplasticiser)
## 3.3.3 Epoxy
## 3.3.4 Non Shrink Grout
## 3.3.5 Water Proofing Compound
## 3.3.6 Polysulphide Sealant
## 3.3.7 Silicon Sealant

### 3.3.1 (a) Cement (OPC-53 grade)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Chemical Tests** | 1. At the beginning for approval of each source and change of source | 1 | IS:12269 – 1987 | |
| a) Chlorides (as cl) | | | | 0.05% max |
| b) Ratio of Alumina to that of Iron Oxide | 2. Once for every lot | 2B | | 0.66 min |
| c) Magnesium (MgO) | 3. Once in 3 months | 3 | | 6.0% max |
| d) Total sulphate content | | | | 3.0% max |
| e) Loss on Ignition | | | | 4.0% max |
| f) Insoluble Residue | | | | 3.0% max |
| g) Lime saturation factor. | | | | 0.8 – 1.02 |
| **2) Physical tests** | 1. At the beginning for approval of each source and change of source | 1 | | |
| a) Setting Time | | | | |
| i Initial | | | | Not less than 30 minimum |
| ii Final | 2. Once for every lot | 2A/2B | | Not more than 10 hours |
| | 3. Once in 3 months | 3 | | |
| b) Soundness (Le Chatelier Expansion) | | | | 10mm Maximum |
| c) Compressive Strength | | | | |
| i) At 3 Days | | | | Not less than 27 Mpa Strength |
| ii) At 7 days | | | | Not less than 37 Mpa Strength |
| iii) At 28 days | | | | Not less than 53 Mpa Strength |
| d) Fineness | | | | 225 $m^2$ / Kg Minimum. |

### 3.3.1 (b) Portland Slag cement

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Chemical Tests** | 1. At the beginning for approval of each source and change of source | 1 | IS:455-1989<br>IS : 4032 : 1985 | |
| a) Magnesium oxide (Mgo) | | | | 8.0 % Maximum |
| b) Sulphur Trioxide ($SO_3$) | 2. Once for every lot<br>3. Once in 3 months | 2B<br>3 | | 3.0 % Maximum |
| c) Sulphide Sulphur(S) | | | | 1.5 % Maximum |
| d) Loss on Ignition | | | | 5.0 % Maximum |
| e) Insoluble Residue | | | | 4.0 % Maximum |
| f) Chloride Content | | | | .05 % Maximum |
| **2) Physical Tests** | 1. At the beginning for approval of each source and change of source<br>2. Once for every lot<br>3. Once in 3 months | 1<br>2A/2B<br>3 | | |
| a) Fineness (Blain's Air permeability method) | | | IS : 4031 (Part 2) : 1988 | Specific Surface shall not be less than $225m^2$ / Kg |
| b) Soundness | | | | |
| i Le-Chateliers Method | | | IS : 4031 (Part 3) : 1988 | Expansion shall not be more than 5mm |
| ii Auto clave expansion | | | | Expansion shall not be more than 0.6% |
| c) Setting time | | | IS : 4031 (Part5) : 1988 | |
| i Initial | | | | Initial setting time not less than 30 minutes |
| ii Final | | | | Final setting time not more than 60 minutes |
| d) Compressive Strength | | | IS : 4031 (Part 6) : 1988 | |
| i 72 ± 1h | | | | Not Less than 16 MPa |
| ii 168 ± 2 h | | | | Not Less than 22 MPa |
| iii 672 ± 4 | | | | Not Less than 33 MPa |

### 3.3.2 Plasticiser (Normal and Retarding Type Superplasticiser)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Water content, percent of control sample** | 1. At the beginning for approval of each source and change of source | 1 | IS:9103-1999 | 80 Maximum |
| **2) Slump** | 2. Once for every lot | 2B | | Not more than 15 mm below that of the control mix concrete |
| | 3. Once in 3 months | 3 | | |
| **3) Time of Setting, allowable deviation from control sample** | | | | |
| a) Initial | | | | Maximum +4 for Retarding type and nil for Normal<br>Minimum +1 for Retarding type and +1.5 for Normal |
| b) Final | | | | Maximum ±3 for Retarding type and ± 1.5 for Normal |
| **4) compressive strength, percent of control sample** | | | | |
| a) 1 day | | | | 140 minimum for Normal only |
| b) 3 days | | | | 125 minimum for Normal as well as Retarding type |
| c) 7 days | | | | 125 minimum for Normal as well as Retarding type |
| d) 28 days | | | | 115 minimum for Normal as well as Retarding type |
| e) 6 months | | | | 100 minimum for Normal as well as Retarding type |
| f) 1year | | | | 100 minimum for Normal as well as Retarding type |
| **5) Flexural Strength, percent of control sample** | | | | |
| a) 3days | | | | 110 minimum |
| b) 7 days | | | | 100 minimum |
| c) 28 days | | | | 100 minimum |



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| | | | | |
|---|---|---|---|---|
| **6) Length change percent increase over control sample**<br>a) 28 days<br>b) 6 months<br>c) 1 year | 1. At the beginning for approval of each source and change of source<br>2. Once for every lot<br>3. Once in 3 months | | | 0.01 maximum<br>0.01 maximum<br>0.01 maximum |
| **7) Bleeding, percent increase over control sample.** | | | | 5 maximum |
| **8) Loss of workability** | | | | At 45 minutes for Normal type admixture and at 2 hours for Retarding type admixture, the slump shall not be less than that of control mix concrete at 15 minutes. |
| **9) Air content (%) over control specimen** | | | | 1.5 maximum |
| **10) Uniformity Tests** | | | | |
| a) Dry Material Content | | | | Within 3% of the value stated by the manufacturer. |
| b) Ash content | | | | Within 1% of the value stated by the manufacturer |
| c) Relative Density | | | | Within 0.02 of the value stated by the manufacturer |
| d) Chlorides ion content | | | | Within 10% of the value or within 0.2 % whichever is greater as stated by the manufacturer |
| e) pH | | | | 7 – 8 |



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### 3.3.3 Epoxy (for joining the segments)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Pot life** | 1. At the beginning for approval of each source and change of source | 1 | F.I.P. Guidelines | Minimum 20 minutes. |
| 2) **Open Time** | | | | Not less than 60 minutes at upper temperature Limits |
| 3) **Thixotropy** | 2. Once for every lot | 2A/2B | | Sag flow should not exceed 30 mm in 10 minutes at upper limit of specified application temperature |
| | 3. Once in a project for every source | 3 | | |
| 4) **Angle of internal friction (Squeezibilty )** | | | | Minimum area of spread in $mm^2$ |
| a) 15 Kg, | | | | 3000 |
| b) 200Kg | | | | 7500 |
| c) 400 Kg | | | | 10,000 |
| 2) **Curing rate** | | | | Comp. Strength of 50x50x50mm size cubes should be |
| a) 12 hrs. | | | | $20 N/mm^2$ |
| b) 24 Hrs. | | | | $60 N/mm^2$ |
| c) 168 Hrs. | | | | $75 N/mm^2$ |
| 3) **Compressive Strength** | | | | Comp. Strength of 50x50x50mm size cubes should be |
| a) 24 Hrs. | | | | $60 N/mm^2$ |
| b) 168 Hrs. | | | | $75 N/mm^2$ |
| 4) **Bonding of cured bonding agent to concrete surface to be joined.** | | | | Should have concrete failure with no evidence of joint failure with concrete of strength 40 Mpa |



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| | | | | |
|---|---|---|---|---|
| **5) Tensile bonding strength.**<br>**6) Shear Strength**<br>**7) Heat resistance**<br>**8) Colour**<br>**9) Shrinkage** | 1. At the beginning for approval of each source and change of source<br>2. Once for every lot<br>3. Once in a project for every source | 1<br>2A/2B<br>3 | F.I.P. Guidelines | Should have concrete failure with no evidence of joint failure with concrete of strength 40 MPa<br>Should have 12 $N/mm^2$ higher than the concrete strength<br>Shear strength at failure should have a strength 10 $N/mm^2$ higher than the concrete strength<br>Should match the column of concrete.<br>Maximum 0.4% after 7 days at the upper limit of specified temperature range |

### 3.3.4 Non Shrink Grout

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Compressive Strength (50mm cubes)** | 1. At the beginning for approval of each source and change of source | 1 | ASTM C109-99<br>ASTM 469-94<br>BS 4551, 1998 | **Age (days)** / **Compressive Strength (Mpa)** Flowable W/P=0.18, Pourable W/P=0.165<br>1: 24, 27<br>3: 45, 54<br>7: 55, 66<br>28: 65, 78 |
| 2) **Compressive Strength with addition of aggregates.** | | | | **Age (days)** / **Compressive strength (MPa) W/P=0.18** 50%, 75%, 100%<br>1: 28, 30, 32<br>1: 50, 52, 55<br>7: 60, 63, 68<br>28: 70, 75, 78 |
| 3) **Flexural Strength** | | | | Age(Days) / Flexural strength (MPa) W/P=0.18<br>1: 2.5<br>3: 7.0<br>7: 9.0<br>28: 10.0 |
| 4) **Time for expansion (after mixing )**<br>a) Start<br>b) Finish | | | | 20 Minimum Preferably<br>120 minutes Preferably |

| | | | | |
|---|---|---|---|---|
| 5) **Pull Out Bond Strength** | 1. At the beginning for approval of each source and change of source | 1 | ASTM C109-99 | (W/P=0.18), 17 N/mm$^2$ @ 7 days and 20 N/mm$^2$ @ 28 days |
| 6) **Time for expansion** | | | ASTM 469-94<br>BS 4551, 1998 | Start : 20 minutes and Finish 120 Minutes |
| 7) **Freshwet Density** | | | | Approximately 2220 Kg/m$^3$ depending on actual consistency used |
| 8) **Young's Modulus** | | | | 28 kN/mm$^2$ |
| 9) **Dynamic Load resistance** | | | | Specimen remains undamaged even after subjecting to alternate loads of 5 N/mm$^2$ & 25 N/mm$^2$ @ 500 cycles/minute for two million cycles. |
| 10) **Coefficient of thermal Expansion** | | | | 11 x 10$^{-6}$/°C |
| 11) **Unrestrained Expansion** | | | | Upto 2 % in the plastic state enables to overcome shrinkage |
| 12) **Pressure to restrain plastic Expansion** | | | | .004 N/mm$^2$ approximately |
| 13) **Flow Characteristics**<br>a) Grout Consistency | | | | Maximum flow distance (in mm) |

| Gap Width (mm) | 50 mm head | 100 mm head | 250 mm head |
|---|---|---|---|
| 20 | 200 | 950 | 1600 |
| 30 | 350 | 1500 | 2300 |
| 40 | 600 | 2200 | 3000 |
| 50 | 900 | 3000 | 3000+ |


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## 3.3.5 Water proofing Compound

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Permeability** | 1. At the beginning for approval of each source and change of source<br>2. Once in a project for every source . | 1<br><br>2B | IS:2645-1975 | Permeability to water of the standard cylindrical specimens prepared with the recommended proportion of the water proofing compound shall be less than 50% of permeability similar specimens prepared without waterproofing compound . |
| 2) **Setting Time.** | | | | Initial Setting Time - Not less than 30 minimum<br>Final Setting time - Not more than 600 minimum |
| 3) **Compressive Strength** | | | | Compressive strength at 72 hrs. – Not less than 160kg/cm$^2$ or 80% of the 3 day compressive strength of cubes prepared without waterproofing compound.<br>Compressive Strength at 168 hrs. – Not less than 220 kg/cm$^2$ or 80% of the 7 day compressive strength of cubes prepared without waterproofing compound. |
| 4) **Chloride Content** | | | | As per the values given by the manufacturer |
| 5) **Sulphate Content** | | | | As per the values given by the manufacturer |



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### 3.3.6 Polysulphide Sealant

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Pot life / work life** | 1. At the beginning for approval of each source and change of source | 1 | IS:12118 (Part I)-1987 | Minimum 2 hours. |
| 2) **Adhesion & Tensile Modulus** | | | | Total Area of failure should not exceed $100mm^2$ and the force required to produce the extension shall be between 25 N and 270 N. |
| 3) **Plastic deformation.** | | | | Not more than 25%. |
| 4) **Adhesion in Peel** | | | | Average peel strength of four strips of backing material should not be less than 25N and the material shall not fail in adhesion over more than 25% of the test area. |
| 5) **Loss of mass after heat ageing** | | | | Not more than 6% (for Gun grade). |
| 6) **Staining** | | | | The sealant shall produce no staining on the surface of test mortar. |

### 3.3.7 Silicon Sealant

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Service Temperature** | 1. At the beginning for approval of each source and change of source | 1 | BS:5889 | $50^0C$ to $100^0C$ |
| 2) **Application Temperature.** | | | ASTMC-920-87 | $10^0C$ to $40^0C$ |
| 3) **Shore 'A' Hardness** | | | | 18 – 32 |
| 4) **Tensile Strength** | | | | 0.5 $N/mm^2$ |
| 5) **Elongation at rupture** | | | | 400% Minimum |
| 6) **Modulus at 100% elongation** | | | | 0.35 MPa Minimum |
| 7) **Tooling time** | | | | 30 minutes minimum |
| 8) **Curved State** | | | | Permanently elastic, mid modulus |
| 9) **Base** | | | | Neutral cure reactive with atmospheric moisture. |

# 3.4 Bitumen

## 3.4.1 Paving Bitumen
## 3.4.2 Industrial Bitumen

### 3.4.1 Paving Bitumen (for BM, DBM, AC)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards | | | | |
|---|---|---|---|---|---|---|---|---|
| 1) **Specific Gravity at $27^0$C** | 1. At the beginning for approval of each source and change of source<br>2. For every Lot per plant | 1 | IS:73 :1992<br>IS:1202-1978 | 0.99 Minimum | | | | |
| 2) **Water, percent by mass** | | 2A/2B | IS:1211-1978 | 0.2 Maximum | | | | |
| 3) **Flash Point, Cleveland open cup, °C** | | | IS:1209:1978 | 175 Minimum | | | | |
| | | | | **Requirements for Grade** | | | | |
| | | | | **S 35** | **S 45** | **S 55** | **S 65** | **S 90** |
| 4) **Softening point °C** | | | IS:1205:1978 | 50 to 65 | 45 to 60 | 45 to 60 | 40 to 55 | 35 to 50 |
| 5) **Penetration at 250C, 100g , 5 sec., 1/10mm** | | | IS:1203:1978 | 30 to 40 | 40 to 50 | 50 to 60 | 60 to 70 | 80 to 100 |
| 6) **Penetration Ratio** | | | IS:1208:1978 | 35 Minimum | | | | |
| 7) **Ductility at 270C** | | | | Minimum 50 for S 35 and 75 for other grades | | | | |
| 8) **Paraffin Wax Content, percent by mass** | | | IS:1208:1983 | 4.5 Maximum | | | | |
| 9) **Frass breaking point °C** | | | IS:9381:1979 | Minimum ( – ) 4 for S 35 and S 45, ( - ) 6 for S 55 and S 65 & ( – )8 for S 90 grade bitumen | | | | |

| | | | | |
|---|---|---|---|---|
| **10) Loss an heating** | 1. At the beginning for approval of each source and change of source<br>2. For every Lot per plant | 1 | IS:1212:1978 | Maximum 1 % by mass |
| **11) Retained Penetration after thin film oven test, 250C,100g , 5 sec., 1/10mm** | | 2A/2B | IS:9382:1979 | 55 % of original for S 35 and S 45, 52 % for S 55 and S 65 and 47 % for S 90 grade |
| **12) Matter soluble in tricholoroethylene,** | | | IS:1216:1978 | 99 % Minimum |
| **13) Viscosity ( in Poise) at** | | | | **<u>Requirements for Grade</u>**<br>**S 35** / **S 45** / **S 55** / **S 65** / **S 90** |
| a) 60°C, | | | IS:1206 (Part-2) – 1978 | 2500±500 / 2000±400 / 1500±300 / 1000±200 / 500±100 |
| b) 135 °C | | | IS:1206 (Part-3) – 1978 | 220 / 210 / 180 / 150 / 110 |

### 3.4.2 Industrial Bitumen (for Mastic Asphalt)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Specific Gravity at 27°C** | 1. At the beginning for approval of each source and change of source<br>2. Once for every Lot | 1<br>2A/2B | IS:702<br>IS:1202 | Minimum 1.05 g/cc |
| 2) **Flash Point** | | | IS:1209 | Minimum 225°C |
| 3) **Softening point** | | | IS:1205 | 80-90°C |
| 4) **Penetration at 25$^0$C, 100g, 5 sec., 1/10** | | | IS:1203 | 20-30 mm |
| 5) **Ductility at 27$^0$C** | | | IS:1208 | 3 cm Minimum |
| 6) **Loss an heating** | | | IS:1212 | 0.3 % Maximum |
| 7) **Solubility in Tri-chloroethylene** | | | IS:1216 | 99 % Minimum |

# 3.5 Prestressing

## 3.5.1 Prestressing System

## 3.5.2 Prestressing Hardware

### 3.5.2.1 Sheathing

#### (a) MS Sheathing

#### (b) HDPE Sheathing

### 3.5.2.2 Other Prestressing Hardware

### 3.5.1 Prestressing System

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1. **Static Load test with tendon – anchorage assembly** | 1. Once at the start of work for the approval of the Prestressing system<br>2. Once in project for each prestressing system for every source of strands | 1<br><br><br><br><br>3 | **FIP recommendations** | 1. The increase in the displacements between the anchorage components as well as between the pre-stressing steel & anchorage components should not be disproportionate to the increase in tendon force.<br>2. The above relative displacement during $0.8F_{pk}$ load should stabilise within first thirty minutes of the load duration of one hour.<br>3. Thew mode of failure & tendon should be by the fracture of the pre-stressing steel.<br>4. Anchorage Efficiency ($\eta_a$) $\geq 0.95$<br>5. Total elongation $\varepsilon_u$ in the free length of the tendon under the measured ultimate force( $F_{TU}$ )shall be $\geq 2$ %. |

| | | | | |
|---|---|---|---|---|
| 2. **Dynamic Load Test with Tendon – anchorage assembly** | 1. Manufacturer's test certificate for every source | 2 | FIP recommendations | Fatigue failure of anchorage components should not occur. Minimum fatigue strength of post tensioning system = 80 Mpa. |
| 3. **Load transfer Test** | 1. Once at the start of work for the approval of the Prestressing system<br>2. Once in project for each prestressing system for every source of strands | 1<br>3 | FIP recommendations | 1. Crack width upon first attainment of upper force 0.8 $F_{PK}$ $\leq$ 0.10 mm<br>2. Crack width upon last attainment of lower force 0.12 $F_{PK}$ $\leq$ 0.10 mm<br>3. Crack width upon final attainment of upper force 0.8 $F_{PK}$ $\leq$ 0.25 mm<br>4. Reading of longitudinal & Transverse strains should have stabilised during cyclic loading (increase in strain in last 2 load cycles <5%)<br>5. Reading of crack width should have stabilised (increase in crack width in last 2 load cycles > .02 mm )<br>6. Measured failure Load $F_u \geq F_{pk}$ $(f_{cm,e}/f_{ck,o})$ and $\geq 1.1\ F_{pk}$ |

### 3.5.2.1 (a) MS Sheathing

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Physical Test** | 1. At the beginning for approval of each source and change of source | 1 | IRC-18-2000 (Appendix – 1 A) | |
| a) Workability Test | | | | No failure or opening takes place |
| b) Transverse Load rating Test | 2. Once for every lot not exceeding 700 metre length | 2A/2B | | The Permanent deformation shall be less than 5% |
| c) Tension Load Test | | | | No deformation of joint and no slippage of couplers |
| d) Water loss Test | | | | Water loss should not exceed 1.5 % of the volume |
| 2) **Dimensions** | | | | |
| a) Diameter | | | | **Size of tendons** — **Minimum Inner dia**<br>6 T 13 — 50 mm<br>12 T 13 — 75 mm<br>19 T 13 — 90 mm<br>Minimum Dia. = 3 times the area of tendons |
| b) Thickness | | | | **Internal dia of tube** — **Min thickness**<br>50mm — 0.3mm<br>75mm — 0.4mm<br>90mm — 0.5mm<br>more than 90mm — as per the recommendation of manufacturer and as per the directions of Engineer |
| 3) **Chemical Composition** | | | | Cold Rolled Cold Annealed Mild Steel |

### 3.5.2.1 (b) Corrugated HDPE Sheathing ducts

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Bond Test** | 1. At the beginning for approval of each source and change of source | 1 | IRC-18-2000 (Appendix – 1 B) | Failure capacity of the bond shall be at least equal to the anchorage efficiency or 95 % of the failure capacity of the tendon. |
| 2) **Compression Test** | 2. Once for every lot | 2A | | Residual thickness of the duct shall be not less than 1.5 mm No failure or opening takes place |

### 3.5.2.2 Other Prestressing Hardware

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Anchor Head** | 1. At the beginning for approval of each source and change of source | 1 | DIN 17200 | |
| a) Ultrasound Test | 2. Once for every lot | 2A/2B | | Satisfactory as reported by radioilogist |
| b) Chemical Analysis | | | | As per manufacturer's recommendations |
| c) Dimensional Test | | | | As per manufacturer's recommendations |
| d) Hardness | | | | 446 to 506 or as per manufacturer's recommendations |
| **2) Barrel** | | | | |
| a) Chemical Analysis | | | | As per manufacturer's recommendations |
| b) Dimensional Test | | | | As per manufacturer's recommendations |
| c) Hardness | | | | 446 to 506 or as per manufacturer's recommendations |
| **3) Bearing Plates** | | | | |
| a) Chemical Analysis | | | | As per manufacturer's recommendations |
| b) Dimensional Test | | | | ±5 mm for outer dimensions and ±5 mm for inner dimensions |
| c) Hardness | | | | 197 to 241 BHN (as tested by Poldi Tester) or as per manufacturer's recommendations |

| | | | | |
|---|---|---|---|---|
| **4) Wedges** | 1. At the beginning for approval of each source and change of source<br>2. Once for every lot | 1<br><br>2A/2B | Manufacturer's specifications | |
| a) Dimensional Check | | | | As per manufacturer's recommendations |
| b) Surface Hardness | | | | Minimum 700 |
| c) Load Test | | | | Satisfactory as per visual examination |
| **5) Trumpet Cone** | | | | |
| a) Dimensional Test | | | | As per manufacturer's recommendations |
| b) Chemical Test | | | | As per manufacturer's recommendations |

## 3.6 Pipes

### 3.6.1 Steel Pipes
### 3.6.2 RCC Pipes
### 3.6.3 HDPE Pipes

### 3.6.1 Steel Pipes

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Chemical Test** | 1. At the beginning for approval of each source and change of source | 1 | IS :1239 (Part 1and 2) | |
| a) Sulphur | | | | Not more than 0.06% |
| b) Phosphorus | 2. Once for every lot | 2A/2B | | Not more than 2.06% |
| **2) Dimensional Tolerance** | | | | |
| a) Outer Dia | | | | For tubes up to & i/c 48.3mm tolerance is + .4mm, –0.8mm<br>Over 48.3 mm ± 1.0% |
| b) Thickness | | | | -10% for Welded Tubes and –12.5 % for Seamless Tubes |
| c) Weight | | | | Single Tube (any qty.) + 10%, -8%<br>Quantities of less than 150m of one size + 10% - 8%<br>Quantities of 150m and more of one size ± 4%. |
| **3) Straightness** | | | | Deviation from straightness shall not be more than 1l/600 where l is the length of pipe. |
| **4) Tensile Test** | | | | Grade · Tensile Strength MPa (Minimum)<br>Yst 210 330<br>Yst 240 410<br>Yst 310 540 |
| **5) Flatting Test** | | | | No opening shall occur by fracture in the weld until the distance between the plates is less than 75% of the original outer dia and no cracks or breaks in the metal elsewhere than in the weld. |

## 3.6.2 RCC Pipes

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Tolerances in Dimensions** | 1. At the beginning for approval of each source and change of source | 1 | IS:458:1988<br>IS:3597 :1985 | |
| a) Wall Thickness | 2. Once for every lot | 2A/2B | | Up to and including 30 mm ± 2mm<br>Over 30 mm and up to and including 50 mm ± 3mm<br>Over 50 mm and up to and including 65 mm ± 4mm<br>Over 65 mm and up to and including 80 mm ± 5mm<br>Over 80 mm and up to and including 95 mm ± 6mm,<br>Over 95 mm ± 7mm |
| b) Internal Dia. of Pipe or Socket | | | | Up to and including 300 mm ± 3mm<br>Over 300 mm and up to and including 600 mm ± 5mm<br>Over 600 mm and up to and including 1200 mm ± 7mm<br>Over 1200 mm ± 10 mm |
| c) Overall Length | | | | ± 1 % of standard Length |
| **2) Three Edge Bearing** | | | | Shall withstand the design Load |
| **3) Water absorption** | | | | After 10 minutes, 2.5 % of dry Mass Maximum and total absorption at the end of 24 Hours shall not exceed 6.5 % of dry mass |
| **4) Hydrostatic Pressure** | | | | No leakage under the design pressure |
| **5) Straightness** | | | | Maximum 3 mm for every m length |
| **6) Reinforcement** | | | | On breaking the Pipe and extracting the reinforcement, it shall be as per the provision |
| **7) Cube Strength** | | | | As per the design strength |


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### 3.6.3 HDPE Pipes

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Hydraulic Characteristics.** | 1. At the beginning for approval of each source and change of source | 1 | IS:4984-1995 | No localized swelling, leakage, weeping, or bursting during subjecting to internal pressure creep test. |
| **2) Reversion Test.** | 2. Once for every lot | 2B | | Longitudinal reversion shall not be more than 3% |
| **3) Density** | | | | 940.5 to 946.4Kg/m$^3$ at 27$^0$C & shall not differ from the nominal value by more than 3kg/m$^3$ |
| **4) Melt Flow Rate (MFR)** | | | | 0.41 to 1.10 at 190$^0$C with nominal load of 5kg and shall be within 20% of the value declared by the manufacturer. |
| **5) Carbon Black Content & Dispersion** | | | | 2.5 $\pm$ 0.5% with uniform dispersion. |

# 3.7 Other Materials

## 3.7.1 Thermoplastic Paints
## 3.7.2 Geotextile
## 3.7.3 Bentonite
## 3.7.4 Chloroprene Elastomer
## 3.7.5 Poly Tetra Fluoro Ethylene (PTFE)

### 3.7.1 Thermoplastic Paints

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Binder content** | 1. At the beginning for approval of each source and change of source | 1 | BS: 3262 and MOST Specifications clause 803 | 18% Minimum by weight |
| 2) **Glass Beads** | 2. Once in a project for every source | 2B | | 30 –40%<br>Gradation of Glass beads<br>**IS Sieve** — **Percentage Passing**<br>1.18 mm — 0-3<br>850 micron — 5-20<br>425 — 65-95<br>180 — 0-10 |
| 3) **Titanium Dioxide content** | | | | 10% Minimum |
| 4) **Calcium Carbonate & Inert fillers.** | | | | 42% Max for white paint and at discretion of manufacturer subject to meeting other specification for yellow paint. |
| 5) **Yellow Pigments** | | | | At direction of manufacturer subject to meeting of other specifications. |
| 6) **Luminance (Daylight)** | | | | 65% Minimum at 45% for white paint and 45% Minimum at 45% for yellow paint |
| 7) **Drying Time** | | | | 15 Minutes Maximum |
| 8) **Skid Resistance** | | | | Not less than 45 |

| | | | | |
|---|---|---|---|---|
| **9) Cracking Resistance at low temperature** | 1. At the beginning for approval of each source and change of source<br>2. Once in a project for every source | 1<br>2B | BS: 3262 and MOST Specifications clause 803 | No cracking on application to concrete blocks. |
| **10) Softening Point** | | | | 102.5 ± 9.5$^0$C |
| **11) Flow resistance** | | | | Not more than 25% |
| **12) Yellowness Index** | | | | Not more than 0.12 |

### 3.7.2 Geotextile

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Thickness** | 1. At the beginning for approval of each source and change of source | 1 | ASTM D 4355 | Not less than 2mm |
| 2) **Weight** | | | | Not less than 225 gm/sqm |
| 3) **Tensile Strength** | 2. Once in a project for every source | 2B | | Minimum 30Kg per 5cm in either direction |
| 4) **Fiber Composition** | | | | 100% polypropylene non-woven |
| 5) **Chemical Resistance**<br>a) Against NaOH<br>b) Against HCl | | | | No appreciable change in breaking strength. |
| 6) **Resistance against photooxidation** | | | | 200-250 hrs. |

### 3.7.3 Bentonite

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Density** | 1. At the beginning for approval of each source and change of source | 1 | MOST specification for Road & Bridge works. | 1.05 g/cc |
| **2) Marsh Cone Viscosity** | | | | 30 to 40 |
| **3) pH value** | 2. Once for every day of Piling | 2A | | 9.5 to 12 |
| **4) Silt content** | | | | less than 1% |
| **5) Liquid limit** | | | | not less than 400% |

### 3.7.6 Chloroprene Elastomer

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Hardness** | As per the requirement of the respective item | 3 | MOST specification for Road & Bridge works. | $60 \pm 5$ IRHD for Elastomeric Bearing and $50 \pm 5$ IRHD for POT-PTFE Bearing |
| 2) **Minimum Tensile Strengths** | | | | 17 MPa minimum for Elastomeric Bearing and 15.5 MPa minimum for POT-PTFE Bearing |
| 3) **Minimum Elongation at Break** | | | | 400% |
| 4) **Maximum Compression set** | | | | 35% (Temp. $100 \pm 1^0$C , Duration 24 hrs.) |
| 5) **Accelerated Ageing** | | | | |
| a) Maximum Change in Hardness | | | | ± 15 IRHD |
| b) Maximum Change in Tensile strength | | | | – 15% Temp. $100 \pm 1^0$C, duration 70 hrs |
| c) Maximum change in elongation | | | | – 40% |
| 6) **Shear Modulus** | | | | 0.8 to 1.20 MPa |
| 7) **Ash Content** | | | | Not more than 5% |

### 3.7.7 Poly Tetra Fluro Ethylene ( PTFE )

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Form** | As per the requirement of the respective item | 3 | BS:3784<br>BS:6564<br>Part 2 - 1991 | Without dimples or the ratio pf dimples (lubrications cavities) to the gross area should not be more than 25%, depth of cavity not more than 2mm. |
| 2) **Density at 23 ± 2$^0$C.** | | | | 2.13 to 2.19 g/cc |
| 3) **Tensile Strength at break** | | | | 24 Mpa (minimum) |
| 4) **Elongation at Break** | | | | 300% (Minimum). |
| 5) **Resistance to heat** | | | | No sign of melting & loss in mass shall not exceed 0.5% |
| 6) **Dimensional stability** | | | | Mass change shall not exceed 0.5%. |

### 3.7.6 Tests on Neoprene Seal (for strip seal expansion joints)

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Hardness** | 1. At the beginning for approval of each source and change of source | 1 | MOST specification for Road & Bridge works | 63 ± 5 shore A |
| 2) **Tensile Strengths** | | | | 11 MPa minimum |
| 3) **Elongation at Break** | 2. Once for every Lot | 3 | | 350% Minimum |
| 4) **Tar Propagation Strength** | | | | |
| a) Longitudinal | | | | Minimum 10 N/mm |
| b) Transverse | | | | Minimum 10 N/mm |
| 5) **Shock Elasticity** | | | | Minimum 25 % |
| 6) **Abrasion** | | | | Minimum 220 $mm^3$ |
| 7) **Residual Compressive strain (22h/70 °C /30 % strain)** | | | | Maximum 28 % |
| 8) **Ageing in hot air** | | | | |
| a) Maximum Change in Hardness | | | | ± 5 shore A |
| b) Maximum Change in Tensile strength | | | | – 20% |
| c) Maximum change in elongation | | | | – 20% |

| | | | | |
|---|---|---|---|---|
| 9) **Ageing in Ozone (24h/50 pphm/ 25°C/ 20 % strain** | 1. At the beginning for approval of each source and change of source | 1 | MOST specification for Road & Bridge works | No cracks |
| 10) **Swelling behaviour in oil** | 2. Once for every Lot | 3 | | |
| a) Volume Change | | | | Maximum 5 % |
| b) Change in Hardness | | | | Maximum 10 Shore A |
| 11) **ASTM oil No. 3** | | | | |
| a) Volume Change | | | | Maximum 25 % |
| b) Change in Hardness | | | | Maximum 20 Shore A |
| 12) **Cold Hardening Point** | | | | Minimum –35° C |

# 3.8 Assembled Accessories

## 3.8.1 POT/PTFE Bearings

## 3.8.2 Elastomeric Bearings

## 3.8.3 Expansion Joints



1965 CPWD/2002—7B

### 3.8.1 POT-PTFE Bearings.

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Dimensional Tolerance** | All bearing to be tested for overall dimension | 3 | MOST specification for Road & Bridge works | |
| a) Plan dimensions | | | | 0 to +5mm |
| b) Overall Height | | | | 0 to +3mm |
| c) Height of any steel component | | | IRC: 83 Part-I | |
| i) Machined | | | | 0 to +1mm |
| ii) Unmachined | | | | Class 2 of IS:4897 |
| d) Height of Elastomer | | | | ± 5% |
| **2) Stainless steel sliding surface** | All bearing to be tested for overall dimension | 3 | | |
| a) Flatness | | | | 0.0004L where L= length is direction of measurement |
| b) Surface finish | | | | Ra < 0.25 pm as per IS:3073 |
| **3) Load Test** | All bearing | 3 | | A test load of 1.25 times the design head there shall be 100% recovery |
| **4) Friction Test** | Two bearings per lot | 3 | | The sufficient of friction shall be less than or equal to 0.05 at the design load. |
| **5) Ultrasonic Test** | All castings | 3 | | Quality level of casting shall be level 3 as per IS:9565 |
| **6) Dye Penetration Test** | All welding | 3 | | There shall be no holes or flaws. |
| **7) Raw Material Testing** | All raw material | 3 | | a. for cast steel, refer clause 3.2.3 of this manual<br>b. for mild steel, refer clause 3.2.4 of this manual<br>c. for stainless steel, refer clause 3.2.5 of this manual<br>d. for elastomer, refer clause 3.7.4 of this manual<br>e. for PTFE, refer clause 3.7.5 of this manual |



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### 3.8.2 Elastomer Bearings

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| **1) Visual inspection** | All bearing | 3 | IRC:83 (part-II-1987 | There shall be no visible defects in surface finish, shape or any other specifically defect. |
| **2) Dimension Test** | All bearing | 3 | | |
| a) Overall Plan Dimension | | | | - 0, + 6mm |
| b) Total Bearings thickness | | | | – 0, + 5% |
| c) Parallelission | | | | |
| i) of top surface of bearings with respect to the bottom surface as datum | | | | 1 in 200 |
| ii) of one side surface with respect to the other as datum | | | | 1 in 100 |
| iii) Thickness of individual internal layer of elastomer | | | | ± 20% (maximum of 2mm) |
| iv) Thickness of | | | | -0, + 1mm |

| | | | | |
|---|---|---|---|---|
| individual outer layer | | | | |
| v) Plan dimension of laminates | | | | - 3mm, +0 |
| vi) Thickness of laminates | | | | ± 10% |
| vii) Parallelission of laminate w.r.t. bearing base as datum | | | | 1 in 100 |
| **3) Axial Load Test** | Two bearings per lot | 3 | IRC:83 (part-II-1987 | Deflection under axial load of 5 MPa to 15MPa for individual bearings shall not vary by more than 20% of the mean value for the entire lot. |
| **4) Shear Modules (G)** | | | | Shear modules shall be 1 ± 0.2 Mpa provided that there is no instability, defect or damage. |
| **5) Elastic Modulus (Short term loading)** | | | | Elastic modules shall be 1 ± 0.2 of 1/C0.2/5$^2$+0.0005) where 5 is the shape factor, provided that there is no defect or damage. |
| **6) Adhesion Strength** | | | | No cracking or petting |
| **7) Ultimate compressive Strength** | | | | Not less than 60Mpa. |
| **8) Tests on Elastomer** | | | | The elastomer shall satisfy the requirement of clause 3.7.4 of this manual. |

### 3.8.3 Strip Seal Expansion Joints

| Test | Frequency | Check Level | Ref. Codes | Acceptance Standards |
|---|---|---|---|---|
| 1) **Tests on Neoprene seal** | Once for all joints | 3 | MOST specification for Road & Bridge Works ($4^{th}$ Revision) | As given in 3.7.6 |
| 2) **Test on Edge Beams**<br>a) Fatigue Strength | Once for each lot | 2B | | There shall be no signs of damage after $2x10^6$ cycles of load charges. The manufacturer shall submit a test certificate from a recognized laboratory. |
| 3) **Test on Anchorage system**<br>a) Dynamic. Loading characteristics | | | | The anchorage system shall be tested in a recognized laboratory for optimum configuration under dynamic loading. |
| 4) **Water Tightness test** | | | | The joint shall be tested in a recognized laboratory for water tightness under a pressure of 4 bar. |
| 5) **Satisfactory Past Performance** | | | | The manufacturer shall submit evidence that the similar joints have performed satisfactorily at other locations |



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# CHAPTER - 4

## QUALITY ASSURANCE PLAN

for

## <u>SITE ACTIVITIES</u>

## Q.A.P for Site Activities

While executing important activities like Piling, Casting of Reinforced Cement concrete elements, construction of Embankment, Road works like WBM, road surfacing activities etc. it has to be ensured that the completed work satisfied the required of Q-4 level of Quality Assurance as per the IRC: SP-47. In addition to the checks and tests on the quality of the materials to be used as enumerated in the previous chapter, it shall be necessary to carry out certain tests during the construction process itself at the various stages of construction. These tests for various activities comprise its QAP. The results of these tests shall be reported as per the proformas given in chapter 8 and the various checks required to be made at different stages have also, been given in chapter 8. A standardised procedure for carrying out the activities have to be viewed as a whole in order to ensure the complete QAP of any particular activity.

**4.1 Mix Design including Trial Mix and acceptance criteria**
**4.2 RCC work**
**4.3 Piling**
**4.4 Embankment construction**
**4.5 Water Bound Macadam**
**4.6 Wet Mix Macadam**
**4.7 Bituminous Works (BM, DBM, AC)**
**4.8 Mastic Works**
**4.9 Reinforced Earth Works**

## 4.1 Mix Design including Trial Mix and Acceptance Criteria

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| 1) **Trial Mix**<br>a) Target Mean Strength | 1.For every design Mix<br>2. For every change in source of any material | IRC : 21-2000 | Initially<br><br>Target Mean Strength = specified Characteristic Strength + current Margain<br>Current Margain = 11 M Pa for M 25, 12 MPa For M30, M 35 and M 40, 13 MPa for M 45 and M 55 & 14 MPa for M 55 and M 60<br><br>Later on<br><br>Target Mean Strength = specified Characteristic Strength + 1.64 x Standard Deviation from at least 40 samples |
| 2) **Acceptance Criteria** | Qty. of Concrete ($m^3$) — No. of Samples<br>1-5 — 1<br>6-15 — 2<br>16-30 — 3<br>31-50 — 4<br>51 and above each — 4 + plus 1 for 50 m3 or part thereof | IRC : 21-2000 | 1. Mean strength of any group of 4 consecutive samples = Specified Characteristic Strength + 3 Mpa<br><br>2. Strength of any sample Specified ≥ Characteristic Strength - 3 Mpa |

## 4.2 R.C.C. work

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| 1) **Workability** | Every Transit Mixer | IS:516-1959 | As per requirement of the item under execution |
| 2) **Compressive Strength** | As per clause 4.1 of this manual | IRC:21 | As per clause 4.1 of this manual |
| a) 7 Days Strength | | | |
| b) 28 Days Strength | | | |
| 3) **Flexure Test** | Once for every Design Mix | MORTH Specifications for Road &Bridge works | |
| 4) **Permeability Test** | Once in a month | | Maximum 25mm on a specimen of 150mmϕ and 160mm height |
| 5) **Density** | Once in a month | | |
| a) Fresh concrete | | | 97.5% of the specified value |
| b) Hardened concrete | | | 97.5% of the specified value |

## 4.3 Piling

| Test | Frequency | Reference Code | Acceptance Standard |
|---|---|---|---|
| **1) Initial Tests** | | IS:2911 (Part-4) -1985 | |
| a) Vertical | Minimum 2 tests | IS:2911 (Part-4) -1985 | The safe vertical load shall be minimum of<br>i) 50% of the final load corresponding to 12mm displacement<br>ii) Final load at which displacement in 5mm<br>iii) Load corresponding to any other specified displacement as per performance requirements |
| **2) Routine Tests** | | | |
| a) Vertical Test | Upto 2% of total piles | | Maximum settlement at a test load of 1.5 times the working load shall not exceed 12mm |
| b) Lateral Load Test | Upto 2% of total piles | | Safe Lateral load shall be the minimum of<br>i) 50% of the final load corresponding to 12mm displacement<br>ii) Final load at which displacement is 5mm.<br>iii) Load corresponding to any other specified displacement as per performance requirements. |
| c) Integrity Test | 20% of total piles | | There shall be no unacceptable flaws in concrete as per the recommendation of the specified agency carrying out the test. |

## 4.4 Embankment Construction

| Test | Frequency | Reference Code | Acceptance |
| --- | --- | --- | --- |
| 1) **Moisture Content** | One test to be conducted for every 1000 $m^2$ of embankment in the lower layers and 500 $m^2$ in the top 60 cm of the embankment (20cm thickness). Each test shall comprise of tests at five locations. | MORTH Specifications for Road and Bridge Works | 1. The moisture content shall be in the range of –1% to +2% of the OMC. |
| 2) **Dry Density** | | IS:2720 (Part –2)<br>IS:2720 (Part-8) | 2. The dry density shall be 95% of the Maximum Dry Density (MDD) in the lower layers of embankment and 100% of MDD in the top 60 cm of the embankment |

## 4.5 Water Bound Macadam

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| 1. Atterberg Limits of binding Material | 1. One test per 25 $m^3$ of aggregate | IS:2720 (Part V) | PI ≤ 6 |
| 2. Atterberg Limits of aggregate passing 425 micron sieve | 1. One test per 100 $m^3$ of aggregate | IS :2720 (Part V) | PI ≤ 6 |

## 4.6 Wet Mix Macadam

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| 1. Atterberg Limits of aggregate passing 425 micron sieve | 1. One test per 100 $m^3$ of aggregate | IS:2720 (Part V) | PI ≤ 6 |
| 2. Density of compacted layer | 1. One test per 500 $m^2$ | IS :2720 (Part VIII) | At least 98 % of MDD |

## 4.7 Bituminous Works (BM, DBM, AC)

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| **1) Marshall stability** | 1. At the time of Mix Design<br>2. Once at the time of work | MORTH Specifications for Road and Bridge Works | **9.0 kN at 60°C** |
| **2) Marshall Flow** | 1. At the time of Mix Design<br>2. Once at the time of work | | **2-4 mm** |
| **3) Percent air voids** | 1. At the time of Mix Design<br>2. Once at the time of work | | **3-6** |
| **4) Percent voids in mineral aggregate filled with bitumen (VFB)** | 1. At the time of Mix Design<br>2. Once at the time of work | | **65-75** |



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| | | | |
|---|---|---|---|
| **5) Percent voids in mineral aggregate (VMA)** | 1. At the time of Mix Design<br>2. Once at the time of work | | Nominal size of Aggregates — Min. VMA<br>9.5 mm Air Voids + 11 %<br>12.5 mm Air Voids + 10 %<br>19 mm Air Voids + 9 %<br>25 mm Air Voids + 8 %<br>37.5 mm Air Voids + 7 % |
| **6) Binder content percent by weight of total mix** | 1. At the time of Mix Design<br>2. Once at the time of work | | 3.1 to 3.4 % for 80 –100 mm thick BM, 3.3 to 3.5 % for 50 –75 mm thick BM<br>Min. 4.0 % for 80–100 mm thick DBM,<br>Min. 4.5 % for 50 – 75 mm thick DBM,<br>5.0 to 6.0 % for 50 – 65 mm thick BC, 5.0 to 7.0 % for 30 - 45 mm thick BC |
| **7) Compacted thickness** | | | As specified in the contract |
| **8) Density of mix** | | | 98% of the lab density |
| **9) Compaction Level** | | | 75 blows on each of the two faces of the specimen |

## 4.8 Bitumen Mastic

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| 1) **Profile**<br>a) Longitudinal<br>b) Cross | Over the entire area | IRC:107-1992<br>IS:1195-1978 | There shall be no irregularity greater than 4mm when tested with a straight edge of 3m length in L-direction and camber template in X-direction |
| 2) **Hardness Number** | One sample to be tested for every 10 MT of Bitumen discharged from the mastic cooker or at least one sample per cooker per day | IS:1195-1978 | • without coarse aggregate at $25^0$C - 60-80<br>• with coarse aggregate at $25^0$C - 10-20 |
| 3) **Bitumen Content** | | IS:1195-1978 | 14 to 17 % by weight of total mixture |
| 4) **Sieve Analysis of Aggregate** (after extraction of Bitumen) | | IS: 2386 (Part-1)<br>IS:383 | Grading of the aggregate as per a Sieve Analysis of aggregate after extraction of bitumen from a sample of 5 Kg. Weight shall be as per the approved mix |

## 4.9 Reinforced Earth System

| Test | Frequency | Reference Code | Acceptance |
|---|---|---|---|
| 1) **Lug Pull Out Test** | 1 for 500 m2 of Panels | As per the specialised agency's recommendations | As per the structural design requirement for RE Wall system. |
| 2) **Strip Pull Out Test** | 1 set of tests ( at every 1.5 m height of backfill) for 500 m2 of Panels | | |
| 3) **Structural behaviour of Panels** | 1 for 500 m2 of Panels | | |
| 4) **Impact Test on Precast Crash barrier over RE Wall.** | 1 test for 200 m length of crash barrier | | |

# CHAPTER - 5

# IN HOUSE /ON SITE TESTING FACILITIES

## In House / On Site Testing Facilities

A Filed laboratory shall be set up at the site of work to take up testing of the basic construction materials like Coarse aggregates, Fine aggregates, Water, Cement, Soil, Earth, Concrete etc. The objective is to carry out certain basic tests on the materials so as to ensure that they satisfy the requirements of extra-high quality. The laboratory, in general, is required to have the following equipment.

1. Square hole Sieves of Size 80mm, 63 mm, 50mm, 40 mm, 31.5 mm, 25mm, 20mm, 16mm, 12.5mm, 10mm, 6.3mm, 4.75mm
2. Fine mesh, wire cloth sieves of size 3.35 mm, 2.36mm, 1.18mm, 600μ, 300μ, 150μ, 75μ
3. Thickness Gauge
4. Length Gauge
5. Balance (for a load of 1000g ±1g)
6. Balance (more than 3 Kg capacity) with 0.1 % accuracy
7. Oven (100 to 110 °C Capacity)
8. A stout water container
9. Two dry soft absorbent cloths each not less than 75 x 45 cm.
10. A shallow trey not less than 650 $cm^2$
11. An airtight container
12. Cylindrical metal measure of 11.5 cm ϕ, 18 cm height
13. Metal containers 15 cm ϕ, 20 cm height
14. Cylindrical metal measure of 1, 3, 15 and 30 l capacity
15. Cylindrical Calibrating container with an internal dia. 100 mm and depth of 150 mm
16. Metal Tray (300 mm square and 400 mm deep) with 100 mm Hole
17. Graduated Glass Cylinder (150 to 200 ml capacity)
18. 15 cm ϕ open-ended steel cylinder, with plunger and base plate
19. Tamping Rod of 16mm ϕ, 60 cm length and rounded at one end
20. Tamping steel Bar 16mm in diameter, 0.6 m length and bullet pointed at the lower end
21. Compressive strength testing machine capable of applying a load of 40 T
22. Soft Brush
23. Pycnometer
24. Means of warm air
25. Filter Papers
26. Funnel
27. Flask of glass or non corrosive metal
28. Specialised Testing Kits for testing Chlorides and Sulphates
29. pH testing Strips
30. Titration Equipment with Pipette
31. Vicat Apparatus
32. Le Chatelier Test Apparatus
33. Vibrating Machine
34. Cube Moulds of 50 mm amd 150 mm size Cube moulds
35. Standard Weights
36. Water Bath

37. Gauging Trowel
38. Planetary Mixer
39. Flow Table
40. Pocking Rod
41. Standard Sand
42. Vernier Caliper
43. Micrometer
44. Small sand Pouring Cylinder
45. Tools for excavating Earth
46. Plane Surface : Glass or Perspex Plate
47. Cylindrical Steel Core Cutter
48. Slump Cone
49. Container with mixing arrangement
50. Concrete Prisms
51. Danial's Gauge
52. Cassgranda Apparatus
53. Proctors Mould
54. Thermometer
55. Steel Tape
56. Hammer
57. Workability Test Apparatus
58. Transverse Load test Apparatus
59. Tension Load test Apparatus
60. Water Loss Test Apparatus
61. Weights
62. Hand Pump and Pressure Gauge
63. Soldering Iron with Solder
64. MS Plate
65. Load cells and meters
66. Jacks and Pumps of suitable capacity as per the design capacity of Pile and RE soil sytem
67. Dial Gauges
68. Stop Watch
69. Benzene

The above list is only a directive list and it is required to be supplemented with the specific requirement of the project. The equipment / testing machines shall be maintained in good working condition and calibrated at regular intervals to maintained accuracy of testing. The site laboratory shall be under the change of a person of the rank of Assistant Engineer with supporting qualified staff to assist him in testing of material. In addition to these equipments, the codes/standards as given in the end of the chapter may also be kept at site for the reference purpose as and when needed required.

## 5.1 Materials

5.1.1 Coarse Aggregates
5.1.2 Fine Aggregates
5.1.3 Water
5.1.4 Cement
5.1.5 Concrete
5.1.6 Earth
5.1.7 Plasticiser
5.1.8 Reinforcement Bars
5.1.9 Epoxy
5.1.10 Bentonite
5.1.11 Bitumen
5.1.12 RCC Pipes
5.1.13 Prestressing Hardware
- 5.1.13.1 MS Sheathing
- 5.1.13.2 HDPE Sheathing

## 5.2 Site Activities

5.2.1 Piling
5.2.2 Bentonite Slurry
5.2.3 Embankment Construction
5.2.4 Bituminous Works
5.2.5 Concrete
5.2.6 Reinforced Soil Works

## 5.3 Calibration of Equipment

### 5.1.1 Coarse Aggregates

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| **1. Particle Size & Shape**<br>a) Size and Grading of Aggregates<br>b) Flakiness Index<br>c) Elongation Index | 2000 g | IS :2386 Part I - 1963 | 1. Square Hole Sieves of Size 80mm, 63 mm, 50mm, 40 mm, 31.5 mm, 25mm, 20mm, 16mm, 12.5mm, 10mm<br>2. Thickness Gauge<br>3. Length Gauge<br>4. Balance (more than 3 Kg capacity) with 0.1 % accuracy<br>5. Oven (100 to 110 °C Capacity) |
| **2. Specific Gravity, water absorption & Density** | 200 g | IS :2386 Part III –1963 | 6. Wire Basket of lesser than 6.3 mm mesh,<br>7. A stout water container<br>8. Two dry soft absorbent cloths each not less than 75 x 45 cm. |
| **3. Mechanical Properties**<br>d) Crushing Value<br>e) Impact Value | 6500 g | IS :2386 Part IV -1963 | 9. A shallow trey not less than 650 $cm^2$<br>10. An airtight container<br>11. Cylindrical metal measure of 11.5 cm $\phi$, 18 cm height<br>12. 15 cm $\phi$ open-ended steel cylinder, with plunger and base plate<br>13. Cylindrical Tamping Rod of 16mm $\phi$, 60 cm length and rounded at one end<br>14. Compressive Testing Machine capable of applying a load of 40 T |

## 5.1.2 Fine Aggregates

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1. **Particle Size & Shape**<br>a) Size and Grading of Aggregates | 2000 g | IS :2386 Part I –1963 | 1. **Square Hole Sieves of Size** 10mm, 6.3mm, 4.75mm<br>2. **Fine mesh, wire cloth sieves** of size 3.35 mm, 2.36mm, 1.18mm, 600μ, 300μ, 150μ, 75μ |
| 2. **Silt Content** | 300 g | IS :2386 Part II –1963 | 3. Balance (more than 3 Kg capacity) with 0.1 % accuracy<br>4. Oven (100 to 110 °C Capacity) |
| 3. **Specific Gravity, water absorption, Bulk Density and Surface Moisture** | 200 g | IS :2386 Part III –1963 | 5. Soft Brush<br>6. Wire Basket of lesser than 6.3 mm mesh,<br>7. A stout water container<br>8. Two dry soft absorbent cloths each not less than 75 x 45 cm.<br>9. A shallow trey not less than 650 $cm^2$<br>10. An airtight container<br>11. Pycnometer<br>12. Means of warm air<br>13. Filter Papers<br>14. Funnel<br>15. Cylindrical metal measure of 3, 15 and 30 l capacity<br>16. Cylindrical Tamping Rod of 16mm ϕ, 60 cm length and rounded at one end<br>17. Flask of glass or non corrosive metal<br>18. 1000 ml measuring cylinder |

### 5.1.3 Water

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| **1) Particle Size & Shape**<br>a) pH value<br>b) Chlorides (as Cl)<br>c) Sulphates (as $SO_3$) | 1 litre of middle stream | As per the kits manufacturer | 1. Specialised Testing Kits for testing Chlorides and Sulphates<br>2. pH testing Strips<br>3. Titration Equipment with Pipette |

## 5.1.4 Cement

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Physical Tests** | | | 1. Vicat Apparatus<br>2. Le Chatelier Test Apparatus |
| a) Consistency of Standard cement paste | | 4031 (Part 4) – 1988 | 3. Vibrating Machine<br>4. Cube Moulds of 50 m size<br>5. Standard Weights |
| b) **Setting Time**<br>i) Initial<br>ii) Final | | 4031 (Part 5) – 1988 | 6. Balance (for a load of 1000g ±1g)<br>7. Water Bath<br>8. Gauging Trowel<br>9. Planetary Mixer |
| c) **Soundness by Le Chatelier Expansion** | | 4031 (Part 3) – 1988 | 10. Flow Table<br>11. Tamping Rod<br>12. Pocking Rod |
| d) **Compressive Strength**<br>i) 3 days<br>ii) 7 days<br>iii) 28 Days | | 4031 (Part 6) - 1988 | 13. Graduated Glass Cylinder (150 to 200 ml capacity)<br>14. Standard Sand |

### 5.1.5 Concrete

| Tests | Sample Size | | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|---|
| | Quantity ($m^3$) | No. of samples | | |
| 1) **Compressive Strength**<br>a) 7 days<br>b) 28 Days | 1 to 5<br>6 to 15<br>16 to 30<br>31 to 50<br>51 and above | 1<br>2<br>3<br>4<br>4 and one additional sample for every additional 50 m3 or part thereof | IS : 516 - 1959 | 1. Cube Testing Machine<br>2. 150 mm size Cube moulds<br>3. Water Bath<br>4. Vernier Caliper<br>5. Micrometer<br>6. Weighing Balance<br>7. Tamping steel Bar 16mm in diameter, 0.6 m length and bullet pointed at the lower end |

### 5.1.6 Earth

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Atterberg Limits**<br>a) **Liquid Limits**<br>b) **Plastic Limits**<br>c) **Plasticity Index** | | IS :2720 (Part V) | 1. Small sand Pouring Cylinder<br>2. Tools for excavating Earth<br>3. Cylindrical Calibrating container with an internal dia. 100 mm and depth of 150 mm<br>4. Balance |
| 2) **OMC** | | IS :2720 (Part VIII) | 5. Plane Surface : Glass or Perspex Plate |
| 3) **Maximum Dry Density** | | IS :2720 (Part VIII) | 6. Metal containers (150 mm dia. and 200 mm deep)<br>7. Cylindrical Steel Core Cutter<br>8. Metal Tray (300 m square and 40 m deep) with 100 mm Hole |

### 5.1.7 Plasticiser

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| **1) Compressive Strength, percent of control sample**<br><br>**2) Loss of Workability (slump in mm) deviation from control sample** | | IS :9103-1999 | 1. Cube Testing Machine<br>2. 150 mm size Cube moulds<br>3. Water Bath<br>4. Vernier Caliper<br>5. Micrometer<br>6. Weighing Balance<br>7. Tamping steel Bar 16mm in diameter, 0.6 m length and bullet pointed at the lower end<br>8. Slump Cone<br>9. Container with mixing arrangement |

### 5.1.8 Epoxy

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Compressive Strength of concrete prism**<br>2) **Pot life**<br>3) **Open Time**<br>4) **Thixotropy**<br>5) **Angle of internal friction (Squeezibility)**<br>6) **Curing rate**<br>b) 12 hrs<br>c) 24 hrs<br>d) 168 hrs<br>7) **Bonding of cured bonding agent to concrete surface**<br>8) **Tensile Bending Strength**<br>9) **Shear Strength**<br>10) **Heat resistance**<br>11) **Colour** | As required to test | FIP Recommendations | 1. Concrete Prisms<br>2. Danial's Gauge<br>3. Compressive strength testing Machine<br>4. M40 grade concrete |

### 5.1.9 **Bentonite**

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Silt Content**<br>2) **Liquid Limit** | As required | MOST specifications $4^{th}$ Revision | 1. 75 micron sieve<br>2. Cassagranda Apparatus |

### 5.1.10 Bitumen

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Penetration at $25^{0}$C (100g / 5 sec., 1/10mm** | As required | IS:1203 :1978 | 1. Proctors Mould<br>2. Thermometer |
| 2) **Softening Point** | | IS:1205 :1978 | |

## 5.1.11 RCC Pipes

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| **1) Dimensions**<br><br>a) Inner diameter<br>b) Wall Thickness<br>c) Length | No. of Pipes — Sample Size<br><br>Upto 50 — 8<br>51 to 100 — 13<br>101 to 300 — 20<br>301 to 500 — 32<br>501 and above — 50 | | 1. Vernier Callipers of suitable dimensions<br>2. Steel Tape<br>3. Micrometer<br>4. Hammer<br>5. Weighing Machine |
| **2) Reinforcement** | 1pipe per Lot | | |

## 5.1.12 Pre-stressing Hardware

### 5.1.12.1 MS Sheathing

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Physical Test**<br><br>a) Workability Test<br>b) Transverse Load Test<br>c) Tension Load Test<br>d) Water Loss Test | 3 samples of 1100 mm length from one lot of supply of 7000 m length | IRC : 18-2000 | 1. Workability Test Apparatus<br>2. Transverse Load test Apparatus<br>3. Tension Load test Apparatus<br>4. Water Loss Test Apparatus<br>5. Pan<br>6. Weights<br>7. Pressure Gauge<br>8. Hand Pump<br>9. Soldering Iron<br>10. Solder<br>11. Anchoring Hook<br>12. MS Plate |

### 5.1.12.2 <u>HDPE Sheathing</u>

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Bond Test** | Three HDPE ducts of length = 40 times the duct diameter | IRC : 18-2000 | 1. 3 Nos. RCC beams with a HDPE duct of length = 40 times the duct diameter.<br>2. Pre-stressing tendon of adequate length<br>3. Tendon anchorage system<br>4. Load cells and meters<br>5. Grout constituents |
| 2) **Compression Test** | | IRC : 18-2000 | |

### 5.2.1 Piling

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Vertical Load Test** | 1. One Pile for testing and 2 piles for reaction | IS :2911(Part IV) | 1. Jacks and Pumps of suitable capacity as per the design capacity of Pile<br>2. Kentledge arrangement including structural steel assembly and concrete Load<br>3. Dial Gauges<br>4. Stop Watch |
| 2) **Horizontal Load Test** | 2. One Pile for testing and 1 piles for reaction | | |

### 5.2.2 Bentonite Slurry

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Mars Cone Viscosity**<br>2) **pH Value**<br>3) **Specific Gravity** | As required | MORTH Specifications for Road and Bridge Works ($4^{th}$ Revision) | 1. pH strips |

### 5.2.3 Embankment Construction

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Moisture Content**<br>2) **Dry Density** | Flat area of 450 $mm^2$ | IS :2720 (Part VIII )<br>IS:2720 (Part XXVIII) | 1. Small sand Pouring Cylinder<br>2. Tools for excavating Earth<br>3. Cylindrical Calibrating container with an internal dia. 100 mm and depth of 150 mm<br>4. Balance<br>5. Plane Surface : Glass or Perspex Plate<br>6. Metal containers (150 mm dia. ana 200 mm deep)<br>7. Cylindrical Steel Core Cutter<br>8. Metal Tray (300 m square and 40 m deep) with 100 mm Hole |

### 5.2.4 **Bituminous Works**

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| **1) Binder Content**<br>**2) Temperature of binder at the time of application**<br>**3) Tack Coat content**<br>**4) Density** | As required | | 1. Benzene<br>2. Weighing Machine<br>3. Thermometer<br>4. Plate<br>5. Extracting Equipment |

### 5.2.5 Concrete

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Slump Test** | One test per pour of concrete | IS : 1195 | 1. Slump Cone<br>2. Tamping Road |

### 5.2.6 Reinforced Soil Wall

| Tests | Sample Size | Reference Code for Testing | Facilities/Equipment required at site |
|---|---|---|---|
| 1) **Lug Pull Out Test**<br>2) **Strip Pull Out Test** | 2 RE Panel<br>3 Strips at different backfill height | As per specialised agency | 1. Jacks and Pumps of suitable capacity as per the design of RE Wall system<br>2. Suitable system for holding the jacks<br>3. Suitable system for holding panel<br>4. Dial gauges for measuring deflection |

## 5.3 Calibration

| Equipment /Machine | Frequency of calibration | Check Level |
|---|---|---|
| 1) **Batching Plant** | Once every 3 months or 5000 m3 of concrete production whichever is earlier | 2A |
| | Once in a year | 3 |
| 2) **Weighing Balances** | Once in 3 Months of use | 2A |
| | Once in a year | 3 |
| 3) **Deflection Gauges** | Once in 3 Months of use | 2B |
| | Once in a year | 3 |
| 4) **Testing Kits** | Once in 3 Months of use | 2A |
| 5) **Jacks** | Once in a 3 months of use | 3 |
| 6) **Cube Testing Machines** | Once in 3 months | 3 |

## LIST OF CODES AND STANDARDS

| IS CODES | DESCRIPTION |
|---|---|
| IS: 73 :1992 | Specification for paving bitumen (second revision) |
| IS: 228 (Part-3) -1987 | Method of chemical analysis of steels: Part 3 Determination of phosphrous by alkalimetric method (third revision). |
| IS: 228 (Part-9) – 1989 | Method of chemical analysis of steels: Part 9 Determination of sulphur in plain carbon steels by evolution method (third revision). |
| IS: 383-1970 | Specification for coarse and fine aggregates from natural sources for concrete (second revision) |
| IS: 455-1989 | Specification for Portland slag cement (fourth revision) (Amendments 2) |
| IS: 456:2000 | Code of practice for plain and reinforced concrete. |
| IS: 458:1988 | Specification for precast concrete pipes (with and without reinforcement ) (third revision) (Amendments 2). |
| IS: 516:1959 | Method of test for strength of concrete (Amendments 2) |
| IS: 702 | Specification for industrial bitumen (second revision) (Amendment 1) |
| IS: 1030:1989 | Carbon steel castings for general engineering purpose (fourth revision) Amendment 1) |
| IS: 1080:1986 | Code of practice for design and construction of shallow foundations on soils (other than raft, ring ad shell) (second revision). |
| IS: 1195-1978 | Specification for bitumen mastic for flooring (second revision) |
| IS: 1202-1978 | Determination of specific gravity (Amendment 1) |
| IS: 1203:1978 | Determination of penetration (Amendments 3) |
| IS: 1205:1978 | Determination of softening point. |
| IS: 1206 (Part-2) – 1978 | Determination of viscosity: Part 2 Absolute viscosity. |
| IS: 1206 (Part-3) – 1978 | Determination of viscosity: Part 3 Kinematic viscosity. |
| IS: 1208:1978 | Determination of ductility. |
| IS: 1209:1978 | Determination of flash point and fire point. |
| IS: 1211-1978 | Determination of water content (Dean and Stark method). |
| IS: 1212:1978 | Determination of loss on heating. |
| IS: 1216:1978 | Determination of solubility in carbon disulphide trichloroethylene (Amendment 1). |

| | |
|---|---|
| IS: 1239 (Part 1) - 1990 | Mild steel tubes, tubulars and other wrought steel fittings : Part 1 Mild steel tubes (fifth revision) (Amendment 1) |
| IS: 1498 | Classification and identification of soils for general engineering purpose (first revision) (Amendments 2). |
| IS: 1500:1983 | Method for Brinell hardness test for metallic materials (second revision) (superseding IS 1789:1961, IS1790:1961 and IS 3054:1965). |
| IS: 1501:1984 | Method of Vickers hardness test for metallic materials |
| IS: 1586:1988 | Method of Rockwell hardness test for metallic material (Scales A-B-C-D-E-F-G-H-K) (second revision) |
| IS: 1608:1972 | Method for tensile testing of steel products (first revision) (Amendment 1). |
| IS: 1663:1972 | Method for tensile testing of steel sheet and strip of thickness 0.5 mm to 3 mm (first revision). |
| IS: 1786-1985 | Specification of high strength deformed steel bars and wires for concrete reinforcement (third revision) (supersdeding IS 1139:1966) (Amendment 1). |
| IS: 2062-1999 | Steel for general structural purpose (fourth revision) (supersedes IS 225:1975). |
| IS: 2386 (Part I)-1963 | Method of test for aggregates for concrete : Part 1 Particle size and shape (Amendments 2) |
| IS: 2386 (Part II)-1963 | Method of test for aggregates for concrete : Part 2 Estimation of deleterious materials and organic impurities (Amendment 1) |
| IS: 2386 (Part III)-1963 | Method of test for aggregates for concrete : Part 3 Specific gravity, density, voids, absorption and bulking. |
| IS: 2386 (Part IV)-1963 | Method of test for aggregates for concrete : Part 4 Mechanical properties (Amendments 3). |
| IS: 2386 (Part V)-1963 | Method of test for aggregates for concrete : Part 5 Soundness. |
| IS: 2386 (Part VII)-1963 | Method of test for aggregates for concrete : Part 7 Alkali aggregate reactivity. |
| IS: 2386 (Part VIII)-1963 | Method of test for aggregates for concrete : Part 8 Petrographic examination) |
| IS: 2629-1985 | Recommended practice for hot-dip galvanzing on iron and steel (first revision) (Amendment 1). |
| IS: 2633-1986 | Method for testing uniformity of coating of zinc coated articles (second revision). |
| IS: 2645-1975 | Specification for integral cement waterproofing compounds (first revision) (Amendment 1). |

| | |
|---|---|
| IS: 2720 Part 2 | Methods of test for soils : Part 2 Determination of water content (second revision) (Amendment 1) |
| IS: 2720 Part 4 | Methods of test for soils : Part 4 Grain size analysis (second revision) |
| IS: 2720 Part 5 | Methods of test for soils : Part 5 Determination of liquid and plastic limit (second revision) |
| IS: 2720 Part 8 | Methods of test for soils : Part 8 Determination of water content - dry density relation using heavy compaction (second revision) |
| IS: 2720 Part 16 | Methods of test for soils : Part 16 Laboratory determination of CBR (second revision)] |
| IS: 2720 Part 27 | Methods of test for soils : Part 27 Determination of total soluble sulphates (first revision) |
| IS: 2720 Part 28 | Methods of test for soils : Part 28 Determination of dry density of soils inplace, by the sand replacement method (first revision) |
| IS: 2911 (Part 4) : 1985 | Code of practice for design and construction of pile foundations : Part 4 load test on piles (first revision) (Amendment 1) |
| IS: 3025(Part 17) | Methods of sampling and test (physical and chemical) for water and wastewater: Part 17 Non-filterable residue (total suspended solids) (first revision) |
| IS: 3025(Part 18) | Methods of sampling and test (physical and chemical) for water and wastewater : Part 18 Volatile and fixed residue (total filterable and non-filterable) (first revision). |
| IS: 3025(Part22) | Methods of sampling and test (physical and chemical) for water and wastewater : Part 22 Acidity (first revision) |
| IS: 3025(Part 23) | Methods of sampling and test (physical and chemical) for water and wastewater : Part 23 Alkalinity (first revision) |
| IS: 3025(Part24) | Methods of sampling and test (physical and chemical) for water and wastewater : Part 24 Sulphates (first revision) |
| IS: 3025(Part32) | Methods of sampling and test (physical and chemical) for water and wastewater : Part 32 Chloride (first revision) |
| IS: 3597 :1985 | Methods of test for concrete pipes (first revision) |
| IS: 4031 (Part 2) : 1988 | Methods of physical tests for hydraulic cement : Part 2 Determination of fineness by specific surface by Blaine air permeability method (first revision) |

| | |
|---|---|
| IS: 4031 (Part 3) : 1988 | Methods of physical tests for hydraulic cement : Part 3 Determination of soundness (first revision) (Amendment1) |
| IS: 4031 (Part 4) : 1988 | Methods of physical tests for hydraulic cement : Part 4 Determination of consistency of standard cement paste (first revision) (Amendment 1) |
| IS: 4031 (Part5) : 1988 | Methods of physical tests for hydraulic cement : Part 5 Determination of initial and final setting times (first revision) (Amendment 1) |
| IS: 4031 (Part 6) : 1988 | Methods of physical tests for hydraulic cement : Part 6 Determination of compressive strength of hydraulic cement (other than masonry cement) (first revision) (Amendment 1) |
| IS: 4032 : 1985 | Method of chemical analysis of hydraulic cement (first revision) |
| IS: 4736-1986 | Hot-dip zinc coatings on mild steel tubes (first revision) (Amendment1) |
| IS: 4984-1995 | Specification for high density polyethylene pipes for potable water supplies, swage and industrial effluents (third revision) |
| IS: 6241 | Method of test for determination of stripping value of road aggregates |
| IS: 6745:1972 | Method of determination of mass of zinc coating on zinc coated iron and steel articles (Amendments 3) |
| IS: 6911:1992 | Stainless steel plate, sheet and strip (first revision) |
| IS: 9103:1999 | Specification for admixtures for concrete |
| IS: 9381:1979 | Methods for testing tar and bituminous materials : Determination of FRAASS breaking point of bitumen |
| IS: 9382:1979 | Methods for testing tar and bituminous materials : Determination of effect of heat and air by thin film oven tests |
| IS: 12118 (Part I)-1987 | Specification for two parts polysulphide based sealants : Part 1 General requirements |
| IS: 12269:1987 | Specification for 53 grade ordinary Portland cement (Amendments 2) |



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## LIST OF IRC CODES

| | |
|---|---|
| IRC-18-2000 | Design Criteria for Prestressed Concrete Road Bridges (Post-Tensioned Concrete) (Third Revision). |
| IRC-21-2000 | Standard Specification and Code of Practice for Road Bridges, Section III- Cement Concrete (Plain and Reinforced) (Third Revision). |
| IRC-83 Part-I | Standard Specification and Code of Practice for Road Bridges, Section IX - Bearings, Part-I: Metallic Bearings (First Revision). |
| IRC-83 (Part-II) -1987 | Standard Specification and Code of Practice for Road Bridges, Section IX - Bearings, Part-II: Elastomeric Bearings |
| IRC-107-1992 | Tentative Specification for Bitumen Mastic Wearing Courses. |
| IRC-SP:47 | Guidelines on Quality Systems for Road Bridge (Plain, Reinforced, Prestressed and Composite concrete). |
| IRC-SP:57 | Guidelines for the Use of Dry Lean concrete as Sub-base for Rigid Pavement. |
| MORTH | Specification for Road and Bridge Works 2001 (fourth revision). |



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# CHAPTER - 6

# OUTSIDE / INDEPENDENT TESTING FACILITIES

## Outside / Independent Testing Facilities

Extensive testing of the materials used for construction is a pre-requisite for attaining high quality of the work. This shall require specialised tests, physical, chemical, ultrasonic, x-ray and various other types of tests which can not possibly be carried out in a site laboratory without adding high-costs on the project. These tests also require specialised personnel who regularly deal in such testing. Therefore, the need arises for carrying out the tests in outside laboratories. These laboratories may be in the Government sector, Semi-Government or Private sector. The outside laboratories shall be short listed before hand. In case of laboratories in the private sector, the past record and reputation of the laboratory must invariably be given due consideration. The infrastructure in these laboratories can be inspected before they are short-listed.

However every laboratory may not have the facility for carrying out all the required tests. This chapter gives an overview of the available testing facilities in various reputed laboratories given below.

1. AES Testing & Research Laboratories (AES)
2. Central Road Research Institute (CRRI)
3. Delhi Test House (DTH)
4. Indian Institute of Technology Delhi (IITD)
5. National Çouncil for cement and Building Materials (NCCBM)
6. Regional Testing Centre (RTC)
7. Sunbeam Auto Limited (SAL)
8. Shri Ram Institute for Industrial Research (SRI)

This information will facilitate selection of a laboratory for any particular testing.

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **1) Coarse Aggregates** | | | | To be Ascertained | | | | |
| a) Particle Size & Shape | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| b) Deleterious Materials | ✓ | × | ✓ | | ✓ | | ✓ | ✓ |
| c) Specific Gravity & Density | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| d) Mechanical Properties | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| e) Soundness | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| f) Alkali Aggregate Reactivity | ✓ | × | ✓ | | ✓ | | ✓ | ✓ |
| g) Petrography Examination | ✓ | × | × | | ✓ | | × | ✓ |
| **2) Fine Aggregates** | | | | | | | | |
| a) Particle Size and shape | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| b) Deleterious Materials | ✓ | × | ✓ | | ✓ | | ✓ | ✓ |
| c) Specific Gravity, Bulk Density, Water absorption and Surface Moisture | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| d) Mechanical Properties | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| e) Soundness | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| f) Mortar Making Properties | ✓ | × | ✓ | | ✓ | | ✓ | ✓ |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **3) Water** | | | | | | | | |
| a) Chemical Analysis | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| b) Physical Analysis | ✓ | × | ✓ | | ✓ | ✓ | ✓ | ✓ |
| **4) Lime** | | | | | | | | |
| a) $CaCO_3$ content | ✓ | ✓ | ✓ | | ✓ | | | |
| b) Sieve Analysis | ✓ | ✓ | ✓ | | ✓ | | | |

| Test Houses→ / Tests ↓ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **5) Earth** | | | | | | | | |
| a) Plasticity Index | ✓ | ✓ | ✓ | | | | ✓ | |
| b) Site content | ✓ | ✓ | ✓ | | | | ✓ | |
| c) CBR | ✓ | ✓ | ✓ | | | | ✓ | |
| d) Clay content | ✓ | ✓ | ✓ | | | | ✓ | |
| e) OMC | ✓ | ✓ | ✓ | | | | ✓ | |
| f) Density | ✓ | ✓ | ✓ | | | | ✓ | |
| g) Liquid Limit | ✓ | ✓ | ✓ | | | | ✓ | |
| h) Grading | ✓ | ✓ | ✓ | | | | ✓ | |
| i) Deleterious Material | ✓ | ✓ | ✓ | | | | ✓ | |
| j) Proctor test | ✓ | ✓ | ✓ | | | | ✓ | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **6) Reinforcement bars** | | | | | | | | |
| a) Chemical Tests | ✓ | × | ✓ | | ✓ | ✓ | ✓ | ✓ |
| b) Physical Test | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| **7) H.T.Strands** | | | | | | | | |
| a) Chemical Test | | | ✓ | | | | ✓ | |
| b) Dimension & Mass | | | ✓ | | | | ✓ | |
| c) Physical Properties | | | ✓ | | | | ✓ | |
| d) Elongation | | | ✓ | | | | ✓ | |
| e) Relaxation Properties | | | | | | | | |
| **8) Cast Iron** | | | | | | | | |
| a) Chemical Test | | × | ✓ | | | | ✓ | |
| b) Physical Properties | | ✓ | ✓ | | | | ✓ | |
| **9) Mild Steel** | | | | | | | | |
| a) Chemical Test | | × | ✓ | | | | ✓ | |
| b) Physical Properties | | ✓ | ✓ | | | | ✓ | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **10) Cement** | | | | | | | | |
| a) Chemical Tests | ✓ | × | ✓ | | ✓ | ✓ | ✓ | ✓ |
| b) Physical tests | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| **11) Concrete** | | | | | | | | |
| a) Mix Design | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| b) Compressive Strength | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| c) Flexural Test | | ✓ | | | ✓ | ✓ | | |
| d) Permeability Test | | × | | | ✓ | ✓ | | |
| **12) Plasticiser** | | | | | | | | |
| a) Water content | ✓ | | | | ✓ | | ✓ | ✓ |
| b) Compressive strength | ✓ | | | | ✓ | | ✓ | ✓ |
| c) Flexural Strength | ✓ | | | | ✓ | | ✓ | ✓ |
| d) Length change | ✓ | | | | ✓ | | ✓ | ✓ |
| e) Bleeding | ✓ | | | | ✓ | | ✓ | ✓ |
| f) Loss of workability | ✓ | | | | ✓ | | ✓ | ✓ |
| g) Air content | ✓ | | | | ✓ | | ✓ | ✓ |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **13) Epoxy** | | | | | | | | |
| a) Pot Life | ✓ | | | | | | | |
| b) Open Time | ✓ | | | | | | | |
| c) Thioxotropy | ✓ | | | | | | | |
| d) Squeezability | ✓ | | | | | | | |
| e) Curing Rate | ✓ | | | | | | | |
| f) Compressive Strength | ✓ | | | | | | | |
| g) Bonding | ✓ | | | | | | | |
| h) Tensile Bonding Strength | ✓ | | | | | | | |
| i) Shear Strength | ✓ | | | | | | | |
| j) Heat Resistance | ✓ | | | | | | | |
| k) Colour | ✓ | | | | | | | |
| l) Shrinkage | ✓ | | | | | | | |
| **14) Non Shrink Grout** | | | | | | | | |
| a) Compressive Strength | | | | | | | | |
| b) Flexural Strength | | | | | | | | |
| c) Time for expansion | | | | | | | | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **15) Water Proofing Compounds** | | | | | | | | |
| a) Permeability | | | | | ✓ | | | ✓ |
| b) Setting Time. | | | | | ✓ | | | ✓ |
| c) Compressive Strength | | | | | ✓ | | | ✓ |
| d) Chloride Content | | | | | ✓ | | | ✓ |
| e) Sulphate Content | | | | | ✓ | | | ✓ |
| **16) Polysulphide Sealant** | | | | | | | | |
| a) Pot life / work life | | | | | | | | |
| b) Adhesion & Tensile Modulus | | | | | | | | |
| c) Plastic deformation | | | | | | | | |
| d) Adhesion in Peel | | | | | | | | |
| e) Loss of mass after heat ageing | | | | | | | | |
| f) Standing | | | | | | | | |

| Test Houses→ / Tests ↓ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **17) Silicon Sealant** | | | | | | | | |
| a) Service Temperature | | | | | | | | |
| b) Application Temperature | | | | | | | | |
| c) Shore 'A' Hardness | | | | | | | | |
| d) Tensile Strength | | | | | | | | |
| e) Elongation at rupture | | | | | | | | |
| f) Modulus at 100% elongation | | | | | | | | |
| g) Tooling time | | | | | | | | |
| h) Cured State | | | | | | | | |
| i) Base | | | | | | | | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **18) Bitumen** | | | | | | | | |
| a) Specific Gravity at $27^0C$ | | ✓ | ✓ | | | ✓ | ✓ | |
| b) Water, percent by mass | | ✓ | ✓ | | | ✓ | ✓ | |
| c) Flash Point, Cleveland open cup | | ✓ | ✓ | | | ✓ | ✓ | |
| d) Softening point | | ✓ | ✓ | | | ✓ | ✓ | |
| e) Penetration | | ✓ | ✓ | | | ✓ | ✓ | |
| f) Penetration Ratio | | ✓ | ✓ | | | ✓ | ✓ | |
| g) Ductility | | ✓ | ✓ | | | ✓ | ✓ | |
| h) Paraffin Wax Content, | | ✓ | ✓ | | | ✓ | ✓ | |
| i) Frass breaking point | | ✓ | ✓ | | | ✓ | ✓ | |
| j) Loss an heating | | ✓ | ✓ | | | ✓ | ✓ | |
| k) Retained Penetration after thin film oven test | | ✓ | ✓ | | | ✓ | ✓ | |
| l) Matter soluble in tricholoroethylene | | ✓ | ✓ | | | ✓ | ✓ | |
| m) Viscosity | | ✓ | ✓ | | | ✓ | ✓ | |

| Test Houses→ / Tests ↓ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **Pre-stressing Hardware** | | | | | | | | |
| **19) MS Sheathing** | | | | | | | | |
| a) Physical Test. | | | | | | | | |
| b) Chemical Tests. | | | | | | | | |
| **20) Anchor Head** | | | | | | | | |
| a) Ultrasound | | | | | | | | |
| b) Dimension | | | | | | | | |
| c) Hardness | | | | | | | | |
| d) Chemical analysis | | | | | | | | |
| **21) Bearing Plates** | | | | | | | | |
| a) Dimension | | | | | | | | |
| b) Hardness | | | | | | | | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **22) Trumpet Cone** | | | | | | | | |
| **23) Barrel** | | | | | | | | |
| a) Physical Test. | | | | | | | | |
| b) Dimension Test | | | | | | | | |
| c) Hardness Test | | | | | | | | |
| d) Chemical Test | | | | | | | | |
| **24) Wedges** | | | | | | | | |
| a) Dimension | | | | | | | | |
| b) Surface Hardness | | | | | | | | |
| c) Load Test | | | | | | | | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **Pipes** | | | | | | | | |
| **25) Steel Pipes** | | | | | | | | |
| a) Chemical Test | | | | | | | | ✓ |
| b) Dimensional Tolerance | | | | | | | | ✓ |
| c) Straightness | | | | | | | | ✓ |
| d) Tensile Test | | | | | | | | ✓ |
| e) Flatting Test | | | | | | | | ✓ |
| **26) RCC Pipes** | | | | | | | | |
| a) Wall Thickness | | | | | | | | |
| b) Three Edge Bearing | | | | | | | | |
| c) Water absorption | | | | | | | | |
| d) Hydrostatic Pressure | | | | | | | | |
| e) Straightness | | | | | | | | |
| f) Reinforcement | | | | | | | | |
| g) Cube Strength | | | | | | | | |



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| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **27) HDPE Pipes** | | | | | | | | |
| a) Hydraulic Characteristics. | | | | | | ✓ | | |
| b) Reversion Test. | | | | | | ✓ | | |
| c) Density | | | | | | ✓ | | |
| d) Melt Flow Rate (MFR) | | | | | | ✓ | | |
| e) Carbon Black Content & Dispersion | | | | | | ✓ | | |



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| Test Houses→ / Tests ↓ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **28) Thermoplastic Paints** | | | | | | | | |
| a) Binder contents | | × | | | | | | |
| b) Glass Beads | | ✓ | | | | | | |
| c) Titanium Dioxide content | | × | | | | | | |
| d) Calcium Carbonate & Inert fillers | | × | | | | | | |
| e) Yellow Pigments | | × | | | | | | |
| f) Luminance (Daylight) | | × | | | | | | |
| g) Drying Time | | ✓ | | | | | | |
| h) Skid Resistance | | ✓ | | | | | | |
| i) Cracking Resistance at low temperature | | × | | | | | | |
| j) Softening Point | | ✓ | | | | | | |
| k) Flow resistance | | ✓ | | | | | | |
| l) Yellowness Index | | ✓ | | | | | | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **29) Geotextile** | | | | | | | | |
| a) Thickness | | | | | | | | |
| b) Weight | | | | | | | | |
| c) Tensile Strength | | | | | | | | |
| d) Fiber Composition | | | | | | | | |
| e) Chemical Resistance | | | | | | | | |
| **30) Bentonite** | | | | | | | | |
| a) Silt content | ✓ | | ✓ | | | | ✓ | |
| b) Liquid limit | ✓ | | ✓ | | | | ✓ | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **31) Chloroprene Elastomer** | | | | | | | | |
| a) Hardness | | ✓ | | | | ✓ | | |
| b) Minimum Tensile Strengths. | | ✓ | | | | ✓ | | |
| c) Minimum Elongation at Break. | | ✓ | | | | ✓ | | |
| d) Maximum Compression set | | ✓ | | | | ✓ | | |
| e) Accelerated Ageing | | ✓ | | | | ✓ | | |
| f) Shear Modules | | ✓ | | | | ✓ | | |
| g) Ash Content | | ✓ | | | | ✓ | | |
| **32) PTFE (Poly Tetra Fluro Ethylene)** | | | | | | | | |
| a) Form | | | | | | | | |
| b) Density | | | | | | | | |
| c) Tensile Strength | | | | | | | | |
| d) Elongation | | | | | | | | |
| e) Resistance to heat | | | | | | | | |
| f) Dimensional stability | | | | | | | | |

| Tests ↓ / Test Houses→ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **33) POT-PTFE Bearings** | | | | | | | | |
| a) Dimensional Tolerance | | ✓ | ✓ | | | | | |
| b) Stainless Steel Sliding Surface | | ✓ | ✓ | | | | | |
| c) Vertical Load Test | | ✓ | × | | | | | |
| d) Friction Test | | ✓ | × | | | | | |
| e) Ultrasonic Test | | ✓ | ✓ | | | | | |
| f) Due Penetration Test | | ✓ | ✓ | | | | | |
| g) Raw Material Testing | | ✓ | ✓ | | | | | |
| **34) Elastomer Bearings** | | | | | | | | |
| a) Visual inspection | | ✓ | | | | | | |
| b) Dimension Test | | ✓ | | | | | | |
| c) Axial Load Test | | ✓ | | | | | | |
| d) Shear Modules | | ✓ | | | | | | |
| e) Elastic Modulus | | ✓ | | | | | | |
| f) Adhesion Strength | | ✓ | | | | | | |
| g) Ultimate compressive Strength | | ✓ | | | | | | |

| Test Houses→ / Tests ↓ | AES | CRRI | DTH | IITD | NCCBM | RTC | SAL | SRI |
|---|---|---|---|---|---|---|---|---|
| **35) Strip Seal Expansion Joints**<br>a) Edge Beam<br>b) Anchorage System<br>c) Water Tightness<br>d) Bearing for support or control system | | | | | | | | |

# CHAPTER - 7

# SITE DOCUMENTS

## Site Documents

Effective documentation of all the activities on a project is of utmost importance. It not only saves valuable time and energy but also helps in keeping a track of the various activities and to ensure that nothing is missed. For example, it shall be useful to keep documentation of movements of drawings to ensure that only correct / latest revisions are adopted for execution. The documentation of test records shall help in checking that the tests are carried out at the required frequency and no test is missed so as to get quality output. Documentation of all the materials as inventory record shall assist in resource planning and ensure availability of material at all times. Separate record for bulk items of high importance, like cement and steel, have to be maintained. These records indicate whether the consumption of these materials is as per the design requirements or not. The instructions given by then site staff to the executing agency and its compliance have to be recorded to ensure that no instruction is lost sight of. Similarly instructions from senior officers and the consultants during their inspection and the consequent action have to be recorded.

Standard formats have been developed for documentation of the various important activities and given in this chapter. Proper documentation shall go a long way is meeting the ends of high quality in the work.

Page No. ......

Name of Work : ..........................................................

Agreement No. : ..........................................................

Name of Agency : ..........................................................

Stipulated date of start : ..........................................................

Stipulated date of completion : ..........................................................

## 7.1 MASTER REGISTER RECORD

| S. No. | Title of Register | Volume No. | Identification no. | Date of Issue | Docketing no. | Signature |
|---|---|---|---|---|---|---|
| | | | | | | |

Continued on Page no. .......

Page No. ......

## 7.2 SITE ORDER RECORD

1. S. No. ..........................................
2. Date & Time of Instructions ..........................................
3. Instructions To ..........................................
4. Instructions

| S.No. | Action Required | Action Taken | Signature |
|---|---|---|---|
| | | | |

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Reviewed by : Comments:

.................... (Signature)

.................................. (Name & Designation)

Continued on Page no. .......

Page No. ......

## 7.3 DRAWINGS RECORD

| S. No. | Details of Drawings | | Receipt of Drawings | | Issue of Drawings | | Status of Drawings (Advance / Good for Construction) | Contractor's Signature | AE/EE's Signature |
|---|---|---|---|---|---|---|---|---|---|
| | Drawing no. and its Revision | Title of Drawing | Date of Receipt | No. of Copies | Issue Date | No. of Copies | | | |
| | | | | | | | | | |

Continued on Page no. .......

Page No. ......

## 7.4 DAILY PROGRESS RECORD

1. Date ..........................................
2. Whether conditions
(a) Temperature — Maximum ........ Minimum.........
(b) Rainfall — ............mm
(c) General Weather
    (i) Sunny
    (ii) Cloudy
    (iii) Windy
(b) Humidityl — ............ %

3. Details of Work Done

| S.No. | Item Executed | Quantity | Location |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

4. Any Special difficulties / happening :

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Continued on Page no. .......

Page No. ......

## 7.5 CEMENT STORE RECORD

Type of Cement : ..................................

Part 'A'

**Monthly Receipt/issue for ...........**

**Opening Balance = ........... bags**

| Date | Quantity Received | | | Quantity consumed | | | Balance at the end of the day (No. of Bags) | Purpose | Signature | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Source | Batch No. | No. of Bags | Issued | Returned | Net Consumed | | | Contractor | Department |
| | | | | | | | | | | |
| Total | | | | | | | | | | |

**Part 'B'**

## Theoretical and Actual Consumption statement

| S.No. | Period | | Items of Work | Quantity Executed (cum) | Theoretical Cement Required (No. of Bags) | Actual Cement Consumed (No. of Bags) | Difference between the theoretical and actual Consumption |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| | | | | | | | |

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Continued on Page no. .......

Page No. ......

## 7.6 STEEL REINFORCEMENT RECORD

**Type of Steel**
Monthly Receipt/Issue for the month ..................

**Designation of Steel Bar ..... mm TMT**

| Date | Quantity Received (MT) | Source | Challan No. | Quantity (MT) issued | Activities for which steel issued | Concumption of steel as per measurement (MT) | Difference between quantities measured and issued (MT) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Continued on Page no. .......

Page No. ......



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## 7.7 CUBE TEST RECORD

1. Grade of Concrete = M ........
2. Cement Content as per Design Mix = ......... Kg/cum

| S. No. | Sample No. | Size of cube | Age of cubes (days) | Representative structural Member | Wet Concrete Property | | Cube Test | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Temperature | Slump | Load at Failure | Area | Compressive Strength |
| 1. | | | | | | | | | |
| 2. | | | | | | | | | |
| 3. | | | | | | | | | |
| 4. | | | | | | | | | |
| 5. | | | | | | | | | |
| 6. | | | | | | | | | |
| Mean | | | | | | | | | |
| Standard Deviation | | | | | | | | | |
| Range | | | | | | | | | |
| Comments : | | | | | | | | | |

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Continued on Page no. .......

Page No. ......

## 7.8 OTHER TESTS RECORD

| | | | | | |
|---|---|---|---|---|---|
| Signature | : | | Signature | : | |
| Date | : | | Date | : | |
| For Contractor | : | | For Department | : | |
| Name | | | Name | | |

Continued on Page no. .......

Page No. ......

## 7.9 EQUIPMENT CALIBRATION RECORD

| | |
|---|---|
| 1. Name of Equipment | ........................................ |
| (a) Make | ........................................ |
| (b) Model | ........................................ |
| (c) Capacity | ........................................ |
| (d) Identification No. | ........................................ |
| 2. Frequency of Calibration | ........................................ |
| 3. Date of last Calibration | ........................................ |
| 4. Next due date of Calibration | ........................................ |
| 5. Agency performing the Calibration | ........................................ |
| 6. Reference of issue of Calibration certificate | ........................................ |
| 7. Reference of filing the Calibration Certificate | ........................................ |

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

Continued on Page no. .......

Page No. ......

## 7.10 INSPECTION RECORD

1. Date and Time of Inspection ..........................................
2. Venue of Inspection ..........................................
3. Name and Designation of Inspecting Authority ..........................................
4. Reference of Inspection Note ..........................................
5. Remarks of Inspecting Authority

6. Communication of Inspection Remarks
6.1 Remarks taken over to Site Order Book, Page No. ................ dated ..................
6.2 Remarks conveyed to contractor vide letter No. .................... dated .................

7. Whether needful action taken by contractor (Yes/No/No action required) ..............
8. Compliance recorded in Site Order Book at Page No................ dated ..............

**Recorded by :** | **Reviewed by :**

Signature :
Date :
Name & :
Designation

Signature :
Date :
Name & :
Designation

Continued on Page no. .....

Page No. ......

## 7.11 NON-CORFORMING ITEMS RECORD

1. Item No. (as per Bill of Quantities ) ..................................................

2. Brief details of the item ..................................................

..................................................

3. Name of designation of the Authority deciding the non conformation :

Name .......................................... Designation ......................................

Reference No. ..................................................

4. Reason of non-conforming ..................................................

5. Nature of Non Confirmation ..................................................

| **6. Comments** | **Yes** | **No** | **N/A** |
|---|---|---|---|
| 6.1 Whether the item is structurally sound | | | |
| 6.2 Whether the item can be accepted at Reduced rates. | | | |
| 6.3 Whether the item requires demolition and re-execution. | | | |

6.4 Remarks indicating the action done by the contractor and the view of department.

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | : | Name | : |

Continued on Page no. .......

Page No. ......

## 7.12 QUALITY AUDIT RECORD

1. Date of Quality Audit ..........................................
2. Venue of Inspection ..........................................
3. Department of Auditing Team ..........................................
4. Head of Audit Party ..........................................
5. Other members of the Audit Team

| | Name | Designation |
|---|---|---|
| (i) | | |
| (ii) | | |
| (iii) | | |

6. Reference of Audit Report ..........................................

7. No. of Paras ..........................................

**8. 1st Reply to Audit Report**

Reference of Reply ..........................................
Rejoinder to reply ..........................................
No. of para dropped ..........................................
Paras outstanding ..........................................

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

**2nd Reply to Audit Report**

Reference of Reply ..........................................
Rejoinder to reply ..........................................
No. of para dropped ..........................................
Paras outstanding ..........................................

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

**d Reply to Audit Report**

| | |
|---|---|
| Reference of Reply | ........................................ |
| Rejoinder to reply | ........................................ |
| No. of para dropped | ........................................ |
| Paras outstanding | ........................................ |

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

**4th Reply to Audit Report**

| | |
|---|---|
| Reference of Reply | ........................................ |
| Rejoinder to reply | ........................................ |
| No. of para dropped | ........................................ |
| Paras outstanding | ........................................ |

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

Continued on Page no. .......

Page No. ......

## 7.13 HINDRANCES RECORD

| S. No. | Title of Hindrance | From | To | Whether Hindrance is on the critical Path | Reasons of Hindrance | Action initiated to remove the Hindrance | Net Effect on the Project |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Continued on Page no. .......
Page No. ......

## 7.14 CONSULTANTS VISIT RECORD

1. Name of consultant ..........................................
2. Name of visiting Representative ..........................................
3. Venue of visit ..........................................
4. Date and Time of visit ..........................................
5. Duration of visit ..........................................
6. Purpose of visit ..........................................
7. Observations/Comments/Advice

8. Action to be taken by the Department/Contrcator

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Consultant | : | For Department | : |
| Name | : | Name | : |

Continued on Page no. .......

Page No. ......

## 7.15 SITE - CORDINATION MEETINGS RECORD

1. Coordination Meeting no. ..........................................
2. Venue of Meeting ..........................................
3. Date and Time of Meeting ..........................................
4. Name of Chairman and Designation ..........................................
5. Name of Other Participants ..........................................

| S.No. | Name of Participants | Designation | Organisation | Telephone | Signature |
|---|---|---|---|---|---|
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |
| 6. | | | | | |
| 7. | | | | | |

6. Person to issue Minutes of Meeting ..........................................
7. Reference of Minutes of Meeting ..........................................
8. Reference of Action Taken Report ..........................................

Continued on Page no. .......

Page No. ......

## 7.16 CHECK LISTS / TEST PROFORMAS RECORD

| S.No. | Title of Check List / Test Proforma | Identification Number | Purpose of Checklist / Test Proforma | Reference of approval | Reference of recording of sample checklist |
|---|---|---|---|---|---|
| | | | | | |

Signature :
Date :
For Consultant :
Name :

Signature :
Date :
For Department :
Name :

Continued on Page no. .......

Page No. ......

# 7.17 INVENTORY RECORD

1. Name of Item ........................................
2. Total Quantity Required ........................................
3. Source ........................................
4. Minimum Size of One Lot ........................................

| S. No. | Date | Previous Quantity | Additional Quantity Procured | Cumulative Quantity | Issued/ Consumed | Cumulative Issue | Balance outstanding Quantity | Present Requirement | Balance /Deficit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

Continued on Page no. .......

Page No. ......

# 7.18 ACTUAL OBSERVATIONS RECORD

1. Name of item observed ..........................................
2. Quantity of item observed ..........................................
3. Starting Time ..........................................
4. Closing Time ..........................................
5. **Various Ingradients Observed**

**(a) Materials**

| S. No. | Type | Quantity |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |

**(b) Labour**

| S. No. | Category/Type of Labour | Quantity |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |

**(c) Machinery**

| S. No. | Type of Machinery | From | To |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

Continued on Page no. .......

Page No. ......

## 7.19 MOCK UP RECORD

1. Name of Mock Up ..........................................
2. Trial No. . ..........................................

| S.No. | Checks | Observations | Acceptable / Not Acceptable/ Suggestions |
|---|---|---|---|
| 1. | Supporting system | | |
| 2. | Form Finish | | |
| 3. | Surface Finish | | |
| 4. | Dimensions | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |

**Result :** Mockup approved for Execution / Another trial required as per the suggestions

**Any Other Comments:**

Signature :
Date :
For Contractor :
Name

Signature
Date
For Department .
Name

Continued on Page no. .......

# 7.20 GUARANTEE BONDS / INSURANCES RECORD

1. Name of Item ..........................................
2. Reference of Guarantee Bond approval ..........................................
3. Date of submission of Bond ..........................................
4. Whether the bond accepted (Yes / No / N.A.) ..........................................
5. Reference of Acceptance ..........................................
6. Period of Bond ..........................................
7. Extension of Bond/Insurance ..........................................

| | | | |
|---|---|---|---|
| Signature | : | Signature | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |



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## 7.21 Safety Assurance Record

1. Date of Inspection :
2. Name and Designation of the Officer performing Inspection :
3. Last date of Inspection :
4. Next date due for Inspection :

| S.No. | Item of Inspection and the required standards | Yes / No / N/A |
|---|---|---|
| 1. | ***For height upto 3.6m height above ground or floor***<br>a) Provision of ladder not steeper than 1:4. | |
| 2. | ***For height more than 3.6m above ground or floor***<br>a) Whether guide rail properly provided and secured.<br>b) Are the working platform, gangway and stairways adequately stiff<br>c) Is working platform, gangway or stairway<br>i) Closely boarded<br>ii) Adequately width<br>iii) Suitably fastened | |
| 3. | ***For opening in the working area***<br>i) Whether suitably fenced or provided with minimum 90cm high railing | |
| 4. | ***Prevention of danger from electrical equipment***<br>i) Is the material stacked causing danger or inconvenience to public<br>ii) Necessary fencing and lights provided to protect the public. | |
| 5. | ***Excavation & Trenching more than 1.2m in depth***<br>i) Is at least 1 ladder for each 30m length provided<br>ii) Is the length of ladder sufficient to extend from the bottom to at least 90cm above ground surface. | |



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| | | |
|---|---|---|
| | iii) Are the sides of trenches secured by timber bracing<br>iv) Is there any excavated material within 1.5m<br>v) Is any undermining or undercutting done. | |
| 6. | ***Asphaltic works***<br><br>Are worker provided with protective footwear, gloves and protective goggles. | |
| 7. | ***Cement***<br><br>i) Are workers handling cement provided with protective goggles and gloves. | |
| 8. | ***Welding works***<br><br>i) Are the workers provided with protective eye shield, gloves and footwear. | |
| 9. | ***Hoisting machines***<br><br>i) Do the machines including their attachment, anchorage and supports have good mechanical construction, sound material and adequate strength, free from patent defect and kept in working order<br><br>ii) Does every rope has adequate strength and free from patent defects<br><br>iii) Is the operator properly qualified<br><br>iv) Is safe working load marked on machines<br><br>v) Are efficient safeguards provides to motors, gearing, transmission, electric wiring and other dangerous part<br><br>vi) Does the workers wear any metallic item while employed on any electrical installation. | |

**General**

1. Are the safety provisions displayed on a notice board at the prominent place at workspace.
2. Are the workers provided with safety helmets of specific colour.
3. Are the workers found with safety belts while working at heights
4. Is the work area will illuminated.
5. Is the work area suitable barricaded with adequate height.
6. Does the necessary cautionary sign board installed at site.

Remarks of the Inspecting Officer :

| | | | |
|---|---|---|---|
| Signature : | | Signature : | |
| Date : | | Date : | |
| For Contractor : | | For Department : | |
| Name | | Name | |

Continued on Page no. .......

# 7.22 Labour Welfare Record

1. Date of Inspection :
2. Name and Designation of the Officer performing Inspection :
3. Last date of Inspection :
4. Next date due for Inspection :

| S. No. | Item | Yes | No | Not applicable |
|---|---|---|---|---|
| 1. | ***First – Aid Box*** | | | |
| a) | i) 12 smail and 6 medium and large sized sterilized dressings<br>ii) 6 packets of sterilized cotton wool.<br>iii) 1 (60ml) bottle containing a 2% alcoholic solution iodine.<br>iv) 1 (60 ml.) bottle containing Salvolatile having the dose and mode of administration indicated on the label.<br>v) 1 roll of adhesive plaster<br>vi) 1 (30 gms.) bottle of potassium permanganate crystals<br>vii) 1 pair of scissors<br>viii) 1 bottle containing 100 tablets (each of 5 gms.) of aspirin<br>ix) Ointment for burns<br>x) A bottle of suitable surgical antiseptic solution | | | |
| b) | Arrangement for recoupment done | | | |
| c) | Location of First – Aid Box | | | |
| d) | Person responsible for keeping the box | | | |
| e) | Is the person-in-charge trained in first-aid treatment | | | |
| 2. | ***Drinking Water***<br>i) Is fit for drinking and cold water available<br>ii) Is it easily accessible<br>iii) Is the sauce well chlorinated before water is drawn<br>iv) Is the source dust and waterproof and properly covered | | | |
| 3. | ***Toilets and Urinals***<br>i) Are the adequate number toilets and urinals properly covered and partitioned available as per following requirement<br>Toilets<br>1 per 25 males or females up to 100 and 1 per 50 male or female 100<br>Urinals<br>1 per 50 males or females up to 500 and 1 per 100 beyond 500 males or females | | | |

| | | | | |
|---|---|---|---|---|
| | ii) Are these properly lighted<br>iii) Are these facilities properly maintained in a clean and sanitary condition at all times. | | | |
| 4.. | ***Provision of shelter during rest***<br>i) Is the shelter of adequate space available separately for men and women labourers | | | |
| 5. | ***Creches***<br>i) Are sufficient rooms for little children available<br>ii) Are the rooms kept clean well lighted and ventilated. | | | |
| 6. | ***Canteens***<br>i) Is adequate canteen facilities provided by the contractor<br>ii) Is the canteen maintained in clean and proper sanitary conditions.<br>iii) Is the dining space adequate.<br>iv) Is the suitable food stuff available<br>v) Is it running on No profit, No loss basis. | | | |
| 7. | ***Anti-Malarial Precautions***<br>i) Are sufficient precautions taken up for filling any borrow pits and spraying of insecticides | | | |

Remarks of the Inspecting Officer :

Signature :
Date :
For Contractor :
Name

Signature :
Date :
For Department :
Name

Continued on Page no. .......

# CHAPTER 8

## CHECKLISTS AND TEST PROFORMAS

# Check-Lists and Testing Proformas

Proper check lists and test proformas play a vital role in not only ensuring the quality control but also for proper documentation of the project. At the end of the project, it will be only the documents which will help in knowing the quality assurance system adopted in that project. In order to maintain the uniformity in the documentation of the total project, some checklists have been given in this chapter along with the testing proformas. Check lists are framed for the selection of the sub agency/supplier etc. and also for ensuring the specifications to be followed in the execution of the work, while the test proformas are to be to be used while conducting any test at site.

In order to ensure that the material, whether raw or assembled, intended to be used on the flyover construction meets the quality standards, the first step is to select a supplier / manufacturer who has the required infrastructure to produce quality material. This includes machines, testing facilities etc. The supplier should also have the capacity to supply the required volumes of material while maintaining consistence in quality. Certain checks shall have to be carried out in order to select and approve one more suppliers or manufacturers for the material to be used in the construction. This shall save the trouble of having to run from one source to the other for getting good quality material. While framing the checklists, emphasis has been paid to cover all these basic parameters which are of high importance for the selection of the supplier or specialised agency. Some checks for approving sources for different type of materials have been given here.

The quality control however does not end with the approval of the source. The material procured from the approved sources needs to be checked frequently for its quality by carrying out certain tests. These tests and their testing frequency have been mentioned in chapter 3. The formats for reporting the results of the tests are given in this chapter. While framing the test proformas for the material testing, the emphasis has been given to the BIS codes which are applicable for the acceptance of the material in the work before the selection as well as during the execution of the work.

Similarly, it has to be ensured that the site activities like piling, concreting, embankment construction, pre-stressing, road work, surfacing, installation of bearings and expansion joints etc. are carried out in a way that the end product satisfies the quality standards. This can be ensured by having checks at different stages as the activity progresses. These checks shall have to be tabulated and separately recorded for further reference. These have been incorporated in the form of "Checklist for Site Activities". Test proformas for reporting of test results whenever required during an activity are also given in this chapter. While framing the checklists for the site activities, emphasis has been given to ensure that the all the site activities are done as per the prescribed specifications for them.

In the test proformas, space has been provided at the top for the identification number. While conducting tests at certain frequencies, unique identification number may be given to the test proformas used every time.

## 8.1.1 Checklist for Source/Agency Approval

8.1.1.1 Coarse Aggregates
8.1.1.2 Fine Aggregates
8.1.1.3 Water
8.1.1.4 Cement
8.1.1.5 Reinforcement/Strands
8.1.1.6 Epoxy
8.1.1.7 Geotextile
8.1.1.8 Plasticiser
8.1.1.9 Granular Sub base
8.1.1.10 Backfillling material (earth)
8.1.1.11 Bitumen
8.1.1.12 Prestressing system
8.1.1.13 RE/RS Wall
8.1.1.14 Thermoplastic Paint
8.1.1.15 Bearings
8.1.1.16 Expansion Joints
8.1.1.17 Hot Mix Plant

### 8.1.1.1 Checklist for source approval for – Coarse Aggregate.

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the supplier : | |
| 2. | Information regarding the other ongoing works where the material is being supplied by this supplier | |
| 3. | Report obtained from the clients referred at S.No. 2 | |
| 4. | What is the petrography of the parent rock? Is it acceptable? | |
| 5. | Will adequate quantity be available for the complete project? | |
| 6. | Have the aggregates been got tested from reputed laboratory as per IS : 383 as per chapter 3 of the manual.?<br>(a copy of the test certificate may be attached) | |
| 7. | Are adequate crushing and transporting facilities available with the supplier/crusher? | |

| | | |
|---|---|---|
| Signed | : | |
| Date | : | |
| For Contractor Name | : | |

### 8.1.1.2 Checklist for source approval for – Fine Aggregate.

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the supplier : | |
| 2. | Information regarding the other ongoing works where the material is being supplied by this supplier | |
| 3. | Report obtained from the clients referred at S.No. 2 | |
| 4. | What is the type of aggregates.<br>(i) Crushed rock.<br>(ii) River sand. | |
| 5. | Will adequate quantity be available for the complete project? | |
| 6. | Have the aggregates got tested from reputed laboratory as per IS : 383 as per chapter 3 of the manual.?<br>(a copy of the test certificate may be attached) | |
| 7. | Are adequate washing and transporting facilities available with the supplier? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.3 Checklist for source approval for – Water

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | What is the source of supply?<br><br>(i) Bore well<br>(ii) Supply of local body<br>(iii) Tankers | |
| 2. | Has the water been got tested from reputed laboratory as per chapter 3 of the manual?<br>(a copy of the test certificate may be attached) | |
| 3. | Will adequate quantity be available from the source for the duration of construction? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.4 Checklist for source approval for – Cement

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the manufacturer/supplier : | |
| 2 | Whether the supplier/manufacturer is among the approved list of the clients. | |
| 3. | Information regarding the other ongoing works where the material is being supplied by this supplier: | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5. | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 6. | Whether the supplier can supply the material in desired size of the lot as per the site schedule. | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.5 Checklist for source approval for – Reinforcement/Strands

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the manufacturer/supplier : | |
| 2 | Whether the supplier/manufacturer is among the approved list of the clients? | |
| 3. | Information regarding the other ongoing works where the material is being supplied by this supplier: | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5 | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 6. | Whether the supplier can supply the material in desired size of lot as per the site schedule. | |

| | | |
|---|---|---|
| Signed | : | |
| Date | : | |
| For Contractor Name | : | |

### 8.1.1.6 Checklist for source approval for – Epoxy

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the manufacturer/supplier : | |
| 2 | Whether the supplier/manufacturer is among the approved list of the clients. | |
| 3. | Information regarding the other ongoing works where the material is being supplied by this supplier: | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5 | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 6. | Whether the supplier can supply the material in desired size of lot as per the site schedule? | |
| 7. | Whether the manufacturer has given the method statement for its application. (attach a copy of the method statement) | |
| 8. | Has the manufacturer furnished any guarantee? | |
| 9. | Will the manufacturer's authorised representative be present during the application of epoxy? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.7 Checklist for source approval for – Geo-Textile

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the manufacturer/supplier : | |
| 2. | Information regarding the other ongoing works where the material is being supplied by this supplier: | |
| 3. | Report obtained from the clients referred at S. No. 2: | |
| 4. | Whether the material satisfies the test requirement as per ASTM D-4355 as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 5. | Is the material indigenous or imported? Is the supply easily available in market. | |
| 6. | Can the agency supply the required quantity of material in the stipulated time? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |



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### 8.1.1.8 Checklist for source approval for – Plasticiser

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name of the Product : | |
| 2. | Type of Product (super plasticiser/ water reducing admixture / retarder etc.) | |
| 3. | Name and address of the manufacturer/supplier : | |
| 4. | Period for which the product is in use: | |
| 5. | Information regarding the other ongoing works where the material is being supplied by this supplier: | |
| 6. | Report obtained from the clients referred at S. No. 2: | |
| 7. | Whether the material satisfies the test requirement as per IS :9103 as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 8. | Can the agency supply the required quantities in the stipulated time as per the site requirement? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.9 Checklist for source approval for – Granular Sub-Base Material

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the supplier : | |
| 2. | Information regarding the other ongoing works where the material is being supplied by this supplier | |
| 3. | Report obtained from the clients referred at S.No. 2 | |
| 4. | Does the agency have arrangement to supply coarse aggregates and moorum? | |
| 5. | Whether the material satisfies the test requirement as per chapter 3 of the manual?<br>(a copy of the test certificate may be attached) | |
| 6. | Can the agency supply the required quantities as per the site schedule? | |
| 7. | Does the agency have adequate arrangements to transport the material to the site? | |
| 8. | Does the agency have equipment like Motor grader, vibratory roller for laying of GSB?<br>If not, what is the arrangement of the contractor? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

## 8.1.1.10 Checklist for source approval for – Backfilling Material (Earth)

| S . No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the supplier : | |
| 2. | Source of the Earth and its distance from the site: | |
| 3. | Is the source approved by the Engineer-in-charge? (Indicate the reference of approval). | |
| 4. | Information regarding the other ongoing works where the earth is being supplied by this supplier: | |
| 5. | Report obtained from the clients referred at S. No. 2: | |
| 6 | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 7. | Whether the supplier can supply the material in desired quantity as per the site schedule. | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

## 8.1.1.11 Checklist for source approval for – Bitumen

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the manufacturer/supplier : | |
| 2 | Whether the supplier/manufacturer among the approved list of the clients? | |
| 3. | Information regarding the other ongoing works where the material is being supplied by this supplier: | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5. | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 6. | Whether the supplier can supply the material in desired size of the lot as per the site schedule. | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

## 8.1.1.12 Checklist for source approval for – Prestressing System

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the prestressing system agency. | |
| 2 | Whether the agency among the approved list of the clients. | |
| 3. | Information regarding the other ongoing works where the agency has done the prestressing : | |
| 4. | Report obtained from the clients referred at S: No. 2: | |
| 5. | Whether the system has been tested as per FIP recommendations for acceptance of prestressing system as given under chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 6. | Whether the prestressing hardware like anchorage system, wedges, barrels, bearing plate. Trumpet cone etc. have been tested as required under chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 7. | Whether the supplier can supply the hardware including jacks and pumps duly calibrated and in adequate numbers so as to met the target progress of the work. | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.13 Checklist for source approval for – Reinforced soil works

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the agency. | |
| 2 | Whether the agency among the approved list of the clients? | |
| 3. | Information regarding the other ongoing works where the agency has done the RE works : | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5. | Whether the agency has given the QAP as per his system. | |
| 6. | Whether the various components have been tested as per the QAP of the agency.<br>(a copy of the test certificate may be attached) | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.14 Checklist for source approval for – Thermoplastic Paint

| S . No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the agency : | |
| 2. | Information regarding the other ongoing works where the work of this kind has been done by this agency: | |
| 3. | Report obtained from the clients referred at S. No. 2: | |
| 4. | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 5. | Whether the supplier can supply the material in desired size of the lot as per the site schedule. | |
| 6. | Does the agency have mechanised facilities for checking the quality of paint? | |
| 7. | Is automatic lane marking machine available with the agency for use in the work? | |
| 8. | Will the agency furnish the performance guarantee as per the MORTH requirement? | |
| 9. | Does the agency has specialised staff for laying the paint? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

## 8.1.1.15 Checklist for source approval for – Bearings.

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Type of Bearing : | |
| 2. | Name and address of the manufacturer/supplier including the location of workshop including the forging facilities (foundry) | |
| 3. | Whether the supplier/manufacturer is among the approved list of the MORTH for the particular type of bearing as per the latest circular?<br>(a copy of the MORTH approval may be attached) | |
| 3. | Information regarding the other ongoing works where the bearing of this type has been supplied by this supplier: | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5. | Has the manufacturer submitted his QAP? | |
| 6. | Whether the material satisfies the test requirement as per QAP of the manufacturer and/or as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 7. | Whether the supplier can supply the material in desired nos. as per the site schedule so that the progress of the work is not hampered? | |
| 8. | Has the agency agreed to furnish a performance bond for 10 years? | |
| 9. | Will the manufacturer's authorised representative be available while the joint is being installed? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

## 8.1.1.16 Checklist for source approval for – Expansion Joints.

| S. No. | Particular | Remarks |
|---|---|---|
| 1. | Type of Expansion Joint : | |
| 2. | Name and address of the manufacturer/supplier including the location of workshop? | |
| 3. | Whether the supplier/manufacturer is among the approved list of the MORTH for the particular type of joint as per the latest circular?<br>(a copy of the MORTH approval may be attached) | |
| 3. | Information regarding the other ongoing works where the expansion joint of this type has been supplied by this supplier: | |
| 4. | Report obtained from the clients referred at S. No. 2: | |
| 5. | Has the manufacturer submitted his QAP? | |
| 6. | Whether the material satisfies the test requirement as per QAP of the manufacturer and/or as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 7. | Whether the supplier can supply the material in desired nos. as per the site schedule so that the progress of the work is not hampered. | |
| 8. | Has the agency agreed to furnish a performance bond for 10 years? | |
| 9. | Will the manufacturer's authorised representative be available while the joint is being installed? | |

| | |
|---|---|
| Signed | : |
| Date | : |
| For Contractor Name | : |

### 8.1.1.17 Checklist for source approval for – Hot Mix Plant.

| S . No. | Particular | Remarks |
|---|---|---|
| 1. | Name and address of the agency/owner of hot mix plant : | |
| 2. | Location of Hot Mix Plant | |
| 3. | Is the plant automatic and fully computerised? | |
| 4. | Information regarding the other ongoing works where the work has been done from this hot mix plant: | |
| 5. | Report obtained from the clients referred at S. No. 2: | |
| 6. | Whether the material satisfies the test requirement as per chapter 3 of the manual.<br>(a copy of the test certificate may be attached) | |
| 7. | Does the plant have all the testing facilities for the aggregates, bitumen and the mix as required under Chapter 3 and 4 of the manual? | |
| 8. | Whether the supplier can supply the material in desired size of the lot as per the site schedule? | |
| 9. | Is there any collaboration of agency with IOC/BPCL for procuring bitumen? | |
| 10. | Does the plant owner has sensor paver, vibratory roller and other machineries required for the bituminous works? | |
| 11. | Does the plant owner have adequate transportation facilities for carrying bituminous mix? | |

| | | |
|---|---|---|
| Signed | : | |
| Date | : | |
| For Contractor Name | : | |

## 8.1.2 Checklist for Site Activities

8.1.2.1 Piling
8.1.2.2 R.C.C. Work

8.1.2.2.1 Staging
8.1.2.2.2 Form-work
8.1.2.2.3 Reinforcement
8.1.2.2.4 Concrete Pour
8.1.2.2.5 Post Concrete Inspection

8.1.2.3 Bearing Installation
8.1.2.4 Expansion Joint Installation
8.1.2.5 Embankment Construction
8.1.2.6 Non Bituminous Road Work
8.1.2.7 Waterproofing Membrane Laying
8.1.2.8 Bituminous Works
8.1.2.9 Thermoplastic Paint

## 8.1.2.1 CHEKLIST FOR BORED CAST – IN- SITU CONCRETE PILES

1. Unique Identification no. of Pile.
2. Pile Group

**Sketch for Pile Group No.**

| *Pile Group No.* . |
|---|
| |

| S No. | Description | Yes / No / NA | Remarks |
|---|---|---|---|
| 1 | **Layout** | | |
| 1.1 | Has the layout been checked as per the coordinates with a total survey station? Whether found correct. | | |
| 2. | **Vertical Alignment** | | |
| 2.1 | Is the vertical alignment correct? | | |
| 3. | **Piling Equipment.** | | |
| 3.1 | Whether piling equipment iss approved.? | | |
| 3.2 | Ref. of approval........................ | | |
| 3.3 | Whether dia of cutting tool is as per the required bore opening? | | |
| 4. | **Liner** | | |
| 4.1 | Is the thickness of liner as specified in the method statement? | | |
| 4.2 | Is the depth of liner from existing ground level as per the drawing? Specify the depth ............ | | |
| 5. | **Bentonite Slurry** | | |

| | | | |
|---|---|---|---|
| 5.1 | Whether bentonite tested as per clause 3.7 of the manual? | | |
| 6. | **Flushing of Bore** | | |
| 6.1 | Is the gravity of bottom slurry after cleaning of bore not more than 1.2? | | |
| 6.2 | Has the bore been cleaned? | | |
| 7. | **Reinforcement** | | |
| 7.1 | Is the reinforcement checked as per checklist ?<br>Reference of approval.......................... | | |
| 7.2 | Whether the cage has been reasonably stiffened as observed during lifting of reinforcement? | | |
| 7.3 | Whether length for construction of pile cap available? | | |
| 8. | **Concreting** | | |
| 8.1 | Whether Checklist for concrete pour has been approved?<br>If yes, reference of approval.................. | | |
| 8.2 | Has the cut off level been checked?<br>Specify................................. | | |
| 8.3 | Does the funnel have adequate holding capacity? | | |
| 8.4 | Whether tremmie pipe was continuously embedded in concrete? | | |
| 8.5 | Is the pile shift within permissibly limit?<br>Specify the shift........................ | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name:<br>Designation | Name:<br>Designation: |
| Signature<br>Date: | Signature<br>Date: |

### 8.1.2.2.1 CHECKLIST FOR STAGING

1. Nomenclature of Item :
2. Dimensions drawing No. :

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Has staging been designed and got approved in advance? | | |
| 2. | Is the base preparation done as per the approved methodology? | | |
| 3. | Is the placing of Concrete Block as per drawing? | | |
| 4. | Is the Erection of V.T. Columns true to plumb? | | |
| 5. | Is the connection of horizontal and diagonal bracing as per drawing? | | |
| 6. | Has all the joints been properly made and stiffened? | | |
| 7. | Is the placing of longitudinal girder and Transverse girders as per drawing? | | |
| 8. | Has staging been done as per approved design? | | |
| 9. | Is the spacing of VT Column according to approved design? | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

### 8.1.2.2.2 CHECKLIST FOR FORM WORK

1. Nomenclature of Item :
2. Dimensions drawing No. :

| S. No. | Description | Yes / No / N/A | Remarks |
|---|---|---|---|
| 1 | Is the shuttering material (wood / steel) as approved ? | | |
| 2 | Is the thickness of shuttering plates as approved? | | |
| 3. | Is the thickness of stiffener as approved? | | |
| 4. | Is pre assembly of shuttering checked and elements of individual shuttering checked before use? | | |
| 5. | Is arrangement of the formwork as per the approved dimension drawing? | | |
| 6. | Has the alignment and levels of the shuttering / form work checked? | | |
| 7. | Is the verticality checked (max. limit – 1 in 1000)? | | |
| 8. | Is shuttering watertight and whether foam and rubber sheet provided? | | |
| 9. | Are shuttering plates suitable to give shutter finish of concrete, i.e. free from dents, scales or pitting etc.? | | |
| 10. | Is the shuttering adequately supported and braced?/ | | |
| 11. | Are the sectional dimensions correct to ± **5mm** & level correct to ± **3mm?**. | | |
| 12. | Are shutter vibrators provided as approved? | | |
| 13. | Are joints between panels flush (no steps / lips)? | | |
| 14. | Are spacers between shutters adequately provided wherever required? | | |
| 15. | Are End Stoppers provided? | | |
| 16. | Is the Oiling of forms done with approved release oil? | | |
| 17. | Are the water stops fixed as required? | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.2.3 CHECKLIST FOR REINFORCEMENT

1. Nomenclature of Item :
2. Structural Drawing No. :
3. Shop Drawing No. :

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1 | Is the drawing in use latest issued for construction purpose? | | |
| 2 | Is Bar Bending Schedule approved ? | | |
| 3. | Ref. of approval ................ | | |
| 4. | Is bar bending and cutting satisfactory? | | |
| 5. | Has Corrosion treatment of bars been carried out in case of scaling of bars? | | |
| 6. | Are bar sizes correct as per BBS? | | |
| 7. | Are bar spacing correct as per BBS? | | |
| 8. | Are bar Lap lengths correct as per the structural drawing? | | |
| 9. | Are bar Laps at correct locations as per the structural drawing? | | |
| 10. | Are all joints tied properly with binders using double knot? | | |
| 11. | Is bar assembly rigid and adequately supported (including spacers/chair supports)? | | |
| 12. | **Cover to reinforcement.** | | |
| 12.1 | Is the concrete for cover blocks of the same grade as the main Concrete? | | |
| 12.2 | Are the cover blocks adequately fixed? | | |
| 12.3 | Is the cover to bottom reinforcement correct? | | |
| 12.4 | Is the cover to top reinforcement correct? | | |
| 12.5 | Is the cover to side reinforcement correct? | | |
| 12.6 | Are the cover blocks of proper size and fixed at proper spacing? | | |

| FOR CONTRACTOR | FOR DEPARTMENT |
|---|---|
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

### 8.1.2.2.4 CHECKLIST FOR CONCRETE POUR

1. Nomenclature of Item :
2. Structural Drawing No. :
3. Date of Casting :

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| **1.** | **Staging and Formwork** | | |
| 1.1 | Is the staging and formwork approved as per checklist as given in clause 8.2.2.1 and 8.2.2.2? | | |
| 2. | **Reinforcement** | | |
| 2.1 | Is the reinforcement approved as per checklist as given in clause 8.2.2.3 | | |
| 3. | **Staging** | | |
| 3.1 | Is the staging approved as per checklist as given in clause 8.2.2.1? | | |
| 4. | **Embedded Parts** | | |
| 4.1 | Are the embedded parts provided as per the requirement? | | |
| 4.2 | Is the alignment and fixing of inserts correct? | | |
| **5.** | **Arrangement of concreting** | | |
| 5.1 | Are construction joints provided as approved? | | |
| 5.2 | Has the old concrete surface been roughened? | | |
| 5.3 | Are materials/ingredients approved as per clause 3.1, chapter 3 of this manual? | | |
| 5.4 | Is batching plant calibration checked? | | |
| 5.5 | Has the concreting sequence been approved? | | |
| 5.6 | Has arrangement for protection from extreme weather during or after concreting been made? | | |
| 5.7 | Are the platforms and access for materials and labour movement provided? | | |
| 5.8 | Is adequate illumination arrangement provided? | | |
| 5.9 | Are safety measures as per safety Assurance Record taken? | | |
| 6. | **During Concreting** | | |
| 6.1 | Does the slump of concrete meet the requirement? | | |
| 6.2 | Number of cube specimens taken | | |
| 6.3 | Is the previously placed layer of concrete green to receive the succeeding layer for amalgamation? | | |
| 6.5 | Is proper vibration done to ensure compaction? | | |

| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
|---|---|
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.2.5 CHECKLIST FOR POST CONCRETE INSPECTION

1. Nomenclature of item :
2. Date of Casting :
3. Date of De-shuttering :
4. Date of inspection :

| S. No. | Description | Yes/ No/N/A | Remarks |
|---|---|---|---|
| 1. | **Alignment / Dimensions of the member** | | |
| 1.1 | Is the alignment correct? | | |
| 1.2 | Are the dimensions correct? | | |
| 2. | **Is any bulging noticed?** | | |
| 3. | **Appearance of surface?** | | |
| 3.1 | Is there any honey combing? | | |
| 3.2 | Are there any an bubbles? | | |
| 3.3 | Are there any cold joints? | | |
| 3.4 | Is shutter finish obtained? | | |
| 4. | **Are there any cracks noticed? If yes, nature of cracks (depth & width)** | | |
| 5. | **Any other defects?** | | |
| 6. | **Any Non conformations?** | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

### 8.1.2.3 BEARINGS INSTALLATION

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | **Seating Of Bottom Plate** | | |
| 1.1 | Has the bearing been placed in proper position and level | | |
| 1.2 | Is the grouting material sieved through 1.18mm sieve available | | |
| 1.3 | Is mixing arrangement checked | | |
| 1.4 | Is the pouring arrangement for grout checked | | |
| 1.5 | Has the grout evenly spread all around and below the bottom plate | | |
| 2. | **Fixing of Top Plate** | | |
| 2.1 | Is the pier segment properly placed over the pier and secured on the jacks/crib supports around the pier | | |
| 2.2 | Are all the pockets properly cleaned and soaked in water | | |
| 2.3 | Is the grouting material sieved through 1.18mm sieve available | | |
| 2.4 | Is mixing arrangement checked | | |
| 2.5 | Is the pumping arrangement for grout checked | | |
| 2.6 | Has the Epoxy mortar applied all around the top plate set | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.4 EXPANSION JOINT INSTALLATION

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Whether the width of expansion gap required as per approved drawing is available? | | |
| 2. | Whether the concrete and reinforcement in the recess of the joint has been cleaned? | | |
| 3. | Whether the reinforcement has been suitably adjusted to allow unhindered joint lowering? | | |
| 4. | Whether the formwork has been checked for shape and tightness? | | |
| 5. | Whether the temperature of the structure at the time of fixing of the joint checked? | | |
| 6. | Is there any difference in the ambient temperature and the temperature considered for pre-setting of the joint? | | |
| 7. | Whether the pre-setting has been corrected for any difference in the ambient temperature and the temperature considered for pre-setting of the joint? | | |
| 8. | Whether the brackets have re-tightened after pre-setting? | | |
| 9. | Whether the lowered joint checked for alignment and level? | | |
| 10. | Whether the welding of the anchor loops has been checked? | | |
| 11. | Whether the auxiliary brackets have been released? | | |
| 12. | Is the grade of concrete poured in the recess same as that of main structure? | | |
| 13. | Is the wearing course on the carriage-way flush with the top of the steel surface? | | |

| FOR CONTRACTOR | FOR DEPARTMENT |
|---|---|
| Name:<br>Designation | Name:<br>Designation: |
| Signature<br>Date: | Signature<br>Date: |

### 8.1.2.5 CHECKLIST FOR EARTHERN EMBAKMENT

Location / Chainage

| S. No. | Description | Yes/ No/N/A | Remarks |
|---|---|---|---|
| 1. | **Back Fill Soil Characteristic** | | |
| 1.1 | Is the earth tested as per clause 3.1 and approved ? Reference of approval............ | | |
| 2. | **Embankment Foundation** | | |
| 2.1 | Whether base of the embankment excavated to a suitable depth ? | | |
| 2.2 | Whether the all clods is broken into Fine Earth? | | |
| 2.3 | Whether the area in the embankment portion is leveled?. | | |
| 2.4 | Whether the surface is well watered before the commencement? | | |
| 3. | **Earth Filling and Compacting** | | |
| 3.1 | Whether the lines of embankment shall be marked by pegs? | | |
| 3.2 | Whether the lines limits of the side slopes is-indicated? | | |
| 3.3 | Whether bamboo/string profiles is erected at suitable spacing? | | |
| 3.4 | Whether the thickness each layer not more than 20cm? | | |
| 3.5 | Whether the embankment materials is laid continuously and parallel to the finishes grade? | | |
| 3.6 | Whether the filling is done in full width including slopes? | | |
| 3.7 | Whether the height of the different section is uniform? | | |
| 3.8 | Whether the maximum size of clods when being placed in lower layer of embankment is not more than 100mm/ | | |
| 3.9 | Whether the maximum size of clods when being placed in top 60cms portion of embankment is not more than 60mm/ | | |
| 3.10 | Whether moisture content of each layer maintained as per OMC? | | |
| 3.11 | Whether the Back Filling of required material has been done against Abutment, Retaining Wall etc.? | | |
| 3.12 | Whether Filter Media and Drainage System of required specifications has been provided against abutments, retaining wall and other components etc. | | |
| 3.13 | Whether roller of adequate capacity (8 to 10T) available? | | |
| 3.14 | Whether the sample is tested once for density test at required frequency? | | |
| 3.15 | Whether density equal to 95% of MDD is available in lower layers and 100% of MDD in top layers. | | |

**FOR CONTRACTOR**

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Date:

**FOR DEPARTMENT**

Name:
Designation:

Signature
Date:

## 8.1.2.6.1 CHEKLIST FOR CONSTRUCTION OF SUBBASE

| S. No. | Description | Yes/ No/NA | Remarks |
|---|---|---|---|
| **1.** | **Sub Grade** | | |
| 1.1 | Has the subgrade finished to required profile and levels? | | |
| 1.2 | Has the subgrade been rolled to the required compaction before laying subbase layers.? | | |
| **2.** | **Spreading** | | |
| 2.1 | Whether the gradation of the aggregates and screening checked? | | |
| 2.2 | Whether the aggregate is uniformly spread by using templates? | | |
| **3.** | **Rolling** | | |
| 3.1 | Whether the rolling proceeds gradually from edge to the center? | | |
| 3.2 | Whether the rolling proceeds from inner to outer edge? | | |
| 3.3 | Whether grading started with power roller of adequate capacity? | | |
| 3.4 | Whether rolling operation is stopped when it causes a wave like motion due to softness of subgrade? | | |
| 3.5 | Whether the rollers at edges runs forward and backward/ | | |
| 3.6 | Whether the roller is moved inward parallel to the center line of the road in successive passes uniformly lapping preceding tracks by at least one half width? | | |
| 3.7 | Whether rolled surfaces checked transversely and longitudinally with suitable means such as straight edges? | | |
| 3.8 | Whether rolling is discontinued when the aggregates is partially compacted with void space sufficient to permit application of screenings. | | |
| **4.** | **Application & Screenings** | | |
| 4.1 | Whether screenings are applied in three or more applications to fill the interstices to the required quantities. | | |
| 4.2 | Whether dry rolling is continued while spreading the screenings? | | |
| 4.3 | Whether the aggregates are not disturbed during spreading of screenings ? | | |
| 4.4 | Whether sub grade is damaged due to addition of successive quantities of water during construction? | | |
| **5.** | **Sprinkling and Grouting** | | |
| 5.1 | Whether after spreading the screenings and rolling, the surface is cautiously sprinkled, swept and rolled with water? | | |
| 5.2 | Whether the additional screenings are applied during sprinkling, sweeping and rolling operation? | | |
| 5.3 | Whether sprinkling, sweeping and rolling operation is continued and the coarse aggregate are well bounded and firmly set? | | |
| 5.4 | Whether grout is formed of screenings blinding material and water. | | |
| 5.5 | Whether a wave of grout is formed in front of the wheels? | | |
| 5.6 | Whether the sub grade is damaged due to use of excessive amount of water? | | |

| | | | |
|---|---|---|---|
| **6.** | **Application of blinding Material** | | |
| 6.1 | Whether the blinding material is added after the application of screenings. | | |
| 6.2 | Whether the surface is sprinkled with water after application of blinding material? | | |
| 6.3 | Whether the surface is rolled by a 8-10 T roller after sprinkling with water? | | |
| 6.4 | Whether the water is applied to the wheels in order to wash down the blinding material? | | |
| 6.5 | Whether the spreading of blinding material, sprinkling of water, sweeping with brooms and rolling is continued until the slurry is formed? | | |
| **7** | **Setting and Drying** | | |
| 7.1 | Whether the road allowed to cure over night after compaction? | | |
| 7.2 | Whether the road is filled with screening and blinding material lightly sprinkled with water, if the defective spot is found? | | |
| 7.3 | Whether traffic is allowed till the macadam is set? | | |

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| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.6.2 CHEKLIST OF LAYING GRANULAR SUB BASE

Location & Chainage :
Carriage Way:

| S. No. | Description | Yes/ No/ NA | Remarks |
|---|---|---|---|
| **1.** | **Sub Grade Preparation** | | |
| 1.1 | Whether the Sub grade has been rolled under 100% OMC and free from vegetation? | | |
| 1.2 | Whether the profile of sub grade is true to the design? | | |
| 1.3 | Are there any soft pockets on sub grade? | | |
| 1.4 | Are Straight edges, leveling instruments, camber board, spirit level, plumb bob, threads etc. are available in working order? | | |
| 2. | **Base Coarse** | | |
| 2.1 | Whether material has been tested as per Chapter3 of QAM? | | |
| 2.2 | Whether material has been tested for CBR value after compaction? | | |
| **3.** | **Laying** | | |
| 3.1 | Whether material has been compacted to the required thickness/ | | |
| 3.1.1 | If not, details of defects. | | |
| 3.1.2 | Details of rectification done. | | |
| 3.1.3 | Time and Date of completion of rectification of defects. | | |

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| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.7 WATER ROOFING MEMBRANE LAYING

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Is the surface area cleaned of all dust with use of compressor? | | |
| 2. | Is the area marked with gridlines on the basis of the size of membrane and the laps required? | | |
| 3. | Is the arrangement for laying the membrane i.e., roller, blow lamp etc. available? | | |
| 4. | Is the membrane of adequate size as per the requirement? | | |
| 5. | Is the MTC available? | | |
| 6. | Is the membrane procured from the approved source? | | |
| 7. | Is the membrane within the expiry period? | | |
| 8. | Is sufficient quantity available for a days work? | | |
| 9. | Are specialised workers available for laying the membrane? | | |

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| Name:<br>Designation | Name:<br>Designation: |
| Signature<br>Date: | Signature<br>Date: |

### 8.1.2.8.1 CHECKLIST ROR DENSE BITUMINOUS MACADAM

Road Name / No.
Location and Chainage

| S. No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Has gradation of the aggregate been checked? | | |
| 2. | Whether the compacted thickness of bituminous macadam is 75mm? | | |
| 3. | Whether the aggregates are premixed with bituminous binder? | | |
| 4. | Whether the binder is straight run bitumen of 80/100 grade (has penetration test been conducted)? | | |
| 5. | Whether the aggregate is clean, strong and durable of fairly cubical shape? | | |
| 6. | Whether the binder content for premixing is 4% by weight of the total mix determined by design mix specify %age in case of variation? | | |
| 7. | Whether the bituminous macadam is laid during rainy or foggy weather? | | |
| 8. | Whether the base coarse is free from dampness or wetting? | | |
| 9. | Whether the atmospheric temperature is greater then $10^0$C? | | |
| 10. | Whether the WBM surface is thoroughly swept, scrapped clean and free from dust? | | |
| 11. | Whether the rate of spread of strength mix bitumen is 10Kg/sqm area? | | |
| 12. | Whether the temperature of binder at the time of mixing is in the range of $150^0$C to $165^0$C? | | |
| 13. | Whether the temperature of aggregate at the time of mixing is in the range of $155^0$C to $163^0$C? | | |
| 14. | Whether the temperature difference between the Binder and the Aggregate is not than $14^0$C? | | |
| 15. | Whether the discharge temperature of mix is in between $130^0$C to $160^0$C? | | |
| 16 | Whether the tipper vehicles are used for transport the mixture from the mixing plant to the point of use? | | |
| 17. | Whether the tipper vehicles are cleaned and covered. | | |

| FOR CONTRACTOR | FOR DEPARTMENT |
|---|---|
| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.8.2 CHECKLIST FOR ASPHALTIC CONCRETE

1. Location of Work
2. Chainage

| S. No. | Description | Yes/ No/N/A | Remarks |
|---|---|---|---|
| 1. | **Materials** | | |
| 1.1 | Is the Ballast approved as per the clause 3.1 of the manual? If yes, reference of approval…………………………………… | | |
| 1.2 | Is the filler material approved as per the clause 3.1 of the manual. If yes, reference of approval……………………… | | |
| 1.3 | Is the bitumen approved as per the clause 3.4 of the manual? If yes, reference of approval……………………………….. | | |
| 4. | **Mix** | | |
| 4.1 | Is the mix as per the approved Job Mix. | | |
| 5. | Is the Hot Mix Plant of adequate capacity and can produce a uniform mix and approved. Reference of approval………………………………….. | | |
| 6. | Is the surface on which bituminous concrete is to be laidis prepared to start the work? | | |
| 7. | Temperature of Binder during mixing ($150^0$ C to $177^0$ C) | | |
| 8. | Temperature of Aggregate during mixing ($155^0$ C to $163^0$ C) | | |
| 9. | Temperature difference between the Aggregates and the binder not more than $14^0$ C? | | |
| 10. | Whether the mixing is homogenous? | | |
| 11. | Whether the mix is transported from the mixing plant to the point of use in suitable tipper vehicles? | | |
| 12. | Whether the tippers are clean and covered? | | |
| 13. | Whether tack coat has been applied. | | |
| 14. | **Spreading** | | |
| 14.1 | Whether the mix is spread by means of a sensor paver ? | | |
| 15. | **Rolling** | | |
| 15.1 | Is the rolling done by 8 to 12 MT,3 wheeled steel roller or a vibratory roller with vibration switched off? | | |
| 15.2 | Is the intermediate rolling done with a 15 to 30MT pneumatic smooth wheeled roller ? | | |
| 15.3 | Is the final rolling done with a 8 to 10 T vibratory roller? | | |
| 16. | **Density** | | |
| 16.1 | Is the relative density equal to at least 98% | | |

**FOR CONTRACTOR**

Name:
Designation

Signature
Date:

**FOR DEPARTMENT**

Name:
Designation:

Signature
Date:

## 8.1.2.8.3 CHECKLIST FOR BITUMINUS MASTIC

| S No. | Description | Yes/No/NA | Remarks |
|---|---|---|---|
| 1 | Whether the mix is spread by wooden floats to the required thickness in between the already laid angle iron? | | |
| 2. | Whether all construction joints are properly and truly made? | | |
| 3. | Whether anti skid material has been pre heated? | | |
| 4. | Whether anti skid chips are pre coated with bitumen and fixed at 100mm spacing both directions? | | |
| 5. | Whether anti skid chips are protruding 1 mm to 4 mm over mastic surface? | | |
| 6. | Whether the joints have been sealed properly? | | |
| 7. | Whether Base Mastic along longitudinal drains has been laid to correct profile and levels? | | |
| 8. | Whether Base Mastic has been finished around the drainage openings for smooth flow of water?. | | |
| 9. | Whether Base Mastic at the junction with the side kerbs laid in correct profile after application of tack coat on concrete surface? | | |
| 10. | Whether there are any spilling or defacing of concrete surfaces due to above processes? | | |
| 11. | Whether final profile has been checked in Longitudinal and Transverse Action? | | |
| 12. | Whether traffic allowed after complete cooling down of Bitumen Mastic. | | |

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| Designation | Designation: |
| Signature | Signature |
| Date: | Date: |

## 8.1.2.9 CHECKLIST FOR THERMOPLASTIC PAINT

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Whether the paint to be used has been tested as per clause 3.7.3? | | |
| 2. | Whether the road surface approved for road marking? | | |
| 3. | Whether the road surface has been thoroughly cleaned of dust/dirt/grease/oily matter or other foreign matter? | | |
| 4. | Whether the pavement temperature checked and found to be more than $10^0$C? | | |
| 5. | Whether arrangements for diversion of traffic made? | | |
| 6. | Whether temperature of the paint at the time of application checked as per specification of the manufacture? | | |
| 7. | Is the time duration during which the paint remains in molten state checked to be not more than 4 hours? | | |
| 8. | Whether the paint has been maintained within the manufacturers specified range during the application.? | | |
| 9. | Is the Painting Process manual or Mechanical (whether approved by the Engineer-in-charge)? | | |
| 10. | Whether thickness of applied paint checked as per BS-3262 (part 3) and found to be minimum 2.5mm? | | |
| 11. | Whether additional glass beads of grading type 2 as per clause 803 4.3.3 Most specification for Road & Bridge works have been sprayed in case of manual application for arrows & letters etc. @ 250g/$m^2$ of area. | | |
| 12. | Whether the finished work is free from ruggedness on sides and ends and parallel to general alignment of the carriageway? | | |
| 13. | Whether the surface is level, uniform and free from streaks? | | |

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| Designation | Designation: |
| Signature | Signature |
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## 8.1.3 Checklist for Launching Girder

### 8.1.3.1 Fabrication

### 8.1.3.2 Testing

### 8.1.3.3 Shifting to site

### 8.1.3.4 Shifting to next location

### 8.1.3.1 FABRICATION OF LAUNCHING GIRDER

| S No. | Description | Yes/No/N/A | Remarks |
|---|---|---|---|
| 1. | Are the approved shop drawings showing details of location, type, size and extent of all welds available | | |
| 2. | Are all the structural members marked with a unique identification number | | |
| 3. | Are templates, jigs and other appliances available for ensuring accuracy of work | | |
| 4. | Are properly calibrated measuring devices available | | |
| 5. | Are the templates used for drilling inspected and approved | | |
| 6. | Is the pressure applying device for straightening or flattening injuring the material | | |
| 7. | Is a program indicating identification and erection marks and details of fabrication and welding available | | |
| 8. | **Preparation of the edges and ends** | | |
| 8.1. | Is the approved arrangement of end/edge planing and cutting available | | |
| 8.2. | Is the machining arrangement for edges 12mm or more thick plates available | | |
| 8.3. | Is the shearing arrangement for less than 12mm thick plates available | | |
| 9. | **Preparation of holes** | | |
| 9.1. | Is the punching and drilling arrangement available | | |
| 9.2. | Is the arrangement for clamping the plates available | | |

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| Name: | Name: |
| Designation | Designation: |
| Signature | Signature |
| Date | Date |

## 8.1.3.2 CHECKLIST FOR TESTING OF LAUNCHING GIRDER

| S No. | Description | Yes/No/N/A | Remarks |
|---|---|---|---|
| 1 | Whether fabrication all different parts complete | | |
| 2. | Is the shop drawing showing loading points available at site | | |
| 3. | Is the testing scheme approved. | | |
| 4. | Is the site properly barricaded and warning signals installed. | | |
| 5. | Are safety precautions like safety helmets, safety belts available. | | |
| 6. | Has adequate lighting arrangement been made. | | |
| 7. | Are the mobile machineries registered and insured. | | |
| 8. | Do the operators possess proper licence from the concerned authority. | | |
| 9. | Are the first Aid facilities available. | | |
| 10. | Are properly calibrated deflection gauges available. | | |

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### 8.1.3.3 CHECKLIST FOR SHIFTING TO SITE

| S.No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1 | Is a crane of adequate capacity available | | |
| 2. | Are licensed crane operator and grade present | | |
| 3. | Are warning signals installed while using the crane | | |
| 4. | Is the trailer of adequate capacity available | | |
| 5. | Is the trailer insured | | |
| 6. | Is the trailer operator licensed | | |
| 7. | Is the permission from traffic police available | | |
| 8. | Has the trailer made a successful Dry Run | | |
| 9. | Is the segment securely fastened to the trailer | | |
| 10. | Are unloading arrangements available at the site | | |
| 11. | Is the stacking area the site demarcated and barricadded | | |

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## 8.1.3.4 CHECKLIST FOR SHIFTING TO NEXT LOCATION

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1 | Is the crane movement area properly barricaded and signalled | | |
| 2. | Is the crane of adequate capacity available in good running condition | | |
| 3. | Is the crane operator licensed and the crane registered with the concerned authorities | | |
| 4. | Is the crane insured | | |
| 5. | Is the movement area identified and clear | | |

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### 8.1.4 Checklist for Launching Operation

8.1.4.1 Erection of Launching Girder
8.1.4.2 Placement of Segment at site
8.1.4.3 Placement of Pier Segment
8.1.4.4 Lifting of Segments
8.1.4.5 Dry Matching
8.1.4.6 Epoxy Application and Joining Segments
8.1.4.7 Prestressing
8.1.4.8 Detaching from Launching Girder

## 8.1.4.1 CHECKLIST FOR ERECTION OF LAUNCHING GIRDER

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Whether proper placement, alignment and level of each Trestle on firm ground done | | |
| 2. | Whether proper placement of 100T jacks with lock nut safety device under LG supporting crossbeams with ram extension of 100-125mm ensured | | |
| 3. | Whether alignment and levels of truss and beams of LG on each trestle ensured | | |
| 4. | Whether temporary locking of LG done | | |
| 5. | Whether proper installation of Crab Trolley ensured | | |
| 6. | Whether free movement of Crab Trolley ensured | | |
| 7. | Whether free movement of Cross Beams ensured | | |
| 8. | Whether arrangement for movement of transverse beam on wooden packing ensured | | |
| 9. | Whether proper hanging of working platform on both sides of the pier ensured | | |
| 10. | Whether surveying arrangements in order | | |
| 11. | Whether transverse locking, rotational locking and longitudinal locking checked | | |

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## 8.1.4.2 CHECKLIST FOR PLACEMENT OF SEGMENT

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Whether centre line marked on the segments? | | |
| 2. | Whether unique identification marking done on segments? | | |
| 3. | Whether pre-stressing ducts checked and cleaned? | | |
| 4. | Whether sand blasting of the segments on match cast faces done? | | |
| 5. | Whether lifting Hangers fixed on the segments? | | |
| 6. | Whether turn buckle fixing done properly on every segment? | | |
| 7. | Whether temporary prestressing frames fixed on each segment? | | |
| 8. | Whether all the segments checked for any damage caused in carriage and necessary repairs carried out ? | | |
| 9. | Whether segments placed below the launching girder in right order and sequence of lifting? | | |

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## 8.1.4.3 CHECKLIST FOR PLACEMENT OF PIER SEGMENT

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Whether the levels of all the corners of top and botttom identified ? | | |
| 2. | Whether the centre line marked on the segments? | | |
| 3. | Whether the position of four corners dropped and marked on the ground for conforming its location by plumb? | | |
| 4. | Whether the cribb support fixed on the ground? | | |
| 5. | Whether the jacks of required capacity placed on the cribb support for taking the load from pier segment? | | |
| 6. | Whether the lifting machinery like crane and crab trolley checked for their being in order? | | |
| 7. | Whether the working area demarcated and barricaded along with sufficient warning signals and proper lighting arrangements? | | |
| 8. | Whether the fixing arrangements of bearing for pier segment checked and found in order? | | |

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## 8.1.4.4 CHECKLIST FOR LIFTING OF SEGMENTS

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Whether the working area demarcaded ? | | |
| 2. | Is the site properly barricaded and warning signals installed. | | |
| 3. | Are safety precautions like safety helmets, safety belts available? | | |
| 4. | Has adequate lighting arrangement been made? | | |
| 5. | Are the mobile machineries registered and insured? | | |
| 6. | Do the operators possess proper licence from the concerned authority? | | |
| 7. | Are all the segments placed as per the lifting sequence? | | |
| 8. | Are all the machineries and crab trolley in working order and checked prior to its use? | | |
| 9. | Is well trained manpower is deployed on the job? | | |

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## 8.1.4.5 CHECKLIST FOR DRY MATCHING OF SEGMENTS

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1 | Is each segment movement in all the directions globally under control? | | |
| 2. | Has a mock up for ensuring the control over the movement of segment done earlier? | | |
| 3. | In the control mechanism for segment moving like turn buckle, jacks, pumps, huck-chuk arrangement well tested for controlled movements? | | |
| 4. | Are the predetermined levels of the segments at corners or at other point available at site? | | |
| 5. | Are the leveling instruments for taking precise levels (like total station survey instrument), steel tape, available for taking the levels of the segment while dry matching? | | |
| 6. | Is the trained manpower available at site? | | |
| 7. | Is the different jacks, gauges, pumps etc. required for use in work listed and calibrated instruments/equipment available? | | |
| 8. | Is the centreline marked on the segment? | | |
| 9. | Whether minor repairing to edges or elsewhere (if required) has been done to the segment? | | |

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| Name:<br>Designation | Name:<br>Designation: |
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## 8.1.4.6 CHECKLIST FOR EPOXY APPLICATION AND JOINING SEGMENTS

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1 | Whether 1mm thick washers to prevent entry of epoxy around sheathing provided on both segments? | | |
| 2. | Whether dry matching of segments completed? | | |
| 3. | Whether both faces of segments cleaned using wet cloth? | | |
| 4. | Is the ambient temperature at the time of application within acceptable limits? | | |
| 5. | Are arrangements for recording of time satisfactory? | | |
| 6. | Is sufficient amount of epoxy available at the site? | | |
| 7. | Are sufficient number of gloves and aprons available at the site? | | |
| 8. | Are trained workers available at the site? | | |
| 9. | Are arrangements for emergency removal of epoxy available at the site? | | |
| 10. | Was the uniform application of epoxy completed within Pot Life? | | |
| 11. | Whether the temporary prestress for joining the segments applied within the open time? | | |
| 12. | Whether sheathing ducts cleaned from either end by using dollies to remove any epoxy going into the ducts? | | |
| 13. | Has all the excess epoxy from the ducts removed? | | |
| 14. | Whether the epoxy squeezing out on sides smoothly finished in the groove? | | |
| 15. | Whether epoxy visible on the segment surface rendered? | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name:<br>Designation | Name:<br>Designation: |
| Signature<br>Date | Signature<br>Date |

## 8.1.4.7 PRESTRESSING

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1 | Whether Sheathing ducts cleaned with compressed air? | | |
| 2. | Whether assembly of Anchor heads to the threaded strands concentric with the bearing plate hole | | |
| 3. | Whether wedges inserted on to the strands and firmed well onto the anchor heads | | |
| 4. | Whether assembly of wedge plate on face of anchor head done | | |
| 5. | Whether assembly of calibrated hydraulic jacks on either side of the cable done with the help of stressing plate | | |
| 6. | Whether hydraulic connection from pump to the hydraulic jack and wedge seating assembly done | | |
| 7. | Whether placing of temporary props done | | |
| 8. | Whether Pre- stressing proforma filled up | | |
| 9. | Whether corrected elongations calculated | | |
| 10. | Whether longitudinal locking of the bearing unlocked as per the construction sequence | | |
| 11. | Whether structural shortening at abutment measured | | |
| 12. | Has the predetermined elongation and forces been achieved? | | |
| 13. | Any corrective steps required if the required elongation and force are not achieved | | |
| 14. | Whether wedge properly seated by operating wedge seating device (indicate wedge seating value....) | | |
| 15. | Whether wedge seating checked after 24hrs.( indicate value...) | | |

| | |
|---|---|
| **FOR CONTRACTOR** | **FOR DEPARTMENT** |
| Name:<br>Designation | Name:<br>Designation: |
| Signature<br>Date | Signature<br>Date |

## 8.1.4.8 CHECKLIST FOR DETACHING FROM THE LAUNCHING GIRDER

| S No. | Description | Yes/ No/ N/A | Remarks |
|---|---|---|---|
| 1. | Is the prestressing complete in a respects with satisfactory results of elongation and pressure? | | |
| 2. | Is the post prestressing inspection done and ensured that no damage of any kind has been caused to any component of the launching girder including the hangers of the segments? | | |
| 3. | Are all the levels of the segments at various points recorded after prestressing and ensured that hogging of the girder is in order? | | |
| 4. | Is the sequence of the release of hangers predetermined? | | |
| 5. | Is the arrangement for taking the levels of the segment after detachment from the launching girder available at site? | | |
| 6. | Is the area for placing the launching girder after detachment demarcated? | | |
| 7. | Are all the precautions like barricading the area, lighting the area and installing warning signals taken? | | |
| 8. | Is the mobile machinery like crane registered and in perfect working conditions? | | |
| 9. | Is the manpower deployed on the job is well trained/licensed and authorised? | | |

| FOR CONTRACTOR | FOR DEPARTMENT |
|---|---|
| Name:<br>Designation | Name:<br>Designation: |
| Signature<br>Date | Signature<br>Date |

**Identification No.** | | | | | | | | | |

## 8.2.1 Test Proforma for pH Value , Chlorine and Sulphate content in water

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Quantity of Water : | Method of Testing : |
| Source : | Date of Testing : |
| To be used in structure : | Sampling and Testing By : |
| | Quantity of sample : : |

**A. pH Value (using pH Strips)**

| SI No of Strips | pH Value | Acceptable Value |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

**B. Chloride Content (using test Kit)**

| Qty of Water taken | Qty. of Reagent 'A' | Qty. of Regent 'B' | Chloride Content (mg/l) |
|---|---|---|---|
| | | | |

**C. Sulphate Content (using test Kit)**

| Qty of Water taken | Qty. of Reagent 'A' | Qty. of Regent 'B' | Sulphate Content (mg/l) |
|---|---|---|---|
| | | | |

Results : Accepted /Not Accepted

Remarks (if Any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

**Identification No.** | | | | | | | | | |

## 8.2.2 Test Proforma for determining the water content of soil

| | |
|---|---|
| Sample No. : <br> Quantity of Soil : <br> Source : <br> To be used in structure : | Date of Sampling : <br> Method of Testing : IS : 2720 (Part II) - 1973 <br> Date of Testing : <br> Sampling and Testing By : <br> Quantity of sample : : |

Method test adopted = Oven Drying / Sand Bath / Alcohol

$W_1$ = Mass of Container with Lid = ................. gms.
$W_2$ = Mass of Container with Lid with wet soil = ................. gms.
$W_3$ = Mass of Container with Lid with dry soil = ................. gms.

$$\text{Water Content } (\omega) = \frac{(W_2 - W_3)}{(W_3 - W_1)} \times 100$$

=.................. %

Results : Accepted /Not Accepted

Remarks (if Any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : <br> Name | For Department : <br> Name |

**Identification No.** | | | | | | | | | |

### 8.2.3 Test Proforma for determining the Dry Density of soil

| | |
|---|---|
| Sample No. : <br> Quantity of Soil : <br> Source : <br> To be used in structure : | Date of Sampling : <br> Method of Testing : IS : 2720 (Part II) - 1973 <br> Date of Testing : <br> Sampling and Testing By : <br> Quantity of sample : : |

Method test adopted = Small Pouring Cylinder / Large Pouring Cylinder

$W_1$ = Weight of sand (+ cylinder ) before pouring = ............gms.
$W_2$ = Mean weight of sand in cone ( of pouring cylinder )= ............gms.
$W_3$ = Mean Weight of sand (+ cylinder ) after pouring = ............gms.
$W_a$ = Weight of sand to fill the calibrating container = $W_1 - W_3 - W_2$ gms.
Bulk Density of sand = $(W_a / V) \times 1000$ Kg/m$^3$ = ................ Kg/m$^3$

$W_w$ = Weight of wet soil from hole ($W_w$) = .................gms.
$W_4$ = Weight of sand (+ cylinder ) after pouring = ................. gms.
$W_b$ = Weight of sand in hole = $W_1 - W_4 - W_2$ = .................gms.

Bulk Density $\gamma_b = (W_w / W_b) \times \gamma_s$ = .................Kg/m$^3$

Water Content ($\omega$) = .......... %

Dry Density $\gamma_d = 100\,\gamma_b / (100 + \omega)$ = .................Kg/m$^3$

Results : Accepted /Not Accepted

Remarks (if Any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : <br> Name | For Department : <br> Name |

Identification No. | | | | | | | | | |

## 8.2.4 Test Proforma for determining the Specific Gravity and Water Absorption of Aggregates

| | | | |
|---|---|---|---|
| Sample No. : | | Date of Sampling | : |
| Quantity of Aggregate : | | Method of Testing | : IS : 2386 (Part III) – 1963 (for aggregates larger than 10 mm) |
| Source : | | Date of Testing | : |
| To be used in structure : | | Sampling and Testing By | : |
| | | Quantity of sample : | : |

$A_1$ = Weight of basket and sample weighed in water = ............ gms.
$A_2$ = Weight of basket and sample weighed in air = ............ gms.
B = Weight of saturated surface dry aggregate in air = ............ gms.
C = Weight of oven dried aggregates in air = ............ gms.

A= Weight of saturated aggregates in water = $A_1 - A_2$ = ............ gms

Specific Gravity = C/(B-A) = ............
Water Absorption ( percentage of dry weight) = 100 (B-C)/C = .......... %

Results : Accepted /Not Accepted

Remarks (if Any) :

| | | | |
|---|---|---|---|
| Signed | : | Signed | : |
| Date | : | Date | : |
| For Contractor Name | : | For Department Name | : |



1965 CPWD/2002—17A

Identification No. | | | | | | | | | |

## 8.2.5 Test Proforma for determining the Specific Gravity and Water Absorption of Aggregates

| | |
|---|---|
| Sample No. : <br> Quantity of Aggregate : <br><br> Source : <br> To be used in structure : | Date of Sampling : <br> Method of Testing : IS : 2386 (Part III) – 1963 (for aggregates smaller than 10 mm) <br> Date of Testing : <br> Sampling and Testing By : <br><br> Quantity of sample : : |

A = Weight of saturated surface dry sample = .......... gms.
B = Weight of pycnometer containing the sample and filled with distilled water = .......... gms.
C = Weight of pycnometer filled with distilled water only = .......... gms.
D = Weight of oven dried sample = .......... gms.

Specific Gravity = D/{A- (B-C)} = ............
Water Absorption ( percentage of dry weight) = 100 (A-D)/D = .......... %

Results : Accepted /Not Accepted

Remarks (if Any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : <br> Name | For Department : <br> Name |

Identification No. | | | | | | | | | |

## 8.2.6 Test Proforma for Sieve Analysis of 10 mm size aggregates

| | | | | |
|---|---|---|---|---|
| Sample No. : | Date of Sampling | : | | |
| Quantity of Aggregate : | Method of Testing | : IS : 2386 (Part I) – 1963 | | |
| Source : | Date of Testing | : | | |
| To be used in structure : | Sampling and Testing By | : | | |
| | Quantity of sample | : | Sample 1 | Sample 2 |
| | | | | |

| IS Sieve Designation | Mass Retained (in gms.) | | | Cumulative Mass Retained (in gms.) | Percentage of Cumulative Mass Retained | Percentage Passing | Acceptable Limits (in %age) |
|---|---|---|---|---|---|---|---|
| | Sample 1 | Sample 2 | **Mean** | | | | |
| 12.5 mm | | | | | | | 100 |
| 10 mm | | | | | | | 85 to 100 |
| 4.75 mm | | | | | | | 0 to 20 |
| 2.36 mm | | | | | | | 0 to 5 |

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

Identification No. | | | | | | | | | |

## 8.2.7 Test Proforma for Sieve Analysis of 20 mm size aggregates

| | | | | |
|---|---|---|---|---|
| Sample No. : | Date of Sampling | : | | |
| Quantity of Aggregate : | Method of Testing | : IS : 2386 (Part I) – 1963 | | |
| Source : | Date of Testing | : | | |
| To be used in structure : | Sampling and Testing By | : | | |
| | Quantity of sample | : | Sample 1 | Sample 2 |
| | | | | |

| IS Sieve Designation | Mass Retained (in gms.) | | | Cumulative Mass Retained (in gms.) | Percentage of Cumulative Mass Retained | Percentage Passing | Acceptable Limits (in %age) |
|---|---|---|---|---|---|---|---|
| | Sample 1 | Sample 2 | **Mean** | | | | |
| 40 mm | | | | | | | 100 |
| 20 mm | | | | | | | 85 to 100 |
| 10 mm | | | | | | | 0 to 20 |
| 4.75 mm | | | | | | | 0 to 5 |

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** | | | | | | | | | |

## 8.2.8 Test Proforma for Sieve Analysis of 40 mm size aggregates

| | | | |
|---|---|---|---|
| Sample No. : | Date of Sampling : | | |
| Quantity of Aggregate : | Method of Testing : IS : 2386 (Part I) – 1963 | | |
| Source : | Date of Testing : | | |
| To be used in structure : | Sampling and Testing By : | | |
| | Quantity of sample : | Sample 1 | Sample 2 |
| | | | |

| IS Sieve Designation | Mass Retained (in gms.) | | | Cumulative Mass Retained (in gms.) | Percentage of Cumulative Mass Retained | Percentage Passing | Acceptable Limits (in %age) |
|---|---|---|---|---|---|---|---|
| | Sample 1 | Sample 2 | Mean | | | | |
| 63 mm | | | | | | | 100 |
| 40 mm | | | | | | | 85 to 100 |
| 20 mm | | | | | | | 0 to 20 |
| 10 mm | | | | | | | 0 to 5 |

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** | | . | | | | | | / | |

### 8.2.9 Test Proforma for Sieve Analysis of 63 mm size aggregates

| | | | | |
|---|---|---|---|---|
| Sample No. : | Date of Sampling | : | | |
| Quantity of Aggregate : | Method of Testing | : IS : 2386 (Part I) – 1963 | | |
| Source : | Date of Testing | : | | |
| To be used in structure : | Sampling and Testing By | : | | |
| | Quantity of sample | : | Sample 1 | Sample 2 |
| | | | | |

| IS Sieve Designation | Mass Retained (in gms.) | | | Cumulative Mass Retained (in gms.) | Percentage of Cumulative Mass Retained | Percentage Passing | Acceptable Limits (in %age) |
|---|---|---|---|---|---|---|---|
| | Sample 1 | Sample 2 | Mean | | | | |
| 80 mm | | | | | | | 100 |
| 63 mm | | | | | | | 85 to 100 |
| 40 mm | | | | | | | 0 to 30 |
| 20 mm | | | | | | | 0 to 5 |
| 10 mm | | | | | | | 0 to 5 |

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

**Identification No.** | | | | | | | | | |

## 8.2.10 Test Proforma for Sieve Analysis of Fine Aggregatess (Coarse Sand)

| | | | | |
|---|---|---|---|---|
| Sample No. : | Date of Sampling : | | | |
| Quantity of Aggregate : | Method of Testing : IS : 2386 (Part I) – 1963 | | | |
| Source : | Date of Testing : | | | |
| To be used in structure : | Sampling and Testing By : | | | |
| | Quantity of sample : | | Sample 1 | Sample 2 |
| | | | | |

| IS Sieve Designation | Mass Retained (in gms.) | | | Cumulative Mass Retained (in gms.) | Percentage of Cumulative Mass Retained | Percentage Passing | Acceptable Limits (in %age) | |
|---|---|---|---|---|---|---|---|---|
| | Sample 1 | Sample 2 | Mean | | | | Zone II | Zone III |
| 10 mm | | | | | | | 100 | 100 |
| 4.75 mm | | | | | | | 90 -100 | 90 -100 |
| 2.36 mm | | | | | | | 75 - 100 | 85 - 100 |
| 1.18 mm | | | | | | | 55 - 90 | 75 – 100 |
| 600 µ | | | | | | | 35 – 59 | 60 – 79 |
| 300 µ | | | | | | | 8 – 30 | 12 – 40 |
| 150 µ | | | | | | | 0- 10 | 0- 10 |

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** | | | | | | | | | |

## 8.2.11 Test Proforma for Flakiness Index

| | | | |
|---|---|---|---|
| Sample No. : | Date of Sampling : | | |
| Quantity of Aggregate : | Method of Testing : IS : 2386 (Part I) – 1963 | | |
| Source : | Date of Testing : | | |
| To be used in structure : | Sampling and Testing By : | | |
| | Weight of each samples : ( in Gms.) ........A | Sample 1 | Sample 2 |
| | | | |

| IS Sieve No. | | Passing through the thickness gauge (in gms.) | |
|---|---|---|---|
| Passing through | Retained on | Sample 1 | Sample 2 |
| 63 mm | 50 mm | | |
| 50 mm | 40 mm | | |
| 40 mm | 25 mm | | |
| 31.5 mm | 25 mm | | |
| 25 mm | 20 mm | | |
| 20 mm | 16 mm | | |
| 16 mm | 12.5 mm | | |
| 12.5 mm | 10 mm | | |
| 10 mm | 6.3 mm | | |
| Total Wt. of material (in gms.) | | | |
| Mean Wt. of two samples....B | | | |

**Flakiness Index = (B/A) x 100 = ...........**

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** | | | | | | | | | |

## 8.2.12 Test Proforma for Elongation Index

| | | | |
|---|---|---|---|
| Sample No. : | Date of Sampling : | | |
| Quantity of Aggregate : | Method of Testing : IS : 2386 (Part I) – 1963 | | |
| Source : | Date of Testing : | | |
| To be used in structure : | Sampling and Testing By : | | |
| | Weight of each samples : ( in Gms.) ........A | Sample 1 | Sample 2 |
| | | | |

| IS Sieve No. | | Passing through the length gauge (in gms.) | |
|---|---|---|---|
| Passing through | Retained on | Sample 1 | Sample 2 |
| 50 mm | 40 mm | | |
| 40 mm | 25 mm | | |
| 25 mm | 20 mm | | |
| 20 mm | 16 mm | | |
| 16 mm | 12.5 mm | | |
| 12.5 mm | 10 mm | | |
| 10 mm | 6.3 mm | | |
| Total Wt. of material (in gms.) | | | |
| Mean Wt. of two samples....B | | | |

**Elongation Index = (B/A) x 100 = ...........**

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

**Identification No.** | | | | | | | | | |

## 8.2.13 Test Proforma for determining the Standard Consistency of Cement

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Quantity of cement : | Method of Testing : IS : 4031 (Part 4) |
| Source : | Date of Testing : |
| To be used in structure : | Sampling and Testing By : |
| | Weight of each samples ( in Gms.) ........A : Sample 1 \| Sample 2 |

| S. No. | Weight of cement (in gms.) | Weight of Water (in gms.) | Penetration of needle from the bottom of Vicat Mould (in mm) | | Is the penetration between 5 to 7 mm (Yes/No) ? | |
|---|---|---|---|---|---|---|
| | | | Sample 1 | Sample 2 | Sample 1 | Sample 2 |
| 1. | | | | | | |
| 2. | | | | | | |
| 3. | | | | | | |
| 4. | | | | | | |
| 5. | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Amount of Water for Standard Consistency of Cement | | | | | | |
| Mean value of Amount of Water .................... B | | | | | | |

Standard Consistency (P) = (A/B) x 100 =..................... percent

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

Identification No. | | | | | | | | | |

## 8.2.14 Test Proforma for determining the Initial and Final Setting Time of Cement

| | | | | |
|---|---|---|---|---|
| Sample No. : | Date of Sampling : | | | |
| Quantity of cement : | Method of Testing : IS : 4031 (Part ) | | | |
| Source : | Date of Testing : | | | |
| To be used in structure : | Sampling and Testing By : | | | |
| | Weight of each samples (in Gms.) ..............A | : | Sample 1 | Sample 2 |
| | | | | |

Standard Consistency (P) = ...........Percent
85 % of P = 0.85 x P = ...........Percent

### Initial Setting Time

**Initial Reading of Stop Watch ($T_0$) for sample I = ............... Minutes**
**for sample 2 = ............... Minutes**

| S. No. | Reading of Stop Watch | Penetration of needle from the bottom of Vicat Mould (in mm) | | Is the penetration between 5 ± 0.5 mm (Yes/No) ? | |
|---|---|---|---|---|---|
| | | Sample 1 | Sample 2 | Sample 1 | Sample 2 |
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Reading of Stop Watch with Penetration between 5 ± 0.5 mm from bottom of Vicat mould ($T_1$)
Sample 1 =.................... minutes Sample 2 =.................... minutes

Initial Setting Time ($T_i$) = $T_1 - T_0$ for
Sample 1 =.................... minutes Sample 2 =.................... minutes

Mean Value of Initial Setting Time = ...............Minutes
Acceptable Value =
Results : Accepted /Not Accepted

Remarks (if any) :

# Final Setting Time

**Initial Reading of Stop Watch ($T_0$) for sample I = ............... Minutes**
**for sample 2 = ............... Minutes**

| S. No. | Reading of Stop Watch | Does the Annular attachment makes an impression on the surface of test block (Yes/No) ? | | Does the Needle makes an impression on the surface of test block (Yes/No) ? | |
|---|---|---|---|---|---|
| | | Sample 1 | Sample 2 | Sample 1 | Sample 2 |
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Reading of Stop Watch when Annular attachment does not make an impression while the needle make an impression on the surface of test **(T2)**

Sample 1 =.................... minutes Sample 2 =.................... minutes

Final Setting Time ($T_f$) = $T_2 - T_0$ for

Sample 1 =.................... minutes Sample 2 =.................... minutes

Mean Value of Final Setting Time = ................Minutes

Acceptable Value =

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** [ ][ ][ ][ ][ ][ ][ ][ ][ ]

## 8.2.15 Test Proforma for determining the Soundness of Cement

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Quantity of cement : | Method of Testing : IS : 4031 (Part 3) |
| Source : | Date of Testing : |
| To be used in structure : | Sampling and Testing By : |
| | Weight of each samples (in Gms.) ........A : Sample 1 \| Sample 2 |

Standard Consistency (P) = ...........Percent
78 % of P = 0.78 x P = ...........Percent

**Date and Time of immersing the sample in water**
**For Sample 1** Date ........... Time ......... **For Sample 2** Date ......... Time .........

**A. Initial Reading after 24 hours**

Date and Time of taking initial Reading
**For Sample 1** Date ........... Time ......... **For Sample 2** Date ......... Time .........

Distance between the indicator points (**$D_1$**)
For Sample 1 = ...........mm For Sample 2 = ...........mm

**B. Final Reading after boiling for 3 hours**

Date and Time of taking Final Reading
**For Sample 1** Date ........... Time ......... **For Sample 2** Date ......... Time .........

Distance between the indicator points ( **$D_2$**)
For Sample 1 = ...........mm For Sample 2 = ...........mm

Expansion of Cement = $D_2 - D_1$
For Sample 1 = ...........mm For Sample 2 = ...........mm

Mean Value of Expansion of Cement = .............. mm
Acceptable Limits = .............. mm

Results Accepted / Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

**Identification No.** | | | | | | | | | |

### 8.2.16 Test Proforma for determining the Compressive Strength of Cement

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Quantity of cement : | Method of Testing : IS : 4031 (Part 6) |
| Source : | Date of Testing : |
| To be used in structure : | Sampling and Testing By : |

Quantity of Cement = 200 g
Quantity of Sand = 600 g

Standard Consistency (P) = ...........Percent
Required Water content (w) = (P/4) + 3 = ...........Percent
Amount of Water to be added = 2 x w = ...........Percent

Date and Time of keeping the sample in moist closet room
Date .................. Time ..................

Date and Time of submerging the samples in clean fresh water
Date .................. Time ..................

Date and Time of testing of Specimens
Date .................. Time ..................
A= X-area of specimen = 70.6 x 70.6 mm = 4984.36 $mm^2$

| S.No. | Maximum Load Applied (P) (in N) | Compressive Strength C = (P/A) (in $N/m^2$) | Variation in compressive Strength $V_c = \frac{(C-C_m)}{C_m} \times 100$ | Is $\lvert V_c \rvert < 10$ (Yes/No) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

Mean Compressive Strength = ........... $N/m^2$
Age of sample = .......... Days
Acceptable Value = ........... $N/m^2$

Results Accepted / Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

**Identification No.** | | | | | | | | | |

## 8.2.17 Test Proforma for Strip Pull Out Test in Reinforced Soil Wall

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Height of Back fill : | Method of Testing : |
| Source of Strips : | Date of Testing : |
| Embedded length of Strip : | Sampling and Testing By : |

Ram area of Jack = .............. $mm^2$
Maximum Test Pressure for Strip Pull out = .............. ($Kg/cm^{2)}$

| Applied Pressure ($Kg/cm^{2)}$ | Applied Force (kN) | Dispalcement Reading (in mm) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Net Displacement at test Pressure = ..........mm
Acceptable Value = ..........mm

Results : Accepted / Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : | For Department : |
| Name | Name |

**Identification No.** | | | | | | | | | |

## 8.2.18 Test Proforma for Lug Pull Out Test from Reinforced Soil Wall Panel

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Identification of RE Wall Panel : | Method of Testing : |
| Source of Lugs : | Date of Testing : |
| Grade of Concrete of RE Panel : | Sampling and Testing By : |

Ram area of Central Hole Jack = ............... $cm^2$
Minimum Force for Lug Pull out at failure = ............... T

| Applied Pressure ($Kg/m^2$) | Applied Force (T) | Remarks |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Load at Failure = .......... T
Minimum accepted Load at Failure = .......... T

Results : Accepted / Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor Name : | For Department Name : |

**Identification No.** | | | | | | | | | |

## 8.2.19 Test Proforma for Bentonite Slurry

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Pile No. : | Method of Testing : |
| Source : | Date of Testing : |
| | Sampling and Testing : By |

| Sample No. | Specific Gravity | pH Value | Mars Cone Viscosity |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| **Mean Value** | | | |
| **Acceptable Limits** | **1.025 Minimum** | **9.5 to 12** | **30 to 40** |

Results : Accepted / Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |



1965 CPWD/2002—18A

Identification No. | | | | | | | | | |

### 8.2.20 Test Proforma for testing the Epoxy Bonding Agent

| | | | |
|---|---|---|---|
| Sample No. | : | Date of Sampling | : |
| Quantity of Epoxy | : | Method of Testing | : |
| Source | : | Date of Testing | : |
| To be used in structure | : | Sampling and Testing By | : |

## 1. Pot Life of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ..........°C
2. Duration of Mixing = 3 minutes

| Time since completion of Mixing (in Minutes) | Remarks (Workable/Stiff/Not Workable) |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

Pot Life of sample of Epoxy = .............. Minutes
Recommended Pot Life = minimum 20 Minutes
Results : Accepted / Not Accepted
Remarks (if any) :

## 2. Open Time of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ..........°C

| Specimen No. | Time since completion of Mixing (in Minutes) | Remarks (Concrete Failure/ Joint Failure) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Open Time of sample of Epoxy = .............. Minutes
Recommended Open Time = minimum 60 Minutes
Results : Accepted / Not Accepted
Remarks (if any) :



1965 CPWD/2002—18B

## 3. Thixotropy of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ...........°C
2. Sample filled in gutter of Daniel's gauge after 10 minutes of 3 minutes mixing

| S. No. | Time reckoned from start (in Minutes) | Sag (in mm) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Sag Flow of Epoxy = .............. Minutes
Recommended sag Flow = maximum 30 Minutes

Results : Accepted / Not Accepted
Remarks (if any) :

## 4. Angle of Internal Friction (Squeezability)

1. Ambient Temperature during Testing = ...........°C
2. Quantity of Bonding Agent 3140 $mm^3$

| S. No. | Load (in Kg.) | Area of Spread (in $mm^2$) | Acceptable Values of the area of Spread (in $mm^2$) |
|---|---|---|---|
| 1. | 15 | | 3000 minimum |
| 2. | 200 | | 7500 minimum |
| 3. | 400 | | 10000 minimum |

Results : Accepted / Not Accepted
Remarks (if any) :

## 5. Curing rate of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ...........°C
2. Size of Cubes = 50 mm x 50 mm x 50 mm

| Curing Time (hrs.) | Failure Load (in kN) | | | Mean Load at Failure (kN) | Compressive Strength ($N/mm^2$) | Acceptable Values ($N/mm^2$) |
|---|---|---|---|---|---|---|
| | Specimen 1 | Specimen 2 | Specimen 3 | | | |
| 12 | | | | | | Minimum 20 |
| 24 | | | | | | Minimum 60 |
| 168 | | | | | | Minimum 75 |

Results : Accepted / Not Accepted
Remarks (if any) :

## 6. Compressive Strength of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ..........°C
2. Size of Cubes = 50 mm x 50 mm x 50 mm

| Age of Specimen (hrs.) | Failure Load (in kN) | | | Mean Load at Failure (kN) | Compressive Strength ($N/mm^2$) | Acceptable Values ($N/mm^2$) |
|---|---|---|---|---|---|---|
| | Specimen 1 | Specimen 2 | Specimen 3 | | | |
| 24 | | | | | | Minimum 60 |
| 168 | | | | | | Minimum 75 |

Results : Accepted / Not Accepted
Remarks (if any) :

## 7. Bonding of Cured Bonding Agent to Concrete surface

1. Ambient Temperature during Testing = ..........°C
2. Compressive Strength of Prism should be approx. 40 $N/mm^2$

| Specimen No. | Remarks (Concrete Failure / Joint Failure) |
|---|---|
| | |
| | |
| | |

Recommendations : Total fracture of concrete paste should occur (concrete failure) with no evidence of bonding agent failure (Joint Failure).

Results : Accepted / Not Accepted
Remarks (if any) :

## 8. Tensile Bending strength of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ..........°C
2. Compressive Strength of Prism should be approx. 40 $N/mm^2$

| Specimen No. | Remarks (Concrete Failure / Joint Failure) |
|---|---|
| | |
| | |
| | |

Recommendations : Total fracture of concrete paste should occur (concrete failure) with no evidence of bonding agent failure (Joint Failure).

Results : Accepted / Not Accepted
Remarks (if any) :

## 9. Shear strength of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ...........°C

| Specimen No. | Load at Failure (kN) | Shear Stress ($N/mm^2$) |
|---|---|---|
| | | |
| | | |
| | | |

Recommendations : Minimum Shear Stress = 12 $N/mm^2$

Results : Accepted / Not Accepted
Remarks (if any) :

## 10. Heat resistance of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ...........°C

| Specimen No. | Load at Failure (kN) | Shear Stress ($N/mm^2$) |
|---|---|---|
| | | |
| | | |
| | | |

Recommendations : Minimum Shear Stress = 10 $N/mm^2$ at 50 °C

Results : Accepted / Not Accepted
Remarks (if any) :

## 11. Colour of Epoxy Bonding Agent

Colour of Epoxy Bonding Agent = ..............
Recommendations : Colour should be similar to adjoining concrete

Results : Accepted / Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : | For Department : |
| Name | Name |

**Identification No.** | | | | | | | | | |

## 8.2.21 Test Proforma for testing the MS Sheathing

| | | | |
|---|---|---|---|
| Sample No. | : | Date of Sampling | : |
| Length of Sheathing | : | Method of Testing | : IRC 18 : 2000 Appendix-1A |
| Source | : | Date of Testing | : |
| To be used in structure | : | Sampling and Testing By | : |

### 1. Workability Test of Sheathing

Length of Sheathing test piece = 1100 m
Dia. of Sheathing = ........mm
Radius of Bent = 1800 mm
No. of cycles = 3

Condition of sealing joints after 3 cycles (any failure or opening of Joints)

............................ .........................................................

Recommendations : No failure or opening of Joints after 3 cycles

Results : Accepted / Not Accepted
Remarks (if any) :

### 2. Transverse Load Rating Test

Length of Sheathing test piece = 1100 m
Dia. of Sheathing = ........mm
Applied Load = ..........N

Permanent Deformation =..........%

Recommendations : Permanent Deformation is less than 5 %

Results : Accepted / Not Accepted
Remarks (if any) :

## 3. Tension Load Test

Length of Sheathing test piece = 1100 m
Dia. of Sheathing = ........mm
Applied Load = ..........N

Condition of joints and couplers (any deformation of Joint or slippage of couplers)

.....................................................................................

Recommendations : No deformation of Joint or slippage of couplers is to be noticed

Results : Accepted / Not Accepted
Remarks (if any) :

## 4. Water Loss Test

Length of Sheathing test piece = 1100 m
Dia. of Sheathing = ........mm
Applied pressure = 0.05 Mpa
Duration of Applied pressure = 5 minutes

Loss of Water = ..........

Recommendations : Maximum loss of water = 1.5 %

Results : Accepted / Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : | For Department : |
| Name | Name |

**Identification No.** | | | | | | | | | |

## 8.2.22 Test Proforma for testing the HDPE Sheathing ducts

| | | | |
|---|---|---|---|
| Sample No. | : | Date of Sampling | : |
| Length of Sheathing | : | Method of Testing | : IRC : 18 –2000 Appendix – 1B |
| Source | : | Date of Testing | : |
| To be used in structure | : | Sampling and Testing By | : |

### 1. Bond Test

| Data | Sample 1 | Sample 2 | Sample 3 |
|---|---|---|---|
| Dia. Of Duct (mm)<br>Length of Duct (in mm,40 times the dia. of duct)<br>Strength of Grout (in $N/mm^2$, Minimum 27 $N/mm^2$)<br>Anchorage Efficiency<br>Failure Capacity of tendon(in Mpa)<br>95 % of failure Capacity (in Mpa)<br>Load at Failure (in Mpa) | | | |
| Mean Load at Failure (in Mpa) | | | |

Recommendations : Failure capacity of bond shall be atleast equal to the anchorage efficiency or 0.95 of failure capacity of the tendon.

Results : Accepted / Not Accepted
Remarks (if any) :

### 2. Compressive Test for the loss of Wall thickness

Size of cube = 300 mm
Load applied over concrete block = 5 kN, Pulling of strand = 200 mm

| Data | Sample 1 | Sample 2 | Sample 3 |
|---|---|---|---|
| Measurements of the indentation formed | | | |
| Mean value of the indentation formed | | | |

Recommendations : The residual thickness of the duct shall not be less than 1.5 mm

Results : Accepted / Not Accepted
Remarks (if any) :

| | | | |
|---|---|---|---|
| Signed | : | Signed | : |
| Date | : | Date | : |
| For Contractor | : | For Department | : |
| Name | | Name | |

**Identification No.** | | | | | | | | | |

## 8.2.23 Test Proforma for determining the crushing and Impact Value of aggregates

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Quantity of Aggregate : | Method of Testing : IS : 2386 (Part IV) – 1963 (for aggregates larger than 10 mm) |
| Source : | Date of Testing : |
| To be used in structure : | Sampling and Testing By : |
| | Quantity of sample : : |

### 1. Aggregate Crushing value

A = Weight of surface dry sample = ............ gms.
B = Weight of fraction passing the2.36 mm Sieve = ............ gms.

Aggregate Crushing Value = (B/A) x 100 = ............
Recommended Value = .............

Results : Accepted /Not Accepted
Remarks (if Any) :

### 2. Aggregate impact value

A = Weight of oven dried sample = ............ gms.
B = Weight of fraction passing the2.36 mm Sieve = ............ gms.

Aggregate Impact Value = (B/A) x 100 = ............
Recommended Value = .............

Results : Accepted /Not Accepted
Remarks (if Any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** | | | | | | | | | |

### 8.2.24 Test Proforma for determining the silt Content of fine aggregates

| | |
|---|---|
| Sample No. :<br>Quantity of Aggregate :<br><br>Source :<br>To be used in structure : | Date of Sampling :<br>Method of Testing : IS : 2386 (Part IV) – 1963 (for aggregates larger than 10 mm)<br>Date of Testing :<br>Sampling and Testing By :<br><br>Quantity of sample : : |

| S. No. | Height of Silt above the sand layer (in mm) A | Height of sand below the Silt layer (in mm) B | Percentage of Silt = (A/B) x 100 | Acceptable Limits |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

Results : Accepted /Not Accepted

Remarks (if Any) :

| | |
|---|---|
| Signed :<br>Date :<br>For Contractor Name : | Signed :<br>Date :<br>For Department Name : |

**Identification No.** | | | | | | | | | |

## 8.2.25 Test Proforma for Testing the Plasticiser

| | |
|---|---|
| Sample No. : | Date of Sampling : |
| Quantity of Plasticiser : | Method of Testing : IS : 9103 - 1999 |
| Source : | Date of Testing : |
| To be used in structure : | Sampling and Testing By : |
| | Quantity of sample : : |

1. Compressive Strength (percentage of Control Sample)

1. Grade of Concrete = M ........
2. Age of Concrete Cubes = ...... days
3. Size of cube

| S. No. | Sample No. | | Compressive Strength of concrete | | | | |
|---|---|---|---|---|---|---|---|
| | | | Control Concrete | | Concrete with Plasticiser | | |
| | Control Concrete | Concrete with Plasticiser | Load at Failure | Compressive Strength | Load at Failure | Compressive Strength | Compressive Strength as percentage of control Sample |
| 1. | | | | | | | |
| 2. | | | | | | | |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |

Recommended Value of the compressive Strength as percentage of control sample :

3 days =125 % minimum, 7 days = 125 % minimum, 28 days = 115 % minimum

Results : Accepted /Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

## 2. Loss of Workability slump in mm, (deviation from control sample)

1. Grade of Concrete = M ........

| S.No. | Slump of concrete ( in mm) | |
|---|---|---|
| | Control Concrete after 15 minutes | Concrete with Plasticiser after 2 h |
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |

Recommended Value of the deviation in slump from control sample :
The slump at the end of 2 hours should not be lesser than that of control concrete after 15 minutes.

Results : Accepted /Not Accepted
Remarks (if Any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

Identification No. | | | | | | | | | |

## 8.2.26 Test Proforma for Anchorage Efficiency Test on Prestressing System

| | |
|---|---|
| Sample No. :<br>:<br><br>Source :<br>To be used :<br>in structure | Date of Casting of beams :<br>Method of Testing : FIP Recommendations<br>Date of Testing :<br>Testing By :<br><br>No. of Beams : : |

<u>**UTS of the Strand**</u>

Jack Details :
Make and Type .
Last calibrated on ............
Ram area = ...................
Strand free Length = .........
Strand Make : ................

| Sample No. | Pressure in Bars | | Load (in T) | | Jack Stroke | | Elongation (in mm) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | Initial | Final | Initial | Final | Initial | Final | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| Mean UTS of Strand | | | | | | | | |

## Anchorage Efficiency Test

| Jack Details : | Tendon Type : |
|---|---|
| Make and Type<br>Last calibrated on ………….<br>Ram area = ………………..<br>Strand free Length = ………<br>Strand Make : …………….. | Actual mean UTS of strand :<br>Actual UTS of tendon assembly : |

| Sample No. | Pressure in Bars | | Load (in T) | | Jack Stroke | | Elongation (in mm) | Dial Gauge (Wedges) reading | | Wedge draw-in | Dial Gauge (Strands) reading | | Strand Movement |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | Final | Initial | Final | Initial | Final | | Initial | Final | | Initial | Final | |
| 1 | | | | | | | | | | | | | |

Zero Correction = ………………., Net Elongation = ……………

Percentage Elongation =

Anchorage Efficiency = $\dfrac{\text{Load at Failure} \times 100}{\text{UTS of tendon assembly}}$

Results : Accepted /Not Accepted

Remarks (if any) :

| Signed : | Signed : |
|---|---|
| Date :<br>For Contractor :<br>Name | Date :<br>For Department :<br>Name |

**Identification No.** | | | | | | | | | |

## 8.2.27 Test Proforma for Load Transfer Test on Prestressing System

| | |
|---|---|
| Sample No. : | Date of Casting of bloacks : |
| | Method of Testing : FIP Recommendations |
| Source : | Date of Testing : |
| To be used in structure : | Testing By : |
| | No. of Blocks : |

**Crack Width Record (mm)**

| Cycle No. | | Face 1 | | Face 2 | | Face 3 | | Face 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Crack no. | Width | Crack no. | Width | Crack no. | Width | Crack no. | Width |
| 1 | At 80 % UTS | | | | | | | | |
| 2 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 3 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 4 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 5 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 6 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 7 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 8 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 9 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| 10 | At 12 % UTS | | | | | | | | |
| | At 80 % UTS | | | | | | | | |
| | At 110 % UTS | | | | | | | | |

## Strain Gauge Readings

| Cycle no. | Load (in T) (% of UTS) | Strain Orientation | Strain gauge Readings (micro strains) | | | |
|---|---|---|---|---|---|---|
| | | | Face 1 | | Face 2 | Face 3 |
| 1 | 0 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 20 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 40 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 60 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 80 % | Horizontal | | | | |
| | | Vertical | | | | |
| 2 | 12 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 80 % | Horizontal | | | | |
| | | Vertical | | | | |
| 3 | 12 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 80 % | Horizontal | | | | |
| | | Vertical | | | | |
| 4 | 12 % | Horizontal | | | | |
| | | Vertical | | | | |
| | 80 % | Horizontal | | | | |
| | | Vertical | | | | |
| | | | | | | |
| | | | | | | |

To be recorded till the strain gauge readings are stabilised

Acceptance Criteria :

1. Crack width at first level of 80 % of UTS = ............ mm
2. Crack width at last level of 12 % of UTS = ............ mm
3. Crack width at final cycle at 80 % of UTS = ............ Mm

4. Measured Failure Load ($F_u$)

   (i) $1.1 \times F_{pk}$ =

   (ii) $(F_{pk} \times f_{cm.e})/f_{ck.o}$ =

Results : Accepted /Not Accepted

Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : Name | For Department : Name |

**Identification No.** | | | | | | | | | |

## 8.2.28 Test Proforma for Vertical Load Test on Piles

Test Pile No. ...........
Date of Testing

Jack Details :
Make and Type
Last calibrated on ............
Ram Dia. = ...................., 1 Division = ................

**Recording of Deflection**

| Date and Time | Pressure applied ($Kg/cm^2$) | Load (in MT) | Dial Gauge Reading (in mm) | | | | Average Reading (in mm) | Average settlement (in mm) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | | | |
| **Pressure Building up** | | | | | | | | | |
| | | | | | | | | | |
| **Pressure Released** | | | | | | | | | |
| | | | | | | | | | |

Recommended Value : Maximum Deflection = 12 mm
Results : Accepted /Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : | For Department : |
| Name | Name |

Identification No. | | | | | | | | | |

## 8.2.29 Test Proforma for Lateral Load Test on Piles

Test Pile No. ...........
Date of Testing

Jack Details :
Make and Type
Last calibrated on ............
Ram Dia. = ..................., 1 Division = ...............

Recording of Deflection

| Time | Pressure applied ($Kg/cm^2$) | Load (in MT) | Dial Gauge Reading (in mm) | | Remarks |
|---|---|---|---|---|---|
| | | | Test Pile | Reaction Pile | |
| **Pressure Building up** | | | | | |
| | | | | | Initial Reading<br><br>Final Reading |
| **Pressure Released** | | | | | |
| | | | | | |

Recommended Value : Maximum Deflection at Peak Load = 5mm
Results : Accepted /Not Accepted
Remarks (if any) :

| | |
|---|---|
| Signed : | Signed : |
| Date : | Date : |
| For Contractor : | For Department : |
| Name | Name |

**Identification No.** | | | | | | | | | |

## 8.2.30 Proforma for Grouting Record in sheathings

Name of Work : ....................................................................................................

Span No........................................ Cable No. ........................................

Date of Prestressing........................... Date of Grouting ...............................

Type of cement : ............................. Date of manufacture: ..........................

Water Cement Ratio (Max. 0.45) : .........

Name and amount of Admixture (if used)..................................... ..........................

Temperature : Mixing Water................. Grout ..............................................

Time : Start .................................... Finish ...........................................

Equipment : Grout Mixer ...................... Grout Pump ....................................

Cable duct Diameter : ......................... Length .............................................

Volume of Grout (in lts.) ...................... Regrouting .......................................

Grouting Pressure ...............................

Cement Consumption : Theoretical .......... Actual .............................................

**Pregrouting Checks :**

**Free of blockage :** 1. Inlet (Yes/No) ......... 2. Outlet (Yes/No) ..............................

3. Vents (Yes/No) ....... 4. Cable ducts (Yes/No) ........................

Leakage observed : (Yes/No) .................. Sealed ............................................

If cable duct blocked : Remedial measures : ...............................................................

**Grouting observations :**

Passage of grouts through vents (Yes/No) ........................................

Passage of grouts through outlets (Yes/No) ........................................

Any equipment failure : ...................................................

**Post Grouting Checks :**

Probing by stiff wire : ...................................................

Results : Accepted /Not Accepted

Remarks :

| | | |
|---|---|---|
| Signed : | Signed : | Signed : |
| Date : | Date : | Date : |
| For system supplier : Name | For contractor : Name | For Department : Name |

## 8.2.31 Proforma for Prestressing record of the cables

**Identification No.** | | | | | | | | | |

Name of flyover :

Average cube strength at the time of stressing :

High Tensile Steel (UTS) = ....................Kg/cm$^2$

Cube Strength at 28 days = ....................Kg/cm$^2$

Span No. : ............................

Element /Girder no. : ................

Last date of concreting : ............

Date of prestressing : ................

Stressing sequence drawing no.

**Marks of Plant used :** Jacks :

Pumps :

Gauges :

Left end of cable = A

Right end of cable = A

Specified gauge pressure during Jacking :

Maximum jack pressure during stressing :

| Cable stressing sequence | | Calculated Elongation (mm) | | Gauge Mark Readings Extension (mm) at the pressure of 100 Kg/cm$^2$ | | | Gauge Mark Readings Extension (mm) at the pressure of 200 Kg/cm$^2$ | | | Reading at instant of Locking Pressure | | | | | | | | Slip (Draw-in) mm | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | Immedia -tely after Locking | | After 24 hours | | Total draw - in | | | | |
| Sequence | Cable marked | Before draw-in (e1) | After draw-in (e2) | $\Delta A_0$(in mm) | $\Delta B_0$(in mm) | e3 $=\Delta A_0 + \Delta B_0$ | $\Delta A_1$(in mm) | $\Delta B_1$(in mm) | e3 $=\Delta A_1 + \Delta B_1$ | $\Delta A_2$(in mm) | $P_A$ Kg/cm$^2$ | $\Delta B_2$(in mm) | $P_B$ Kg/cm$^2$ | E5 $=\Delta A_2 + \Delta B_2$ | Initial Elongation upto 100 Kg/cm2 e6 =e4 – e 3 (in mm) | Total Elongation e7 =e5 –e3 + e6 (mm) | Deviation = e1 –e7 (in mm) | $SA_0$ | $SB_0$ | $SA_{24}$ | $SB_{24}$ | $S = SA_0 + SB_0 + SA_{24} + SB_{24}$ | Net Elongation e8 =e7 – S (in mm) | Devaition after draw-in = e2 –e8 (mm) | %Excess/shortfall in deviation after darw in $=\frac{(e2\text{-}e8)\text{x}100}{e2}$ | Remarks |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| Signed : | Signed : | Signed : |
| Date : | Date : | Date : |
| For system supplier Name : | For contractor Name : | For Department Name : |

# CHAPTER 9

# METHOD STATEMENTS

9.1 **Bored Cast-In-Situ Piles**

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## 9.1 METHOD STATEMENT FOR INSTALLATION OF BORED CAST-IN-SITU PILES .

9.1.1 Pile point will be marked on the ground with Total Survey Station.

9.1.2 The Rotary boring machine will be moved to pile location and positioned w.r.t. pile center point ensuring verticality of mast with in-built indicator panel facility or with spirit level.

9.1.3 After boring of about 5 to 6 mtr. Temporary steel casing or approx. 5m depth will be placed in plumb position and checked with help of spirit level.

9.1.4 Boring shall be carried out using rotary auger/bucket up to the tip of pile. The depth of the bore shall be checked with a steel wire and tape.

9.1.5 The sides of bore hole shall be stabilized even during boring by use of bentonite slurry through out its length. The level of bentonite suspension shall be maintained up to approx. 1.0M above the bottom level of temporary casting at the top.

9.1.6 The bottom of bore hole shall be cleaned thoroughly using bucket.

9.1.7 Full length of steel reinforcement cage with spacer blocks will be lowered into the borehole.

9.1.8 8" / 10" dia tremmie pipe shall be lowered into bore hole keeping the bottom of tremmie approximately 300mm above pile bottom level.

9.1.9 The bore hole shall again be cleaned by bentonite circulation by pumping fresh bentonite solution of a specific gravity of at least 1.025. The adequacy of pump for flushing piles more than 20 mtr deep will be ensured.

9.1.10 After ensuring that the out coming bentonite slurry is clean and consistency of the same is almost equal, (density to be measured & maintained ) as that of fresh bentonite slurry, the bentonite circulation will be stopped.

9.1.11 If bore is left without concreting for more than two hours, it shall be flushed again.

9.1.12 Hopper will be placed on tremmie pipe.

9.1.13 Ready mix concrete of required grade with 150 to 180mm slump shall be brought by transit mixers.

9.1.14 Concrete shall be poured through tremmie pipe (directly from transit mixer in the hopper).

9.1.15 Concreting shall generally be poured with minimum interruption. However, under unavoidable circumstance if the operation has to be suspended temporarily, then the tremmie pipe shall be raised and lowered slowly from the time to time to avoid setting of concrete around it.

9.1.16 Sacrificial concrete at top will be cast for atleast 1m.

9.1.17 The tremmie pipe shall be removed in stage during pouring of concrete ensuring that the tremmie bottom is always within the concrete. The operation shall be continued till the entire length of pile is cast.

9.1.18 The boring machine shall be brought back to location and temporary casing shall be removed using casing adapter.

9.1.19 Bore soil / bentonite mud shall be removed with the help of loader and tippers.

## 9.2 METHOD STATEMENT- LOAD TEST ON PILES.

9.2.1 The initial load test to be carried out as per IS-2911 Part-4- 1985.

9.2.2 The Kentledge structure shall be designed according to the applicable loads.

9.2.3 A pit of 12Mx12M shall be excavated up to 2m below the ground level.

9.2.4 Further, pit about 3 M x 3 M shall be excavated around the test pile up to about 150mm below the test level of 1.40 M height below the bottom level of previous pit.

9.2.5 The pile shall be chipped off in order to remove the weak concrete and finished smooth at the test level with the same grade of concrete as in the pile.

9.2.6 The supports for the main girders shall be made of RCC and the top level shall be maintained at a pre-determined level, so that there is a gap of about 50mm between the jack assembly and the soffit of the main girders at the zero-load position. Sketch is shown in the drawing.

9.2.7 The jacks shall be placed over M.S. Plates on the pile, so that the center of gravity of the jacks is over the center of the M.S. Plates and over the center of the pile.

9.2.8 The Kentledge structure be placed in position as per design. The girders shall be tack-welded with reinforcement bars so as to keep them in position during the loading. The Kentledge shall be covered with M.S. plates of 4mm thickness.

9.2.9 It is to be ensured throughout the process of loading that the kentledge load shall be concentric with the center of the pile.

9.2.10 The Kentledge shall be loaded with sand bags/precast concrete blocks/sand.

9.2.11 Datum bars shall be provided with its supports at a distance of 5M from the edge of the piles. The supports shall be embedded in concrete into the ground. The datum bars shall be made of rigid structure steel material. The datum bars shall be so arranged as to accommodate dial gauges at three edges of the pile, the edges making apex points of an equilateral triangle.

9.2.12 Three numbers of magnetic stands shall be placed on the pile at the apex points as mentioned above. The magnetic stands shall be placed on M.S. Plates fixed to the pile surface with some adhesive material.

9.2.13 The dial gauges to be used for the test shall be of 0.01mm sensitivity.

9.2.14 The dial gauges shall be fixed with the arms of the magnetic stands and shall be adjusted at '0' reading.

9.2.15 The test shall be carried out by applying series of vertical downward increment loads, each increment being of about 20% of the test load on the pile.

9.2.16 Taking of measurement or displacement in each stage of loading shall be maintained till rate of displacement of the pile top is either 0.1mm in first 30 minutes or 0.2mm in first one hour or till 2 hours whichever occurs first.

9.2.17 The load shall be applied until the maximum test load is reached or the settlement exceeds 10% of the pile dia, whichever occurs earlier.

9.2.18 The test load shall be maintained for 24 hours and hourly readings shall be taken.

9.2.19 The load shall be started to be released in the reverse order of the increment applied. Each load stage shall be maintained for 30 minutes and the readings shall be recorded.

9.2.20 A graph shall be plotted showing loads on X-axis and corresponding displacements on Y-axis and the same shall be presented along with the load test Record Form.

9.2.21 A sample proforma for recording of observation is given.

9.2.22 Pressure shall be applied through 2 Nos. electrically operated hydraulic jacks, each of 500MT capacity which are synchronized to work together.

9.2.23 Pressure gauge and dial gauges shall be got calibrated prior to testing from a reputed laboratory approved Engineer-in-Charge.

## 9.3 METHOD STATEMENT FOR CASTING OF PILE CAPS

**9.3.1** The casting of pile caps will be taken up for pile groups cleared from all the routine tests i.e, Integrity Tests, Vertical Load Tests & Lateral Load Tests if the piles of that pile group are to be tested for any one of more of this tests. Before that the verticality and shift of the individual pile will be checked and recorded in the test given under chapter 8.

**9.3.2** **SHUTTERING MATERIAL** – Pre-fabricated standard steel plate (1200 x 500 or 600 x 900 mm) will be joined with the help of bolts. Suitable packing to be provided to prevent leakage between successive plates.

**9.3.2** **INSPECTION AND INSTALLATION OF SHUTTERING :** The shuttering will then be supported by struts at suitable intervals to render the whole arrangement rigid. The straightness, line and level will be checked as per drawing. Before fixing of shuttering, it would be properly cleaned and the surfaces shall be treated with shuttering oil. Final cleaning of the enclosure will be done with compressor just before the casting of concrete. The position of reinforcement of pile cap and pier dowels will be checked with respect to the centerline of the bridge and the centerline of shuttering as well. To support the dowels of piers, staging shall be erected with scaffolding pipes to the full height at the opposite sides of the pile cap along the major axis of pier. This staging will be done at a suitable location outside the pile cap shuttering at for placing reinforcement of piers, one full set of links will be placed each, at the base (on the bottom layer reinforcement of Pile Cap), inside the template of the starter & at one place for the whole height of pier. A coat of cement will be applied on these dowels.

**9.3.3** **POURING AND COMPACTION :** Casting will be done with crane & bucket arrangement or directly by transit mixer and chute. Pouring of concrete will be done in inclined layers. Concrete shall be deposited just on top of the top reinforcement layer. Compaction will be carried out by needle vibrators. The concreting shall be continued from one end and laid at such a speed that the unfinished face remains plastic. If under any circumstances concrete of the preceding layer looses its plasticity, a coat of cement slurry will be applied on this concrete surface to start further concreting. Small pieces of reinforcement would be inserted party inside the concrete top surface so that protruded portion may be used for proper supporting of the props/turn buckle of the pier. These shall be cut up to one inch below the concrete, painted with epoxy paint and surface repaired with epoxy mortar afterwards.

**9.3.4** **PIER DOWEL AND CASTING OF STARTER :** The checking of pier Dowel & Casting of starter will be done with a template (350mm or so high). The template will be in accurate lines, placed on chairs and well supported. These chairs will be welded to the top layer reinforcement of pile cap. The starter will be poured in the same operation of pile cap casting. The alignment and location of starter will be checked again before casting of starter.

**9.3.5 DESHUTTERING AND INSPECTION :** De-shuttering will be done after 24 hours and inspection of the de-shuttered surface shall be carried out immediately and remedial action of the surfaces, if any, shall be done with the concurrence of the department.

**9.3.6 CURING :** After de-shuttering, the vertical surfaces shall be wrapped with Hessian cloth and curing will be done by water spraying . The top surface will be inundated for 14 days by making a bund of 50mm height in cement mortar all round its periphery.

## 9.4 METHOD STATEMENT FOR DENSE BITUMINOUS MACADAM (INCLUDING BITUMINOUS MACADAM).

9.4.1 The work shall be carried out as per IRC:27.

9.4.2 The DBM will be taken up when

a) The WBM has completely dried for approach area and after completion of curing period of the bridge deck in Viaduct portion.

b) Before starting with DBM, the WBM surface will be checked & rectification if required will be done by removing the whole depth for the affected area & rectifying the same with new material. However, in case of minor undulation in WBM/Bridge deck surface, priming coat application will start as usual & extra amount of DBM material required will be filled. The surface will thoroughly be cleaned from dust.

c) The weather is dry having temperature more than $10^0$.

9.4.3 Job mix crushed stone, stone dust, hydrated lime & bitumen will be used as per job mix formula.

9.4.4 Mixing will be done in a hot mix plant , Capacity of the plants shall be of the order of 30T per hours.

9.4.5 The surface of WBM shall be thoroughly cleaned of all dust & oil etc.

9.4.6 Spreading : Spreading will be done with paver finisher order wide areas, however for narrow areas manual spreading will be done after approval of Engineer-in-Charge.

9.4.7 Rolling: Initial rolling will be done by 8 to 10 T static roller, Intermediate rolling & finishing rolling will be done with vibro roller. Rolling will be done from outer edge to inner edge. The roller shall proceed on the fresh materials with rear wheel leading so as to minimise the pushing of mix & each pass of roller shall over lap on preceding one by half the width of rear wheel. The paver will spread 2.7mtr. wide material up to the decided length. The wheel of roller shall be kept most to prevent the mix adhering to them. Rolling will continue till field density is achieved to 98% of laboratory density in Marshal mould.

9.4.8 **Joint preparation** : All transverse joints shall be cut & painted with hot bitumen & longitudinal joints shall be heated to $80^0$C to start next operation.

**9.4.9 Temperature requirement :**

a) Temperature at the time of laying shall be between $120^0$ C to $160^0$C.

b) Rolling operation to be completed within mixing temp. $100^0$.

9.4.10 **Surface Accuracy** : With an edge of 3 mtrs The maximum allowable undulations shall be less than 6mm & 10mm in transverse & longitudinal directions respectively. However maximum number of undulation exceeding 6mm in any 300mtrs. In longitudinal length shall not exceed 20.

9.4.11 **Rectification :** The surface accuracy shall be checked immediately after rolling surface irregularities which fall outside the specified tolerance as stated above shall be rectified by removing not less than 10 sqm area & relaying with fresh materials. In no case shall depressions be filled up with screen or binding material.

## 9.5 METHOD STATEMENT FOR BITUMINUS CONCRETE

9.5.1 The work shall be carried at as per IRC: 29.

9.5.2 The job will be taken up over completed bituminous macadam as enumerated in bituminous macadam work after application of tack coat.

9.5.3 Same methodology will followed from as at serial no. 9.3.2 to 9.3.1 except that for surface finish 3 mtrs. Edge should an undulation less than 3mm in any direction.

## 9.6 METHOD STATEMENT FOR 25MM BITUMEN MASTIC WORK

9.6.1 The work shall be carried out as per IRC: 107

9.6.2 **Start:** The job will be taken up when.

(a) Bituminous concrete work s over and has dried.
(b) The weather is dry having temperature more than $10^0$C.

9.6.3 **Cleaning**: the surface shall be thoroughly cleaned. Spots rich in binder shall be scraped because this binder will soften under high application temperature. This area shall be repaired by the same mix of bituminous concrete.

9.6.4 **Tack Coat:** Application of tack coat with 80 / 100 or 60/70 grade bitumen @7.5 to 10kg/sq.m.

9.6.5 **Job Mix:** Material will be mixed and used as per job mix formula. Mixing will be done in mastic cooker. Wheel harrows, wooden trowels, heavy wooden floats suitable hands tool gauges and angle irons required to contain mastic in desired width and thickness are required at site.

9.6.6 **Spreading :** Bitumen mastic shall be deposited directly on the prepared base with chicken wire mesh immediately in front of spreader which is spread by means of wooden float to the required thickness.

9.6.7 **Surface finish :** The bituminous mastic surface has got very fine texture on spreading hence provides little resistance to skidding. Therefore approved quality of 9.5mm pre-coated stone are pressed on to the surface @ 0.005 $M^3$ per 10 $M^2$ with a spacing not more than 10cm center to center. These stone chips will protrude 3 to 4 mm from the surface.

9.6.8 **Joint Preparation :** An excess quantity of hot bitumen mastic is applied on the existing joints and are trimmed to make then flush with the surface of other sides.

9.6.9 **Temperature requirement :** The activities shall be carried out as per the following temperatures.

(a) Mixing and cooking $200^0$C
(b) Laying temperature $170^0$ C
(c) Anti skid aggregate pressing temperature $80^0$ to $100^0$ C.

9.6.10 **Surface Accuracy :** The finished surface shall be checked with an edge of 3 mtrs. and the maximum allowable undulations shall not be more than 4mm in any direction.

9.6.11 **Traffic movement :** Traffic will be allowed when the bitumen mastic has cooled down to ambient temperature.

## 9.7 METHOD STATEMENT FOR INSTALLATION OF POT-CUM-PTFE BEARINGS AND VERTICAL ELASTOMER BEARINGS

### 9.7.1 GENERAL

9.7.2 Care should be taken during installation of the bearings to permit their correct functioning in accordance with the design scheme.

9.7.3 To prevent contamination, dismantling of the bearings at site is not advisable.

9.7.4 The load is to be transferred on to the bearings only when the bedding material has developed sufficient strength. That is the props for the formwork can only be removed after elapse of appropriate time. In special case this can be ensured by suitable devices like jack etc.

9.7.5 Temporary clamps and shims (introduced to maintained designed pre-setting and working clearance) should be removed at an appropriate time, before the bearing is required to permit movement.

9.7.6 Permitted installation tolerance of the bearing from the plane of sliding has to be maintained.

9.7.7 The cement based free flow non-shrink grout of quality approved by the Engineer-in-Charge and the epoxy based grout whichever is specified should be used at the site. For the proprietary grout mixes appropriate instructions from the manufacturer may be followed specially regarding the following :

Preparation - concrete cleaning, roughening, presoaking etc.

Forms - sturdiness, leak proofing, shape, header, funnel, vents etc.

Bearing base - cleaning etc.

Placement - mixing, consistency, time period, finishing etc.

Protection - curing, ambient temperature etc.

### 9.7.8 SEATING OF BEARING

Seating of bearings shall be as per manufacturer's instructions.

### 9.7.9 IN-SITU CASTING OF SUPERSTRUCTURE

9.7.9.1 Formwork around the bearing should be carefully sealed to prevent leakage.

9.7.9.2 Sliding plates should be fully supported and care taken to prevent tilting, displacement or distortion of the bearings under the weight of wet concrete.

9.7.9.3 The bearings should be protected during concreting operation. Any mortar contaminating the bearing should be completely removed before it sets.

## 9.7.10 SEATING OF POT BEARING

### 9.7.10.1 Using Template

9.7.10.2 Template with required rigidity and matching holes corresponding to the base of the bearing to be used.

9.7.10.3 All the Anchors are fitted to the lower face of the template using the anchor screws but with steel washer replacing the elastomer washers. Separate screws may be used in case of inconvenience in the length of the original anchor screws.

9.7.10.3 The template assembly to be located with regard to level and alignment. It is to be ensured that the top of the anchors lie in a horizontal plane at the required elevation. The anchors may be tied/welded to reinforcements to avoid displacement during concreting.

9.7.10.4 Concreting of the pedestal/pier cap is done to a level leaving a gap of 20-25 mm below the template.

9.7.10.5 The template and steel washers are removed prior to placement of the bearing assembly with temporary clamps. The bearings assembly is fitted to the anchors with the help of anchor screws and elastomer washers. Check level at the bearing.

9.7.10.6 The gap below the bearing assembly is grouted with cement based grout. Refer to Cl.1.6 above.

### 9.7.10.2 Without Template with Gap

9.7.10.2.1 Pockets commensurate with the sizes of the anchors shall be kept in pedestals during concreting of the same. The pedestal shall be cast approximately 25 mm short of the required finished level.

9.7.10.2.2 Anchors are fitted to the bearing bottom with elastomer washers and anchor screws. The bearing assembly is seated in the location on steel chairs/packs. The anchors fitted below the bearing will go into the pockets in the bed block. Check level and alignment of the bearing. It is also to have ensured that the bearing seats in a horizontal plane.

9.7.10.2.3 The gap below the bearing assembly including anchor pockets is grouted with cement based grout.

### 9.7.10.3 Without Template without Gap

9.7.10.3.1 Elongated pockets commensurate with the sizes of the anchors shall be kept in pedestals during concreting of the same. The geometry and location of the anchor pockets (with tapered funnel extension if required) shall be such that after placement of the bearing the pockets can be successfully grouted. The pedestal shall be cast 5 - 15 mm protruding out of the required finished level. The required level shall be achieved by chipping before placement of the bearing. Excellent control will be required at the site for casting dead level or 1 - 3 mm down from the required level.

9.7.10.3.2 The pedestal top is chipped. Semi dry mortar pack or epoxy mortar with quartzite sand is spread over the bed block. Anchors are fitted to the bearing bottom with elastomer washers and anchor screws. The bearing assembly is seated in the location keeping level and alignment.

9.7.10.3.3 The anchor pockets are grouted with cement based grout. Refer to cl. C.1.6 above.

## 9.7.11 SEATING OF PIN BEARING

9.7.11.1 Backing plate with studs welded on the face opposite to the seating of the bearing will be delivered by the manufacturer.

9.7.11.2 This backing plate is to be accurately positioned on the reinforcement grid of the pedestal and leveled.

9.7.11.3 Studs may be tack welded/tied-to the reinforcements to keep the backing plate in proper location during casting.

9.7.11.4 Depth of embedment of the backing plate in the concrete will be as per relevant drawing.

9.7.11.5 The round base of the pot (bottom) of the Pin Bearing assembly will be connected to the backing plates by anchor screws after concreting of pier cap/pedestal.

9.7.11.6 In order to ensure successful transfer of large horizontal forces to be resisted by the Pin Bearing, great care should be taken in detailing the reinforcement in the structure and the superstructure adjacent to the studs in the backing plate.

## 9.7.12 SEATING OF ELASTOMERIC BEARING

(For installation on a non-horizontal plane)

9.7.12.1 Elastomeric bearings will be delivered with mild steel backing plate fastened to the bearing from the manufacturer.

9.7.12.2 Template of 6 mm mild steel plate and of size same as bearing holding base plate with matching holes for the anchor screws are to be used.

Anchors are to be fitted to the templates with the anchor screws but with mild steel washers in place of elastomer washers. The above template assembly is to be fitted in the formwork at its proper location and in a vertical plane.

9.7.12.3 After casting of the pedestal and removal of the formwork, the template is to be removed.

**9.7.13 Face Plate**

**9.7.13.1 Without template in situ casting**

9.7.13.1.1 The sub-assembly of elastomeric bearing with the mild steel backing plate is to be fitted to the embedded Anchors with anchor screws and elastomeric washers replacing the steel washer.

9.7.13.1.2 A clear gap is required between the stainless steel face of the elastomeric bearing and that of the vertical face of the face plate with Stainless Steel (SS) top installed on the projection below the soffit. This shall be achieved by inserting removable steel shims of thickness as per the drawing, during preparation of the formwork before casting of the superstructure.

9.7.13.1.3 The face plate with Stainless Steel top and pack plate are assembled with the anchors with elastomeric washers and anchor screws. The assembly is to be fitted in the formwork at its proper location and in a vertical plane. The removable steel shims are to be removed at an appropriate time after the casting of the superstructure.

**9.7.13.2 With Template with Grouting**

9.7.13.2.1 Template of 6 mm mild steel plate and of size same as for face plate with SS top and matching holes for the anchor screws are to be used. Anchors are to be fitted to the templates with the anchor screws but with mild steel washers in place of elastomer washers. Separate screws may be used in case of inconvenience in the length of the original anchor screws. The above template assembly is to be fitted in the formwork for the superstructure at its proper location and in a vertical plane.

9.7.13.2.2 After removal of the superstructure formwork, the template is to be removed.

9.7.13.2.3 The faceplate with the required thickness of pack plate is to be loosely fitted to the anchors embedded in the projection below the superstructure, with elastomer washers and anchor screws.

9.7.13.2.4 The sub-assembly of elastomeric bearing with the mild steel backing plate is to be fitted to the embedded anchors in the pedestal with anchor screws and elastomeric washers replacing the steel washer this time.

9.7.13.2.5 The required clearance between the stainless steel face of the elastomeric bearing and that of the vertical faceplate installed on the projection below the soffit is to be checked. After adjustment of the required working clearance the small gap between the vertical face of the projection below the soffit and the back of the face plate (with pack plates if any) are to be grouted with epoxy grout.

## 9.8 METHOD STATEMENT FOR INSTALLATION OF STRIP SEAL/ MODULAR STRIP SEAL EXPANSION JOINTS

### 9.8.1 INSTALLATION

9.8.2 The Joint shall be installed by the manufacturer / supplier only.

9.8.3 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 of design data of the manufacturer. The surface 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.

9.8.4 The recess shall be shuttered in such a way that dimensions in the drawing are maintained. The formwork shall be rigid and firm.

9.8.5 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.

9.8.6 The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be leveled and finally aligned and the anchorage steel 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.

9.8.7 Controlled concrete having strength not less than that in superstructure subject to the minimum of M35 shall be filled into the recess. The packing concrete must feature low shrinkage. Good compaction and careful curing of concrete is particularly improvement. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.

9.8.8 The chloroprene seal shall be field installed in continuous lengths spanning the entire roadway-width. To ensure proper fit of the seal and increase the ease of installation, dirt, spatter or standing water shall be removed from the steel cavity using a brush, scrapper or compressed air. The seal shall be installed without damage to the seal by suitable hand method or machine tools.

9.8.9 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 carriage way surfacing is placed.

9.8.10 The carriage way 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 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.



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## 9.9 METHOD STATEMENT FOR CONSTRUCTION OF EARTHEN EMBANKMENT

9.9.1 **Setting out:** After Cleaning the site where embankment is to be constructed, the limits of embankment / sugared shall be marked on the ground by fixing pegs on both sides at regular intervals. The embankment / subgrade shall be built sufficiently wider (approx 1m on each side) than the design dimension.

9.9.2 **Preparation of foundation of embankment:** The original ground shall be leveled, scarified, sprinkled with water and than compacted by rolling to achieve at least 75% of the maximum dry density (MDD) of the difference between the top of sub grade and ground level is less than 0.5m and the ground does not have a density of at least 97% the MDD, the ground shall be loosened upto 0.5m below the proposed sub grade level, water to OMC and compacted to 97% of the MDD.

9.9.3 **Laying / Spreading Earth :** The embankment and sub grade shall be laid in layers not exceeding 20cm compacted thickness over the entire embankment width, finished by a mortar grader having hydraulic control.

9.9.4 **Maintaining Moisture Content :** The M.C. (moisture content) of each layer shall be checked. If the earth is too wet, it shall be spread for drying and if it is too dry, water shall be spin welded so that the OMC is obtained.

9.9.5 **Compaction :** Each layer shall be compacted with a roller of 8 to 10MT capacity to at least 95% of the MDD in lower layers and 100% of the MDD in top layers. The field density shall be checked as specified in chapter 8.

9.9.6 **Finishing :** The shoulder / verges and site slops shall be dressed so as to conform to the alignment , levels, cross-section and dimensions shown in the approved drawing.

9.9.7 **Turfing :** The site slops shall be turfed as per specifications of the contract.

## 9.10 METHOD STATEMENT FOR WATER BOUND MACADAM

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

9.10.2 **Spreading Aggregate:** The aggregate shall be spread uniformly to proper profile by suing templates placed across the road six meters apart, in such quantities that thickness of each compacted layer is not more than 100mm for grading 1 and 75 mm for grading 2 and 3 as specified clause 404.2.5 MOST specification for road and bridge works.

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

9.10.4 **Compaction :** Compaction shall be done with three wheeled power rollers of 80 to 100KN capacity or tandem or vibratory rollers of 80 to 100kN static weight as approved by the Engineer-in-Charge. Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the center line of the road, in successive passes uniformly lapping preceding tracks by at least one half width. Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosing the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired cross fall (camber) and grade. In no case shall the sue of screenings be permitted to make up depressions.

9.10.5 **Application of Screenings :** After the coarse aggregate ha been rolled, screening to completely fill the interstices shall be applied gradually over the surface. Dry rolling shall be done while the screening are being spread. The screening shall be uniformly spread in thin layers at a slow and uniform rate followed by dry rolling and brooming.

9.10.6 **Sprinkling of water and grouting :** After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the course aggregate has been thoroughly keyed well set in its full depth and a grout has been formed of screenings.

9.10.7 **Application of binding material :** After application of screenings the binding material shall be applied in thin layers, copiously sprinkle with water and the resulting slurry swept with brooms and rolled.

9.10.8 **Setting & Drying :** After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filed be screening and binding material, lightly sprinkled with water and rolled.

9.10.9 **Checking and surface finish :** The surface finish shall be checked for a regularities as per the tolerance specified in clause 902 of MOST specification for road and bridge works.

## 9.11 METHOD STSTEMENT FOR LAUNCHING OPERATION

### 9.11.1 PREPARATORY WORK

1.) At the casting yard, before a segment is removed from the casting bed, the centre line of the segment will be marked on each segment and the levels of the steel plate fixed at each corner of the segment will be recorded. Each segment will have a painted identification mark.
2.) The segments will then be separated, placed on the stacking bed. Each pre-stressing duct will be cleaned and checked by passing a dolly to ensure that there is no blockage.
3.) Top and side inserts will be fixed. The top insert is fixed by pre stressing with BBRV tendons and the side insert through a pin bolted to the inserts already placed inside at the time of concreting.

### 9.11.2 LAUNCHING OPERATION

STAGE 1

STEP 1

1.) Foundation for each trestle will be prepared.
2.) Trestle will be erected and secured to the foundation. Each trestle will have a 100-ton jack with lock nut safety device.
3.) Erect Launching Girder trusses, place them over the jacks on each trestles ensuring perfect alignment. The two trusses will then be connected to each other and levelled by means of jacks. The lock nuts of each jack will be tightened. Crab trolley will then be installed on top of the L.G. Cross beam trolleys will be installed over wooden packing at the bottom chord of each L.G. truss. Two working platforms movable on wheels will be hung from the L.G. assembly. Install pot PTFE bearings over the top of the pier as per the manufacturer instructions and lock them to prevent rotation.
4.) Transport and lift pier segment and place it over the bearing ensuring that the pier segment is properly in position and in longitudinal and cross gradient. Lock the bearing / pier segment against longitudinal and transverse movement.
5.) Place auxiliary support over the pier segment as per the drawing. Support the bottom chord of the L.G. by tightening the 200-ton jacks placed on the auxiliary support and tighten the lock nuts.

STEP 2

1.) Lift segment 1 by crab trolley from the trailer.
2.) Move segment 1 to its correct longitudinal position and rotate it as required.
3.) Attach vertical hangers of predetermined length. The hangers can be made of BBRV wire cables having type F60 anchors fixed to the top cross beam trolley of each L.G. truss and type B60 stressing anchor attached to the two inserts fixed to the segment.
4.) Repeat the above operations 1 to 3 for each segment in the predetermined sequence.

5.) Bring next segment close to the pier segment by sliding the transverse cross beam trolley over wooden blocks by using a hand operated winch. Tilt it to the correct gradient by means of turnbuckle. Tilt it in longitudinal and transverse directions by adjusting the height of the hangers by means of jacks. Minor adjustment for shifting the segment in transverse direction can be made by using screw jacks to push the F60 anchor head. The shear keys of the segments should match. This is referred to as dry matching.
6.) Repeat operations 1 to 5 for each segment to dry match the entire bridge unit.

Step 3

1.) Pull back the segments away from the pier segment using the hand winch creating a gap of 500 mm on either side of pier segment.
2.) Bring segments closer and make final adjustments to ensure a perfect match. Pull away the segments again to create a gap of 500 mm between segments.
3.) Fix foam washers around each sheathing duct to prevent leakage of epoxy glue into the ducts.
4.) Apply epoxy glue to both contact surfaces and bring back the two segments together.
5.) Install pre stressing cables (BBRV) of predetermined length between top and side insert frames of the segments.
6.) Provide temporary pre stressing on top and bottom with the predetermined jacking force. This is carried out by use of 4 jacks each installed at the 2 top and 2 side insert frames connected through a manifold. The jacks are connected in pair to two power packs. The Prestressing is to be carried out within the pot life of the epoxy.
7.) At the time of temporary pre stressing a dolly is placed in each sheathing duct to ensure that the glue does not block the ducts.
8.) Repeat operations 2 to 7 for all the segments in predetermined sequence till the whole bridge unit is erected.

STEP 4

1.) Install P.T. tendons by manually pushing strands into the ducts. Pre stress each tendon as per the requirement.
2.) Release the jacks at auxiliary support and then at the trestles to release the vertical hangers.
3.) Remove the crab trolley, hangers from L.G.
4.) Lift the L.G. truss one by one by crane and install them over the next trestle of required height.

STAGE 2

Follow all the steps of Stage 1 to complete all the bridge units and then cast the connecting segments as in-situ segments. Prestressing is done after the in-situ segments as per the design as per the step 4 of Stage I.

# CHAPTER – 10

## NON CONFORMING PRODUCTS AND PROCEDURES

# NON CONFORMING PRODUCTS AND PROCEDURES

In broad terms, for the Quality Assurance of the finished works it is necessary for the materials and workmanship to comply with the Contract requirements. Non-complying works shall be rejected.

The statement above is true in general terms but special difficulties arise in the case of concrete, where the non-compliance may only be known after 28 day cube test results. In these cases removal, re-execution or rectification of the work is usually difficult. Therefore separate procedures are laid out below for non-complying concretes. A similar situation may also arise when test results of some materials arrive after the same has already been incorporated in the project. This happens when certain materials like Admixture which require long term tests, such as development of compressive and flexural strength over 1 year and length change over 1 year, to be performed and the construction can not wait for them. Other such example is long term corrosion resistance test on coatings. Many a times test results may get delayed accidentally and the material may have been incorporated in the project. All such situations need to be dealt with in a careful manner This section describes procedures for the same.

## 10.1 Concrete works

The primary means by which Quality Assurance shall be achieved is by the procedures described in Chapters 3, 4 and 6 .

### 10.1.1 Non-compliance Other Than Strength or Finish

In the event that any requirement other than strength and standard of finish is not met then the following procedure shall be followed:-

1) The Contractor shall be notified without delay verbally and in writing by the following means :-

a) Return of the Request for Inspection form signed "not approved" with the reasons for rejection stated.

b) Issue of a Site Instruction or Site Works Order or letter stating the facts and confirming that the works are not approved.

2) Approval to carry out concreting of a similar nature shall be withheld.

3) The Contractor shall be asked for his proposals to rectify the non-compliance which may involve resubmission of materials, new trial mixes, revised method statement.

4) The acceptance or rejection of any unapproved concrete work shall be referred to the Engineer.

5) When satisfied with the measures taken to ensure future compliance the Engineer shall confirm approval to continue concrete for - permanent works.

### 10.1.2 Non-Compliance with Strength requirements

1) The Specifications for concrete recognises the statistical possibility of cube failures and thus limits of mean, standard deviations, minimum values of strength are specified. A single isolated unsatisfactory cube result is not usually cause for rejection. The rejection criteria is as set out in the Contract agreement.

2) In order to provide assurance against strength failures the procedures described in Chapter 4 shall be observed.

3) In the event of cube failures outside the provision of the Contract then the non-compliance procedures described in the specifications shall be followed.

In addition the following procedures shall be followed :-

a) Approval of concrete of similar works shall be withheld.

b) All aspects of concreting shall be reviewed.

c) The cause of failure shall be identified and measures taken to remedy the problem.

4) The repair/ rectification procedures for commonly arising defects should be covered by tender specifications, from which the contractor shall be asked to state his exact proposals for rectification. It shall be ensured that the faulty work is made good following approved method and retested and/or inspected.

5) The fact of non-compliance & rectification means as proposed should be conveyed to the Engineer and for review & opinion about :-

a) acceptability of Contractor's proposal.
b) further non-destructive testing, if any.
c) acceptability in case strength is achieved at a later age (e.g. 90 days).

d) acceptability at the level of strength achieved for the stress levels in concerned members.

e) rejection of concrete.

### 10.1.3 Non-Compliance with Finish Requirements

In order to prevent occurrence of unacceptable standard of finish the procedures for formwork and trial panels described in shall be followed. This will involve preparation of scaled Mock up trials if provided for in the contract or ordered by the Engineer in case of specific doubts (see chapter for records of Mock ups).

Where the required finish is not attained then the non- compliance procedure described in the Specifications shall be followed.

In addition the following procedures shall be followed :

a) Approval of similar formwork shall be withheld.

b) All aspects of formwork shall be reviewed.

c) The cause of poor finish shall be identified.

## 10.2 Works other than concrete

### 10.2.1 Procedure

The procedure for acceptance of finish works for earthworks, formwork, reinforcement, coatings on reinforcement, materials for concrete, prestressing and bridge finishing works are straightforward and shall be as follows:-

1. Regular and special testing, logging of results and inspections shall determine compliance or non-compliance.

2. Any non-compliance shall without delay be notified to the Contractor. This shall be done both verbally and in writing by the following means :-

   a) Return of the Request for Inspection form signed "not approved" with the reasons for rejection stated.

   b) Issue of a Site Inspection or Site Works Order or letter stating the facts and confirming that the works are not acceptable for inclusion in the permanent works.

3. The Contractor shall be asked to state his exact proposals for rectification and it shall be ensured that the faulty work is made good and retested or inspected as decided by the Engineer.

It is mandatory that all instances of works outside the Specifications are recorded in writing to the Contractor. This ensures that :-

1) The Contractor is irrefutably informed.

2) A record of non-compliance is built up to give a general guide to the Contractor's performance.

The Quality Assurance Manager shall summarise the following information for each category of work :-

1) The total number of inspections and tests.

2) The number of "first time" approvals i.e. the number of times the material or workmanship is approved on the first test or inspection.

3) The number of second, third, fourth etc. inspections or tests of the same work required before final approval.

4) The percentage of first time approvals, second, third, etc. over suitable time intervals.

From the above information, the Engineer shall review the Contractor's superintendence and take action where necessary to improve matters. From increases or decreases in the number of first time approvals, the improvement or deterioration in Contractor's performance can be monitored. The record of repair/rectification, retesting, inspection & acceptance shall be kept as part of "as built" documentation. Record of all references to designers for opinion/rectification and approvals given by them. Record of compliance to the modifications in procedures, testing etc., if any, shall be properly maintained

### 10.2.2 Admixtures

In case the material test show non compliance prior to its use then the complete material lot shall be removed from the site at once and the procedure stated above shall be followed. But, in case results arrive after the particular Admixture has been used in the concrete then the contractor shall be required to give his methodology of rectification, strengthening and get it approved by the Engineer before execution. Such a rectified structure shall be subject to appropriate non destructive testing, if felt necessary by the Engineer. If no satisfactory method is found then the structural members incorporating the non compliant material shall be dismantled at no cost to the owner/client. In the case of proprietary materials such as Admixture, Bearings, Expansion joints etc the respective manufacturer shall invariably be consulted for analysis of the problems and possible rectification measures.

### 10.2.3 Cement and Other Materials

The procedure indicated above shall be adopted.

### 10.2.4 Load Test on the Bridge

In case load test of the bridge is carried out either as per the original tender requirement or due to rectifications and the same fails to pass then the following procedure shall be followed.

i) Contractor to propose elaborate scheme of strengthening the bridge components not passing the test criteria.

ii) If satisfactory strengthening is not possible but it is found that the bridge can be allowed with lesser load rating which may be acceptable to the owner, the same shall be done with prior written approval of the Owner/Engineer and a suitable penalty may be charged from the contractor.

iii) In case none of the above two conditions are applicable then the non conforming bridge components shall be demolished and removed from the site at no extra cost to the owner.

### 10.2.5 Pile Foundation

The procedures to deal with non compliance of the construction materials of piles shall be as detailed in the above clauses. However, construction tolerances, which will be as defined in clause 1116 of MOST Specifications for Road and Bridge Works (third revision) unless specified otherwise in the tender document. In case the particular limits of tolerances are exceeded, the contractor shall be required to remove/abandon such piles/foundations at no extra cost to the owner. In case, for any unavoidable reasons, it is decided to retain the non complying piles/foundations, a check of structural safety shall be made by the contractor. If all the bridge components are still found to be safe, the same may be retained after payment of suitable penalty by the contractor to the owner.

### 10.2.6 Well Foundations

Similar to piles the procedure to deal with the non compliant materials shall be the same as in the case of pile foundations described above. Tilt and shift of well is a very common problem with well foundations. In case tilt and/or shift of well exceeds the limits specified in clause 1207.8 of MOST Specifications for Road and Bridge Works (third revision) unless specified otherwise in the tender document, the contractor shall be required to remove/abandon such well/foundation at no extra cost to the owner. In case, for any unavoidable reasons, it is decided to retain the non complying well/foundation, a check of structural safety shall be made by the contractor. If all the bridge components are still found to be safe, the same may be retained after payment of penalty as per clause 1212 of MOST Specifications for Road and Bridge Works (third revision) unless specified otherwise in the tender document by the contractor to the owner. Any additional costs incurred on this account shall be borne by the contractor.

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