NATIONAL HIGHWAYS AUTHORITY OF INDIA

(Ministry of Shipping, Road Transport and Highways)

(Department of Road Transport and Highways)

QUALITY ASSURANCE MANUAL

2006

First Published: July 2006

Printed at:........

FOREWORD

The National Highways Development Project (NHDP), entrusted to NHAI for implementing a massive and ambitious programme to modernise India's highway network. The impact of this infrastructure project on the economy is already being felt. Consistency in the quality of the road and promotion of quality as part of the work culture of the organisation entrusted with this challenging task of road building have assumed paramount importance.

For establishing uniform standards and procedures, the Ministry of Shipping Road Transport and Highways constituted a Committee headed by Shri S C Sharma, the then Director General (Road Development) and Additional Secretary. Preparation of a Quality Assurance Manual for NHAI was one of the tasks entrusted to the Committee. The Committee got the Quality Assurance Manual prepared through Dr. L.R. Kadiyali and M/s. Tandon Consultants Pvt. Ltd., New Delhi. NHAI has adopted this Quality Assurance Manual.

The Quality Assurance Manual is a base document outlining policy procedures, responsibilities, acceptance criteria and documentation needed for the successful implementation of a project. It spells out the quality policy of the Authority, various duties of the contractors, the requirements of quality assurance as per ISO-9000, working out of quality index, reference to the IRC guidelines, use of standard forms for different objectives etc. This is a reference document for use of NHAI officials and Supervision Consultants, and ensuring its enforcement in the field. The Supervision Consultant may improve upon it in preparing the project specific Quality Assurance Plans while following the guidelines contained in the Manual.

I would like to express my sincere appreciation of the efforts of all those involved in preparation of the Manual which will prove a very useful and convenient reference manual.

(Santosh Nautiyal)
Chairman, NHAI

July 14, 2006

Table of Contents

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 General

National Highways Authority of India is a premier organisation which has been taking several challenging highway projects involving major bridges in addition to roads with a specific view to reduce the construction time so as to reduce traffic disturbances, usually faced during construction. While, speed is the criteria, quality can not be ignored under any circumstances. With this philosophy in view it was decided to prepare a uniform Quality Assurance Manual (QAM) to be followed for all highway projects in the country.

This QAM has been prepared to compile 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 inspection, testing and reporting. However, this Manual does not deal with day-to-day technical requirements, nor does it provide solutions to technical problems, as these technical issues are usually administered by the Specifications and other Contract Documents.

It is anticipated that the Supervision Consultant will develop a project specific Supervision Manual based on the following guidelines. Similarly, the Contractor will propose his Quality Assurance Plan (QAP) keeping the minimum requirements of this QAM in view.

The document is broadly based on the norms set up by Indian Roads Congress publications SP: 47-1998 and SP: 57-2001. Since, all the highway projects are on National Highways qualifying Class Q3 (High QA) of the publication, and the fact that level of supervision has to be uniform over the entire project, the Manual has been based on Class Q3 of the publication. In case of superior facilities like Expressways and Innovation bridges requiring Extra High QA (Class Q4) the additional provisions, in terms of additional and increased frequency of testing etc. have been indicated in the Manual. Sometimes, specific components of Class Q3 projects may be required to be updated to Class Q4. A concept of Levels of testing has been introduced in order to cover up elaborate planning of testing of materials and products depending upon various factors related to each material/product.

Every effort has been made to design this Manual so that adherence to its guidelines will result in efficient, safe and consistent supervision of the works in strict conformance to 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 road and bridge projects of this type, with specific guidelines and forms, where appropriate, being generated based on standard practices in India in conformance with MOSRTH 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 construction supervision process.

It is to be noted that although the intention of this Manual is to provide efficient, high quality construction and safety, adherence to the adopted guidelines does not necessarily guarantee that these attributes are achieved. This points to the need, therefore, for all users 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.

1.2 Coverage of the Manual

This Manual is divided into 4 chapters and this chapter elaborates the guidelines for the use of the Manual.

Chapter 2 deals with the general subject of Management of Quality, including organization, duties and responsibilities, inspections and reports.

Chapter 3 deals with the Quality Assurance Plan (QAP) and covers aspects like sampling and testing of materials and acceptance criteria.

Chapter 4 deals with Quality Audits, both internal and external.

1.3 Definitions

The following definitions shall apply:

1.3.1 Quality System

The organization structure, responsibilities, procedures, processes and resources needed for implementing quality management.

1.3.2 Quality Assurance (QA)

Quality Assurance is defined as all the planned and systematic activities implemented within the Quality System and demonstrated as needed to provide adequate confidence that an entity will fulfill the requirements.

1.3.3 Quality Assurance Manual

A Quality Assurance Manual is a base document outlining policy, procedures, responsibilities, compliance, acceptance criteria and documentation needed for the successful implementation of a project. It should be prepared and accepted by all parties concerned before the start of a project.

It should generally cover the following:

(a) Identification of all parties involved in QA and their inter-relationship;
(b) Internal QA system of each party;
(c) Levels of cross-checking/verification in case of multiple verifications/ controls, including systems of inspection and audit, wherever applicable;
(d) Organization of personnel, responsibilities and lines of reporting for QA purposes;
(e) Criteria for acceptance/rejection, including identification of proper authorities for such decisions;
(f) Inspection at the end of defect liability period;
(g) Items to be covered in maintenance manual; and
(h) All formats for documentation.

1.3.4 Quality Control (QC)

The operational techniques and activities that are used to fulfill requirements for quality. All those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

1.3.5 Quality Audit

A systematic and an independent examination to determine whether quality activities and related results comply with planned arrangements are implemented effectively and are suitable to achieve objectives.

1.4 Scope and Applications

The NHAI attaches highest importance to the achievement of the quality of works and materials as envisaged in the design and specifications. It is the policy of the NHAI to foster the highest standards of workmanship in the works such that the full value for the investments made is realized and the highway performs in the best way during the design life. Towards achieving this overall policy, NHAI realize the importance of Quality Assurance in their projects.

Quality Assurance systems are needed for a highway project at various levels. For example, a QAM is required for each of the following activities:

(a) Design and Project Preparation
(b) Construction
(c) Operation and Maintenance
(d) Production of Manufactured Items

There are several organizations involved in the design, construction, operation and maintenance of a road project. These are:

(a) The Client (in the present case NHAI)
(b) The Design Consultant
(c) The Contractor
(d) The Supervision Consultant
(e) The Operation and Maintenance Agency
(f) The Independent Engineer who supervise the work of a private operator

Each of these organizations has to prepare a QAM covering their activities and scope of work.

The present QAM is intended for use by the NHAI as the client, in supervising the execution of works, as spelt out in the Terms of Reference. The guidelines contained in the present QAM are the minimum requirements and the Supervision Consultant can improve upon these in his Construction Supervision Manual.

CHAPTER 2

MANAGEMENT OF QUALITY

CHAPTER 2

MANAGEMENT OF QUALITY

2.1 Organisation for Quality Assurance

The Quality Assurance unit should be independent entity reporting directly to the Team Leader of the Supervision Consultant. The Supervision Consultant should evolve a suitable organizational structure keeping in view various aspects of contract management, experts required for various activities and quality assurance.

An indicative organizational structure is given in Fig. 2.1. This should be suitably changed for each project, depending upon individual site requirements and the scope of work.

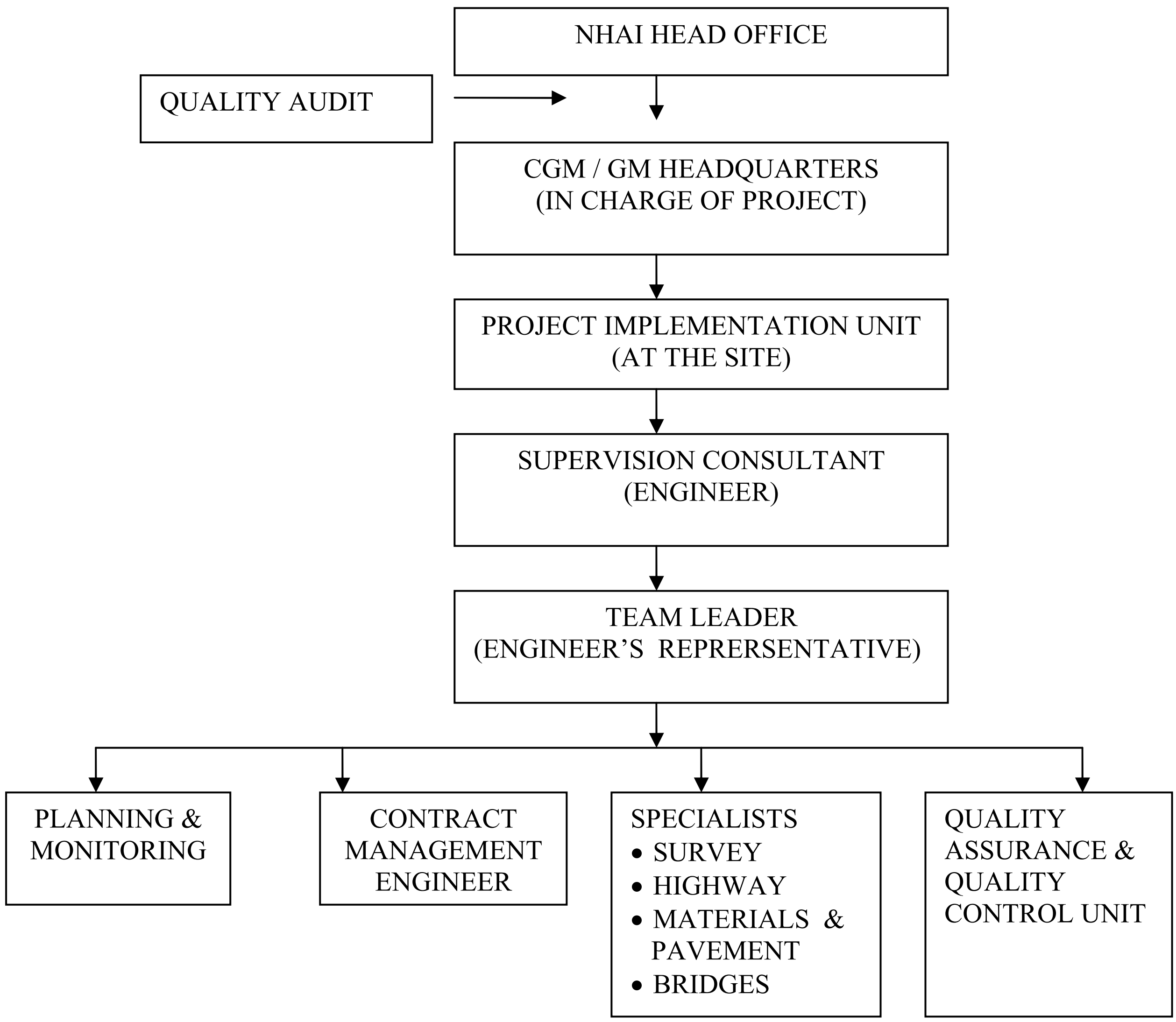


FIG. 2.1. TYPICAL ORGANISATIONAL STRUCTURE FOR PROJECT IMPLEMENTATION

2.2 Duties and Responsibilities

In most of the NHAI contracts, the NHAI is the "Employer" and the Supervision Consultant is the "Engineer". The latter appoints a Team Leader, who is designated as the "Engineer's Representative". The Engineer's Representative performs various duties and is delegated authority in terms of various clauses of the Contract. The Engineer's Representative may appoint a Resident Engineer (RE) for each construction package. The Construction Supervision Manual shall lay down the functions to be exercised by the Engineer, Engineer's Representative and Resident Engineer.

In the supervision of works, a typical road package involves the services of senior professional staff and support staff.

It is necessary that the duties and responsibilities of each of these are clearly understood and specified. These are specified in Appendix 1. These duties and responsibilities may vary from job to job, and should be clearly laid down for each project. The exact duties and responsibilities for each job shall be prepared by the Supervision Consultant.

2.3 Methods Statement

Prior to the commencement of important item of work and activity (which may be listed by the Engineer and given to the Contractor), the Contractor is required to submit for approval by the Resident Engineer a "Methods Statement", which describes the methodology as to how he (the Contractor) plans to carry out that item of work/activity in accordance with the Specifications. The Methods Statements shall be developed to a degree of detail depending upon:

(a) The intricacy of operations for carrying out the proposed construction activity; and
(b) The extent to which the methodology is detailed out in the Specifications.

The Methods Statement shall describe the equipment to the deployed (size/number/capacity), the sequence of operations, field trials if any are involved, design of mixes, job-mix-formulae, temporary works erection and launching, traffic management plan, safety precautions, environmental protection measures etc.

The Methods to be furnished by the Contractor in respect of each major activity shall be step-wise sequencing of tasks, and should be detailed and meaningful. The Engineer shall either straightway give his consent or ask for modification before acceptance. The following lists out some important activities, and details out what would be expected.

(a) Major Earthwork Operations

(i) Tests for borrow area soils
(ii) Type and number of excavation plant and transportation machinery and their anticipated outputs
(iii) Method of working in cut and fill sections
(iv) Type and number of spreading plant for filling and anticipated outputs
(v) Type and number of compaction plant and anticipated outputs
(vi) Testing and layer approval
(vii) Method of working for site clearance and dealing with trees and vegetation
(viii) Setting out and control of levels and batters
(ix) Details of disposal areas for unsuitable material
(x) Details of suitable borrow areas for imported fill

(b) Bridge Works

(i) Details of all temporary works for construction of substructure and superstructure
(ii) Details of piling or well-sinking or open foundation, bed protection method
(iii) Details of proposed formwork and false work requirements
(iv) Reinforcement and duct fixing and cables
(v) Concreting and curing including compaction, machinery deployment
(vi) Stressing, anchorage and grouting
(vii) Manufacture of bearings, their testing and installation
(viii) Expansion joints
(ix) Parapet rail fabrication and fixing
(x) Back-filling

(c) Fixing of PTFE cum POT Bearing

(i) Manufacturer of the bearings
(ii) Date of supply of the bearings
(iii) Expected date of installation
(iv) Precise sequence of operations such as preparation of pockets, placements of sleeves, placement and aligning of bearing, grouting, tightening of bolts etc.
(v) Likely difficulties which may be faced and corrective measures
(vi) Location where the bearing was tested
(vii) Manufacturer’s warrantee period

(d) Pavement Works

For flexible and/rigid pavement construction including sub-base, road base, DBM and asphaltic layers or DLC and pavement concrete

(i) Proposed method of working e.g., preparation of surface, control of levels etc.
(ii) Type and number of laying plant and anticipated outputs
(iii) Type and number of compaction plant and anticipated outputs
(iv) Layer Approvals
(v) Curing arrangements

(e) Environmental Safeguards

The measures to be taken by the Contractor shall be addressed to the prevention of any damage or pollution to the environment at the site and adjoining areas, viz.:

(i) Restoration of quarry areas and plantation
(ii) Disposal of waste materials and construction equipment on completion of works
(iii) Air dust and noise pollution from construction activities
(iv) Labour camp
(v) Effluent treatment and waste disposal
(vi) Social disturbance caused by the presence of the temporary labour force
(vii) Effects on navigational and water flow at bridge crossings

(f) Temporary Traffic Diversions and Traffic Crossings

(i) Details of any temporary traffic diversions that may be required in order to execute the works safely
(ii) Proposed length of diversion
(iii) Duration of operation of diversion
(iv) Constructional details of diversion including signage
(v) Details of proposed traffic management, including liaison with the police and concerned authorities

(g) Concrete Production and Transport

Detail proposed set-up for the production and transport of concrete

(i) Location and layout of batching plants
(ii) Details of plant size, type and estimated outputs
(iii) Details of cement storage and handling

(iv) Details of aggregate stockpiles and storage capacities
(v) Details of water supply and chilling arrangements
(vi) Details of proposed transport of concrete

(h) Asphaltic Concrete Production and Transport

Detail proposed set-up for the production and transport of asphaltic and bitumen paving products

(i) Location and layout of asphalt plant
(ii) Details of plant size, type and estimated outputs
(iii) Details of aggregate stockpiles, handling etc
(iv) Details of bitumen storage, heating facilities etc
(v) Details of proposed transport of mixed materials
(vi) Dust nuisance.

(i) Quarrying and Crushing Operations

Detail proposed set-up for production of aggregates and other stone products to be incorporated in the works:

(i) Location of proposed quarry
(ii) Details of proposed method of operation of quarry i.e., development and operation of quarry face, outputs etc
(iii) Details of proposed plant installations giving type and size of main items and layout of crushing operations showing production flow through to final products.

(j) Control and Administration Systems

This will give details of following

(i) Codes of Practice to be used for the design of temporary or permanent works for which the contractor is responsible, and copies of codes that will be kept in the site library
(ii) Inventory of standard specifications covering every element of the works and copies of which will be held in the site library
(iii) Drawing management system
(iv) Establishment and checking procedures for main survey and bench marks
(v) Routine for checking and calibration of surveying instruments
(vi) Layout of laboratory and inventory of materials testing equipment
(vii) Statutory laws, acts and regulations that relate to any operations that will be performed, specifically relating to control and use of explosives and detonators, operation of

machinery, health and safety on site, environmental safeguards etc.

(viii) Fire prevention and fighting measures
(ix) Safety measures
(x) First aid facilities and procedures to be adopted in the event of accidents to personnel
(xi) Measurements before covering

2.4 Contractor's Works Programme

Based on deadlines specified in the Contract, the Contractor is required to submit a Works Programme to be approved by the Engineer that provides for completion of the Works in accordance with these deadlines. Approval of the programme by the Engineer shall be given based on completeness (i.e., includes all activities) and accuracy (activities are properly sequenced) of the proposal, and on comparison of total output of the Contractor's scheduled mobilized equipment with the types and actual quantities of works scheduled to be completed during each month of the specified construction period. An additional check shall be made to ensure that outputs for relevant activities are reduced realistically during the monsoon period.

Following approval of the Contractor's initial Works Programme, the programme is reviewed periodically in order to appraise the need for changing the proposed scheduling of activities to be in line with actual construction progress. In the case where deviations from the proposed schedule are significant enough to raise concern with regard to the Contractor's to complete the woks on time, the Contractor is to be required to provide an acceptable revised programme to catch-up and meet the original deadline requirements (i.e. he may need to mobilize additional equipment, or work additional hours per week etc).

2.5 Working Drawings

2.5.1 General

The Engineering Design Drawings depicting the designs and scope of works are legal documents which form an integral part of the Contract, and the Contractor is required to perform the work in accordance with them. Consequently, to achieve proper administration of the contract the transmittal of the approved design drawings, and subsequently submitted drawing related to "works" and "dayworks" orders, must be handled with circumspection and properly recorded at all stages to avoid unnecessary disputes and claims.

2.5.2 Submittal of Approved Design Drawings

(a) The Engineering Design Drawings approved by the Employer (i.e. the tender drawings) are first to be reviewed by the Supervision Consultant's Design Review Team with regard to accuracy and completeness, and he will make recommendations, additions, etc. to be carried out for the designs.
(b) Following completion of the incorporation of any revision together with any further required drawings instructed by the Employer, the Employer is to approve the revised drawings and issue them to the Team Leader for submittal to the Contractors. All drawings are to be signed and transmitted officially.
(c) The Contractor will then be issued with two (2) sets of approved construction drawings which have been marked "Approved for Construction" and signed and dated. A register of drawings issued shall be maintained.
(d) To expedite start of the work, the drawings may be issued in groups rather than as a complete set, and / or only parts of specific drawings may be approved for construction at any one time.

2.5.3 Priorities for Preparation of working Drawings

In allocating priorities for working drawing preparation, the following aspects are to be taken into account.

(a) Contractor's approved construction programme and construction sequence
(b) Delivery times for construction material
(c) Fabrication times for manufactured items
(d) Any design work or shop drawings required from the Contractor.

2.5.4 Review, Revision and Recording of Drawings

The review, revision and control of the record keeping of all Contract drawings are to be carried out in accordance with following guidelines.

(a) The Engineer's representative and/or the Resident Engineer will review the drawing and note any drawings inconsistent with contractual obligations.
(b) All drawings issued to the Contractor will first be checked by the Resident Engineer for variations implications from the Scope of Works or departures from the Specifications. The results of this check will serve to initiate, if necessary, the appropriate procedure for issue of a Variations Order.

(c) If necessary, the Engineer's Representative will liaise with the designer to ensure the designer is aware of any drawing that is inconsistent with the contractual obligations or that may give rise to a variation. This will give the designer the opportunity to reconsider or confirm the revised drawing prior to issue to the Contractor.

(d) When any drawing is revised, copies of the revised drawings should be issued to the Contractor with the revision clearly marked.

(e) After issue of drawings to the Contractor, the Contractor's Administration Engineer will update the master set of drawings and Drawings Issue Register (see Form V-I in Appendix V).

2.6 Site Inspections, Daily Reports and Diaries

2.6.1 Site Inspections

To ensure the Contractor's strict contact compliance, it is mandatory that all personnel charged with inspection responsibilities properly prepare themselves in advance through detailed study and understanding of the Plans and Specifications. On-site observations of the field engineer's activities and procedures will be made by the RE to ensure compliance with plans and Specifications.

The field engineer's activities will be determined by the Contractor's construction activities, and they will be notified of these in advance based on Inspection Request Form (IRF) submittals from the Contactor. It is the Highway Engineer's responsibility to follow up on the IRF. A sample of the IRF is given in Appendix V (form V-2)

Field engineers are authorized to inspect all work done and material furnished. Such inspection will extend to all parts of the works and to the preparation, fabrication or manufacture of the materials to be used. The field engineers are not authorized to alter or waive any provision of the contract conditions or documents.

The Highway Engineer is responsible for keeping his Resident Engineer informed as to progress of the work and the manner in which it is being done, and also to call the Contractor's attention to any non-compliance with the drawings or specifications. He is not authorized to approve or accept any portion of the work, or to issue instruction contrary to the plans and specifications, or to act on behalf of the Contractor. The field engineers have authority to reject unsatisfactory workmanship, defective materials and to recommend suspension of any work that is being improperly performed, subject to approval by the Resident Engineer and or the Team Leader.

The field engineers may exercise such additional authority only as may, from time to time delegated to them by the Resident Engineer and/or as approved by the Team Leader.

2.6.2 Daily Inspection Reports

A Daily Report must be completed by each field engineer (see Appendix V, Form V-3). These daily Reports will be reviewed and compiled by the RE and will constitute part of the final Project documentation submitted to NHAI.

The Daily Report from each field engineer must include but not be limited to the following items:

(a) Quantities of work performed under their inspection, such as cubic meters of material acceptably placed etc;
(b) Site instructions given (Form V-5);
(c) Unusual or unsatisfactory conditions;
(d) Delays encountered;
(e) Number of men or man-hours employed;
(f) Equipment, Plant, methods used by the Contractor;
(g) Tests performed to satisfy quality control, and as samples taken;
(h) Weather conditions and effect on the works; and
(i) Daywork records, if any.

2.6.3 Field Inspection Diaries

Each field engineer will keep personnel Diary Notebook to accumulate during the day all data used to prepare his Daily Report. Notes made in their Diary Notebook will be recorded neatly, clearly and will be dated, signed and in sufficient detail to be clearly understood. This Diary Notebook will also include the field engineer's working hours and work location details for each day.

The field engineer's Diary Notebook must be properly identified, indexed and periodically turned in to the RE for his review and safe-keeping. At the end of the Project these Diary Notebooks will be returned to each field engineer.

The field engineer's Daily Report will contain quantities of work satisfactorily performed each day under their inspection. These quantities will be based on measurements if the quantity is for a particular section of work that is complete or based on an estimate if the work is ongoing. Sketches with dimensions and calculations should be attached to the Reports as required.

Mechanical Plant and Equipment should be inspected periodically. A sample form for the inspection Report is given in Appendix V, Form V-4.

CHAPTER 3

QUALITY ASSURANCE PLAN

CHAPTER 3

QUALITY ASSURANCE PLAN

3.1 Introduction

The Quality Assurance Plan (QAP) is the methodology that is selected for ensuring that the project incorporates all elements that are needed for the successful design, construction and maintenance of a project. Since projects vary in scope, the QAP has to be project-specific. The QAP should deal with all aspects of selection and testing of materials, acceptance criteria, guidelines for non-conforming materials and works and documentation.

3.2 Quality Control

3.2.1 Types of Quality Control

One of the most important tasks of the supervision during the execution of a road contract is technical quality control, i.e. control as to whether the materials and work supplied by the Contractor meet the technical requirements in the contract specifications. There are two types of quality control, which are described below:

(a) Control of Methods

Method control is usually carried out by the Consultant`s field staff whose job it is to be on the site and supervise the Contractor during the execution of the works. At the same time the field staff will perform simple measurements, such as the recording of the thickness of fill layers, the temperature of asphalt material, and the slump of cement concrete.

(b) Control of End-Results

End-result control includes field tests e.g. control of the evenness of completed pavement layers and laboratory tests, e.g. Marshall tests on asphalt materials. Other tests are a combination of field and laboratory tests. An example of this is the compaction control of earthworks where the achieved density is determined by means of a field test, and where the IS/ AASHTO density with which the result should be compared is found by means of a laboratory test. End-results control is carried out by laboratory technicians, and most of the work consists of laboratory tests.

3.2.2 Performance of Quality Control

3.2.2.1 Testing Facilities

Before the Contractor initiates earthworks, asphalt paving, concrete works etc., the corresponding test facilities must be available, i.e.

(a) Laboratories must be built and equipped;
(b) Laboratory equipment must be procured and tested;
(c) Test forms must be prepared; and
(d) Laboratory technicians must be employed and trained.

An illustrative list of minimum equipment needed for the site laboratory is enclosed at Appendix III. The Contractor may also get the tests carried out in recognized testing laboratories outside for tests of a special nature not covered by the equipments indicated in Appendix III. Such testing must be preceded by approval of the Engineer. The testing equipment must be regularly serviced as recommended by the suppliers. A calibration chart must be available for each equipment. Forms for laboratory testing are given in Appendix IV.

3.2.2.2 Start-up Problems

It is important that start-up problems have been solved before the Contractor starts work. There is often a special need for technical control during the start of the work, because the Contractor has start-up problems. Specifications normally not only state the technical requirements which must be met by materials and works, but also the test methods which must be used for the end-result control. In most cases this is necessary to be able to define the requirements clearly.

3.2.2.3 Test Specification

Specification usually describe test methods by referring to standard methods issued by Ministry of Shipping, Road Transport & Highways (MOSRTH), the American Standards for Testing Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO), the British Standards (BS) and the Bureau of Indian Standards (BIS).

3.2.2.4 Testing Frequency

The frequency of technical control is usually laid down by the Consultants at the beginning of a project and is generally related to the specifications. A testing plan giving the testing frequency, standards, acceptance criteria and agency responsible for the tests must be prepared by the Contractor and got approved by the Engineer. Appendix II gives the Quality Control Tests and Acceptance Criteria, assembled from IRC and MOSRTH documents.

3.2.2.5 Method Control

Method control is carried out according to the type of work. Where the work method is of considerable importance and requires constant supervision to achieve the quality, or where in some case, the quality is difficult to improve on, there should always be a field engineer on the site. Examples are the ramming of piles, the laying of asphalt, and concreting etc. Where work methods are of less importance or quality is constantly being achieved by the contractor, there may be no need for continuous surveillance. Examples are excavation and compaction of soil.

3.2.2.6 End-result Control

The frequency of end-result control depends on the quality parameters that are to be checked. Parameters which can vary considerably are continuously controlled. Examples are the composition of asphalt materials and the compaction of asphalt courses. As regards regulating laboratory tests the specification usually determines the number of tests. When the works are started and in cases where difficulties as regards compliance with quality requirements are encountered, laboratory testing will normally be intensified.

3.2.2.7 Quality Parameters

Quality parameters which are usually more or less constant, e.g. the Los Angeles Strength of stone materials from the same quarry, are only controlled occasionally. The same applies to parameters which can be checked fairly well with the naked eye, e.g. the particle form of crushed stone. As regards the quality of manufactured materials produced by using advanced technology, e.g. steel and bitumen, one usually trusts the manufacturer`s certificates, but when in doubt carry out additional tests.

3.2.2.8 Reporting of Test Results

The test results must be recorded systematically in a register, which must be signed by the testing authority and the representative of the Engineer, if present during the tests. Form V-6 gives the format for daily tests on highway works.

3.2.2.9 Interpretation of Test Results

The test results should be plotted on a graph sheet showing the dates/sample numbers on the x-axis and the test values on the y-axis. The statistical "warning limits" and "action limits" should be indicated on these graphs. When any test results falls outside the "warning limits", the cause should be investigated and suitable corrective action taken. When any test result falls outside the "action limits", the process should be stopped, and a thorough investigation made into the entire process, and the cause for faulty performance determined. Suitable remedial action should be immediately taken and the process brought under control.

3.2.2.10 Statistical Quality Control

Quality control based individual tests do not ensure well defined qualities of a product. One has therefore, for many years in the industry, used statistical methods where works and supplies are approved or rejected after an evaluation of the average and standard deviation of a number of test results. Similar methods are gradually gaining way in the road construction sector, and today it is not unusual to use statistical methods for the quality control. The IRC Handbook on Quality Control (SP-11) may be consulted for guidance. The use of Control Charts for establishing the trend line, and the time when corrective steps are to be taken is recommended.

3.2.2.11 Monitoring of Quality Control

The Engineer has the authority and responsibility for monitoring the use of the Quality Control System and for ensuring that the above policies are being implemented, and to consider the need for changes.

The contractor is required to carry out and is responsible for:

- Sampling and testing
- Measurements

But the obligations of the Contractor do not relieve the Engineer / the Resident Engineer of their duties towards the Employer:

(a) The Engineer shall carry out such duties in issuing

- Decisions
- Certificates
- Orders

as specified in the contract.

(b) The Engineer / the Resident Engineer's contractual duties are to

- Watch and supervise the works
- Test and examine materials and workmanship
- Exercise "process control" wherever needed

Therefore, the Resident Engineer assisted by qualified and adequate staff must carry out supervision and control such as:

- Sub-soil investigations
- Inspection of works and workmanship
- Geometric control and measurements
- Quality control of works and materials

The Resident Engineer's staff may be divided into categories so that the supervisory organization is made up of bodies with their own field of responsibility such as:

- Structures
- Highway
- Materials and laboratory

It is naturally of great importance that each field of responsibility works in a competent and well-organised manner.

It is just as important, however, that all the fields of responsibility of the organization work well together, so there does not appear any "no man's land" between the respective fields of responsibility.

Designated areas of individual responsibility should keep close contact with other members of the team so that information on faulty workmanship etc. is passed on to the people responsible.

It is the Resident Engineer`s responsibility that the supervision organization meets these functional requirements.

3.3 Approval of Quarries and Borrow Areas

The Contractor is to obtain approval from the Material Engineer through the Resident Engineer for each Quarry and Borrow Area to be used in the project prior to commencement of quarrying and/or borrow area excavation activities. The primary considerations to be considered by the Engineer in granting approval are:

- The proposed materials meet specification requirements
- The Contractor has legal approval by the owner to excavate/remove materials from the proposed quarry/borrow area
- The Contractor submits an acceptable "Environmental Management Plan" for development; use and closing down of the proposed quarry/borrow area, together with any other approvals or documents that may be required from the Ministry of Environment and Forests or other concerned authorities.

The steps to be followed for approval of each Quarry/Borrow Area are:

(a) The Contractor is to complete the "Materials Sources Data" form giving details regarding size, location, orientation and access for the proposed quarry/borrow area (rough map to be drawn). Also to be included are the list of materials to be sourced for the project works (e.g. embankment, GSB, WMM etc), and the estimated quantities for these materials.

(b) The results of laboratory tests conducted on the materials jointly sampled with the Consultant's Material Engineer (or his designated representative) are to be summarized on the approval form, and complete copies of all tests are to be attached to the form.

(c) The Contractor is to attach to the completed "Materials Sources Data" form, a letter, or some other form of written acknowledgement, that indicates that the owner of the quarry/borrow area agrees to the Contractor removing the proposed types and quantities of materials indicated in the form.

(d) The Contractor attaches to the completed "Material Sources Data" form, his proposed "Environmental Management Plan" for development, use and closing down of the proposed quarry/ borrow area. Photographs of the sources site, including access roads, etc. should be included with the proposal so that the base line conditions of the Quarry/Borrow Area to be clearly established.

(e) Following receipt of the proposal for approval of quarry(ies)/borrow area(s), the Resident Engineer is to dispatch a team consisting of the Environmental Officer and Materials Engineer to inspect the proposed site, who will then report on their findings to the Resident Engineer.

(f) Based on the Contractor's proposal, and on the site inspection team's comments, the Resident Engineer will (within five days after receipt of the proposal) reply to the Contractor in accordance with the one of the following:

(i) The Quarry/Borrow Area is approved as proposed.
(ii) The proposed Quarry/Borrow Area is approved subject to one or more required changes/additions etc (to be detailed by the Resident Engineer)
(iii) The contractor is requested to revise and re-submit all or part of the proposal submittal, giving details of required changes, additional requirements etc.
(iv) The proposed Quarry/Borrow Area is rejected.

With regard to approval of Quarry/Borrow Area, the Consultant is to pay particular attention to requirements of the Environmental Management Plan for the package, particularly with regards to:

(a) Selection of area

(i) Borrow Areas not to be within the Project Right-of-Way.
(ii) Borrow Areas preferred in non-productive, barren lands, raised lands, waste lands, etc.
(iii) Borrow Areas to be located on agricultural land should first have the top 150 mm minimum removed and stockpiled. The stockpiled topsoil is to be replaced and spread over the original areas after excavation for borrow is completed.
(iv) For quarry areas, particular care is to be taken to ensure that testing (and approval) is given for only areas to be indicated on the plan for which the materials have homogeneous properties. Similarly, the depth and extent of overburden to be removed prior to quarrying is to be accurately measured and clearly indicated.

(b) Transport of Materials

(i) All movements and access of equipment to be stationed in the designated areas are to cause minimum compaction of the soil (in critical areas/situations, the Engineer may require that all such equipment have tracks rather than wheels).

(ii) All transport vehicles are to be covered and have adequate covers, sides and tailgates to prevent spillage of materials.

(iii) All transport vehicles are to select appropriate routes and delivery times, and are to adopt safe driving habits so as to ensure the minimum of inconvenience to affected village inhabitants, and to reduce accident potential. The contractor is responsible for the repair/maintenance of all roads and facilities damaged by his transport equipment.

(c) Development/Redevelopment of Borrow Pits and Quarries

(i) Both during and following completion of the excavation activities in the borrow areas, the Engineer, together with the Environmental Officer, are to inspect the areas to ensure that the borrow pits and access roads are properly graded and drained to ensure minimum erosion, and to prevent run-off from either collecting or from damaging adjacent properties. All existing trees within the boundary of the quarry/borrow areas should be preserved and protected.

(ii) Temporary stockpiles of blasted quarry materials and borrow areas soils are to be located so as to ensure smooth flow of traffic within the areas and for access to main roads, and are to be designed so as to minimize contamination and damage from rainfall/run-off etc.

(iii) Borrow Areas (except in cases where the landowner has agreed that the borrow pit is to be excavated so as to form an appropriate pond for agricultural purpose), will be redeveloped by filling and providing 150 mm thick layer of preserved topsoil. The contractor is to also replace any vegetation removed.

(iv) The Material Engineer and other consultancy field staff are to continue to monitor the quarry/borrow materials both by periodic sampling and testing of the materials as well as by "visual" assessment. As soon as tests indicate any significant change in a material's property, or if a change is suspected visually, then the material properties are to be certified by testing and if the variation(s) is considered to be significant then a new application for approval of sources must be lodged, and the above procedure repeated.

It is to be noted that all field activities for the above are not to commence until appropriate Inspection Request Forms are completed, submitted and approved.

3.4 Approval of Materials

3.4.1 General

All materials proposed by the contractor to be used in the project works are to be approved first. In general, there are four types of materials to be approved.

(a) Natural Materials – materials with little or no processing except for perhaps screening for oversize and removal of unsuitable particles, etc. An example of this is soil embankment materials.

(b) Processed Materials – materials that require significant processing, including removal of unsuitable particles, crushing, screening and perhaps, blending of sizes. These materials are homogeneous, but with specified gradations. An example of this is Wet Mixed Macadam Base Course.

(c) Manufactured Materials – specially homogeneous construction materials, like Portland cement and bitumen, that are used for blending with natural materials (generally soil or aggregate) to obtain a pavement mix.

(d) Designed Materials- materials that involve the mixture, to specific proportions of two or more different, natural, processed or manufactured materials to obtain a modified material giving a set of desired specific properties.

Approval of each of the above material types is required, however the requirements for obtaining approval of materials for each type differs slightly.

3.4.2 Approval of Natural Materials

Natural materials are mined (i.e., excavated) and hence the first step, following assurance that the material(s) is acceptable for its intended purpose, is to obtain approval for the Borrow Area or Quarry.

Approval of the material for construction is then obtained by submittal of test results for all tests required by the Specifications (i.e., to prove that the material meets all minimum properties required), and, in some cases, by construction of trial sections to prove that this material can be placed in the field so as to attain minimum required field properties (e.g. to meet minimum density, etc.)

3.4.3 Approval of Processed Materials

Approval of processed materials follows that noted above for “natural” materials, except that usually the specifications are tighter (e.g. the material may also have to meet stringent gradation limits), and a greater variety of tests (and production/storage) conditions are required to be met.

3.4.4 Approval of Manufactured Materials

Approval of manufactured materials, based on specific Specifications requirements, is generally given in two stages.

(a) Initial Approval – given prior to receipt of the materials based on submittal of appropriate testing results confirmed by the manufacturer (note that claims by manufactures, or tests etc. by distributors, etc. are not to be accepted).

(b) Final Approval – given based on initial approval plus positive results being obtained for all “acceptance” tests required by the Specifications, or as directed by the Engineer. The Quality Assurance System and plan of the manufacturer shall also be examined before approval.

3.4.5 Approval of Designed Materials

Approval of “designed” materials for the project concerns those mix designs for Cement Concrete (for concrete pavements, box culverts, bridges etc) and Asphaltic Concrete (flexible pavement materials including bituminous macadam, dense bituminous macadam, bituminous concrete, mixed seal surfacing, semi dense bituminous concrete and seal coat). Due to the complexity of these “mixed” materials, and the plants for producing the range of materials sizes, final approval is deferred until completion of the following steps:

(a) Approval of sources (generally quarries) for each of the processed material constituents to be included in the final mix design.
(b) Approval of each of the individual processed materials and manufactured materials to be included in the final mix design.
(c) Tentative approval of a laboratory based mix design, based on a mixture of approved materials so that the mixture meets all Specifications requirements.

(d) Tentative approval of a plant mix design, based on proportioning of aggregate bins materials and manufactured materials to closely approximate the proportioning of material types/sizes finalized for the laboratory based mix design (i.e. and so that the mixture still meets the minimum Specifications requirements).
(e) Conduct trial section of works (off the project site) using the tentatively approved plant mix design and placing the mixture in accordance with a previously approved construction methodology that conforms to Specifications requirements.
(f) Based on successful laying of the mixture in accordance to the approved Methodology, conformance of the placed mixture to required placing temperatures, levels and finish, etc. and conformance to quality control requirements as verified by successful testing in accordance with the Specifications, the Material Engineer is to give final approval of the mix design based on the plant mix proportions.

3.4.6 Revocation (withdrawal) of Material Approvals

Following approval of the job mixture (i.e. the job mix formula), the Material Engineer, and all field support staff are to continue to monitor both the test results and the visual characteristics of the approved mix as placed to identify at an early stage any significant change in the mix design that may adversely influence the adherence of the approved mix design to the Specifications. A new mix design (or adjustment of the plant proportioning of materials to re-establish the approved job mix formula) will be required when it is observed that significant changes in the mix design properties are causing the mixture to no longer meet all Specification requirements. In addition, a new mix design will be required when either the approval of a material source or approval of one of the materials is revoked (i.e. withdrawn).

3.4.7 Reporting and Recording Material Approvals

The Material Engineer is to notify in writing the Resident Engineer and the Highway Engineer (and the Contractor through the Resident Engineer) each time a new source, material and /or mix design is either approved or the approval is revoked. This information is to be included in the Monthly Quality Control Report to be submitted with the Monthly Progress Report.

Records are to be kept by the Material Engineer giving current approvals of all Borrow Areas, Quarries (all types) and Mix Designs for all BOQ items. These current summarizes are to be included as part of the Monthly Quality Control Report.

3.4.8 Approval of layers of Road Works

Road Works involve placement of earth and other pavement courses in layers. Form V-6 gives the OK Card for use in this task.

3.5 Sampling of Materials

3.5.1 Sampling Requirements

All construction materials to be used in the permanent works are to be sampled jointly by the Consultant and Contractor prior to commencement of the Works. This includes sampling for materials to be tested for proposing approval of the material source as well as sampling of materials for approval of the individual construction materials. In both cases, and for each instance, the Contractor must give notification of a request for such sampling to the Consultant in advance (minimum 48 hours) by way of the Inspection Request Form (IRF) – see Form V-2, Appendix V. All assistance (e.g. sampling instruments and equipment, sample bags, and labour etc.) that is required for carrying out the sampling activities are to be provided by the Contractor. For sampling activities, the Consultant is to be represented by the Material Engineer or his appointee.

3.5.2 Sampling Guidelines

All sampling is to be carried out in accordance with instructions to be given by the Consultant. Sampling procedures are to follow recognized guidelines of good engineering practice. These include:

(a) Obtaining samples from at least three areas.
(b) Ensuring that the sampled materials and locations are "typical" for the material to be tested.
(c) Ensuring that all overburden etc. is removed within the stockpiles rather than from the surface (top, side or base of the stockpile) in order to avoid the collection of segregated materials.
(d) Ensure that sufficient quantities are sampled to enable all tests to the conducted, plus additional material, to be stored for subsequent testing if required.
(e) Ensure that each sample bag is marked/labeled both inside and outside, giving the sample number, material type, sample location, date and number of the bag, as well as any additional information instructed by the Material Engineer or his appointee.

3.5.3 Preparation and Storage of Samples

Samples collected are reduced and prepared as per standard methods (Indian Standards), with an additional sufficient quantity retained in appropriately sealed bag(s) or container(s) and separately kept in the sample storage room of the laboratory for additional testing and/or future reference as required. Concrete samples in particular are to be carefully cured and kept in the curing tank of the laboratory. Access to stored samples is under the strict direct control of the Consultant's Material Engineer. Details of all samples stored are to be kept in a register to be administered by the Material Engineer.

3.6 Field Testing Laboratory

The Field Testing Laboratory, including all furniture, testing equipment and apparatus as required by the Specifications is to be provided and maintained by the Contractor together with the provision of all necessary utilities (e.g. electricity, water, sewerage and drainage). The design and layout of the laboratory is to be approved by the Resident Engineer based on recommendations by the Material Engineer. It is the responsibility of the Contractor to ensure that the laboratory is proficiently guarded at all times of the day and night (i.e. to control access and maintain security), is cleaned daily and is properly maintained.

Testing equipment and apparatus are to be initially approved, and subsequently periodically checked, by the Consultant to assure proper operation, accuracy, correct calibration and complete conformance to all Specifications requirements. Likewise, all testing procedures detailed in the Specifications and procedures instructed by the Material Engineer as part of his Quality Control and Quality Assurance Plan are to be strictly adhered to by the Contractor. The consultant is to supervise, monitor and check all aspects of the testing procedures, including sample storage, preparation, testing and analysis and reporting of testing results. All relevant material testing details related to sample preparation, testing and analysis of results are to the recorded on the relevant standard testing form(s) given in Appendix IV.

3.7 Acceptance Testing

3.7.1 General

All materials included in the construction works for which quality control tests are specified, and for which approval by the Engineer has been previously given, are to be inspected and checked for acceptability in accordance with the Specifications requirements.

Any of the completed construction works in which unapproved and/or untested and/or unaccepted materials are incorporated without approval or written permission from the consultant are deemed performed at the Contractor's risk and are considered as unacceptable and unauthorized.

3.7.2 Routine Acceptance Tests

All sampling and quality control testing, as well as check tests to verify quality of materials, are to be conducted by the Contractor at his own expense under the direct supervision of the Consultant. The kind(s) of test(s) and frequency of testing should conform to the Minimum Quality Control Testing Requirements of the MOSRTH Specifications. Sampling and Testing should be in accordance with the relevant IS methods. Tests are to be reported on proper forms, samples of which are shown in Appendix IV.

3.7.3 Special Tests

The Agreement with the Supervision Consultant generally provides for the Engineer to order special tests to be conducted of materials and /or the completed works as required, although it is noted that "The Engineer will seek prior approval of the Employer in issuing the order of special tests". The works contract generally notes that the Contractor will be responsible for the cost of special tests if the tests show that the materials, plant or workmanship not be in accordance with the provisions of the contract.

Special tests are generally ordered by the Engineer when there is some concern with some aspect of the routine acceptance tests (e.g. sampling technique, sample contamination, testing equipment problem, operator error, etc). Based on the above, the following procedure is to be adopted for special testing:

(a) Identify routine testing concern and request agreement from the Material Engineer and the Resident Engineer that a special test is required.

(b) Identify what/how/where/when the special test is to be conducted.

    (i) By the Contractor within the Field Laboratory
    (ii) By the internal independent testing (i.e. by the consultant within the field Laboratory).
    (iii) By external independent testing.

(c) Obtain approval of the Employer for making the special test, if needed by contract provision.

(d) Based on the results of the special test(s), identify who will be responsible for the payment of the special test.
(e) Following implementation of any relevant actions indicated based on the results of the special test, record the test results, and also include the results as part of the "Quality Control Test Statement" to be submitted with, and as part of, the Supervision Consultant's Monthly and Quarterly Progress Reports.

3.7.4 Quality Control Test Statement (Monthly Progress Report)

In accordance with the Consultant's contract agreement and standard construction supervision practice, the list of laboratory test results completed during the month, and the statistical interpretations, are to be included as an integral part of each of the supervision consultant's Monthly Progress Report to be submitted to the Employer. This summary of field and laboratory test results is referred to as a Quality Control Test Statement and is to include the following:

(a) Item description and kind of test.
(b) Numbers of tests complete, passed and failed.
(c) Analysis of test results and establishment of trends.
(d) Any appropriate remarks or comments, based on trend detected and any corrective action needed.

3.8 Special Consideration for Bridges

As already explained in chapter one, three levels (viz., Level 1, 2 & 3) of tests have been identified. Depending on the material and prevailing best practices the level of its testing has been decided. While all the materials are required to be tested before being allowed to be incorporated in the structure, further tests depend on the importance of the material. Usually all the materials will undergo Level 2 testing out of which some tests may be done in the in-house/site laboratory and the remaining may be done in an approved external laboratory if the facility is not available in the in-house/site laboratory. For example an admixture is required to be tested at Level 1 which represents usual testing in the manufacturer's laboratory. In addition it will undergo Level 2 testing and moreover some of its tests would undergo Level 3 testing due to high sensitivity of the material. On the other hand cement can be tested in the in-house lab as well, especially, for some of the simpler tests such as Setting Time, Mortar Cube strength etc., whereas, chemical tests can only be done in an external laboratory. Therefore, cement qualifies for all levels viz., Level 1, 2A, 2B and 3 of testing. Here again Level 3 testing is required due to sensitivity and importance of the material.

In some of the specialized materials like pre-stressing hardware, bearings and expansion joints many test facilities are not available in external laboratories. In such cases even the Level 3 tests need to be performed in the manufacturer's work laboratory.

It is very important and essential to obtain a signed certificate of conformance/non-conformance of the material to meet the targeted requirements of the relevant codes and standards.

3.9 Guidelines for Non-Conforming Works

3.9.1 General

In broad terms, it is necessary that the materials and workmanship conform with the contract requirements, and ideally non-conforming work shall be rejected. Whenever the work falls short of the requirements, the matter shall also be brought to the notice of the Employer.

But special difficulties arise in the case of some items of work such as concrete, where the non-conformance may only be known after few days cube results become available, in which period work has progressed further. In some of the situations, acceptance after repair/review for adequacy is feasible. Therefore, separate procedures are laid out for some of the non-conforming situations. In case the feasible items do not meet the requirements after such repair/review, the non-conforming item should be rejected. It is also necessary to refer to Head Office and/or designer in certain cases of non-conformance to seek their advice and guidance.

3.9.2 Concrete/Bituminous Works

The primary means by which Quality Assurance shall be achieved is by the procedures described in relevant material qualification and workmanship method statement. The non-conforming concrete/ bituminous items shall be further reviewed as given below:

3.9.3 Non-conformance 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:

(a) The Contractor shall be notified without delay verbally, and in writing by the following means:

(i) Return of the Request for Inspection Form signed "not approved" with the reason for rejection stated.
(ii) Issue of a Site Inspection or Site Order or letter stating the facts and confirming that the works are not approved.

(b) Approval to carry out concreting/asphalting of a similar nature shall be withheld.
(c) The Contractor shall be asked for his proposals to rectify the non-compliance, which may involve re-submission of materials, new trial mixes, and revised method statements.
(d) The acceptance or rejection of any unapproved concrete/asphalt work shall be returned to the Engineer.
(e) When satisfied with the measures taken to ensure future compliance, the Engineer shall confirm approval to continue concrete/bituminous items for permanent works.

3.9.4 Non-conformance with Strength Requirements

(a) The specification strength/density for concrete/bituminous works recognizes statistical possibility of specimen failure and thus limits of means, standard deviation, minimum values of strength are specified. The rejection criteria are set out in the agreement.
(b) Materials that are stored for a long time shall be retested at regular intervals before use. Any deterioration in the quality shall be detected and defective material rejected and removed from site.
(c) In the event of cube/density results fall short of the provision of the Contract then the non-compliance procedures described below shall be followed:
    (i) Approval of concreting/asphalting of similar works shall be withheld.
    (ii) All aspect of concreting/asphalting shall be reviewed.
    (iii) The clause of failure shall be identified and measures taken to remedy the problem.
(d) Various repair/rectification procedures for commonly arising/non-conformance, are specified in contract. The Contractor shall furnish his exact proposals for rectification under consideration.
(e) The fact of non-conformance and the proposed rectification procedure is conveyed to the Engineer/design organization of owner (or design consultant) for review and opinion about:
    (i) Acceptability of measure proposed by the Contractor, if any
    (ii) Further non-destructive testing, if any
    (iii) Acceptability in case strength is achieved at a later age (e.g 90 days)
    (iv) Acceptability at the level of strength achieved for the stress levels in concerned members.

(v) Acceptance of repair/rectifications/strengthening measures with modifications, if required, or rejection.

(f) Rejection in case the item does not pass modified acceptance limits after repairs.

3.9.5 Non-conformance with Finish Requirements

(a) Where the required finish is not attained then the non-conformance procedure for repair/rectification in the Specifications shall be followed.

(b) In addition the following procedure shall be followed.
  (i) Approval of similar work shall be withheld.
  (ii) All aspects of work shall be reviewed
  (iii) The cause of poor finish shall be identified

(c) Revise specification/instructions to avoid further recurrence of non-conformance.

Non-conformance in case of earthwork, base and other pavement coarse are treated as per above guidelines as applicable.

3.9.6 Non-conformance in respect of Concrete Works in Bridges

3.9.6.1 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.

(a) The Contractor shall be notified without delay verbally and in writing by the following means:
  (i) Return of the Request for Inspection Form singed "not approved" with the reasons for rejection stated.
  (ii) Issue of a Site Instruction or Site Works Order or letter stating the facts and confirming that the works are not approved.

(b) Approval to carry out concreting of a similar nature shall be withheld.

(c) The Contractor shall be asked for his proposals to rectify the non-compliance which may involve resubmission of materials, new trial mixes, and revised method statement.

(d) The acceptance or rejection of any unapproved concrete work shall be referred to the Engineer.

(e) When satisfied with the measures taken to ensure future compliance the Engineer shall confirm approval to continue concrete for permanent works.

3.9.6.2 Non-compliance with Strength Requirements

(a) The specifications for concrete recognizes 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 are as set out in the Contract Agreement.

(b) 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:

- (i) Approval of concrete of similar works shall be withheld.
- (ii) All aspects of concreting shall be reviewed.
- (iii) The cause of failure shall be identified and measures taken to remedy the problem.

(c) The repair/rectification procedures for commonly arising defects should be covered by tender specification, 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 methods and retested and/or inspected.

(d) The fact of non-compliance and rectification means as proposed should be conveyed to the Engineer and for review and opinion about:

- (i) Acceptability of Contractor's proposal
- (ii) Further non-destructive testing, if any
- (iii) Acceptability in case strength is achieved at a larger age (e.g. 90 days)
- (iv) Acceptability at the level of strength achieved for the stress levels in concerned members.
- (v) Rejection of concrete.

3.9.6.3 Non-compliance with Finish Requirements

In order to prevent occurrence of unacceptable standard of finish the procedures for formwork described in the specifications 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.

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.

3.9.7 Non-conformance in Works other than concrete in Bridges

3.9.7.1 Procedure

The procedure for acceptance of finish works for formwork, reinforcement, coatings on reinforcement, materials for concrete, pre-stressing and bridge finishing works are straightforward and shall be as follows:

(a) Regular and special testing, logging of results and inspections shall determine compliance or non-compliance.
(b) Any non-compliance shall without delay be notified to the Contractor. This shall be done both verbally and in writing by the following means:
    (i) Return of the Request for Inspection Form signed "not approved" with the reasons for rejection stated.
    (ii) 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.
(c) 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.

3.9.7.2 Admixtures

In case the material tests show non-compliance prior to their use then the complete material lot shall be removed from the site at once and the procedure stated in 3.9.7.1 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-complaint 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.

3.9.7.3 Cement and other Materials

The procedure indicated in 3.9.7.1 shall be adopted.

3.9.7.4 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.

(a) Contractor to propose elaborate scheme of strengthening the bridge components not passing the test criteria.
(b) 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.
(c) 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.

3.9.7.5 Pile Foundation

The procedure 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 116 of MOSRTH Specifications for Road and Bridge Works 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.

3.9.7.6 Well Foundations

The procedure to deal with the non-complaint 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 the case tilt and/or shift of well exceeds the limits specified in clause 1207.8 of MOSRTH Specifications for Road and Bridge Works unless specified otherwise in the tender document, the Contractor shall be required to remove/abandon such well/foundations at no extra cost to the owner. In case, for any unavoidable reasons, it is decided to retain 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 MOSRTH Specifications for Road and Bridge Works unless specified otherwise in the tender documents by the Contractor to the owner. Any additional costs incurred on this account shall be borne by the Contractor.

3.9.7.7 Records

It is mandatory that all instances of works outside the Specifications are recorded in writing to the Contractor. This ensures that:

(a) The Contractor is irrefutably informed.
(b) 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:

(a) The total number of inspections and tests.
(b) The number of "first time" approval i.e. the number of times the material or workmanship is approved on the first test or inspection.
(c) The number of second, third, fourth etc. inspections or tests of the same work required before final approval.
(d) The percentage of first time approvals, second third etc. over suitable time intervals.

From the above information, the Engineer shall review the Contactor's superintendence and take action where necessary to improve matters. From increase or decrease in the number of first time approvals, the improvement or deterioration in Contract's performance can be monitored. The record of repair/rectification, retesting, inspection & acceptance shall be kept as part of "as built" documentation including 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.

3.10 Documentation

3.10.1 General

Upon completion of each Contract Section, and the completion of the Project, there are several documents to be prepared and submitted to the Employer. The following should be checked with the Employer as the project nears completion.

(a) The As-built drawings/plans
(b) The Final Take-off quantities and amounts
(c) Contract Documentation
(d) Final Completion report

Although those final documentation are to be submitted at the end of Contract "Section" period, they have to be prepared as work progresses, and finalized when works are nearing completion.

3.10.2 As-built Drawings

The conditions of Contract provide all information as to the required content of "As-built Drawings", and responsibilities for their completion. It is the Contractor's responsibility to prepare the As-built Drawings. The Resident Engineer must supervise, monitor, and check the preparation of the As-built Drawings. The preparation of these drawings must be performed during the course of the works and must not be left until "substantial completion" to commence. As the works are completed they are to be surveyed and the drawings prepared.

3.10.3 Final Take-off of Quantities and Amounts

As the works progress, interim measurements of the approved works are taken for monthly certification. In parallel, as the works are completed a final accurate measurement of the works must be performed. This survey information is used in the preparation of the Record (As-built) Drawings.

It is important to note that the final quantification for payment is not a mere take-off of the as-built quantities, but rather the quantification of the specified works as described in the design drawings (As-staked with any approved modifications) and in the Specifications. For example, the thickness of pavement concrete specified may be 230 mm+/-5mm. If the Contractor places from 225 mm to 235 mm, he is entitled to be paid for 230mm; if he places below 225 mm his claim may be rejected or the payment adjusted. If above 235 mm he will only receive payments for that specified (i.e. 230 mm). However, it is to be noted that the As-built Drawings must show the actual thickness placed.

3.11 Forms for Testing

Appendix II gives the Quality Control Tests and Acceptance Criteria.
Appendix IV gives recommended forms for testing.

CHAPTER 4

QUALITY AUDIT

CHAPTER 4

QUALITY AUDIT

4.1 Introduction

Quality Audits (QA) are required for detecting whether the procedures adopted ensuring the quality of works are at variance with those required by the contract and/or as set out in the contract administration procedure and/or the Quality Assurance Plan.

There are basically two levels of Quality Audit, viz.,

(a) internal
(b) external

These are discussed separately here.

4.2 Internal Quality Audit

The internal quality audit is the audit performed by agencies such as Design Consultants, Supervision Consultants and the Contractors. The plans for Quality Audit by these individual agencies are to be implemented by the respective agencies.

4.2.1 Auditing Procedures

(a) The Quality Audit Plan for the Project will specify the scope, type and frequency of Quality Audits to be undertaken. Audits may be of the following types:
   (i) Procedures Audit
   (ii) Systems Audit, or
   (iii) Product Audit

An auditor will be nominated by the agency for this purpose.

(b) The nominated auditor will give at least 7 days notice in writing to the representative of the intended audit and will specify which aspects of the works are to be audited.
(c) Prior to the audit being undertaken, the auditor will prepare checklists of specific details of procedures to be audited.
(d) At the start of the audit, the auditor will hold an audit opening meeting to explain the purpose and procedure to be adopted for the audit with the agency's representative and any other persons involved in the audit. Attendees at the meeting will complete an attendance sheet.

(e) The Auditor will undertake the audit using the prepared checklists. Any non-conformance identified is to be recorded on the Notification and Corrective Action Request Form. A separate form will be completed for each non-conformance.
(f) At the completion of the audit, the auditor will hold a closing meeting with the agency's representative and others to explain the results of the audit and to handover any Non-conformance Notification and Corrective Action Requests. The agency's representative will sign the request signifying that he understands the nature of the non-conformance.
(g) The auditor will forward an audit report to the agency's representative within 14 days giving a full account of the audit undertaken. Originals of Non-conformance Notifications and Corrective Action Requests will be attached to the report for action by the agency's representative.
(h) The agency's representative will propose an action to correct the non-conformance and the auditor must concur with the proposed action for it to be considered acceptable. The agency's representative will also undertake action to prevent a recurrence of any non-conformance.
(i) The auditor will follow up on any proposed action as a result of the audit and will so record in the form when satisfied that action has been undertaken in a satisfactory manner.

4.2.2 Auditing Responsibilities

The agency responsible for Quality Assurance will:
(a) Prepare a quality audit plan for the project, and
(b) Maintain records of quality audits undertaken

The Auditors will:
(a) Give notice of intended audits;
(b) Prepare checklists for use during an audit;
(c) Undertake the audit and complete any Non-conformance Notifications and Corrective Action Requests necessary
(d) Concur with proposed satisfactory dispositions and follow up on any dispositions or corrective actions to be undertaken; and
(e) Complete an audit report for each audit

The agency's representative will:
(a) Propose dispositions for non-conformance and propose corrective actions, and
(b) Undertake action to prevent a recurrence of any non-conformance or to correct any non-conformance.

4.2.3 Auditing Documentation and records

(a) Quality Audit Checklists

(b) Non-conformance Notification and Corrective Action Request Forms
(c) Audit Reports

A copy of the Audit Report shall be sent to the NHAI for their information.

4.3 External Quality Audit

4.3.1 External Auditors

NHAI may appoint independent agencies (consultants) to carry out external audit of its projects. This external audit system is to serve as a management tool to ensure proper implementation of the project specific Quality Management System (QMS) by examining various components of the same such as Quality Supervision Manual (QSM) of Supervision Consultant/ Project Management Consultant, Quality Management Plan (QMP) of Contractor, and other documents which are part of the projects QMS. The external audit should also cover the project specific data, records, analysis of data, etc., which arise in the process of implementation of QMS for execution of the project.

The external audit is proposed to be carried out by NHAI by appointing 'External Auditors', who are qualified specifically for the audit functions. These can be organizations/association of experts, or individuals depending upon the scope of audit.

NHAI will decide from project to project the coverage of audit and define the number of partial audits in Terms of Reference (TOR) given to the bidders in the procurement documents for appointment of external auditors.

4.3.2 Working of External Auditors

The External Auditor has to function as a part of overall system interacting with different organizations at different points of time, such as:

(a) Appointment
(b) Preparatory work
(c) Mobilization for audit
(d) Corrective follow-up-action
(e) Second cycle of audit repeating the process from 'appointment' onwards if the auditor is to be changed, otherwise starting from the stage of 'conducting audit' and ending up by reporting auditor's observations.

The organizations involved are:

(a) NHAI and its officers at various levels from Top Management, Head Office, Engineering Offices and Site Office.
(b) Supervision Consultant (SC)/ Project Management Consultants (PMC) consisting of his Head Office and Project Office.
(c) Main Contractor and his sub-contractors together with other associated agencies such as manufacturers and suppliers of materials etc.

All "Quality Management Systems" of the agencies connected with the execution in field including his own Quality Supervision Manual (QSM) will be co-related, cross-referenced and made into a consistent set in an overall "umbrella" document for the project. The External Auditor is appointed to audit the actual implementation and functioning of QMS and assess the efficiency of the Quality System. The Auditor will submit his findings and recommendations to the CGM/Member (Tech) and the 'Quality Cell' in his office. The scope of audit and its reporting will be as per the "Terms of Reference (TOR)" of auditor's appointment.

In order to ensure that the persons conducting audit are properly briefed and are trained for the job, a short orientation-cum-training programme will be conducted before start of actual audit.

4.3.3 Aspects to be covered by External Audit

In principle, the external audit should cover all aspects of the 'Quality Management System' set-up for the project and all organizations which have influence on the outcome of the project. However, such comprehensive audits may or may not be called for depending on the aims set up by owner's organization (NHAI). It is a normal practice to conduct partial audits covering specific functions or items only by mobilizing qualified auditors specializing in aspects to be covered. This process also permits inspection of various aspects on a selective basis where need for verification of only some of the aspects is more urgent. This, for example is a case of:

(a) Serious level of non-compliance observed in the previous audits.
(b) Different aspects of working assume comparatively greater or lesser importance as project progresses from mobilization to completion. Thus initially the audit of organizational set up and plant and equipment may be of primary interest. Set up and functioning of field/laboratory testing will be important at later stages.

The following list of partial audits is covered in detail in this section.

4.3.4 Partial Audit – Organizational set-up and experience level

(A) Scope

To verify actually deployed organizational set-up of all concerned parties.

(a) NHAI
(b) Design Consultants
(c) Proof Consultant, Peer Review Consultant
(d) SC/ PMC
(e) Contractors

(B) Base Documents

In order of priority (subject to existence and availability)

(a) QA Manuals of Project (Umbrella document called PMC's Supervision Manual) and other manuals of SC/ PMC, Contractor and associated other parties.
(b) Contractor's QA documents specified in Contract (Quality Management Plan).
(c) Parent Organization's Overall Set-up and Practices in absence of project specific manual (Quality Assurance Manual).

(C) Method of Verification

Step 1: Get statement/documentation from SC/ PMC including C.V. data of deployed personnel.
Step 2: Meet personnel at site and verify the above.
Step 3: Interview persons whose qualification/experience appears to be weak and ascertain their ability to fulfill the assigned task, as well as back-up guidance available to them.

(D) General Contents of Report (To be given to both SC/ PMC & NHAI)

(a) Observations of compliance w.r.t. stated intentions/ requirements in agreement.
(b) Assessment made by auditor based on Steps 2 to 3 above (method of verification).
(c) Specific corrective actions.
(d) Recommendations (not binding portion) for training/senior level support.
(e) It is NOT in auditor's purview to ask for replacement but he should bring out the weaknesses and strengths.

4.3.5 Partial Audit – Plant and equipment

(A) Scope

Verify actually deployed plant and equipment in-working condition against

(a) As declared in Contract Agreement
(b) As needed in judgment of SC/ PMC & Contractor due to actual state of work at time of audit.

(B) Base Document

Submission of requirement from SC/ PMC based on:

(a) Contract Document
(b) Assessment arising from Detailed Construction Programme (e.g. Clause 14 Programme of FIDIC document).
(c) Presently (i.e. at the time of audit) needed plant/equipment as recorded/ instructed in the minutes of Progress Review Meetings or other correspondence
(d) Calibration of plant/equipment and servicing records
(e) Availability/deployment records

(C) Method of Assessment

(a) Documented list (with rated capacities of plant)
(b) Physical verification of available numbers in working order
(c) Output recorded at site vis-à-vis stated ratings
(d) Interview of SC/ PMC's managerial and working level staff as well as lab in-charge
(e) Contractor's plant operators working level staff for gathering/verifying information/data

(D) Report

(a) Status Report
(b) Comments on productivity and overall effect on progress (w.r.t. Clause 14 Programme) or other agreed programme (weekly/ monthly planning).
(c) Comments/report on (e) and (f) listed under base document above.
(d) Adequacy of capacity of stand-by equipment/plant

4.3.6 Partial Audit: Testing & Quality Control (Covering Field & Laboratory)

(A) Scope

To verify if testing and Q.C. requirements, as specified in contract and Quality Manuals are being carried out, documented and used to control the quality of finished product. Audit is to cover the management and methodology of the operations based on records, interviews etc. and not audit the quality of end product itself.

(B) Base Document

(a) Q.A. Manual (especially the planning proformae)
(b) Technical Specifications
(c) Calibration and certification data of test equipments
(d) Documentation
(e) Record of test results and analysis, corrective actions and result of actions.

(C) Method of Verification

(a) Records of testing and control charts etc.
(b) Interview staff in-charge of field testing
(c) Interview laboratory staff
(d) Interview R.E. and field staff of SC/ PMC and Contractor using the results for controlling quality works.
(e) Sample field inspection (and testing in case of doubt)

(D) Report

(a) Observations/Compliance of earlier auditor's report
(b) Comments on documentation
(c) Assessment of adequacy of testing facilities and level of competence of staff
(d) Report on use of Q.C. system by field staff to achieve quality
(e) Analysis of trends based on recorded results
(f) 'Quality Index' for various operations to be worked out and reported (As per IRC Guidelines on Quality Systems for Roads and Bridges).
(g) Non-compliance report

4.3.7 Partial Audit: Methodology, Workmanship (Technical Requirements of Specification)

(A) Scope

To verify that:

(a) Method Statements and other documents as required by Quality Supervision Manual (QSM) by SC/ PMC are prepared and approved.
(b) Workmanship aspects of specifications are adequately covered
(c) Flow chart of activities and involvement of various personnel of contractor, SC/ PMC, Field/Lab testing staff in carrying out any item of work is prepared and understood by all involved.
(d) Non-conformance is being corrected and corrective actions taken
(e) Training of staff is adequate

(B) Base Documents

(a) Contract Agreement
(b) Quality Supervision Manual of SC/ PMC
(c) Contractor's Quality Manual Plan
(d) Organisation's overall QMS if it exists (such as ISO:9000 Certification)

(C) Method of Verification

(a) Study of documents
(b) Interview
(c) Inspect record of training and question staff
(d) Overall field inspection of ongoing operations and completed work

(D) Contents of Reports

(a) Adequacy of document
(b) Quality of Method Statements
(c) Level of understanding by working staff
(d) Site Observations
(e) Suggestions for improvement

(Notes: To assess existing level and improvement achieved from last audit a suitable marking/rating system to be developed).

4.3.8 Partial Audit : Safety Aspects

(A) Scope

To verify compliance with requirements of Agreement regarding

(a) Set-up for taking care of accidents during/after working hours including immediately fist-aid, availability of doctor, hospitalization etc.
(b) Preventive safety measure during work including personal safety of workers and third party.

(c) All insurances kept fully paid up and operative.
(d) Safe working methods (e.g. blasting operations, safety barricades, warning signs at diversions, helmets, safety belts etc.).

(B) Base Documents

(a) Contract Agreement
(b) SC/ PMC's Report
(c) Methodology statements

(C) Method of Verification

(a) SC/ PMC's Report
(b) Previous Auditors' Report
(c) Physical verification of documents
(d) Observations in field
(e) Interview with staff/workers

(D) Reporting

(a) Report adherence/non-compliance
(b) Specifically bring to attention of SC/ PMC/ NHAI (PD) immediately (advance reporting)

4.3.9 Partial Audit: (Optional – Disputes and Dispute Resolution, Legal, Financial etc.)

The financial aspects will particularly cover critical examination of variation orders, excesses (actual and anticipated) etc. The disputes review will cover grievances and difference cropping up and correspondence in that regard and suggestions to resolve/avoid such disputes/claims. The audit of these aspects will be optional; to be carried out if required specifically by NHAI, at mutually agreed fees.

4.3.10 Monitoring of Quality Audit Reports (QAR)

The Quality Auditor shall send QAR to the QMS cell in the H.O. of NHAI with a copy to CGM concerned and PD concerned. The PD shall report compliance, after due consultation with the SC/ PMC, to the CGM, who will pursue all pending points till their final compliance and initiate contractual and other actions necessary on the QAR. In case the CGM disagrees with the findings or recommendation in the QAR, he may send his observations to the Member (Technical) concerned for over-ruling of such findings or recommendations in the QAR. After final order of the Member (Technical) in this regard, a report shall be sent to the Chairman, NHAI.

The QMS Cell in H.O. shall pursue and keep track of all points of QAR till their final compliance or over-ruling as above. The QMS Cell in H.O. shall also periodically review QARs to examine whether any corrective actions are necessary to avoid recurrence on other works in future and make suitable proposals to the Chairman, NHAI.

Appendix I

Duties and Responsibilities of Senior Professional Staff for Quality Assurance

Appendix I

Duties and Responsibilities of Senior Professional Staff for Quality Assurance

Position	Abbreviation
KEY STAFF	
Project Leader	PL
Team Leader	TL
Senior Contract Specialist	CS
Senior Pavement Expert	PAV
Resident Engineer	RE
Material Engineer	ME
Highway Engineer	HE
Bridge Engineer	BE
SUB-PROFESSIONAL STAFF	
Highway Cum CADD Expert	CE
Quantity Surveyor	QS
Survey Engineer	SE
Environmental Officer	EO
FIELD STAFF	
Field Engineer (Highway)	AHE
Field Engineer (Bridge)	ABE
Field Engineer (Quality)	AME
Site Supervisor (Roads)	SR
Site Supervisor (Bridge)	SB
Site Supervisor	SQ
Lab Technician	LT
Surveyor	S
SUPPORT STAFF	
Cad Operator	CAD O

The duties and responsibilities of the professional staff given here are illustrative in nature, and may vary from job to job.

Team Leader

Responsible to: NHAI (the Employer)

Sl. No.	Tasks	In association with
1	To oversee the implementation of the quality policy	RE+CE
2	To co-ordinate preparation of the monthly and quarterly reports on Quality System.	RE+ME+CE+HE+QS

Senior Contracts Specialist

Responsible to: Team Leader

Sl. No.	Tasks	In association with
1	Prepare input reports/schedules to relevant provisions of the contract documents, including variation orders, quality Assurance Plan etc.	TL+RE
2	Review Contract documents and advice on steps to be taken to resolve any identified problems, inconsistencies, anomalies etc.	TL+Employer

Senior Pavement-cum-Material Engineer

Responsible to: Team Leader

Sl. No.	Tasks	In association with
1	Guiding and supervising the Resident Engineer and Highway Engineer in prescribing appropriate construction methodologies	TL+RE
2	Ensure control testing and specifications, etc. are appropriate; and are included as part of the Quality Assurance Plan to ensure a high quality pavement is constructed.	TL+RE+ME
3	Identify existing and where possible, likely future problems/issues that may effect the quality of progress of the pavement works.	TL+RE+Employer
4	Provide expertise required to help resolve problems related to pavement or quality or construction progress.	TL+RE+ME
5	Identify and resolve and material related problems associated with quarry approvals, material testing, approval of materials and mix designs, laying procedures, slump control specifications etc.	RE+ME
6	Provide input to, and give final approval of, all aspects of the Quality Assurance Plan related to the specification, testing, approval and use of materials and mix designs in pavement construction.	TL+RE+ME
7	Check and assist, as required, with the design equipping and organization of the contractor's site laboratories.	

Resident Engineer

Responsible to: Team Leader

Sl. No.	Tasks	In association with
1	To prepare monthly progress report for submission to the Employer	TL+QS+CE+HE+ ME
2	To ensure that the construction of the works are supervised in accordance with established procedures.	HE+ME
3	To ensure compliances with quality system requirements.	ME+HE+BE
4	To prepare reports on technical matters for the Team Leader as required.	ME
5	To advise the Team Leader on technical matters	ME+HE
6	To supervise the construction of the "works", as Team Leader's representative, within the powers delegated by the Team Leader and in accordance with any policies and procedures established by the Employer.	TL
7	To establish and maintain a quality plan for the site activities under his control and to ensure compliance of all activities.	HE+ME+BE
8	To ensure compliance with all requirements of the safety, health and environment management system.	ME+EO+HE
9	To discuss design problems with Team Leader	HE+BE+CE
10	To organize with the Bridge and Highway Engineer and implement procedures for design and drawing changes and for the checking of temporary works proposals.	BE+HE+CE
11	To establish and maintain documented quality management system.	TL
12	To carry out quality audits and to advise the Team Leader of the level of compliances.	HE+ME
13	To review the effectiveness of the quality management system and to advice the Team Leader	ME+HE+BE
14	To Advise the Team leader on matters related to quality assurance	ME+HE
15	To advise the Team Leader of comment on contractor's quality assurance proposals	ME
16	To carry out audits and report as required on the Contractor's quality assurance arrangements.	ME+HE

Material Engineer

Responsible to: Team Leader & Resident Engineer

Sl. No.	Tasks	In association with
1	To establish and maintain site laboratory and testing procedures	AME+LT
2	To establish material control testing requirements to be followed by the Contractors	AME+LT
3	To establish and maintain a computerized database for the compilation of materials testing results produced by the Contractors.	AME+CO
4	To inspect/review the Contractor's material criteria and sources.	AME+LT
5	To check and approve the suitability of proprietary materials for incorporation into the works.	AME+LT
6	To review the Contractor's materials testing methods and operations.	AME+LT
7	To provide materials advise to the site supervisory teams and operations.	AME
8	To prepare monthly Project Quality Control reports for the Resident Engineer.	AME+CO
9	To undertake materials check testing as requested by the Resident Engineer.	AME+LT
10	To ensure compliance with quality system requirements.	RE
11	To manage laboratory teams and operations.	AME+LT
12	To provide expert technical advice to the Resident Engineer on the requirements of materials testing.	-
13	To comment on and assist with the approval of Contractor's proposals relating to concrete mixes, asphalt mixes, the use of special materials etc.	AME+SPECIALI ST
14	To establish and maintain a healthy and safety plan.	AME

Highway Engineer

Responsible to: Resident Engineer

Sl. No.	Tasks	In association with
1	To organise and supervise the inspection of the execution of construction work to ensure compliance with the drawings, specifications, safety and environmental provisions.	RE+AHE+SE
2	To ensure the maintenance of daily records of all activities carried out on the Contract and of the site diaries in respect of the Contract structures.	AHE
3	To ensure that measurement checks and testing to ensure the accuracy of the works are carried out	AHE+SE+LT
4	To ensure that the construction drawings are reviewed in advance of construction.	RE+ME
5	To check the Contractor's method statements	AHE+SE
6	To check the Contractor's as-built drawings	RE+BE+CE
7	To ensure that the contractor is informed of any deficiency in the standard of workmanship	RE+AHE
8	To direct team in the establishment of survey control points	AHE+SE
9	To co-ordinate and collate the information provided by the daily records and site diaries of the works supervisors and prepare input to the Weekly Reports on all activities carried out in the section of works under his control	AHE+CO
10	To supervise and instruct the work supervisors with respect to inspection of the works and carrying out measurement checks and testing to ensure the accuracy of the works	AHE+SE
11	To provide advice and information to the Resident Engineer and Quantity Surveyor in matters relating to measurements, valuation and certification, in researching the Contractor's claims and the preparation of Various Orders.	RE+QS
12	To be responsible for the management of drawings and documentation	HE+BE+CAD O +CO+OM
13	To prepare drawings.	HE+BE+CAD O +CO+CE

Bridge Engineer

Responsible to: Resident Engineer

Sl. No.	Tasks	In association with
1	To check temporary works design proposals and shop drawings	RE+ABE
2	To ensure periodic visits on site	TL+RE
3	To organize effective supervision, and to ensure construction implementation as per design	RE+ME+ABE+SE
4	To inspect works with respect to method of pouring concrete, workmanship, capability of equipment to be used in substructure and superstructure.	RE+ME+ABE

Quantity Surveyor

Responsible to: Resident Engineer

Sl. No.	Tasks	In association with
1	To ensure that the completed work complies with the quality plan	RE+HE+ME+QAS

Survey Engineer

Responsible to: Resident Engineer

Sl. No.	Tasks	In association with
1	To check and agree with the Contactor (as well as with the Authorities concerned) on the Vertical and horizontal co-ordinates of the principal survey control points in the region of the project.	RE+HE+S
2	To check and report on the Contractor's main survey control points, in order that "approval to proceed" with setting out the works can be issued.	RE+HE+S
3	To check the contractor's setting out of the works in order that "approval to proceed" with construction can be issued.	RE+HE+S
4	To agree with the Contractor on existing ground levels, existing features and obstructions prior to the commencement of the works and to assist the Highway Engineer with the processing of data obtained from such surveys.	RE+HE+S
5	To assist Resident Engineer's staff in checking local setting out	RE+HE+AHE
6	To check main control set out by the Contractor, and agree any required deviation in levels or co-ordinates.	RE+HE+S

Environmental Officer

Responsible to: Resident Engineer

Sl. No.	Tasks	In Association with
1	To assess and monitor environmental management plan based on Contract document.	TL+RE
2	To ensure that the Contractor fulfills all his obligations with respect to the environment during construction.	HE+AHE
3	To tackle day-to-day problems on this account and suggest corrective measures as and when required.	TL+HE+AHE
4	Interact with different agencies like NGOs, World Bank, MOEF and State Regulatory Authorities.	TL
5	To prepare status report on implementation of environment management plan.	HE+AHE

Field Engineer (Highway)

Responsible to: Highway Engineer

Sl. No.	Tasks	In Association with
1	To review construction drawings in advance of the works	HE+SE
2	To ensure that the Contractor is informed of any deficiency in his execution of the construction work.	HE
3	To ensure the safety of the public by regularly checking and monitoring the Contractor's traffic management arrangements and to promote safe working conditions for all staff and operatives engaged on the contract.	ME+HE
4	To assist the Highway Engineer in his duties	—
5	To watch over the execution of construction work to ensure compliance with the drawings, specifications, safety and environmental provisions.	HE+SE+SR
6	To inform the Contractor in respect of any deficiency in the execution of the construction work	HE+SR
7	To carry out measurement checks and testing as instructed by the Resident Engineer as appropriate to ensure the accuracy of the works.	RE+HE+SR
8	To maintain daily records of all activities being carried out in the section of works under his control.	HE+SR
9	To maintain daily records of weather conditions and of plant and labour returns.	HE+SR
10	To assist the Quantity Surveyor in the measurement and recording of the works	HE+SE+SR
11	To check, when appropriate the setting out of the works.	HE+SE+SR

Field Engineer (Bridge)

Responsible to: Bridge Engineer

Sl. No.	Tasks	In Association with
1	To check bridge design details on site	RE+BE
2	To check temporary works design proposals	RE
3	To prepare reports for the Bridge and Materials Engineers	RE+BE
4	To check steel reinforcement schedule	BE+SB

Field Engineer (Quality)

Responsible to: Material Engineer

Sl. No.	Tasks	In Association with
1	To assist the Material Engineer in his tasks and duties	LT
2	To manage the day-to-day running of the laboratory	LT
3	To instruct materials technicians and assistants on procedures and to as a materials technician.	ME+LT
4	To supervise on a day-to-day basis the Contractor's concrete and/or asphalt plants, including sampling, testing and approval of contractor's materials.	ME+LT
5	To maintain all necessary records relating to the operation of these plants, the raw materials and the finished products.	CO+LT

Site Supervisor (Roads)

Responsible to: Field Engineer (Highways)

Sl. No.	Tasks	In Association with
1	To review construction drawings in advance of the works	HE+AHE
2	To ensure that the Highway Engineer is informed of any deficiency in the Contractor's execution of the construction work	AHE
3	To assist in the safety of the public by regularly checking and monitoring the Contractor's traffic management arrangements and to promote safe working conditions for all staff and operatives engaged on the Contract.	ME+HE+AHE
4	To assist the Highway Engineer in his duties	_
5	To watch over the execution of construction work to ensure compliance with the drawings, specifications, safety and environmental provisions.	HE+SE+AHE
6	To inform the Contractor and Highway Engineer in respect of the deficiency in the execution of the construction work	HE+AHE
7	To carry out measurement checks and testing as instructed by the Highway Engineer as appropriate to ensure the accuracy of the works	HE+AHE
8	To maintain daily records of all activities being carried out in the section of works under his control.	HE+AHE
9	To assist the Quantity Surveyor in the measurement and recording of the works.	HE+SE+AHE
10	To check, when appropriate the setting out of the works.	HE+SE+AHE

Site Supervisor (Bridge)

Responsible to: Field Engineer (Bridge)

Sl. No.	Tasks	In Association with
1	To provide check bridge design details on site.	BE+ABE
2	To check all for work and shuttering	ABE
3	To check temporary works design proposals	BE+ABE
4	To review costing for bridge work items	QS+ABE
5	To prepare reports for the Bridge Engineer	ABE
6	To check steel reinforcement placements	BE+ABE
7	To check all dimensions of completed work to ensure conformance with the designs	ABE

Lab Technician

Responsible to: Assistant Material Engineer

Sl. No.	Tasks	In Association with
1	To perform day-to-day testing of materials in the laboratory at on site, including concrete, asphalt mixes and inbound materials under the direction of the Assistant Material Engineer	ME+AME
2	To ensure that correct testing procedures are adopted.	AME
3	To prepare laboratory and site testing records.	AME+AHE+CO
4	To provide Assistant Material Engineer, the date necessary to maintain the site records.	CO

Surveyor

Responsible to: Survey Engineer

Sl. No.	Tasks	In Association with
1	To check and agree with the Survey Engineer (as well as with the Authorities concerned) on the vertical and horizontal co-ordinates of the principal survey control points in the region of the project.	SE+HE
2	To complete surveys necessary to check and report on the Contractor's main survey control points, in order that "approval to proceed" with setting out the works can be issued.	SE+HE
3	To check the Contractor's setting out of the works in order that "approval to proceed" with construction can be issued.	SE+HE
4	To check with the Contractor surveys of existing ground levels, existing features and obstructions prior to the commencement of the works and to assist the Survey Engineer with the processing of data obtained from such surveys.	RE+HE+SE
5	To assist the Survey Engineer by the provision of measurements and levels at interim and final stages of construction in order that interim and final measurement of the works can be evaluated.	HE+QS+SE
6	To assist the Survey Engineer, as required, on requirements for setting out of the works and inform of any matters that need to be instructed to the Contractor.	HE+SE
7	To assist the Survey Engineer staff in checking local setting out.	HE+SE
8	To check main control, set out by the Contractor including any required deviations in levels or co-ordinates.	HE+SE
9	To reports and documents for the surveyor.	SE

CAD OPERATOR

Responsible to: Team Leader, Resident Engineer & Highway Engineer

Sl. No.	Tasks	In Association with
1	Preparation of drawings and detail drawings for the Project.	RE+HE+CE
2	Preparation of working drawings	HE+AHE+CE
3	Preparation of as built drawings	HE+AHE+CE
4	Maintaining all the records of drawing related jobs (i.e. duplicating modification, if any).	AHE+CO
5	Revision of drawings under direction of Team Leader, Highway Engineer and Resident Engineer.	PL+CE

APPENDIX II

QUALITY CONTROL TESTS AND ACCEPTANCE CRITERIA

PART A
(ROAD WORKS)

Appendix II

Quality Control Tests and Acceptance Criteria
Part A (Road Works)

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
(A) Earthwork				
1	Grain size analysis	IS : 2720 – Part 4	2 tests per 3000 cum	
2	Liquid Limit Index and Plasticity Index	IS : 2720 – Part 5	2 tests per 3000 cum	
3	Free Swelling index	IS: 2720 - Part 40		
4	Laboratory Compaction	IS : 2720 –Part 7 & 8	2 test per 3000 cu m	
5	Deleterious Content • Organic matter • Soluble matter	 IS : 2720 – Part 22 IS : 2720 – Part 27	 As and when required by Engineer As and when required by Engineer	
6	CBR of borrow area	IS: 2720 – Part 16		

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
7	Field Density	IS: 2720 – Part 28	(a) One per 1000 sqm of compacted area of embankment (b) One per 500 sqm of compacted area of shoulders and sub-grade	Mean Density to be not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation
(B) Granular Sub-Bases and Bases				
8	Gradation	IS: 2720 – Part 4 and IS: 2786 – Part 1	One per 200 cum	Accept if specimen falls within specified limits
9	Atterberg Limits	IS: 2720 – Part 5	One per 200 cum	Accept if results are within specified limits
10	Moisture content/dry density relationship	IS: 2720 – Part 7 & 8	One per 250 cum	
11	Density of compacted layer	IS: 2720 – Part 28	One per 500 sqm	Mean Value to be not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation
12	Deleterious Constituents compacted layer	IS: 2720 – Part 22 & 27	As required by the Engineer	Accept if the values are within specified limits

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
13	CBR	IS: 2720 – Part 16	As required by the Engineer	Mean Value to be not less than the specified value plus $\left(1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right)$ times standards deviation
14	Water absorption	IS: 2386 – Part 3	Initially one set of 3 representative specimens for each source of supply	Accepts if the values are within specified limits
(C) Lime/Cement Stablised Soil Sub-Base				
15	Quality of lime	IS: 1514	One test for each consignment subject to a minimum of one test per 5 tonnes	
16	Quality of cement	IS: 269, IS: 455 or IS:1489	One test for each consignment subject to a minimum of one test per 5 tonnes	
17	Lime/Cement content		Regularly, through procedural checks	
18	Degree of pulverisation	IS: 2720 – Part 4	Periodically, as considered necessary	

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
19	CBR or Unconfined Compressive Strength on a set of 3 specimens	CBR: IS: 2720 - Part 16 UCS: IS:2720 - Part 10	As required by the Engineer	Mean Value to be not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.
20	Moisture content prior to compaction		One test per 250 sqm	
21	Density of compacted layer	IS: 2720 – Part 28	One test per 500 sqm	Mean Density to be not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.
22	Deleterious constituents	IS: 2720 – Parts 22 & 27	As and when required by the Engineer	Accept if the values are within specified limits
(D) Wet Mix Macadam				
23	Aggregate impact value	IS: 2386 - Part 4 or IS: 5640	One test per 200 cum of aggregates	Accept if the values are below acceptable value
24	Grading	IS: 2386 - Part 1	One test per 100 cum of aggregates	Accept if the values are within acceptable value
25	Flakiness and Elongation Index	IS: 2386 - Part 1	One test per 200 cum of aggregates	Accept if the values are below acceptable value

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
26	Atterberg limits of portion of aggregate passing 425 micron	IS: 2720 - Part5	One test per 100 cum of aggregates	Accept if the values are below acceptable value
27	Density of compacted area	IS: 2720 - Part 28	One test per 500 sqm	Mean Density to be not less than the specified value plus $\left[1.65 - \dfrac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.
(E) Bituminous Construction				
28	Quality of binder	IS: 8887 for Emulsion IS: 217 for Cutback IS: 73 for Paving Bitumen	No. of samples per lot as per IS	Accept if the material properties are within the values specified
29	Aggregate Impact Values of Aggregates	IS: 2386 - Part 3	One test per 50 cum of aggregates	Accept if test results is less than the specified value
30	Los Angeles Abrasion value of Aggregates	IS: 2386 - Part 3	One test per 50 cum of aggregates	Accept if test results is less than the specified value
31	Flakiness and Elongation index of Aggregates	IS: 2386 - Part 1	One test per 50 cum of aggregates	Accept if test results is less than the specified value

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
32	Stripping value of Aggregates	IS: 6241	One set of 3 specimens for each source of supply	Accept if test results conforms to standards laid down
33	Water Absorption of Aggregates	IS: 2386 - Part 3	One set of 3 specimens for each source of supply	Accept if test results is less than the specified value
34	Grading of Aggregates	IS:2386 - Part 1	One test per 25 cum of aggregates	Accept if gradation is within the specified limits
35	Polished Stone value of Aggregates	BS: 812 - Part 114	As required	Accept if value is above the minimum specified
36	Percentage of fractured faces	IS: 2386 - Part 1	One test per 50 cum of Aggregates	Accepts if the value conforms to requirements
37	Soundness of aggregates	IS: 2386 - Part 5	One test per each source of supply	Accept if the value is below the value specified.
38	Rate of spread of binder in spraying work	--	One test per 500 sqm, and not less than two tests per day	Mean Value of binder to be not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
39	Binder temperature	--	At regular close intervals	
40	Rate of spread of aggregates in surface dressing	--	One test per 500 sqm of work, and not less than two tests per day	Mean Value of aggregate quantity to be not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.
41	Water sensitivity	AASHTO-T 283-89	One test of 3 specimens for each source of supply	Accepts if the minimum retained strength is above the specified value
42	Binder Content of mix and aggregate grading for Bituminous Macadam	Aaphalt Institute Manual MS-2	Periodic, subject to minimum of two tests per day per plant	Accept if the binder content is not less han the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation. Accept grading if within specified limits.

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
43	Binder content of mix and aggregate grading for Dense Bituminous Macadam/Semi-dense Bituminous Concrete and Bituminous concrete	Aaphalt Institute Manual MS-2	One test per 400 tonnes of mix, subject to a minimum of two tests per plant per day	Accept if the binder content is not less than the specified value plus $\left[1.65 - \dfrac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation. Accept grading if within specified limits.
44	Aggregates grading for Bituminous Macadam	IS:2386 - Part 1	Two tests per plant per day both on the individual constituent and mixed aggregates from the dryer	Accept if the grading is within specified limits
45	Aggregate grading for Dense Bituminous Macadam/Semi-dense Bituminous Concrete and Bituminous Concrete	IS: 2386 - Part 1	One set of tests on individual constituents and mixed aggregate from the dryer for each 400 tones of mix subject to a minimum of two tests per plant per day	Accept if the grading is within specified limits

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
46	Stability of Mix	Asphalt Institute Manual MS-2	For each 400 tonnes of mix produces, a set 3 Marshal specimens, subject to a minimum of two sets per plan per day	Accept if the Mean Stability is not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.
47	Temperature of bitumen in boiler and aggregate in dryer	--	At regular close intervals	
48	Density of compacted mix	--	One test per 250 sqm of area	Accept if the Mean Density is not less than the specified value plus $\left[1.65 - \frac{1.65}{(\text{No of samples})^{0.5}}\right]$ times standards deviation.
49	Rate of spread of mixed material	--	At regular intervals through checks over layer thickness	

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
50	Softening Point of Modified Binder	IS: 1205	Initially on submission, and thereafter daily if site blended and weekly if pre-blended	Accept if variation from recommended value is not more than 1.65 times the standard deviation
51	Penetration at 25^0 C and 4^0 C of Modified Binder	IS: 1203 and IS: 1205	Initially on submission, and thereafter daily if site blended and weekly if pre-blended	Accept if variation from recommended value is not more than 1.65 times the standard deviation
52	Elastic Recovery of Modified Binder	ASTM D 5976-1996 Appendix II	Initially on submission, and thereafter daily if site blended and weekly if pre-blended	Accept if variation from recommended value is not more than 1.65 times the standard deviation
53	Ductility of Modified Binder	IS: 1208	Initially on submission, and thereafter daily if site blended and weekly if pre-blended	Accept if variation from recommended value is not more than 1.65 times the standard deviation
54	Flash Point of Modified Binder	IS: 1209	Initially on submission, and thereafter daily if site blended and weekly if pre-blended	Accept if variation from recommended value is not more than 1.65 times the standard deviation

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
55	Fraass breaking of Modified Binder	IS: 9381	Initially on submission	Accept if variation from recommended value is not more than 1.65 times the standard deviation
56	Viscosity at 150^0 C of Modified Binder	IS: 1206	Initially on submission	Accept if variation from recommended value is not more than 1.65 times the standard deviation
57	Thin film Oven Test, Penetration, Softening Point, Elastic Recovery of Residue and Loss on Heating of Modified Binder	IS: 9382	Initially on submission	Accept if variation from recommended value is not more than 1.65 times the standard deviation
(F) Concrete Pavement				
58	Cement	IS: 269 IS:455 IS:1489 IS:8112 IS:12269	Once for each source of supply and occasionally when called for in case of long/improper storage	Accept if the test results are within prescribed limits

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
59	Gradation of Aggregates	IS: 2386-Part 1	One test for each day's work; periodicity may be relaxed later at the discretion of the Engineer	Accept if the gradation falls within the prescribed limits
60	Deleterious Constituents of Aggregates	IS: 2386-Part 2	One test for every day's work initially may be relaxed later at the discretion of the engineer	Accept if the deleterious contents are less than the limits prescribed.
61	Water Absorption of Aggregates	IS: 2386-Part 3	Regularly as required, subject to a minimum of one test a day for coarse aggregates and two tests a day for fine aggregates,	The water absorption data shall be used for correcting the water demands of the mix on a daily basis.
62	Los Angeles Abrasion of Aggregate Impact Value	IS: 2386-Part 4	One for each source of supply and subsequently on a monthly basis	Accept if the result is not more than the specified value by 1.65 times the standard deviation.
63	Soundness	IS: 2386-Part 5	Before approving the aggregate and every month subsequently	Accept if the test value is below the specified value.
64	Alkali-Aggregate Reactivity	IS: 2386-Part 7	Before approving the aggregate and every month subsequently	Accept if the test result conforms to the value specified.

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
65	Water	IS: 456	Once for approval of source of supply, and subsequently only in case of doubt	Accept if the test result conforms to the value specified.
66	Concrete Strength	IS: 516	2 cubes and 2 beams per 150 cum (one for 7 days and one for 28 days), or a minimum of 6 cubes and 6 beams per day's work, whichever is more	Accept if the mean value is not less than the specified value plus 2.33 times the standard deviation and if not more than one value as strength less than the specified value.
67	Core Strength of Hardened Concrete	IS: 516	As per the requirements of the Engineer, only in case of doubt	Accept if the individual test result is more than the specified value
68	Workability of fresh concrete (Slump Test)	IS: 1199	One test for each dumper load at both batching Plant site and paving site, initially when work starts. Subsequently, sampling may be done for alternate dumper.	—

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
69	Thickness	--	From the level data of pavement and sub-base at grid points of 5/6.25m x 3.5m	Accept if the tolerance is -5 mm to +25 mm of specified thickness
(G) Control of Alignment Level and Surface Regularity				
70	Horizontal Alignment	--	--	The edges of the carriageway shall be correct within a tolerance of ± 10 mm from the designed alignment. For lower layers of the pavement, the tolerance is ± 25 mm.
71	Surface Levels (a) Sub-grade (b) Sub-base (i) Flexible pavement (ii) Concrete pavement	-- --	-- --	Tolerance allowed + 20mm -25mm +10mm -20mm +6mm -10 mm

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
	(c) Base course for Flexible Pavement (i) Bituminous (ii)Other than Bituminous (machine laid) (iii)Other than Bituminous (manually laid)	--	--	 + 6 mm - 6 mm + 10 mm - 10 mm + 15 mm - 15 mm
	(d) Wearing Course for Flexible Pavement (i) Machine laid (ii) Manually laid (e) Cement Concrete Pavement	-- --	-- --	 + 6 mm - 6 mm + 10 mm - 10 mm + 5 mm - 5 mm

Sr. No.	Test	IS No.	Frequency	Acceptability Criteria
72.	Surface Regulatory Measured by 3m straight edge	--	--	
	(a) Bituminous surface			3 mm
	(b) Bituminous base course			6 mm
	(c) Granular sub-base/base course			8 mm
	(d) Sub-bases for concrete pavement			10 mm
	(e) Concrete pavement surface			3 mm

APPENDIX II

QUALITY CONTROL TESTS AND ACCEPTANCE CRITERIA

PART B
(BRIDGE WORKS)

APPENDIX II

Quality Control Tests and Acceptance Criteria
Part B (Bridge Works)

Coarse Aggregates

Tests	Sample Size	Reference Code for Testing	Facilities/Equipment required at site
1. Particle Size & Shape (a) Size and Grading of Aggregates (b) Flakiness Index (c) Elongation Index	2000 g	IS:2386 Part I – 1963	(i) Square Hole Sieves of size 80mm, 63mm, 50mm, 40mm, 31.5mm, 25mm, 20mm, 16mm, 12.5mm, 10mm (ii) Thickness Gauge (iii) Length Gauge (iv) Balance (more than 3 kg capacity) with 0.1% accuracy (v) Oven (100 to 110°C Capacity) (vi) Wire Basket of lesser than 6.3mm mesh (vii) A stout water container
2. Specific Gravity, Water Absorption & Density	200 g	IS:2386 Part III – 1963	(viii) Two dry soft absorbent cloths each not less than 75x45 cm (ix) A shallow tray not less than 650 cm^2 (x) An airtight container (xi) Cylindrical metal measure of 11.5cm Φ, 18cm height
3. Mechanical Properties (a) Crushing Value (b) Impact Value	6500 g	IS:2386 Part IV – 1963	(xii) 15 cm dia. open-ended steel cylinder, with plunger and base plate (xiii) Cylindrical Tamping Rod of 16mmΦ, 60 cm length and rounded at one end (xiv) Compressive Testing Machine capable of applying a load of 40 T

Fine Aggregates

Tests	Sample Size	Reference Code for Testing	Facilities/Equipment required at site
1. Particle Size & Shape (a) Size and Grading of Aggregates **2. Silt Content** **3. Specific Gravity, Water Absorption, Bulk Density and Surface Moisture**	2000 g 300 g 200 g	IS:2386 Part I – 1963 IS:2386 Part II – 1963 IS:2386 Part III – 1963	(i) Square Hole Sieves of: 10mm, 6.3mm, 4.75mm (ii) Fine mesh, wire cloth sieve of size 3.35mm, 2.36m, 1.18mm, 600μ, 300μ, 75μ (iii) Balance (more than 3 capacity) with 0.1% accuracy (iv) Oven (100 to 110°C Capacity) (v) Soft Brush (vi) Wire Basket of lesser than 6.3 mm mesh, (vii) A stout water container (viii) Two dry soft absorbent cloths each not less than 75x45 cm (ix) A shallow tray not less than 650 cm^2 (x) An airtight container (xi) Pycnometer (xii) Means of warm air (xiii) Filter Papers (xiv) Funnel (xv) Cylindrical metal measure of 3, 15 and 30 L capacity (xvi) Cylindrical Tamping Rod of 16mmΦ, 60 cm length and rounded at one end (xvii) Flask of glass or non corrosive metal (xviii) 1000 ml measuring cylinder

Water

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment require site
1. Particle Size & Shape (a) pH value (b) Chlorides (as CI) (c) Sulphates (as SO_3)	1 litre of middle stream	As per the kits manufacturer	(i) Specialized Testing Kits for testing Chlorides and Sulphates (ii) pH testing Strips (iii) Titration Equipment with Pipette

Cement

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required site
1. Physical Tests (a) Consistency of standard cement paste (b) Setting Time (i) Initial (ii) Final (c) Soundness by Le Chatelier Expansion (d) Compressive Strength (i) 3 days (ii) 7 days (iii) 28 days		IS: 4031 (Part 4) – 1988 IS: 4031 (Part 5) – 1988 IS: 4031 (Part 3) - 1988 IS: 4031 (Part 6) – 1988	(i) Vicat Apparatus (ii) Le Chatelier Test Apparent (iii) Vibrating Machine (iv) Cube Moulds of 50 mm size (v) Standard Weights (vi) Balance (for a load of 1000g ±1g) (vii) Water Bath (viii) Gauging Trowel (ix) Planetary Mixer (x) Flow Table (xi) Tamping Rod (xii) Pocking Rod (xiii) Graduated Glass Cylinder (150 to 200 ml capacity) (xiv) Standard sand

Concrete

Tests	Sample Size		Reference Code for Testing	Facilities /Equipment required at site
1. Compressive Strength (a) 7 days (b) 28 days	Quantity (cum) 1 to 5 6 to 15 16 to 30 31 to 50 51 and above	No. of samples 1 2 3 4 4 and one additional sample for every additional 50 cum or part thereof	IS:516-1959	(i) Cube Testing Machine (ii) 150 mm size Cube Moulds (iii) Water Bath (iv) Vernier Caliper (v) Micrometer (vi) Weighing Balance (vii) Tamping steel bar 16mm in diameter, 0.6m length and bullet pointed at the lower end

Plasticiser

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. Compressive Strength, percent of control sample **2. Loss of workability (slump in mm) deviation from control sample**		IS:9103-1999	(i) Cube Testing Machine (ii) 150 mm size Cube Moulds (iii) Water Bath (iv) Vernier Caliper (v) Micrometer (vi) Weighing Balance (vii) Tamping steel Bar 16mm in diameter, 0.6m length and bullet pointed at the lower end (viii) Slump Cone (ix) Container with mixing arrangement

Epoxy

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

Bentonite

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. **Silt Content** 2. **Liquid Limit**	As required	MOSRTH Specifications 4th Revision	(i) 75 Micron sieve (ii) Cassgranda Apparatus

RCC Pipes

Tests	Sample Size		Reference Code for Testing	Facilities /Equipment required at site
1. **Dimensions**	No. of pipes	Sample size		(i) Vernier Calliper of suitable dimension (ii) Steel Tape (iii) Micrometer (iv) Hammer (v) Weighing Machine
(a) Inner diameter	Upto 50	8		
(b) Wall Thickness	51 to 100	13		
(c) Length	101 to 300	20		
	301 to 500	32		
	501 and above	50		
2. **Reinforcement**	1 pipe per Lot			

Pre-stressing Hardware

MS Sheathing

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. Physical Test (a) Workability Test (b) Transverse Load Test (c) Tension Load Test (d) Water Loss Test	3 samples of 1100mm length from one lot of supply of 7000m length	IRC : 18-2000	(i) Workability Test Apparatus (ii) Transverse Load Test Apparatus (iii) Tension Load Test Apparatus (iv) Water Loss Test Apparatus (v) Pan (vi) Weights (vii) Pressing Gauge (viii) Hand Pump (ix) Soldering iron (x) Solder (xi) Anchoring Hook (xii) MS Plate

HDPE Sheathing

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. Bond Test **2. Compression Test**	Three HDPE ducts of length = 40 times the duct diameter	IRC : 18-2000 IRC : 18-2000	(i) 3 Nos. RCC beams with a HDPE duct of length = 40 times the duct diameter (ii) Prestressing tandon of adequate length (iii) Tendon anchorage system (iv) Load cells and meters (v) Grout constituents

Site Activities

Piling

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. Vertical Load Test **2. Horizontal Load Test**	One Pile for testing and 2 piles for reaction One Pile for testing and 1 piles for reaction	IS : 2911 (Part IV)	(i) Jaws and Pumps of suitable capacity as per the design capacity of Pile (ii) Kentledge arrangement including structural steel assembly and concrete load (iii) Dial Gauges (iv) Stop Watch

Bentonite Slurry

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. Mars Cone Viscosity **2. pH Value** **3. Specific Gravity**	As required	MOSRTH Specifications 4th Revision	pH strips

Concrete

Tests	Sample Size	Reference Code for Testing	Facilities /Equipment required at site
1. Slump Test	One test per hour of concrete	IS : 1195	(i) Slump Cone (ii) Tamping Road

Calibration

Equipment/Machine	Frequency of calibration	Check Level
1. Batching Plant	Once every 3 months or 5000 cum of concrete production whichever is earlier Once in a year	2 3
2. Weighting Balances	Once in 3 months of use Once in a year	2 3
3. Deflection Gauges	Once in 3 months of use Once in a year	2 3
4. Testing Kits	Once in 3 months of use	2
5. Jacks	Once in a 3 months of use	3
6. Cube Testing Machines	Once in 3 months	3

For Concrete Works

Coarse Aggregates

<table>
<tr><th>Test</th><th>Frequency</th><th>Check Level</th><th>Ref. Codes</th><th>Acceptance Standards</th></tr>
<tr><td>1. Particle Size and Shape</td><td>Once for every source approval
Once in a week</td><td>1

2A</td><td>IS:383-1970
IS:2386 (Part I) -1963</td><td></td></tr>
<tr><td>(a) Sieve Analysis</td><td></td><td></td><td></td><td>
<table>
<tr><th>Grading</th><th>IS Sieve Designation</th><th>Percentage passing (by Weight)</th></tr>
<tr><td>20 mm Nominal Size</td><td>40 mm</td><td>100</td></tr>
<tr><td></td><td>20 mm</td><td>85 – 100</td></tr>
<tr><td></td><td>10 mm</td><td>0 – 20</td></tr>
<tr><td></td><td>4.75 mm</td><td>0 – 5</td></tr>
<tr><td>12.5 mm Nominal Size</td><td>20 mm</td><td>100</td></tr>
<tr><td></td><td>12.5 mm</td><td>85 – 100</td></tr>
<tr><td></td><td>10 mm</td><td>0 – 20</td></tr>
<tr><td></td><td>4.75 mm</td><td>0 – 5</td></tr>
</table>
</td></tr>
<tr><td>(b) Flakiness Index and Elongation Index</td><td></td><td></td><td></td><td>35% Maximum value of combined Elongation and Flakiness Index</td></tr>
</table>

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
2. Deleterious Materials	Once for every source approval At every change of source	I 2B	IS:383-1970 IS:2386 (Part II) -1963	<table><tr><th>Deleterious Material</th><th>Percentage by Weight (Maximum)</th></tr><tr><td>(i) Coal & Lignite</td><td>1</td></tr><tr><td>(ii) Clay & Lumps</td><td>1</td></tr><tr><td>(iii) Material finer that 75 micron IS Sieve</td><td>3</td></tr><tr><td>(iv) Soft Fragment</td><td>--</td></tr><tr><td>(v) Shale</td><td>--</td></tr><tr><td>Total</td><td>5</td></tr></table>
3. Specific Gravity & Density	Once for every source approval Once in a fortnight	1 2A	IS:383-1970 IS:2386 (Part III)-1963	Test is required for maintaining uniformity of material brought from the source
4. Mechanical Properties				
(a) Aggregate Crushing Value (b) Impact Value	Once for every source approval Once in a week	1 2A	IS:383-1970 IS:2386 (Part IV)-1963	45% maximum by Weight 45% Maximum by Weight
(c) 10 percent Fines (d) Abrasion Value	Once for every source approval Once in 3 months	1 2B		5T Minimum 50% Maximum by Weight
5. Soundness	Once for every source approval Once every 3 months	1 2B	IS:383-1970 IS:2386(Part V)-1963	Maximum Average Loss of Weight after 5 cycles (i) Tested with Sodium Sulphate - 12% (ii) Tested with Magnesium Sulphate - 18%

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
6. Surface moisture content	Once for every source approval At every change of mix design Every time making the concrete	1 1/2A 2A	IS:383-1970 IS:2386(Part III)-1963	Test required to adjust the water content in the mix design before starting any concrete mixing.
7. Alkali Reactivity	Once for every source approval Once in 3 months	1 2B	IS:383-1970 IS:2386(Part VII)-1963	Innocuous Aggregate
8. Petrographic Examination (a) Trade Group (b) Petrological name & Description (c) Description of Bulk (d) Particle Shape (e) Surface texture	Once for every source approval Once in 3 months	1 2B	IS:383-1970 IS:2386(Part VIII)-1963	Information required for approval of source

Fine Aggregates

<table>
<tr><th>Test</th><th>Frequency</th><th>Check Level</th><th>Ref. Codes</th><th>Acceptance Standards</th></tr>
<tr><td>1. Particle Sizes</td><td>Once for every source approval
Once in a month</td><td>1

2A</td><td>IS:383-1970
IS:2386(Part I)-1963</td><td>Fine Aggregates should be of grading from Zone-I to Zone-II as given below
<table>
<tr><th>IS Sieve Designation</th><th colspan="3">Percent by weight passing for</th></tr>
<tr><td></td><td>Zone-I</td><td>Zone-II</td><td>Zone-III</td></tr>
<tr><td>10 mm</td><td>100</td><td>100</td><td>100</td></tr>
<tr><td>4.75 mm</td><td>90-100</td><td>90-100</td><td>90-100</td></tr>
<tr><td>2.36 mm</td><td>60-95</td><td>75-100</td><td>85-100</td></tr>
<tr><td>1.18 mm</td><td>30-70</td><td>55-90</td><td>75-100</td></tr>
<tr><td>600 µ</td><td>15-34</td><td>35-59</td><td>60-79</td></tr>
<tr><td>300 µ</td><td>5-20</td><td>8-30</td><td>12-40</td></tr>
<tr><td>150 µ</td><td>0-10</td><td>0-10</td><td>0-10</td></tr>
</table></td></tr>
<tr><td>2. Deleterious Materials</td><td>Once for every source approval
Once in a month</td><td>1

2B</td><td>IS:383-1970
IS:2386(Part II)-1963</td><td>
<table>
<tr><th>Deleterious Material</th><th>Percentage by weight (max.)</th></tr>
<tr><td>Coal & lignite</td><td>1</td></tr>
<tr><td>Clay Lumps</td><td>1</td></tr>
<tr><td>Material finer than 75 micron IS Sieve</td><td>3</td></tr>
<tr><td>Soft Fragment</td><td>_</td></tr>
<tr><td>Shale</td><td>1</td></tr>
<tr><td>Total</td><td>5</td></tr>
</table></td></tr>
<tr><td>3. Silt Content</td><td>Once for every source approval
Once daily</td><td>1

2A</td><td></td><td>Maximum 8% or as specified in Tender Document</td></tr>
</table>

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
4. Specific Gravity & Density	Once for every source approval Once every 3 months	1 2A	IS:383-1970 IS:2386(Part III)-1963	Test is required for maintaining uniformity of material brought from the source
5. Water Absorption	Once for every source approval Once Daily	1 2A	IS:383-1970 IS:2386(Part III)-1963	Test required for adjusting the water content in the mix design before starting any concrete mixing.
6. Soundness	Once for every source approval Once every 3 months	1 2B	IS:383-1970 IS:2386(Part V)-1963	Maximum Average Loss of Weight after 5 cycles (i) Tested with sodium Sulphate - 10% (ii) tested with Magnesium Sulphate - 15%

Water

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Analysis				
(a) PH value	Once for every source approval	1	IRC:21:2000	Minimum 6
(b) Chlorides (as CI)	Every Quarterly	2B	IS:3025 (Part 32)	2000mg/L for concrete not containing embedded steel & 500mg/L for RCC and PSC
(c) Sulphates (as SO_3)	Chemical Tests daily in the site Laboratory with testing kits	2A	IS:3025(Part 28)	400mg/L
(d) Neutralisation with NaOH (with phenolphathalein as indicator)			IS:3025(Part 22)	Max. 5 ml of 0.2 normal NaOH to neutralize 100ml sample of water
(e) Neutralisation with H_2SO_4 (with mixed indicator)			IS:3025 (Part 23)	Max. 25 ml of .02 normal H_2SO_4 to neutralize 100ml sample of water
2. Physical Analysis				
(a) Suspended matter	Once for every	1	IS:3025 (Part 17)	2000 mg/1 max.
(b) Organic matter	source approval		IS:3025 (Part 18)	200 mg/1 max.
(c) Inorganic matter	Every Quarterly	2B	IS:3025 (Part 18)	3000 mg/1 max.

Steel and Iron
Reinforcement Bars (CTD, TMT)

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Tests				
(a) Carbon (b) Sulphur (c) Phosphorus (d) Sulphar+ Phosphorus	Once for every source approval Once for every lot Once every 3 months	1 2B 3	IS:1786:1985	0.30 max. 0.06 max. 0.06 max. 0.11 max.
2. Physical Test				
(a) Ultimate Tensile Strength	Once for every source approval Once for every lot Once every 3 months	1 2B 3		10% more than the actual 0.2% proof stress but not less 485 MPa
(b) 0.02% proof stress				415 MPa Min.
(c) % Elongation				14.5 min.
(d) Bend Test				To be satisfactory
(e) Rebend Test				To be satisfactory
(f) Mass per meter run(Kg)				6.31 ±3% for 32 mm dia, 4.830±3% for 28 mm dia, 3% for 25mm dia, 2.470± 3% for 20 mm dia, 1.580±5% for 16 mm dia, 0.888±5% for 12 mm dia,

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

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

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
3. Physical Properties				
(a) Breaking Strength of strands (b) 0.2% proof load	Once for every source approval Once for every lot	1 3	IS:14268-1995	<table><tr><td>Nominal Dia (mm)</td><td>Breaking strength (KN)</td><td>0.2% proof load (KN)</td></tr><tr><td>12.7</td><td>183.7</td><td>165.3</td></tr><tr><td>15.2</td><td>260.7</td><td>234.6</td></tr></table>
4. Elongation	Once for every source approval Once for every lot	1 3	IS:14268-1995	Minimum 3.5% on minimum gauge length of 600 mm
5. Relaxation Properties				
(a) 100 hours	Once for every source approval Once for every lot	1 3	IS:14268-1995	Relaxation Losses not more than 1.8% when loaded to 70% of specified minimum breaking load
(b) 1000 hours	Once for every source approval Once in the project for each source	1 3		Relaxation Losses not more than 2.5% when loaded to 70% of specified minimum breaking load
6. Modulus of Elasticity	Once for every source approval Once for every lot	1 3	IS:14268-1995	18870 to 20910 Kg/sq mm

Cast Steel (For bearings grade 280-520 W)

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Tests	Once for every source approval Once in a project for each source	1 3	IS:1030:1989	C - 0.25% Max. Mn – 1.20 Si – 0.60 P - 0.10 S – 0.035 Ni – 0.40 Cr – 0.35 Cu – 0.40 Mo – 0.15 V – 0.05
2. Physical Tests				
(a) Ultrasonic Tests (b) Magnetic Particle Examination (c) Liquid Penetrant Examination (d) Radiographic Examination	Once for every source approval Once in a project for each source	1 3		No deformation should be observed

Mild Steel

<table>
<tr><th>Test</th><th>Frequency</th><th>Check Level</th><th>Ref. Codes</th><th>Acceptance Standards</th></tr>
<tr>
<td>1. Chemical Composition</td>
<td>Once for every source approval
Once in a project for each source</td>
<td>1
3</td>
<td>IS:2062-1999</td>
<td>
<table>
<tr><th>Grade</th><th>Designation</th><th>C</th><th>Mn</th><th>S</th><th>P</th><th>Si</th><th>Carbon equal value max.</th></tr>
<tr><td>A</td><td>Fe410WA</td><td>0.23</td><td>1.5</td><td>0.05</td><td>0.05</td><td>0.04</td><td>0.42</td></tr>
<tr><td>B</td><td>Fe410WB</td><td>0.22</td><td>1.5</td><td>0.046</td><td>0.045</td><td>0.04</td><td>0.41</td></tr>
<tr><td>C</td><td>Fe410WC</td><td>0.20</td><td>1.5</td><td>0.040</td><td>0.04</td><td>0.04</td><td>0.39</td></tr>
</table>
Nitrogen Content 0.012%
Nb, V & Ti content (all or any) 0.2%
</td>
</tr>
</table>

Stainless Steel

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards	
1. Chemical Tests					
(a) Carbon	Once for every source approval	1	IS-6911:1992	C – 0.08%	Max ± 0.01%
(b) Silicon				Si – 1%	Max ± 0.05%
(c) Manganese	Once in a project for each source	3		Mn – 2%	Max ± 0.04%
(d) Nickel				Ni – 10% to 14%	Max ± 0.15%
(e) Chrornium				Cr – 16% to 18%	Max ± 0.2%
(f) Molybdenum				Mo – 2% to 3%	Max ± 0.1%
(g) Sulphur				S- 0.03%	Max ± 0.05%
(h) Phosphorus				P – 0.045%	Max ± 0.01%
2. Mechanical Tests					
(a) Tensile Test	Once for every source approval	1	IS:1663:1972	Minimum 440 MPa	
(b) Yield Strength			IS:1608:1972	Minimum 200 MPa	
(c) Hardness Test	Once in a project for each source	3	IS:1500:1983	Brinell – Maximum 192, Rockwell – Maximum 95	
(d) Elongation			IS:1501:1984	Minimum 40% in 50 mm	
			IS:1586:1988		

Galvanizing

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Mass of Zinc Coating	One Test per lot	3	IS:6745-1972	400g/m² 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, rums, 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. **Nominal bore of tube after galvanizing** / **Dia of rod**: 8mm – 4mm 10mm – 6mm 15mm – 11mm 20mm – 16mm 25mm – 21mm
4. Uniformity of Galvanized Coating	One Test per lot	3	IS:4736-1986	The galvanized coating shall withstand 4 one minute dips.
5. Adhesion Test	One Test per lot	3	IS:2629-1985	Galvanized tubes upto and including 50mm nominal bore when bent cold through 90° 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,

Free Bore Test rod sizes:

Nominal bore of tube after galvanizing	Dia of rod
8mm	4mm
10mm	6mm
15mm	11mm
20mm	16mm
25mm	21mm

Chemicals
(a) Cement (OPC- 53 grade)

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Tests				
(a) Chlorides (as Cl)	Once for every source approval	1	IS:12269-1987	0.05% max
(b) Ratio of Alumina to that of Iron Oxide	Once for every lot	2B		0.66 min
(c) Magnesium (MgO)	Once every 3 months	3		6.0% max
(d) Total Sulphur content (SO_3)				3.0% max
(e) Loss on Ignition				4.0% max
(f) Insoluble residue				2.0% max
(g) Lime saturation factor				0.8- 1.02
2. Physical Tests				
(a) Setting Time	Once for every source approval	1		
(i) Initial				Not less than 30min.
(ii) Final	Once for every lot	2A/2B		Not more than 600 min
(b) Soundness (Le Chatelier Expansion)	Once every 3 months	3		10mm (max.) and 0.8% (max)
(c) Compressive Strength				
(i) At 72±1 hr				Not less than 27 MPa Strength
(ii) At 168±2 hrs				Not less than 37 MPa Strength
(iii) At 672±4 hr				Not less than 53 MPa Strength
(d) Fineness (Blain's air permeability method)				225 M^2 /Kg Minimum.

(b) Cement (OPC- 43 grade)

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Tests				
(a) Chlorides (as Cl)	Once for every source approval	1	IS:8112-1989	0.05%max.
(b) Ratio of Alumina to that of Iron Oxide	Once for every lot	2A/2B		0.66min
(c) Magnesium (MgO)	Once every 3 months	3		6.0% max
(d) Total Sulphur content (SO_3)				3.0% max
(e) Loss on Ignition				5.0% max
(f) Insoluble residue				2.0% max
(g) Lime saturation factor				0.66 - 1.02
2. Physical Tests	Once for every source approval	1		
(a) Setting Time				
(i) Initial	Once for every lot	2A/2B		Not less than 30min.
(ii) Final	Once every 3 months	3		Not more than 600 min
(b) Soundness (Le Chatelier Expansion)				10 mm (max.) and 0.8% (max)
(c) Compressive Strength				
(i) At 72±1 hr				Not less than 23 MPa Strength
(ii) At 168±2 hrs				Not less than 33 MPa Strength
(iii) At 672±4 hr				Not less than 43 MPa Strength
(d) Fineness (Blain's air permeability method)				225 M^2 /Kg Minimum.

(c) Cement (OPC- 33 grade)

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Tests				
(a) Chlorides (as Cl) (b) Ratio of Alumina to that of Iron Oxide (c) Magnesium (MgO) (d) Total Sulphur content (SO_3) (e) Loss on Ignition (f) Insoluble residue (g) Lime saturation factor	Once for every source approval Once for every lot Once every 3 months	1 2A/2B 3	IS: 8112-1989	0.05%max. 0.66min 6.0% max 3.0% max 5.0% max 4.0% max 0.66 - 1.02
2. Physical Tests (a) Setting Time (i) Initial (ii) Final	Once for every source approval Once for every lot	1 2A/2B		Not less than 30min. Not more than 600 mins
(b) Soundness (Le Chatelier Expansion)	Once every 3 months	3		10mm (max.) and 0.8% (max)
(c) Compressive Strength (i) At 72±1 hr (ii) At 168±2 hrs (iii) At 672±4 hr				Not less than 16 MPa Strength Not less than 22 MPa Strength Not less than 33 MPa Strength
(d) Fineness (Blain's air permeability method)				225 M^2 /Kg Minimum.

(d) Portland Slag Cement

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Tests				
(a) Magnesium Oxide (MgO)	Once for every source approval	1	IS:455-1989	8%max.
(b) Sulphur Trioxide (SO_3)			IS:4032:1985	3%max
(c) Sulphide Sulphur (S)	Once for every lot	2A/2B		1.5% max
(d) Loss on Ignition	Once every 3 months	3		5% max
(e) Insoluble residue				4% max
(f) Chloride Content				0.05% max
2) Physical Tests				
(a) Fineness (Blain's Air permeability method)	Once for every source approval	1	IS:4031 (Part 2) :1988	Specific Surface shall not be less than 225m^2 /Kg
	Once for every lot	2A/2B		
(b) Soundness	Once every 3 months	3		
(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 (Part 5) : 1988	
(i) Initial				Initial setting time not less than 30min
(ii) Final				Final setting time not more than 600 min
(d) Compressive Strength			IS:4031 (Part 6) : 1988	
(i) At 72±1 hr				Not less than 16 MPa Strength (or as specified by manufacturer)
(ii) At 168±2 hrs				Not less than 22 MPa Strength (or as specified by manufacturer)
(iii) At 672±4 hr				Not less than 33 MPa Strength (or as specified by manufacturer)

Normal Water Reducing Superplasticiser

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Water content, percent of control Sample	Once for every source approval Once for every lot Once every 3 months	1 2B 3	IS:9103-1999	80 Max.
2. Slump				Not more than 15mm below that of the control mix concrete
3. Time of setting, allowable deviation from control sample (Hours)				
(a) Initial				
(i) Max				Max –
(ii) Min				Min + 1.5
(b) Final				
(i) Max				Max ± 1.5
(ii) Min				Min –
4. Compressive strength, percent of control sample				
(a) 1 day				140 min.
(b) 3 days				125 min.
(c) 7 days				125 min.
(d) 28 days				115 min.
(e) 6 months				100 min.
(f) 1 year				100 min.

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
5. Flexible Strength, percent of control sample				
(a) 3 days				110 min.
(b) 7 days				100 min.
(c) 28 days				100 min.
6. Length change percent increase over control sample				
(a) 28 days				0.01 max.
(b) 6 months				0.01 max.
(c) 1 year				0.01 max.
7. Bleeding, percent increase over control sample				5 max.
8. Loss of workability				At 45 min., the slump shall not be less than that of control mix concrete at 15 minutes
9. Air Content(%) over control specimen				1.5% max.
10. Uniformity Tests				
(a) Dry Material Content				Within 3% of the value stated by the manufacture
(b) Ash content				Within 1% of the value stated by the manufacture
(c) Relative Density				Within 0.02 of the value stated by the manufacture

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
(d) Chlorides ion content (e) pH Value				Within 10% of the value or within 0.2% whichever is greater as stated by the manufacture 7-8

Epoxy

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Pot life (a) Open Time (b) Thixotropy (c) Angle of internal friction (Squeezibility) (i) 15 kg. (ii) 200 kg (iii) 400 kg	Once for every source approval Once for every lot Once in a project lot each source	1 2A/2B 3	F.I.P	(a) Min. 20 minutes. Not less than 60 minutes at upper temperature Limits (b) Sag flow should not exceed 30mm in 10 minutes at upper limit of specified application temperature (c) Min. area of spread in mm^2 (i) 3000 (ii) 7500 (iii) 10000
2. Curing rate (a) 12 hrs. (b) 24 hrs. (c) 168 hrs.				Comp. strength of 50x50x50mm size cubes should be (a) $20N/mm^2$ (b) $60N/mm^2$ (c) $75N/mm^2$
3. Compressive Strength (a) 24 hrs. (b) 168 hrs.				Comp. strength of 50x50x50mm size cubes should be (a) $60N/mm^2$ (b) $75N/mm^2$

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
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.
5. Tensile bonding strength				Should have concrete failure with no evidence of joint failure with concrete of strength 40 MPa.
6. Shear Strength				Should have $12 N/mm^2$ higher than the concrete strength
7. Heat Resistance				Shear strength at failure should have a strength $10N/ mm^2$ higher than the concrete strength
8. Colour				Should match the colour of concrete
9. Shrinkage				Max. 0.4% after 7 days at the upper limit of specified temperature range

Non-Shrink Grout

<table>
<tr><th>Test</th><th>Frequency</th><th>Check Level</th><th>Ref. Codes</th><th>Acceptance Standards</th></tr>
<tr><td>1. Compressive Strength (50mm cubes)</td><td>At the approval of source

At every change of source</td><td>1

1</td><td></td><td>
<table>
<tr><th>Age (days)</th><th colspan="2">Compressive Strength (MPa)</th></tr>
<tr><th></th><th>Flowable W/P = 0.18</th><th>Pourable W/P = 0.165</th></tr>
<tr><td>1</td><td>24</td><td>27</td></tr>
<tr><td>3</td><td>45</td><td>54</td></tr>
<tr><td>7</td><td>55</td><td>66</td></tr>
<tr><td>28</td><td>65</td><td>78</td></tr>
</table>
</td></tr>
<tr><td>2. Compressive Strength with addition of aggregates</td><td></td><td></td><td></td><td>
<table>
<tr><th>Age (days)</th><th colspan="3">Compressive strength (MPa), W/P =0.18% of aggregate</th></tr>
<tr><td>1</td><td>50%</td><td>75%</td><td>100%</td></tr>
<tr><td>3</td><td>28%</td><td>30%</td><td>32%</td></tr>
<tr><td>7</td><td>50%</td><td>52%</td><td>55%</td></tr>
<tr><td>28</td><td>70%</td><td>75%</td><td>78%</td></tr>
</table>
</td></tr>
<tr><td>3. Flexural Strength</td><td></td><td></td><td></td><td>
<table>
<tr><th>Age (days)</th><th>Flexural strength (MPa) W/P = 0.18</th></tr>
<tr><td>1</td><td>2.5</td></tr>
<tr><td>3</td><td>7.0</td></tr>
<tr><td>7</td><td>9.0</td></tr>
<tr><td>28</td><td>10.0</td></tr>
</table>
</td></tr>
</table>

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
4. Time for expansion (after mixing) (a) Start (b) Finish				(a) 20 minutes preferable (b) 120 minutes preferable

Waterproofing Compound

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Permeability	Once for every source approval Once for every lot Once in the project for every change of source	1 1 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 min. Final Setting Time – Not more than 600 min.
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. Compressive Strength at 168 hrs. – Not less than 220kg/cm^2 or 80% of the 7 day compressive strength of cubes prepared without waterproofing compound.
4. Chloride Content				As per the values declared by the Manufacturer
5. Sulphate Content				As per the values declared by the Manufacturer

Sealants

Polysulphide Sealant

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Pot life/ work life	Once in the beginning for approval of source	1	IS:12118 (Part I) - 1987	Minimum 2 hours.
2. Adhesion & Tensile Modulus	Once for every charge of source	1		Total area of failure should not exceed 100mm^3 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.

Silicon Sealant

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Service Temperature	Once in the beginning for approval of source	1	BS:5889 ASTMC-920-87	50°C to 100°C
2. Application Temperature	Every change of source Once in every lot	1 1		10°C to 40°C
3. Shore 'A' Hardness				18-32
4. Tensile Strength				0.5N/mm^2
5. Elongation at rupture				400% min.
6. Modulus at 100% elongation				0.35 MPa Min.
7. Tooling time				30 minute min.
8. Curved State				Permanently elastic, and modulus
9. Base				Neutral cure reactive with atmospheric moisture.

Pre-Stressing

Pre-stressing System

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Static Load test with tendon – anchorage assembly	(i) Once at the start of work for the approval of the pre-stressing system/source of strands (ii) Once for every source approval (iii) Once in the project for change in each pre-stressing system/source of strands	1 1 3	FIP recommendations	(i) 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. (ii) The above relative displacement during $0.8F_{pk}$ load should stabilize within first thirty minutes of the load duration of one hour. (iii) The mode of failure & tendon should be by the fracture of the pre-stressing steel. (iv) Anchorage Efficiency (η_a) ≥0.95 (v) Total elongation ε_u in the free length of the tendon under the measured ultimate force F_{TU} shall be ≥2%.
2. Dynamic Load Test with tendon –anchorage assembly	(i) Manufacturer's test certificate (ii) Once fore every source approval	1 1	FIP recommendations	(i) Fatigue failure of anchorage components should not occur. (ii) Minimum fatigue strength of post tensioning system = 80 MPa.

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
3. Load transfer test	(i) Once at the start of work for the approval of the prestressing system. (ii) Once for every source approval (iii) Once in the project for change in each pre-stressing system/source of strands	1 1 3	FIP recommendations	(i) Crack width upon first attainment of upper force 0.8 F_{pk} ≤0.10 mm (ii) Crack width upon last attainment of lower force 0.12 F_{pk} ≤0.10 mm (iii) Crack width upon final attainment of upper force 0.8 F_{pk} ≤0.25 mm (iv) Reading of longitudinal & Transverse strains should have stabilized during cyclic loading (increase in strain in last 2 load cycles < 5%) (v) Reading of crack width should have stabilized (increase in crack width in last 2 load cycles > .02 mm) (vi) Measured failure Load Fu≥Fpk(fem.e/fck,o) and ≥1.1 Fpk

Pre-stressing Hardware
(a) MS Sheathing

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

(b) Corrugated HDPE Sheathing

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Bond Test	Once for every source approval	1	IRC-18-2000 (Appendix – I 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	Once for every lot	2A		Residual thickness of the duct shall be not less than 1.5 mm No failure or opening takes place.

Other Pre-stressing Hardware

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. **Anchor Head**				
(a) Ultrasound Test				(a) Satisfactory as reported by radiologist
(b) Chemical Analysis	Once for every source approval	1	DIN 17200	(b) As per manufacturer's recommendations
(c) Dimensional Test	Once for every lot	2B/2A		(c) As per manufacturer's recommendations
(d) Hardness				(d) 446 to 506 or as per manufacturer's recommendations
2. **Barrel**				
(a) Chemical Analysis				(a) As per manufacturer's recommendations
(b) Dimensional Test				(b) As per manufacturer's recommendations
(c) Hardness			DIN17200	(c) 446 to 506 or as per manufacturer's recommendations
3. **Bearing Plates**				
(a) Chemical Analysis				(a) As per manufacturer's recommendations
(b) Dimensional Test			DIN 1691	(b) ± 5mm for outer dimensions and ±5mm for inner dimensions
(c) Hardness				(c) 197 to 241 BHN (as tested by Poldi Tester) or as per manufacturer's recommendations
4. **Wedges**				
(a) Dimensional Check			Manufacturer's specifications	(a) As per manufacturer's recommendations
(b) Surface Hardness				(b) Minimum 700
(c) Load Test				(c) Satisfactory as per visual examination
5. **Trumpet Cone**				
(a) Dimensional Test			Manufacturer's specifications	(a) As per manufacturer's recommendations
(b) Chemical Test				(b) As per manufacturer's recommendations

Pipes

Steel Pipes and Spouts

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Chemical Test (a) Sulphur Content (b) Phosphorus Content	Once for every source approval	1		(a) Not more than 0.06% (b) Not more than 2.06%
2. Dimensional Tolerance (a) Outer Dia	Once for every source approval Once for every lot.	1 2A		(a) For tubes up to & i/c 48.3 mm tolerance is + 4mm, -0.8mm Over 48.3mm ± 1.0%
(b) Thickness				(b) Welded Tubes + Not limited and – 10% Seamless Tubes + Not limited and – 12.5%
(c) Weight				(c) Single Tube (any qty.) + 10%, -8% Quantities of less than 150m of one size + 10% -8% Quantities of 150m and more of one size ± 4%
3. Straightness	Once for every source approval Once for every lot	1 2A		Deviation from straightness shall not be more than L/600 where L is the length of pipe.

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
4. Tensile Test	Once for every source approval Once for every lot	1 2A		Grade — Tensile Strength MPa (Min.) Yst 210 — 330 Yst 240 — 410 Yst 310 — 540
5. Flatting Test	Once for every source approval	1		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

RCC Pipes

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Tolerances in Dimensions	At the start of work for source approval	1	IS:458:1988	(i) Up to and including 30 mm ± 2mm (ii) Over 30 mm and up to and including 50mm ± 3mm
(a) Wall Thickness	Once for every Lot for each size	2A	IS:3597:1985	(iii) Over 50 mm and up to and including 65mm ± 4mm (iv) Over 65 mm and up to and including 80mm ± 5mm (v) Over 80 mm and up to and including 95mm ± 6mm (vi) Over 95 mm ± 7mm
(b) Internal Dia. of Pipe or Socket				(i) Up to and including 300 mm + 3mm (ii) Over 300 mm and up to and including 600 mm + 5mm (iii) Over 600 mm and up to and including 1200 mm + 7mm (iv) 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 Max, 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

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
5. Straightness				The deviation from straightness when tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed 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

HDPE Pipes

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Hydraulic Characteristics	Once for every source approval. Once for every lot	1 2B	IS:4984-1995	No localized swelling, leakage, weeping, or bursting during subjecting to internal pressure creep test.
2. Reversion Test				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.

Other Materials

Thermoplastic Paints

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. **Binder content**	Once for every source approval	1	BS:3262 and MOSRTH Specifications Clause 803	18% Min. by weight
2. **Glass Beads**	Once in a project for every change of source	2B		30 – 40% **Gradation of Glass beads** **IS Sieve** — **Percentage Passing** 1.18 mm — 0-3 850 micron — 5-20 425 micron — 65-95 180 micron — 0-10
3. **Titanium Dioxide**	Once for every source approval Once in a project for every change of source	1 2B		10% Minimum
4. **Calcium Carbonate & Inert Fillers.**	Once for every source approval Once in a project for every change of source	1 2B		42% Max for white paint and at discretion of manufacturer subject to meeting other specification for yellow paint.

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
5. Yellow Pigments				At direction of manufacturer subject to meeting of other specification.
6. Luminance (Day light)	Once for every source approval Once in a project for every change of source	1 2B		65% Min. at 45% for white paint and 45% Min. at 45% for yellow paint
7. Drying Time				15 Minutes Max.
8. Skid Resistance				Not less than 45
9. Cracking Resistance at low temperature				No cracking on application to concrete blocks.
10. Softening Point	Once for every source approval Once in a project for every change of source	1 2B		102.5 ± 9.5^{0}C
11. Flow resistance				Not more than 25%
12. Yellowness Index				Not more than 0.12

Bentonite

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Density **2. Marsh Core Viscosity** **3. pH value** **4. Silt content** **5. Liquid limit**	Once for every source approval Once for every day of piling	1 2A	MOSRTH specification for Road & Bridge works.	1.05g/cc 30 to 40 9.5 to 12 less than 1% not less than 400%

Chloroprene Elastomer

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Hardness	Once for every source approval As per the requirement of the respective item	1 3	MOSRTH Specification for Road & Bridge works	60± 5 IRHD for elastomeric bearings 50+5 for POT-PTFE Bearings
2. Minimum Tensile Strengths				17 MPa minimum for elastomeric bearings 15.5 MPa for POT-PTFE Bearings
3. Minimum Elongation at Break				400%
4. Maximum Compression set				35% (Temp. 100 ± 1^{0}C, Duration 24 hrs.)
5. Accelerated Ageing				
(a) Max. Change in Hardness				±15 IRHD
(b) Max. Change in Tensile strength				-15% Temp. 100 ± 1^{0}C, duration 70 hrs
(c) Max. change in elongation				-40%
6. Shear Modulus				0.8 to 1.20 MPa
7. Ash Content				Not more than 5%

Poly Tetra Fluro Ethylene (PTFE)

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Form	Once for every source approval As per the requirement of the respective item	1 3	BS: 3784 BS: 6564 Part 2 - 1991	Without dimples or the ratio of dimples (lubrications cavities) to the gross area should not be more than 25%, depth of cavity not more than 2 mm
2. Density at 23 ± 2^{0}C				2.13 to 2.19 g/cc
3. Tensile strength at break				24 MPa (min.)
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%

Tests on Seal for Strip Seal Expansion Joints

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Hardness	Once for every source approval	1	MOSRTH Specification for Road & Bridge works	63 ± 5 shore A
2. Tensile Strength	Once for every Lot	3		11 MPa minimum
3. Elongation at Break				350% minimum
4. Tar Propagation Strength (a) Longitudinal (b) Transverse				 Min. 10 N/mm Min. 10 N/mm
5. Shock Elasticity				Min. 25%
6. Abrasion				Min. 220 mm^3
7. Residual Compressive Strain (22h/70deg C/30% Strain)				Max. 28%
8. Ageing in hot air (a) Max. change in hardness (b) Max. change in Tensile strength (c) Max. change in Elongation				 (a) 5 shore A (b) 20% (c) 20%

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
9. Ageing in Ozone (24h/50 pphm/25 deg C/20 % strain				No cracks
10. Swelling behaviour in oil (a) Volume change (b) Change in hardness				Max. 5% Max. 10 shore A
11. ASTM oil No. 3 (a) Volume Change (b) Change in hardness				Max. 25% Max. 20 shore A
12. Cold Hardening Point				Min. -35 deg C

Assembled Accessories

POT-PTFE Bearings

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Dimensional Tolerance (a) Plan dimensions (b) Overall Height (c) Height of any steel component (i) Machined (ii) Unmachined (d) Height of Elastomer	All bearing to be tested for overall dimension	3	MOSRTH Specification for Road & Bridge works IRC: 83 Part-I	 0 to +5 mm 0 to +3 mm 0 to + 1mm Class 2 of IS: 4897 ± 5%
2. Stainless steel sliding surface (a) Flatness (b) Surface finish	All bearing to be tested for overall dimension	3		0.0004L where L= Length is direction of measurement Ra < 0.25 pm as per IS: 3073
3. Load Test Vertically & horizontally including Rotation capacity	All bearing to be tested	3		A test load of 1.25 times the design head there shall be 100% recovery
4. Friction Test	Two bearings selected at random per lot	3		The sufficient of friction shall be less than or equal to 0.05 at the design load

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
5. Ultrasonic test	All castings to be tested	3		Quality level of casting shall be level 3 as per IS: 9565
6. Dye Penetration Test	All welding to be tested	3		There shall be no holes or flaws.
7. Raw Material Testing	Once for every source approval All raw material to be tested	1 3		(i) For cast steel, refer clause 3.2.3 of this Manual (ii) For PTFE, refer clause 3.7.5 of this Manual (iii) For stainless steel, refer clause 3.2.5 of this Manual (iv) For elastomer, refer clause 3.7.4 of this Manual (v) Mild steel 3.2.4.

Elastomer Bearings

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Visual inspection	All bearing shall be tested	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 shall be tested	3		
(a) Overall Plan Dimension				- 0, + 6 mm
(b) Total bearings thickness				- 0, + 5%
(c) Parallelism				
(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 2 mm)
(iv) Thickness of individual outer layer				- 0, + 1 mm

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
(v) Plan dimension of laminates				- 3 mm, +0
(vi) Thickness of laminates				± 10%
(vii) Parallels ion of laminate w.r.t. bearing base as datum				1 in 100
3. Axial Load Test	Two bearings selected at random from each lot shall be tested	3		Deflection under axial load of 5 MPa to 15 MPa for individual bearings shall not vary by more than 20% of the mean value for the entire lot.
4. Shear Modules (G)	Two bearings selected at random from each lot shall be tested	3		Shear modules shall be 1±0.2 MPa provided that there is no instability, defect or damage.
5. Elastic Modulus (Short term loading)	Two bearings selected at random from each lot shall be tested	3		Elastic modules shall be 1 ± 0.2 of 1/C0.2/5^2 10.0005) where 5 is the shape factor, provided that there is no defect or damage.
6. Adhesion Strength	Two bearings selected at random from each lot shall be tested	3		No cracking or petting
7. Ultimate compressive strength	Two bearings selected at random from each lot shall be tested	3		Not less than 60 MPa

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
8. Tests on Elastomer	Two bearings selected at random from each lot shall be tested	3		The elastomer shall satisfy the requirement of clause 3.7.4 of this Manual.

Strip Seal Expansion Joints

Test	Frequency	Check Level	Ref. Codes	Acceptance Standards
1. Tests on Neoprene seal	Once on all the joints	3	MOSRTH Specific-ation for Road & Bridge Works	As given in 3.7.6.
2. Test on Edge Beams (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 (a) Dynamic Loading Characteristics	Once for each lot	2B		The anchorage system shall be tested in a recognized laboratory for optimum configuration under dynamic loading.
4. Water Tightness test	Once for each lot	2B		The joint shall be tested in a recognized laboratory for water tightness under a pressure of 4 bars.
5. Satisfactory Past Performance	Once for each lot	2B		The manufacturer shall submit evidence that the similar joints have performed satisfactory at other locations.

Mix Design including Trial Mix and Acceptance Criteria

Test	Frequency	Ref. Codes	Acceptance
1. Trail Mix (a) Target Mean Strength	For every design Mix For every change in source of any material	IRC:21-2000	(i) Initially Target Mean Strength (TMS) = specified Characteristic strength+current Margin. Current Margin =11 MPa for M25, 12 MPa for M30, M35 and M40, 13 MPa for M45 & M55 and 14 MPa for M55 and M60 (ii) Later on during construction Target Mean Strength = specified characteristic Strength+1.64 x standard deviation from at least 40 samples. (iii) During preparation of trial mixes. Average strength of 9 cubes at 28 days shall be more than TMS -3.5 MPa
2. Acceptance Criteria	**Qty. of Concrete (M^3)** / **No. of Samples** 1-5 / 1 6-15 / 2 16-30 / 3 31-50 / 4 51 and above each / 4 plus 1 for $50m^3$ or part thereof	IRC:21-2000	(i) Mean strength of any group of 4 consecutive samples = specified characteristic strength -3 MPa (ii) Strength of any sample ≥ specified characteristic strength -3 MPa (iii) The test strength of the sample shall be the average of the strength of 3 specimens. The individual variation should not be more than ±15% of the average.

R.C.C. Work

Test	Frequency	Ref. Codes	Acceptance
1. Workability	Every Transit Mixer	IS:516-1959	As per requirement of the item under execution.
2. Compressive strength (a) 7 days strength (b) 28 days strength	As per clause 4.1 of this Manual	IRC:21	As per clause 4.1 of this Manual
3. Flexure Test	Once for every design mix	MOSRTH Specifications for Road & Bridge works	
4. Permeability Test	Once in a month		Maximum 25mm on a specimen of 150mm dia and 160mm height
5. Density (a) Fresh concrete (b) Hardened concrete	Once in a month		 97.5% of the specified value 97.5% of the specified value

Piling

Test	Frequency	Ref. Codes	Acceptance
1. Initial Tests			
(a) Vertical	Minimum 2 tests for each size of Pile	IS:2911 (Part-4) - 1985 IS:2911 (Part-4) - 1985	The sale vertical load shall be minimum of (i) 50% of the final load corresponding to displacement of 1/10th pile dia (ii) 2/3rd of final load at which displacement is 12mm (iii) Load corresponding to any other specified displacement as per performance requirements
2. Routine Tests			
(a) Vertical Test	2% of total piles subject to minimum 2 tests for each size		Maximum settlement at a test load of the working load shall not exceed 12mm
(b) Lateral load test	Upto 2% of total piles		Maximum displacement at 1.5 times the Force should be 5mm.
(c) Integrity test	20% of total piles		There shall be no unacceptable flaws in concrete as per the recommendation of the specified agency carry out the rest.

APPENDIX III

LIST OF EQUIPMENT TO BE PROVIDED IN SITE LABORATORY
(Illustrative)

AND

EXTERNAL INDEPENDENT TESTING

Appendix III

List of Equipment to be provided in Site Laboratory

General

(i)	Oven-electrically operated, thermostatically controlled, range upto 200°C sensitivity 1°C	1 No.
(ii)	Platform balance 300 kg capacity	1 No.
(iii)	Balance 20 kg capacity-self indicating types	1 No.
(iv)	Electronic Balance 5 kg capacity accuracy 0.5 gm	2 Nos.
(v)	Water bath-electrically operated and thermostatically controlled with adjustable shelves, sensitivity 1°C.	1 No.
(vi)	Thermometers:	
	Mercury-in-glass thermometer range 0°C to 25°C	4 Nos.
	Mercury-in-steel thermometer with 30 cm stem, range upto 300°C	1 No.
(vii)	Kerosene or gas stove or electric hot plate	1 No.
(viii)	Glasswares, spatulas, wire gauzes, steel scales, measuring tape, casseroles, karahis, enameled trays of assorted sizes, pestle-mortar, porcelain dishes, gunny bags, plastic bags, chemicals, digging tools like pickaxes, shovels etc	As required
(ix)	Set of IS sieve with lid and pan: 450mm diameter	
	63 mm, 53 mm, 37.5 mm, 26.5 mm, 13.2 mm, 9.5 mm, 6.7 mm and 4.75 mm size	1 Set
	2.36 mm, 2.0 mm, 1.18 mm, 600 micron, 425 micron, 300 micron, 150 micron and 75 micron	2 Sets
(x)	Water testing kit	1 Set
(xi)	First aid box	1 Set

For soils and aggregates

(i)	Riffle Box	1 No.
(ii)	Atterberg Limits (liquid and plastic limits) determination apparatus	1 Set
(iii)	Compaction Test Equipment both 2.5 kg and 4.5 kg rammers (Light and Heavy compactive efforts)	1 Set
(iv)	Dry Bulk Density Test apparatus (sand pouring cylinder, tray, can etc.) complete	1 Set
(v)	Speedy Moisture Meter complete with chemicals	1 Set
(vi)	Post-hole Auger with extensions	1 Set
(vii)	Core cutter apparatus 10 cm dia, 10/15 cm height, complete with dolly, rammer etc.	1 Set
(viii)	Aggregate Impact Value Test apparatus/Los Angeles Abrasion Test apparatus	1 Set
(ix)	Flakiness and Elongation Test Gauges	1 Set
(x)	Standard measures of 30, 15 and 3 litres capacity along with standard tamping rod	1 Set

(xi)	California Bearing Ratio test Apparatus	1 Set
(xii)	Unconfined compression test apparatus	1 Set

For Bitumen and Bituminous Mixes

(i)	Penetrometer with standard needles	1 Set
(ii)	Riffle box – small size	1 No.
(iii)	Centrifuge type bitumen extractor, hand operated, complete with petrol/commercial benzene.	1 Set
(iv)	Marshall stability test apparatus, complete with all accessories	1 Set
(v)	Field density bottle along with cutting, tray, chisel, hammer and standard sand	2 Nos.
(vi)	3 m straight edge	1 Set
(vii)	Camber board	1 No.
(viii)	Core cutting machine with 10 cm dia diamond cutting edge	1 Set
(ix)	Vacuum pump and 3 specific gravity bottles	1 Set

For Cement and Cement Concrete

(i)	Vicat apparatus for testing setting times	1 Set
(ii)	Slump testing apparatus	4 Sets
(iii)	Compression and Flexural strength testing machine of 200 tonne capacity with additional dial for flexural testing	1 No.
(iv)	Needle Vibrator	2 Nos.
(v)	Air Meter	1 No.
(vi)	Vibrating hammer for vibrating dry mix as for Dry Lean Cement concrete sub-base	1 No.
(vii)	Core cutter apparatus 150 mm dia	1 Set

Note: The items and their numbers listed in this Clause shall be decided by the Engineer as per requirements of the Project and modified accordingly.

EXTERNAL INDEPENDENT TESTING

Testing of some materials for quality control needs to be carried out in external laboratories for two reasons. One because certain test facilities are not available at the site or the other because independent testing of certain materials qualifying level 3 need to be tested in external laboratory. This Chapter lays down the minimum requirements that a testing laboratory needs to fulfill for any given test(s) and gives addresses of some of the suggested testing laboratories. It is not necessary that one lab carried out all the tests. Laboratories for various tests shall be selected based on the facilities available with the same.

Requirements of Testing Laboratory

The testing lab shall meet the following minimum requirements:

(a) Should have a library of all the relevant codes and standards containing guidelines for carrying out the tests and the once indicating the acceptance criteria.
(b) All the required equipment for the relevant testing in good working condition should be available.
(c) Equipment requiring calibration should be calibrated at required frequency. Relevant calibration certificates should be available for inspection.
(d) Facilities for obtaining required atmosphere conditions for tests such as temperature and relative humidity should be available.
(e) Equipment should be of adequate capacity to carry out the relevant tests.

Some suggested Testing Laboratories

It is advised that the testing laboratory be situated as close to the site of works as possible so that samples can be easily and quickly transported to the laboratory. Sometimes size and weights of samples are so large that they may require special arrangement for their transportation. Smaller distance will also facilitate better frequency of sampling and testing.

Name and addresses of a few laboratories in India are indicated below. Any other laboratory meeting the selection criteria to the satisfaction of the engineer may also be selected for carrying out the tests:

a) Delhi Test House
A 62-63, GT-Karnal Road
Industrial Area, Opposite Hans Cinema
Azadpur, Delhi-110033
Phone: 7437327 Fax: 7435509

b) AES Testing & Research laboratories
1304, Nirman Tower
26, Barakhamba Road
New Delhi-110001
Phone: 3323256

c) Regional Testing Centre (NR)
Sahid Capt Gaur Marg
Okhla, New Delhi-110020

d) Central Road Research Institute
Delhi Mathura Road
P.O. CRRI, New Delhi-110020

e) Indian Institute of Technology
Hauz Khas
New Delhi-110016

f) Shriram Institute of Industrial Research
19, University Road
Delhi-110007
Phone: 7257267 Fax: 7257676

g) Torsteel Research Foundation in India
1/4 APE Trust Building, 2nd Floor
Bull Temple Road
Bangalore-560017
Phone: 080-6612908 Fax: 080-6616524

APPENDIX IV

FORMS FOR TESTING

PART A: ROAD WORKS

Appendix IV

FORMS FOR TESTING

PART A: ROAD WORKS

1. EARTHWORKS
2. SUB-BASE AND BASE
3. BITUMINOUS MATERIALS
4. CONCRETE
5. GENERAL WORKS

EARTHWORK

1. Liquid Limit and Plasticity Index
2. Laboratory Compaction
3. Grain size analysis
4. Field Density
5. Calibration of sand
6. Excavation Control
7. Embankment/Sub-grade Control
8. Organic Matter in Soil
9. Determination of total soluble Sulphates
10. Determination of Free Swelling Index of Soils
11. California Bearing Ratio Test Data Sheet

LIQUID LIMIT AND PLASTICITY INDEX DETERMINATION
(IS: 2720 - Part 5)

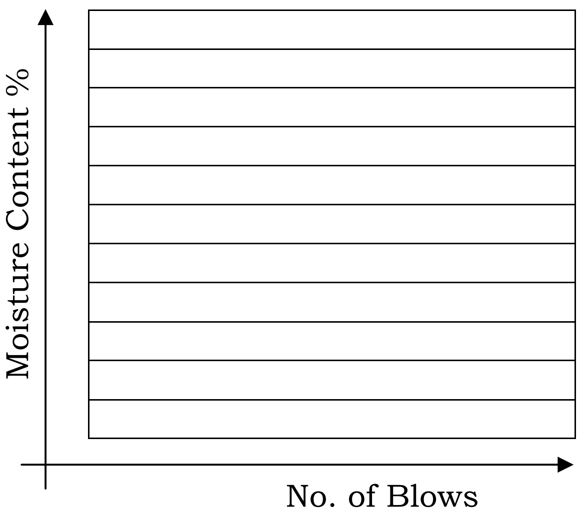
Contractor: ________________________ Date: ________________________________
Station: ___________________________ Sample No.: __________________________
Original Source: ____________________ Tested by: ___________________________

LIQUID LIMIT DETERMINATION

Determination No.				
Container No.				
No. of Blows				
Wt. of Can + Wet Soil, g				
Wt. of Can + Dry Soil, g				
Wt. of Water, g				
Wt. of Can, g				
Wt. of Dry Soil, g				
Water content, %				

PLASTIC LIMIT DETERMINATION

Determination No.				
Container No.				
Wt. of Can + Wet Soil, g				
Wt. of Can + Dry Soil, g				
Wt. of Water, g				
Wt. of Can, g				
Wt. of Dry Soil, g				
Water content, %				
Average Water Content, %				



GRAIN SIZE ANALYSIS	
IS Sieve	% Passing
4.75 mm	
0.425 mm	
0.075 mm	

Plastic Limit: ________________
Plasticity Index: ________________
Classification: ________________
Remarks: ________________
____

Submitted by: Checked by: Approved by:

Submitted by:	Checked by:	Approved by:
________________________	____________________	____________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

LABORATORY COMPACTION
(IS: 2720 - Parts 7 & 8)

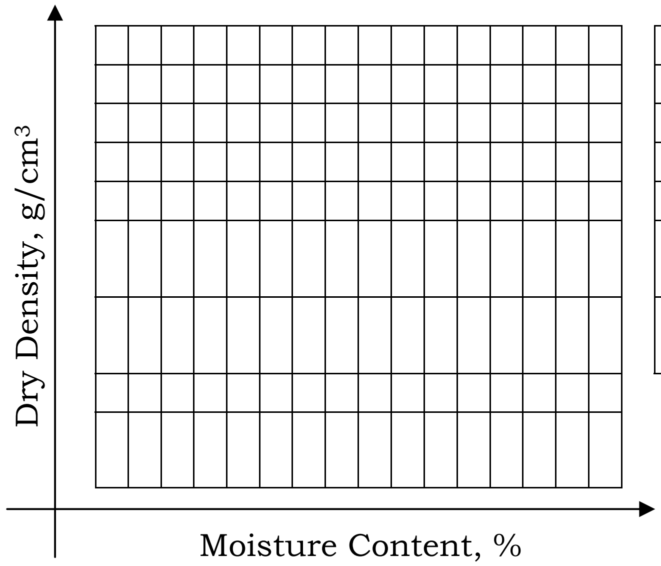
Contractor: ______________________________ Date: __________________
Station: _________________________________ Sample No.: ____________
Soil Description: _________________________ Date Tested: ____________
Tested by: _______________________________
Test Designation: Part 7/Part 8 (circle one) Specimen Preparation: Single/Separate (circle)

WATER CONTENT DETERMINATION

Sample No.	**1**		**2**		**3**		**4**		**5**	
Moisture Can No.										
Wt. of Can + Wet Soil, g										
Wt. of Can + Dry Soil, g										
Wt. of Water, g										
Wt. of Can, g										
Wt. of Dry Soil, g										
Water content, %										
Average Water Content, %										

DENSITY DETERMINATION

Wt. of Moist Soil + Mould, g					
Wt. of Mould, g					
Wt. of Moist Soil, g					
Vol. of Mould, cm^3					
Wet Density, g/cm^3					
Dry Density, g/cm^3					



Diameter of mould, mm	
Weight of rammer, kg	
Height of fall, mm	
No. of blows	
No. of layers	
Optimum Moisture Content, %	
Maximum Dry Density, g/cm^3	

Remarks: ______________________
____

Submitted by: Checked by: Approved by:

______________________ ______________________ ______________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

GRAIN SIZE ANALYSIS
(IS: 2720 Part - 4)

Sample No.: ______________________ Date Sampled: ______________________
Source: __________________________ Date Tested: ________________________
Proposed Use: ____________________ Original Wt., g = ____________________
Oven Dry Wt., g = ___________________
Wash Oven Dry Wt., g = _______________

IS Sieve (mm)	**Wt. Retained (g)**	**% Retained**	**Cumulative**			**Remarks**
			Wt. Passing (g)	**% Passing**	**% Retained**	
100.0						
53.0						
25.0						
19.0						
12.5						
10.0						
6.5						
4.75						
2.36						
0.425						
0.075						
Pan						
Wash Loss						
Total						

GRAVEL, %	
SAND, %	
SILT & CLAY, %	

ACCEPTANCE CRITERIA SPECIFIED:
____
____

Remarks: ____

Submitted by: Checked by: Approved by:

Submitted by:	Checked by:	Approved by:
______________________	______________________	______________________
Contractor’s Representative	Materials Engineer Consultant	Resident Engineer Consultant

FIELD DENSITY TEST
(Sand Replacement Method, IS: 2720 Part - 28)

Contractor: ____ Date: ________________
Location/Layer: ________________________ Quantity Represented: ___________

WET DENSITY DETERMINATION

Laboratory No.				
Location of Test				
Sand Cone Apparatus No.				
Wt. of App. filled with Sand, g				
Wt. of App. & Remaining Sand, g				
Wt. of Sand in Hole, Cone & Plate, g				
Wt. of Sand in Hole, g				
Bulk Density of Sand used, g/cm^3				
Vol. of Test Hole, cm^3				
Wt. of Excavated Materials, g				
Wet Density, g/cm^3				

MOISTURE CONTENT DETERMINATION

Can No.				
Wt. of Wet Sample + Can, g				
Wt. of Dry Sample + Can, g				
Wt. of Can, g				
Wt. of Water, g				
Wt. of Dry Sample, g				
Moisture Content, %				

DEGREE OF COMPACTION

Dry Density, g/cm^3				
Max. Dry Density, g/cm^3				
Optimum Moisture Content, %				
Degree of Compaction, %				
Required Degree of Compaction, %				
Standard Deviation, g/cm^3				

Remarks: ____

Submitted by:	Checked by:	Approved by:
________________________	____________________	____________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

CALIBRATION OF SAND
(IS: 2720 Part - 28)

Sample No.: ____________________________ Calibration Date: ______________

Source: ________________________________ Calibrated by: _________________

Test No.	**1**	**2**	**3**	**4**
Wt. of Cylinder + Sand before Pouring into Calibrating Can, g				
Wt. of Cylinder + Sand after Pouring into Calibrating Can, g				
Wt. of Sand in Cone + Calibrating Can, g				
Wt. of Sand before pouring onto Level Platform, g				
Wt. of Sand after pouring onto Level Platform, g				
Wt. of Sand in Cone, g				
Wt. of Sand in Calibrating Can, g				
Vol. Of Calibrating Can, cu. Cm				
Bulk Density of Sand, g/cu. Cm				
Ave. Bulk Density, g/cu. Cm				
Ave. of Wt. of Sand in Cone, g				

Remarks: ____

Submitted by:	Checked by:	Approved by:
______________________	______________________	______________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

EXCAVATION CONTROL

Contractor: ________________________________ Date: __________

Station: From km ____________________________ to km __________

Total Volume of Excavation, m^3: ______________________________

Description of Materials: ______________________________________

TEST RESULTS		SAMPLES			
		1	**2**	**3**	**4**
GRADATION	PASSING 25.0 mm				
	PASSING 4.75 mm				
	PASSING 0.075 mm				
MOISTURE CONTENT, %					
LIQUID LIMIT, %					
PLASTICITY INDEX, %					
FREE SWELLING INDEX, %					
OMC, %					
MDD, g/cm^3					
CLASSIFICATION (MOSRTH Clause 301.2)					

CONCLUSION:

SUITABLE

For embankment Sta. ______________

For subgrade Sta. ________________

For stockpile Sta. ________________

UNSUITABLE

For disposal at __________

____

Remarks: ____

Submitted by:

____

Contractor's Representative

Checked by:

____

Materials Engineer
Consultant

Approved by:

____

Resident Engineer
Consultant

EMBANKMENT/SUBGRADE CONTROL

Station: From Km To Km	Date:
Layer Width:	Layer thickness:
Actual Fill Height:	Depth below Subgrade:
Soil Description:	Taken From:
Compacted by (Compaction Equipment):	

TEST RESULTS		SPECS. REQMT.	SAMPLES 1	2	3	4	5
GRADATION	PASSING 50.0 mm						
	PASSING 4.75 mm						
	PASSING 0.075 mm						
Moisture Content, %							
Liquid Limit, %							
Plasticity Index, %							
Free Swelling Index, %							
Soluble Sulphate Content, g/l							
OMC, %							
MDD, g/cm^3							
Degree of Compaction, %							
Soil Classification (IS 1498)							

Remarks: ____________________

Submitted by:	Checked by:	Approved by:
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

DETERMINATION OF ORGANIC MATTER (SOIL)
(IS: 2720 Part - 22)

Description of Material: ____________________ Date of Sampling: __________

Location: _________________________________ Sampled by: ________________

Tested by: ________________________________ Date of Testing: _____________

Determination No.	**1**	**2**	**3**
Total Weight of Original Sample (W_1), g			
Weight of Soil Passing 10 mm Sieve (W_2), g			
Weighing Bottle No.			
Weight of Weighing Bottle and Dry Soil after Taking Specimen for Test, g			
Weight of Weighing Bottle and Dry Soil before Taking Specimen for Test, g			
Weight of Dry Soil Specimen Used (W_3), g			
Volume of Ferrous Sulphate Solution added to Standarize Potassium Dichromate Solution (x), ml			
Volume of Potassium Dichromate Solution used to Oxidize Organic $V= 10.5\,(1-y/x)$, ml			
Percentage of Organic Matter in Soil = $(0.6\, W_2\, V) / (W_1 \quad W_3)$			

Remarks: ____

Submitted by: Checked by: Approved by:

_______________________	___________________	___________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

DETERMINATION OF TOTAL SOLUBLE SULPHATES
(IS: 2720 Part - 27)

Description of Material: ______________________ Date of Sampling: __________

Location: ____________________________________ Sampled by: ________________

Tested by: ___________________________________ Date of Testing: _____________

Determination No.			
Weight of Specimen, g			
Volume of N/4 Barium Chloride added (x), ml			
Volume of N/4 Potassium Chromate Solution used in Back Titration (y), ml			
N/4 Barium Chloride actually used for Precipitating Sulphate			
Sulphate as Sodium Sulphate in Soil, % by Mass= 0.0177 (100) (x-y)			

Remarks: ____

Submitted by:	Checked by:	Approved by:
________________________	___________________	__________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

DETERMINATION OF FREE SWELL INDEX OF SOILS
(IS: 2720 Part - 40)

Description of Material: ____________________ Date of Sampling: __________

Location: ________________________________ Sampled by: ______________

Tested by: _______________________________ Date of Testing: ____________

Determination No.	**Measuring Cylinder No.**		**Reading After 24 hours**		**Free Swell Index, %**
	Kerosene	**Distilled Water**	**Kerosene**	**Distilled Water**	

Remarks: ____

Submitted by: | Checked by: | Approved by:

________________________ ___________________ ___________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

CALIFORNIA BEARING RATIO TEST DATA SHEET
(IS: 2720 Part - 16)

Molding Date :	Penetration Date :
Sample No.:	Tested by:

Density Data

A. Condition of Specimen	Before Soaking	After Soaking
B. Wt. of Compacted Sample, Mold and Base Plate, g		
C. Wt. of Mold and Base Plate, g		
D. Wt. of Sample, g		
E. Height of Specimen, cm		
F. Vol. of Specimen, cm^3		
G. Wet Density, g/cm^3		
H. Moisture Content, %		
I. Dry Density, g/cm^3		

Expansion Ratio Determination

J. Surcharge Weight, kg		O. Expansion Ratio:
K. Initial Height of Specimen, mm		O = (N/K) (100)
L. Initial Dial Gauge Reading, mm		
M. Final dial Gauge Reading, mm		
N. Difference, mm		

Water Content Data

	Before Compaction	**After Compaction**	**After Soaking**	
			Top 30 mm	**Bulk**
Wt. of Can + Wet Soil, g				
Wt. of Can + Dry Soil, g				
Wt. of Water, g				
Wt. of Can, g				
Wt. of Dry Soil, g				
Water Content, %				
Average Water Content, %				

Penetration Data

Penetration	**Test No.**			
	Local Dial Reading	**Total Load (kgf)**	**Corr. (kgf)**	**CBR**
0.5 mm				
1.0 mm				
1.5 mm				
2.0 mm				
2.5 mm				
4.0 mm				
5.0 mm				
7.5 mm				
10.0 mm				
12.5 mm				

Penetration	**Unit Std. Load (kgf/cm^2)**	**Total Std. Load (kgf)**
2.5 mm		
5.0 mm		
7.5 mm		
10.0 mm		
12.5 mm		

Remarks: ____

Submitted by: ____________________ Contractor's Representative

Checked by: ____________________ Materials Engineer Consultant

Approved by: ____________________ Resident Engineer Consultant

Sub-base and Base

1. Sub-base Control
2. Base Control
3. Abrasion Test by Los Angeles Machine
4. Specific Gravity and Water Absorption of Aggregates
5. Aggregate Impact Value
6. Sieve Analysis of Fine and Coarse Aggregates
7. Flakiness and Elongation Index
8. Soundness Test for Aggregates

SUB-BASE CONTROL

Contractor: ______________________________Date: ____________________

Station: From km _________________________ to km ___________________

Source: ____

Compacted by (Compaction Equipment): _______________________________

Tolerances from the Design	Required	Measured	Permitted Variation
Layer Thickness			
Elevation of Surface			
Surface Irregularity (by 3 m straight edge)			
Crossfall			
Longitudinal Grade Over 25 m			

TEST RESULTS		**SPECS. REQMT.**	**SAMPLES**				
			1	**2**	**3**	**4**	**5**
GRADATION	PASSING 25.0 mm						
	PASSING 4.75 mm						
	PASSING 0.075 mm						
Natural Moisture Content, %							
Liquid Limit, %							
Plasticity Index, %							
L.A.A., %							
CBR, %							
OMC, %							
MDD, g/cm^3							
Field Density, g/ cm^3							
Degree of Compaction, %							

Remarks: ____

Submitted by:	Checked by:	Approved by:
______________________	______________________	______________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

BASE CONTROL

Contractor: ______________________ Date: ______________________

Station: From km ______________________ to km ______________________

Source: ____

Compacted by (Compaction Equipment): ______________________

TEST RESULTS		SPECS. REQMT.	SAMPLES				
			1	2	3	4	5
GRADATION	PASSING 25.0 mm						
	PASSING 4.75 mm						
	PASSING 0.075 mm						
Natural Moisture Content, %							
Liquid Limit, %							
Plasticity Index, %							
L.A.A., %							
CBR, %							
OMC, %							
MDD, g/cm^3							
Field Density, g/ cm^3							
Degree of Compaction, %							

Remarks: ____

Submitted by: Checked by: Approved by:

______________________ ______________________ ______________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

ABRASION TEST BY USE OF THE LOS ANGELES MACHINE (IS: 2386 Part - 4)

Contract: ________________________________ Date Sampled: ____________________
Kind of Material: _________________________ Date Tested: ______________________
Source: __________________________________ Quantity Represented: ____________

Passing	Retained On	Grading and Weight in gm of Test Sample			
		A	B	C	D
37.5	25.0	--	--	--	--
25.0	19.0	--	--	--	--
19.0	12.50	--	--	--	--
12.5	9.5	--	--	--	--
9.5	6.3	--	--	--	--
6.3	4.75	--	--	--	--
4.75	2.36	--	--	--	--
TOTAL		--	--	--	--

Note: The test sample shall conform to one of the grading in the above table.

SPEED	GRADING	NO. OF SPHERES	WEIGHT OF CHARGE, gm
	A	12	
	B	11	
	C	8	
	D	6	

Specification's Limit	
DBM	
Other Works	

Note: The abrasive charge shall consist of cast iron or steel spheres approximately 47.6 mm in diameter and each weight between 390 and 445 grams. The charge depending upon grading of test sample shall be as tabulated above.

Calculations: Abrasion Loss, % = (A-B) / B x 100 = _______________

Where: A = Original oven dried weight, g = ___________
B = Oven dried weight retained on 1.70 mm sieve after abrasion, g = ___________

Remarks: ____

Submitted by: Checked by: Approved by:

________________________ ____________________ __________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

DETERMINATION OF SPECIFIC GRAVITY & WATER ABSORPTION

Sample No.: ______________________________ Sampling Date: __________________

Source/Location: _________________________ Testing Date: ____________________

Determination No.	1	2
Wt. of saturated surface dry sample, g		
Wt. of pycnometer containing sample & water, g		
Wt. of pycnometer filled with water, g		
Wt. of oven dried sample, g		
Specific Gravity on oven dried basis		
Ave. Specific Gravity		
Water Absorption		
Average Water Absorption		

Specific Gravity = (Wt. of OD sample)/(Wt. of SSD sample – [(Wt. of Pyc. containing sample & Water) – (Wt. of Pyc. filled with Water)]

Water Absorption = [(Wt. of SSD sample – Wt. of OD sample)/(Wt. of OD sample)] (100)

Remarks: ____
____

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

AGGREGATE IMPACT VALUE
(IS: 2386 Part - 4)

Location:	Tested by:
Material:	Date:

Quarry:	Range of Sieve: 10.0 mm to 12.5 mm
Date Sampled:	No. of Blows: 15
Location:	Height of Fall: 380 mm
Method of Sampling: By means of scoop	Method of Crushing: Sudden

Sample No.	**Wt. of Container (g)**	**Wt. of Container + Aggregate (g)**	**Wt. of Aggregate Before Compaction (g)**	**Wt. of Aggregate Retained on 2.36 mm sieve (g)**	**Wt. of Aggregate Passing on 2.36 mm sieve (g)**	**Aggregate Impact Value (%)**
					Average	:

Remarks: ____

Submitted by: Checked by: Approved by:

Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (IS: 2386 Part - 1)

Source of Material: ____________________________ Date Sampled: _____________
Description: ___________________________________ Date Tested: _______________

Wet Wt.: **Oven Dried Wt.:** **Washed Oven Dried Wt.:**

IS Sieve (mm)	Wt. Retained (g)	% Retained	% Cumulative Retained	% Cumulative Passing	Specification Limits
75.00					
63.00					
45.00					
40.00					
37.50					
26.50					
22.40					
20.00					
19.00					
16.00					
13.20					
12.50					
11.20					
10.00					
9.50					
5.60					
4.75					
2.80					
2.36					
1.18					
0.710					
0.600					
0.425					
0.300					
0.150					
0.090					
0.075					
Pan					
Wash Loss					
Total					

Remarks: ____

Submitted by: Checked by: Approved by:

_________________________ _____________________ ___________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

FLAKINESS AND ELONGATION INDEX
(IS: 2386 Part - 1)

Source of Material: ______________________________ Date Sampled: _____________
Description: ____________________________________ Date Tested: _______________

Sieve Size (mm)	**Total Wt. of Aggregates Retained (g)**	**Wt. Retained on Flakiness Gauge (g)**	**Wt. Passing on Flakiness Gauge (g)**
63 – 50			
50 – 40			
40 – 31.5			
31.5 – 25			
25 – 20			
20 – 16			
16 – 12.5			
12.5 – 10			
10 – 6.3			
Total			

Percentage of Flakiness Index:
(Total Wt. of Agg. Ret. on Flakiness Ga./Wt. Passing on Flakiness Ga.)(100)
= __________________

Sieve Size (mm)	**Total Wt. of Aggregates Retained (g)**	**Wt. Retained on Elongation Gauge (g)**	**Wt. Passing on Elongation Gauge (g)**
50 – 40			
40 -25			
25 – 20			
20 -16			
16 – 12.5			
12.5 – 10			
10 – 6.3			
Total			

Percentage of Elongation Index Value:
(Total Wt. Ret. on Elongation Ga./Total Wt. Passing on Elongation Ga.)(100)
= __________________

COMBINED PERCENTAGE OF FLAKINESS & ELONGATION = __________________

Remarks: ____

Submitted by:	Checked by:	Approved by:
______________________	______________________	______________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

SOUNDNESS TEST DATA
(IS: 2386 Part - 5)

Soundness Test for Fine Aggregates

Sieve Size		Grading of Original Sample, %	Weight of Test Fractions Before Test, g	Percent Passing After Test (Actual Loss)	Weighted Average (Corrected Percent Loss)
Passing	Retained				
0.150 mm	-		-	-	-
0.300 mm	0.130 mm		-	-	-
0.600 mm	0.300 mm				
1.18 mm	0.600 mm				
2.36 mm	1.18 mm				
4.75 mm	2.36 mm				
10 mm	4.75 mm				
Total	-			-	

Soundness Test for Coarse Aggregates

Sieve Size		Grading of Original Sample, %	Weight of Test Fractions Before Test, g	Percent Passing After Test (Actual Loss)	Weighted Average (Corrected Percent Loss)
Passing	Retained				
63 mm	40 mm				
40 mm	20 mm				
20 mm	10 mm				
10 mm	4.75 mm				
Total	-			-	

Remarks: ____

Submitted by: Checked by: Approved by:

______________________ ______________________ ______________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

BITUMINOUS MATERIALS

1. Sieve Analysis
2. Bitumen Penetration Test
3. Mix Design by Marshall Method
4. Marshall Test
5. Marshall Test Result
6. Binder Content and Gradation of Mix
7. Bituminous Plant Mix Control
8. Application of Bituminous Prime/Tack Coat
9. Bituminous Concrete Surface Control
10. Stripping Value of Aggregates

SIEVE ANALYSIS OF ASPHALTIC MIXED AGGREGATES
(IS: 2386 Part - 1)

Source of Material: ______________________________ Date Sampled: ______________

Description: ______________________________________ Date Tested: ________________

Dry Wt.: **Dry Fraction for Wash:** **Washed Oven Dried Wt.:**

IS Sieve (mm)	Wt. Retained (g)	% Retain-ed	% Cumul-ative Retained	% Cumul-ative Passing	Governing Specifications		
					Limit	JMF	Limit after Applying Tolerance
26.50							
19.00							
13.20							
4.75							
2.36							
1.18							
0.600							
0.300							
0.075							
Pan							
Wash Loss							
Total							

Remarks: ____

Submitted by: Checked by: Approved by:

__________________________ ____________________ ___________________

Contractor's Representative

Materials Engineer
Consultant

Resident Engineer
Consultant

GRADING OF AGGREGATES FOR DENSE BITUMINOUS MACADAM
(MOSRTH Clause 507.2.5)

Source of Material: ______________________________ Date Sampled: ______________

Description: ______________________________________ Date Tested: ________________

Wet Wt.: **Oven Dried Wt.:** **Washed Oven Dried Wt.:**

IS Sieve (mm)	Wt. Retained (g)	% Retained	% Cumulative Retained	% Cumulative Passing	Specifications Limits
37.5					100
26.5					90 – 100
13.2					56 – 80
4.75					29 – 59
2.36					19 – 45
0.300					5 – 17
0.075					1 – 7
Pan					
Wash Loss					
Total					

Remarks: ____

Submitted by: Checked by: Approved by:

__________________________ ____________________ ___________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

BITUMEN PENETRATION TEST

Trial No.	1			2			3		
Specimen	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Initial Reading									
Final Reading									
Average Value									

Remarks: ____

____

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

HOT MIX DESIGN DATA BY THE MARSHALL METHOD

Location/Source: ________________________ Dated Sampled: ____________________

Date Tested: _____________________________Tested by: __________________________

Description of Sample: ___________________% AC by wt. of mix: _________________

Sp. Gr. Of AC (G_{ac}): _____Pen. Grade: ____ Ave. Bulk Sp. Gr. of Agg. (G_b): _______

SAMPLE		Set I				Set II			
		1	2	3	Average	4	5	6	Average
a	Sample Height, mm								
b	Wt. of Sample in Air, g								
c	Wt. of SSD Sample in Air, g								
d	Wt. of sample of Water, g								
e	Bulk Volume, cc								
f	Bulk Density, g/cc								
g	AC by Wt. of Agg., %								
h	AC by Wt. of Mix, %								
i	Vol. of AC, %								
j	Vol. of Agg., cc								
k	Vol. of Voids, %								
l	Max. Theor. Density, g/cc								
m	Voids in Mineral Agg., %								
n	Voids Filled with Asphalt, %								
o	Air Voids in Total Mix, %								
p	Stability (measured), kg								
q	Correlation Ratio								
r	Stability (Adjusted), kg								
s	Loss of Stability, %								
t	Flow, mm								
u	Rigidity Ratio								
v	Swell, %								

Remarks: ____

Submitted by: Checked by: Approved by:

Submitted by:	Checked by:	Approved by:
________________________	___________________	__________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

MARSHALL TEST

Location: ______________________ Date Tested: ________________

Date Sampled: ____________________Tested By: _________________

DENSITY DETERMINATION	JMF Density:					
Sample No.	1	2	3	4	5	6
(a) Wt. in Air, g						
(b) Wt. in air SSD, g						
(c) Wt. in Water, g						
(d) Volume, cc						
(e) Density, g/cc						
(f) Air Voids in Mix, %						
(g) VMA, %						
(h) Stability						
(i) Flow, mm						

Remarks: ____

Submitted by:

____

Contractor's Representative

Checked by:

____

Materials Engineer
Consultant

Approved by:

____

Resident Engineer
Consultant

MARSHALL TEST RESULT

	25 mm	12.5 mm	Grit	Lime
% of Aggregates				

SOURCE:
LOCATION: BITUMEN S.G.:
TYPE OF MIX: BITUMEN GRADE:

Sl. No.	% of Bitumen	Dry Sample (g)	S.S.D Weight (g)	Volume (cc)	Bulk Density (g/cc)	Avg. Bulk Density (g/cc)	Mix Density (theoretical)	Marshall Stability Load (kg) (A)	Strength (3.86") in kg	Ave. Strength in kg	Flow in mm	Ave. Flow (2 to 4)	% of Air Voids (3 to 5)	% of VMA (10 to 12)	% of VFB (65 to 75)

Remarks: ______________________________

Submitted by: Checked by: Approved by:

___________________ ___________________ ___________________
Contractor's Representative Materials Engineer Consultant Resident Engineer Consultant

BINDER CONTENT & GRADATION OF THE MIX

Sample No.:	Date:
Type of Mix:	Source:
Wt. of Mix before Extraction, g:	Location:
Wt. of Mix after Extraction, g	Sample Taken from:
Wt. of Binder, g:	% of Binder Content in Mix:

SIEVE ANALYSIS AFTER EXTRACTION

IS SIEVE (mm)	Wt. of Agg. (g)	% of Agg. Retained	% of Agg. Passing	Specification Limits	Remarks

Remarks: ____
____

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

BITUMINOUS PLANT MIX CONTROL

Sieve Size (mm)	Job Mix Formula	Measured Results		Range	Tolerance from JMF
Sand Equivalent					
Abrasion					
Bulk Sp. Gr.					
Stripping					
Mineral Filler:					
Plasticity Index					
Bituminous Material:					
Penetration					
Mix:					
Bitumen content, %					
Density, g/cm^3					
Air Voids, %					
Stability, (corrected)					
Flow					
Voids in Mineral Agg., %					
Specimen Height, cm					
Bulk Sp. Gr.					
Temperature of Mix					

Remarks: ____

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

APPLICATION OF BITUMINOUS PRIME/TACK COAT
(As suggested by the Asphalt Institute)

Contract: ______________________________ Date: ____________________
Kind of Bitumen Material: ______________________________________
Station Limits: From ______________________ To ____________________
Length (m): ______________ Width (m): ___________ Area (m^2): _____________

1. Application Temperature of Prime/Tack Coat:
2. Observed Temperature of Prime/Tack Coat:
3. (a) Unit Weight Prime/Tack Coat:
   (b) Unit Weight of Chips (Loose) Tonne/m^3:
4. Correction Factor at observed Temperature:
5. (a) Speed of Distributor: _____________ kph (b) Height of Spray Bar: 0.35 m

Tray No.				
6. Weight of Tray, g				
7. Weight of Tray with Bitumen, g				
8. Weight of Bitumen (7-6), g				
9. Area of Tray, cm^2				
10. Rate of Spray (8/9), g/cm^2				
11. Rate of Spray (10/0.10), kg/m^2				
12. Rate of Application, (11/3a), l/m^2				
13. Average Rate of Application, l/m^2				
14. Governing Specifications, l/m^2	Primer binder	Tack coat-kg/10m^2		

CHIPS SPREADING

Tray No.				
15. Weight of Tray, g				
16. Weight of Tray + Chips, g				
17. Weight of Chips (16 – 15), g				
18. Area of Tray, cm^2				
19. Rate of Application (17/18), g/cm^2				
20. Average (Ave. of 19/0.10), kg/m^2				
21. Ave. Rate of Application (3b/20), m^2/m^2				
22. Governing Specification, m^2/m^2				

Remarks: ____

Submitted by:	Checked by:	Approved by:
____________________	____________________	____________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

BITUMINOUS CONCRETE SURFACE COURSE CONTROL

Chainage:	Lane:
Pavement Thickness:	Surface Width:

Bituminous Conc. Type:	LABORATORY		FIELD		
Specimen No.					
Date Sampled					
Date Tested					
Ave. Thickness, cm					
(a) Specimen Wt. in Air, g					
(b) Specimen Wt. in Water, g					
(c) SSD Specimen Wt., g					
(d) Bulk Sp. Gr. D = A/(C-B), g/cm^3					
(e) Maximum Sp. Gr. AC by wt. of agg., %					
Air Voids n = [(E-D)/E]100, %					
Degree of compaction = (D Field/D Lab)100, %					
Marshall Stability (adjusted)					
Flow					
Surface Irregularity, mm					

SPECIFICATIONS:

Min. Degree of Compaction:	AC Range (% dry agg.):
Min. Marshall Stab:	Surface Tolerance (3 m Str. Edge):
Flow Range:	

Remarks: ____

Submitted by: Checked by: Approved by:

______________________ ______________________ ______________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

DETERMINATINO OF STRIPPING VALUE OF AGGREGATES (IS: 6241)

Source/Location: ________________________ Size of Lot: ___________________________

Material: _________________________________ Date of Sampling: ___________________

Size of Sample: ___________________________ Date of Testing: _____________________

Determination No.			
Type of Aggregate			
Type of Binder			
% Binder used			
Total Weight of Aggregates			
Total Weight of Binder			
Temperature of Water Bath, ^{0}C			
Stripping Value, %			
Mean Stripping Value, %			

Remarks: ____

Submitted by: Checked by: Approved by:

__________________________ ____________________ ___________________

Contractor's Representative

Materials Engineer
Consultant

Resident Engineer
Consultant

CONCRETE

1. Silt Content in Sand
2. Sieve Analysis of fine and Coarse Aggregates
3. Flakiness and Elongation Index
4. Consistency of cement
5. Trial Mix Design
6. Compressive Strength Concrete/Mortar Cubes
7. Flexural Strength of Concrete Beams
8. Calibration of Concrete Batching Plant
9. Alkali-Aggregate Reactivity
10. Workability/Consistency of Fresh Concrete
11. Estimation of Organic Impurities in Fine Aggregates
12. Fineness of Cement
13. Initial and final Setting Time of cement
14. Determination of clay Lumps
15. Determination of soft particles
16. Determination of light weight pieces (coal and lignite)
17. Determination of clay, fine silt and fine dust (Sedimentation method)

SILT CONTENT IN SAND

Sample No.:	Sampling Date:
Source/Location:	Testing Date:
Tested by:	

Trial No.	1	2	3
Total Volume of sand taken			
Volume of Sand after Submerging			
Volume of Silt after Submerging			
Silt Content, %			
Average. %			

Silt Content = [(Vol. of Silt after Submerging)/
(Vol. of Sand after Submerging)] x 100

Acceptance criteria specified: ______________________________

____

Remarks: ______________________________

____

Submitted by: | Checked by: | Approved by:

______________________ ______________________ ______________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

CONSISTENCY OF CEMENT

SAMPLE No.:	DATE OF SAMPLING:
SOURCE/LOCATION:	
DELIVERY CHALLAN NO. & DATE:	TESTING DATE:
CEMENT MANUFACTURER:	
GRADE & TYPE OF CEMENT:	TESTED BY:
BATCH NO. (W/M/Y):	

Trial No.	Wt. of Cement (gm)	Water (cc)	Water (%)	Needle Penetration mm	Remarks
					STANDARD
					CONSISTENCY
					AT 28 DEGREES
					TEMPERATURE

ACCEPTANCE CRITERIA:
STANDARD CONSISTENCY (P): %
INITIAL SETTING TIME : min. 30 minutes
FINAL SETTING TIME : max. 600 minutes

Remarks: ____

Submitted by:	Checked by:	Approved by:
________________	________________	________________
Contractor’s Representative	Materials Engineer Consultant	Resident Engineer Consultant

TRIAL MIX DESIGN DETAILS
GRADE -

1	Mix Ref. No.					
2	Date of Casting					
3	Type of Cement					
4	Type of Concrete					
5	Type of Admixture					
6	Cement in kg/m^3					
7	Water in kg/m^3					
8	w/c Ratio					
9	A/c Ratio					
10	FA/CA Ratio					
11	% of FA					
12	% of CA					
13	Proportions of Ingredients					
	25 mm					
	12.5 mm					
	Natural Sand					
	Crush Sand					
14	Admixture dosage ml/m^3					
15	Slump @ 0 minute					
	Slump @ 45 minutes					
16	Concrete Temp. @ 0 minute					
	Concrete Temp. @ 45 minutes					
17	Compressive Strength					
	3 days					
	7 days					
	28 days					
19	REMARKS					

Remarks: ____

Submitted by:	Checked by:	Approved by:
______________________	______________________	______________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

COMPRESSIVE STRENGTH OF CONCRETE/MORTAR CUBES
(IS: 516)

Sample No.	Date of Casting	Structure/ Location	Grade of Concrete	Age (Days)	Slump (mm)	Section Area (cm^2)	Sample Height (cm)	Density on Test Date (kg/m^3)	Comp. Load (kN)	Comp. Strength (N/mm^2)	Ave. Comp. Strength (N/mm^2)	Remarks

Submitted by:

____

Contractor's Representative

Checked by:

____

Materials Engineer
Consultant

Approved by:

____

Resident Engineer
Consultant

FLEXURAL STRENGTH OF CEMENT CONCRETE BEAMS

Sample No.	Date of Casting	Structure/ Location	Grade of Concrete	No. of Days	Slump (mm)	Dimension (cm)	ID Mark	Weight (g)	Load (kN)	Comp. Strength (N/mm^2)	Ave. Comp. Strength (N/mm^2)

Remarks: ____

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

CALIBRATION CONCRETE BATCHING PLANT

Location:	Date of Calibration:
Type:	Calibrated by:

Description	Trial – 1	Trial – 2	Trial – 3	Trial – 4	Trial - 5
FEEDER BIN 1					
(a) As per computer					
(b) As per weigh bridge					
(c) Difference					
FEEDER BIN 2					
(a) As per computer					
(b) As per weigh bridge					
(c) Difference					
FEEDER BIN 3					
(a) As per computer					
(b) As per weigh bridge					
(c) Difference					
FEEDER BIN 4					
(a) As per computer					
(b) As per weigh bridge					
(c) Difference					
FEEDER BIN 5					
(a) As per computer					
(b) As per weigh bridge					
(c) Difference					

Remarks: ____

____

Submitted by:	Checked by:	Approved by:
____________________	____________________	____________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

ALKALI AGGREGATE REACTIVITY TEST DATA
(IS: 2386 Part 7: Mortar Bar Method)

Type of Aggregate: ___________________Type of Portland cement: __________________
Source of Aggregate: _________________Source of Portland cement: ________________

Alkali Content of Cement: %$K_3$0: ________ %Na_3O: _____ %Na_3O: ___________

Specimen No.						Remarks
Initial Measurement:	Date					
Temp., ^{0}C: _________	Time					
Rel. Humidity %	Length, mm					
Measurement at 1 month:	Date					
Temp., ^{0}C: _________	Time					
Rel. Humidity %:	Length, mm					
	Ave. Expansion, mm					
Measurement at 2 month:	Date					
Temp., ^{0}C: _________	Time					
Rel. Humidity %:	Length, mm					
	Ave. Expansion, mm					
Measurement at 3 month:	Date					
Temp., ^{0}C: _________	Time					
Rel. Humidity %:	Length, mm					
	Ave. Expansion, mm					
Measurement at 6 month:	Date					
Temp., ^{0}C: _________	Time					
Rel. Humidity %:	Length, mm					
	Ave. Expansion, mm					
Measurement at 9 month:	Date					
Temp., ^{0}C: _________	Time					
Rel. Humidity %:	Length, mm					
	Ave. Expansion, mm					
Measurement at 12 month:	Date					
	Time					
Temp., ^{0}C: _________	Length, mm					
Rel. Humidity %:	Ave. Expansion, mm					

Examination at end of Test:

Description of Warping: --

Pattern & Location of Cracking: ---

Superficial Deposits/Exudations: --

Submitted by:	Checked by:	Approved by:
____________________	____________________	____________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

WORKABILITY/CONSISTENCY OF FRESH CONCRETE
(SLUMP TEST)
(IS: 1199)

Structure Details	Grade of Concrete	w/c	Slump (mm)	Average (mm)	Remarks

Submitted by:	Checked by:	Approved by:
____________________	____________________	____________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

ESTIMATION OF ORGANIC IMPURITIES (FINE AGGREGATES)
(IS: 2386 Part - 2)

Source/Location: ____________________ Material Description: ________________

____________________ ________________

Date of Sampling: ____________________ Date of Testing: ______________________

Result of Comparison with Standard Solution: Darker/Lighter (circle one)

Remarks:____

Submitted by: Checked by: Approved by:

________________________ ___________________ __________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

FINENESS OF PORTLAND CEMENT BY 0.075 mm SIEVE (IS 4031)

Cement Brand: ________________________ Date of Sampling: __________________

Source: ________________________________ Date of Testing: ____________________

Size of Sample: _________________________ Size of Lot: _________________________

Determination No.	Weight of Sample (g)	Weight of Residue (g)	Fineness (%)

Remarks:____

Submitted by: Checked by: Approved by:

________________________	___________________	__________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

DETERMINATION OF INITIAL AND FINAL SETTING TIME OF HYDRAULIC CEMENT BY VICAT NEEDLE
(IS: 4031)

Cement Brand: ________________________ Date of Sampling: __________________

Source: ________________________________ Date of Testing: ____________________

Size of Sample: _________________________ Size of Lot: _________________________

Determination No.		
Normal Consistency		
Time when water is added to cement		
Time at initial setting		
Total time taken for initial setting		
Time at final setting		
Total time taken for final setting		

Remarks:____

Submitted by: Checked by: Approved by:

________________________ ___________________ __________________

Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

DETERMINATION OF CLAY LUMPS
(IS: 2386 Part - 2)

Source/Location: ____________________ Material Description: ________________

Date of Sampling: ___________________ Date of Testing: _____________________

Determination No.			
Weight of Oven dried sample (W), g			
Weight of sample after removal of clay Lumps (R), g			
Percentage of clay Lumps (L) L = (W – R) (100) / (W)			

Remarks:____

Submitted by: Checked by: Approved by:

_______________________ ___________________ _________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

DETERMINATION OF SOFT PARTICLES
(IS: 2386 Part - 2)

Source/Location: ____________________ Material Description: ________________

Date of Sampling: ___________________ Date of Testing: _____________________

	Sieve Size, mm				
	Over 10 to 12.5	Over 12.5 to 20	Over 20 to 25	Over 25 to 40	Over 40 to 50
Weight of Particles tested, g					
No. of Particles tested					
Weight of Particles classified as Soft, g					
No. of Particles classified as Soft					
% of Test sample classified as Soft by weight					
% of Test sample classified as Soft by Number of Particles					
Ave. % of Test Sample classified as Soft by weight					
Ave. % of Test Sample classified as Soft by Number of Particles					
Ave. % of Test Sample classified as Soft based on Grading*					

* Refer to original grading of aggregates received for examination

Remarks:____

Submitted by: Checked by: Approved by:

________________________ ___________________ __________________

Contractor's Representative | Materials Engineer Consultant | Resident Engineer Consultant

DETERMINATION OF LIGHT-WEIGHT PIECES (COAL AND LIGNITE) (IS: 2386 Part - 2)

Source/Location: ____________________ Material Description: ________________

Date of Sampling: ___________________ Date of Testing: _____________________

Determination No.			
Dry weight of decanted pieces (W_1), g			
Dry weight of portion of sample coarser than 300 micron Sieve (W_2), g			
Dry weight of portion of sample coarser than 4.75 mm Sieve (W_3), g			
Percentage of Light-Weight Pieces (L): $L = (100) (W_1) / W_2)$ – for Fine Aggregates $L = (100) (W_1) / W_3)$ – for Coarse Aggregates			

Remarks:____

Submitted by: Checked by: Approved by:

________________________ ___________________ __________________

Contractor's Representative

Materials Engineer
Consultant

Resident Engineer
Consultant

DETERMINATION OF CLAY, FINE SILT AND FINE DUST (SEDIMENTATION METHOD) (IS: 2386 Part - 2)

Source/Location: ____________________ Material Description: ________________

Date of Sampling: ___________________ Date of Testing: _____________________

Determination No.			
Weight of Original Sample (W_1), g			
Weight of Dried Residue (W_2), g			
Volume of Pipette (V), ml			
Percentage of Clay and Fine Silt or Fine Dust $= (100/W_1) \{[(1000)(W_2) / (V)] - 0.8\}$			

Remarks:____

Submitted by: Checked by: Approved by:

________________________ Contractor's Representative

___________________ Materials Engineer Consultant

__________________ Resident Engineer Consultant

GENERAL

1. Sample Log
2. Quality Control Test Statement
3. Material Source Data
4. Surface Regularity Longitudinal

SAMPLE LOG

Field Sample No.	Description	Date Sampled	Kind of Test	Date Tested	Quantity Represented	Original Source of Material	Remarks

Remarks:____

Submitted by:	Checked by:	Approved by:
____________________	____________________	____________________
Contractor’s Representative	Materials Engineer Consultant	Resident Engineer Consultant

Quality Control Test Statement

Item No.	Description	Kind of Test	Number of Tests Conducted			Remarks
			Completed	Passed	Failed	

Remarks: ____

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

MATERIALS SOURCES DATA

NOTE: TO BE SUBMITTED WITH ATTACHED MARKED-UP MAP AND ANY AVAILABLE TEST RESULTS 1. Map: Sketch to indicate source site, shape, location and access/direction/distances to site, etc. 2. Test Results: To include all test sheets/results for each test required to obtain approval of source.	FORM: ______ Date: _______ Package ______ Section ______ Chainage: From:_________ To: _________

SOURCE NAME/LOCATION	MATERIAL TYPE (Sand, Rock, Cement etc.)	TO BE USED FOR (BOQ Item Nos.)	AVAILABLE QUANTITY (m^3)	HAUL LEAD TO SITE (km)	COMMENT/ENVIRONMENTAL ISSUE

Submitted by:

____
Contractor's Representative

Checked by:

____
Materials Engineer
Consultant

Approved by:

____
Resident Engineer
Consultant

SURFACE REGULARITY LONGITUDINAL

CHAINAGE	R1	R2	R3	L3	L2	L1

Remarks:____

Submitted by:	Checked by:	Approved by:
________________________	____________________	__________________
Contractor's Representative	Materials Engineer Consultant	Resident Engineer Consultant

APPENDIX IV

FORM FOR TESTING

PART B: BRIDGES

Appendix IV

FORMS FOR TESTING

PART B: BRIDGES

1. CHECK LISTS FOR SOURCE/AGENCY APPROVAL
2. FORMS FOR TESTING MATERIALS

CHECKLISTS

Checklist for Source/Agency Approval

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 got tested from reputed laboratory as per IS: 383 as per chapter 3 of the Manual? (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	:

Fine Aggregates

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 (i) Crushed rock (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? (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	:

Water

S. No.	Particular	Remarks
1	What is the source of supply? (i) Bore well (ii) Supply of local body (iii) Tankers (iv)	
2	Have the water got tested from reputed laboratory as per chapter 3 of the Manual? (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	:

Cement

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? (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	:

Reinforcement/Strands

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? (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	:

Epoxy

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? (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?	
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 authorized representative be present during the application of epoxy?	

Signed	:
Date	:
For Contractor Name	:

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? (a copy of the test certificate may be attached)	
8	Can the agency supply the required quantities in the stipulated time as pr the site requirement?	

Signed	:	
Date	:	
For Contractor Name	:	

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? (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	:

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? (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? (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	:

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	Repot obtained from the clients referred at S. No. 2:	
4	Whether the material satisfies the test requirement as per chapter 3 of the Manual? (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 mechanized 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 MOSRTH requirement?	
9	Does the agency has specialized staff for laying the paint?	

Signed	:
Date	:
For Contractor Name	:

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 (foundary)?	
3	Whether the supplier/manufacturer among the approved list of the MOSRTH for the particular type of bearing as per the latest circular? (a copy of the MOSRTH approval may be attached)	
4	Information regarding the other ongoing works where the bearing of this type has been supplied by this supplier:	
5	Report obtained from the clients referred at S.No. 2:	
6	Has the manufacturer submitted has QAP?	
7	Whether the material satisfies the test requirement as per QAP of the manufacturer and/or as per chapter 3 of the Manual? (a copy of the test certificate may be attached)	
8	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?	
9	Has the agency agreed to furnish a performance bond for 10 years?	
10	Will the manufacturer's authorized representative be available while the joint is being installed?	

Signed	:
Date	:
For Contractor Name	:

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 among the approved list of the MOSRTH for the particular type of joint as per the latest circular? (a copy of the MOSRTH approval may be attached)	
4	Information regarding the other ongoing works where the expansion joint of this type has been supplied by this supplier:	
5	Report obtained from the clients referred at S.No. 2:	
6	Has the manufacturer submitted his QAP?	
7	Whether the material satisfies the test requirement as per QAP of the manufacturer and/or as per chapter 3 of the Manual? (a copy of the test certificate may be attached)	
8	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?	
9	Has the agency agreed to furnish a performance bond for 10 years?	
10	Will manufacturer's authorized representative be available while the joint is being installed?	

Signed	:
Date	:
For Contractor Name	:

Checklist for Site Activities

Bored Cast-in-Situ Concrete Piles

1. Unique identification no. of Piles
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 as 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		

S.No.	Description	Yes/No/NA	Remarks
	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?		
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? If yes, reference of approval………………		
8.2	Has the cut off level been checked? 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 permissible limit? Specify the shift…………………		

FOR CONTRACTOR

Name:
Designation

Signature
Date:

FOR DEPARTMENT

Name:
Designation

Signature
Date:

RCC Work

Staging

1. Nomenclature of Item
2. Dimensions drawing No.

S.No.	Description	Yes/No/NA	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.	Are the Connection of horizontal and Diagonal bracing as per drawing?		
6.	Are 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

Name:
Designation

Signature
Date:

FOR DEPARTMENT

Name:
Designation

Signature
Date:

Form Work

1. Nomenclature of Item
2. Dimensions drawing No.

S.No.	Description	Yes/No/NA	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 $\pm$ **5mm** & level correct to $\pm$ **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 0iling 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:

Reinforcement

1. Nomenclature of item
2. Structural Drawing No.
3. Shop Drawing No.

S.No.	Description	Yes/No/NA	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 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 drawings?		
10.	Are all joints tied properly with binders using double knot?		
11	Is bar assembly rigid and adequately supported (including spacers/chairs 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:

Concrete Pour

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

S. No.	Description	Yes/No/ NA	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 arrangements provided?		
5.9	Are safety measures as per safety Assurance Record Taken?		
6	**During Concreting**		
6.1	Is the slump of concrete meets the requirement?		
6.2	Number of cube specimens taken		
6.3	Is the previously placed layer of concrete green		

S. No.	Description	Yes/No/ NA	Remarks
	to receive the succeeding layer for amalgamation?		
6.4	Is proper vibration done to ensure compaction?		

FOR CONTRACTOR **FOR DEPARTMENT**

Name:
Designation

Signature
Date:

Name:
Designation

Signature
Date:

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/NA	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 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: Designation	Name: Designation
Signature Date:	Signature Date:

Bearings Installation

S. No.	Description	Yes/No/NA	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: Designation	Name: Designation
Signature Date:	Signature Date:

Expansion Joint Installation

S.No.	Description	Yes/No/NA	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:	Name:
Designation	Designation
Signature	Signature
Date:	Date:

Asphaltic Concrete

1. Location of work
2. Chainage

S. No.	Description	Yes/No/NA	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 laid is prepared to start the work?		
7	Temperature of Binder during mixing (150 °C to 177 °C)		
8.	Temperature of Aggregate during mixing (155 °C to 163 °C)		
9	Temperature difference between the Aggregates and the binder not more than 14 °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 30 MT pneumatic smooth wheeled roller?		

S. No.	Description	Yes/No/NA	Remarks
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:

Thermoplastic Paint

S. No.	Description	Yes/No/NA	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 °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 2.5 mm?		
11	Whether additional glass beads of grading type 2 as per clause 803, 4.3.3 MOSRTH specification for Road & Bridge works have been sprayed in case of manual application for arrows & letters etc @ 250g/m^2 of area.		

S. No.	Description	Yes/No/NA	Remarks
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?		

FOR CONTRACTOR

Name:
Designation

Signature
Date:

FOR DEPARTMENT

Name:
Designation

Signature
Date:

Checklist for Launching Girder

Fabrication of Launching Girder

S.No.	Description	Yes/No/NA	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 programme 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 planning and cutting available		
8.2	Is the machining arrangement of 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		

S.No.	Description	Yes/No/NA	Remarks
9.2	Is the arrangement for clamping the plates available		

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

Testing of Launching Girder

S. No.	Description	Yes/No/NA	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		

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

Shifting of Launching to Site

S. No.	Description	Yes/No/NA	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 barricaded		

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

Shifting of Launching to Next Location

S. No.	Description	Yes/No/NA	Remarks
1.	Is the crane movement area properly barricaded and signaled		
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		

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

Checklist for Launching Operations

Erection of Launching Girder

S. No.	Description	Yes/No/NA	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		

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

Placement of Segment

S. No.	Description	Yes/No/NA	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 pre-stressing 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?		

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

Placement of Pier Segment

S. No.	Description	Yes/No/NA	Remarks
1	Whether the levels of all the corners of top and bottom 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 crib support fixed on the ground?		
5	Whether the jacks of required capacity placed on the crib 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?		

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

Lifting of Segments

S. No.	Description	Yes/No/NA	Remarks
1.	Whether the working area demarcated?		
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 license 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?		

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

Dry Matching of Segments

S. No.	Description	Yes/No/NA	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	Are the different jacks, gauges, pumps etc. required for use in work listed and calibrated instruments/ equipment available?		
8	Is the centerline marked on the segment?		
9	Whether minor repairing to edges or elsewhere (if required) has been done to the segment?		

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

Epoxy Application and Joining Segments

S. No.	Description	Yes/No/NA	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: Designation	Name: Designation
Signature Date:	Signature

Prestressing

S. No.	Description	Yes/No/NA	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….)		

S. No.	Description	Yes/No/NA	Remarks
15	Whether wedge seating checked after 24 hrs. (indicate value....)		

FOR CONTRACTOR

Name:
Designation

Signature
Date:

FOR DEPARTMENT

Name:
Designation

Signature

Detaching From the Launching Girder

S .No.	Description	Yes/No/NA	Remarks
1	Is the pre-stressing complete in respects with satisfactory results of elongation and pressure?		
2	Is the post pre-stressing 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 pre-stressing 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 authorized?		

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

PROFORMAS

Identification No. | | | | | | | |

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

Sample No.:
Quantity of Water:
Source:
To be used in structure:

Date of Sampling:
Method of Testing:
Date of Testing:
Sampling and testing by:
Quantity of Sample:

A. pH Value (using pH Strips)

Sl. 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 :

Date :

For Contractor :
Name :

Signed :

Date :

For department :
Name :

Identification No. | | | | | | | |

Test Proforma for determining the Water Content of Soil

Sample No. :	Date of Sampling:
Quantity of Soil :	Method of Testing: IS: 2720 (Part II) - 1973
Source :	Date of Testing:
To be used in structure:	Sampling and testing by:
	Quantity of Sample:

Method test adopted = Oven Drying / Sand Bath / Alcohol

W1 = Mass of Container with Lid = ... gms.
W2 = Mass of Container with Lid with wet soil = ... gms.
W3 = Mass of Container with Lid with dry soil = ... gms.

$$\text{Water Content } (\omega) = \frac{(W2 - W3) \times 100}{(W3 - W1)}$$

= ----------------%

Results: Accepted / Not Accepted

Remarks (if any):

Signed :	Signed :
Date :	Date :
For Contractor :	For department :
Name :	Name :

Identification No. | | | | | | | |

Test Proforma for determining the Specific Gravity and Water Absorption of aggregates larger than 10 mm

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:

A1 = Weight of basket and sample weighed in water = ... gms.
A2 = 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 = A1 – A2 = ...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	For Department
Name:	Name:

Identification No. | | | | | | | |

Test Proforma for determining the Specific Gravity and Water Absorption of aggregates smaller than 10 mm

Sample No.: Date of Sampling:
Quantity of Aggregate: Method of Testing: IS: 2386 (Part III)-1963 (for aggregates smaller than 10 mm)

Source: Date of Testing:
To be used in structure: Sampling and testing by:
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 For Department
Name: Name:

Identification No. | | | | | | | |

Test Proforma for Sieve Analysis of 10 mm size aggregates

Sample No.:
Quantity of Aggregate:
1963
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part I)-

Date of Testing:
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	% 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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for Sieve Analysis of 20 mm size aggregates

Sample No.:
Quantity of Aggregate:
1963
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part I)-

Date of Testing:
Sampling and testing by:

Quantity of Sample:	Sample 1	Sample 2

IS Sieve Designation	Mass Retained (in gms.)			Cumulative Mass Retained (in gms.)	% of Cumu-lative Mass Retained	% Pass-ing	Accept-able 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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for Sieve Analysis of 40 mm size aggregates

Sample No.:
Quantity of Aggregate:
1963
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part I)-

Date of Testing:
Sampling and testing by:

Quantity of Sample:	Sample 1	Sample 2

IS Sieve Designation	Mass Retained (in gms.)			Cumul-ative Mass Retained (in gms.)	% of Cumul-ative Mass Retained	% Passing	Accept-able 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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

<u>Test Proforma for Sieve Analysis of Fine Aggregates (Coarse Sand)</u>

Sample No.:
Quantity of Aggregate:
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part I)-1963
Date of Testing:
Sampling and testing by:

Quantity of Sample:	Sample 1	Sample 2

IS Sieve Designation	Mass Retained (in gms.)			Cumu-lative Mass Retai-ned (in gms.)	Percent-age of Cumul-ative Mass Retained	Per-cent-age 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	60-70
300 µ							8-30	12-40
150 µ							0-10	0-10

Results: Accepted / Not Accepted

Remarks (if any):

Signed:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for Flakiness Index

Sample No.:
Quantity of Aggregate:
1963
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part I)-

Date of Testing:
Sampling and testing by:

Weight of each sample (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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for Elongation Index

Sample No.:
Quantity of Aggregate:
1963
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part I)-

Date of Testing:
Sampling and testing by:

Weight of each sample (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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for determining the Standard Consistency of Cement

Sample No.:
Quantity of Cement:
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 4031 (Part – 4)
Date of Testing:
Sampling and testing by:

Weight of each sample (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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

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

Sample No.:
Quantity of Cement:
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 4031 (Part)
Date of Testing:
Sampling and testing by:

Weight of each sample (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 (T0) for Sample 1 = ... 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 (T1)
Sample 1 = ... minutes Sample 2 = ... minutes

Initial Setting time (T_I) = T1 – T0 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 1 = ... Minutes
for sample 2 = ... Minutes

S. No.	Reading of Stop Watch	Does the Annular attachment make an impression on the surface of test block (Yes/No)		Does the Needle makes impression on the surface 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 m 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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

<u>Test Proforma for determining the Soundness of Cement</u>

Sample No.:
Quantity of Cement:
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 4031 (Part 3)
Date of Testing:
Sampling and testing by:

Weight of each sample (in Gms)........ A	Sample 1	Sample 2

Standard Consistency (P) = ... Percent
78% of P = 0.78 x) = ... 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 (D1)
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 (D2)
For Sample 1 = ... mm For Sample 2 = ... mm

Expansion of Cement = D2 – D1
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:

Date:
For Contractor
Name:

Signed:

Date:
For Department
Name:

Identification No. | | | | | | | |

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

Sl. No.	Maximum Load Applied (P) (in N)	Compressive Strength C=(P/A) (in N/m^2)	Variation in compressive Strength $Vc = \frac{(C-Cm)}{Cm} \times 100$	Is |Vc|< 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 For Department
Name: Name:

Identification No. | | | | | | | |

Test Proforma for Bentonite Slurry

Sample No.:
Pile No.:
Source:

Date of Sampling:
Method of Testing:
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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

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:

I. Pot Life of Epoxy Bonding Agent

1. Ambient Temperature during testing = ...^{0}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):

II. Open Time of Epoxy Bonding Agent

1. Ambient Temperature during Testing = ...^{0}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):

III. Thixotropy of Epoxy Bonding Agent

1. Ambient Temperature during Testing = …………^{0}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 = minimum 30 Minutes
Results: Accepted/Not Accepted
Remarks (if any):

IV. Angle of Internal Friction (Squeezability)

1. Ambient Temperature during Testing = …………^{0}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

Remarks: Accepted/Non Accepted
Remarks (if any):

V. Curing rate of Epoxy Bonding Agent

1. Ambient Temperature during Testing = …………^{0}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)	Compr-essive 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):

VI. Compressive Strength of Epoxy Bonding Agent

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

Age of Specimen (hrs.)	Failure Load (in kN)			Mean Load at Failure (kN)	Compr-essive Strength (n mm^2)	Acceptable Values (n mm^2)
	Speci-men 1	Speci-men 2	Speci-men 3			
24						Minimum 60
168						Minimum 75

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

VII. 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):

VIII. 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):

IX. Shear strength of Epoxy Bonding Agent

1. Ambient Temperature during Testing = …………^{0}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):

X. Heat resistance of Epoxy Bonding Agent

1. Ambient Temperature during Testing = …………^{0}C

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

Recommendations: Minimum Shear Stress = 10 N/mm^2 at 50 ^{0}C

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

XI. 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 Name:	For Department Name:

Identification No. | | | | | | | |

Test Proforma for testing the MIS 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 losss of water = 1.5%

Results: Accepted/Not Accepted

Remarks (if any):

Signed:	Signed:
Date:	Date:
For Contractor Name:	For Department Name:

Identification No. | | | | | | | |

Test Proforma for testing the HDPE Sheathing ducts

Sample No.:
Length of Sheathing:
Source:
To be used in structure:

Date of Sampling:
Method of Testing: IRC 18: 2000 Appendix-1B
Date of Testing:
Sampling and Testing by:

1. Bond Test

Data	**Sample 1**	**Sample 2**	**Sample 3**
Dia. of Duct (mm) Length of Duct (in mm, 40 times the dia. of duct) Strength of Grout (in N/mm^2, Minimum 27 N/mm^2) Anchorage Efficiency Failure Capacity of tendon (in MPa) 95% of failure capacity (in MPa) Load at failure (in MPa)			
Mean Load at Failure (in MPa)			

Recommendations: Failure capacity of bond shall be at least 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**
Measurement 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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for determining the crushing and Impact Value of aggregate

Sample No.:
Quantity of Aggregate:

Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part IV) – 1963 (for aggregates larger than 10 mm)
Date of Testing:
Sampling and Testing by:
Quantity of sample:

1. Aggregate Crushing value

A = Weight of surface dry sample = ... gms.
B = Weight of fraction passing the 2.36 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 the 2.36 mm Sieve = ... gms.

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

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

Signed:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for determining the silt content of fine aggregates

Sample No.:
Quantity of Aggregate:

Source:
To be used in structure:

Date of Sampling:
Method of Testing: IS: 2386 (Part IV) – 1963 (for aggregates larger than 10 mm)
Date of Testing:
Sampling and Testing by:
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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

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:

I. 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	Compr-essive Strength	Load at Failure	Compr-essive 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):

II. 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. | | | | | | | |

Test Proforma for Anchorage Efficiency Test on Prestressing System

Sample No.:
Source:
To be used in structure:

Date of Sampling:
Method of Testing: FIP Recommendations
Date of Testing:
Testing by:
No. of Beams:

UTS of the Strand

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:
Make and Type
Last calibrated on ………………
Ram area ……………………….
Strand free Length …………….
Strand Make: …………………..

Tendon Type:
Actual mean UTS of strand:
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 = $\dfrac{\text{Load at Failure x 100}}{\text{UTS of tendon assembly}}$

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

Signed:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

<u>Test Proforma for Load Transfer Test on Prestressing System</u>

Sample No.:
Source:
To be used in structure:

Date of Casting of blocks:
Method of Testing: FIP Recommendations
Date of Testing:
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								

Cycle No.		Face 1		Face 2		Face 3		Face 4	
		Crack no.	Width	Crack no.	Width	Crack no.	Width	Crack no.	Width
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				

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 For Department

Name: Name:

Identification No. | | | | | | | |

Test Proforma for Vertical Load Test on Piles

Test Pile No. ………….
Date of Testing:

Jack Details:
Make and Type
Last calibrated on ……………
Ram Dia. = ……………… 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:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Test Proforma for Lateral Load Test on Piles

Test Pile No. ………….
Date of Testing:

Jack Details:
Make and Type
Last calibrated on ……………
Ram Dia. = ……………… 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 Final reading
Pressure Released					

Recommended Value: Maximum Deflection at Peak Load = 5 mm

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

Signed:

Date:

For Contractor
Name:

Signed:

Date:

For Department
Name:

Identification No. | | | | | | | |

Proforma for Grouting Record in Sheathings

Name of work: ....

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

Date of Pre-stressing .... Date of Grouting ....

Type of Cement .... Date of Manufacture ....

Water Cement Ration (Max. 0.45) ....

Name & 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/N) ....

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: ....

Proforma for Grouting Record in Sheathings

Name of work: ………………………………………………………………………… ……

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

Date of Pre-stressing …………………. Date of Grouting ………………………

Type of Cement ………………… Date of Manufacture ……………………

Water Cement Ration (Max. 0.45) ……

Name & 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/N) …………

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 (if any):

Signed:	Signed:	Signed:
Date:	Date:	Date:
For System Supplier: Name:	For Contractor: Name:	For Department: Name:

WELL FOUNDATIONS
HISTORY OF SINKING

Client:
Consultant:
Contractor:
Project:

TILT & SHIFT IN WELL NO. **DISTANCE OF STEINING FROM REF POINTS**

Date	Total height of steining of casted	Total sinking with Ref to BM	Reduced Levels (R.Ls) of Guage Marks						Tilt along X Axis Col 6 divided by well dia	Tilt along Y Axis Col 6 divided by well dia	Resul-tant = Tilt/ Sqrt of $(Col10)^2 + (Col11)^2$	SHIFT						
			Along X-Axis			Along Y-Axis						Along X-Axis with direction metre		Along Y-Axis with direction metre	Resultant = Sqrt of $(Col13)^2 + (Col14)^2$	Act-ion taken for rect-ifica-tion	Remarks	Sign of Supervising Officer
			XA	XB	Col 5- Col 4	YA	YB	Col 8- Col 7										
1	2	3	4	5	6	7	8	9	10	11	12	13 A	13 B	14	15	16	17	18

WELL FOUNDATIONS
HISTORY OF SINKING

Client:
Consultant:
Contractor:
Project:
Form

HISTORY OF SINKING OF WELL NO.

Lowest bed level .... Lowest water level .... Highest flood level............
Height of Curb .... Height of cutting edge .... Founding level.................

Date ....

Date and Time	STEINING					SINKING					Depth of sump below cutting edge	Strats met with	Quantity of Dredged Material	Report any special method of sinking employed	Action taken for rectific	Remarks	Sign of Supervising Officer
	Reduced level of bottom of cutting edge	RL of top of steining before casting	RL of top of steining the casting	Height of steining cast	Total height of steining (inc) curbe and cutting edge (Col 4 - Col 3)	RL ref level at which cutting edge was placed	Initial Guage Reading Metre	Final Guage Reading Metre	Sinking During the day (Col 9- Col 8)	RL of bottom of cutting edge (Col2- col 10)							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Proforma for prestressing record of the cables

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

Name of flyover:	Span No.: ……………	Stressing sequence drawing no.	Left end of cable = A
Average cube strength at the time of stressing:	Element/Girder no.: ………………………	Marks of Plant used: Jacks:	Right end of cable = A
High Tensile Steel (UTS)= ……..kg/cm²	Last date of concreting: ………………………	Pumps:	Specified gauge pressure during Jacking:
Cube Strength at 28 days= ……..kg/cm²	Date of prestressing: ………………………	Gauges:	Maximum jack pressure during stressing:

Cable stressing sequence		Calculated Elongatin (mm)		Gauge mark readings extension (mm) at the pressure of 100 kg/cm²			Gauge mark readings extension (mm) at the pressure of 200 kg/cm²			Reading at instant of locking pressure					Initial Elongation upto 100 Kg/cm² e6 = e4 – e3 (in mm)	Total Elongation e7 = e5 – e3 + e6 (mm)	Deviation = e1 – e7 (in mm)	Slip (Draw-in) mm					Net Elongation e8 = e7 – S (in mm)	Deviation after draw-in = e2 – e8 (mm)	% Excess/shortfall in deviation after draw in = (e2-e8)x100 c2	Remarks
																		Immediately after Locking		After 24 hours		Total draw-in				
Sequence	Cable marked	Before draw-in (el)	After draw-in (e2)	ΔA_0 (in mm)	ΔB_0 (in mm)	$e3 = \Delta A_0 + \Delta A_0$	ΔA_1 (in mm)	ΔB_1 (in mm)	$e3 = \Delta A_1 + \Delta B_1$	ΔA_2 (in mm)	P_A kg/cm²	ΔB_2 (in mm)	P_B kg/cm²	$E5 = \Delta A_2 + \Delta B_2$				SA_0	SB_0	SA_{24}	SB_{24}	$S = SA_0 + SB_0 + SA_{24} + SB_{24}$				

Signed:	Signed:	Signed:
Date:	Date:	Date:
For System Supplier:	For Contractor:	For Department:
Name:	Name:	Name:

APPENDIX V

FORMS FOR REPORTS AND RECORDS

Appendix V

FORMS FOR REPORTS AND RECORDS

FORM V-1

DRAWING ISSUE FORM

Sheet No. of

		DATE OF ISSUE											
		Day											
		Month											
		Year											
DRAWING TITLE	DRAWING NO.	DRAWING REVISION NO.											
NO. OF DRAWINGS ISSUED TO:													
Legend		Client											
		Contractor											
		Site Office											
		Other											
PURPOSE OF ISSUE		Information											
		Approval											
		Comment											
		Construction											
		Other											

Attached drawings have been checked and agree with above list

Issued by: ________________________Receipt Acknowledged: _________________________

FORM V-2

INSPECTION REQUEST FORM (Initial/Resubmittal)

Package ______________________ Section ____________________________ Contractor ______________________

Activity Location	Chainage	BOQ Item	Activity Description	Schedule		Inspection Result/Remarks
				Date	Time	

Requested by: _________ Contractor _________ Date/Time Requested by: _________ Contractor _________ Date/Time Requested by: _________ Contractor _________ Date/Time

Comments:

____
____
____
____
____

Notes:

1. Contractor to submit Request minimum of 48 hours in advance of work requirements.
2. Consultants to return approved or disapproved original and one copy to the contractor before work proceeds.

Request to begin activity is: APPROVED/DISAPPROVED

____
Resident Engineer
Date/Time:

Request turned

____
Contractor
Date/Time:

FORM V-3

DAILY REPORT

DATE: ________________ **Weather A.M.** _____________
PAGE: ________________ **P.M.** _____________
BILL NO. ____

ACTIVITIES (Item No., description, locations, quantity or work, etc.)
MANPOWER (Engineers, foremen, skilled laborers, operators, others)
EQUIPMENT (Type, No. working/idle)
PROBLEMS/ISSUES ENCOUNTERED (Disturbances, accidents, etc.)
REMARKS (Inspecting officers, site instructions, emergency work orders, etc.)

Prepared by: Noted:
Designation: Resident
Engineer

(Contractor's Representative)

FORM V-4

MECHANICAL PLANT /MACHINERY INSPECTION REPORT

Contractor ____________________ Package No. ____________________________

Inspection Date ________________ Time ___________________________________

Plant Machine Type _________________ Model No. __________________________

Manufacturer ______________________ Manufacturer date __________________

General Conditions

Description	**Condition O.K./Poor/Not O.K.**	**Remarks/Defects**
Overall Appearance		
Tyres/Drums/Tracks		
Stearing Brakes		
Operator/Understanding/Training		
Environmental Condition		

Specification Requirements

Spec. Clause No.	**Description Specification requirement**	**Rating O.K./Poor/Not O.K.**	**Remarks/Defects**

Final Recommendations:

____
____
____

Noted by: Recommended by: Approved by:

Signature: _________________ _________________ ______________

Designation: Contractor's Rep.	Consultant's Rep.	Resident Engineer
Date _____________	Date _____________	Date ____________

Copy to:

1. Resident Engineer
2. Highway Engineer
3. Contractor

FORM V-5

SITE INSTRUCTION NO.

CONTRACTOR: ____

CONTRACT NO.: ____

To:

_____________________ Date: ____________________

Contractor's Field Rep.

Site Instruction:

____

Resident Engineer Date

Received & Noted By

____

Contractor's Representative

C.C: TEAM LEADER, CONSULTANT

FORM V-6

O.K. CARD

CONTRACTOR: →

LAYER : ____

CHAINAGE : ____

DATE : ____

____
Contractor Representative

CONSULTANT: →

CH: Km ________________ to Km _________________

		REMARKS
a)	Level:	__________
b)	Density:	__________
c)	MC:	__________
d)	Tolerance:	__________

F/E Supervisor

Remark's:

RE/ME

_____________________ ___________________
(Contractor Representative) Approved/Not Approved