## Section 8

# Materials and Specifications for Structures

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# MATERIALS AND SPECIFICATIONS FOR STRUCTURES

## 8.1 General

(i) All materials to be used in the structures shall be in conformity with the IRC/ MOSRTH Specifications, unless specified otherwise in this Section. If the Concessionaire proposes to use any material, which is not covered in IRC/ MOSRTH Specifications, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified in this Manual. Proprietary products proven by international usage in comparable bridge projects, proposed to be used shall be supported with authenticated licensing arrangement with the manufacturer.

(ii) The Concessionaire shall identify the proposed sources of materials and submit the proposal to IE for review and comments, if any, prior to delivery. If it is found that proposed sources of supply do not produce uniform and satisfactory products at any time during execution, the Concessionaire shall procure acceptable materials conforming to the specifications from other sources.

(iii) The samples required for review shall be supplied well in advance, at least 48 hours or minimum time required for carrying out the relevant tests, whichever is more. Delay in submission of samples shall not be acceptable as a reason for delay in completion of the works/extension of time for completion.

(iv) In case of manufactured items, the Concessionaire shall submit to the Independent Engineer for review and comments, if any, the details pertaining to the product/ process/system covering inter-alia:

(a) General features of the product/process/ system along with specifications and standards adopted for the product/ process/system;

(b) Authenticated copies of license/ agreement;

(c) Name of manufacturer and name of product/process/system;

(d) Details of projects where the product/ process/system has been successfully used;

(e) Limitations, if any;

(f) Acceptance test and criteria;

(g) Installation & maintenance procedure and schedule; and

(h) Performance warranty

(v) The Concessionaire shall set up a full-fledged laboratory at site, as per the agreement for testing of all materials and finished products. He shall make arrangements for additional/confirmatory testing of any material including imported materials/products for which facilities at site laboratory are not available.

## 8.2 Structural Concrete

**8.2.1** The Concrete for use in structures shall conform to the provisions in Clauses 302.6 to 302.9 of IRC:21 and Section 1700 of MOSRTH Specifications. Wherever High Performance Concrete (HPC) is proposed to be used, the same shall conform to the provisions of IRC:SP:70. Sampling and Testing of Concrete shall be as per Clause 302.10 of IRC:21. Acceptance criteria for concrete shall conform to Clause 302.11 of IRC:21. Concrete to be produced shall conform to the requirements as specified below.

**8.2.2** A dense and well compacted concrete provides effective protection against corrosion of steel in reinforced/prestressed concrete members. To achieve this, the Concessionaire shall pay special attention to the following elements, which have a bearing on the production of a durable concrete:-

(i) Quality of materials - cement, aggregate, water and admixtures, both mineral and chemical,

(ii) Mix design,

(iii) Mixing and placing of concrete - Concrete shall preferably be produced in a mixing and batching plant,

(iv) Vibration and compaction,

(v) Curing,

(vi) Cover to reinforcement/tendons, and

(vii) Detailing.

**8.2.3** The following points are also important in production of durable concrete, which shall be duly considered and adopted:-

(i) Minimum chloride content in concrete as specified in IRC:21,

(ii) Regular testing of water used for making concrete as per IRC:21,

(iii) Compatibility testing of admixtures with type of cement,

(iv) Permeability test for concrete,

(v) Testing of aggregates for alkali-silica reaction.

**8.2.4** The mix designs for concrete shall be got reviewed by the Independent Engineer prior to construction.

## 8.3 Cement

Any type of cement specified in IRC:21 may be used for the works subject to limitations, if any, specified therein.

## 8.4 Coarse Aggregates

(i) Before the commencement of the works, at least three samples in accordance with the procedure laid down in IS: 2430 shall be taken for each quarry source to ascertain the quality, suitability and fitness of the available material for use in the works. Fresh tests shall be conducted, in case there is any change in the source or the type of rock being quarried. The proposal, along with a copy of test reports, shall be submitted to the Independent Engineer for review and comments, if any.

(ii) Aggregate having more than 0.5% of sulphate as $SO_3$ with water absorption more than 2% of its own weight shall not be used.

(iii) In case of doubt, the alkali-aggregate reactivity shall be tested in accordance with IS: 2386 (Part 6). Coarse aggregates having positive alkali-silica reaction (ASR) shall not be used.

(iv) The maximum value of flakiness index for coarse aggregates shall not exceed 35 percent.

### 8.5 Sand/Fine Aggregates

(i) All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386 (Part I to VIII). The fineness modulus of fine aggregates shall be between 2.0 and 3.5.

(ii) Before the commencement of the works, at least three samples as per IS: 2430 shall be taken for each quarry source, to ascertain the quality, suitability and fitness of the available material for use in the works and the proposal along with a copy of test reports shall be submitted to the Independent Engineer for review and comments, if any.

(iii) Fine aggregates having positive alkali-silica reaction shall not be used.

### 8.6 Water

(i) Water for use in the works for mixing and curing shall be in conformity with Clause 302.4 of IRC:21.

(ii) Water from each source shall be tested before the start of works and thereafter every three months and after each monsoon, till the completion of the works and proposal along with a copy of test reports shall be submitted to the Independent Engineer for review and comments, if any.

### 8.7 Chemical Admixtures

**8.7.1** Chemical Admixtures are proprietary items and shall be obtained only from reputed manufacturers with proven track record, quality assurance and full-fledged laboratory facilities for manufacture and testing.

**8.7.2** The following guidelines shall be followed in their selection and use of the admixtures:-

(i) The chemical admixtures shall comply with IS: 9103 and meet the requirements stipulated in Clause 5.5 of IS:456.

(ii) The admixtures generating hydrogen or nitrogen or containing nitrates, sulphides, sulphates, or any other material liable to affect the reinforcement/embedments or concrete shall not be used.

(iii) Compatibility of admixture with the cement being used shall be tested before actual use in the works. The test shall be repeated in case of change of type or grade or source of cement.

(iv) Admixtures shall not impair the durability of concrete. They shall not combine with the ingredients to form harmful compounds or endanger the protection of reinforcement against corrosion.

(v) The packing of admixtures shall clearly indicate the name of the manufacturer/

supplier, brand name (name of the product), date of production and expiry, batch/ identification number.

**8.7.3** The Concessionaire shall obtain a Certificate from manufacturer/supplier and submit to the Independent Engineer for review and comments, if any. The Certificate shall include the following information concerning the proposed admixture;

(i) Normal dosage with permissible range as a percentage of weight of cement and adverse effects, if any, of over and under dosage.

(ii) Chemical names of main ingredients.

(iii) Chloride content, if any, expressed as a percentage by weight of the admixture.

(iv) Values of dry material content with relative density of the admixture, which can be used for Uniformity Tests.

(v) pH value and colour.

(vi) Whether or not the proposed admixture leads to the entrainment of air when used as per the manufacturer's recommended dosage and if so, to what extent.

(vii) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.

(viii) Confirmation that there is no risk of corrosion of reinforcement or other embedments.

(ix) Latest date of test and name of the laboratory.

(x) Shelf life, maximum and minimum temperature for storage, precautions to be taken while mixing and any other instructions for use.

**8.7.4** In addition to conforming to the requirements of IS:9103, the proposed admixture shall also satisfy the following conditions;

(i) "Plasticisers" and "Super-Plasticisers" shall meet the requirements indicated for "Water reducing Admixtures".

(ii) The chloride content of the admixture shall not exceed 0.2 per cent by weight of admixture when tested in accordance with IS:6925.

(iii) Except where resistance to freezing and thawing and to disruptive action of deicing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS:1199 shall not be more than 2 percent higher than that of the corresponding control mix and in any case, not higher than 3 percent of the test mix.

(iv) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from same batch at different times. The tests that shall be performed along with permissible variations over the values stated by the manufacturer are given below;

| | |
|---|---|
| • Dry Material Content: | within 3 percent and 5 percent of liquid and solid admixture respectively. |

- Ash Content: within 1 percent of the value stated by the manufacturer.
- Relative Density: (for liquid admixtures) within 2 percent

(v) All tests relating to the concrete admixtures shall be conducted periodically at an independent laboratory and compared with the data furnished by the manufacturer.

## 8.8 Steel

### 8.8.1 *Steel for Prestressing*

(i) The prestressing steel shall be of any of the following types:

(a) Plain hard drawn steel wire conforming to IS:1785 (Part-I) and IS:1785 (Part- II),

(b) Cold drawn indented wire conforming to IS:6003,

(c) High tensile steel bar conforming to IS:2090,

(d) Uncoated stress relieved strand conforming to IS:6006, and

(e) Uncoated stress relieved low relaxation steel conforming to IS:14268.

(ii) Data in respect of modulus of elasticity, relaxation loss at 1000 hours, minimum ultimate tensile strength, stress-strain curve etc. shall be obtained from the manufacturers. Prestressing steel shall be subjected to acceptance tests prior to actual use on works. Guidance may be taken from BS:4447. The modulus of elasticity value, as per acceptance tests, shall conform to the design value, which shall be within a range not more than 5 per cent between the maximum and the minimum.

### 8.8.2 *Reinforcement/Untensioned Steel*

(i) All reinforcing steel for use in works, shall be procured from original producers or their authorized agents.

(ii) Only new steel shall be brought to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bars shall be discarded. Cracked ends of bars shall be cut before use.

(iii) All reinforcement shall be free from loose rust and coats of paints, oil, mud or any other substances, which may destroy or reduce bond. The reinforcement bars bent and fixed in position shall be free from loose rust or scales, coats of paints, oil, mud or chloride contamination and other corrosion products. Where cleaning of corroded portions is required, effective method of cleaning such as sand blasting or other method shall be submitted to the Independent Engineer for prior review and comments, if any.

### 8.8.3 *Steel for Bearings*

Mild steel, high tensile steel, cast steel, steel forgings, and stainless steel shall conform to the provisions contained in clause 925.1 of IRC:83 (Part III).

### 8.8.4 *Structural Steel*

All structural steel, castings and forgings, fasteners (bolts, nuts, washers and rivets),

welding consumables, wire ropes and cables shall conform to the provisions of Clauses 505.1.2, 505.2, 505.3, 505.4 and 505.6 of IRC:24 respectively.

### 8.9 Storage of Materials

All materials shall be stored at proper places so as to prevent their deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective after review by the Independent Engineer shall not be used in the works and shall be removed from site by the Concessionaire at his cost. Such materials shall not be made acceptable by any modifications.

### 8.10 Reports to be submitted

The Concessionaire shall submit test results of all materials and finished products proposed to be used in the Project Highway, as specified in the QC documents, to the Independent Engineer for review and comments, if any.