

SECTION – III
REINFORCEMENT WORK

1.0 GENERAL

1.1 Standards

Work shall be carried out to Indian Standards and Code of Practices. In absence International Standards shall be followed. These shall be latest issue. List given hereunder is not to be considered as conclusive and is for reference and guidance only. Any discrepancies /conflict noticed shall be directed to the Architect for his direction/approval. However as a general rule more stringent specification shall take precedence.

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| 1. | IS 226 | Specification for steel standard quality |
| 2. | IS 228 | Methods for chemical analysis of steels |
| 3. | IS 280 | Specification for mild steel wire for general engineering purpose. |
| 4. | IS 432 | Specification for mild steel and medium tensile steel burn and hard drawn steel wires for concrete requirement. |
| | Part 1 | Mild steel and Medium tensile steel bars. |
| | Part 2 | Hard drawn steel wire. |
| 5. | IS 456 | Code of practice for construction and design of reinforced concrete. |
| 6. | IS 816 | Code of practice for use of metal arc welding for general construction in mild steel |
| 7. | IS 961 | Specification for structural steel : high tensile steel bars |
| 8. | IS 1566 | Hard drawn steel wire fabric for concrete reinforcement. |
| 9. | IS 1599 | Method of Bend test |
| 10. | IS 1642 | General requirements for fire protection. |
| 11. | IS 1785 | Cold drawn stress relieved wire (part I) |
| 12. | IS 1786 | Specification for high strength deformed steel bars and wires for concrete reinforcement. |
| 13. | IS 2751 | Code of practice for welding of MS bars. |
| 14. | IS 2502 | Code of practice for bending and fixing of bars for concrete reinforcement. |
| 15. | IS 2751 | Code of practice for welding of Bars |
| 16. | IS 3696 | Safety Code of scaffolds and ladders : |

	Part 1	Scaffolds
	Part 2	Ladders
17.	IS 4014	Code of practice for steel (Part 1 & 2) tubular scaffolding
18.	IS 4082	Recommendation on stacking and storage of construction materials at site
19.	IS 5525	Recommendation for detailing of reinforcement in RCC work.
20.	IS 9417	Recommendation for welding cold worked steel bars for reinforced concrete construction
21.	IS 10790	Method of sampling of steel for prestressed and reinforced concrete

1.2 Quality Assurance

1.2.1 The Contractor shall procure and provide reinforcing steel bars conforming to IS specified and shall comply with all physical, chemical and mechanical test. Each type shall be from same manufacturer.

1.2.2 Steel manufacturers shall conform steel produced conforms IS requirements for reinforced cement concrete works.

Steel shall not react chemically with ingredient of reinforced cement concrete which are harmful to strength, durability of reinforced cement concrete.

1.2.3 Unit weights and diameter of rolled steel bars shall conform to IS.

1.2.4 Provide supervision and work force with minimum 5 (five) years experience to ensure workmanship of specified quality.

1.2.5 Contractor to undertake documenting of

☐ Test reports for steel brought at site for each lot

a) Chemical composition from factory

b) Mechanical

c) Physical

☐ Barbending schedule for cutting and bending

☐ Record of laps and anchors / development length

1.2.6 Work shall not be subjected to harmful, dangerous and damaging exposures.

1.2.7 Steel used on site shall be from leading manufacturers like SAIL, TISCO, RINL

1.2.8 Couplers

☐ The Contractor shall procure Couplers conforming to IS or ISO 15835-1 : 2009 and ISO 15835-2 : 2009 for test and as modified in draft IS CED54 20 May 2010 (or as approved and published by BSI) and shall be purchased from approved manufacturer as given by Structural PM.

- ☐ Type of threading shall be as required for specific use and as approved by the Structural Consultant / PM.
- ☐ IS Code references given there in for metallic materials, testing, sampling etc. shall be as detailed in draft IS.
- ☐ Material test reconsult of complains shall be conforming to IS code as listed.
- ☐ Coupler manufacturer shall give test certification along with each lot of supply.
- ☐ Threading at site or at factory shall be done as per code and agency should have experience of minimum 2 years.

1.3 Submittals

- 1.3.1** Submit for approval of the Architect all details of Material / Product which conforms the specification laid down in documents.

1.3.2 Submittals shall include

- ☐ Product data sheet
- ☐ Manufacturers certificates
- ☐ Test report of laboratories
- ☐ Alternative product if any with tabulation for conformation that alternatives proposed meets / exceeds specification.

1.3.3 Samples

Samples of type of materials to be used. Further during construction samples shall be taken and tested by the Contractor as per specification and as directed / instructed by the Architect. The cost of samples and test shall be borne by the Contractor within quoted prices.

1.3.4 Shop drawings

Contractor shall prepare and submit bar bending schedule based on structural detailed drawing prior to fabrication for approval of the Architect.

1.3.5 Submittals for Couplers

- ☐ Samples along with name of manufactures
- ☐ Technical literature
- ☐ Test Certificates
- ☐ Experience of threading agency

1.4 Examination of Conditions

Contractor shall inspect and examine sub stratas and confirm prior to start that.

- ☐ Substrate is acceptable and approved by Architect
- ☐ Conditions are satisfactory
- ☐ Setting out/Layout is verified

- Corrective measures needed if any are within reach and contractor proceeds with full responsibility for work.

2.0 MATERIAL

2.1.0 Reinforcing Bars

- 2.1.1 Reinforcement bars used in construction shall be mild steel or medium tensile steel round bars and high strength deformed bars. Steel shall be fresh and new. It shall be free of defects and free of rust, oil, paints, grease, loose mill scale or any other deleterious material undesirable for RCC or prevent adhesion of concrete with reinforcement.

Steel should be from the original iron ore producers (like SAIL, TATA, RIN). If other steel is to be used then billets should be approved from SAIL, TATA, RINL. Other steel can be used only after prior approval of the PM.

2.1.2 M S Plain

Rolled mild steel and medium tensile steel plain round bars used in concrete shall conform to IS 432 Part I. Steel received shall conform to the following IS with regard to manufacturing and chemical composition.

1. M.S. bar Grade I Steel designation Fe 410-S of IS 226
2. M.S. bar Grade II Steel designation Fe 410-O of IS 1977
3. Medium Tensile Steel designation Fe 540 Steel bars W-HT IS 961

- 2.1.3 Nominal sizes and tolerances shall be as specified in IS 432 Part I. Physical requirements shall be determined in accordance with IS 1608, read in conjunction with IS 226. For reference of minimum requirements, properties are tabulated in IS 432 Table 1 “Mechanical properties of bars mild steel & tensile steel bars”.

2.1.4 Tor Steel

High-strength deformed bars for use as reinforcement in concrete shall be of grade Fe 415, Fe 500 and Fe 550 conforming to IS 1786.

- 2.1.5 Chemical composition shall conform to IS 1786 when made as a relevant part of IS 228.

- 2.1.6 Welding of cold work steel bars in reinforcement shall be permitted as per IS 2751 and 9417. (Recommendation for welding cold worked steel bars for RCC).

- 2.1.7 Nominal sizes, cross sectional areas and their mass shall be as specified in IS 1786, allowing due consideration for tolerances specified therein.

2.1.8 Physical properties

- a) It shall satisfy IS 1599 test for bend and rebend test in conjunction with IS 226.
- b) Bond requirements shall be deemed to have been satisfied if it meets clause 4.0 of IS 1786.

- c) Tensile, proof stress and percent elongation shall be as per table 3 of IS 1786.

2.1.9 Material received at site shall have ISI certification mark. Each bundle or coil containing the bars shall be suitably marked with ISI certification mark. Also bars shall be marked to identify categories. This shall be done as per IS 1387.

In case bars are without ISI certification mark, the manufacturer shall give a certificate stating process of manufacture, chemical composition and mechanical properties. Each certificate shall indicate the number or identification mark of the batch production/ cast to which it applies. Corresponding number or identification mark should be found on the material.

2.1.10 All reinforcement material shall be free from loose mill scale, excessive rust, loose rust, pitting, oil, grease, paint, mud or any foreign deleterious material present on the surface. Cleaning shall be done to the satisfaction of the Architect.

2.1.11 Each batch brought at site shall be tested prior to use for respective specification / physical properties. Cost of all such tests shall be borne by the contractor. Material acceptable as per IS shall be allowed into the works. All rejected material shall be removed from site by the contractor within 3 days of rejection. If the same is not done, the Architect shall impose a penalty of Rs.500/- per metric ton per day. This will be without any appeal and shall not be subjected to arbitration.

2.2.0 Cover block

Cover blocks shall be of non-corrosive material such as plastic but not wooden or broken bricks or stone. Designed purpose made PVC cover spacers shall be used in the Works. Concrete cover spacers may be permitted by the Architect. Such concrete spacers shall be cast from concrete and not cement-mortar. Strength of these blocks shall be equal to the strength of concrete in use. These should be fully cured prior to use in works.

2.3.0 Binding Wire

Binding wire shall be 18 gauge GI wire conforming to IS 280. It shall be free from rust, oil, paint, grease, loose mill scale or any other deleterious material undesirable for the reinforcement and concrete or which may prevent adhesion of concrete with reinforcement.

2.4.0 Mechanical Splices

Mechanical Splices fabricated out of steel pipes, sheets etc. capable of withstanding bending and compression stress equal to 1.25 times of those specified for reinforcing bars shall be used. Supplier of splices should submit details about quality of materials, mechanical test results and method of splicing. Required hydraulic press and clipping equipments shall be arranged by the Contractor.

Samples pieces shall be prepared at site and shall be tested for torsion. Sample pieces results should give value of about 1.5 times than required for reinforcing bars.

2.5.0 Couplers

Coupling materials shall conform to IS 1608, 1828 (Part1) 6886 & 12872

Each Couplers shall be indelibly and clearly marked indicating class nominal size of bar for which it is intended. Marking shall be such that racing the reinforcing Couplers to cash from where made. Also mark/ brands should be visible.

3.0 SCOPE OF WORK

The contractor shall be responsible for

3.1 Material Procurement

- a) The contractor will submit the Schedule of Procurement of steel in consultation with Architect as specified and conforming to specifications detailed in drawings and bills of quantities.

The steel is free supply by the client to be delivered to site as per approved indent of the contractor to agreed schedule. However further all balance work to complete the reinforcement bar item shall be same as materials are supplied by the Client.

- b) Receive steel and stack with covering on firm platform free of contamination.
- c) Collect samples of each type for every batch received and test as per IS for
- ☐ Unit weight per running meter
 - ☐ Cross section area
 - ☐ Bend / Rebend Test
 - ☐ Ultimate tensile strength
 - ☐ Yield stress
 - ☐ Elongation
- d) Procure binding wire, cover blocks splices etc.
- e) Procure Couplers of type and strength as specified

3.2 Prepare bar bending / cutting schedule detailing schedule covering as under and obtain approval of Architect.

- ☐ Cutting lengths
- ☐ Laps / Coupler
- ☐ Rings for various locations and items
- ☐ Chairs

3.3 Transport, cut, bend and shift to site reinforcing bars.

- 3.4 Place in position and tie as detailed in drawing reinforcement with specified cover.
- 3.5 Provide attendance to keep reinforcement in position during concreting.
- 3.6 Disposal of surplus reinforcement steel as per approval of the Architect.
- 3.7 Provide anticorrosive treatment to reinforcement bars including required handling, application, touch up and maintenance till concreting by either
- a) CECRI System : Cement polymer composite coating system
 - b) Fusion bonded epoxy coating.
- 3.8 Providing required tools, plants, equipments such as
- ☐ Material cutting and bending tools
 - ☐ Bending platform Bar cutting machine
 - ☐ Bar bending machine
 - ☐ Hydraulic clipping machines
- 3.9 Unit weights payable per metre shall be as follows-
1. 6 mm : 0.22 kg/Rmt
 2. 8 mm : 0.40 kg/Rmt
 3. 10 mm : 0.62 kg/Rmt
 4. 12 mm : 0.89 kg/Rmt
 5. 16 mm : 1.58 kg/Rmt
 6. 18 mm : 2.00 kg/Rmt
 7. 20 mm : 2.47 kg/Rmt
 8. 22 mm : 2.98 kg/Rmt
 9. 25 mm : 3.85 kg/Rmt
 10. 28 mm : 4.83 kg/Rmt
 11. 32 mm : 6.31 kg/Rmt
 12. 36 mm : 7.99 kg/Rmt
 13. 40 mm : 9.85 kg/Rmt
- 3.10 Thread the bars at site or factory as required.
- 3.11 Check bar threading is of required length.
- 3.12 Couplers are fitted to minimum length within Couplers.
- 3.13 Check both side threads prior to shifting at site.
- 3.14 Mechanical Couplers shall be able to transfer of axial tensile force and / or compressive force from 1 bar to another.
- 3.15 Fitting matching threaded Coupling device over the ends of two reinforcing bars.
- 3.16 Length of Couplers shall be as per code.

4.0 WORKMANSHIP

4.1 Fabrication of reinforcement

Reinforcement shall be fabricated as per the drawing and approved bar bending schedule. Bending shall be done mechanically or with hand but to the correct radius, with proper tools and platform and shall conform to IS 2502. Bending of material shall be cold bending only. Material shall be inspected for visible defects such as cracks, brittle, excessive rust, loose mill scale, etc. Cracked ends of bars shall not be used in Works. Also the bars should be free from any deleterious material and hence the best practice shall be to hose down reinforcement just prior to concreting.

It is important that bending, straightening, cutting, etc. shall be carried out in a manner not injurious to the material and the safety of the persons working should be ensured.

4.2 Anchoring

Anchoring of bars and stirrup shall be provided exactly as detailed in the structural drawing or as directed by the Architect.

4.3 Lapping of bar

Laps shall be strictly as per the drawing or as directed by the Architect. For general guidance, the following principles shall be followed as given in IS 456.

- a) Splices shall be provided as far as possible away from sections of maximum stress and be staggered.
- b) Not more than half of the total bars shall be spliced at a section.
- c) Where more than one half of the bars are spliced at a section or where splices are made at points of maximum stress, special precautions shall be taken, such as increasing the length of lap and/or using spirals or closely spaced stirrups around the length of the splice.
- d) Lap splices shall not be used for bars larger than 36 mm diameter: For larger diameters, bars may be welded. In cases where welding is not practical, lapping of bars larger than 36 mm diameter may be permitted and additional spirals should be provided around the lapped bars.
- e) Lap length including anchorage value of hooks in flexural tension shall be L_d (as defined in 25.2.1 of IS 456) or 50 dia whichever is greater.
- f) When splicing of welded wire fabric is to be carried out, lap splices of wires shall be made so that the overlap measured between the

extreme cross wires shall be not less than the spacing of cross wires plus 10 cm.

Lapping of Bar

- 4.3.1 Lapping of bar can be with physical reinforcement of bar or by using approved type of coupler. Coupler shall be strictly as per the drawing or as directed by the PM. For general guidance, the following principles shall be followed as given in IS 456.
- 4.3.2 Installation of Couplers shall be as per written instruction given by approved manufacturer and as approved by PM. The work shall be done exactly as specified and should achieve performance under different site circumstance.

4.4 Spacing of bars

Bars shall be placed in position as shown in the drawing. Following guidelines as given in IS 456 shall be followed in case of difficulties or shall be carried out as directed by the Architect.

- a) Horizontal distance between two parallel main reinforcing bars shall usually not be less than the greatest of the following:
 - 1. The diameter of the bar, if the diameters are equal.
 - 2. The diameter of larger bar, if the diameters are unequal, and
 - 3. 5 mm more than the nominal maximum size of coarse aggregate (By using reduced size of aggregate in congested reinforced area, conditions given hereof should be overcome).
- b) Greater horizontal distance should be provided. But when needle vibrators are used, distance between bars of a group may be reduced to two-thirds of the nominal maximum size of the coarse aggregate, provided sufficient space is left between groups of bars to enable the vibrator to be immersed.
- c) Where there are two or more rows of bars, the bars shall be vertically in line and the minimum vertical distance between the bars shall be 15 mm, two-thirds the nominal maximum size of the aggregate or the maximum size of bar, whichever is more.

4.5 Cover to reinforcement

Reinforcement shall have concrete cover and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as specified in drawing or as directed by the Architect. The following guidelines are to be observed in the absence of the above.

- a) At each end of the reinforcing bar, not less than 25 mm, nor less than twice the diameter of such bar;
- b) For a longitudinal bar in a column, not less than 40 mm, nor less than the diameter of such bar. In the case of columns of minimum

dimension of 200mm or under, whose reinforcing bars do not exceed 12 mm, a cover of 25 mm.

- c) For longitudinal reinforcing bar in beam, not less than 25 mm, nor less than the diameter of such bar.
- d) For tensile, compressive, shear or other reinforcement in slab, not less than 15 mm, nor less than the diameter of such bar; and
- e) For any other reinforcement, not less than 15 mm, nor less than the diameter of such bar.
- f) Increased thickness shall be provided in case the concrete members are in the surrounding of harmful chemicals, saline atmosphere, etc. and the cover shall be 50 mm or more as directed by the Architect.
- g) For concrete members totally immersed in sea water, the cover shall be 40 mm more than specified above (a) to (f).

This shall be 50 mm more for periodical immersion in sea water.

- h) Concrete cover should not exceed 75 mm in any case. Cover to reinforcement shall be as specified in the drawing or as directed by the Architect.

Details given in sub para (a) to (h) are for guidance and shall be followed in absence of any specific direction.

4.6 Welded joints or mechanical connections

- A) Welded joints or mechanical connections in reinforcement may be used but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of the connected bars. Welding of reinforcement shall be done in accordance with IS recommendation. Welded joints shall preferably be located at points where steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that, at any one section, not more than 33 percent of the rods are welded.
- B) Welding rods used shall conform to IS 814 : covered electrodes for metal arc welding of structural steel. Work shall be carried out by a competent welder. Samples from work site shall be taken at regular intervals and tested. Frequency and number of samples shall be as directed by the Architect.

4.7 Fixing in position

4.7.1 Correctly cut and bent bars shall be accurately placed in position as detailed in the drawing. Unless otherwise specified by the Architect, reinforcement shall be positioned within the tolerance as under :

- a) for effective depth 200 mm or less, + 10 mm
- b) for effective depth more than 200 mm, + 15 mm

4.7.2 But in no case shall the cover be reduced by more than 5 mm of that specified. There shall be no compromise on cover for foundation work.

- 4.7.3 Reinforcing bars shall be held in position during the placing of concrete by use of PVC or concrete cover blocks (made of equal strength of well-cured concrete in use), steel chair spacers, steel hangers, supporting wires, etc. and secured by tying with an GI binding wire of 18 gauge as approved by the Architect.
- 4.7.4 Layer of bars shall be separated by precast concrete spacer blocks or spacer bars. Reinforcement shall be in correct position prior to start of concreting. No reinforcing bar shall be placed on freshly laid concrete for adjusting bar spacing. Care shall be taken to maintain reinforcement in position and keep it clean, throughout the period till it is embedded in the concrete. For maintaining cover, pieces of broken stone or brick or wooden blocks shall not be used at any stage.
- 4.7.5 Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time is the radius of the bend less than 4 bar diameters in case of plain mild steel or 6 bar diameters for deformed bars. Care shall be taken when bending back bars to ensure that the concrete around is not damaged/disturbed.

5.0 MEASUREMENTS

Reinforcement shall be measured as follows :

1. Lengths of different diameters of bars actually used including authorised overlaps shall be measured nearest to a centimeter and their weight calculated.
 - a) If steel is procured by the contractor, weight per metre given in table 3.9 shall be used.
 - b) If material is supplied by the client free of cost on tonnage basis to the project site, per metre weight for each diameter of the bar shall be fixed by the Architect from actual stocks of steel available at site or weight per meter given in table 3.9 shall be used.
2. Chairs and spacer bars shall not be measured and paid. For reconciliation purpose it will be taken into account.
3. In case of welded coupled joints, measurement for payment shall be equivalent to the length of overlap, as per design.
4. Price build-up shall include, in addition to cost of material,
 - a) Cover blocks of PVC or concrete.
 - b) Cutting, bending, placing and fixing in position.
 - c) Binding wire as approved.
 - d) Cleaning of bars.
 - e) Unloading, weighing cost (to conform the weight of steel) and storing the same in proper forms and conditions on suitable platforms.

5. In case the material is supplied by the owner free-of-cost, it shall include the following in addition to 4a) to 4d) above.

Transportation from owner's store to work site and returning surplus material back to store.

6. For purpose of reconciliation, maximum wastage permitted shall be 3% of the actual material used (returnable to owner). Balance shall be charged at 1.5 times the actual market rates as penalty.

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