

i. Prestressing steel shall be continuously protected against corrosion, until grouted. The corrosion protector shall have no deleterious effect on the steel or concrete or on the bond strength of steel to concrete. Grouting shall conform to these specifications or as directed by the Engineer or specified in Contract Specifications.

ii. In the case of external prestressing, steel shall be encased in suitable polyethylene pipes before grouting.

F. Sheathing Joints and Couplings

i. Joints in sheathing shall, if so instructed be sealed with a heat shrink tape.

ii. Special attention should be paid to its junction at the anchorage. It should tightly fit on the trumpet end of anchorage and the junction should be sealed, preferably, with heat shrink tape.

iii. The heat shrink tape is supplied in the form of bandage rolls which can be used for all diameters of sheathing ducts. The bandage is coated on the underside with a heat sensitive adhesive so that after heating the bandage material shrinks on the sheathing duct and ensures formation of a leak-proof joint. The heating is affected by means of a soft gas flame.

iv. The sheathing and all joints shall be water tight. Any temporary opening in the sheathing shall be satisfactorily plugged and all joints between sheathing and any other part of the prestressing system shall be effectively sealed to prevent entry of mortar, dust, water or other deleterious matter. Sheathing shall be neatly fitted at joints without internal projection or reduction of diameter. Enlarged portions of the sheathing at couplings or anchorages shall be of sufficient length to provide for the extension of the tendons.

G. Grout vents

Grout vents of at least 20mm diameter shall be provided at both ends of the sheathing and at all valleys and crests along its length. Additional vents with plugs shall also be provided along the length of sheathing such that the spacings of consecutive vents do not exceed 20m. Each of the grout vents shall be provided with a plug or similar device capable of withstanding a pressure of 1.0MPa without the loss of water, air pressure or grout.

H. Anchorages

All bearing surface of the anchorages shall be cleaned prior to concreting and tensioning. Anchor cones, blocks and plates shall be securely positioned and maintained during concreting such that the center line of the duct passes axially through the anchorage assembly. The anchorages shall be recessed from the concrete surface by a minimum cover of 100mm. After the prestressing operations are completed and prestressing wire/strands are cut, the surface shall be painted with two coats of epoxy of suitable formulation having a dry film thickness of 80 microns per coat and entire recess shall be filled with concrete or non-shrink/pre-packaged mortar or epoxy concrete.

7. Tensioning Equipment

A. All tensioning equipment shall be procured from authorized manufacturers only and be approved by the Engineer prior to use. Where hydraulic jacks are used, they shall be power driven unless otherwise approved by the Engineer. The tensioning equipment shall satisfy the following requirements:

i. The means of attachments of the prestressing steel to the jack or any other tensioning apparatus shall be safe and secure.

ii. Where two or more wires/strands constitute a tendon, a single multi-pull stressing jack shall be used which is capable of tensioning simultaneously all the wires/strands of the tendon. Suitable facilities for handling and attaching the multi-pull jack to the tendons shall be provided.

iii. The tensioning equipment shall be such that it can apply controlled total force gradually on the concrete without inducing dangerous secondary stresses in steel, anchorage or concrete; and

iv. Means shall be provided for direct measurement of the force by use of dynamometers or pressure gauges fitted in the hydraulic system itself to determine the pressure in the jacks. Facilities shall also be provided for the linear measurement of the extension of prestressing steel to the nearest mm and of any slip of the gripping devices at transfer.

B. All dynamo meters and pressure gauges including a master gauge shall be calibrated by an approved laboratory immediately prior to use and then at intervals not exceeding 3 months and the true force determined from the calibration curve.

C. Pressure gauges shall be concentric scale type gauges accurate to within two per cent of their full capacity. The minimum nominal size of gauge shall be 100 mm. The gauge shall be so selected that when the tendon is stressed to 75 per cent of its breaking load, the gauge is reading between 50 per cent and 80 per cent of its full capacity.

D. Provision shall be made for the attachment of the master gauge to be used as a check whenever requested for by the Engineer.

8. Post Tensioning procedure

A. Tensioning force shall be applied in gradual and steady steps and carried out in such a manner that the applied tensions and elongations can be measured at all times. The sequence of stressing, applied tensions and elongations shall be in accordance with the approved drawing or as directed by the Engineer.

B. It shall be ensured that in no case, the load is applied to the concrete before it attains the strength specified on the drawing or as stipulated by the prestressing system supplier, whichever is more.

C. After prestressing steel has been anchored, the force exerted by the tensioning equipment shall be decreased gradually and steadily so as to avoid shock to the prestressing steel or anchorage.

D. The tensioning force applied to any tendon shall be determined by direct reading of the pressure gauges or dynamo meters and by comparison of the measured elongation with the calculated elongation. The calculated elongation shall be invariably adjusted with respect to the modulus of elasticity of steel for the particular lot as given by the manufacturer.

E. The difference between calculated and observed tension and elongation during prestressing operations shall be regulated as follows:

i. If the calculated elongation is reached before the specified gauge pressure is obtained, continue tensioning till attaining the specified gauge pressure, provided the elongation does not exceed 1.05 times the calculated elongation. If 1.05 times the calculated elongation is reached before the specified gauge pressure is attained, stop stressing and inform the Engineer.

ii. If the calculated elongation has not been reached at the specified gauge pressure, continue tensioning by intervals of 5 kg/sq.cm until the calculated elongation is reached provided the gauge pressure does not exceed 1.05 times the specified gauge pressure.

iii. If the elongation at 1.05 times the specified gauge pressure is less than 0.95 times the calculated elongation, the following measure must be taken, in succession, to determine the cause of this lack of discrepancy:

- Check the correct functioning of the jack, pump and leads.
- De-tension the cable. Slide it in its duct to check that it is not blocked by mortar which has entered through holes in the sheath. Re tension the cable if free.
- Re-establish the modulus of elasticity of steel for the particular lot from an approved laboratory.

iv. If the required elongation is still not obtained, further finishing operations such as cutting or sealing, should not be undertaken without the approval of the Engineer.

v. When stressing from one end only, the slip at the end remote from the jack shall be accurately measured and an appropriate allowance made in the measured extension at the jacking end.

vi. A complete record of prestressing operations along with elongation and jack pressure data shall be maintained in the prescribed format. The number of stages of prestressing and grouting shall be reduced to a minimum, preferably 2 in the case of simply supported girders.

vii. Grouting shall conform to provisions in CBC. A record of grouting operations shall be maintained in a format given by Engineer.

9. Pre Tensioning procedure

Transfer of Prestress

- i. While the process of tensioning can be accomplished by means of hydraulic jacks, some positive mechanical means shall be provided to maintain the tension during the entire period between the tensioning of the wires/strands and transfer of the prestressing force to the concrete element.
- ii. Transfer of prestress shall not proceed until the Engineer has approved the proposed method. Tendons and deflection devices shall be released in such a pre-determined order that unacceptable tensile stresses are not induced in the concrete.
- iii. Prior to transfer of the force to the units, all wire tendons shall be tested for tightness and any loose tendon shall be reported to the Engineer who will decide whether the units affected shall be rejected.
- iv. The Engineer may require that tendons be marked at each end of any unit to allow measurement of the pull in of the concrete.
- v. Tendons shall be released gradually and preferably simultaneously.

Cutting of wires : Precautions to be taken

- i. Under no circumstances shall tendons/wire be cut while under tension.
- ii. On completion of the transfer of prestress, the projecting lengths of tendon shall be cut off flush with the end surface of the unit, unless otherwise shown, by a method approved by the Engineer.
- iii. In no case shall the transfer of prestressing force to the concrete elements take place before concrete attains the strength specified in the drawings. To determine the specified strength, additional cube testing shall be undertaken at the Contractor's cost. In case steam curing is employed, the cubes shall be placed in the same environment as the concrete elements to obtain an accurate assessment of concrete strength at the time of transfer.
- iv. The sequence of transfer of prestressing force shall be done strictly as indicated in the drawings and ensuring that eccentricities of the prestressing force in the vertical and horizontal directions of the concrete elements is a minimum during the entire sequence.
- v. The maximum slip of any tendon during transfer shall not exceed 3mm at any end of the concrete element. In case this slip is exceeded, the concrete element in question shall be rejected.

Protection of Ends

- i. The exposed ends of the tendons and the concrete surfaces of the ends of the units shall be wire brushed clean of all rust, loose mortar, grease and dirt.
- ii. The exposed ends of the tendons and concrete surface within 50mm of tendons shall be then abraded to provide a clean sound surface. An epoxy tar paint suitably formulated to give a dry film thickness of 80 microns per coat shall then be immediately applied over the ends of the tendons unless otherwise directed.

iii. A second coat of paint shall be applied prior to the drying out of the first coat.

Safety Precautions during Tensioning

These are applicable for both pre-tensioning and post tensioning operations.

- Care shall be taken during tensioning to ensure the safety of all persons in the vicinity.
- Jacks shall be secured in such a manner that they will be held in position, should they lose their grip on the tendons.
- No person shall be allowed to stand behind the jacks or close to the line of the tendons while tensioning is in progress.
- The operations of the jacks and the measurement of the elongation and associated operations shall be carried out in such a manner and from such a position that the safety of all concerned is ensured.
- A safety barrier shall be provided at both ends to prevent any tendon, which might become loose from recoiling unchecked.
- During actual tensioning operation, warning sign shall be displayed at both ends of the tendon. No person shall stand behind in line with jacks while tendon/wire are being stressed.
- After prestressing, concrete shall neither be drilled nor any portion cut nor chipped away nor disturbed, without express approval of the Engineer.
- No welding shall be permitted on or near tendons nor shall any heat be applied to tendons. Any tendon which has been affected by welding, weld spatter or heat shall be rejected.

TESTS AND STANDARDS OF ACCEPTANCE

- The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.
- The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

MEASUREMENT:

The measurement for prestressing steel wires shall be made on the actual length of wires from end to end of cut-face of anchorages for post tensioned concrete as per the profile drawing and shall not include the extra length of wires at both ends. For pretensioned concrete the measurements of high tensile steel wires shall be measured from end to end of concrete faces and shall not include extra length of wires at both ends. The rates for high tensile steel work shall include formation of cables in position including cost of spacers, transporting, anchorages, sheathing, grouting, stressing and all other relevant work including staging etc.

GENERAL

i. The contractor has to fulfill all the statutory requirements of factory act and labour laws amended from time to time as applicable.

- ii. The quantities and items of execution are based on preliminary estimate and designs. However, certain variations are likely to occur during the course of execution depending on site conditions. Such unexpected variations may lead to minor changes in design during execution, which the contractor shall execute at the same accepted rate.
- iii. All the conditions, specifications etc., stipulated in the tender booklet shall be meticulously and carefully gone through.
- iv. All the particulars called for in the tender booklet should be filled up carefully.
- v. The items of works required to be done, firm rate and the quantities are given in the schedule.
- vi. All arrangement of safety & security of men & material engaged by the contractor to be made by the contractor. No extra payment will be made to the contractor on this account.

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