

Post Tensioning

Post tensioning is an useful method of reducing size or increasing load bearing capacities of concrete structural elements like bridge decks, girders and suchlike. Unlike pre-stressing, where stresses are applied to steel well before pouring concrete, in case of post-tensioning the same are applied only after concrete attains sufficient strength. Like pre-stressing, Post tensioning too is an extensive subject for studies. Some useful practical points on Post tensioning in a RCC bridge deck are briefly discussed herein.

The key materials involved in Post tensioning of a concrete bridge are:

a) Steel cables of required diameter. These are usually composed of several steel strands twisted together. These cables are located within concrete at suitable locations as per design requirements over and above normal steel reinforcement. Ordinary steel re-bars are installed prior to pouring, as usual, while the cables to be post-tensioned are introduced later and conduits for that purpose are left within concrete accordingly (as per construction drawings). As part of quality control measures, materials test certificates from the manufacturer of the cables are scrutinised. Besides, physical inspection and more importantly, laboratory tests, such as, tensile strength test, relaxation test etc. are conducted to ensure the quality of these all-important elements. For general idea, the ultimate tensile strength for these should be at least 1770 N/sq.mm.

b) Ducts & Couplers: These are the conduits for providing the steel cables inside concrete. The couplers join the ducts to render several pieces of ducts a single, leak-proof conduit of required length. The dia. of ducts depends upon the dia. of cables to be inserted and is specified in construction drawings. Quality control measures for these primarily include physical inspection & scrutiny of material test certificates from manufacturer.

c) Anchorage Assembly: This include trumplate, anchor blocks etc. and is essential in order to provide anchorage to the steel cables during application of tensile stress. The precise orientation of this assembly with relevant details is illustrated in construction drawings. Physical inspection & scrutiny of material test certificates from the manufacturers are important aspects of quality control measures. For general idea, the anchrage efficiency should not be less than 90%.

d) Grout: Grout is another important element of the process of post-tensioning of RCC bridges. The steel cables inside the conduits within concrete are fully grouted after application of tensile stress to the same is over. Stringent quality control measures are adopted for grouts & grouting of this kinds in order to ensure quality of high standard. Sufficient quality tests are conducted on grout, such as, fluidity test, bleeding test, volume change test, compressive strength test etc. in order to examine it,s quality. For more details on grouts & grouting, refer earlier posts on the topic.

The main equipments used in post tensioning operationing are:

a) Stressing Equipments: These include jack & pump of suitable capacities. Proper calibration certificates for these equipments are quite necessary. For general idea, calibration tolerances for these max be +/- 2%. Calibrations are checked periodically in order to ensure accuracy throughout. Scrutiny of friction loss calculations for the jack is also important in addition to other documents related to these items. Physical inspection is done periodically.

b) Threading Equipment: This consists of Strand Dispenser & a Pushing Machine. Physical inspection and scrutiny of supplier's documents are part of quality control measures.

c) Grout Mixer: As the name suggests, this one is used for mixing grout to be used for grouting the steel cables inside concrete. Large quantity of high quality grout mixes are required for the purpose and ordinary methods of mixing are usually not deployed. Physical inspection of equipment, scrutinies of supplier's documents, calibration certificate etc. are important aspects of quality control measures. For general idea, the grouting equipment should have a constant delivery pressure not exceeding 1 MPa.

Execution of post-tensioning operation in a Reinforced Cement Concrete (RCC) bridge or similar structure primarily include the following steps:

Cutting & Handling of Strands: The same is done as per approved Job Procedure, shop drawings in conjunction with relevant specifications. Cutting of strands are best done by friction saw or high-speed abrasive cutting wheel. Proper inspection is necessary in order to ensure compliance to specifications & job procedures.

Ducts & Anchorages Installation: The same is done as per approved Job Procedure & shop drawings in conjunction with relevant specifications. Proper inspection is necessary in order to ensure compliance to specifications, job procedures and drawings. For general idea, placement tolerances for ducts and anchorages are normally kept within +/- 5mm and anchorages are kept perpendicular to the tendons within +/- 1°.

Anchor cones, Plates & Blocks: These provide the necessary anchorage to the cables while applying tensile stresses. Proper inspection is necessary in order to ensure compliance to specifications, drawings etc.

Threading of Tendons: Proper inspection is necessary in order to ensure compliance to specifications, job procedure etc. For general idea – tendons to be cut at least 3 days after completion of grouting. Friction test on tendons are also conducted as per specifications. Total friction losses estimated from friction test on tendon should not exceed theoretical friction losses. Otherwised all wires are lubricated and re-tensioned.

Tensioning: Tensioning of cables or tendons are continued until required tendon load and extension are achieved. For general idea – forces on tendons should not exceed 75% of the prescribed minimum ultimate tensile strength of tendon material except during application of stress when the same should not exceed 80%. Proper inspection is necessary in order to ensure compliance to specifications, job procedure, drawings etc. and tensioning record sheets are kept.

Extension Measurement: Proper inspection is necessary in order to ensure compliance to specifications and job procedure. For general idea — measured extension is maintained within +/- 5% of estimated extension. Extension record sheets are maintained as part of QC measure.

Grouting: Proper inspection is necessary in order to ensure compliance to specifications, job procedure etc. For general idea — grout delivery pressure & w/c ratio should not exceed 1 MPa & 0.45 respectively. Grout temperature is also kept under control, say, within 32°C. The entire quantity of grout planned for a day or so needs to be injected in one continuous operation. Grout should be placed within 30 minutes of completion of mixing. Grout record sheets are maintained as part of QC measures.

The above steps have been discussed very briefly in order to provide a quick practical idea on the subject which otherwise is an extensive one. For more details, one needs to refer to specifications, job procedures, drawings etc.

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