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Study of Prestressed Concrete

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ABSTRACT

Prestressed concrete are widely used for the construction of major civil engineering structures. Concrete structures undergo distress with time due to environmental and other unfavorable operating conditions. To assess the safety and serviceability of the distressed concrete structure and to take decision on the possible repair measures, it is necessary to reliably estimate the existing level of stress. Determination of in-situ stress on the concrete surface is one way to assess the prestressing force available in the prestressed concrete members. Assessing the existing level of stress in prestressed concrete structures in service is fairly a difficult task and the engineers are often faced with lack of actual design / construction details and environmental service conditions. In-situ stress determination is based on the measurement of strain release due to local elastic stress relief, caused by core drilling and creation of stress-free boundaries. Three techniques, namely concrete core-drilling technique, concrete core trepanning technique and concrete core-drilling strain gage technique (CDSG) were developed to evaluate the in-situ stress under uniaxial and biaxial stress conditions.

Keywords: FRP, concrete beam, experimental work, prestress, shear strength

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1. INTRODUCTION

Prestressed concrete is a form of concrete used in construction which is "pre-stressed" by being placed under compression prior to supporting any loads beyond its own dead weight. This compression is produced by the tensioning of high-strength "tendons" located within or adjacent to the concrete volume, and is done to improve the performance of the concrete in service. Tendons may consist of single wires, multi-wire strands or threaded bars, and are most commonly made from high-tensile steels, carbon fibre or aramid fibre. The essence of prestressed concrete is that once the initial compression has been applied, the resulting material has the characteristics of high-strength concrete when subject to any subsequent compression forces, and of ductile high-strength steel when subject to tension forces. This can result in improved structural capacity and/or serviceability compared to conventionally reinforced concrete in many situations.

Prestressed concrete is one form of reinforced concrete. The compressive force is applied to members through a tensioned steel tendon or Fiber Reinforced Polymer (FRP) tendons, which is anchored at the ends or have a good bond to the concrete. This compression due to prestress causes stresses that reduces or nullifies the tensile stress in concrete, which is caused by bending due to applied load. If there is no tensile stress in the concrete, the cross section will not crack, and bearing capacity will increase.

2. MATERIAL

(A) Cement: present day concrete, cement is a mixture of lime stone and clay heated in a kiln at 1400 to 1600ºC. The types of cement permitted by IS: 1343 - 1980 for prestressed applications are the following. The information is revise as per IS: 456 - 2000, Plain andReinforced – Concrete Code of Practice.

a) Ordinary Portland cement confirming to IS: 269 - 1989, Ordinary Portland Cement, 33 Grade – Specification.
b) Portland slag cement confirming to IS: 455 - 1989, Portland Slag Cement – Specification, but with not more than 50% slag content.

c) Rapid-hardening Portland cement confirming to IS: 8041 - 1990, Rapid Hardening Portland Cement – Specification.

(B) Water : The water should satisfy the necessities of Section 5.4 of IS: 456 - 2000. "Water use for mixing and curing shall be clean and free from injurious amounts of oils, salts, acids, alkalis, sugar, organic materials or other substances that may be venomous to concrete and steel".

(C) Admixtures: These are used for improving the properties of concrete. The admixtures can be broadly divided into two types: chemical admixtures and mineral admixtures. The general chemical admixtures are as follows.
1) Air-entraining admixtures 2) Water reducing admixtures 3) Set retarding admixtures 4) Set accelerating admixtures 5) Water reducing and set retard admixtures 6) Water reducing and set accelerate admixtures.

(D) Prestressing Steel : 1) Forms of Prestressing Steel The development of prestressed concrete was influenced by the invention of high strength steel. It is an alloy of iron, carbon(1.5%), manganese,silicon(.3-.4%), and optional materials. The following material describes the types and properties of prestressing steel:-

a) Wires A prestressing wire is a single unit ready of steel. The nominal diameters of the wires are 2.5, 3.0, 4.0, 5.0, 7.0 and 8.0 mm.

b) Strands A few wires are spun together in a helical form to form a prestressing strand. The central wire is larger than the other wires.

c) Tendons A group of strands or wires are placed together to form a prestressing tendon. The tendons are useing in post-tensioned members.

d) Cables A group of tendons form a prestressing cable. The cables are useing in bridges.

e) Bars A tendon can be made up of a single steel bar. The diameter of a bar is much more than that of a wire. Bars are accessible in the following sizes: 10, 12, 16, 20, 22, 25, 28 and 32 mm

3. TESTING PROCEDURE

The beams were arranged as simply supported in the testing machine and subjected to a single point load at midspan, The beams were loaded in deflection control with increments of 3.9·10-4 in. (0.01 mm) per second until flexural cracks appeared at the bottom of the beam. The initial crack was marked and the beam unloaded and reloaded again until the crack re-opened. In order to determine the so-called decompression load, one LVDT-gauge was mounted across the crack. The beams were loaded and unloaded three times in order to monitor the accuracy of the measurements. Shown is the arrangement of the beams in the testing machine. Shown is the LVDT-gauge mounted across the crack. The decompression load was determined from the load versus crack-width diagram where a significant change in the displacement, recorded by the LVDT gauge, occurred after the crack re-opened. The decompression load was determined by intersecting the tangents of the two slopes, where the crack-width versus load diagram for one of the loading cycles for beam number 1 is shown.

The final decompression load was calculated as the mean value of the decompression loads of the three loading cycles. The intersection point was found using , was estimated visually (i.e. "by hand"),δthe following procedure: the intersection point, regression lines were adapted to the upper and lower slopes of the curve, respectively. For the 10-4.lower slope, the regression line was adapted from the point where the displacement was 4 10-4.in. (0.01 mm) (avoiding the irregularities in the region 0-4 in.) to the point on the slope 10-4. - 2δcorresponding to the displacement in. (0.005 mm). For the upper slope the 10-4. + 2δregression line was adapted between the point corresponding to the displacement in. 10-4.(0.005 mm) to the endpoint of the slope, 7.3 in. (0.02 mm). This procedure, i.e. 10-4.adding/subtracting 2 in. (0.005 mm) to/from the intersection point, was used in order to avoid the irregularities when the change in slope occurs. Finally, the final intersection point was found by intersecting the upper and lower regression

4. TESTING RESULTS:

The measured and initial prestressing forces and prestress losses for each beam are presented

Table 1: initial prestressing forces and prestress losses for each beam

Beam	Initial prestress	Measured Prestressed force,kips		Prestress Losses,%
		Average	Range	
1	567	349	343-358	38
2	567	351	346-356	38
3	567	215	211-226	61
4	550	346	343-353	37
5	550	281	276-284	48

CONCLUSIONS

The prestress losses in the beams are relatively high compared to results from similar tests found in the literature, which probably is due to the ambient climate in which the beams have been stored. An almost constant temperature of 90°F (32°C) and low relative humidity increases both the creep and shrinkage strains in the concrete. **-** Model B3 was the most accurate of the prediction models and was in good agreement with the prestress losses obtained from the tests. **-** Most of the prediction models underestimate the measured prestress losses, one possible explanation for the deviation between prediction models and measured prestress losses is the influence of the ambient climate.

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