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Design of Prestressed Precast Beam

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ABSTRACT

Prestressed beam is defined as beam that had internal stresses introduced to counteract ,to the degree desired, the tensile stresses that will be imposed in service. The stress is usually imposed by tendons of individual hard-drawn wires, cables of hard-drawn wires, or bars of high strength alloy steel. Compressive stressed can be introduced either by pretensioning or by post-tensioning. The current paper emphasizes on prestressed design of precast beam considering various stages such as transfer stage, lifting stage, erection stage. The paper also enclosed the various losses that takes place during prestress and after prestressing.

Keywords: Prestressing, precast beam, losses in prestressing, Sign Convention - indicates Tension and + indicates Compression

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I. INTRODUCTION

Precast beam: The precast beams are those which are cast in factory's, away from the structure in a very controlled environment, and ideal conditions are provided to castings so as to ensure the maximum strength of the beam. They are cast, compacted, set and cured in very controlled environment and after getting its required strength they are transported to the real location where the beams are to be used and placed as whole and joint are made.

Prestressing - Prestressing is introducing a compressive Stresses to the concrete to counteract the Tensile Stresses that will result from an applied load. There are two methods of introducing prestressing to a concrete, namely Pre-Tensioning and Post Tensioning.

Losses in Prestressing - The force which is used to stretch the wire to the required length must be available all the time as prestressing force if the steel is to be prevented from contracting. Contraction of steel wire occurs due to several causes, affecting reduction in the prestress. This reduction in the prestressing force is called loss in prestress.

In a prestressed concrete beam, the loss is due to the following:

1) Elastic shortening
2) Shrinkage of concrete
3) Creep of concrete
4) Frictional loss
5) Relaxation of steel

II. PROBLEM FORMULATION

Design of a Rectangular Precast Prestressed Beam is carried out based on the 'Permissible Stresses' mentioned in IS 1343:2012. The length of beam is 6 m. The various loads considered are as follows:

For Transfer Stage: Self Weight of Beam.

For Lifting Stage: Self Weight of Beam considering Lifting points at distance 0.5 m from both the ends.

For Service Stage: Self Weight of Beam, Dead loads acting on beam such as floor load, wall load

III. LOSSES DURING PRESTRESSING

Based on the Beam designed, i.e. 4 strands of ϕ15.2 mm prestressed at 0.76fpu at 50 mm distance from soffit and creates a prestressing force of 791.62 kN.

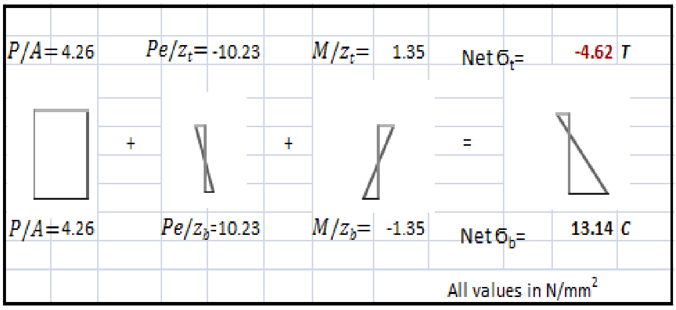
During Transfer Stage there is loss due to Elastic Deformation which is = 82 N/mm^2
Hence Prestressing Force at Transfer Stage is 709.62 kN.

During Service Stage there are losses due to Elastic Deformation, Creep, Shrinkage and Relaxation of Strands.
Losses due to Creep of Concrete = Es*Єcr ultimate = 140.67 N/mm^2
Losses due to Shrinkage = Es*Єcs = 85.90 N/mm^2
Loss due to Relaxation of Strands = 2.5% = 35.34 N/mm^2
Total losses at Service Stage is 343.93 N/mm^2
Hence Prestress Force during Service Stage is 447.71 kN.

IV. STRESS EVALUATION AT VARIOUS STAGES

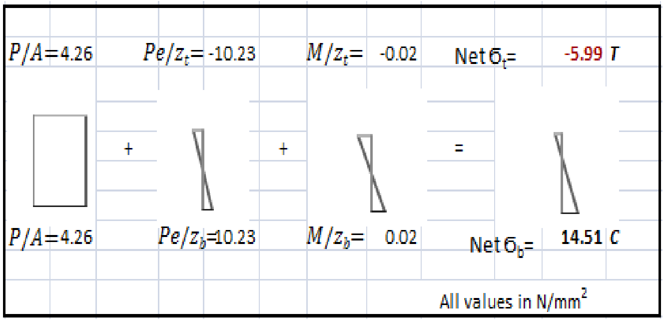
1) Stress Evaluation at Transfer Stage:

Stress due to Prestressing Force = P/A = 4.26 N/mm^2
Stress due to 'P.e' = 10.23 N/mm^2
Stress due to 'M' = 1.35 N/mm^2



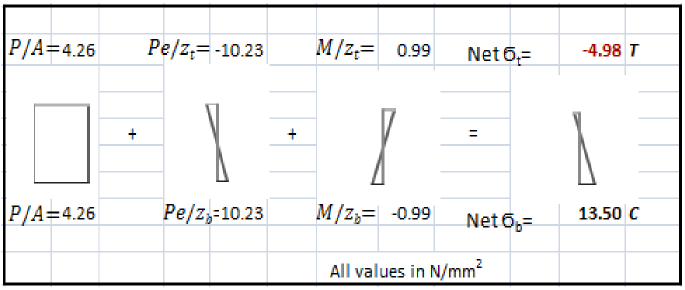
2) Stress Evaluation at Lifting Stage : At Lifting Points

Stress due to Prestressing Force = P/A = 4.26 N/mm^2
Stress due to 'P.e' = 10.23 N/mm^2
Stress due to 'M' = 0.02 N/mm^2



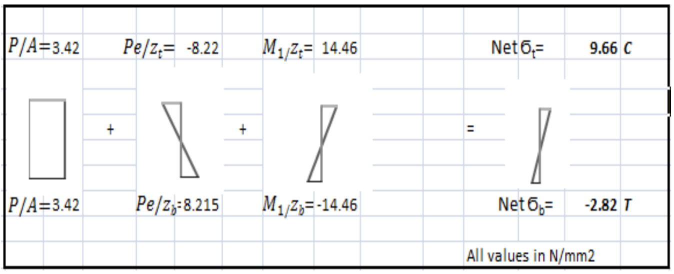
4) Stress Evaluation at Lifting Stage: At Mid Span

Stress due to prestressing force = P/A = 4.26 N/mm^2
Stress due to 'P.e' = 10.23 N/mm^2
Stress due to 'M' = 0.99 N/mm^2



5) Stress Evaluation at Service Stage: At Mid Span

Stress due to prestressing force = P/A = 4.26 N/mm^2
Stress due to 'P.e' = 10.23 N/mm^2
Stress due to 'M' = 14.46 N/mm^2



Upward Deflection due to prestressing is 4.18 mm and
Downward Deflection due to service loads is 9.21mm
Hence the net deflection value is 5.03 mm (downward)

V. CONCLUSION

After the evaluation of Stresses at various stages, it is found that the stresses are within the limiting constraints. The locations where the tension stresses are exceeded are controlled by introducing tension reinforcement in the beam. Net deflection is within the limiting criteria as prescribed by IS 1343 : 2012.

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