Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 6, Issue 7; October-December, 2019, pp. 447-450
© Krishi Sanskriti Publications
http://www.krishisanskriti.org/Publication.html

Study on Effect of Decrease in Depth of Bottom Flange of an I-Section Beam Subjected to Prestress

Rekha. M[1], Swethaa. B[2] and Ramya. S[3]

[1]*Assistant Professor, Department of Civil Engineering, Sri Lakshmi Ammal Engineering College*
[2]*Assistant Professor, Department of Civil Engineering, Sri Lakshmi Ammal Engineering College*
[3]*Assistant Professor, Department of Civil Engineering, Sri Lakshmi Ammal Engineering College*
E-mail: [1]jasminerekha19@gmail.com, [2]swethaabaskaran@gmail.com, [3]ramya.chml@gmail.com

Abstract—*Structural members being the backbone of every construction, will always be looked upon with a scope for development in every aspect possible, be it strength, durability, material usage etc. With the perspective on improving the equivalent, and expository investigation has been taken up for a Prestressed concrete beam of I-Section has been analysed for various loading criteria. When it comes to economy, I section can be considered an advantage as it consumes less materials. Further reduction in the size of the bottom flange and its effect on resultant stress has been studied without compromising with the ability of the beam in carrying design loads. The scope of this research thus focuses on limiting the size of the bottom flange of the I-Section without having to permit tensile stresses in the bottom flange even at excessive loading condition.*

1. INTRODUCTION

The permanent stress in the structural element has been induced intentionally in a concrete structure, for improving its behavior and strength under various service conditions called prestress. In reinforced concrete, a composite material with combined advantages of concrete and steel. The compressive stresses are endured by concrete while tensile stresses are entirely taken care of by steel. In prestressed concrete, compression is induced prior to external loading. The tensile stresses caused by the external load could be counteracted by this priorly induced stresses. This compression stress 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.

2. LITERATURE STUDY

Yoyong Arfiadi and Alfian WirantaZebua(2015),. have analysed the cross-section and the prestressing force for an optimized PCS section, for a greater economy. For PCS members, identifying the section fulfilling the optimum criteria is not an easy task. This because there is no corrolation between the size of cross-section and prestressing force in the structure. The optimization using both sections and prestressing force is carried out by real coded genetic algorithm.

Abejide et al. (2014) has presented the probabilistic evaluation of the safety of post-tensioned prestressed concrete simply supported bridge beams at ultimate limit state in flexure as specified in ACI 318 (2002) with due consideration to the loadings recommended in BS 5400 (1978), and AASHTO (2004), is presented with a review of the relevant design process.

Abhinav S. Kasat et al. (2012) has analyzed the prestressed concrete beams by using finite element analysis using ANSYS 12.1 and they investigated on the study of deformation of the structural properties such as deflection, stress distribution using a rectangular beam. The beam is modelled as simply supported beam and showing the various results on experimental study to reduce the strand stress range at such critical sections providing to be beneficial to byproduct of strengthening and also shows the failure mechanism of a prestressed concrete beam is modeled.

Nimiya Rose Joshuva et al. (2010) have studied the response of reinforced and pre-tensioned concrete beams to vertical loading using the finite element software package ANSYS 12.0. On comparing the behavior of the RC beam with that of the prestressed concrete beam, the advantage of prestressing was verified as the prestressed concrete beam was seen to show a higher service load range and higher ultimate load capacity.

Paolo Casadei et al. (2005) have investigated on the flexural performance of pre-stressed concrete double T beams upgraded in the positive moment region with steel reinforcement polymer composing materials and reports on the test results to failure of three beams, a control specimen, a beam strengthened with one ply of SRP (steel reinforced polymer).

The third beam strengthened with two piles of SRP anchored at both end with SRP U-wraps showing significant on both flexural capacity and enhanced pseudo-ductility has been reported. SRP composite materials have shown to be effective in increasing the flexural capacity of the double-T PC beams. End anchors in the form of SRP U-wraps have shown to be effective by preventing a complete detachment, once debonding has occurred throughout the concrete-SRP interface.

3. ANALYTICAL WORK

The analytical work of prestressed concrete single span I-section beam has been carried out using structural analysis and design software STAAD. Pro. In the analysis of development of stresses in PSC structural sections concrete has been considered homogeneous and elastic material and the planar sections remains in its state even after the flexure takes place.

3.1 Properties of the Section

The beam considered has the span(L) of 10 m with depth (D) of 1500 mm. The width of the top flange (B1) is 1000 mm with thickness (T1) being 150 mm. The width (B2) of the web is 200 mm. The width and thickness/depth (T3) of the bottom flange is 150 mm. The depth of the bottom flange being varied gradually by reducing 150mm to 0 mm without compromising the overall depth of the section.

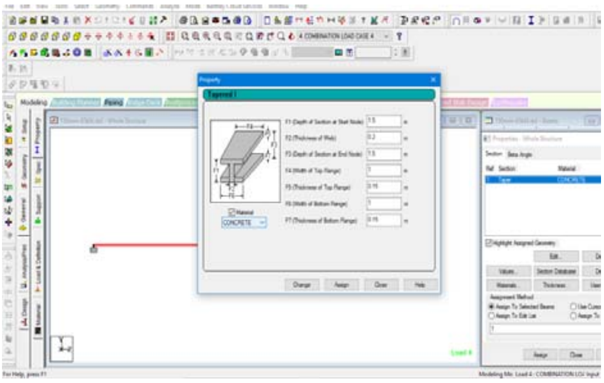

Figure 1: Assigning section property for I-section beam.

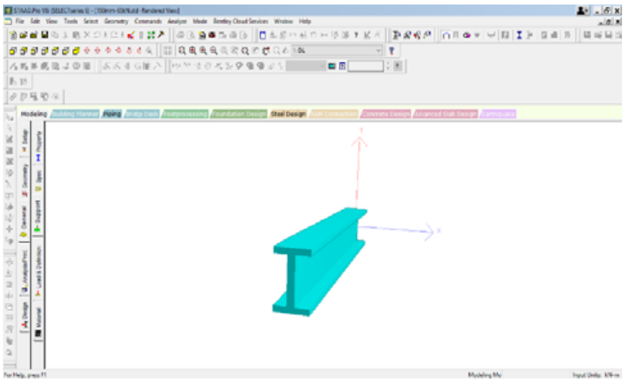

Figure 2: 3D view of I-section beam.

Figure 1. and Figure 2. explain how the section property has been assigned and the three-dimensional view of the I-Section beam respectively.

The material properties for beam (I-section) are Characteristic compressive strength concrete, f_{ck} is 35N/mm^2 and with reference to IS 1343-1 /clause 5.2.3.1, Young's modulus of elasticity, E is $5000\sqrt{35}$ 2474.87N/mm^2. The unit weight of concrete, γ is 25N/mm^2. Figure 3. explains how the material property has been assigned.

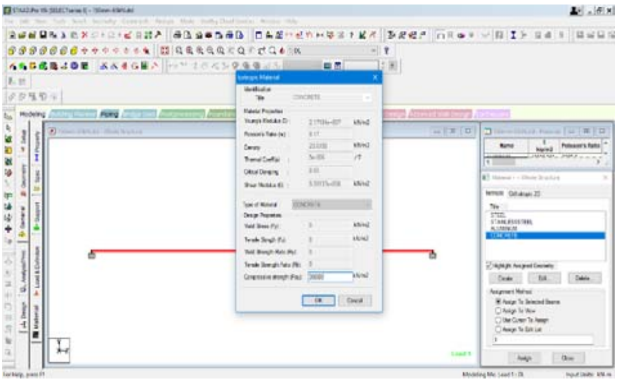

Figure 3: Assigning material property.

3.2 End Condition

The beam is considered fixed at both the ends. Fixed supports can resist vertical and horizontal forces as well as a moment. Since they restrain both rotation and translation, they are also known as rigid supports.

3.4 Load and Load Combinations

The following load and load combinations has been considered for the stress analysis of the PSC beam. The primary load cases such as dead load, external load was considered. The TABLE 1. shows various load combinations considered. Also, prestressing of magnitude 250kN has been considered in this analytical study. The load combinations of various loading conditions have been considered as per Indian Standards.

Table 1: Load Combinations.

S. No.	Factor F1	Load	Factor F2	Load	Factor F3	Load kN/m	
1	1.5	DL	1	POST	1.5	L	5
2	1.5	DL	1	POST	1.5	L	10
3	1.5	DL	1	POST	1.5	L	15
4	1.5	DL	1	POST	1.5	L	20
5	1.5	DL	1	POST	1.5	L	25
6	1.5	DL	1	POST	1.5	L	30

Note: Load Combination is considered as [(F1 × DL) + (F2 × POST) + (F3 × L)]

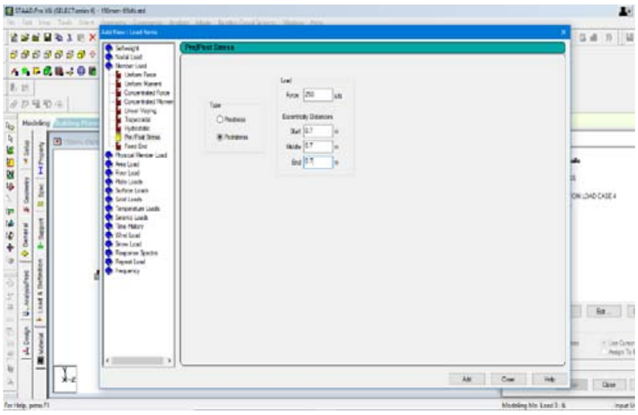

Figure 4: Assigning poststress force.

3.5 Post processing

Once the material properties, section properties and the load cases are assigned, analysis is performed. The stresses at the top and bottom flanges of the critical load cases are considered. The external load of magnitude 5kN/m, 10kN/m, 15kN/m and 25kN/m, 30kN/m has been applied for each section, wise 150 mm, 90 mm, 30mm and 0 (T-section) are studied at the midspan of the beam and the resultant stress values at the 4 corners are tabulated correspondingly.

The resultant stress diagram of I-section beam with varying the depth of the bottom flange and for various external load cases has been shown in the Figure 5-6. The stress variations in the beam subjected to flexure has been shown clearly with colour ranges. In Figure 5 the maximum compressive stress is 2.34 and maximum tensile stress is 1.45. It shows the stress at midspan of the beam. The corner stress at both corners of top and bottom fibre at 5m has been tabulated.

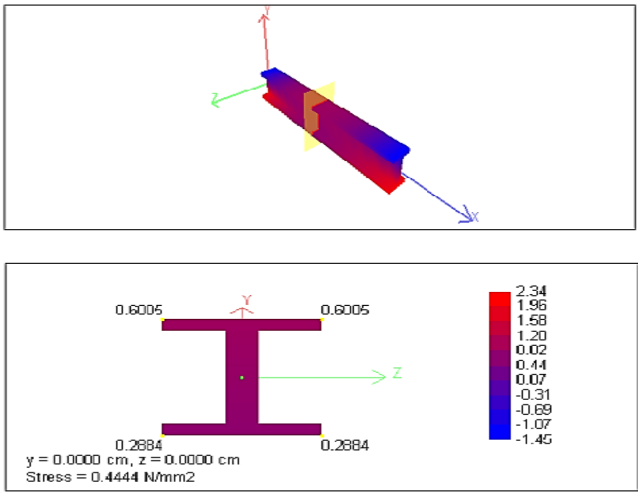

Figure 5: Resultant stress diagram of beam with bottom flange of 150mm thickness at 25kN/m.

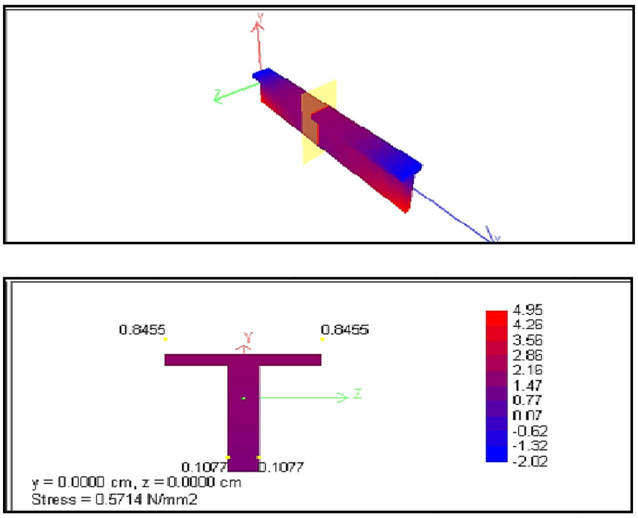

Figure 6: Resultant stress diagram of beam with no bottom flange (T-Section) at 25kN/m.

3.6 Data Interpretation

From the results it has been understood that as the bottom flange thickness/depth has been reduced there is a considerable increase in stress and the further reduction has induced tensile stresses. As the load increases for the same area, the stress has been increased which is a known fact. Even as the external load increases in magnitude for the same section it has the capability to withstand higher stresses.

4. RESULTS AND DISCUSSION

Figure 7 - 11 shows the graphical representation of stress at bottom fibre in varying section and their corresponding magnitude of load.

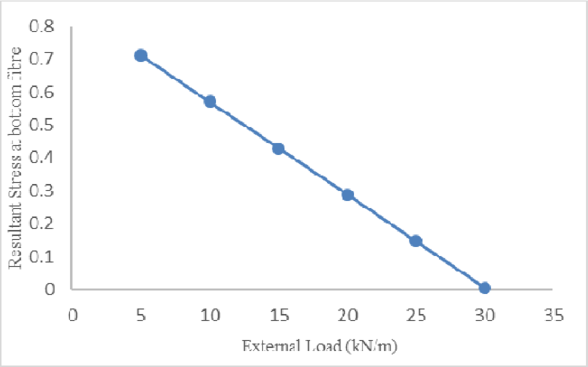

Figure 7: Resultant stress at the bottom fibre vs external load with bottom flange 150mm thick.

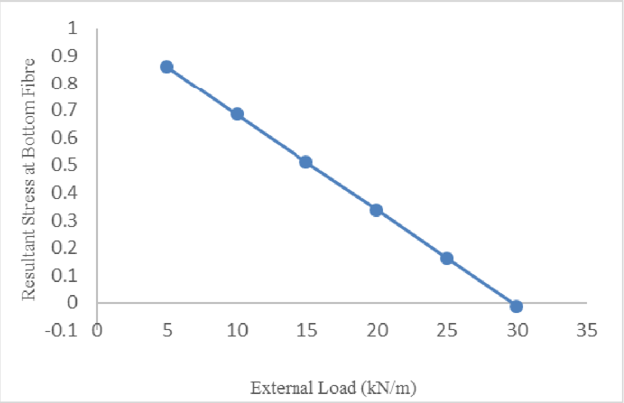

Figure 8: Resultant stress at the bottom fibre vs external load with bottom flange 90mm thick.

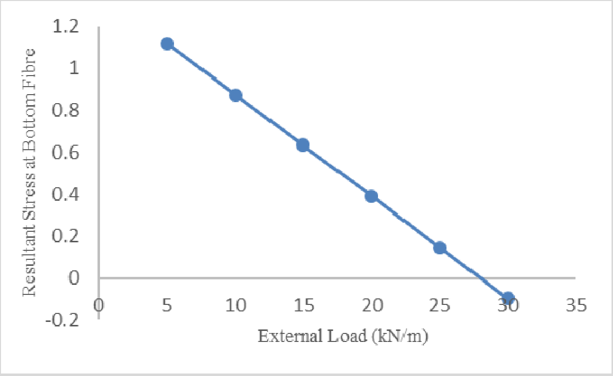

Figure 9: Resultant stress at the bottom fibre vs external load with bottom flange 30mm thick.

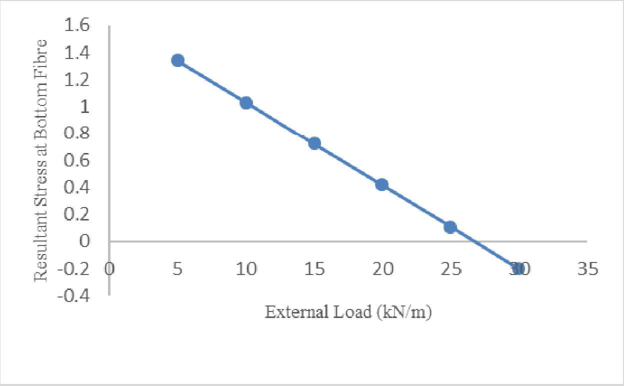

Figure 10: Resultant stress at the bottom fibre vs external load with no bottom flange (T-section).

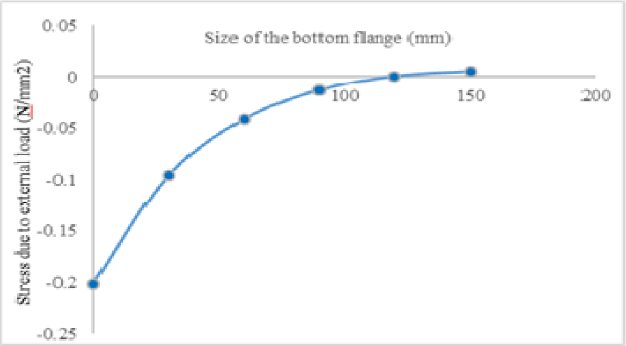

Figure 11: Resultant stress at the bottom fibre vs bottom flange thickness at 30kN/m external load.

5. CONCLUSION

1. It can be seen that the depth of the bottom flange of the beam section plays a major role in limiting the tensile stresses in the bottom fibre.
2. It can also be inferred that when the depth of the flanges are maintained equal, there are no tensile stresses developed considerably even at heavier loading conditions.
3. But, as the depth of the flange gets reduced gradually, tensile stresses are found to occur at relatively heavier loads.

REFERENCES

[1] Abhinav S. Kasat &Valsson Varghese (2012) "Finite Element Analysis of Prestressed Concrete Beams" International Journal of Advanced Technology in Civil Engineering Vol.1.

[2] Abejide Gbenga Samuel &Abejide O. S (2014) "Safety Analysis of Prestressed Concrete Bridge Beams in Flexure", International Journal of Sciences: Basic and Applied Research(IJSBAR) Vol.17, No 2, PP 260- 274.

[3] Rajesh Bhargava, K. K. Pathak & Saleem Akhtar (2015) "Numerical and Experimental Investigations of Single Span Pre-Stressed Concrete Beams", Journal of Indian Concrete.

[4] Anupam Sharma & Suresh Singh Kushwah (2015) "Comparative Analysis of Reinforcement & Prestressed Concrete Beams", International Journal of Current Engineering and Technology, Vol. 5, No.4.

[5] Satyajeet B. Mopari& Ajinkya D. Raut, (2015) "Experimental Study of Steel Fiber Prestressed Concrete Beam for Shear, Bending and Torsion", Journal of Innovation in Engineering Science and Technology

[6] Mohamed Husain, Khaled Fawzy, & Ahmed Nada,(2015) "Numerical Analysis Investigation of the Behaviour of Prestressed Beams with Carbon Fiber Strands" Journal of Engineering and Innovative Technology(IJEIT).

[7] Shady H. Salem, Khalid M. Hilal, Tarek K. Hassan, Ahmed S. Essawy, (2013) "Experimental Behaviour of Partially Prestressed High Strength Concrete Beams", Open Journal of Civil Engineering, Vol.3.