EXAMPLE 2-020
Simply Supported Pre-stressed Concrete T-Beam under 4-Point Loading

1. EXAMPLE DESCRIPTION

Figure 1 shows a simply supported pre-stressed beam (Pre-stressing force of 34.33 KN). The displacement control is applied till reaching the failure of the beam. Dimensions and loading setup are shown in Fig. 1.a. The mesh discretization of the beam used in ELS is shown in Fig.1.b.

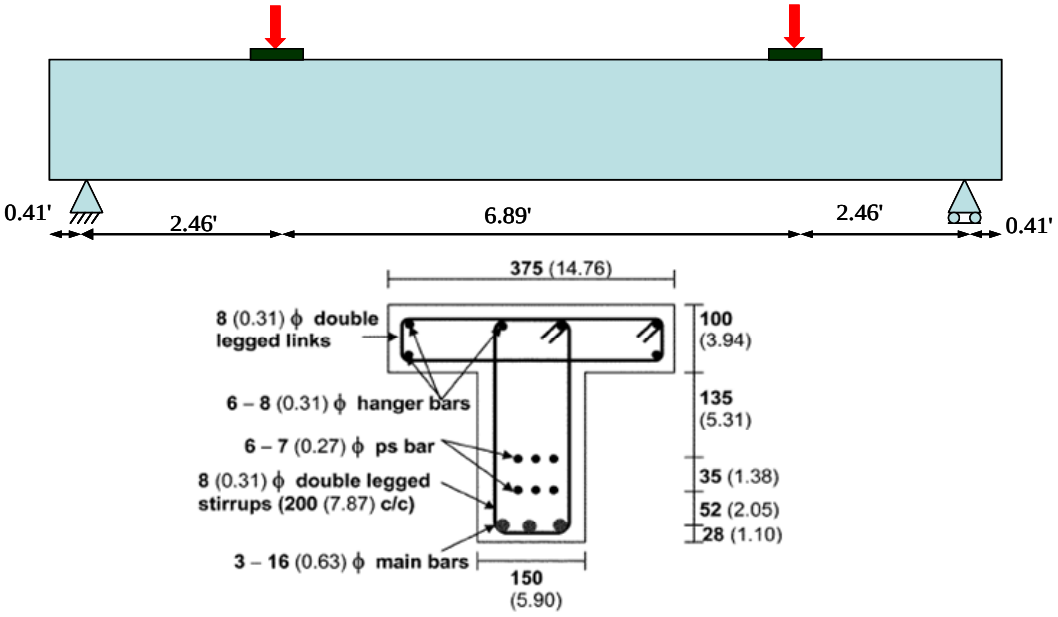

Fig. 1.a Problem geometry [Ref. 1]

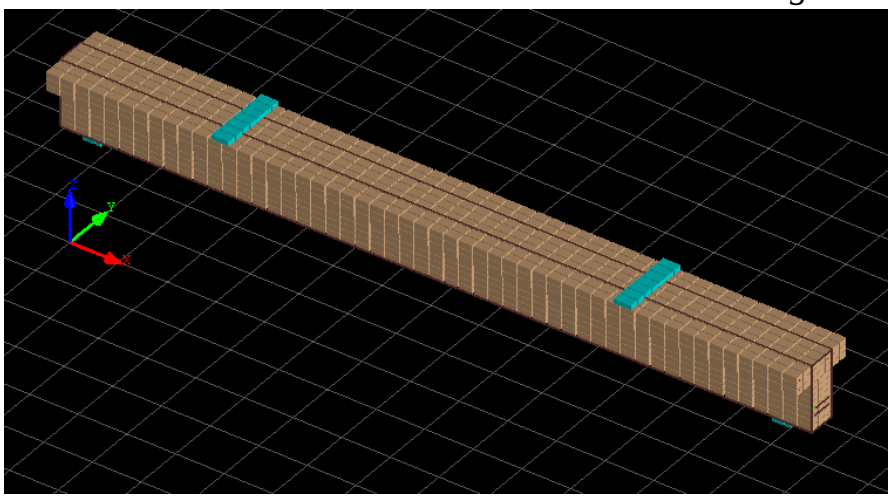

Fig. 1.b ELS mesh

Fig. 1 Simply supported pre-stressed beam

2. MATERIAL PROPERTIES

The compressive strength of the concrete is 10.80 ksi (0.074 kN/mm^2), while the yielding stress of the steel reinforcement is 63.08 ksi (0.43 kN/mm^2) The yielding stress of the tendons is 208.8 ksi (1.44 kN/mm^2).

The applied element method follows a discrete crack approach, in which, the material is represented by a group of springs located at the surfaces of the element. The springs represent the axial and shear behavior of the material. For more details about material constitutive models refer to the ELS® technical manual.

3. RESULTS

Figure 2 illustrates the Load-deflection analytical results compared to the experimental ones. As can be obviously seen, the results are very close to the experiments. The behavior is well predicted in the elastic stage, the post cracking stage and post-yielding stage. In other words, the overall response could be successfully obtained by ELS.

Figure 3 shows the calculated principal strain contours. The principal strains represent a good, obvious representation of crack localizations. Fig. 4 shows the observed experimental cracking pattern of the Beam. The experimental cracks are generally in a good agreement with the ELS results.

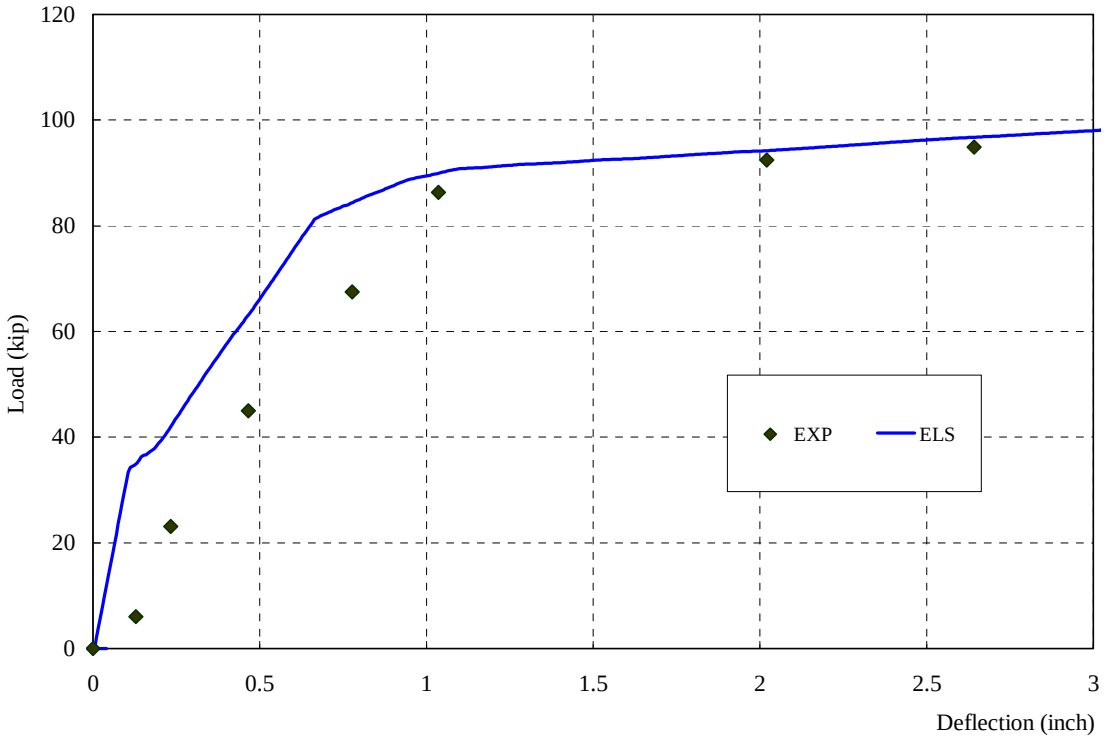

Fig. 2 Load-deflection predicted by ELS in a comparison to the experimental results

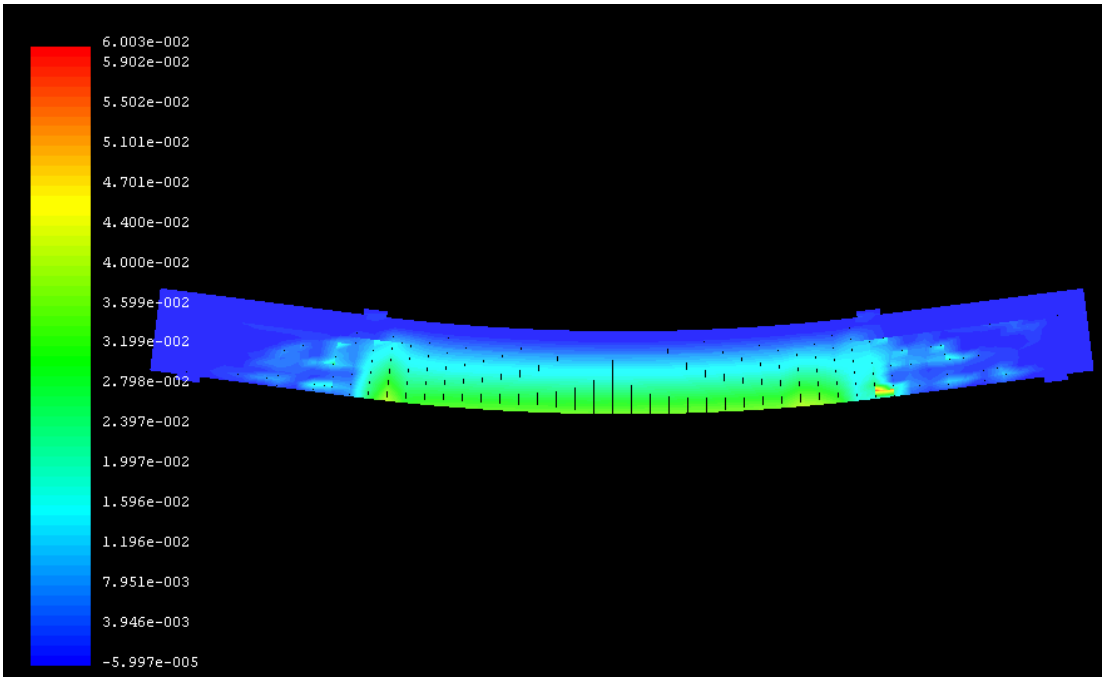

Fig. 3 Principal strain contours predicted by ELS

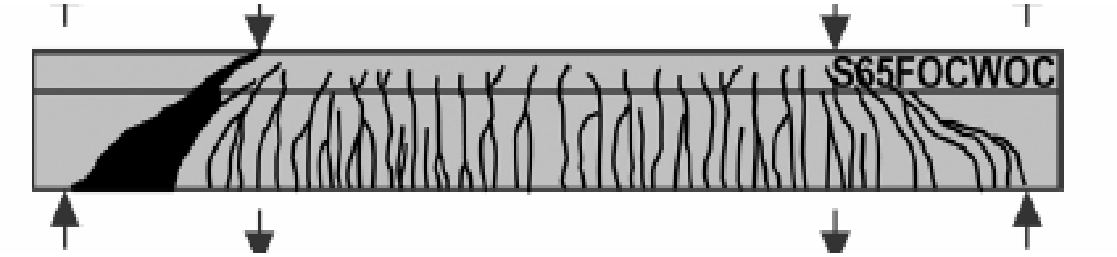

Fig. 4 Observed experimental cracking pattern

4. CONCLUSIONS

Based on the analytical and experimental results, it can be concluded that the ELS can successfully analyze and predict a close-to-reality behavior of external Pre-stressed beams in the elastic, post-cracking and post-yielding stages.

5. REFERENCES

1- Job Thomas and Ananth Ramaswamy, "Shear Strength of Prestressed Concrete T-Beams with steel Fibers Over Partial/Full Depth ", ACI Structural Journal, V.103, No. 3, May-June 2006.

2- Technical Manual of Extreme Loading for Structures.