EXAMPLE 2-002

Reinforced Concrete Deep Beam without Web Reinforcement Subjected to Four-Point Loading

1. EXAMPLE DESCRIPTION

Fig.1 shows a reinforced concrete deep beam subjected to four-points loading under displacement control till reaching failure [Ref. 1]. Dimensions, reinforcement details and loading setup are shown in Fig. 1.a. The beam has no web reinforcement except at the end, beyond the support, and in the middle 15.75" of the beam, in order to hold the top reinforcement. The mesh discretization of the beam used in ELS is shown in Fig.1.b.

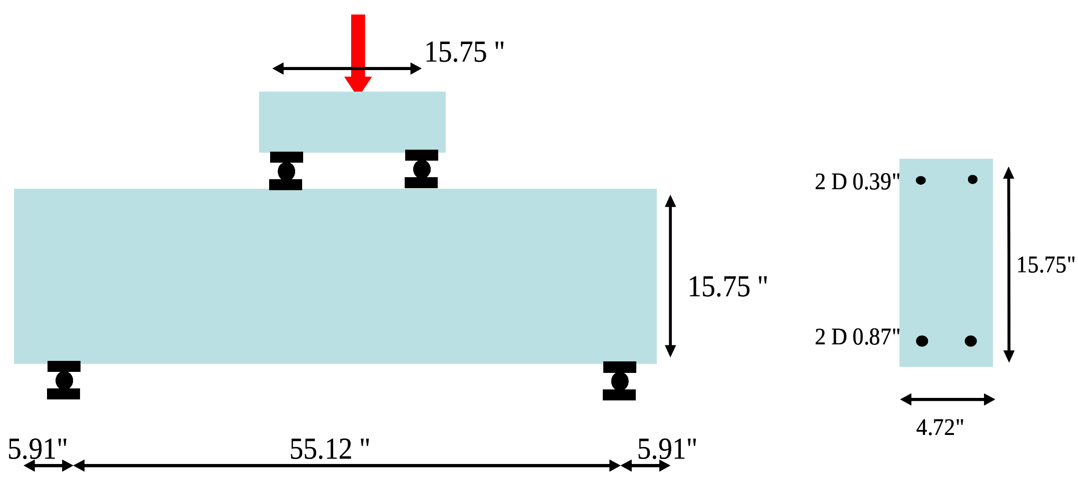

Fig. 1.a Problem geometry

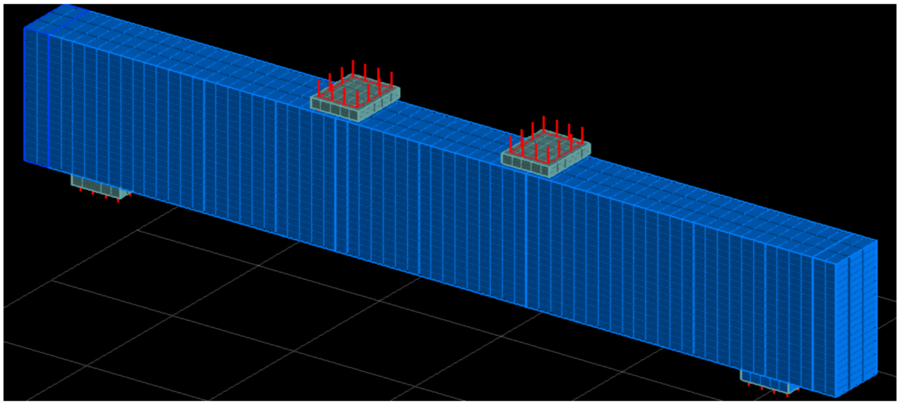

Fig. 1.b ELS mesh.

Fig. 1 Simply supported RC deep beam subjected to 4 point loading.

2. MATERIAL PROPERTIES

The compressive strength of concrete is 7.11 ksi (0.05 kN/mm^2), while the yield stress of the reinforcement was 56.89 ksi (0.39 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

Fig. 2 illustrates the load-deflection analytical results compared to the experimental ones. As can be seen, the results are close to the experiments. The behavior is well predicted in the elastic stage as well as in the post cracking stage. The failure mode is well captured. Compression failure at the end of the diagonal crack, beneath the loading plate, took place and the load dropped at that stage. The overall response could be successfully obtained by ELS.

Fig. 3 shows the calculated principal strain contours as well as the deformed shape. The principal strains represent a good, obvious representation of crack localizations. The deformed shape also shows the crack openings. The crack opening is shown as a movement of the neighboring elements far away from each other, i.e. it is a discrete crack. Fig. 4 shows the observed experimental cracking pattern where experimental cracks are generally in good agreement with the ELS results.

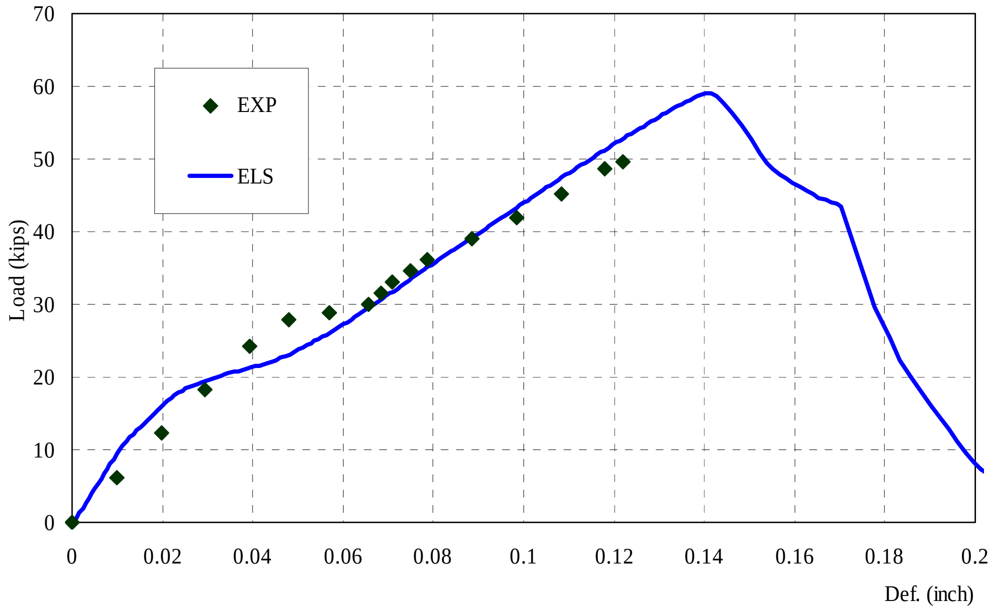

Fig. 2 Load-deflection predicted by ELS in a comparison to the experimental results.

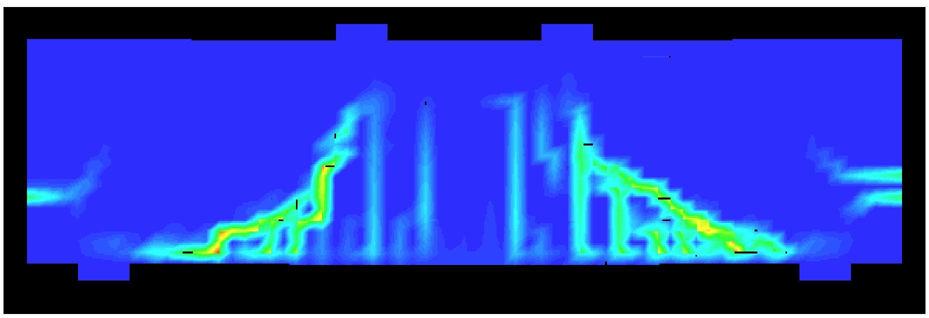

Fig. 3.a Principal strain contours.

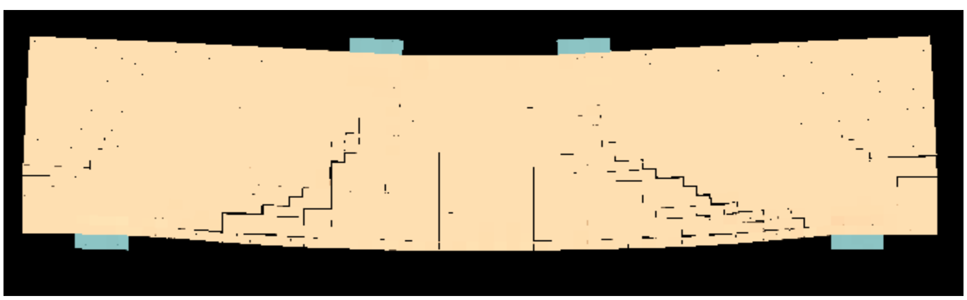

Fig. 3.b Cracking pattern.

Fig. 3 Calculated principal strain contours and cracking pattern.

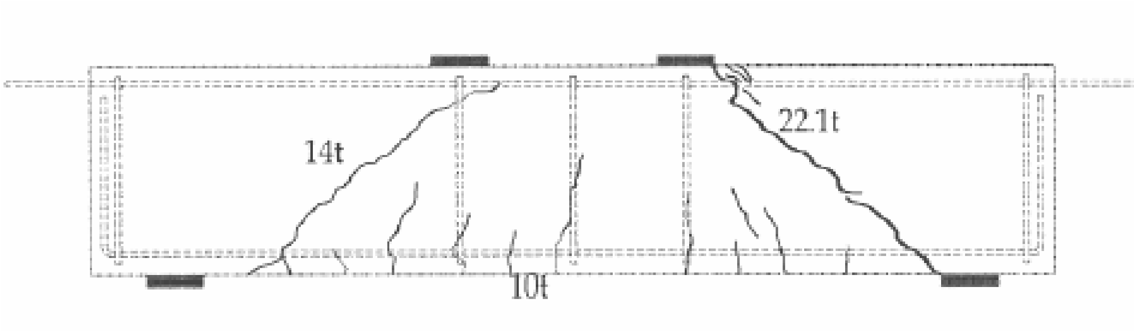

Fig.4 Observed experimental cracking pattern

4. CONCLUSIONS

Based on the analytical and experimental results, it can be concluded that ELS can successfully analyze and predict a close-to-reality behavior of reinforced concrete deep beams failing in shear.

5. REFERENCES

1- Chang-Jin Yang and Dae-Han Jun "A Study On The Shear Behavior Of Deep Beam Under Point Loads", Proceedings of the ninth East Asia-Pacific Conference on Structural Engineering and Construction, Bali, Indonesi, 2003, pp.85-90

2- Technical Manual of Extreme Loading for Structures.