EXAMPLE 3-001
Reinforced Concrete Deep Beam under Cyclic Load

1. EXAMPLE DESCRIPTION

Figure 1 illustrates a reinforced concrete deep beam subjected to inversed cyclic loading [Ref. 1]. Dimensions, reinforcement details and loading setup are shown in Fig.1.a. The mesh discretization of the problem as used in ELS® is shown in Fig.1 .b. Figure 2 shows the displacements at each stage.

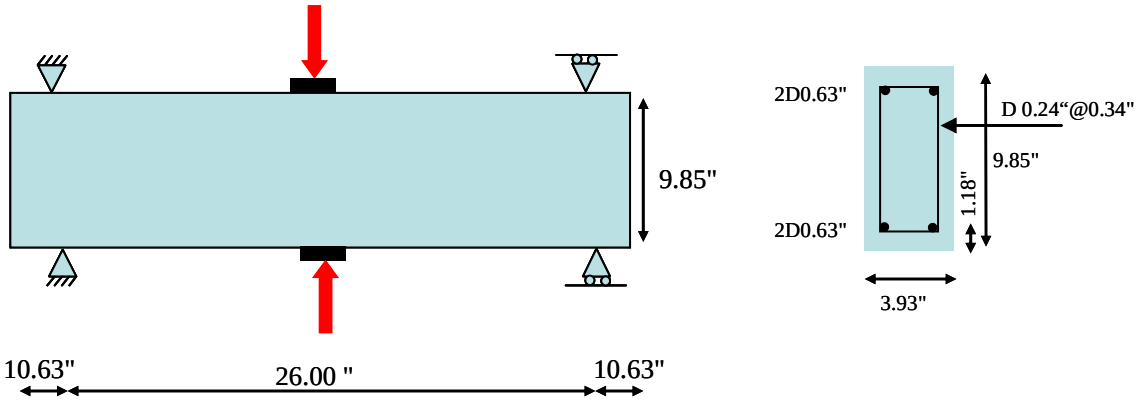


Fig. 1.a - Problem geometry

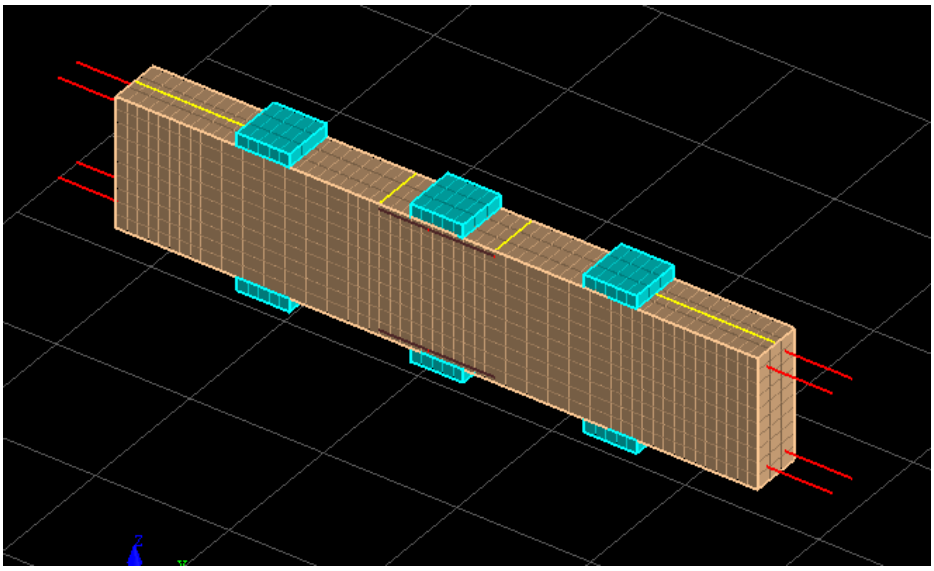


Fig. 1.b ELS Mesh

Fig. 1 Reinforced concrete Deep Beam under cyclic load

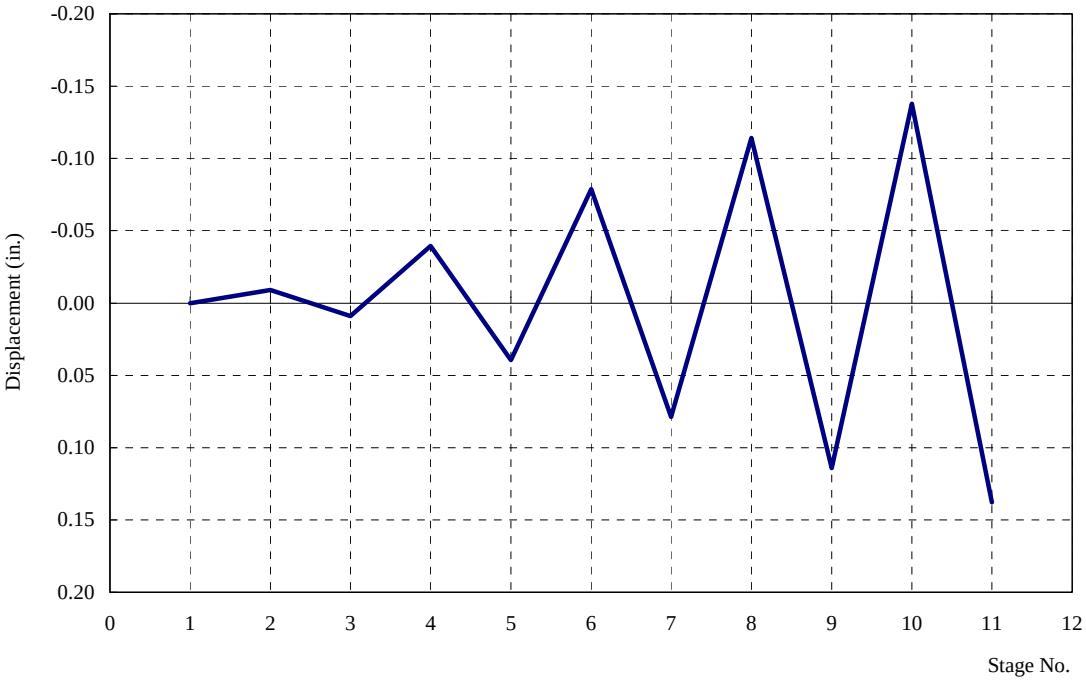


Fig. 2 Input displacements at each stage

2. MATERIAL PROPERTIES

The compressive strength of concrete is 7.91 ksi (0.055kN/mm^2), while the yield stress of the reinforcement was 51.77 ksi (0.36 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 3 illustrates the analytical load-deflection curve compared to the experimental one. As can be obviously seen, the analytical results are in a good agreement with the experiments, despite some discrepancy in the hysteretic loops. The behavior is reasonably predicted in the elastic stage, post cracking stage, post-yielding stage, and in the hysteretic loops. The overall response could be generally well obtained by ELS.

Fig. 4 shows the observed experimental cracking pattern of the Beam compared with the ELS®. The experimental cracks are generally in a good agreement with the ELS results.

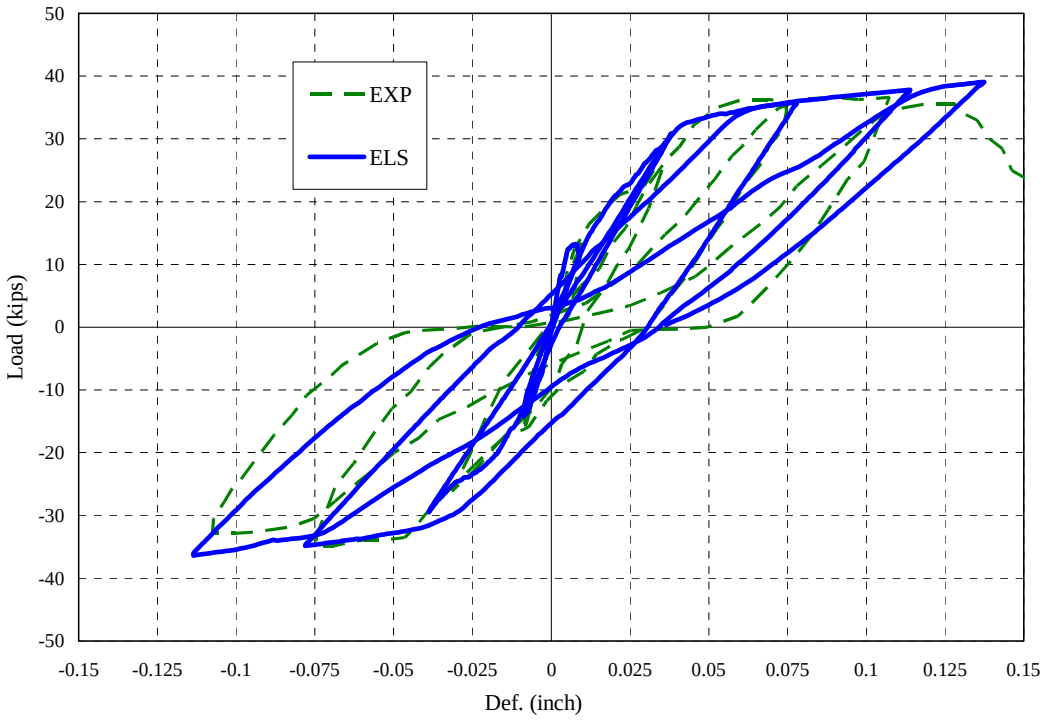
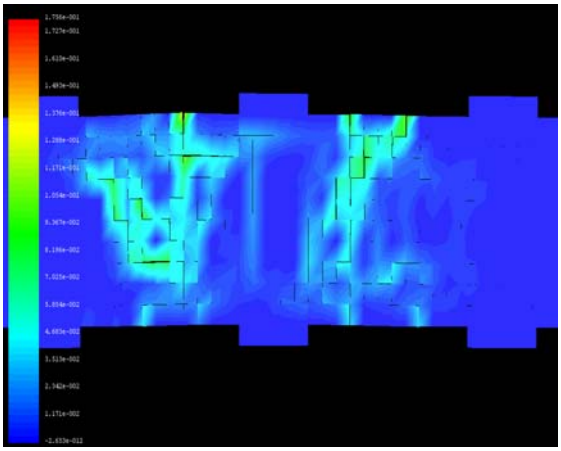
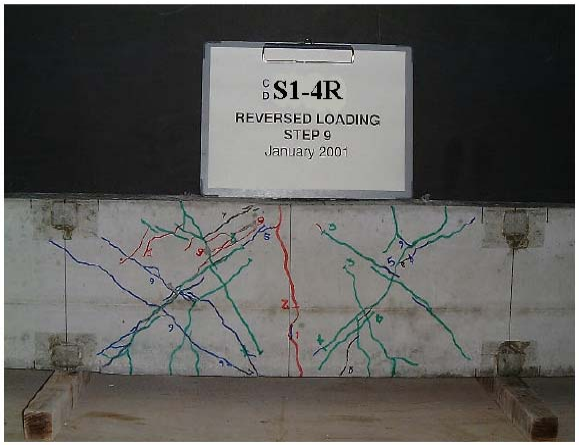


Fig. 2 Load-deflection predicted by ELS in a comparison to the experimental results



ELS



Experimental

Fig. 3 Cracking Patterns Predicted by ELS in a comparison to the experimental results

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 nonlinear behavior of reinforced concrete structures under cyclic loading.

5. REFERENCES

1- Thammanoon denponangpan "Effect of reversed loading on shear behavior of reinforced concrete", www.kochi-teck.ac.jp/library/ron/2000/g/1035013.PDF

2- Technical Manual of Extreme Loading for Structures.