EXAMPLE 3-003
Reinforced Concrete Slab under Cyclic Point Load

1. EXAMPLE DESCRIPTION

Figure 1 illustrates a reinforced concrete slab subjected to cyclic loading at its top. 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 [Ref. 1]. Figure 2 shows the displacements at each stage.

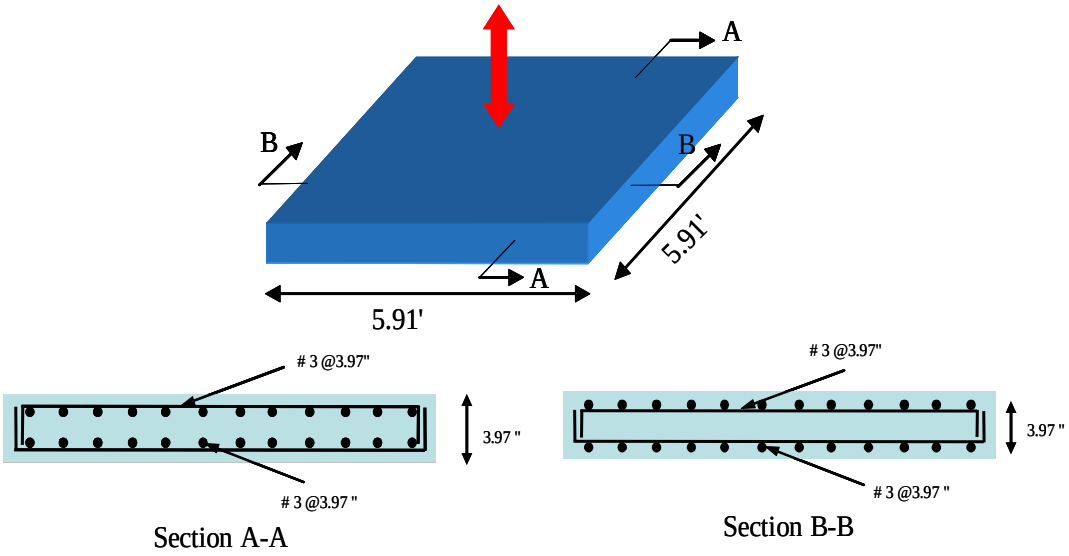


Fig. 1.a Problem geometry

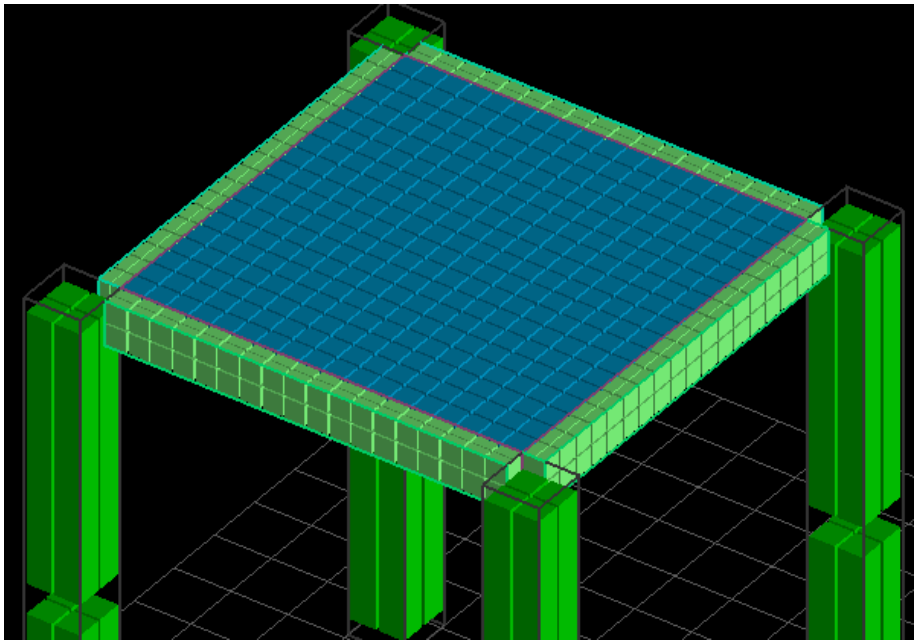


Fig. 1.b ELS mesh

Fig. 1 Reinforced concrete slab under cyclic point load

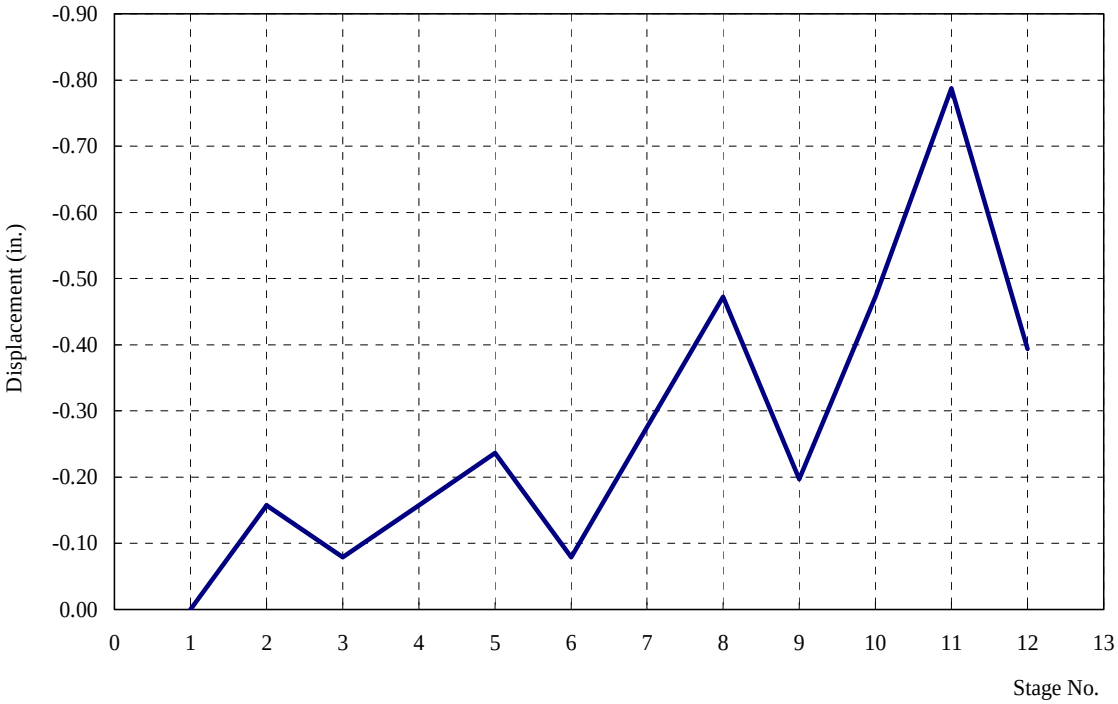


Fig. 2 Input displacements at each stage

2. MATERIAL PROPERTIES

The compressive strength of the culvert concrete is 5.26 ksi (0.037 kN/mm^2), while the yield stress of the reinforcement was 54.08 ksi (0.38 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 load-deflection analytical results compared to the experimental ones. As can be obviously seen, the results are close to 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. Te overall response could be generally well obtained by ELS.

Figure 4 shows the calculated principal strain contours. The principal strains represent a good, obvious representation of crack localizations Fig. 5 shows the observed experimental cracking pattern of the side walls and top slab of the slab. The experimental cracks are generally in a good agreement with the ELS results.

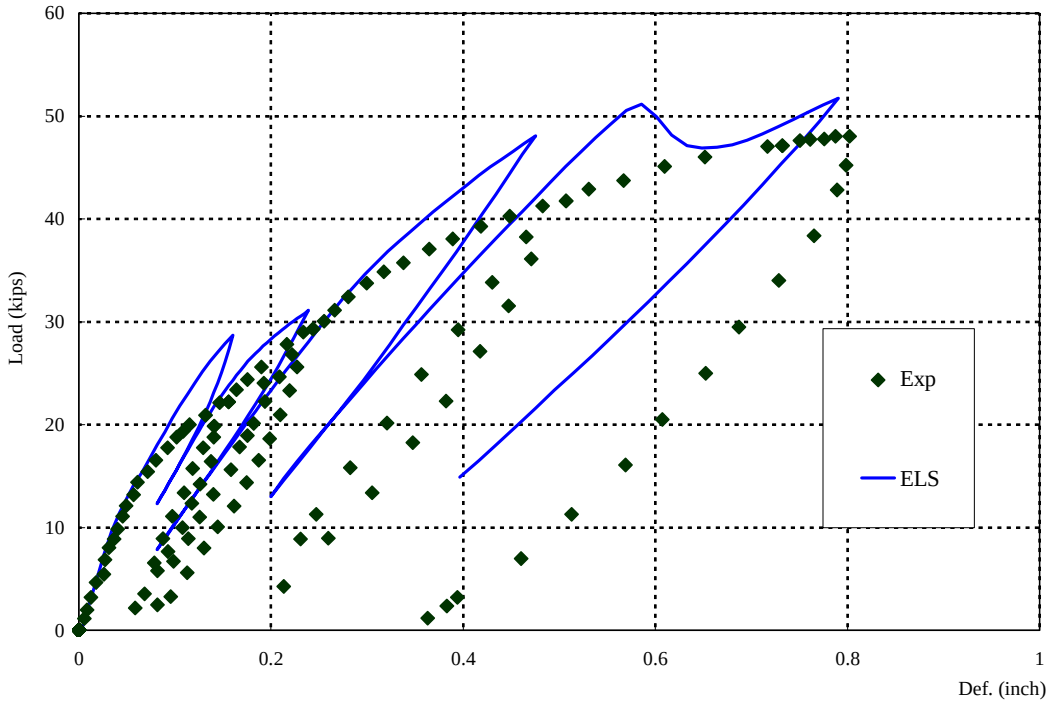
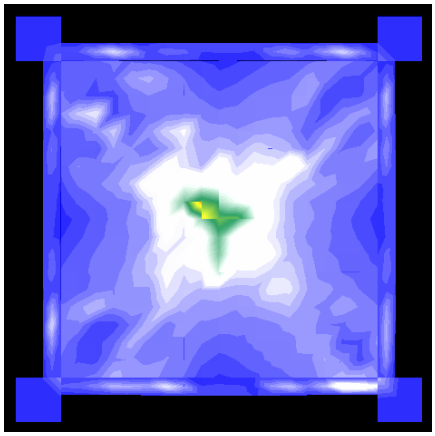
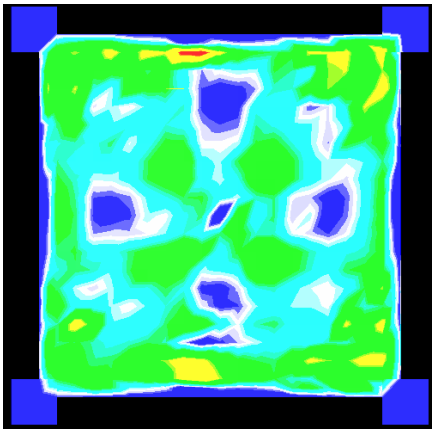


Fig. 3 Load-deflection predicted by ELS in a comparison to the experimental results

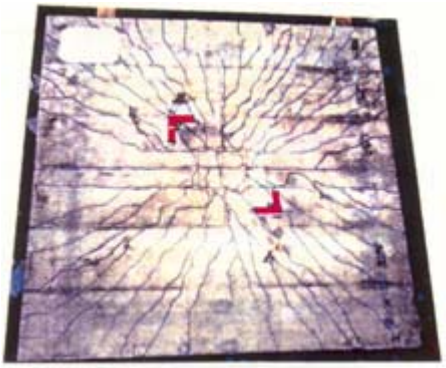


Bottom Face

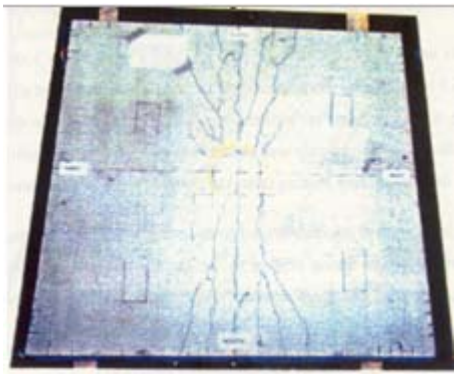


Top Face

Fig. 4 Calculated principal strain contours



Bottom Face



Top Face

Fig. 5 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 nonlinear behavior of reinforced concrete structures under cyclic loading.

5. REFERENCES

1- IRAWAN Paulus "Three dimensional analysis of reinforced concrete structures" Ph. D. dissertation, The University of Tokyo, 1995.

2- Technical Manual of Extreme Loading for Structures.