EXAMPLE 1-001
Linear Analysis of a Statically Indeterminate Beam

1. EXAMPLE DESCRIPTION

Fig. 1 shows a statically indeterminate beam. Dimensions, geometry and cross section are shown in Fig.1.a. Loading is shown in Fig.1.b & Fig.1.c. The ELS mesh and beam loading and boundary conditions are shown in Fig.1.c.

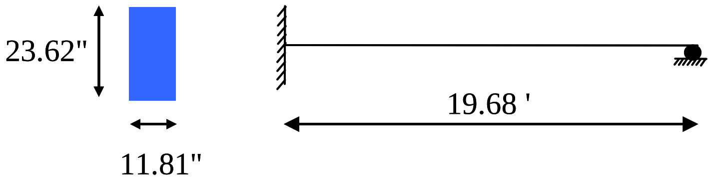

Fig. 1.a Geometry of the beam.

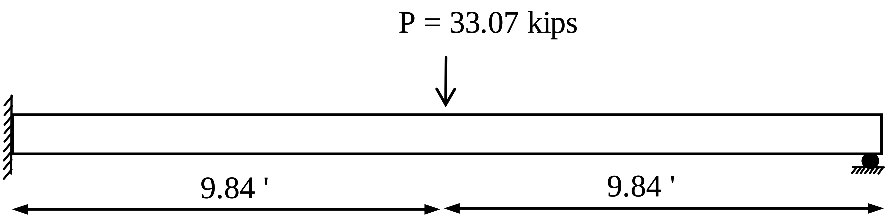

Fig. 1.b Beam loading

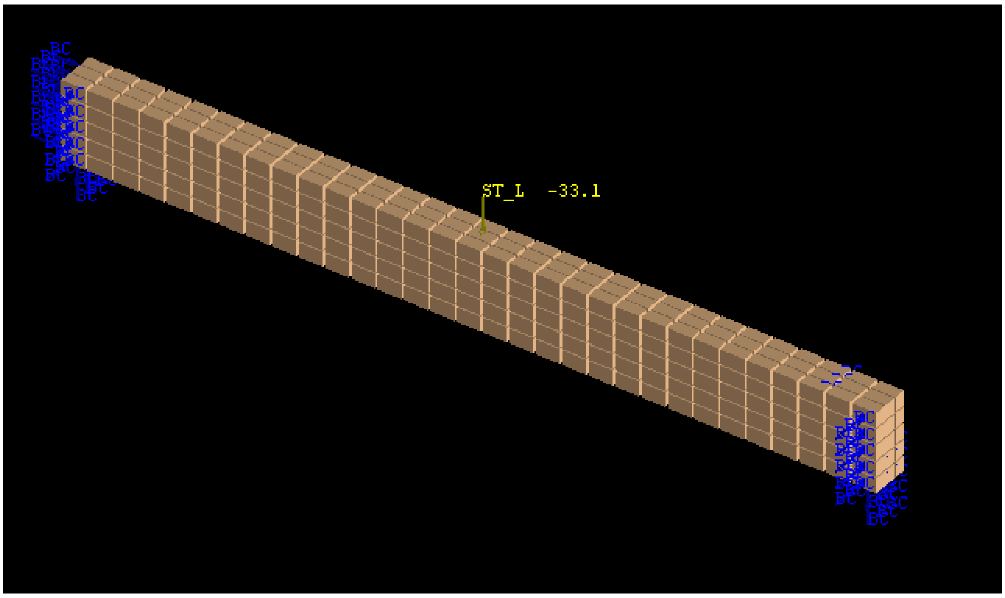

Fig. 1.c ELS mesh, boundary

2. MATERIAL PROPERTIES

The material composing the beam is assumed elastic with a modulus of elasticity of 3499.35 ksi (24.131 kN/mm^2). The shear modulus is 1400 ksi (9.652 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

The applied element method (AEM) and hand calculations (elementary beam theory) give the deflection at mid span and the rotation at the hinged end as follows:
The deformation shape of the beam is as follows;

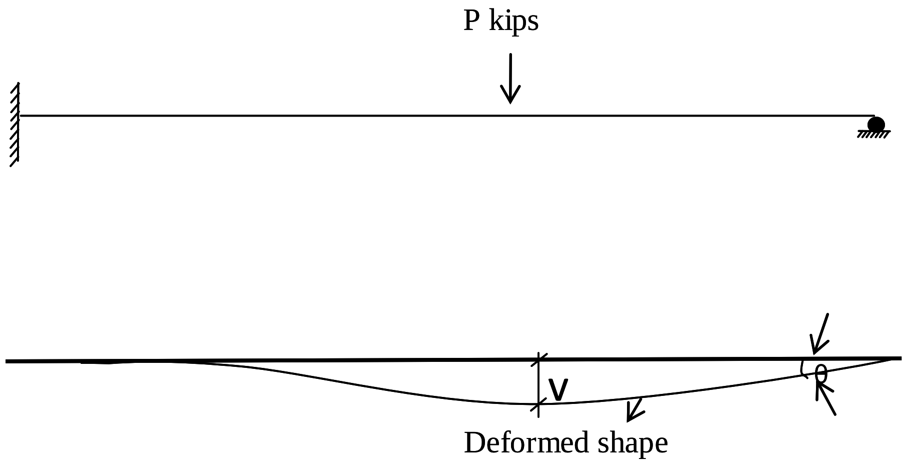

Fig. 3.a Deformed shape

The deflection of beam at mid span using elementary beam theory[1] is as follows;

$$v = \frac{-7 \times PL^3}{768EI}\ , \qquad P = 33.07\ \text{kips}$$

$$v = 0.0875\,\text{inch}$$

The calculated deflection from ELS is 0.081 as shown in Fig. 3.b.

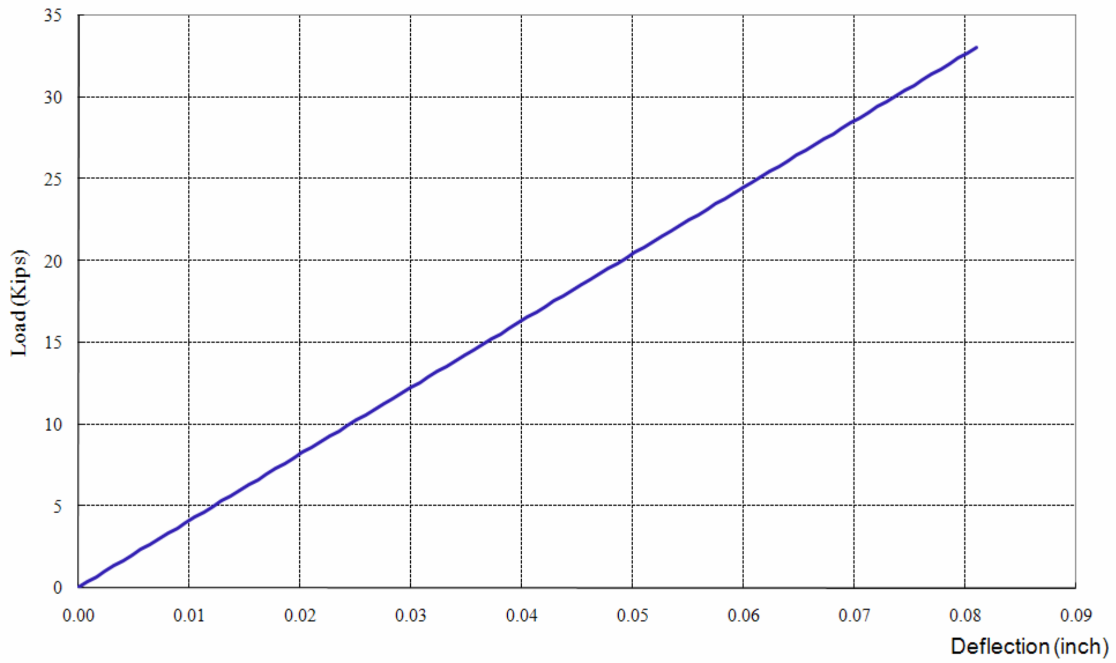

Fig. 3.b Load-deflection relation at mid span using ELS

The rotation at the beam end using elementary beam theory[1] is as follows;

$$\theta = \frac{PL^2}{32EI} = 0.00127 \text{ rad}$$

The rotation from ELS analysis is 0.00119 rad as shown in Fig. 3.c;

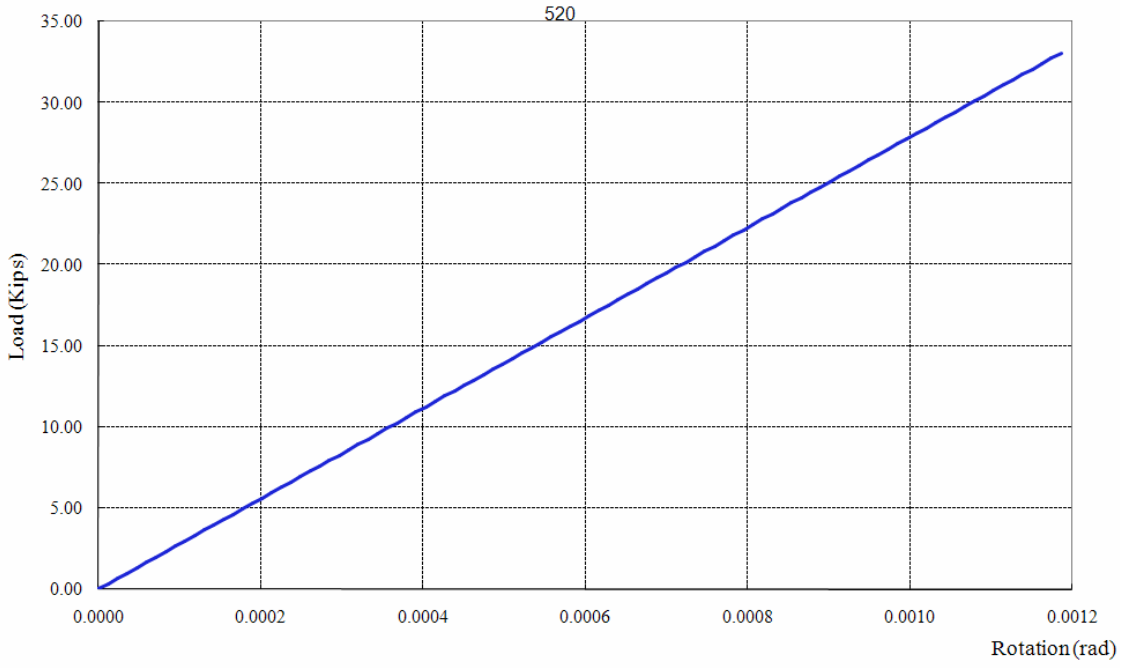

Fig. 3.c Load rotation relation at the hinged end using ELS

4. CONCLUSION

Based on the results obtained from numerical results of ELS®, it can be concluded that the ELS® gives similar results to beam theory.

5. REFERENCES

1- David V. Hutton, Fundamentals of finite element analysis, Elizabeth A. Jones, 2004

2- Technical Manual of Extreme Loading for Structures.