

**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.

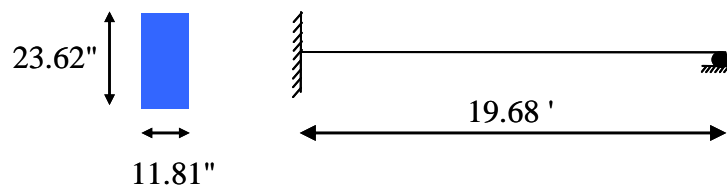


Fig. 1.a Geometry of the beam.

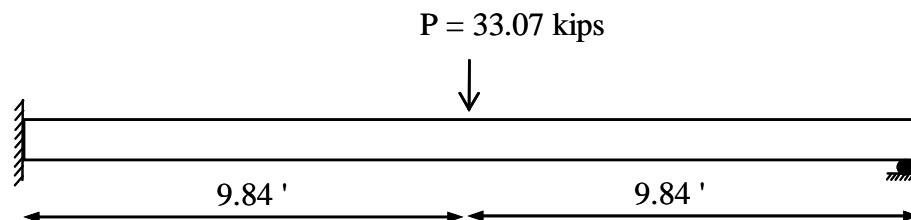


Fig. 1.b Beam loading



### 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;

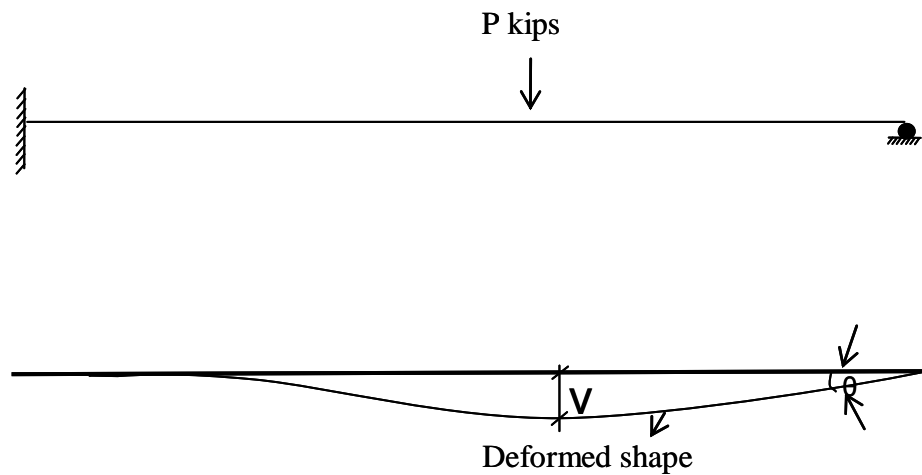


Fig. 3.a Deformed shape

The deflection of beam at mid span using elementary beam theory<sup>1</sup> is as follows;

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

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

The calculated deflection from ELS is 0.0867 as shown in Fig. 3.b.

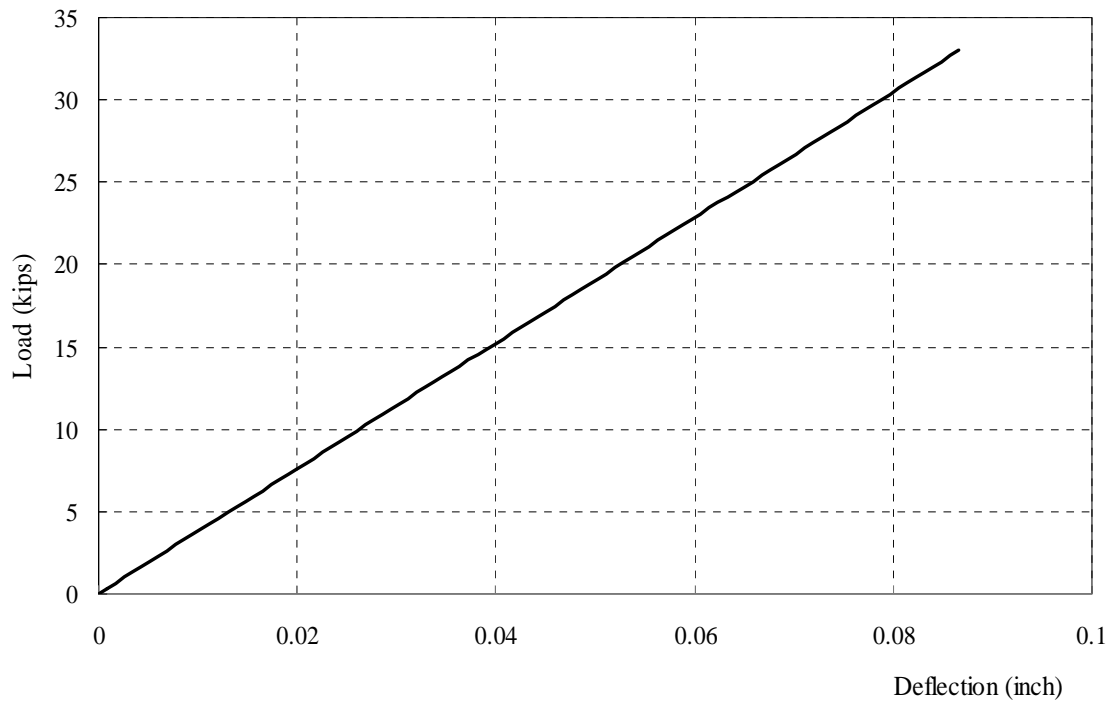


Fig. 3.b Load-deflection relation at mid span using ELS

The rotation at the beam end using elementary beam theory<sup>1</sup> is as follows;

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

The rotation from ELS analysis is 0.00127 rad as shown in Fig. 3.c;

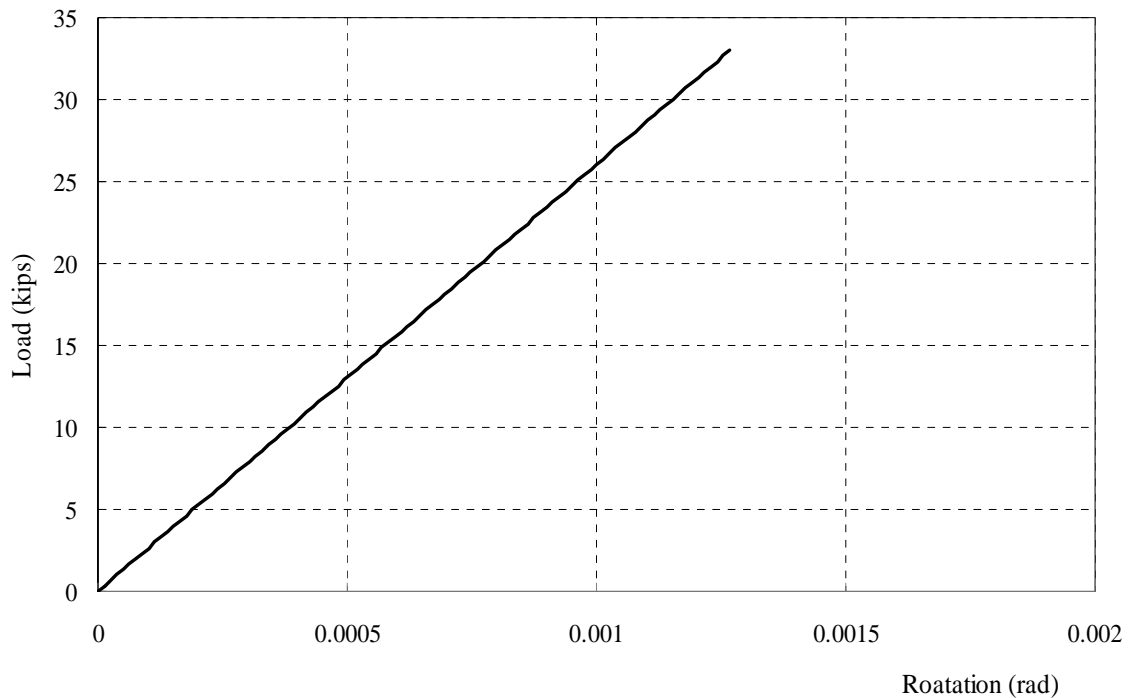


Fig. 3.c Load rotation relation at the hinged end using ELS

#### 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.