EXAMPLE 1-002

Linear analysis of statically indeterminate Frame

1. EXAMPLE DESCRIPTION

Fig.1.a shows a statically indeterminate frame. Fig.1.b and Fig.1.c show dimensions, geometry and cross section. The ELS mesh and beam loading are shown in Fig.1.d.

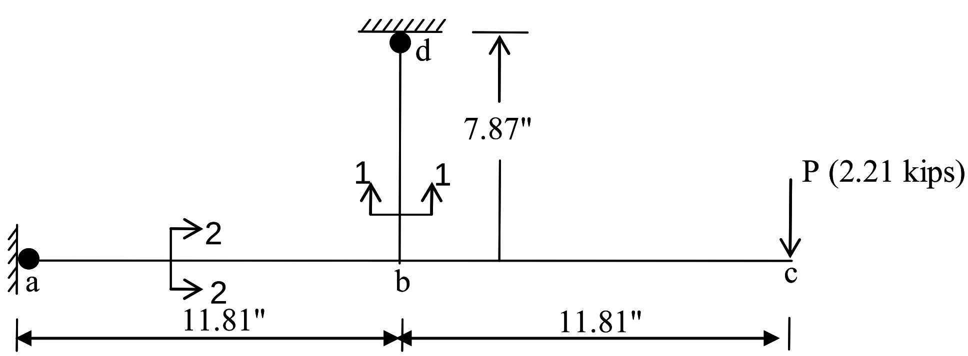

Fig. 1.a Geometry and loading

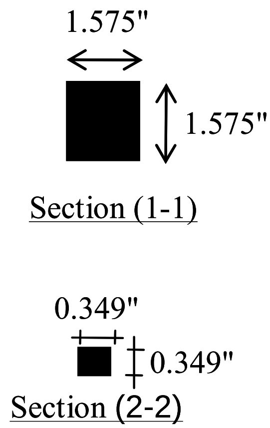

Fig. 1.b Frame cross sections

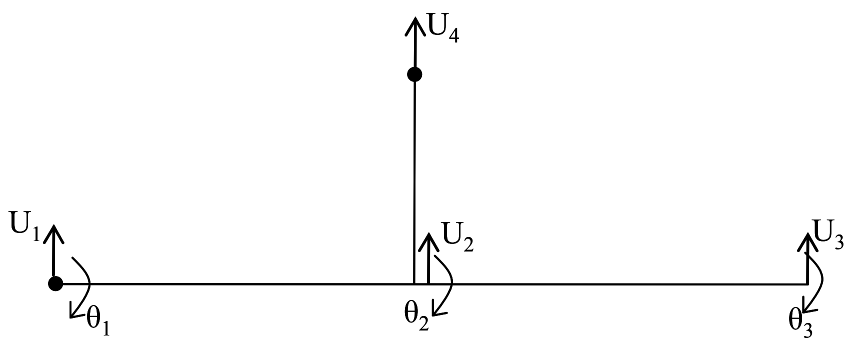

Fig. 1.c Rotation and displacement at every joint

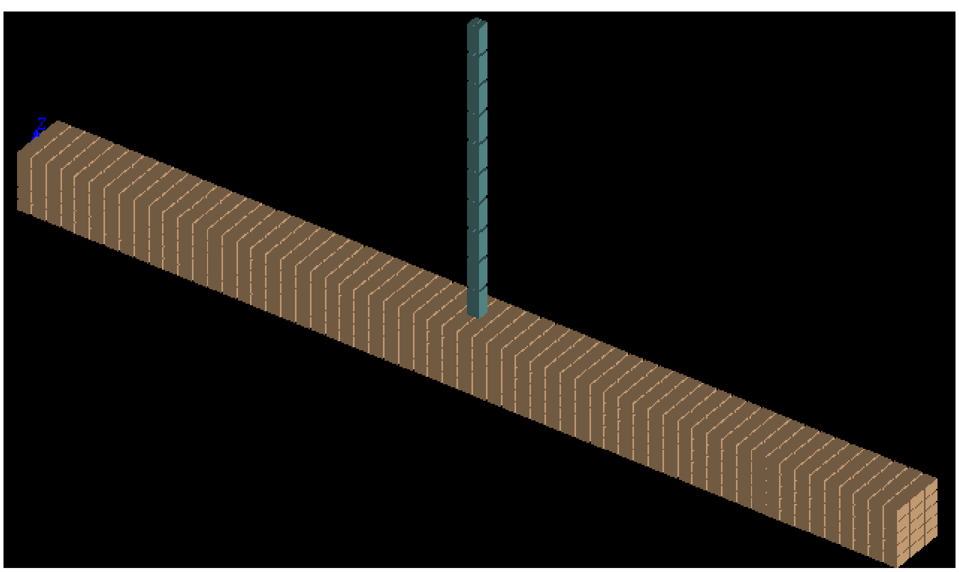

Fig. 1.d ELS mesh.

2. Material Properties

The material composing the beam (a-c) is assumed elastic with a modulus of elasticity of 30022.7 ksi ($2.07x10^5$ N/mm^2). The shear modulus is 12009 ksi (82800 N/mm^2). The material composing the beam (b-d) is assumed elastic with a modulus of elasticity of 10007 ksi ($6.9x10^4$) N/mm^2. The shear modulus is 4003 ksi (27600 N/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 rotation of the beam at mid span using elementary beam theory [Ref. 1] equals 0.009 rad while using ELS gives 0.009 rad. Fig. 3.a shows the analytical results obtained using ELS and using Beam theory.

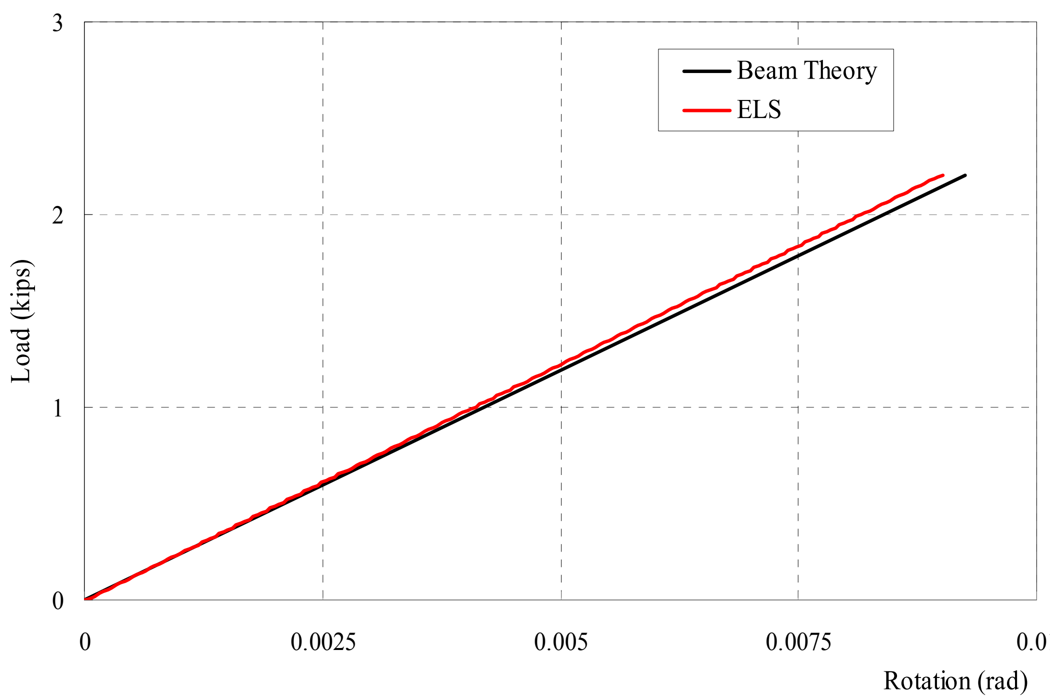

Fig. 3.a Load rotation relation at point B

The deflection of the beam at mid span (u_2) using elementary beam theory [Ref. 1] equals -0.029 inch while ELS gives u_2=-0.0296 inch. Fig. 3.b shows the analytical results obtained using ELS and using Beam theory.

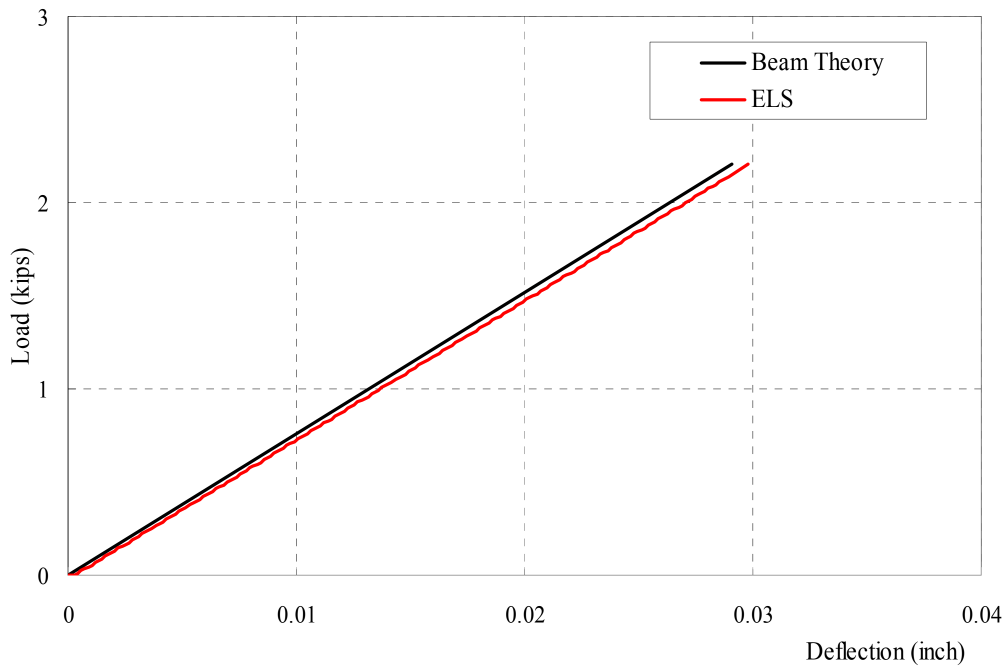

Fig. 3.b Load deflection relation at point B

The rotation at the beam end using elementary beam theory [Ref. 1] equals 0.0194 rad while using ELS gives 0.0192 rad. Fig. 3.c shows the analytical results obtained using ELS and using Beam theory.

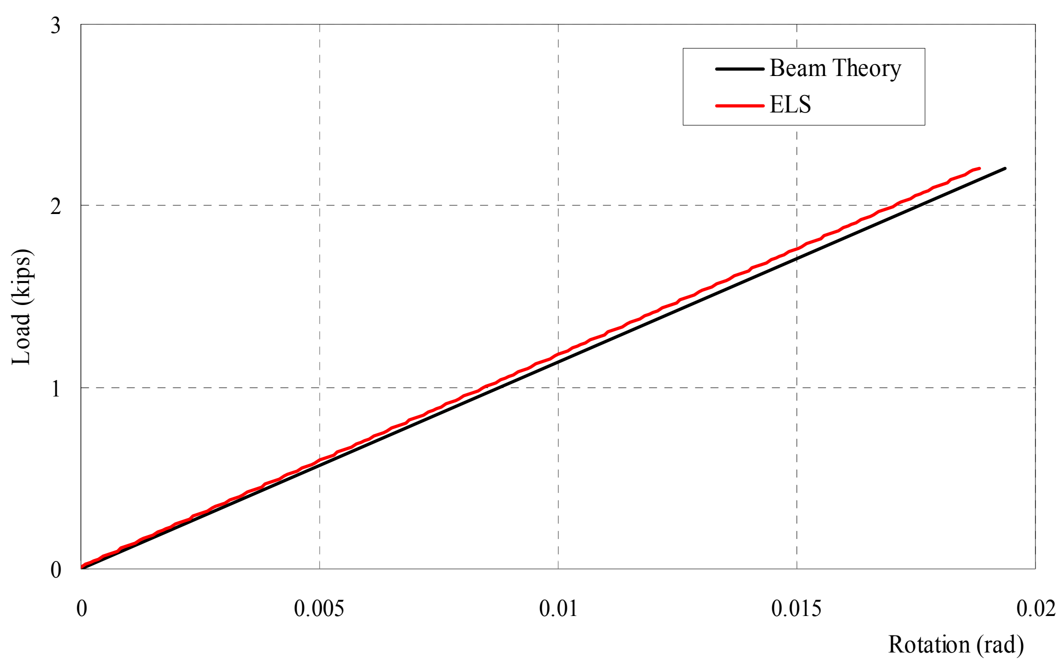

Fig. 3.c Load rotation relation at point C

The deflection at the beam end using elementary beam theory[1] equals 0.219 inch while using ELS gives 0.217 inch. Fig. 3.c shows the analytical results obtained using ELS and using Beam theory.

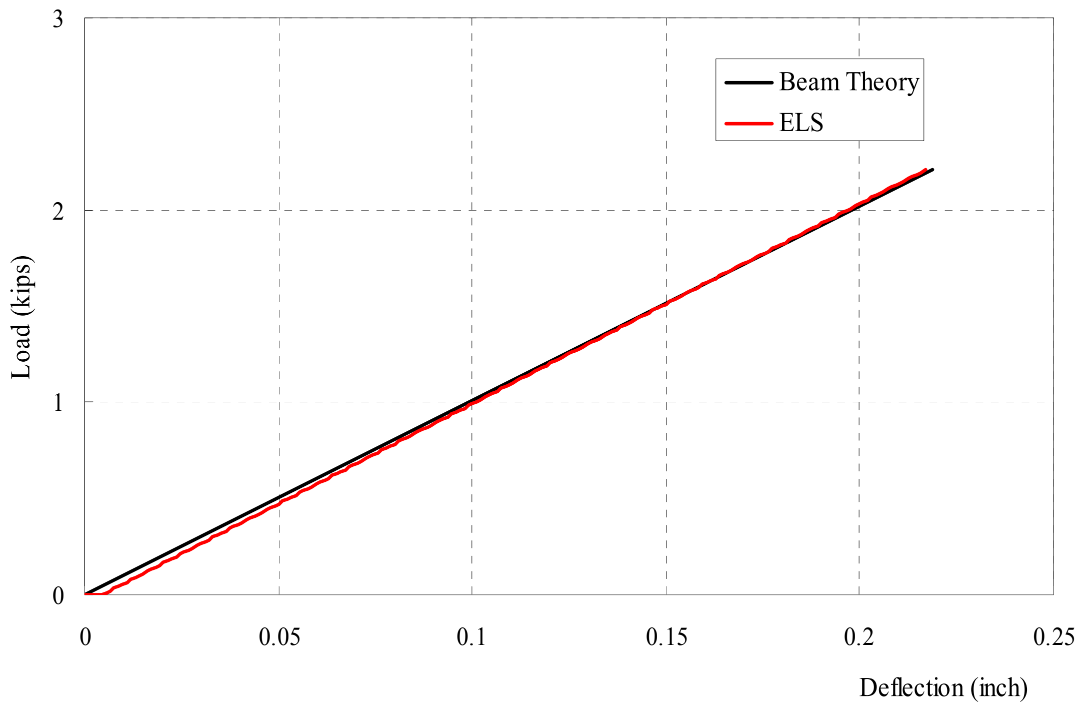

Fig. 3.d Load deflection relation at point C

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.