

ME 478 FINITE ELEMENT ANALYSIS – Spring 2013

Project #1 - Due Apr. 19

We wish to determine the maximum stress and deflection of a steel shelf from a Scandinavian manufacturer (Figure 1). To simplify the three-dimensional structure, we can consider a two-dimensional model of the pin-jointed members that supports each end of the shelf. Good engineering practice often involves first analyzing the simplest model that can address the major questions being asked and then developing more complex models as understanding of the problem grows.

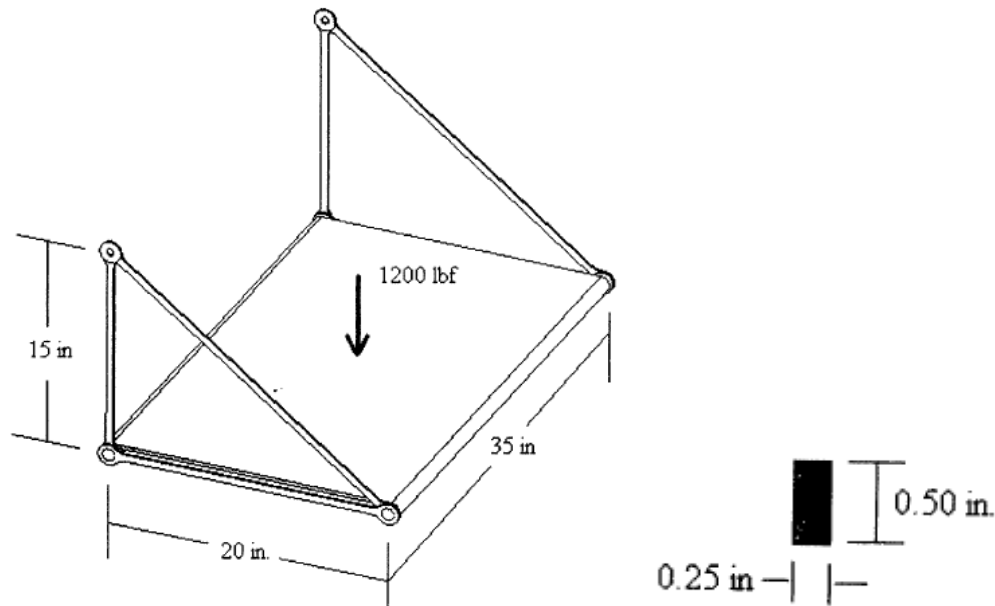


Figure 1. Steel Shelf and Support Member Cross Section

From Figure 1, the area of each support member in the structure is $0.25 \times 0.50 = 0.125 \text{ in}^2$, and the values of the material properties we will use for steel are *elastic modulus*, $E = 30 \times 10^6 \text{ psi}$ and *Poisson's ratio*, $\nu = 0.27$. Neglect twisting of the structure by using truss element for simplicity of the problem. Perform a 2-D analysis of truss by taking advantage of the shelf's symmetry.

Results

1. Plot the deformed (+ undeformed) shape for the structure if the members were pinned together with single bolts (i.e. each member is a single truss element, ANSYS-LINK1).
2. What is the maximum stress in the support structure and where is it located? Why?
3. What can you conclude by comparing your stress values with yield strength of commonly used steels, which range from 280 to 1600 MPa?
4. Obtain the support reactions from your ANSYS model and compare them with your analytical solution.
5. Now we wish to evaluate the performance of a composite tube as a replacement for the diagonal member in the support structure. The elastic modulus of the composite tube material is $1.2 \times 10^7 \text{ psi}$, its Poisson's ratio is 0.3 and the tube has a cross sectional area of 0.35 in^2 . Repeat 1 ~ 4. How does it compare with the all-steel results?