ES128: Homework 5
Due in class on Wednesday, 21 April 2010

Problem 1

For the beam shown in Fig. 1, compute the deflection at the element nodes. The modulus of elasticity is $E = 10 \times 10^6$ Pa and the cross section is as shown in Fig. 1. Also compute the maximum bending stress. Use the finite element method with the minimum number of elements.

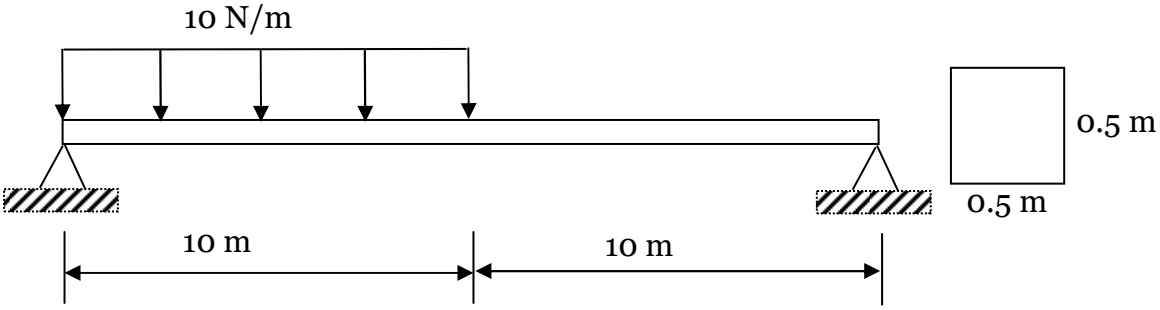

Fig. 1

Problem 2

The two-dimensional frame structure shown in Fig. 2 (next page) is composed of two 2×4 m steel members ($E = 10 \times 10^6$ Pa), and the 2 m dimension is perpendicular to the plane of loading . All connections are treated as welded joints. Using two beam-axial elements and the node number as shown, determine

a. The global stiffness matrix.
b. The global load vector.
c. The displacement components of node 2.
d. The reaction forces and moments at nodes 1 and 3.
e. Maximum stress in each element.

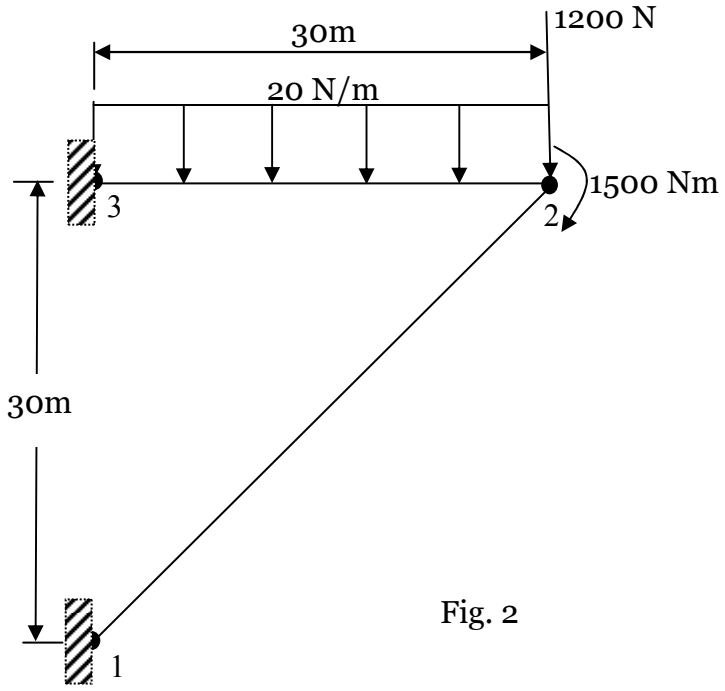

Fig. 2

Problem 3

A square frame of length L = 1 m on each side is subject to equal and opposite horizontal loads P = 100 N. Each of the four beam members has a square cross-section of width a = 2 cm. The material is steel with Young's modulus E = 200GPa. Obtain the horizontal displacement, Δ, of joint A relative to joint C. (Hints: Make use of the two-fold symmetry to reduce the number of unknowns. Take the displacement components and rotation to vanish at the center of the frame. Symmetry dictates that the horizontal displacement and rotation vanish at B, while the vertical displacement and the rotation vanish at A.)

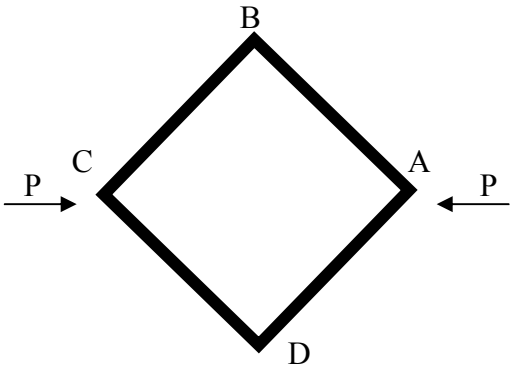

Fig. 3