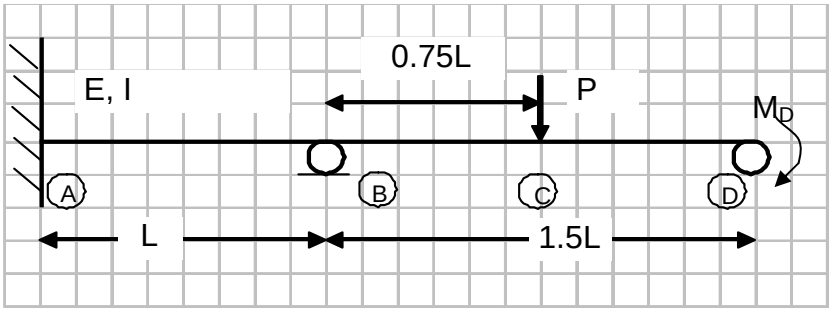
CEE 379 Problem Set 9 Autumn 2007

(Due Nov. 21 in class or 4:30 PM in 233 More)

Both problems in this assignment refer to the beam shown below, with L = 22 ft. The beam has the following properties: E = 29,000 ksi, I = 1500 in^4, depth = 15.6 in. The beam is subjected to a downward load of 12 k at pt C and a clockwise applied moment, M_D, of 40 k-ft at D. Neglect the self-weight of the beam.



Problem 1. Consider this structure as THREE BEAM MEMBERS (AB, BC and CD), with joint loads and moments (no member loads). Solve this problem by implementing the direct stiffness method using a spreadsheet, as shown in class. You may work in groups of two to prepare the spreadsheet for Problem 1. List your spreadsheet partner on the first page of your solution. Complete other parts of your Problem 1 (e.g., load, shear and bending moment diagrams) individually.

a) Assuming that axial deformations are negligible, what is the degree of kinematic indeterminacy?

b) Determine the beam stiffness matrix, k, for all three beams (AB, BC, CD).

c) Express the equilibrium equations at each free DOF in terms of the displacements and rotations at the free DOF. Express these relationships in matrix form (i.e., $\mathbf{K_{11}\, D_u = Q_k}$).

d) Solve for the unknown displacements and rotations (i.e., $\mathbf{D_u = K_{11}^{-1}\, Q_k}$).

e) Using the beam stiffness matrices, compute the end forces and moments (i.e., **q = kd**) for all three beams.

f) Neatly sketch the beam loads and reactions on a diagram of the beam.

g) Using the sign convention discussed in class, draw the shear diagram for the beam (from A to D). Show locations and magnitudes of the maximum positive and negative shears.

h) Using the sign convention discussed in class, draw the bending moment diagram for the beam (from A to D). Show the location of the largest positive and negative bending moments in the beam.

i) Neatly sketch the deflected shape for the beam. Show magnitudes of calculated joint displacements and rotations.

j) At the locations of the largest positive and negative moments, determine the flexural stresses at the top and the bottom of the beam. Would the beam meet a requirement that the maximum flexural stress not exceed 20 ksi.

Problem 2. Consider the same beam considered in Problem 1. Without using a spreadsheet, solve the following problem, treating the structure as TWO BEAM MEMBERS (AB and BD) with joint and member loads.

a) Assuming that axial deformations are negligible, what is the degree of kinematic indeterminacy?

b) Solve for the unknown displacements and rotations (i.e., $\mathbf{D_u = K_{11}^{-1} Q_k}$).

c) Compute the end forces and moments (i.e., **q = kd**) for all three beams.

d) Compare your results for a), b) and c) with the corresponding results you obtained in Problem 1.