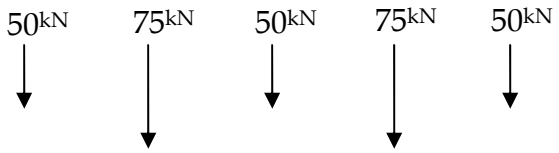
4.440 / 4.462 Basic Structural Design
Spring 2009

Assignment #1

1) A cable must support five point loads as shown below. Label the problem with Bow's notation. Draw the force polygon and determine the shape of the cable if the horizontal component of cable force is 200 kN. (Draw your force polygons on the load line at left below, where 1 cm = 50 kN.) Now draw a new force polygon below with the horizontal force component of 800 kN and determine the shape of the cable based on the new force polygon. For each case, draw the cable below the point loads and determine the size of the tension reactions needed to support the cable. What do you notice about the geometry of the cable in each case? How does the sag of the cable change in relation to the horizontal force in the cable?



Suggested scale: 1 cm = 50 kN

2) As the structural guru in Frank Gehry's office, you must propose a system for carrying column loads over a truck loading zone in the basement of a new building. The inclined columns carry the weight of five stories above and this load must be transferred over an open space as illustrated in Figure 1. Each column carries an axial load of 200 kips and is inclined at a slope of 4:1 as shown.

a) Label the problem using Bow's notation to facilitate a graphical solution.

b) On a separate piece of paper, draw the load line for the problem using the loads given in Figure 1. (You may choose to draw the force polygon at a convenient scale.)

c) Using graphic statics, propose a structural solution in axial compression for the problem which does not interfere with the zone marked by a dashed line in Figure 1. Your arch must be supported on the foundation beneath the building and should be horizontal at the crown of the arch. Draw your design on Figure 1. (Note: you may wish to experiment with several trial pole locations before deciding on the final form.)

d) Based on the force polygon for this problem, which element of the arch carries the highest load? Using concrete with an allowable stress of 1,300 psi (1 kip = 1,000 lbs, so this is 1.3 kips/in^2), what is the minimum required cross-sectional area? (Recall that stress is force/area.)

e) Based on the results of (d), propose a suitable cross-section for this part of your arch.

f) In terms of construction, name one advantage and one disadvantage to your proposed system.

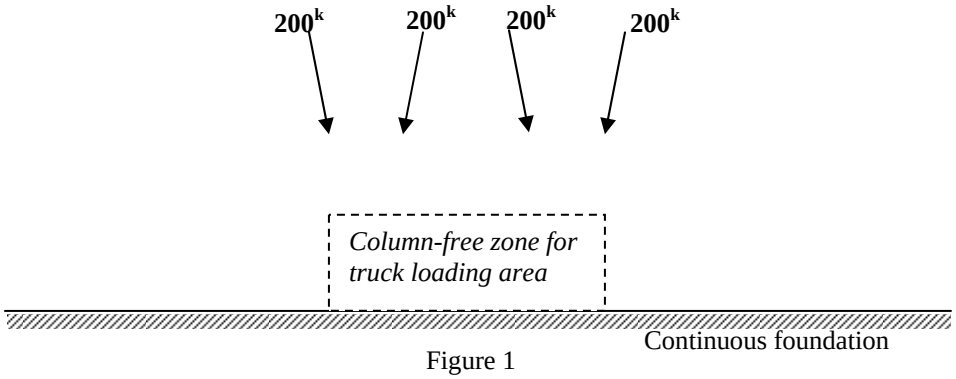


Figure 1

3) Solve for the internal forces in the crane of Figure 2 using
   a) graphical methods, and
   b) numerical methods

due to the applied load of 40 kips. Assume that two separate cables are fixed to the end of the mast (ie the cable is not continuous). Label tension and compression.

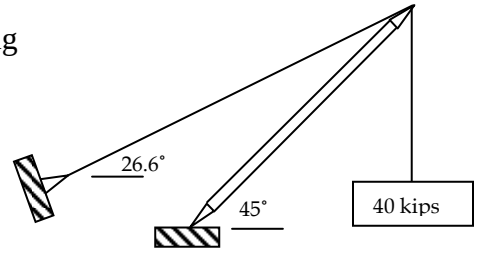


Figure 2

c) Now suggest a redesign to decrease the mast force.