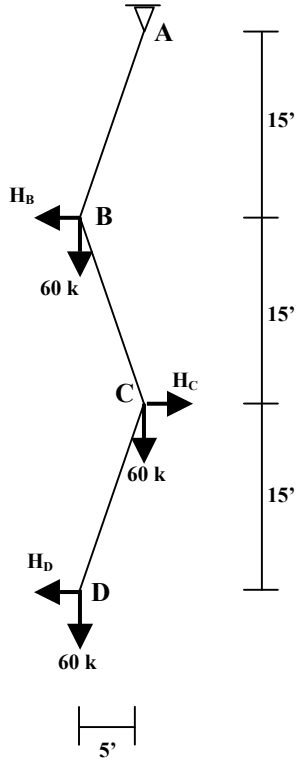
HOMEWORK #1: EQUILIBRIUM OF MASONRY STRUCTURES

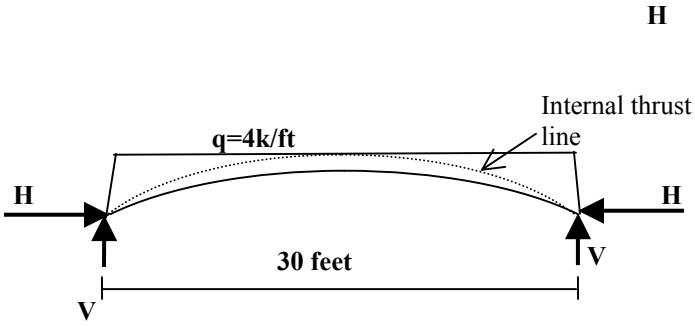
READING: Schodek, Structures, Chapter 5, pp. 184-227, 4th Ed., 2001.

1) A hanging cable supports 60 kip loads at intervals of 15 feet. (1 kip = 1000 pounds) Point B and Point D are displaced to the left by 5 feet due to external horizontal applied loads, H_B and H_D. Point C is displaced to the right by a horizontal load H_C so that it is directly under the support at Point A. Assuming the cable is weightless and acts in pure tension under the applied loads:



a) What is the external horizontal force H_D at point D?
b) Isolate joint C and determine the forces acting to keep it in equilibrium. (Hint: be sure to distinguish between *external* and *internal* forces.) What is the value of H_C? Draw a free body diagram showing all the forces acting on point C.
c) Repeat (b) for point B.
d) What are the force reactions at A?
e) Draw the cable with all forces acting on it. Demonstrate that horizontal, vertical, and rotational equilibrium are satisfied, ie, $\Sigma F_x=0$, $\Sigma F_y=0$, and $\Sigma M=0$.
f) What is the value of internal force in the cable in section AB, BC, and CD?

2) An unreinforced masonry arch spans 30 feet with a rise of 3 feet at the crown. The self-weight of the masonry is assumed to be 200 pounds per square foot, so that a 20 foot wide section of the arch must support a load of 4 kips/foot. What is the horizontal thrust H? (For simplicity, assume that the load is distributed evenly and the internal thrust line is parabolic.) What is the vertical reaction V at each support?



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3) Design a three story load bearing masonry structure following the geometry of the cable in problem #1 above. Assume that the horizontal reactions at B, C, and D are provided by the thrust of an arch in the adjacent span. If each arch spans 30 feet and supports 4 kips/foot, what is the required rise of each arch for equilibrium? You may neglect the weight of the masonry columns for simplicity. Produce an approximate sketch of your structure, showing the columns and at least half of each arch. Include a thrust line within the masonry corresponding to the internal forces due to self-weight.

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