Lab 1: Stress in Tensile and Compressive Structures

Introduction

1. State the goal of each section of the lab, and describe the steps of each procedure that help you to achieve this goal, using diagrams as necessary.

Part 1: Cable Strength

2. Show your results from table 1, including units.
3. Draw a graph of breaking tension (y-axis) vs. cross-sectional area (x-axis). How is the breaking stress represented on this plot?
4. Should the breaking stress values (f) for each cable be the same? How different are they?
5. If our desired safety factor is 2, what is the allowable stress on each cable?

Part 2: The Washington Monument

6. Draw sketches of both the whole and partial model based on the templates on the following page. Make sure to include on the sketch the values for the height of both models, and dimensioned diagrams of the cross-sectional area at the base of each model.
7. Show your measured observations of the models from table 2, including units.
8. Show your results from table 3, including units.
9. Explain why the cross-sectional area of the monument at the mid-height is lower than it is at the base of the monument.
10. Describe why you think any percentage difference in the stresses have occurred. Explain what you think would need to change, showing calculations, to reduce the percentage difference to 0.

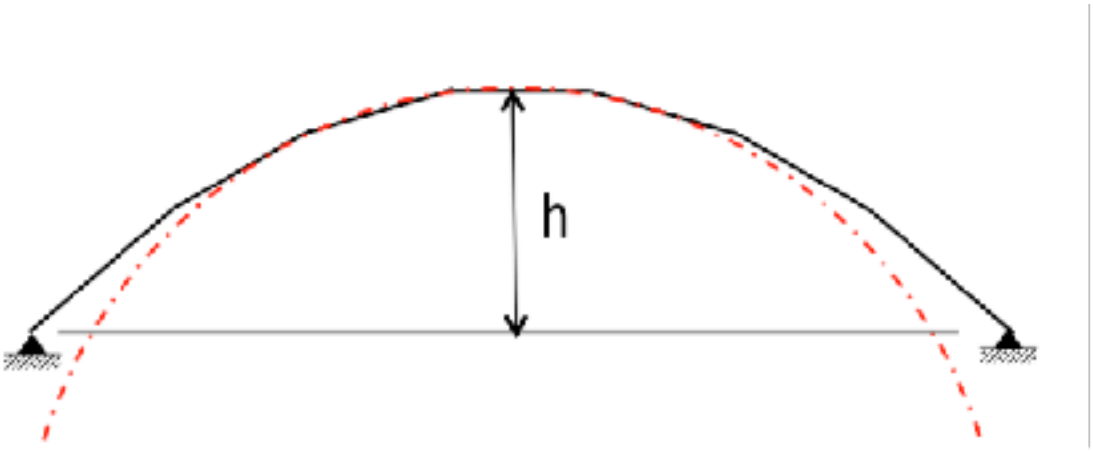
Part 3: Cable and Arch Shape

11. What shape does the chain take under uniform loading?
12. What cable shape would you expect if you were supporting a bridge deck by a very large number of suspenders: a. parabolic; or b. semicircular?
13. Where must the majority of the total load be placed on a suspension bridge in order for its cable to take on a semicircular shape? Are suspension bridges ever subjected to this loading scenario (considering only dead load)?

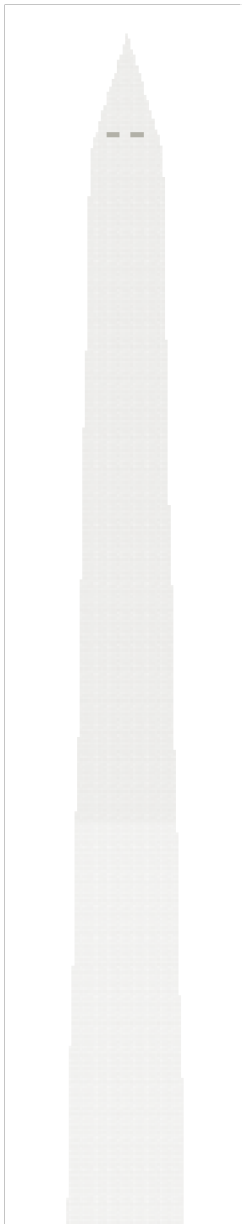
14. Graphic Statics for an arch analysis (to be taught in 'lab-precept')

    a. Solve for the shape and forces of the arch shown on the last page of this document. Assume that the center element (ae) has a load of 10 KN as shown. Use the scale shown to solve the problem. The final answer should look similar to that shown below.
    b. The dashed red line represents a circular form. The shape of the arch under uniform loading acting under *pure* compression therefore does not look like a circle. What shape is it?
    c. Note that in graphic statics BOTH the loads and shape end up being drawn to scale. In that case, solve for the height of the arch "h" as illustrated below.
    d. If the load on element ae is increased to 20 KN, will h increase or decrease? Explain your response based upon the *conceptual* drawings of graphic statics (i.e., you do not need to actually solve for it, but explain the process that would lead you to the answer of increase or decrease).

15. How does your solution to question 14 relate to that which you saw in lab with the cable under uniform load. Compare the force (tension vs. compression) and the form.

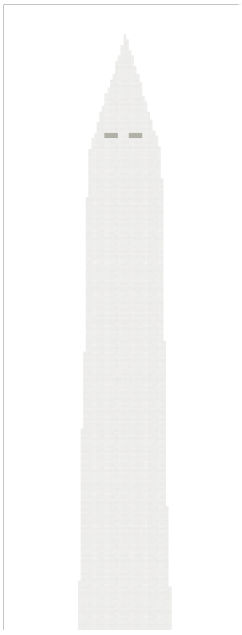


Washington Monument Sketch Templates (Question 6)



Full Model

Full Model
Cross-Section



Half Model

Half Model
Cross-Section

DESIGN OF AN ARCH IN PURE COMPRESSION UNDER UNIFORM LOAD