Clarkson University
ES222 Statics – Fall 2013
Design Problem 1

Design Problem Description

Your team works for a wireless communications company that is installing a new 80 ft. tall communications tower. The standard design for anchoring the tower is shown in Figure 1 below.

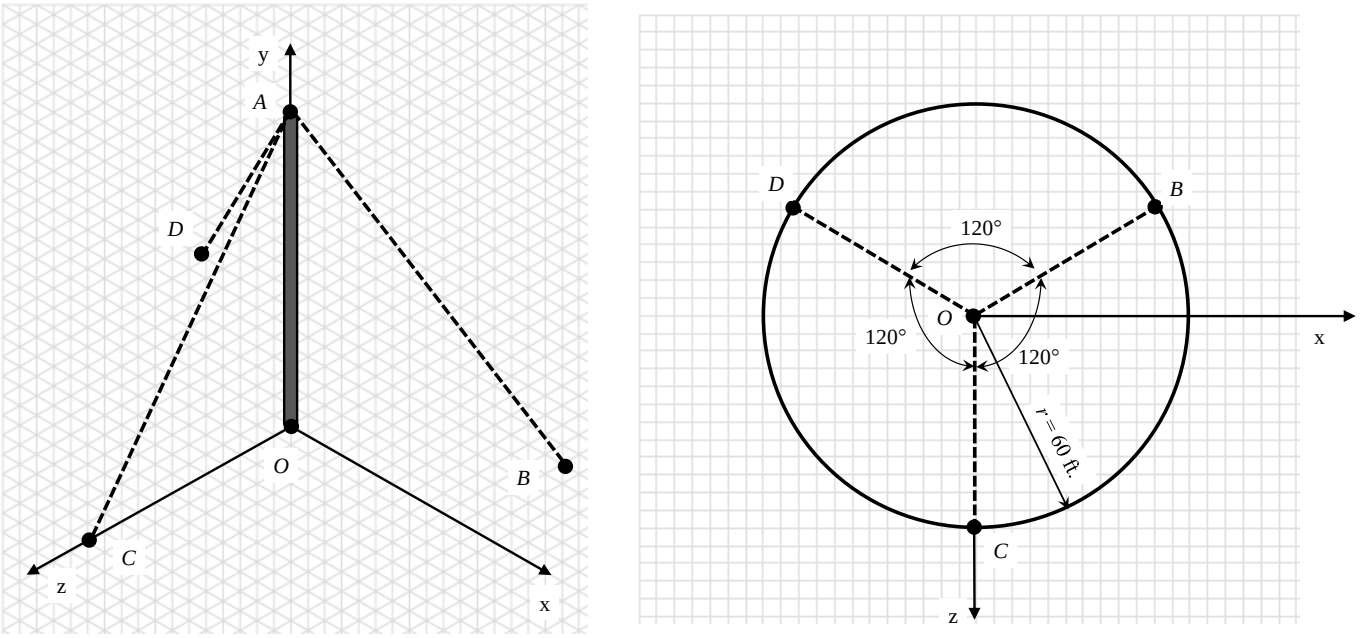

Figure 1. Standard Design. Left: Isometric view, showing tower *AO* and the three anchor bolts at *B*, *C* and *D*. Right: Plan view looking down at the ground, showing the positions of the three anchor bolts at *B*, *C* and *D*, in the x-z plane.

The tower will be installed in a congested urban setting; there are many existing buildings, streets and sidewalks (see Figure 2 on next page). The location of the base of the vertical tower has already been selected (point *O*) and bolt *C* has already been installed; these two locations cannot be changed. Your team must select locations for bolts *B* and *D*. Your company has contracted with the Office Building owners and one of the anchor bolts must be installed on the roof of the office building, which is 45 feet tall. You cannot install anchor bolts on sidewalks, streets or on the warehouse. The streets are 25 ft. wide and the sidewalks are 10 ft. wide.

Design:

Your team must determine the new locations for anchor bolts *B* and *D*, subject to the following requirements. The resultant force acting at point *A* due to the three cables must be exactly $\vec{R} = 0\,\hat{i} - 1200\,\hat{j} + 0\,\hat{k}$ lb. (that is, the three cables pull down-ish on point *A*.) Each anchor bolt can be located no closer to *O* than 40 ft. and no farther away from *O* than 90 ft. The anchor bolt locations must be specified in whole feet (that is, no decimals or fractions of feet, so 60 ft. would be allowable, but 60.5 feet would not). The new cable tensions can be no more than twice the cable tension of the standard design, and no less than 200 lb.

Design Document:
Your final design document must contain the sections outlined in the Design Problem Grading Rubric, provided separately. In addition, for this design problem you must provide:

- Provide figures and calculations used to determine the cable tensions for the original standard design.
- A primary Design Figure similar to Figure 2, given below, showing your selected locations for the anchor bolts, including all necessary dimensions.
- Calculations proving that your selected design satisfies all the requirements.
- Any additional figures used to conduct the analyses and calculations.
- In your Summary and Conclusions section, discuss the following:
  - Based on what you have learned in your design and analyses processes, describe some future changes you could make and how these changes would "improve" your design.

Note: If desired, you may use Matlab, Excel (or some other computer program) to assist in your design and analysis process. However, **you must provide complete hand calculations for your final design**. (Stating "see Matlab code" is not acceptable.)

See the Design Problems Assignments handout for additional Design Document Requirements. Staple the Design Problem Cover Sheet to the front of your Design Document.

Note: Powerpoint files of Figures 1 and 2, plus a figure for sketching possible solutions will be posted on Moodle.

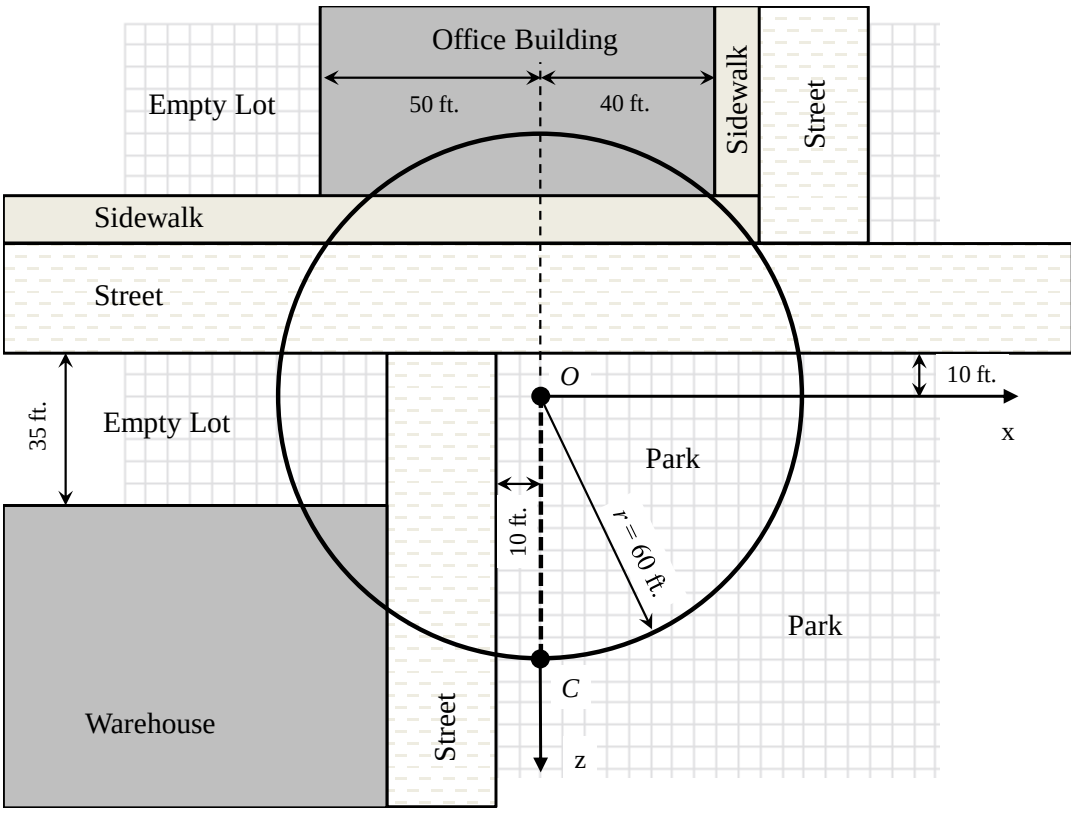

Figure 2. Plan view of the installation site, showing installed location of anchor bolt *C* and locations of office building, warehouse, streets and sidewalks. (Scale: 1 square is 5 ft. × 5 ft.)