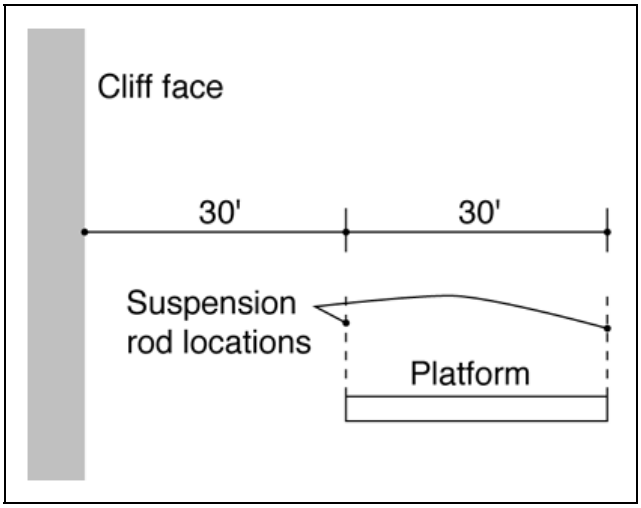
LAB 6: STRUCTURAL DESIGN WITH COMPUTER ANALYSIS

OVERVIEW

Working in teams of two people at one computer, consider the conceptual design of a structure to suspend a platform from a cliff face, according to the geometry shown below.



The platform is to be supported by suspension rods that attach to the structure you will design. Assume each hanger rod exerts a downward force of 20 kips.

CRITERIA

Use Arcade to design the structure using the following highly simplified criteria.

- The maximum downward deflection of the structure should not exceed 2 inches.
- No single horizontal reaction should exceed 60 kips.
- No single vertical reaction should exceed 30 kips.
- All members should be steel, with a cross area of 20 in^2, and a moment of inertia of 700 in^4.

Your should try to minimize the weight of your structure while meeting the performance criteria.

ANALYSIS NOTES

The following notes provide advice and direction on building and interpreting your analysis model.

BUILDING THE MODEL

- **Nodes**: Nodes define the geometry of the model. Start by adding nodes at all points of support and member end points.
  > You may want to activate the snap grid by clicking *Settings > Graphic >Grid* and then checking *Snap grid on* in the upper window.
- **Elements:** Use Arcade Beam-1 elements for all members (these are elastic beam elements). Click *Build > Elements > Beam-1*, enter the required properties in the left window, and then click from node to node to add elements.
- **Supports:** In your model, assume the cliff face is a vertical line where the x coordinate equals zero.
  - The cliff face is the only place where supports can be located, therefore supports in your model can be used only on nodes where the x coordinate is zero.
    > A support on any node to the right of the cliff face would be a "sky hook". Bad idea.
- **Loads:** To model the loads from the hanger rods there must be at least one node with an x coordinate of 30 feet which has a 20 kip downward load applied to it, and another node with an x coordinate of 60 feet and a similar downward load.
- **Gravity**: You should include gravity in the model so that the self-weight of the structure is accounted for. Click the menu item *Settings > Gravity*. In the window above the Build View, click the button labeled *1g* for *Gravity*.
- **Damping**: Click *Settings > Damping > Nodes.* In the window above the Build Window, click the button labeled *Heavy* for *Node mass-proportional damping*.
  > Damping subdues vibrations of the model resulting from the application of load.

INTERPRETING THE RESULTS

- **Run the simulation**: Click *Simulation > Start* (or click the blue triangle button in the upper left).
  > The program begins the simulation of applying loads to the structure.
- **Reactions**: To display the reactions on screen, click the menu item *Settings > Graphic > Supports*. In the upper window in the *Reaction forces* group, click the check boxes for *Display* and *Magnitudes*.
  > You may need to adjust the force scaling factors and the view for the reaction magnitudes to be visible.
- **Displacements**: To check displacements, click the menu item *General > Show info*. In the left window, in the *Node Info* group, click the checkbox labeled *Displacement.* Then click on any node to find its displacement.
- **Self weight**: To find the self weight of the model, click the menu item *Settings > Model Statistics*, and read the *Element weight*.

GENERAL ADVICE

- **Changing node position**: To change the coordinates of a node, click *Build* > *Nodes*, and then use the table in the upper window to change node coordinates.
- **Deleting things**: As you modify your model in design iterations, it is likely you will need to delete elements or nodes. There are two ways to delete things:
    - **Delete from table:** Go to the table where the item is listed (e.g. the node table for nodes, or the support table for supports), and press the *Delete* key.
        Note that the *Delete* key is different from the *Backspace* key. The Backspace key is used for removing text while typing.
    - **Delete using selection**: Click the menu item *General* > *Select items*, then click on the item you want to select (hold down the shift key for multiple selections). After selecting the items you want to delete, in the left window, click the *Delete selected items* button.
        You can also drag a rectangle around or across items you want to select.
        You can control what item types are selected using the checkboxes in the left window.

        Note that when a node is deleted, all loads, supports, and elements associated with the node are also deleted.

- **Save your file.** Save your file early and often to avoid losing work.

WHAT TO SUBMIT

Do the following:

- **Names**: Click the menu item *Settings* > *Notes*. In the *Title* slot of the upper window, type your name, your partner's name.
- **Model weight**: In the *Notes* slot of the upper window, type the weight of your model (e.g. 10.3 kips, whatever your model weight is).
- **Submit file**: Save your file to the *lab-06* folder in the class submit folder.
    It is not necessary for both you and your partner to submit a file. Just submit the file to the folder of the person who logged on to the computer, and make sure both names are listed in the Title slot.