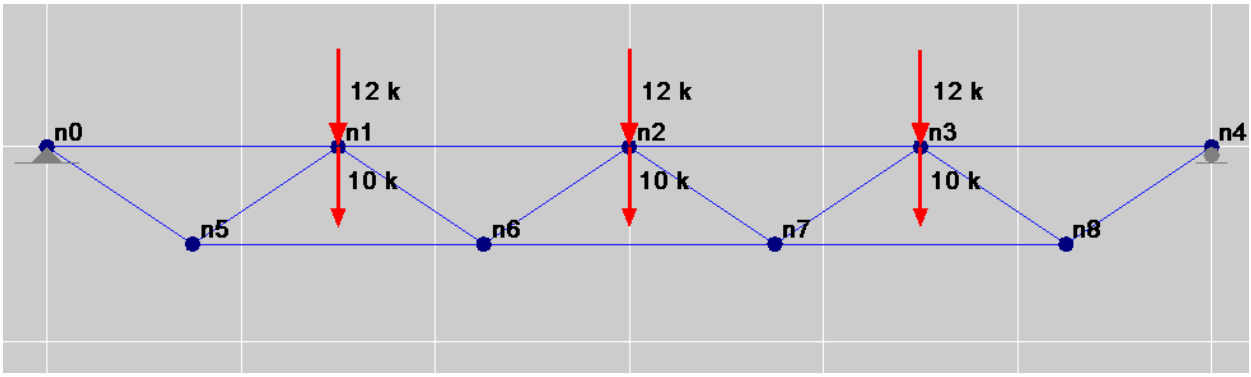
HOMEWORK 11

Overview

In this problem, you will modify an Arcade model so that it meets structural design criteria for strength and stiffness. The model is a truss which would carry half the load of a pedestrian bridge. The figure below shows the geometry and loading of the structure.



The grid lines are spaced at 10-foot intervals. The 10-kip loads represent the dead load of the bridge deck. The 12-kip loads represent the live load of people on the bridge.

The starting file *hw-11-start.rcd* for the model is in the Classes folder

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Arch324-Martini-SP04\homework_files\hw_11
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Design Objective

There are two performance criteria for the model:

- **Stiffness**: Under full dead and live service load, the deflection at midspan should not exceed L/500, where L is the 60-foot clear span of the structure.
- **Strength**: Under an overload of 1.2 times the dead load and 1.6 times the live load, no member should exceed the yield stress of 50 ksi (note this criteria is unrealistic since it neglects buckling, but is sufficient for the purposes of this exercise.) The strength analysis must account for the fact that live load may be unevenly distributed.

The design objective is to find a configuration that meets the above performance criteria with a self weight of 1.6 kips or less.

Design Parameters

This simplified problem has the following (highly limited) design parameters:

- **Member sizes**: There are two available member sizes:
    - **HSS 5.0x0.125**: A round pipe with an outside diameter of 5 inches and a nominal wall thickness of 0.125 inches. The cross section area is 1.78 square inches. Call this the light member.
    - **HSS 5.0x0.25**: A round pipe with an outside diameter of 5 inches and a nominal wall thickness of 0.25 inches. The cross section area is 3.49 square inches. Call this the heavy member.

- **Truss Profile:**
    - The profile of the truss can be modified by changing the y coordinates of the nodes labeled n5, n6, n7 and n8.
    - No other node coordinates may be changed.
    - The depth of the modified truss may be no greater than 10 feet.

Getting started

Copy the starting file from its classes directory and run the model. The file includes a loading sequence with the following stages.

1. Service level: dead load plus live load at all points. (from simulation time 1 second to 3 seconds)
2. Overload level: dead load plus live load at one point. (from simulation time 5 second to 6 seconds)
3. Overload level: dead load plus live load at two points. (from simulation time 7 second to 8 seconds)
4. Overload level: dead load plus live load at three points. (from simulation time 9 seconds)

To meet the performance criteria, the structure should have acceptable deflections at stage 1, and not experience yielding in any member during stages 2, 3, and 4.

Running the model reveals that the configuration in the file does not work, since members yield during the overload stages.

Modifying your model

To find a workable configuration, you will need to modify the model, then run the simulation and check the performance. Modify the properties of the model as follows:

Changing member sizes:

- Click *Build* > *Elements* > *Truss-2*. A table with data for the elements will appear in the upper window.

- To change an element from the heavy section to the light section, set the *area* property for that element to 3.49 square inches.

- To change an element from the light section to the heavy section, set the *area* property for that element to 1.78 square inches.

Changing the truss profile:

- Click *Build* > *Nodes*. A table with data for the nodes will appear in the upper window.

- To change the profile, modify the *Y coord* property of the nodes labeled *n5*, *n6*, *n7*, or *n8*.

Testing your model

To test for stiffness, do the following:

- Run the simulation. During the first second of the simulation, the loads will ramp up to full value, and then stop

- After the loads stop ramping, click the pause button (or press the F7) key, to pause the simulation.

- Check the displacement of node *n2* using the info tool. If the downward movement is less than the allowable deflection, then the stiffness is acceptable.

To test for strength, do the following:

- After checking the stiffness, resume the simulation by clicking the pause button again.

- Allow the simulation to continue running through stage 4 of the loading sequence.

- If any of the members yield during stages 2, 3 or 4, then the strength is not acceptable and the truss needs to be modified and tested again.

Structural weight

To check the weight of the model, click *Settings* > *Model Statistics* and look at the value labeled *Element weight*. The weight of the initial model is 1.167 kips. Modifying the structure to meet the requirements will require increasing the weight. It is possible to meet the criteria with a model weighing less than 1.3 kips, but it is acceptable for the assignment to have a weight of 1.6 kips or less.

What to submit

- Make a hard-copy screen dump that shows the configuration of your model. Label by hand which elements use the heavy section and which use the light. Write the self weight of the model on the sheet. Submit this to the homework boxes outside my office.

- Submit the Arcade file describing your modified file to the appropriate submit directory for hw_11 on Classes.