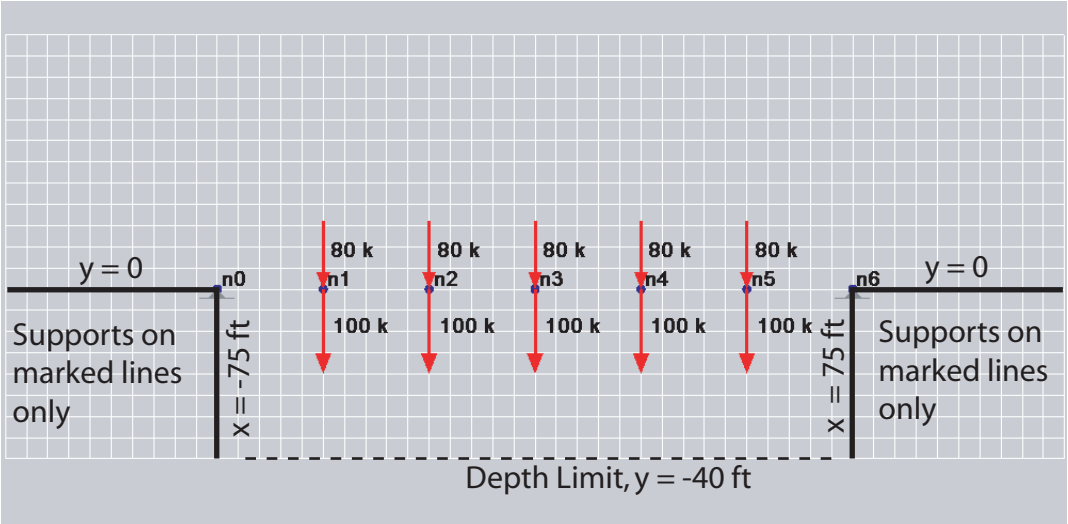
HOMEWORK 13: DIGITAL BRIDGE PROJECT

OVERVIEW

In this assignment, you will develop a design for an Arcade model using design constraints and performance criteria. The criteria concern strength, stiffness, and redundancy; the design objective is to minimize the self weight of the model. The figure below shows the portion of the model defined in the starting file, plus annotation describing some of the constraints:



The model and constraints represent a bridge crossing a canyon. The constraints on support location represent the walls of the canyon and flat ground on either side. Nodes *n0* through *n6* and their associated loads represent the trajectory of the bridge deck and the loads that the deck would impose on the bridge superstructure. You are designing a model of the superstructure that would go on one side of the bridge, carrying half of the dead and live load from the deck.

You can get the file *hw-13-start.rcd* from the following folder on Classes:

```
Arch324-Martini-SP04\homework_files\hw_13
```

The project is to be done in teams of two. The team assignments are posted on the course web site.

MODEL TESTING

The class meeting on Wednesday, April 21 will be devoted to testing the structural models in a session similar to that for physical model project. Each team will be asked to briefly explain the reasoning and approach underlying their model design, and then the model will be tested and discussed.

RULES FOR CREATING AND MODIFYING THE MODEL

In creating your design, you will add nodes, elements, and supports to the model from the start file according to the following rules:

- **Nodes**.
  - Nodes *n0* through *n6* included in the start file must be completely unchanged.
  - There is a depth limit of 40 feet. No nodes may have a y coordinate lower than -40 feet.

- **Elements**:
  - Use only truss-2 elements (which model yielding and fracture). You may use any cross section area.
  - You must use the steel material defined for the truss-2 elements and not change its properties.
  - You may place no more than one element between any pair of nodes.

- **Supports**: Supports may be added only to nodes which lie on the lines marked in the figure above. This is equivalent to the following constraints on the coordinates of nodes that have supports:
  - $y = 0$ and $x \leq -75$ ft.
  - $y = 0$ and $x \geq 75$ ft
  - $x = -75$ ft. and $-40 \leq y \leq 0$
  - $x = 75$ ft. and $-40 \leq y \leq 0$

No other aspects of the model may be changed (e.g. loads, actions, etc.)

DESIGN CRITERIA AND OBJECTIVES

There are three 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 150-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.) The strength analysis must account for the fact that live load may be unevenly distributed.

- **Redundancy**: The structure should have *single-member redundancy*, meaning that any member can be removed from the loaded structure without causing complete collapse. During the load sequence, I will use the bomb tool to remove a member from your structure (I may do this several times to test the effect of removing different members).

LOAD SEQUENCE

The load sequence is defined in the start file, as follows:

1. **Service full**: dead load, plus live load at all points.
2. **Overload full**: dead load, plus live load on all five points.
3. **Overload left**: dead load, plus live load on the two leftmost points.
4. **Overload right**: dead load, plus live load on the three rightmost points.

Check deflections under service loads during stage 1, service full load.

SCORING

- **Self Weight:**

50 kips < weight	0 points
45 kips < weight ≤ 50 kips	4 points
40 kips < weight ≤ 45 kips	8 points
35 kips < weight ≤ 40 kips	10 points
30 kips < weight ≤ 35 kips	12 points
weight ≤ 30 kips	14 points

- **Redundancy**
  If your model passes the series of single-member redundancy tests, you will receive an additional 4 points. Passing means that the structure is still able to function as a bridge, even though there may be yielding and large deflections.

  If your model fails the series of single-member redundancy tests, 4 points will be subtracted from your weight score.

- **Stiffness:**

4.00 in < deflection	0 points
3.60 in < deflection ≤ 4.00 in	2 points
deflection ≤ 3.60 in	4 points

- **Strength:**
  If any of the elements in your model yield during the load sequence, your weight score is automatically set to 4 points, regardless of the weight of your model.

- **Presentation:**
  Each team member will receive 4 points for attending the entire model testing session and presenting their model.

WHAT TO SUBMIT

- Hard copy:
  - Make a hard-copy screen dump that shows the configuration of your model. Submit this to the homework boxes outside my office.
  - Write the names of both team members and the model weight on the sheet.

- Arcade file:
  - Submit the Arcade file describing your modified file to the appropriate submit directory for *hw_13* on Classes.
  - Type the names of both team members in the *Notes* slot in the upper window (Click *Settings > Notes* to see this window).
  - You can submit the file to the folder of just one team member, rather than both. Make sure that the names of both members are typed in the file.