Lab 5A: Bridge Design

Transformation: Learning into Design

Use the following Resources to complete the report:

- You need to download the LAB REPORT GUIDELINES from the following link: https://commons.princeton.edu/cee262/labs/ before starting to write your report.
- The following LAB PROCEDURE contains information on the experimental process.

Introduction

Design competitions are catalysts for structural art. Winning proposals highlight the two principles of design – discipline and play. Discipline is defined by the necessity to meet certain spatial, economic and strength requirements. Play is produced by the innovation that improves a good design into a winning design. In this lab, you will work in groups to produce a foot-long bridge that will be tested to failure and judged for aesthetics.

Constraints

1. Geometric: Your bridge is required to **span 12''** and have a **maximum width of 3''**. Your bridge will be tested using one of the three layouts depicted in **Figure 1,** where the entire bridge (apart from the anchor cables) needs to be situated within the green shaded area. Regardless of the chosen design, your bridge **total depth (distance from lowest point to highest point) cannot exceed 4'', and the bridge must be situated at least 1.5'' above the support beam at the midspan**. There must be a "vehicular" clearance envelope along the entire length of the deck for two directions of traffic, each 1 in x 1 in. Please consult with your AI if you have any questions about design constraints.

2. Economic: Cost constraints are expressed in terms of a budget of materials. You may choose to use **two out of the five packages** provided. Any materials damaged or misused during construction can be traded in for new supplies at any point. A limited amount of hot glue comes with each package, it may only be used as glue (i.e. you cannot stick together glue sticks).

Package	
P1	12 popsicle sticks + 2 glue sticks
P2	12 popsicle sticks + 2 glue sticks
P3	2‘ x 1’ ft cardstock + 100 pieces of pasta* + 4 glue sticks
P4	12’ string + 100 pieces of pasta* + 4 glue sticks
P5	500 pieces of pasta* + 6’ string + 8 glue sticks

** Pasta available: 1” wagon wheels, ¾” wagon wheels and 1½” penne*

3. Strength: The strength demands are expressed in terms of supports and loads.

Supports: Your bridge must be connected to 4’’ dowels (provided), which will be placed against abutments (see **Figure 1**). For suspension bridges, cables can be anchored to support beam through the drilled-holes 4’’ from the abutments.

Loading: Your bridge will be tested using Pasco Testing machine, where four concentrated loads spaced approximately 2.5’’ apart will be applied. Hence **the deck is required to have enough space to receive the loads**. The total weight will be increased gradually using the crank. Failure is registered when the lowest point on the bridge deck has deformed downwards more than 1 inch. As an example, **Figure 2** displays a truss bridge constructed using Layout A, with loads applied using the Pasco testing machine.

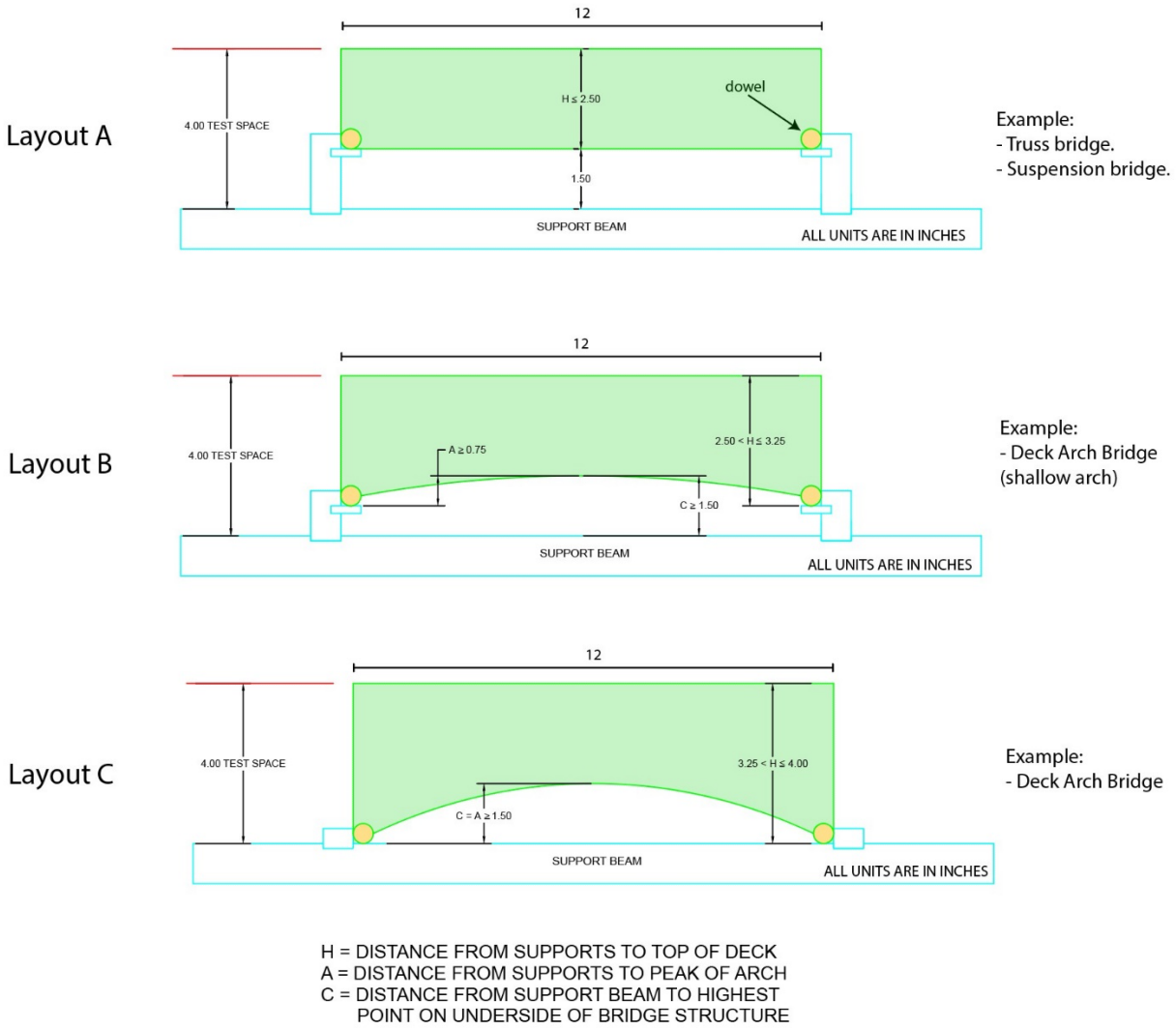

Figure 1 Bridge different layouts (choose one)

Note: Interior abutments are rigidly fixed to a horizontal clearance of 12” (the bridge, including the dowels, must fit exactly to this distance). **Check with your AI to make sure your design fits into the gap before you start construction**

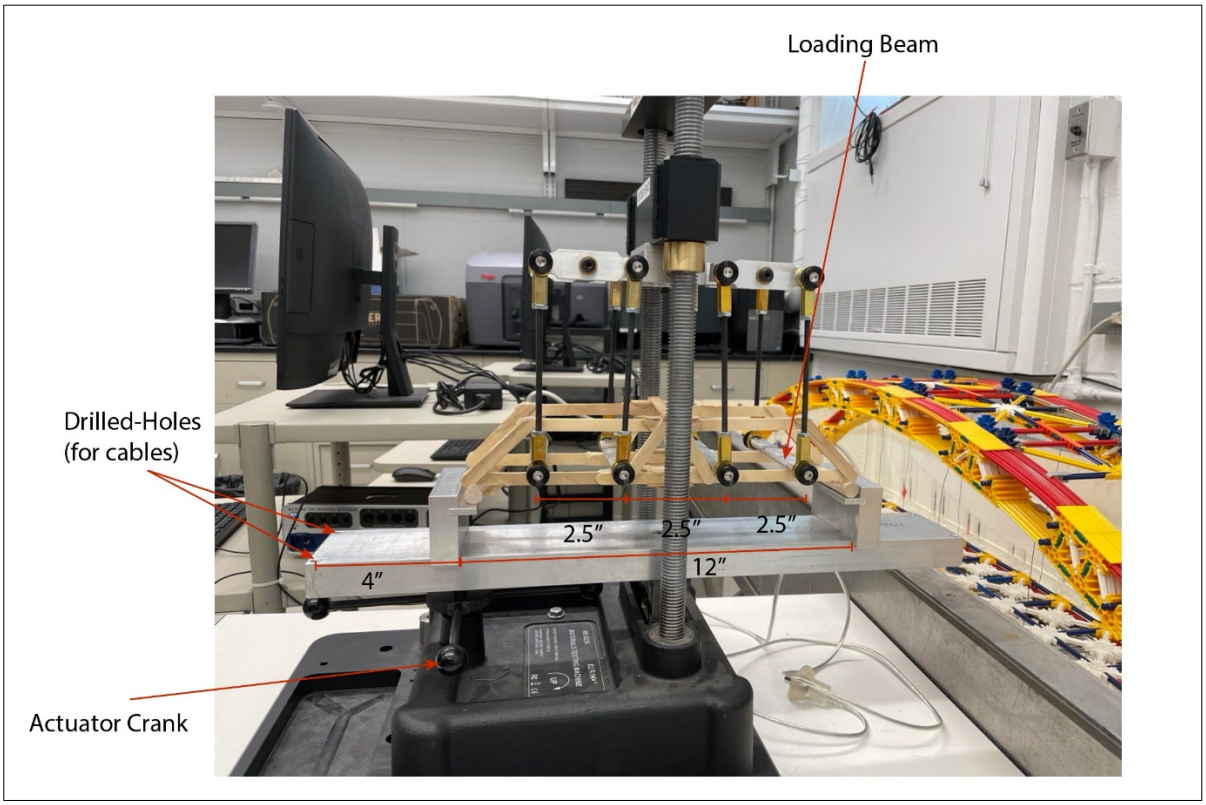

Figure 2 loading setup for a simple truss bridge (layout A)

Schedule

- *Week 9:* Design Bridge – Choose a bridge type, choose two packages, and prepare a conceptual drawing. The conceptual drawing should clearly show:

    1. all structural elements
    2. materials used for each element.
    3. dimensions
    4. location of loading
    5. location and orientation of reaction forces
    6. Predict how much load your bridge will hold. Record this weight for test week.

    You should also be able to clearly articulate the reasons for the choices you make at this point (you will be asked to explain the design of your bridge in your lab

report). Make notes as you move through the design process so as to make sure that you don't forget.

- *Week 10:* Build Bridge
- *Week 12:* Test Bridge

Grading breakdown

The Bridge Design (5A) and Shell Design (5B) labs are combined to equal one full lab. Your grade for Bridge Design will be based primarily on your lab report. In addition, a portion of the grade for this lab is determined by the ability of your bridge to able to support at least 5 lbs, and the elegance of your bridge. The grading breakdown is as follows:

Lab Report	70%
Bridge supports 5 lbs	20%
Elegance	10%

Contest

The bridge competition will be based on efficiency and elegance. Because material and costs are constrained, efficiency is defined entirely by the load capacity of your bridge. Elegance will be judged by a committee of your instructors and professors. The top ten efficient and top ten elegant structures for the course will be announced. Additionally, the three groups with the best overall bridges will be given a special award at the final exam review. Overall ranking will be decided by 70% efficiency and 30% elegance.