ARCH 314
STRUCTURE I

RECITATION SESSION 4
FACULTY: Prof. Peter Von Buelow
GSI: Faezeh Choobkar
FALL 2025

TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Welcome to recitation session

Introduction:

Faezeh Choobkar (PhD student)
Contact: faezehch@umich.edu
Office hours: by appointment

Outline:

Quick Recap
Provide the solution for the assignment (Problem set 3)
Answering student's questions
Recitation lab: Adding Forces

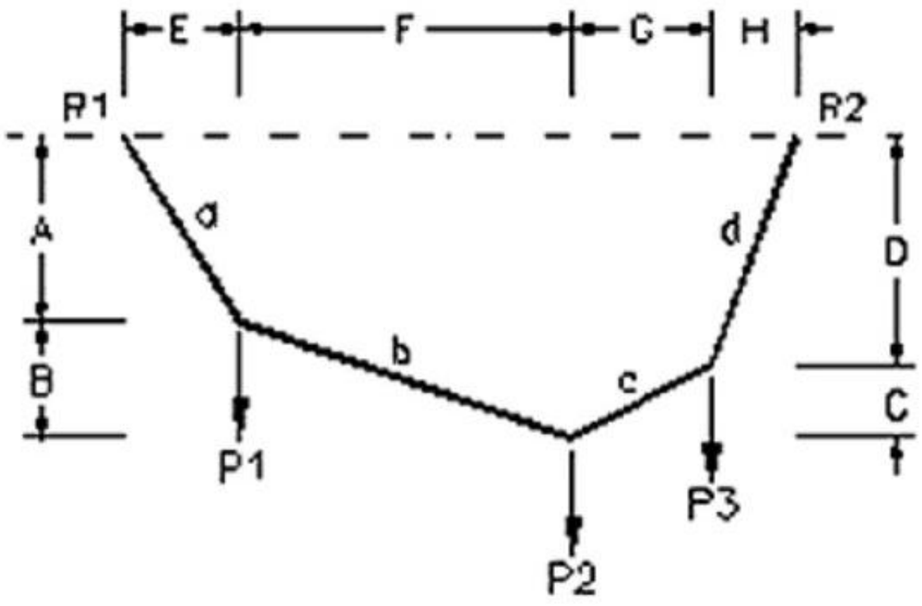
Problem Set 6

6. Cable Systems

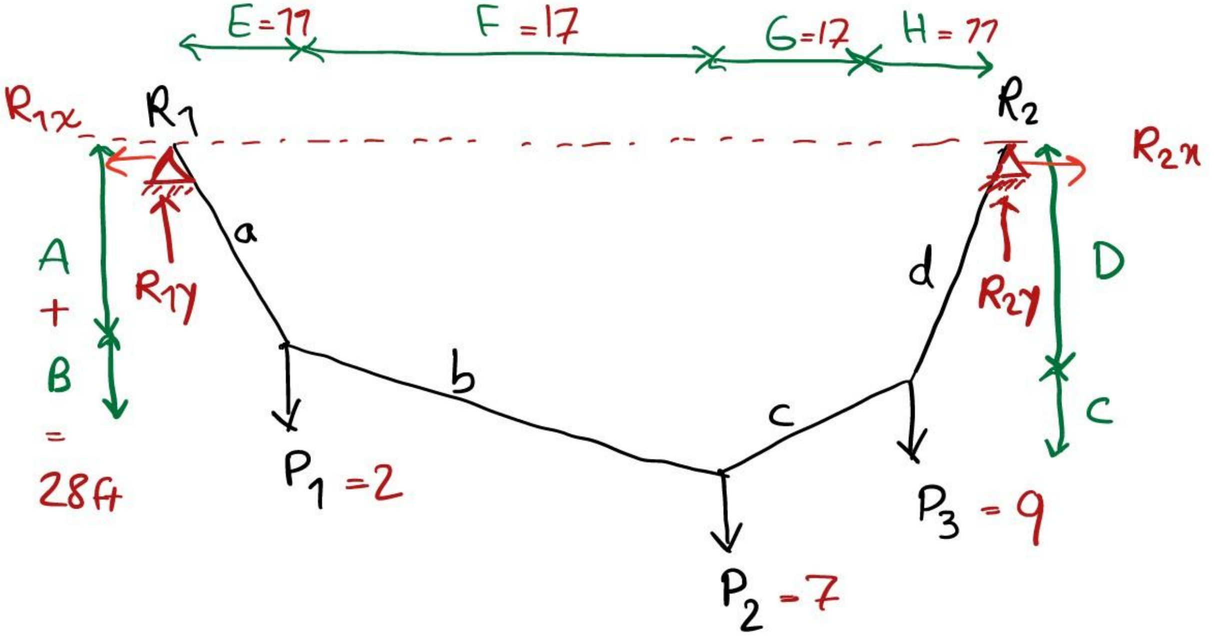
For the cable loaded as shown, determine the horizontal and vertical components of each end reaction, and the tensile force in each cable segment.

DATASET: 1 -2- -3-

Length E	11 FT
Length F	17 FT
Length G	17 FT
Length H	11 FT
Center height (A + B)	28 FT
Force P1	2 KIPS
Force P2	7 KIPS
Force P3	9 KIPS



Problem Set 6



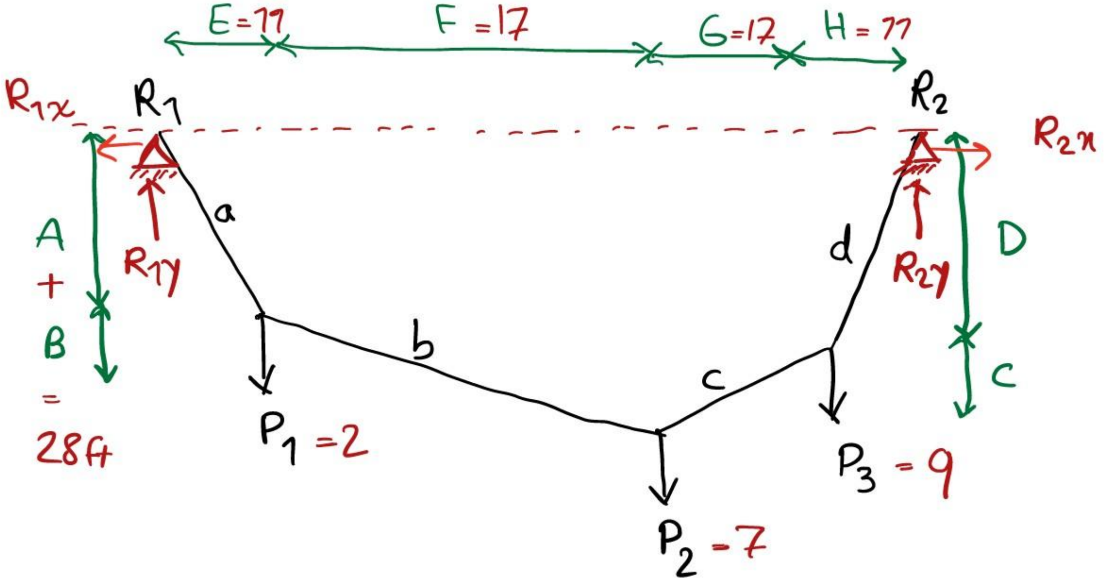
$$\Sigma M_{R_1} = 0$$

$$P_1 \times E + P_2 (E+F) + P_3 (E+F+G) - R_{2y} (E+F+G+H) = 0$$

$$2(11) + 7(17+11) + 9(11+17+17) - R_{2y}(11+17+17+11) = 0$$

$$R_{2y} = 11.125$$

Problem Set 6



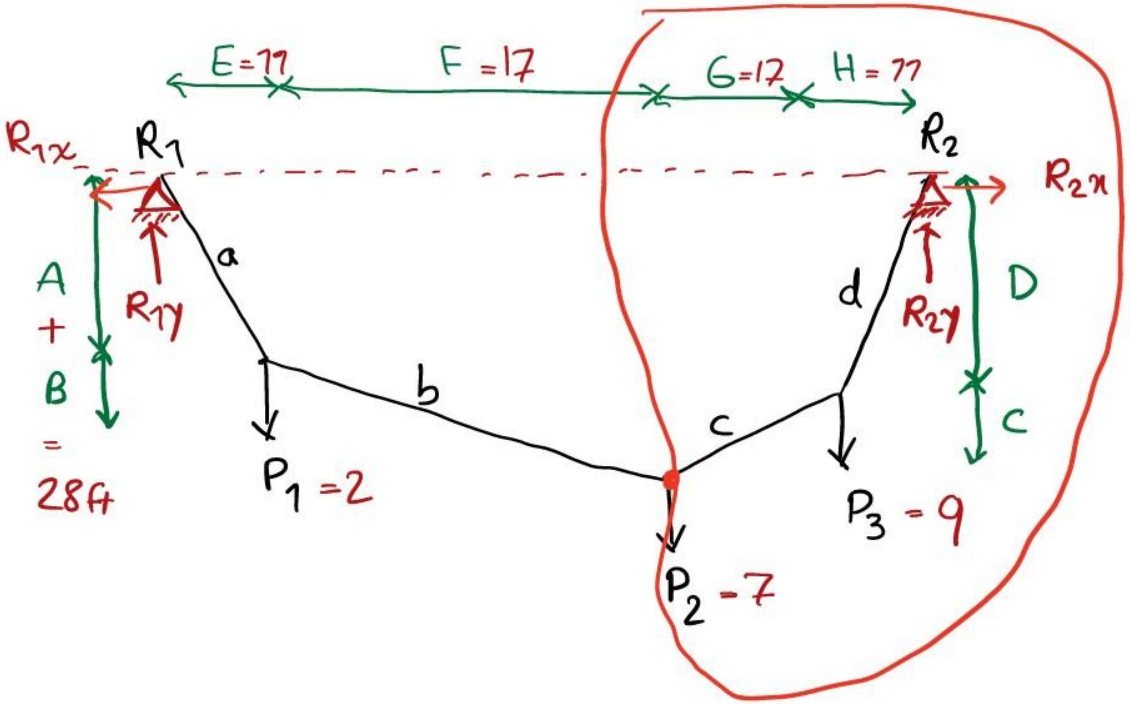
$$\Sigma M_{R_2} = 0$$

$$R_{1y}(E+F+G+H) - P_1(F+G+H) - P_2(G+H) - P_3(H) = 0$$

$$R_{1y}(56) - 2(45) - 7(28) - 9(11) = 0$$

$$R_{1y} = 6.88$$

Problem Set 6



Right side:

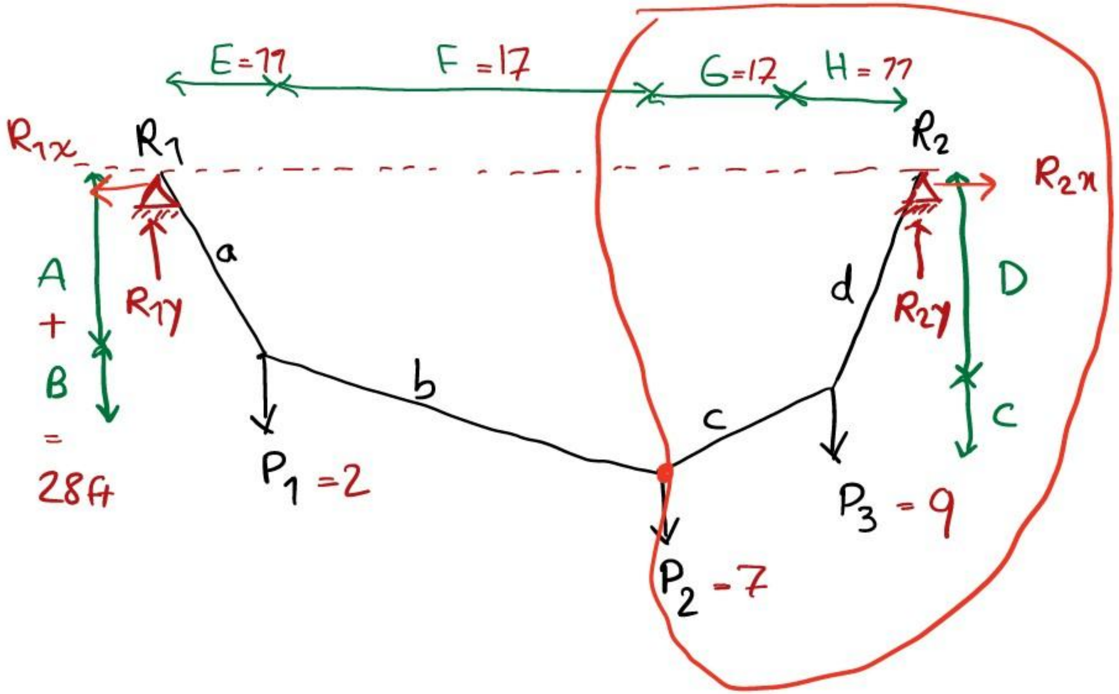
$\Sigma M_C = 0$

$P_3(G) - R_{2y}(G+H) + R_{2x}(G+H) = 0$

$9(17) - 11.125(17+11) + R_{2x}(17+11) = 0$

$R_{2x} = +5.66$

Problem Set 6



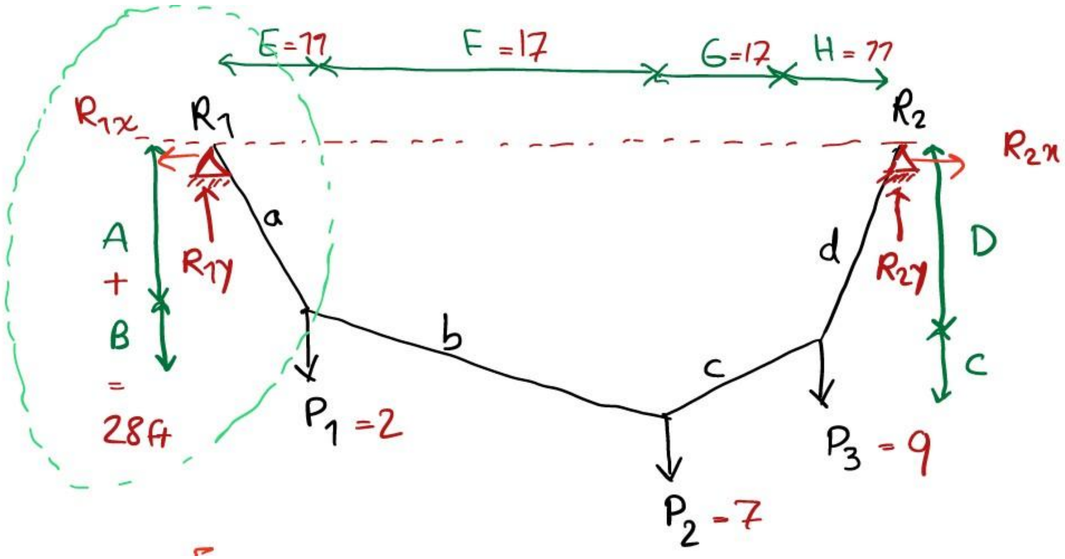
$\Sigma f x = 0$

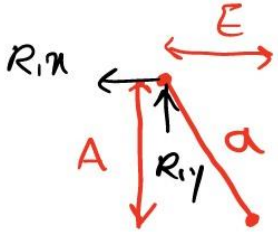
$R_1 x + R_2 x = 0$

$R_1 x + 5.66 = 0$

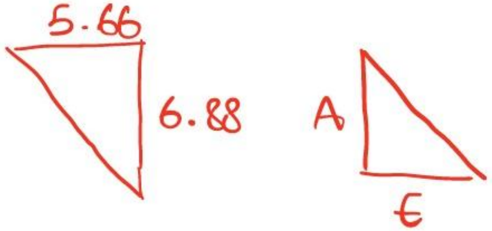
$R_1 x = -5.66$

Problem Set 6





$$a = \sqrt{6.88^2 + 5.66^2} = 8.90$$



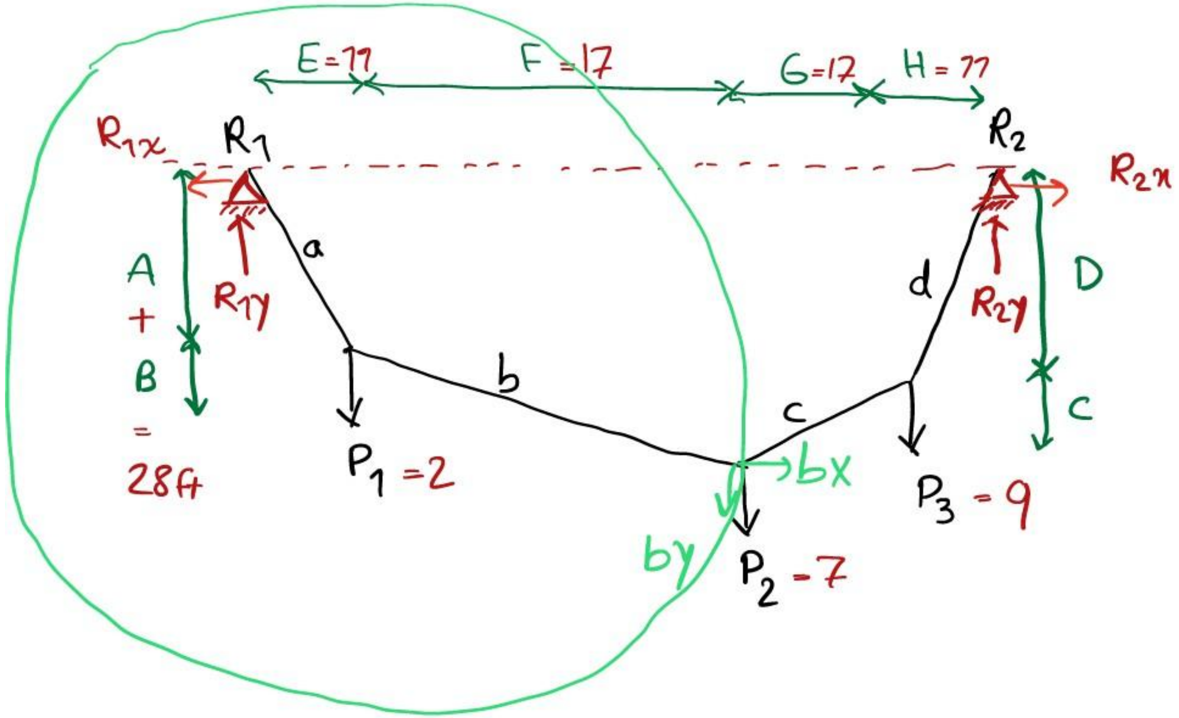
$$\frac{A}{E} = \frac{6.88}{5.66} = \frac{A}{11}$$

$A = 13.37$

$A + B = 28$

$B = 14.63$

Problem Set 6



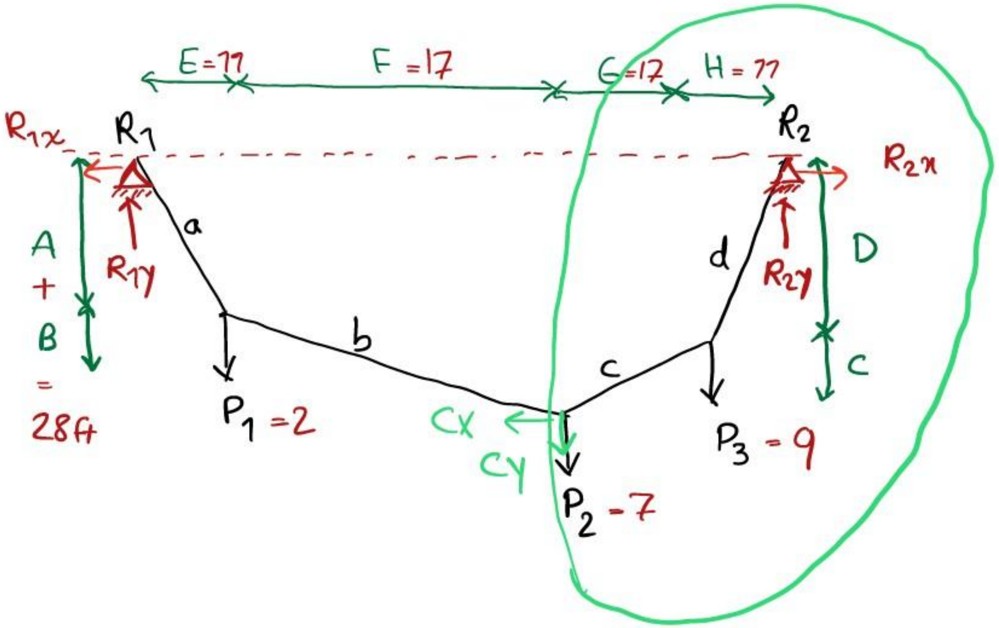
$\Sigma Fy = 0$

$6.88 - 2 - by = 0 \rightarrow by = 4.87$

$bx - R_1X = 0 \rightarrow bx = 5.66$

$b = \sqrt{5.66^2 + 4.87^2} = 7.46$

Problem Set 6



$$\Sigma F_x = 0$$

$$R_{2x} - C_x = 0 \rightarrow C_x = 5.66$$

$$\Sigma F_y = 0$$

$$R_{2y} - P_3 - C_y = 0$$

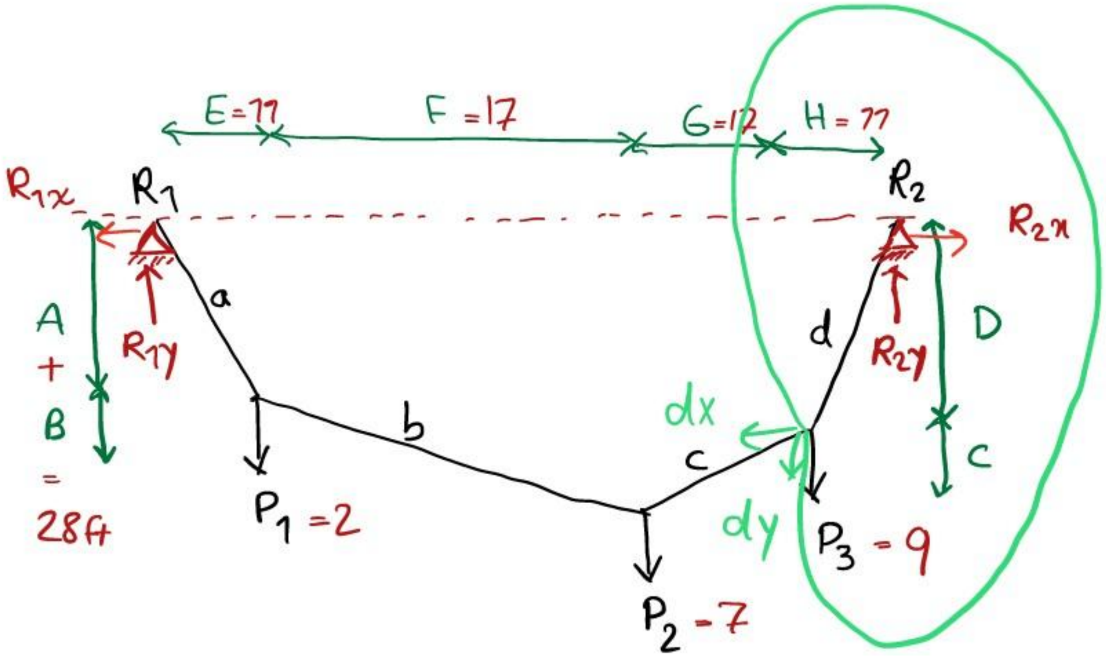
$$11.125 - 9 - C_y = 0 \rightarrow C_y = 2.125$$

$$C = \sqrt{5.66^2 + 2.125^2} = 6.04$$

$$\frac{C_y}{C_x} = \frac{c}{G} \rightarrow \frac{2.125}{5.66} = \frac{c}{17} \rightarrow c = 6.38$$

$$D + c = 28 \rightarrow D = 21.62$$

Problem Set 6



$$\Sigma f_x = 0$$

$$R_2x - dx = 0 \rightarrow dx = 5.66$$

$$\Sigma f_y = 0$$

$$R_2y - dy = 0 \rightarrow dy = 11.125$$

$$d = \sqrt{11.125^2 + 5.66^2} = 12.48$$

Preliminary Report

1.State the design intent and concept
say what you set out to achieve with your truss bridge and why the chosen concept makes sense structurally. Tie this directly to “explaining the structural design logic.”

2.Describe the load path (deck → joints → members)
Explain how the **distributed roadway load** is carried by the **deck** and transferred as **point loads to the truss joints** beneath it; then trace how those nodal loads flow through web members and chords to the supports. This directly reflects the brief’s load modeling note.

Preliminary Report

3.Explain support conditions
Clarify how the bridge bears on its supports and why that works with your load path. The brief urges you to consider “the way in which your bridge rests on the supports.”

5.Anticipate member force signs (T/C)

Before calculation, state which members you expect in tension vs compression, and why. This shows understanding of truss behavior that later matches your analysis section.

6.Relate geometry to force flow

Connect panel lengths, panel heights (depth), and web patterns to expected axial forces, buckling risk in compression members, and efficiency.

Preliminary Report

7.Member sizing strategy

Explain your plan for sizing members **from axial forces** using $A = P/F$ or $F = P/A$, and how preliminary force expectations influenced which members you made thicker/thinner. This aligns with the brief's required approach.

8.Critical member & likely failure mode

Identify the most critical member you expect to govern ultimate capacity and state why you think it will fail first.

examples

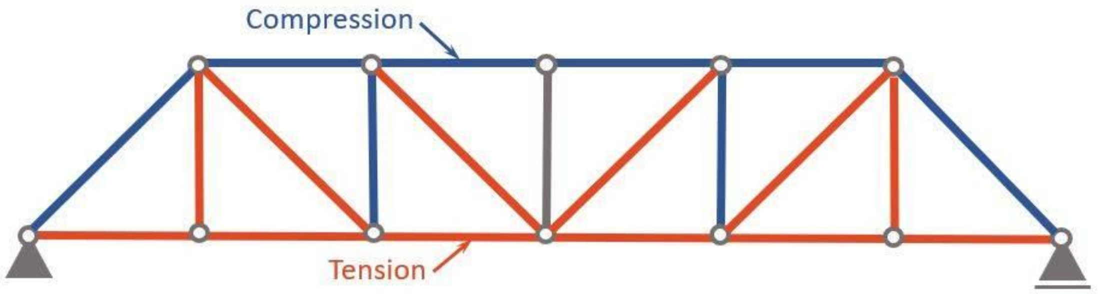
Pratt Truss

Description: One of the most common American trusses, widely used in 19th–20th century railway and highway bridges.

Logic: Diagonal members slope **toward the center** of the span. Under gravity loads, diagonals take **tension**, verticals take **compression**, which is efficient because slender diagonals can carry tension without buckling.

Analysis highlights:

- Top chord in compression, bottom chord in tension.
- Clear, predictable load paths make analysis simple with the *method of joints*.
- Often chosen when material in tension (like steel or good-quality wood) is economical.



examples

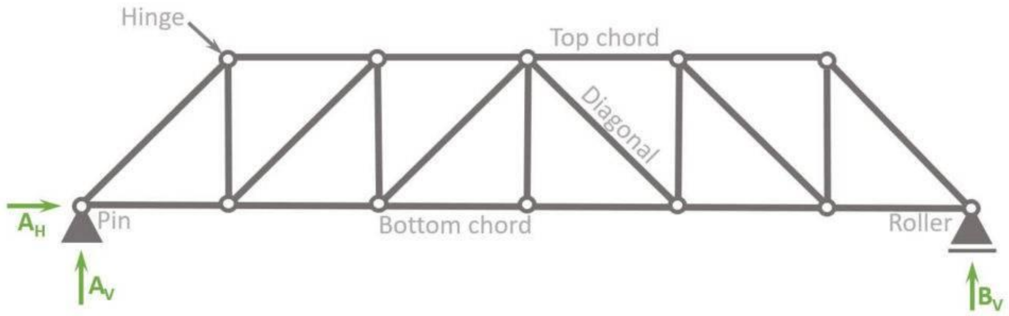
Howe Truss

Description: Common in timber bridges during the 19th century (opposite force pattern to Pratt).

Logic: Diagonals slope **away from the center** of the span. Diagonals are **in compression**, while verticals are **in tension**.

Analysis highlights:

- Works well with timber, since wood handles compression well.
- Heavier than Pratt for the same span, but construction with timber and iron rods made it historically popular.
- Critical failure mode: buckling of diagonals.



examples

Quebec Bridge (Canada, 1917)

Astoria–Megler Bridge (Oregon, USA, 1966)

Ikitsuki Bridge (Japan, 1991)

LAB

Truss Stability

Description

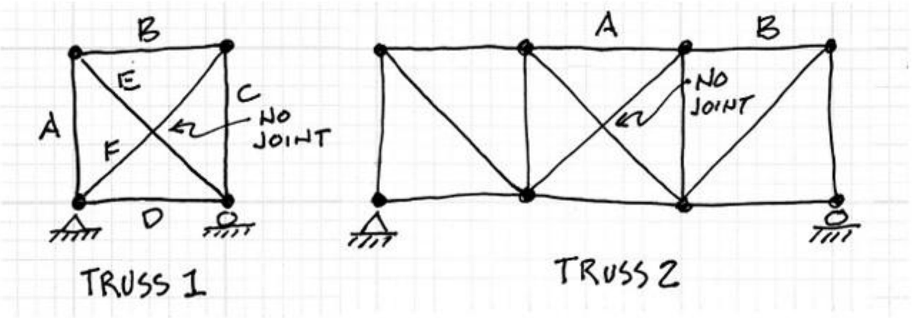
This project takes a look at the stability and instability of trussed structures based on member number and placement

Goals

To make use to the truss stability equation.
To observe limitations of the truss stability equation.

Procedure

1. Use the truss stability equation, k=2j-r , to determine whether Truss 1 is unstable, stable, or indeterminate.
2. Make a sketch of Truss 1 with member A removed. Based on the stability equation, what is the status of the truss now? Would you agree?
3. Now repeat this for each of members in Truss 1 one at a time. Does the truss remain stable in each case?
4. Use the truss stability equation to determine whether Truss 2 is unstable, stable, or indeterminate.
5. Make a sketch of Truss 2 with member A removed. Based on the stability equation, what is the status of the truss now? Would you agree?
6. Make another sketch of Truss 2 with member B removed. Based on the stability equation, what is the status of the truss now? Would you agree?
7. Try removing other members from Truss 2. Make a sketch of two of these showing one which remains stable and one which becomes unstable with one member removed.



k = 2j – r if
m < k then unstable
m = k then stable and determinate
m > k then stable and indeterminate