TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Arch314
STRUCTURES I

Fall 2024
Recitation

FACULTY: Prof. Peter von Bülow
Mohsen Vatandoost

Welcome to Recitation session 10/04

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Office hours:

By appointment
Click here to schedule

Please feel free to ask questions.

Welcome to Recitation session 10/04

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(Homework 7)**
- Answering student's questions
- Lab: __
- **Bridge_1** project (providing more details + the requirements for the reports)

Please feel free to ask questions.

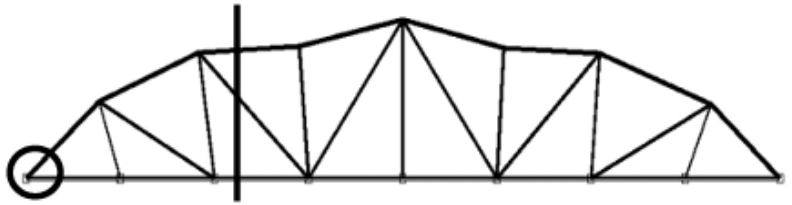
Contact: Mohsenv@umich.edu

Recap of the week

Truss Analysis

Method of Joints

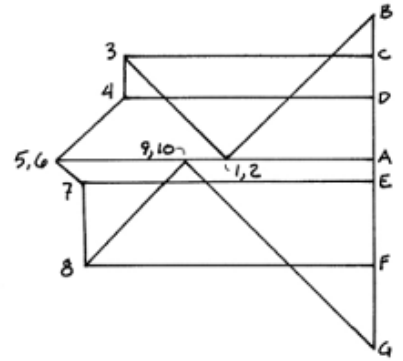
Method of Sections



Graphic Methods

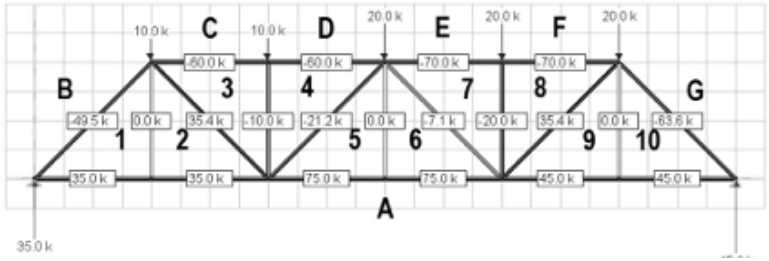
James Clerk Maxwell 1869
M. Williot 1877
Otto Mohr 1887
Heinrich Müller-Breslau 1904
William Baker, SOM

James Clerk Maxwell



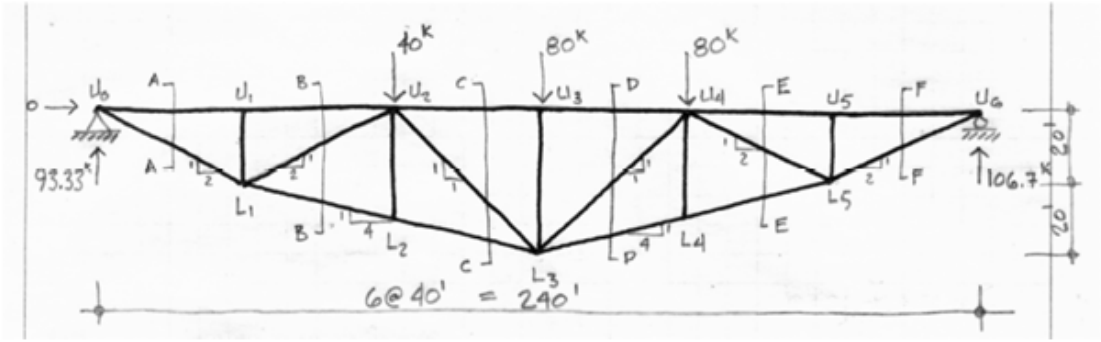
Computer Programs

Dr. Frame (2D)
STAAD Pro (2D or 3D)
West Point Bridge Designer

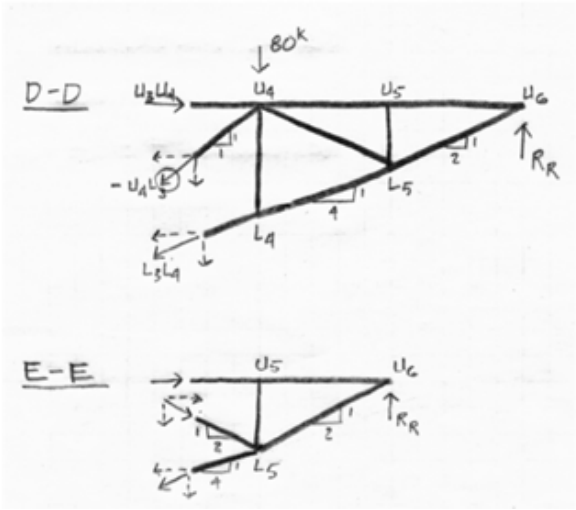


Recap of the week

Method of Sections - procedure



1. Solve Reactions
2. Cut section through member
3. Choose point **where all but one of the unknown forces cross** and ΣM
4. Continue with ΣF_H and ΣF_V



Provide the solution for the assignment – **HW7**

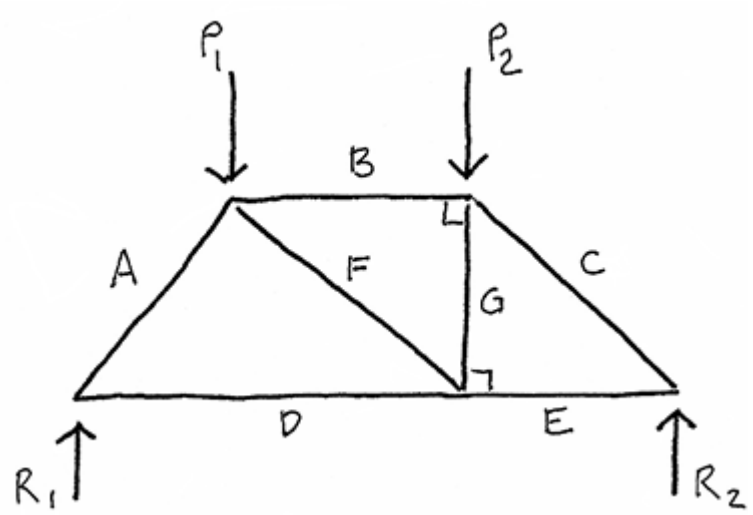
- **Problem:**

8. Truss Systems

Find the internal forces in members: a, b, h, g, j, k, l.

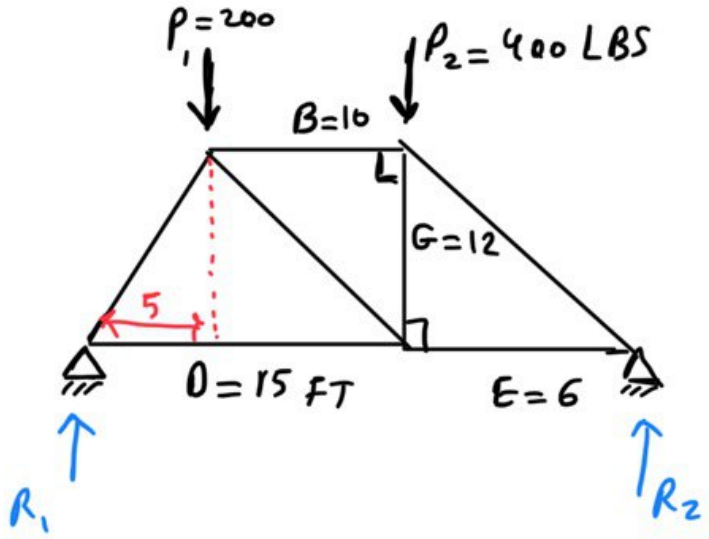
DATASET: 1 -2- -3-

Length B	10 FT
Length D	15 FT
Length E	6 FT
Length G	12 FT
Load P1	200 LBS
Load P2	400 LBS



Provide the solution for the assignment – **HW7**

method of Joints
(cut FBD of one Joint)



solve external reactions:

$$\sum M_{@1} = 0$$

$$P_1 \times (O-B) + P_2 \times O - R_2 (O+E) = 0$$

$$200 \times (15-10) + 400 \times 15 - R_2 (15+6) = 0$$

$$\rightarrow \underline{R_2 = 333.34} \text{ LBS} \quad (2)$$

$$\sum M_{@2} = 0$$

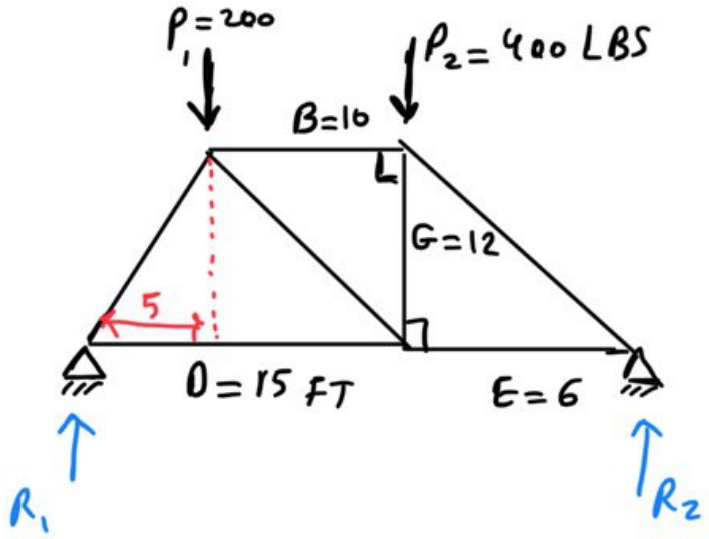
$$-P_2 \times E - P_1 (B+E) + R_1 (O+E) = 0$$

$$-400 \times 6 - 200(10+6) + R_1 (15+6) = 0$$

$$\underline{R_1 = 266.67} \text{ LBS} \quad (1)$$

Provide the solution for the assignment – HW7

- Solution:



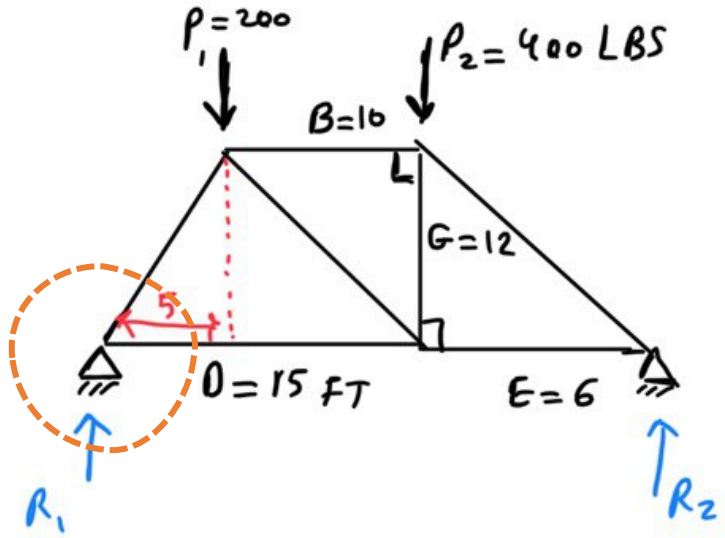
Check:

$$\Sigma F_y = 0$$

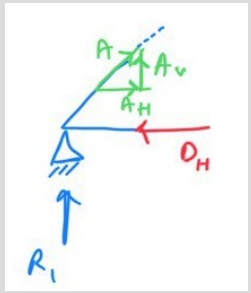
$$R_1 - P_1 - P_2 + R_2 = 0$$

$$266.67 - 200 - 400 + 333.34 = 0$$

Provide the solution for the assignment – **HW7**



FBD of one joint

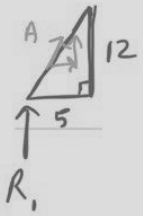


$\sum F_y = 0$

$R_1 + A_V = 0 \longrightarrow A_V = -R_1$

$\longrightarrow \boxed{A_V = -266.67}$ (9)

Triangle proportions:

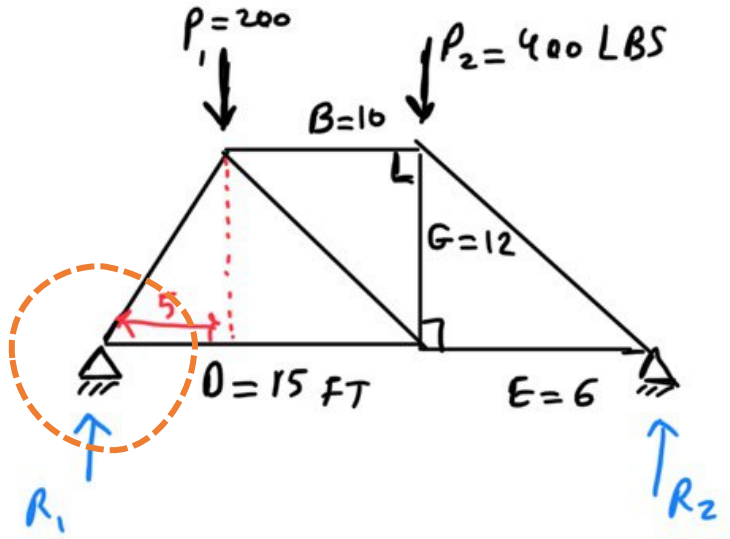


$\frac{A_H}{A_V} = \frac{5}{12} \longrightarrow \frac{A_H}{-266.67} = \frac{5}{12}$

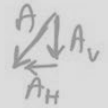
$\longrightarrow \boxed{A_H = -111.1125}$ LBS (3)

Provide the solution for the assignment – **HW7**

- Solution:



The negative values shows we need to change direction of forces in member A.

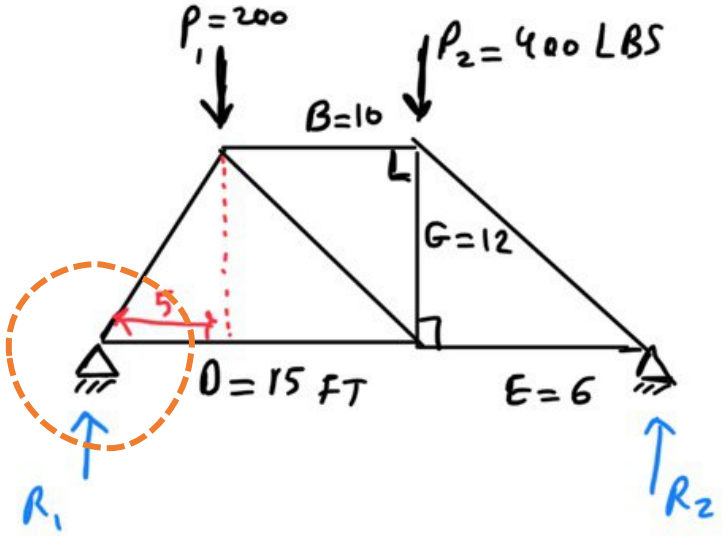


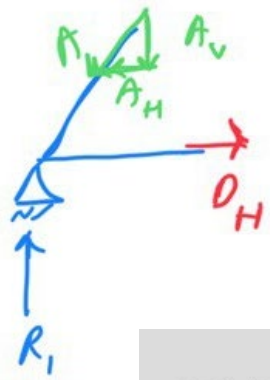
Compression (6)

(5) $A = \sqrt{A_H^2 + A_V^2} = \sqrt{111.1125^2 + 266.67^2} = 288.89$ LBS

Pythagorean

Provide the solution for the assignment – **HW7**

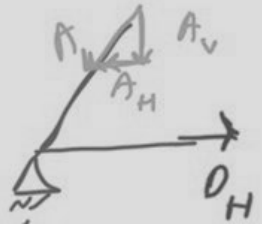




$\Sigma F_x = 0$

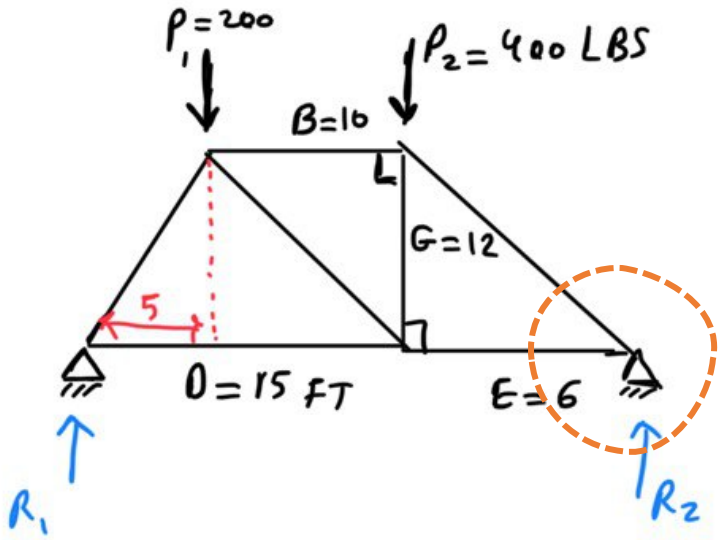
$-A_H + D_H = 0 \longrightarrow D_H = A_H$

$\longrightarrow \boxed{D_H = 111.1125}$ LBS (13)

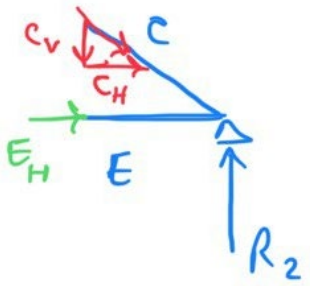


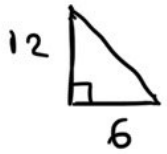
D → Tension (14)

Provide the solution for the assignment – **HW7**



FBD





$$\sum F_y = 0$$

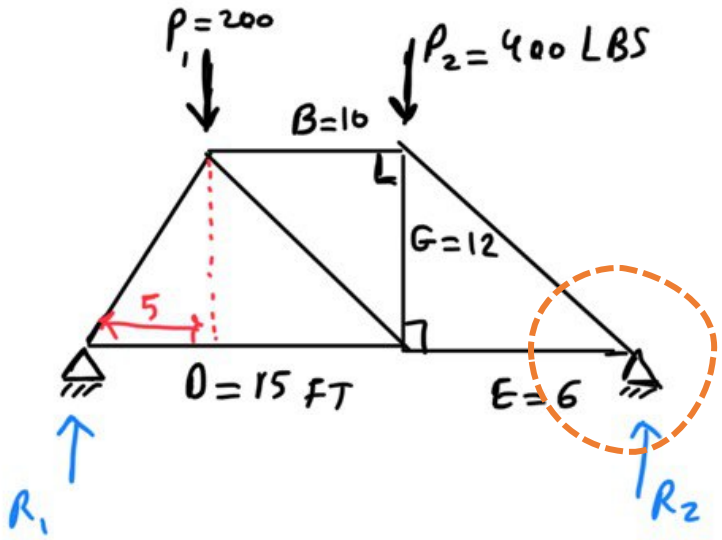
$$R_2 - C_V = 0 \longrightarrow C_V = R_2 = 333.34 \text{ LBS} \quad (10)$$

$$\frac{C_H}{C_V} = \frac{6}{12} \longrightarrow C_H = \frac{6 \times 333.34}{12} = \boxed{166.67 \text{ LBS}} \quad (9)$$

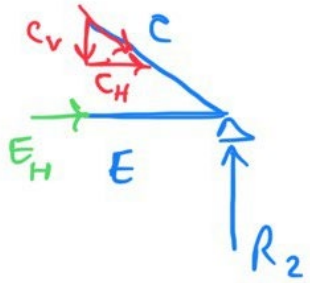
$$C = \sqrt{C_H^2 + C_V^2} = \sqrt{166.67^2 + 333.34^2} = \boxed{372.68 \text{ LBS}} \quad (11)$$

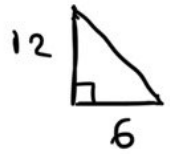
C _ Compression (12)

Provide the solution for the assignment – **HW7**



FBD





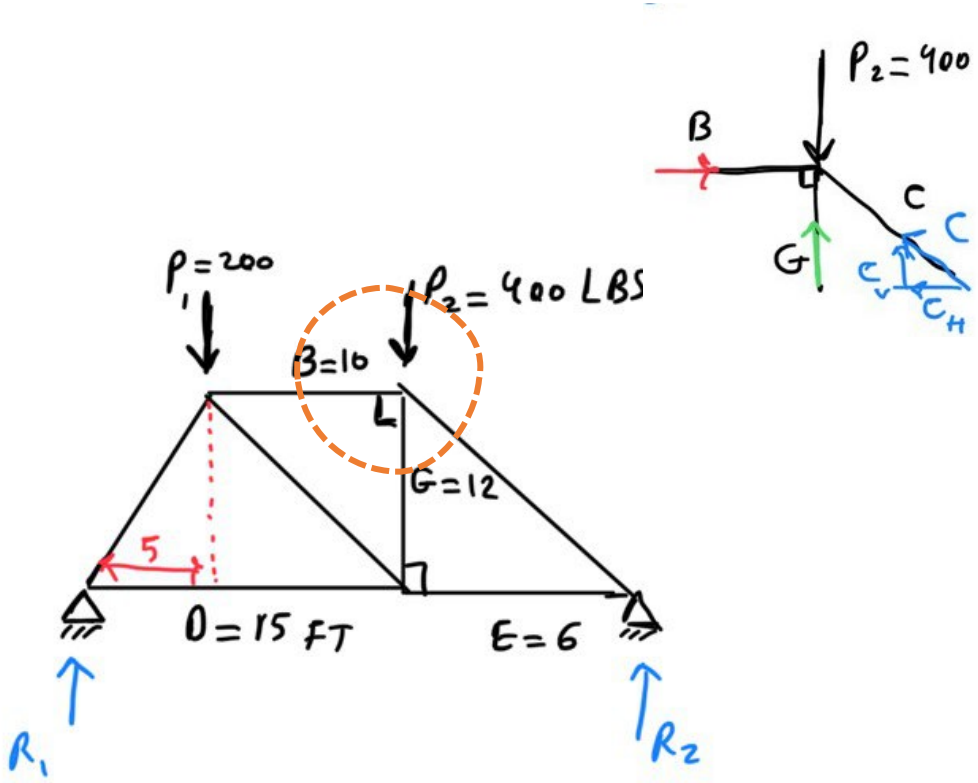
$\sum F_x = 0$

$E_H + C_H = 0 \longrightarrow E_H = -C_H = \underline{-166.67}$ LBS (15)

The negative value for E_H indicates our assumption were not true, so the correct direction of E_H is ←

E_Tension (16)

Provide the solution for the assignment – **HW7**



$\sum F_y = 0$

$-P_2 + G_v + C_v = 0$ (21)

$-400 + G_v + 333.34 = 0 \longrightarrow \boxed{G_v = 66.67}$ LBS

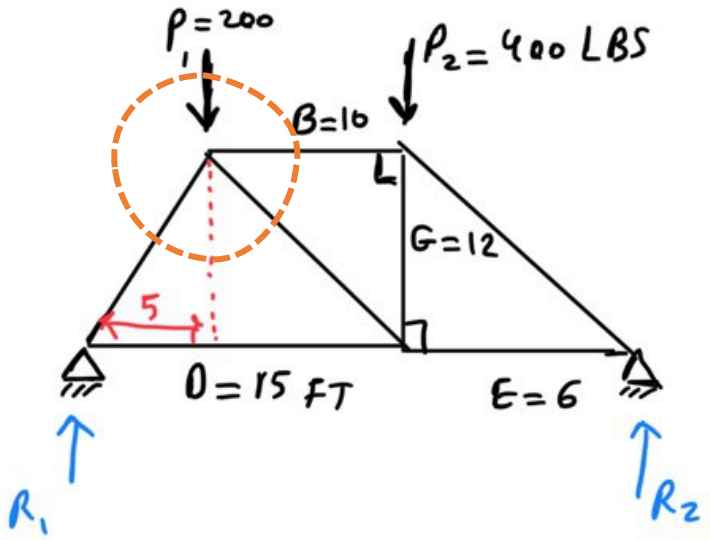
G_Compresion (22)

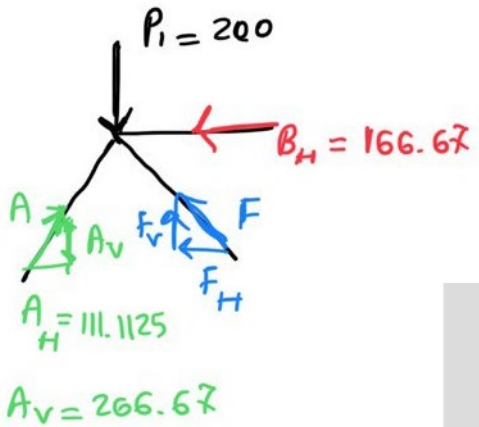
$\sum F_x = 0$ (23)

$B_H - C_H = 0 \longrightarrow B_H = C_H = \boxed{166.67}$ LBS

B_Compresion

Provide the solution for the assignment – **HW7**





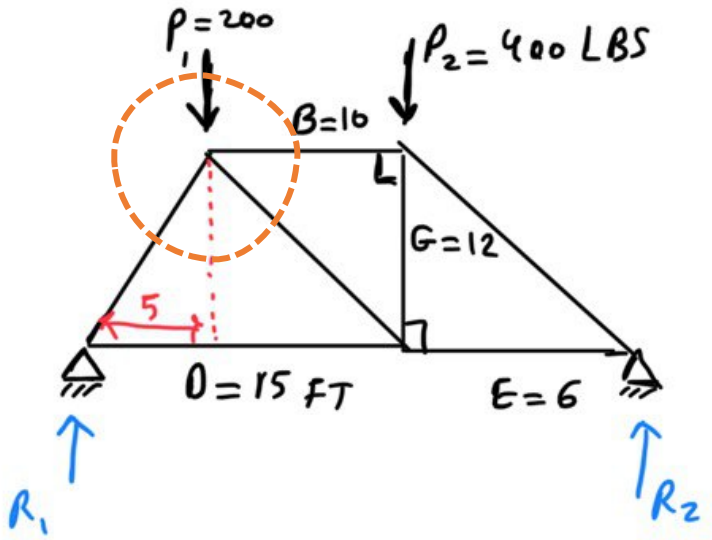
$$\sum F_x = 0$$

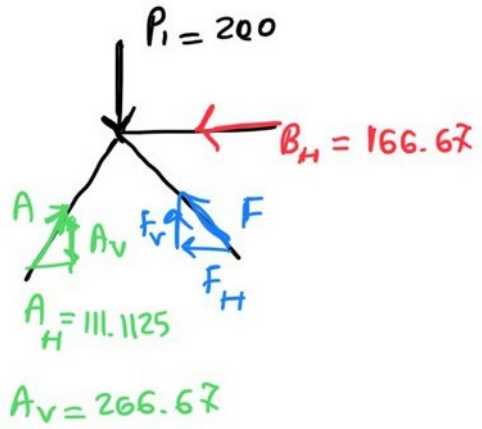
$$A_H - B_H - F_H = 0$$

$$111.1125 - 166.67 - F_H = 0$$

$$\longrightarrow F_H = -55.5575 \text{ LBS} \quad (17)$$

Provide the solution for the assignment – **HW7**





$$\sum F_y = 0$$

$$-P_1 + A_V + F_V = 0 \quad (18)$$

$$-200 + 266.67 + F_V = 0 \rightarrow F_V = -66.67$$

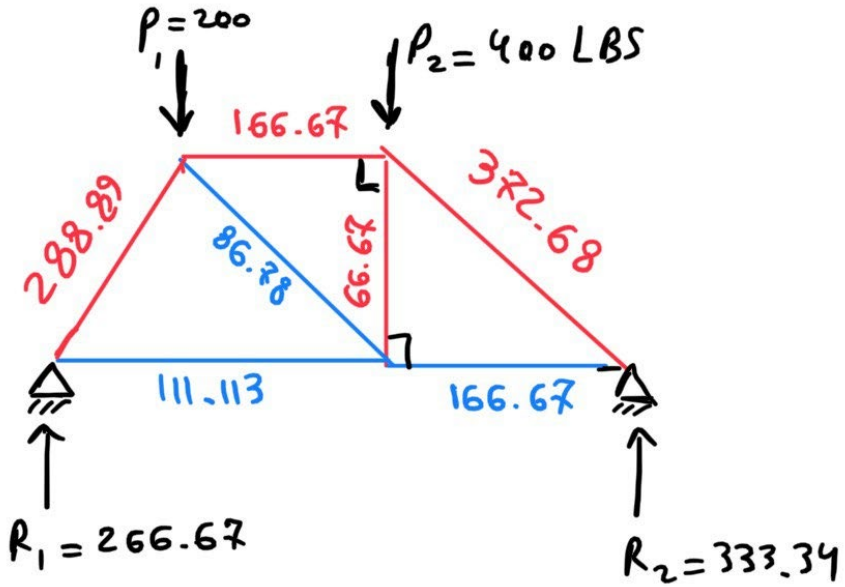
$$F = \sqrt{F_H^2 + F_V^2} = 86.78 \text{ LBS} \quad (19)$$

Again negative sign for F_H, F_V

↳ change the direction

F_tension

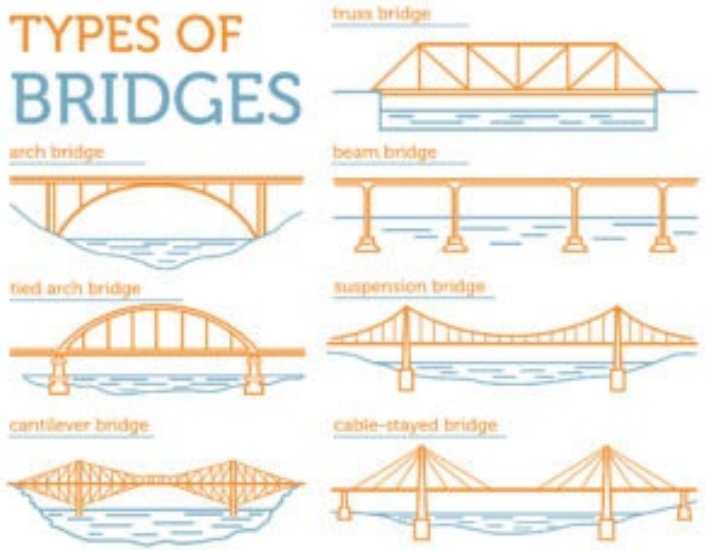
Provide the solution for the assignment – **HW7**



Compression = Red
Tension = Blue

Bridge Project

Truss Bridge



Description

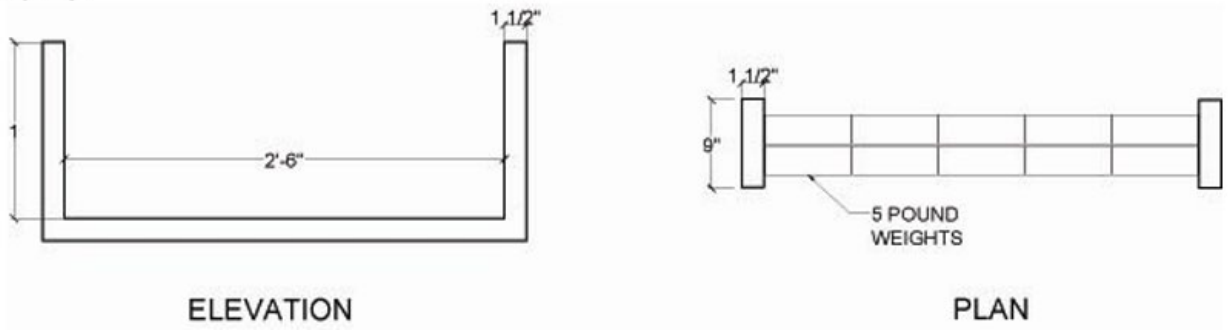
This project gives students the chance to apply concepts learned in truss analysis to the design of a small road bridge. The project also introduces techniques for design and testing of structural models. Work is to be conducted in groups of up to four people. The project is divided into three parts: 1) initial conceptual design and analysis, 2) design development and testing, 3) post analysis and documentation.

Objectives

- to explore the geometric design parameters of a structural truss through bridge design.
- to perform quantitative analysis as a means of testing and evaluating a design.
- to test a design concept using a 1:64 (3/16" = 1') scale structural model.
- to document the results in a clear, well organized report.

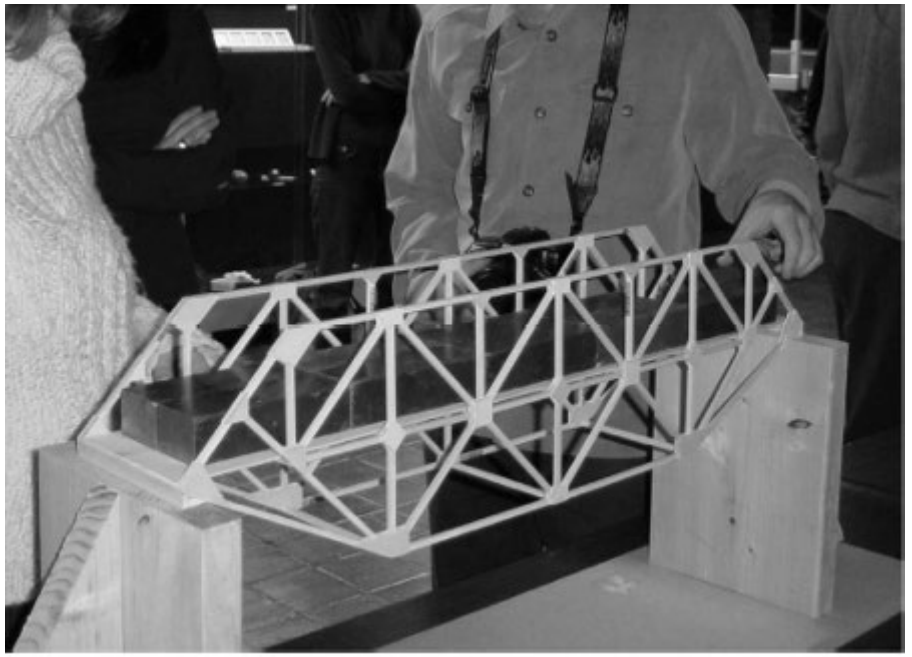
Bridge Project

Testing Frame:



Span=160 ft (scaled = 30 in)
Max. Depth = 53 ft (10 in)
Max. Deck = 8 in (1/8 in thick)

Max Weight = 68k (4 oz)
Material = wood + glue



Bridge Project

Documentation

see tally sheet for detail
development of prelim
revised analysis
final design
test results
post-test analysis

Score Tally

Three Parts

prelim report	40
testing	60
final report	150

Preliminary Report

Explanation

concept
truss type

Analysis

member forces (Dr Frame)
member sizing
selfweight
capacity

Presentation

letter size report

Due Date

6 October 2023

Criteria

dimensions – 30" span
loading – 50 lbs min.
Materials – wood + glue

Efficiency score

weight limit – 4 oz. (minimize)
load capacity – 50 lb (maximize)
(4/weight)x50 + (load/50)x9

Submission

preliminary report
model testing
final report

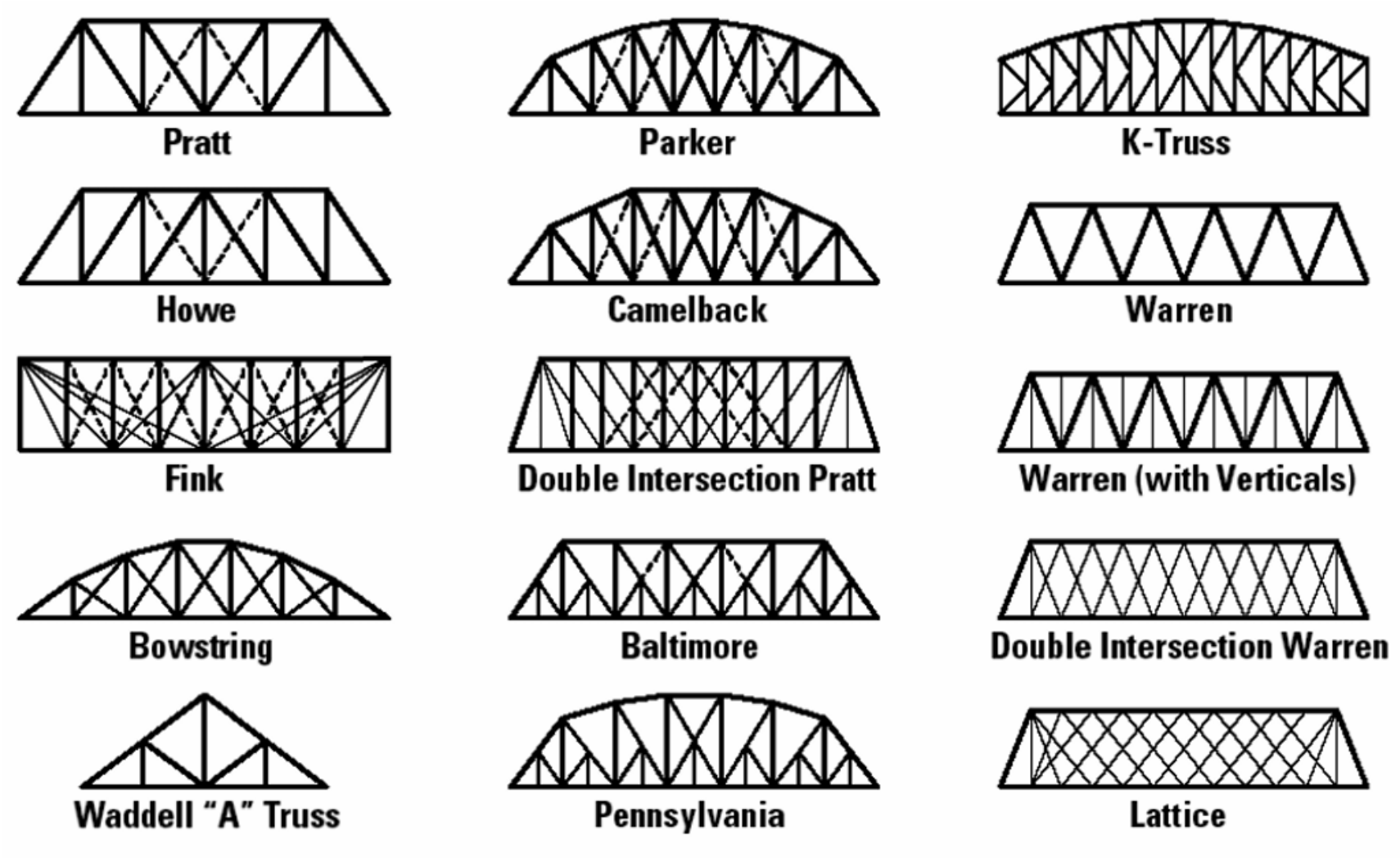
Final Report

Documentation

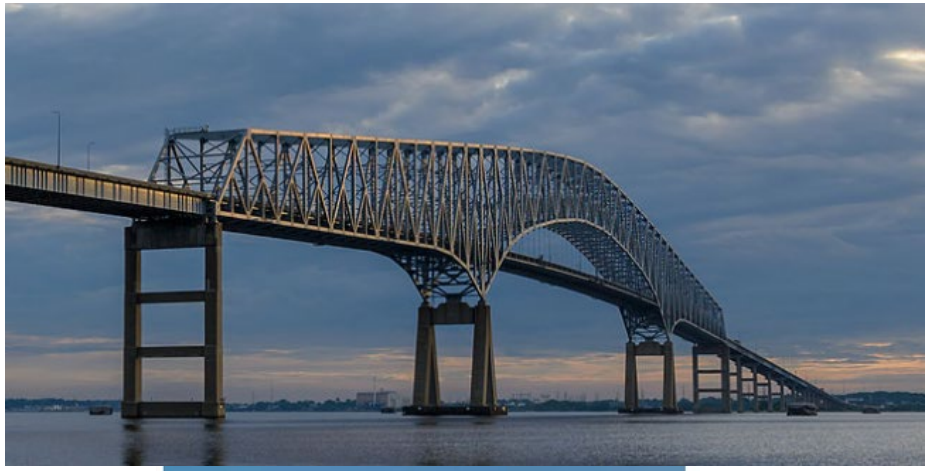
see tally sheet for detail
development of prelim
revised analysis
final design
test results
post-test analysis

Bridge Project

Remember!
Triangles are Sturdy, Stable Shapes



Bridge Project – Some good examples



Thank you.

Any question?

Please feel free to ask questions.

Contact: Mohsenv@umich.edu