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 10/11

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Office hours:

Room 3104
Wed: 11:30 – 13:30
Mon, Fri: 11:30 - 12:30
By appointment

Please feel free to ask questions.

Welcome to Recitation session 10/11

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(No assignment for this week!)**
- Answering student's questions
- Lab: **Graphic Statics**
- **Bridge_1** project (providing feedbacks)

Please feel free to ask questions.

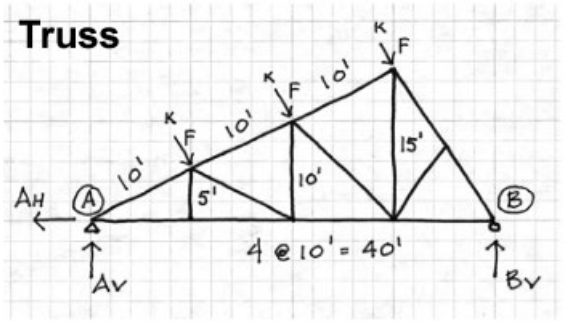
Contact: Mohsenv@umich.edu

Recap of the week

Pinned Frame vs. Truss

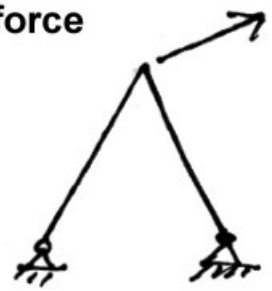
Trusses:

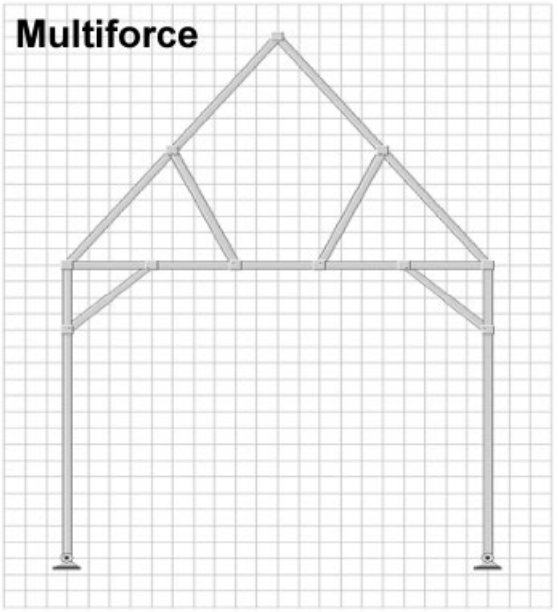
- 2-force members
- ridged bodies



Pinned Frames:

- 2-force or multiforce (axial or bending)
- ridged body or mechanism

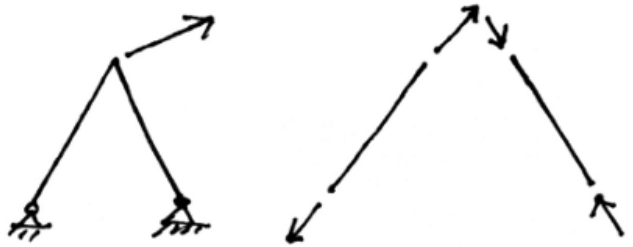




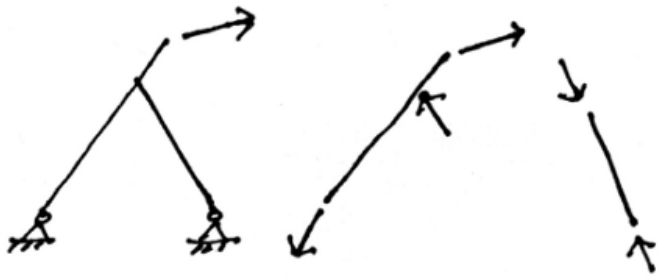
Recap of the week

Frame Types

Frames with 2-force members
(axial forces)



Frames with multiforce members
(bending + axial forces)

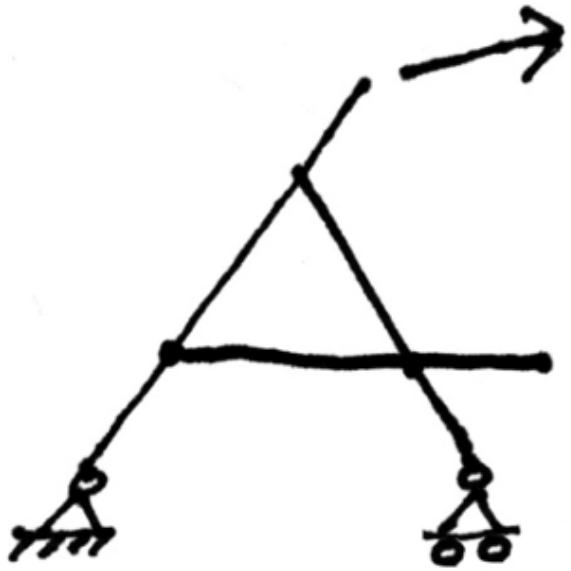


Recap of the week

Multiforce Member Frames

Procedure

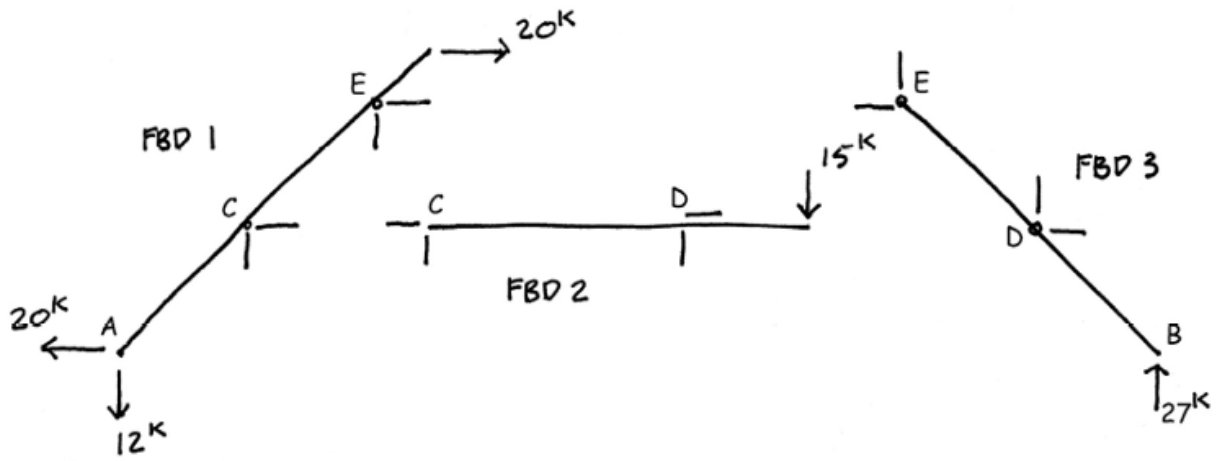
1. Solve external supports
2. Cut FBD of each member
3. Solve forces at joints.
4. Some members will be multiforce, they will be in bending.



Recap of the week

Analysis

2. Cut FBD of each member



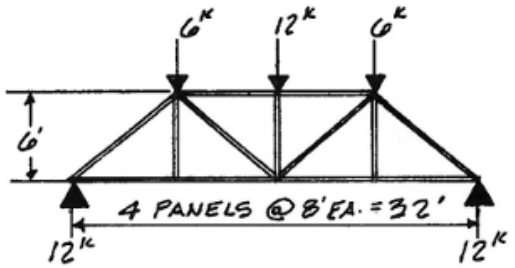
- Work between the FBDs using 3 equations of statics.
- End force components can be solved as axial and normal forces.
- The normal forces are “shear” forces and result in moments or “bending” forces.
- Not all systems are statically determinate and may then require other methods.

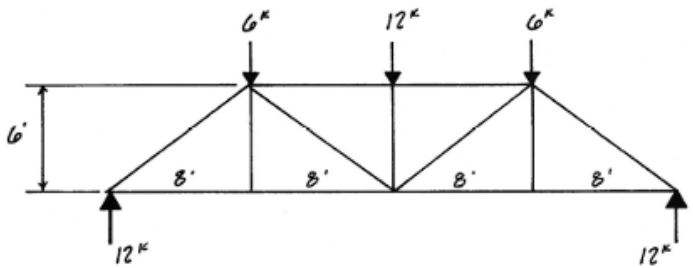
Recap of the week

Graphic Statics - Step 1

Draw the truss to scale

- Solve for all external forces on the truss.
- Make a simple line drawing of your truss.
- Draw it to scale.

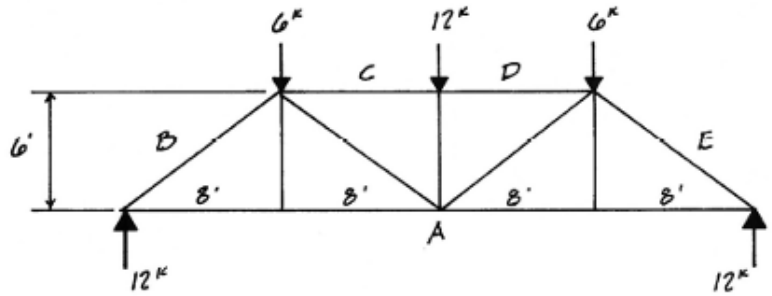




Graphic Statics - Step 2

Letter external spaces

- Label each space outside the truss with a letter.
- Start at bottom center (by convention).
- Continue in a clockwise direction around the outside of the truss.

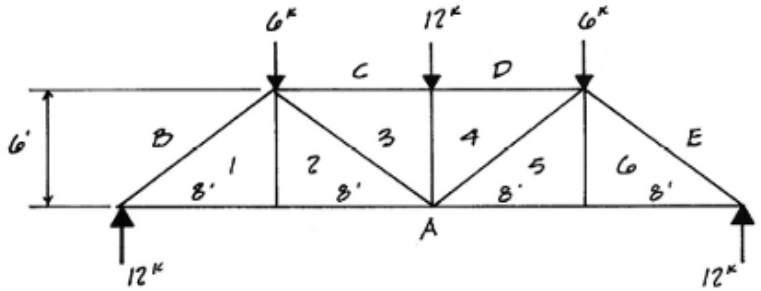


Recap of the week

Graphic Statics - Step 3

Number internal spaces

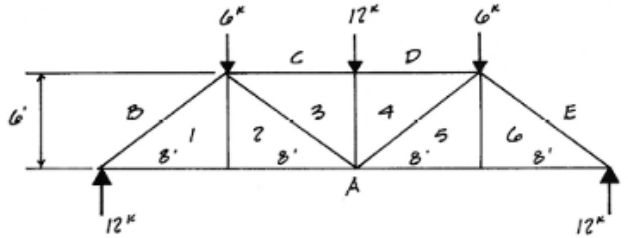
- Number each space inside the truss.
- Number from left to right.



Graphic Statics - Step 4

Draw the force diagram

- Start in the external space (A) and move clockwise to the next space (B).
- Note the direction and magnitude of the external force you cross (12k up).
- Draw this force to scale.
- The force starts with the tail (A) and continues to the head (B).

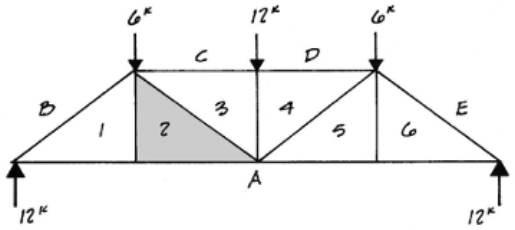


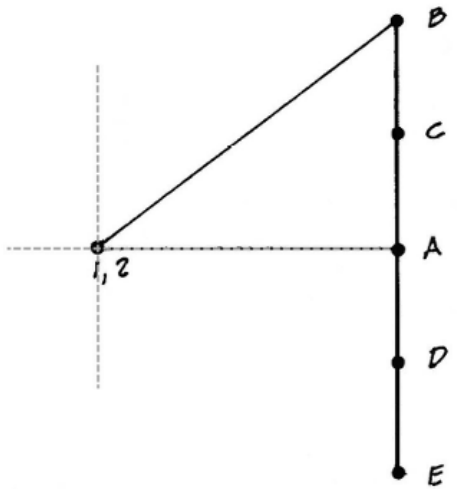
Recap of the week

Graphic Statics - Step 5

Draw the member forces

- Now find the next point (2).
- Choose two spaces that are adjacent to space this next space (2).
- Now move to the next external space (A) adjacent to this internal space (2).
- Draw a line with the same slope as the member crossed starting at the letter of the external space (A).
- Now observe the member which is between the next two spaces (1 & 2).
- Draw a line with the same slope as the member through the location of the point which labels the adjacent space (1).
- The scaled length of the line equals the force. If a line has zero length (like 1-2) then the force in the member is zero.

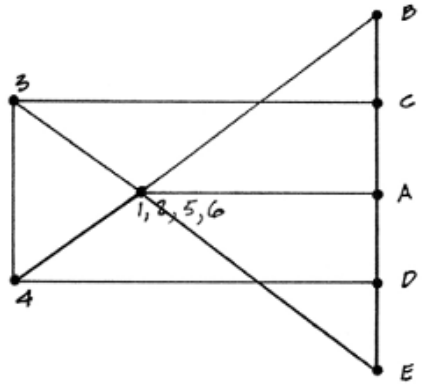


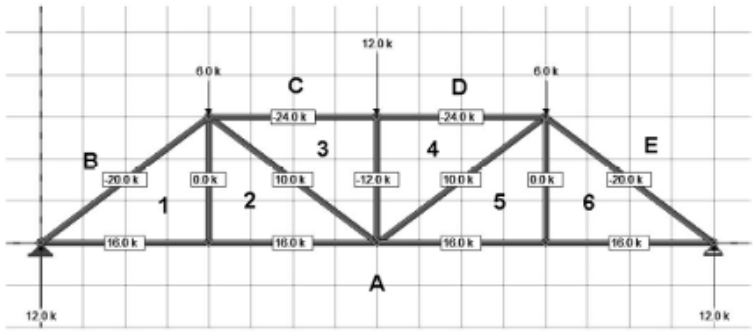


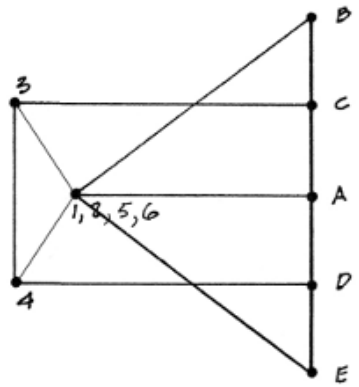
Recap of the week

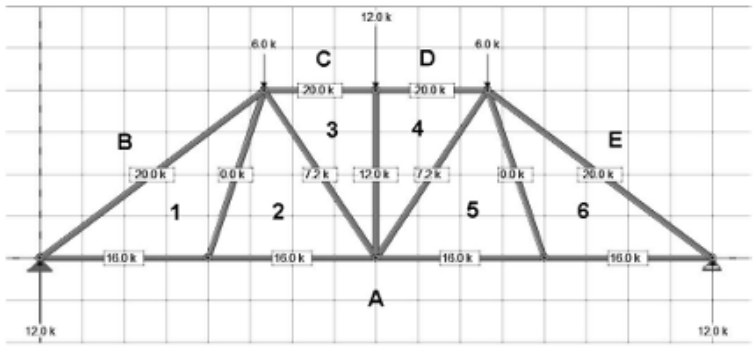
Graphic Statics - Design

The geometry and force diagrams are duals. Changing one will result in changes in the other and vice versa. Design a truss to achieve desired forces by modifying the force diagram, and then modifying the geometry diagram to match.

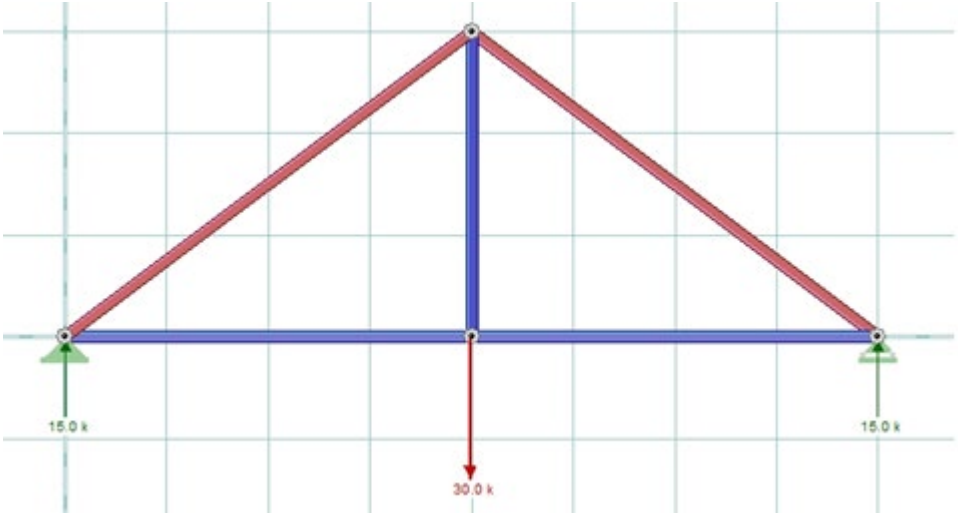








Lab: Graphic Statics



Graphic Statics

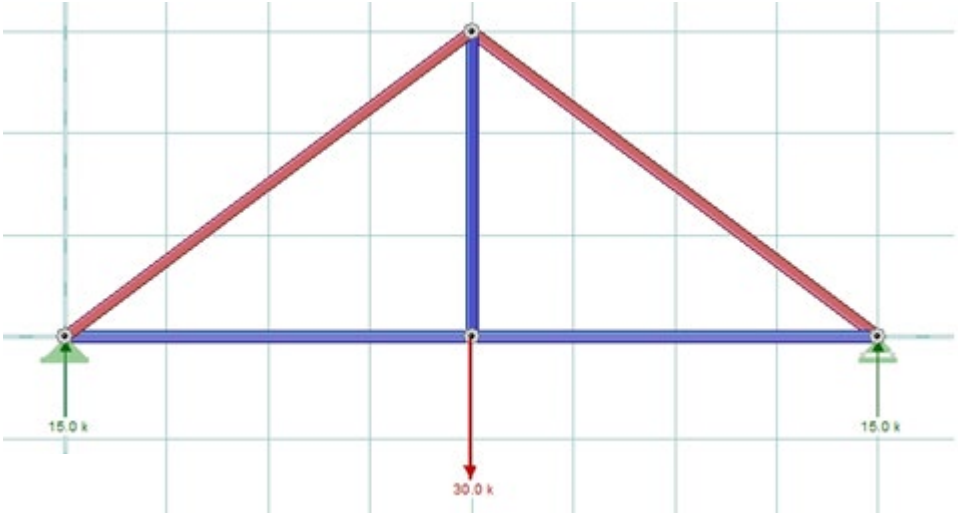
Description

This project provides opportunity to explore the graphic method of truss analysis

Goals

To draw a graphic force diagram for a given truss.
To determine the member forces.

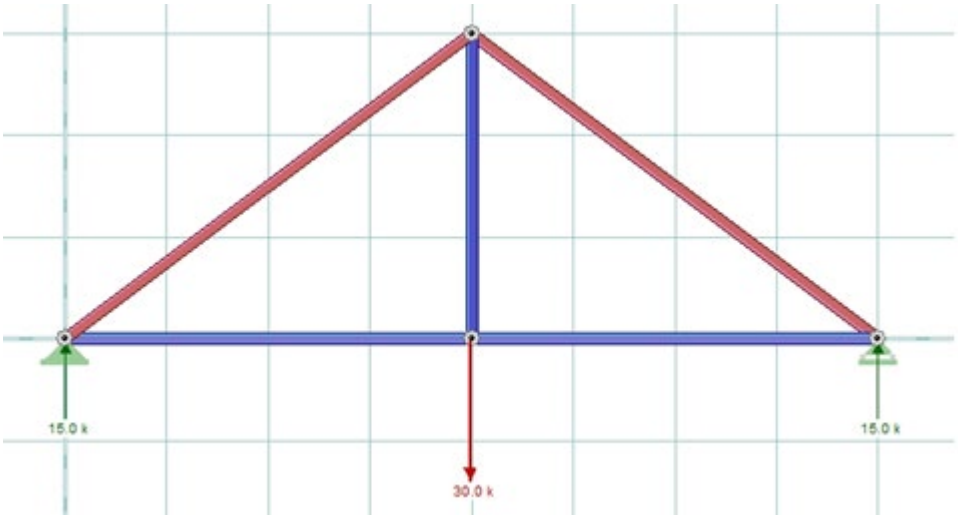
Lab: Graphic Statics

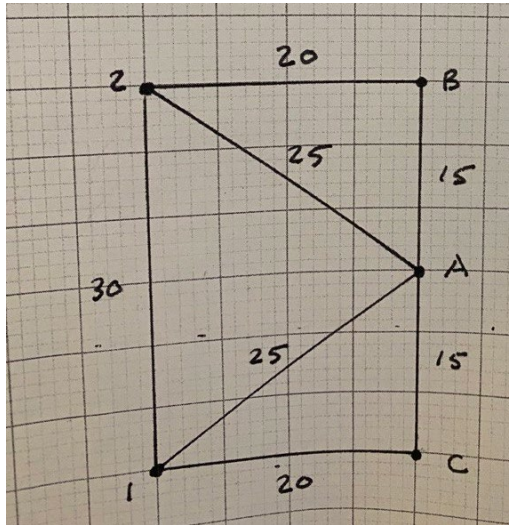


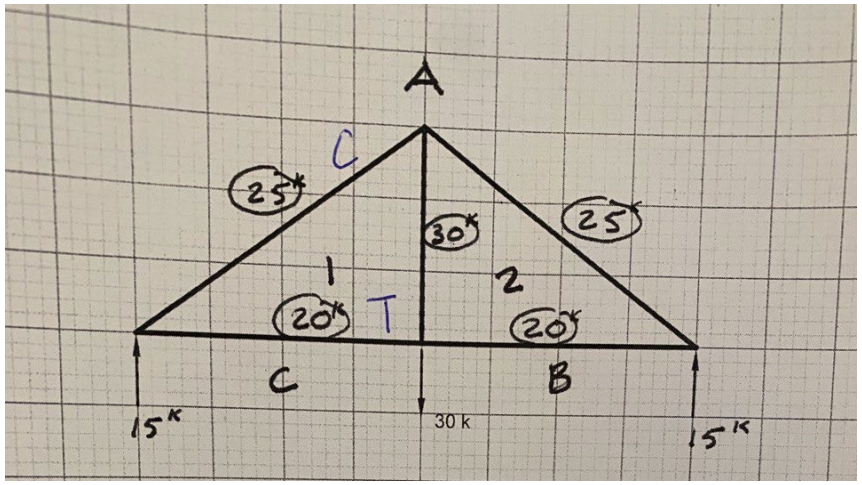
Procedure

1. Determine the end reactions for the given king post truss.
2. Label the external cells. (A, B, C)
3. Label the internal cells. (1, 2)
4. Draw the force vectors. (*AB, BC, CA*)
5. Draw vector *C1* through point C.
6. Draw vector *A1* through point A.
7. Label the intersection of *C1* and *A1* as point 1.
8. Draw vector *B2* through point B.
9. Draw vector *A2* through point A.
10. Label the intersection of B2 and A2 as point 2.
11. Draw vector *12* connecting points 1 and 2.
12. Measure each vector to determine the force in the member.
13. Record the force value next to the member on the truss drawing.

Lab: Graphic Statics





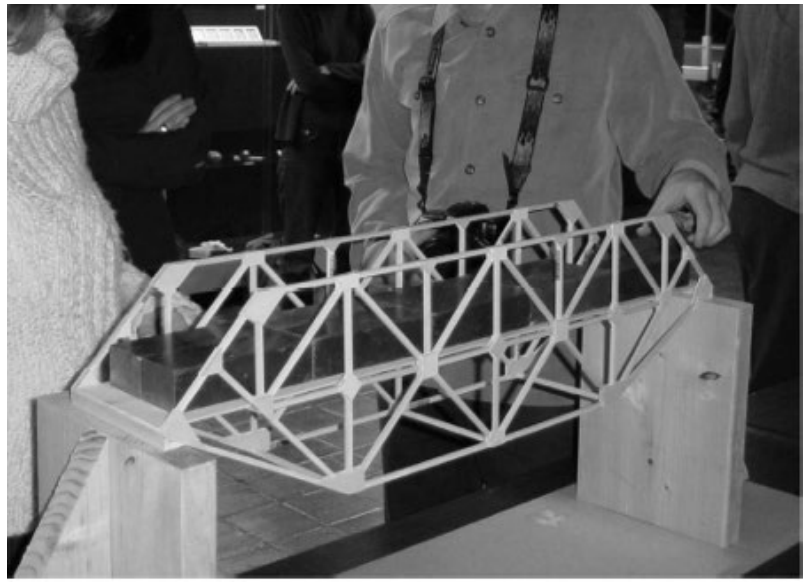


Bridge Project

FEEDBACKS + Challenges

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

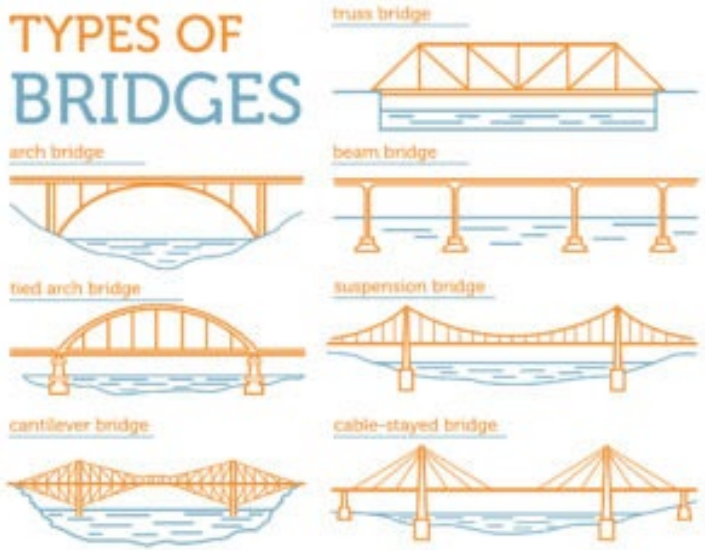


Bridge Project

- Have creativity!
- Refine your initial design
- Iteration to upgrade your design
- Pay attention to the Tally sheet requirements.
  (We Don’t want you to lose points!)
- A long-continuous member is allowed.
- Deck required to be designed flat
- Look at the examples provided in the course website

Bridge Project

Truss Bridge



Description

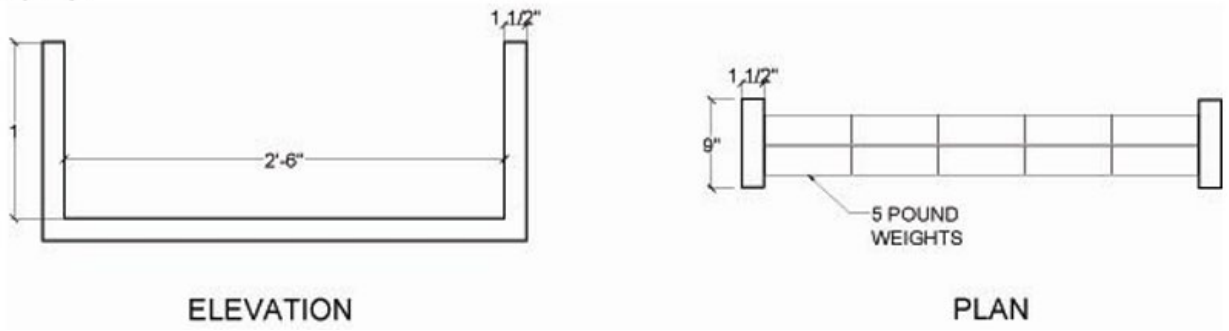
This project gives students the chance to apply concepts learned in truss analysis to the design of a small road bridge. The project also introduces techniques for design and testing of structural models. Work is to be conducted in groups of up to four people. The project is divided into three parts: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



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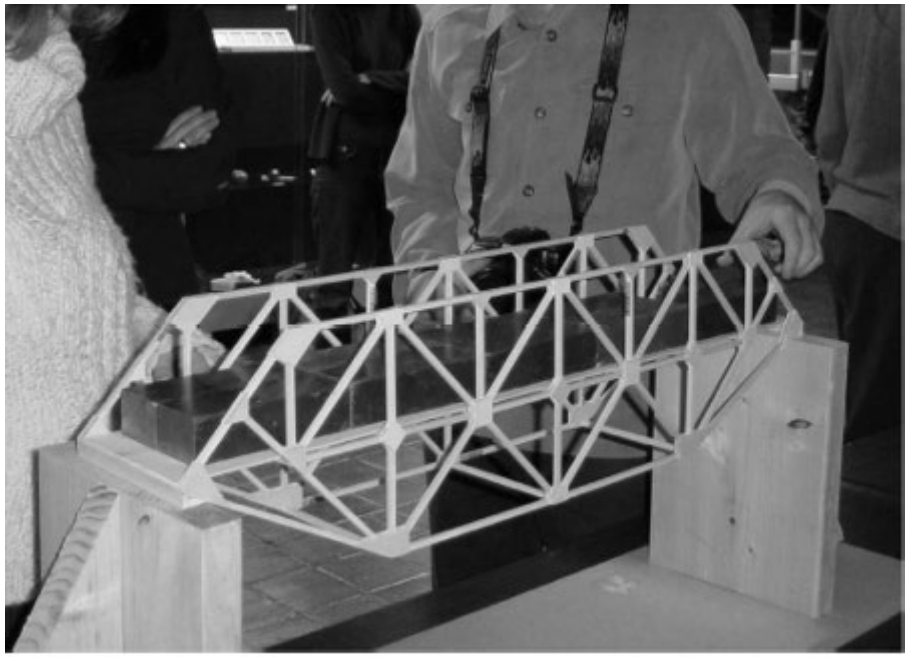


Bridge Project

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

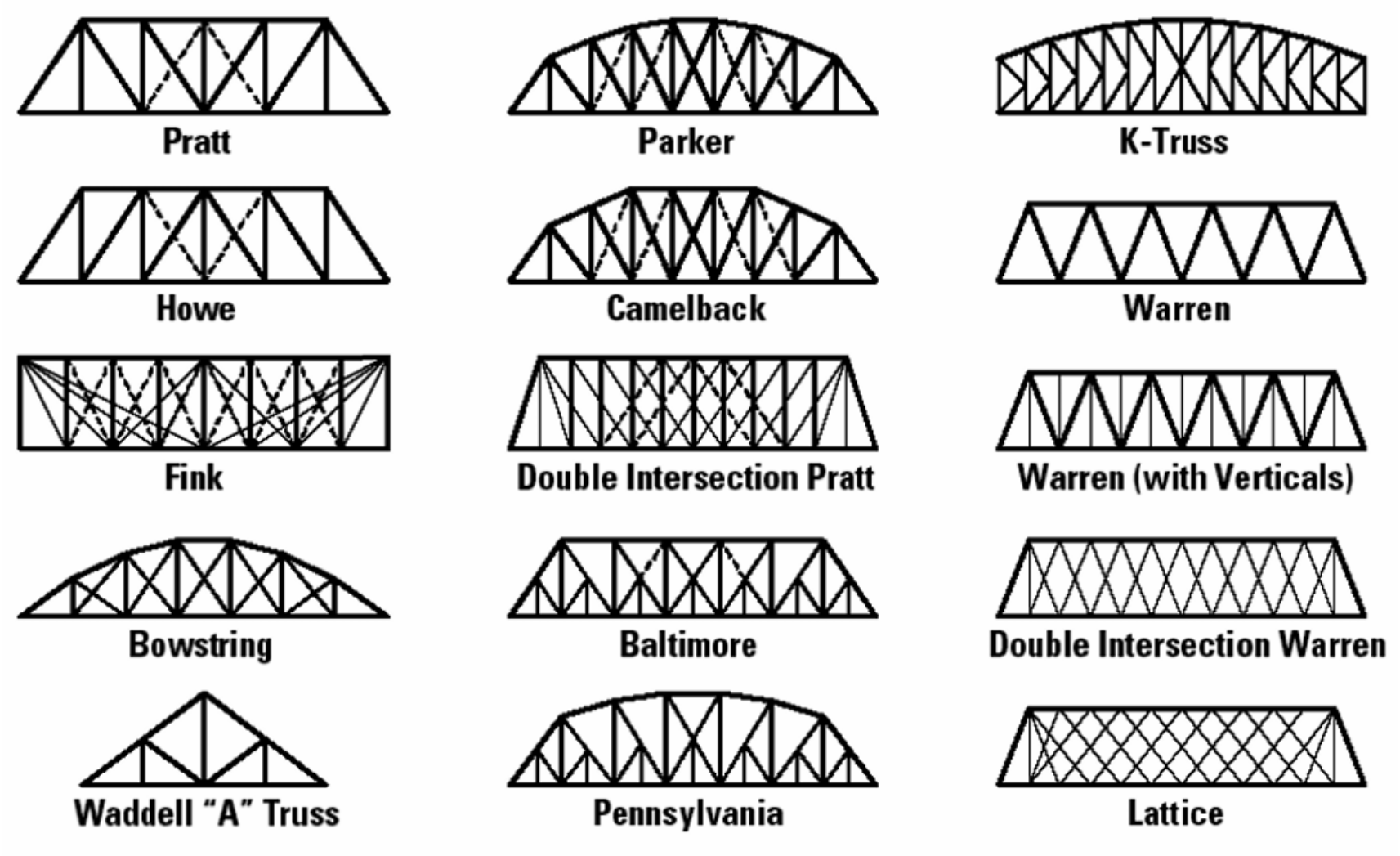
Final Report

Documentation

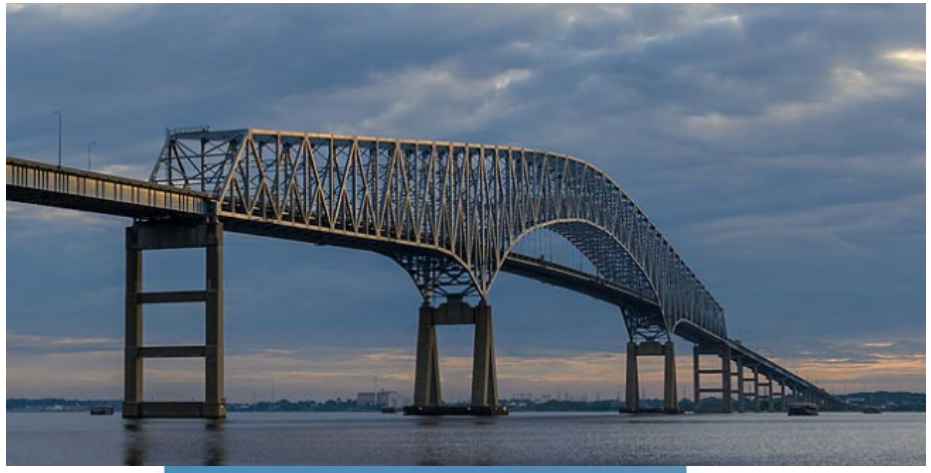
see tally sheet for detail
development of prelim
revised analysis
final design
test results
post-test analysis

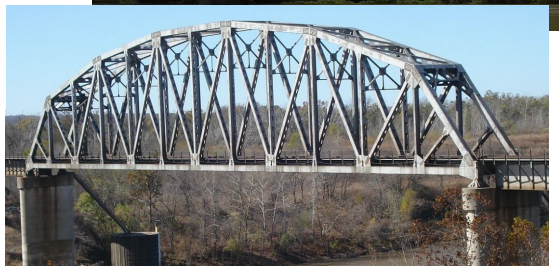
Bridge Project

Remember!
Triangles are Sturdy, Stable Shapes



Bridge Project – Some good examples





Thank you.

Any question?

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