truss

Academic Resource Center

Introduction

- A truss is a structure composed of slender members joined together at their end points;
- Each member only takes axial forces.

Application

- Roof trusses

  - efficient for big spans:

    Examples: column-less exhibition halls; warehouses

- Bridge trusses

Analysis Methods

- Method of Joints
- Method of Sections
- The trusses are statically determinate

Method of Joints

- Principle

  If a truss is in equilibrium, then each of its joints must also be in equilibrium.

- Procedure

  - starts with a joint that has no more than two unknown forces

Method of Joints (con't)

- Establish the x and y axis;
- At this joint, $\sum Fx = 0$ and $\sum Fy = 0$
- After finding the unknown forces applied on this joint, these forces become the given values in the analysis of the next joints.

Method of Joints (con't)

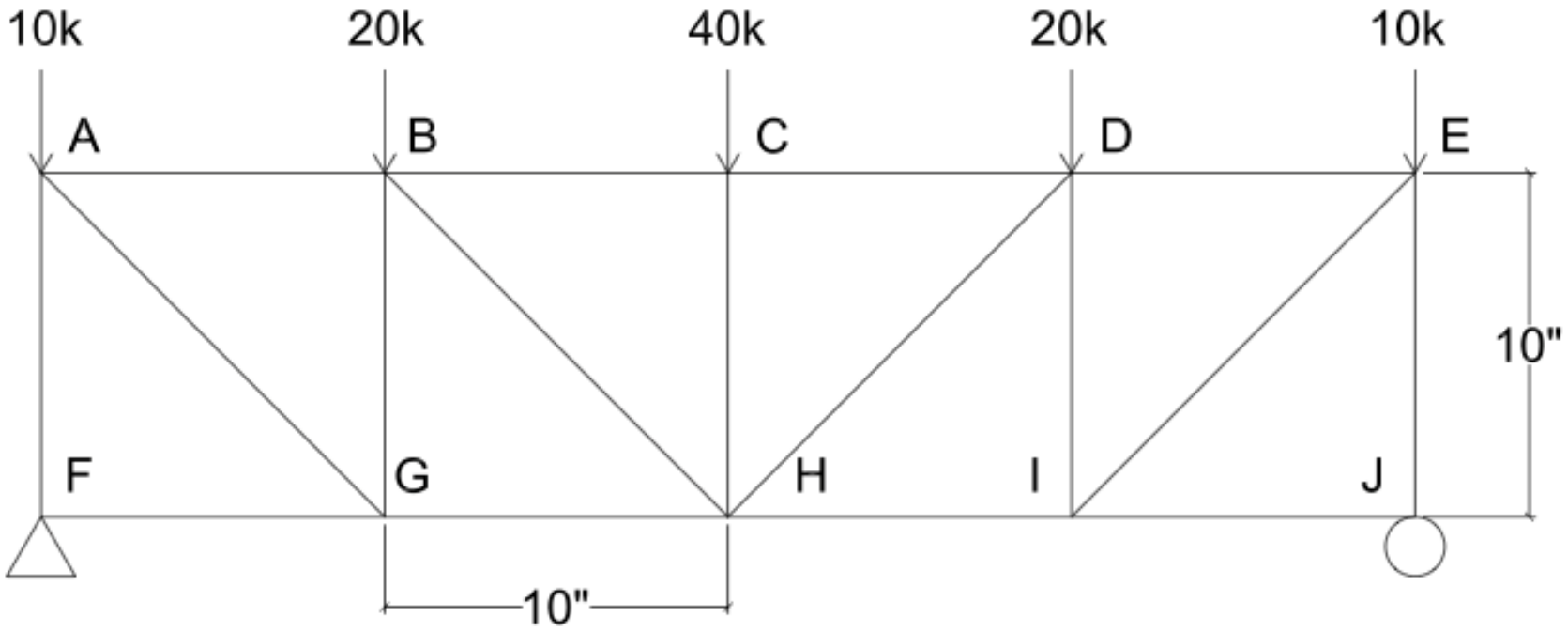
- Tips

- The joints with external supports always connect with two truss members. Thus many times, the analysis starts from analyzing the supports. Therefore very often the analysis begins with finding the reaction forces applied at the supports.

Method of Joints (con't)

- Pay attention to symmetric systems and zero-force members. Identification of these special cases sometimes will make the whole analysis WAY EASIER!!

Example



Find the force in each member

Example

- Identify the truss is symmetric

- Finding the reaction forces:

$\sum Fx = 0;$

$\sum Fy = R(Fy) + R(Jy) - 40k - 20k - 20k - 10k - 10k = 0;$

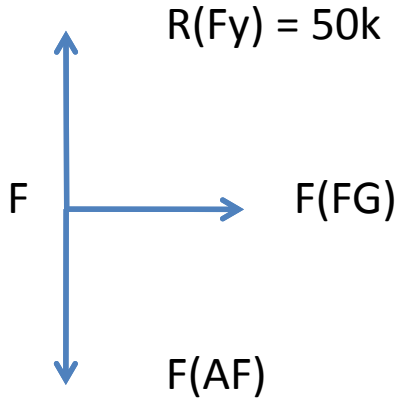
$\sum M(F) = 0;$

$R(Jy) \times 40'' - 20k \times 10'' - 40k \times 20'' - 20k \times 30'' - 10k \times 40'' = 0$

Find $R(Fy) = R(Jy) = 50$

- Start off with joint A

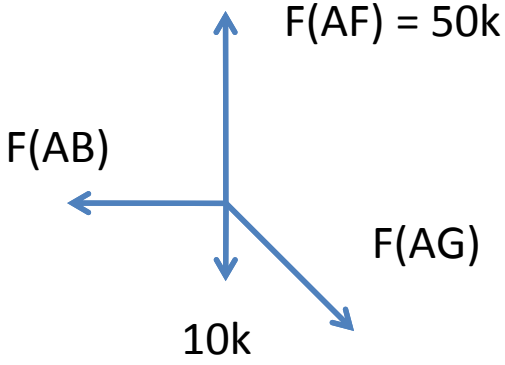
Example



$\sum Fx = F(FG) = 0$

$\sum Fy = 50k - F(AF) = 0$

Find F(AF) = 50k (in compression)



$\sum Fx = F(AG) \times \sin 45 - F(AB) = 0$

$\sum Fy = 50k - F(AG) \times \cos 45 - 10k = 0$

Find F(AG) = 56.6k (in tension)

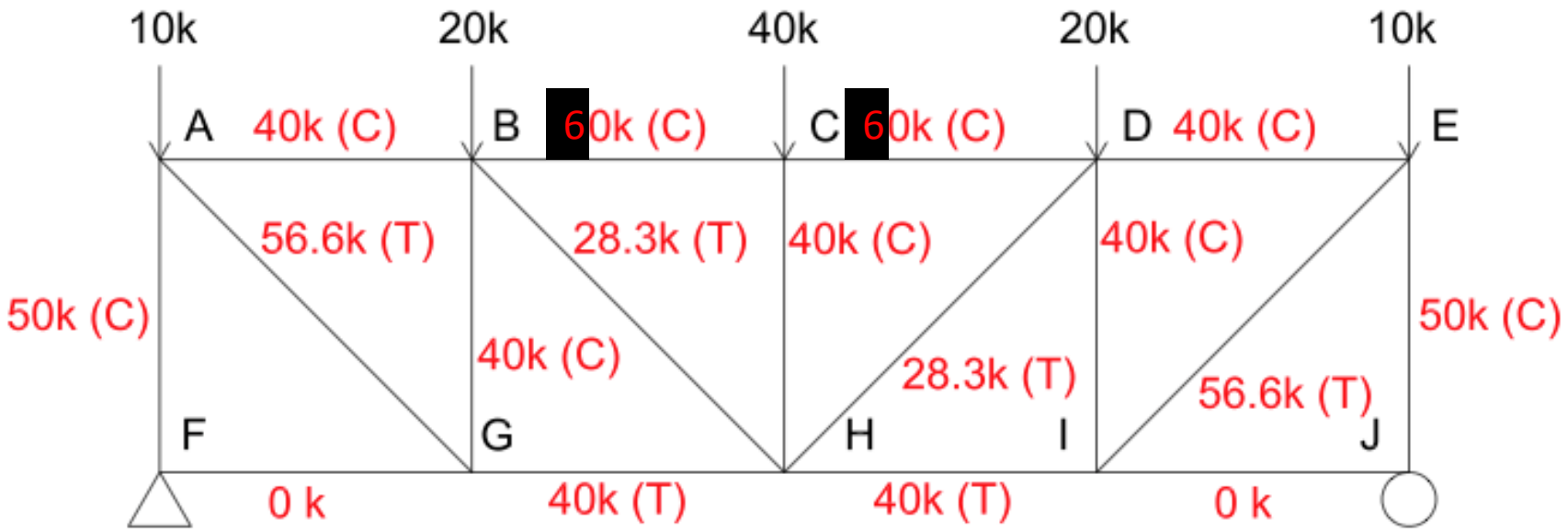
F(AB) = 40k (in compression)

Example

- By using the same method, analyze joint B, C, G, H;

- Since the truss is symmetric, the forces on the members are symmetric as well. Thus we only need to anaylze half of the truss and then mirror the forces onto the rest half. The result is shown in the following slide:

Example


10k
20k
40k
20k
10k
A
B
C
D
E
40k (C)
60k (C)
60k (C)
40k (C)
56.6k (T)
28.3k (T)
40k (C)
40k (C)
50k (C)
50k (C)
40k (C)
28.3k (T)
56.6k (T)
F
G
H
I
J
0 k
40k (T)
40k (T)
0 k

Method of Sections

- Principle

  If a truss is in equilibrium, then which ever section of the truss being considered must also be in equilibrium.

- Procedure

- Finding the reaction forces;

Method of Sections (con't)

- Make a cut through the members where the unknown forces are applied;

- Establish equilibriums for one of the sections: $\sum Fx = 0$; $\sum Fy = 0$; $\sum M = 0$;

- If your result comes out to be negative, then it means you assumed a wrong direction of the force.

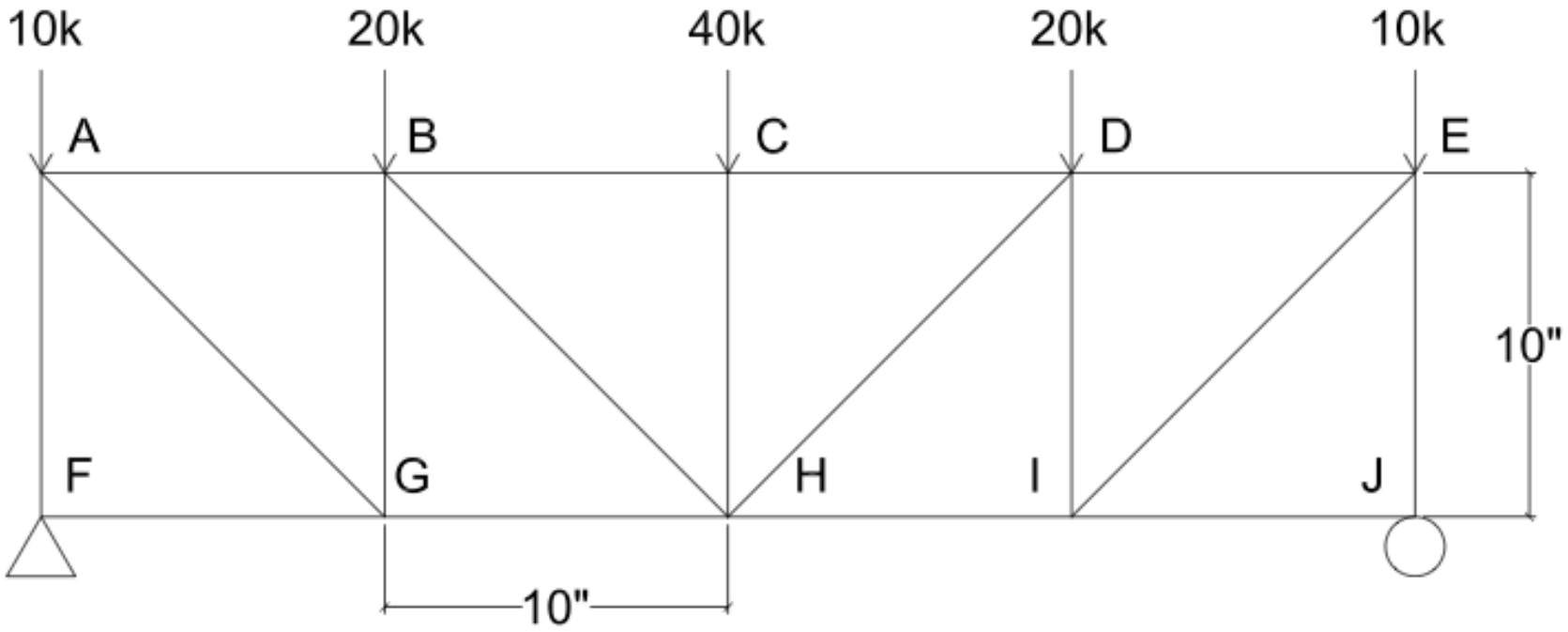
Method of Sections (con't)

- Application

- The method of sections is commonly used when the forces in only a few particular members of a truss are to be determined;

- The method of sections is always used together with the method of joints to analyze trusses.

Example



Find the force in member BC, BH and GH

Example

- Finding the reaction forces as we did in the previous example:

$\sum Fx = 0;$

$\sum Fy = R(Fy) + R(Jy) - 40k - 20k - 20k - 10k - 10k = 0;$

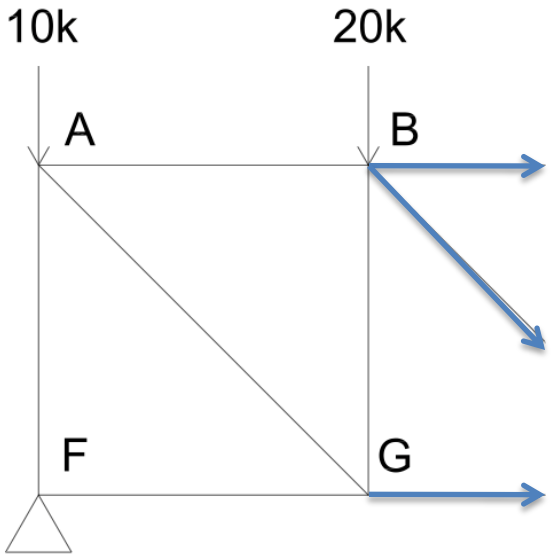
$\sum M(F) = 0;$

$R(Jy) \times 40'' - 20k \times 10'' - 40k \times 20'' - 20k \times 30'' - 10k \times 40'' = 0$

Find $R(Fy) = R(Jy) = 50$

Example

- Since the forces of particular members laying in the middle of the truss are asked, we use the method of section. Cut the truss through the members with the unknown forces:



Assume the direction of the forces as shown in the diagram

Example

- Write the equation of equilibrium for the section:

$\sum Fx = F(BC) + F(BG) \times \sin 45 + F(GH) = 0$

$\sum Fy = 50k - 10k - 20k - F(BG) \times \cos 45 = 0$

$\sum M(B) = F(GH) \times 10'' + 10k \times 10'' - 50k \times 10'' = 0$

Solve the equilibrium, we find:

F(GH) = 40k (in tension)

F(BG) = 28.3k (in tension)

F(BC) = -60k (the negative sign means we assumed the wrong direction. BC is in compression)