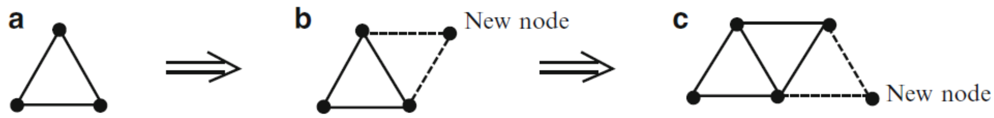
3. Trusses

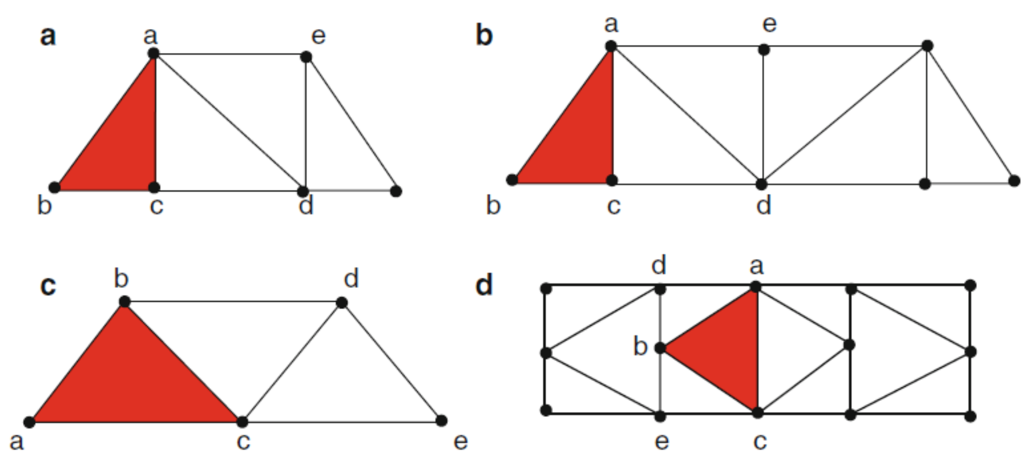
Simple truss structures are formed by combining one-dimensional linear members to create a triangular pattern. One starts with a triangular unit, and then adds a pair of members to form an additional triangular unit. This process is repeated until the complete structure is assembled.



Types of trusses:

1. Simple truss

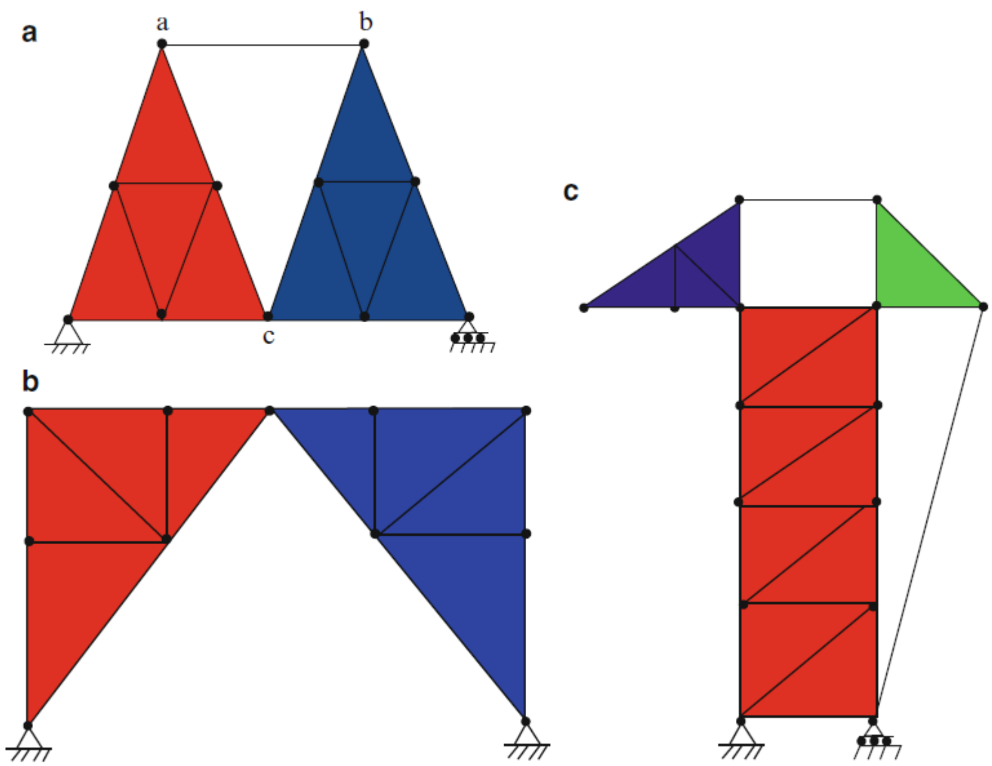
   This type of trusses is formed by a basic triangle (three members connecting at three joints) each new joint is connected to the basic triangle by two new bars.



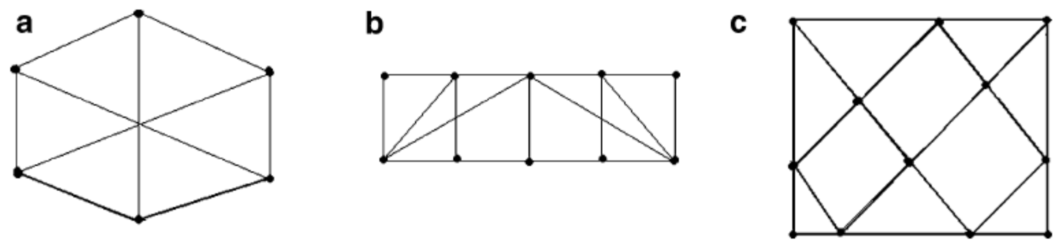
2. Compound Truss:

Trusses may also be constructed by using simple trusses as the "members," connected together by additional bars or joints to be as one rigid framework. These structures are called compound trusses. Figure below shows several examples of compound trusses, where the simple trusses are shown as shaded areas.

a. Three links.
b. Pin and link.
c. Pin and two links.
d. Three pins.



3. Complex Truss:

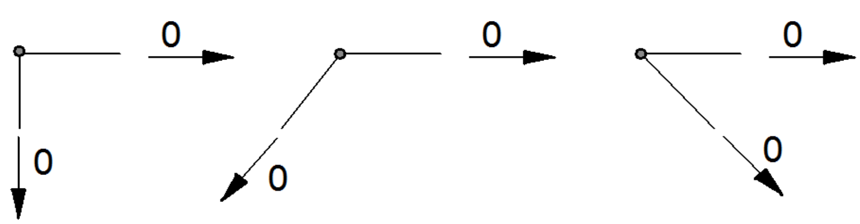


Method of joints:

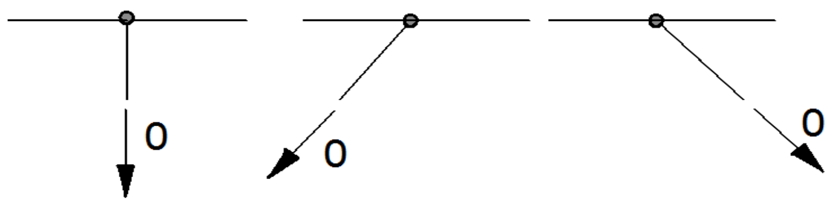
Each joint of a plane truss is subjected to a concurrent force system. Since there are two equilibrium equations ($\sum F_x = 0$, $\sum F_y = 0$) for a 2-D concurrent force system, one can solve for at most two force unknowns at a particular joint. The strategy for the method of joints is to proceed from joint to joint, starting with the free body diagram of a joint that has only two unknowns, solving for these unknowns, and then using this newly acquired force information to identify another eligible joint. One continues until equilibrium has been enforced at all the joints. When all the joints are in equilibrium, the total structure will be in equilibrium.

Notes:

1. If No External Load Is Applied to a Joint That Consists of Two Bars, the Force in Both Bars Must Be Zero.



2. If No External Load Acts at a Joint Composed of Three Bars Two of Which Are Collinear the Force in the Bar That Is Not Collinear Is Zero.



Method of section:

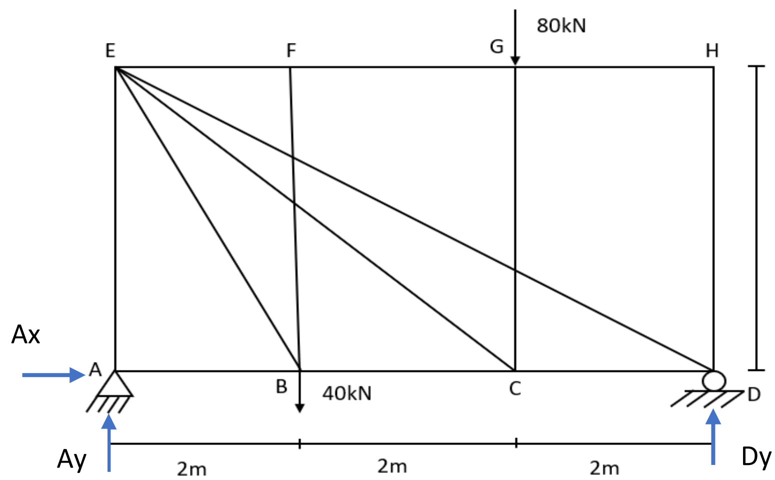
To analyze a stable truss by the method of sections, we imagine that the truss is divided into two free bodies by passing an imaginary cutting plane through the structure. The cutting plane must, of course, pass through the bar whose force is to be determined. At each point where a bar is cut, the internal force in the bar is applied to the face of the cut as an external load. Although there is no restriction on the number of bars that can be cut, we often use sections that cut three bars since three equations of static equilibrium are available to analyze a free body.

If the force in a diagonal bar of a truss with parallel chords is to be computed, we cut a free body by passing a vertical section through the diagonal bar to be analyzed. An equilibrium equation based on summing forces in the y direction will permit us to determine the vertical component of force in the diagonal bar.

If three bars are cut, the force in a particular bar can be determined by extending the forces in the other two bars along their line of action until they intersect. By summing moments about the axis through the point of intersection, we can write an equation involving the third force or one of its components.

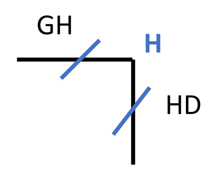
Example 1

Find the axial force in all members of the truss shown below:



Sol.

Joint H as F. B. D.



$F_{GH} = F_{HD} = 0$

$\sum F_X = 0$

$Ax = 0$

$\sum M_A = 0$

$40 \times 2 + 80 \times 4 - Dy \times 6 = 0$

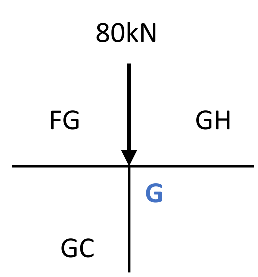
$Dy = 66.66$ kN

$\sum Fy = 0$

$-80 - 40 + 66.66 + Ay = 0$

$Ay = 53.33$ kN

Joint G as F. B. D.



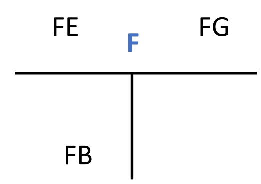
$\sum Fy = 0$

$F_{GC} + 80 = 0$

$F_{GC} = -80 = 80$ kN   Comp.

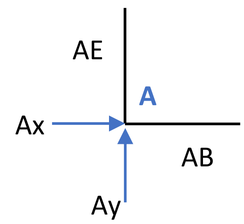
$\sum Fx = 0 \longrightarrow F_{GF} = 0$

Joint F as F. B. D.



$F_{FB} = 0$, $F_{FE} = 0$, $F_{FG} = 0$

Joint A as F. B. D.

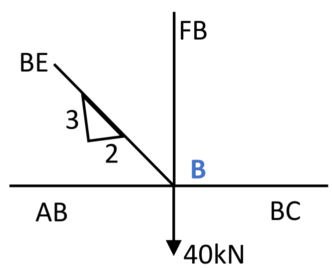


$\sum Fy = 0$

$53.33 + F_{AE} = 0$

$F_{AE} = -53.33 = 53.33$ kN   Comp.

Joint B as F. B. D.



$\sum Fy = 0$

$F_{BE} \times 3/\sqrt{13} - 40 = 0$

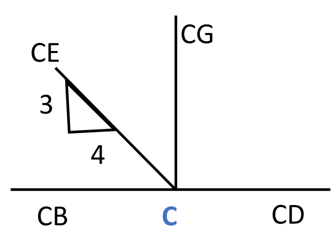
$F_{BE} = 48.07$ kN   Ten.

$\sum Fx = 0$

$F_{BC} - 48.07 \times 2/\sqrt{13} = 0$

$F_{BC} = 26.6$ Ten.

Joint C as F. B. D.



$\sum Fy = 0$

$F_{CE} \times 3/5 - 80 = 0$

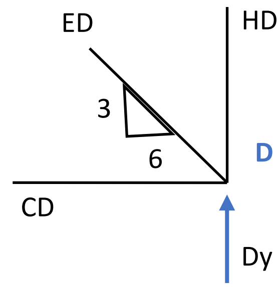
$F_{CE} = 133.3$ kN   Ten.

$\sum Fx = 0$

$F_{CD} – 26.6 - 133.33 \times 4/5 = 0$

$F_{CD} = 133.26$ Ten.

Joint D as F. B. D.



$\sum Fy = 0 \longrightarrow F_{ED} = 0$

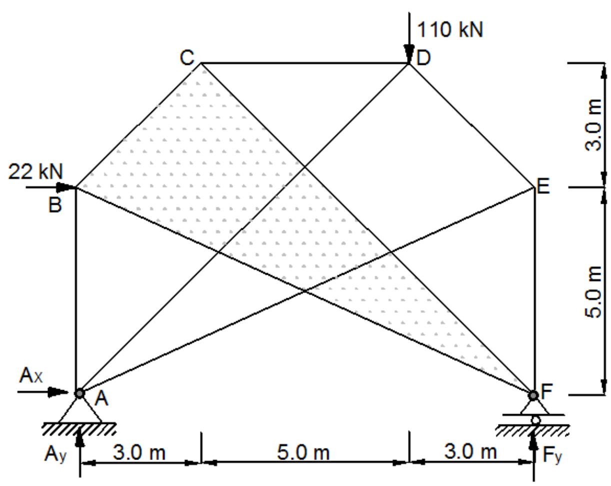
$\sum Fx = 0$

$-F_{ED} \times 6/\sqrt{45} – 133.26 = 0$

$F_{ED} = - 148.989 = 148.989$ kN   Comp.

Example 2

Find the axial force in members AB, CD & EF.



Sol.

$\sum M_A = 0$ +↻

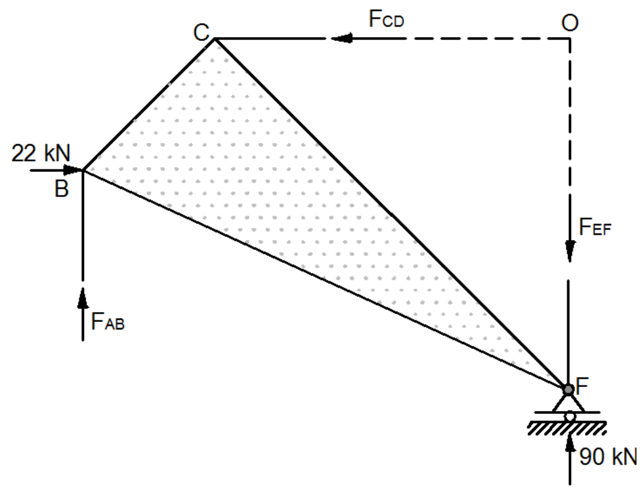
$110 (8) + 22 (5) - F_y (11) = 0 \longrightarrow F_y = 90$ kN

$\sum F_y = 0$

$90 - 110 - A_y = 0 \longrightarrow A_y = 20$ kN

$\sum F_x = 0$

$22 - A_X = 0 \longrightarrow A_X = 22$ kN



$\sum F_x = 0$

$22 - F_{CD} = 0$

$F_{CD} = 22$ kN Comp

$\sum M_A = 0$ +↻

$-22\,(3) + F_{AB}\,(11) = 0$

$F_{AB} = 6$ kN Comp

$\sum F_y = 0$

$90 + 6 - F_{EF} = 0$

$F_{EF} = 96$ kN Comp