Akanksha

Structural Analysis

Structural Dynamics by MARIOPAZ

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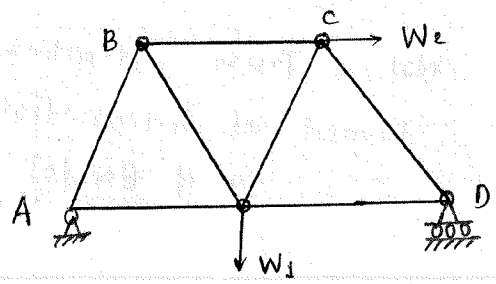
Ch : 01 Analysis of Statically Determinate Trusses

 # Truss - It is a structure in which all members are subjected to axial forces only. (Tension and compression).

Bending Moment is zero everywhere in this structure.

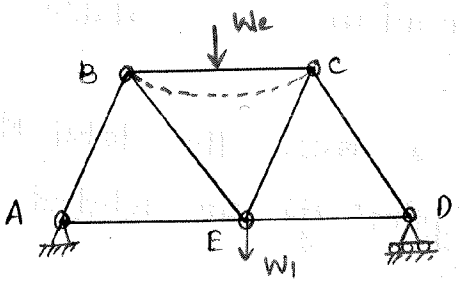


: Truss (In a truss, all members are called links).

NOTE - (i) **Link** :- If any structural member connected by pins at the ends and Not loaded at intermediate location, is called a link.

(ii) **Frame** :- It is a structure in which members are subjected to bending moment also. (In addition to tension and compression.)

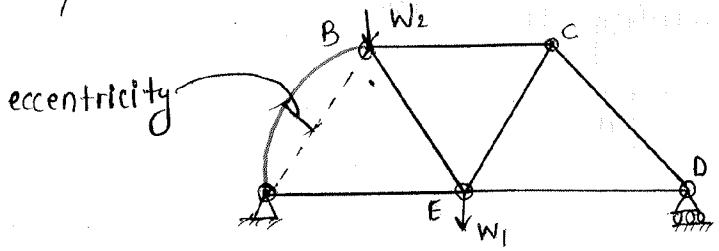
(To called a truss members must behave like a link)

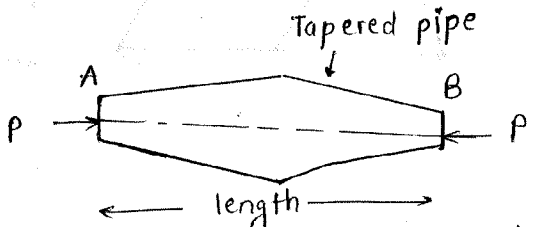


: Frame (as member BC Bends).

(3) Assumptions in the Analysis of Trusses.

(a) All members must be straight and connected by smooth pins at the ends (otherwise, if the members are curved, then they will bend and the structure cannot be called as a Truss.)



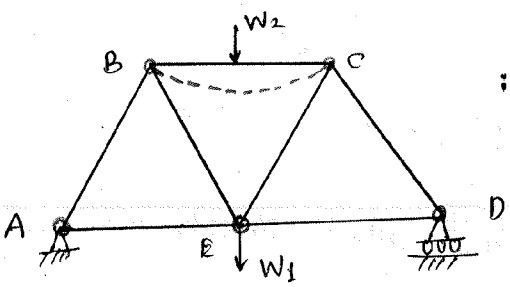


used as a compression member.

2M Members must be straight but need NOT to be Prismatic.

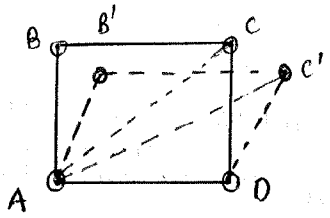
Prismatic – Having same c/s throughout its length.

(b) Loads must be applied only at the joints (otherwise, if the loads are applied at intermediate locations of the members, then they will bend and the structure cannot be called as a Truss.

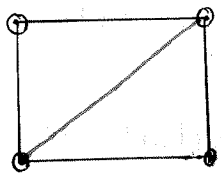


: Not a Truss (Member BC is loaded at intermediate location, so it Bends).

(4) Mechanism – unstable structure. (without increasing stress strain coming).



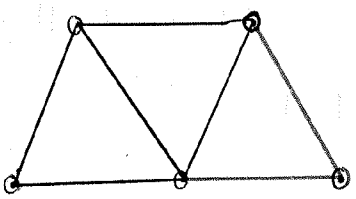
4 link Mechanism



stable structure

Conclusion :- In a truss, the total No. of members (m) and total no. of joints (j) are related by :

$$\boxed{(m) = (2j - 3)}$$ **



For the first 3 joints, 3 members are required. For each additional joint, 2 members are required.

combining these two statements,

$$\boxed{m = 2J - 3}$$

NOTE :- If the above condition is satisfied, then we get a stable, triangulated and determinate truss.

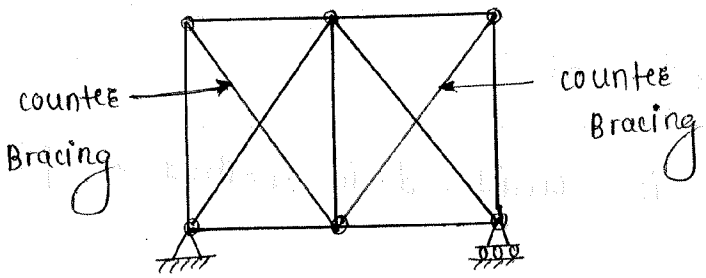
2M

(5) (a) If $m = (2J-3)$ - perfect, stable Truss

(b) If $m < (2J-3)$ - Deficient or unstable Truss

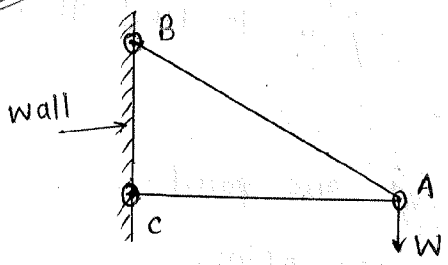
(c) If $m > (2J-3)$ - Redundant Truss [We provide more members than $(2J-3)$ to make the structure more stable.]

This additional members are called counter Bracing.



Que: (1) For the structure shown in fig., Bending moment exists in the member. (a) AC (b) AB (c) Both AB, AC (d) No Member

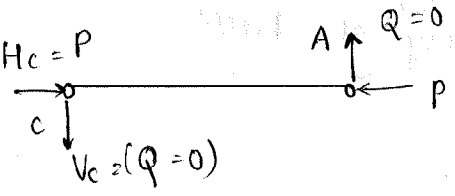
2M



Note: 1) since all members are straight connected by pins and loaded at intermediate locations, they behave like links So No member Bends.

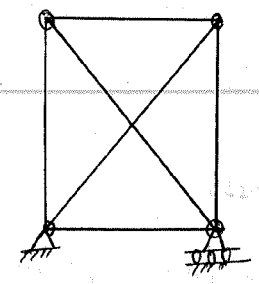
Note:

(a)



Link { If $Q \neq 0$, anticlockwise couple cannot be Balanced and it will not be in equilibrium }.

Que: (2) The truss shown in Fig. (a) Perfect (b) Deficient (c) Redundant (d) None



$m = 6$
$J = 4$

$m \quad (2J-3)$
$6 \quad (2\times4-3)$
$6 > 5$

conclusion : Redundant Truss (1 countee Bracing member).

Analysis of Trusses
- (a) Method of joints (particular case of method of section only.)
- (b) Method of sections

(a) Method of Joints :~

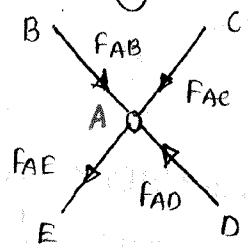
(1) Equillibrium of a joint is considered in method of joints.

(2) Procedure :~

(I-step) - Find the support reactions by considering equillibrium of entire truss.

step-II] - consider equillibrium of a joint where only 2 unknown forces are available and use $\Sigma X = 0$ $\Sigma Y = 0$ to find them.

similarly, proceed to the othee joint.



: Coplanar, concurrent force system.

concurrent - Meeting at one point.

coplanar - Lying in one plane.

system - Group of Forces.

$\boxed{\Sigma X = 0}$

$\boxed{\Sigma Y = 0}$

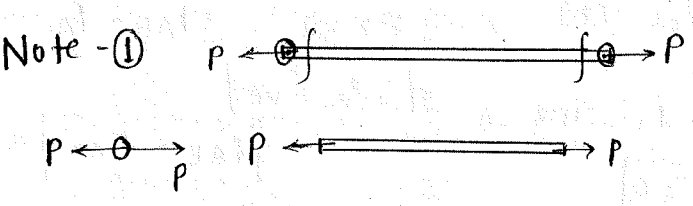
$\boxed{\Sigma M_A = 0 \quad \Rightarrow 0 = 0}$

conclusion - In a coplanar, concurrent force system the No. of equations of equilibrium available are only two. ($\Sigma x = 0$ $\Sigma y = 0$).

2M

With two eqn's. we can only find two unknown forces. so, we must select a joint where only two unknown forces are available.

Note - (1)



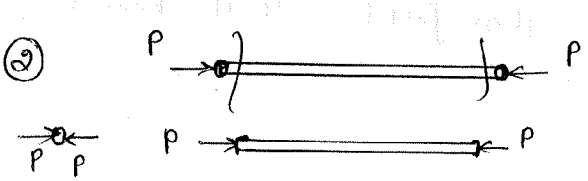
FBD of Bolt

FBD of a Member

FBD of Bolt or pin.

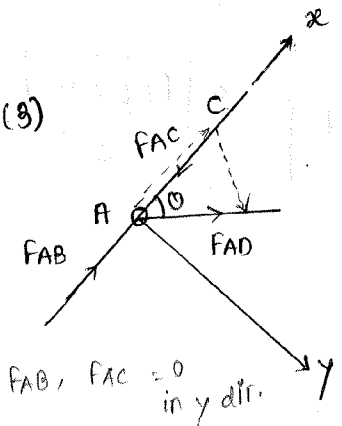
conclusion :- If arrow mark is away from joint or bolt it means that Force in the member is Tensile.

(2)



conclusion :- If the arrow mark is towards the pin or bolt then it means that the force in the member is compressive.

(3)



tail to head ⋯→

collinear - same line of action.

$\Sigma y = 0$

$+F_{AD} \cdot \sin\theta = 0$ (only).

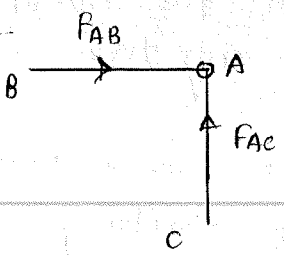
$\sin\theta \neq 0$

[↑ +ve ↓ -ve]

$\boxed{F_{AD} = 0}$

conclusion - At a joint, if three members or 3 forces are meeting, 2 members are collinear, then force in the third member is Always zero.

(4)



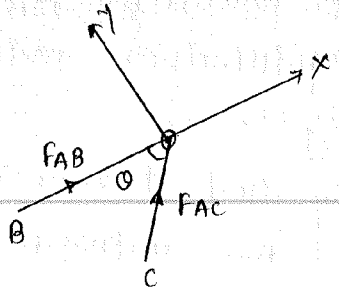
Two Non-collinear Forces (at $\theta = 90°$)

$\Sigma X = 0 \Rightarrow \boxed{F_{AB} = 0}$

$\rightarrow$ +ve $\leftarrow$ -ve

$\Sigma Y = 0$

$[\uparrow$ +ve $\downarrow$ -ve$]$ $\Rightarrow \boxed{+F_{AC} = 0}$

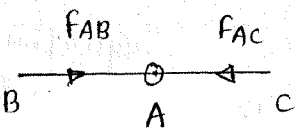


Two Non-collinear Forces (θ)

$\Sigma Y = 0 \Rightarrow F_{AC} \cdot \sin\theta = 0$

$\boxed{F_{AC} = 0}$

$\Sigma X = 0 \Rightarrow \boxed{+F_{AB} = 0}$



Two collinear forces

$\Sigma X = 0 \quad +F_{AB} - F_{AC} = 0$

$[\rightarrow$ +ve $\leftarrow$ -ve$]$

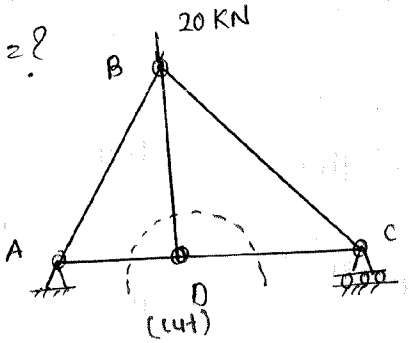
$\boxed{F_{AB} = F_{AC}}$ *

$F_{AB} \neq 0$

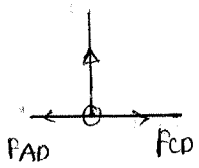
$F_{AC} \neq 0$

conclusion- At a joint, if two Non-collinear members are meeting with No external load at that joint then Forces in Both members will be zero.

Que: (3) $F_{BD} = ?$



two collinear At third $F_{BD} = 0$ (Ans)



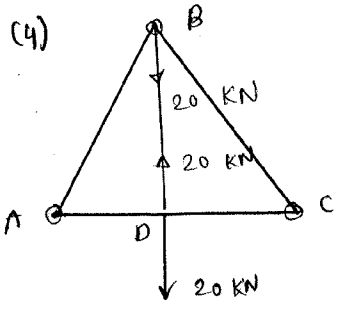
F.B.D. of Bolt at D

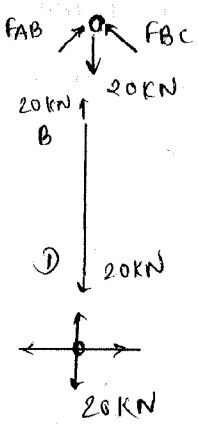
$\Sigma Y = 0$

$[\uparrow$ +ve $\downarrow$ -ve$]$

$\therefore \boxed{F_{BD} = 0}$: Ans

Que: (4)





FBD of Bolt at B

FBD of member BD

FBD of Bolt at D.