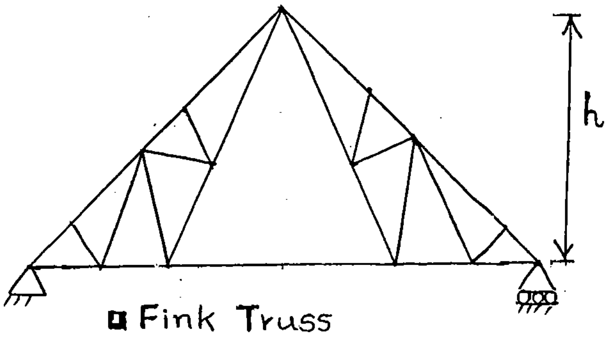
4th sept,
SATURDAY

11. ROOF TRUSSES

→ Selection criteria for Roof truss :

- Span of the truss.
- Pitch of the truss.



■ Fink Truss

Pitch of the truss depends on :

(i) Type of roof covering material to be used for truss (like AC sheets, GI sheets, plastic sheets)

(ii) Lightening & ventilation requirement.

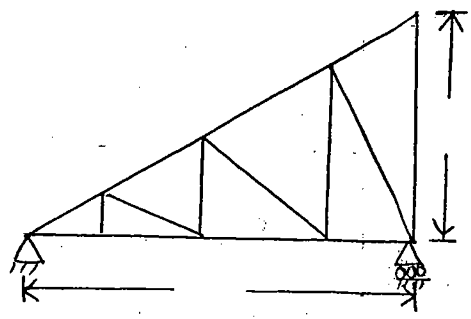
$$\text{Pitch} = \frac{\text{Rise}}{\text{Span}} = \frac{h}{L}$$

$$\text{Slope} = \tan\theta = \frac{\text{Rise}}{\text{Half span}} = \frac{h}{L/2} = \frac{2h}{L}$$

$$\boxed{\text{Slope} = 2 * \text{pitch}}$$ (for symmetric truss)

* North Light Roof Truss

- Spans upto 10 m
- Day light is main criteria for selection of North light roof truss.

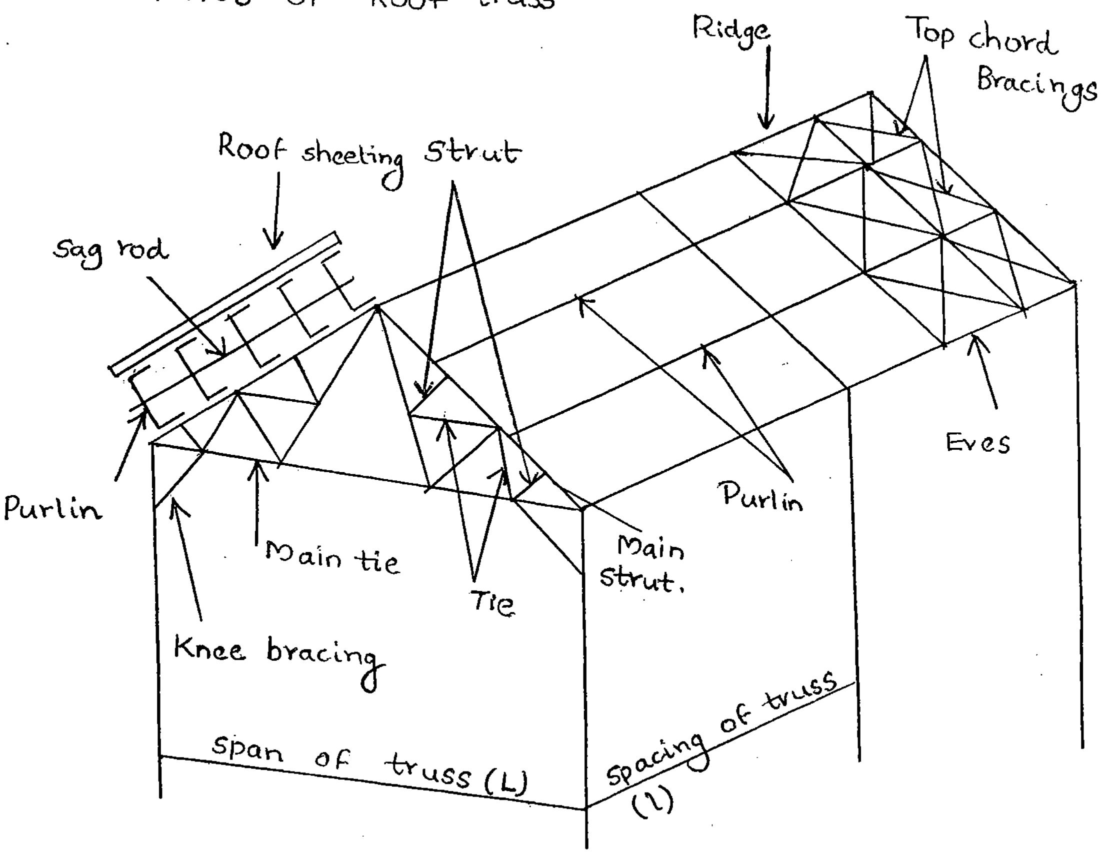


■ North light Roof Truss

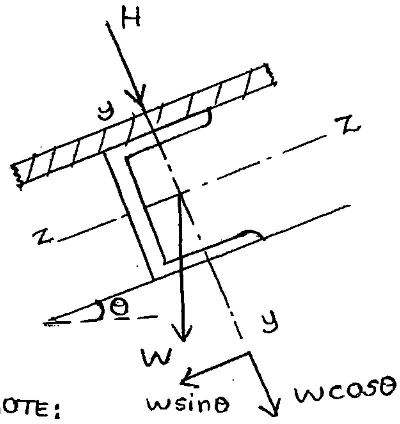
$$\text{Pitch} = \frac{h}{L}$$

$$\text{Slope} = \tan\theta = \frac{h}{L} \Rightarrow \boxed{\text{Pitch} = \text{Slope}}$$

→ Elements of Roof truss



⊙ Top Chord bracings are not required when masonry walls are provided.



$$M_{zz} = \frac{\gamma_L (H + w\cos\theta) l^2}{10}$$

$$M_{yy} = \frac{\gamma_L (w\sin\theta) l^2}{10}$$

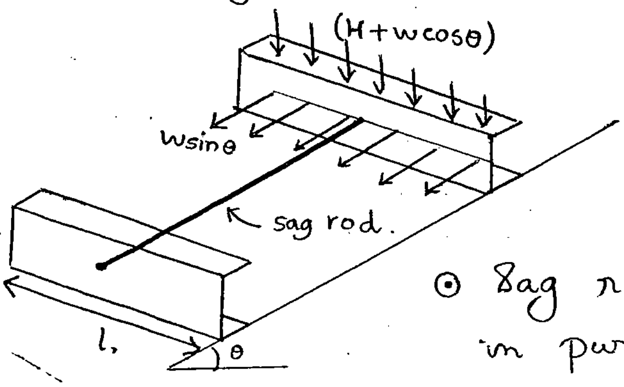
w → gravity load due to DL & LL (N/m or kN/m)

H → load due to wind pressure (N/m or kN/m)

γ_L → load factor.

NOTE:

⊙ Purlin member may be designed as simply supported beam or cantilever beam or continuous beam. IS 800: 2007 recommends to design as continuous beam subj to biaxial bending mome

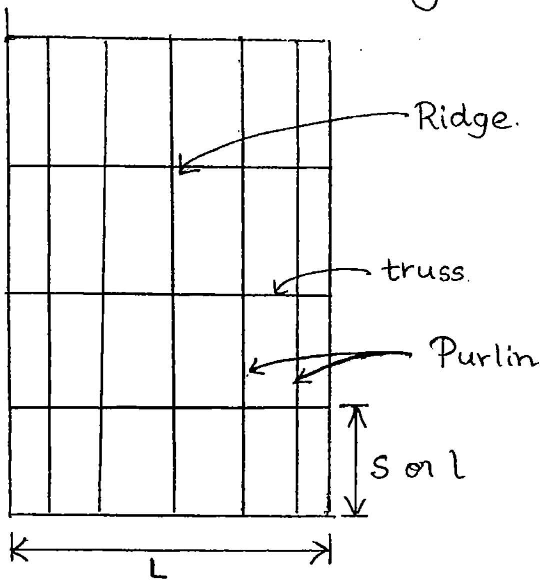


$$M_{yy} = \frac{\gamma_L\, w\sin\theta\, (l/2)^2}{10}$$

$$= \frac{1}{4} \gamma_L \frac{w\sin\theta\, l^2}{10}$$

⊙ Sag rod will minimise ~~slopes~~ deflection and BM in purlin member about <u>minor principal</u> axis

→ Economical Spacing of Truss (S or l)



t → cost of truss per unit area

p → cost of purlin per unit area

r → cost of roof sheeting per unit area.

x → total (or) overall cost of roof building per unit area.

$$x = t + p + r$$

⊙ $t \propto \frac{1}{S} \Rightarrow t = \frac{C_1}{S} \quad \therefore C_1 = tS$

$$M = \frac{wl^2}{10} \Rightarrow p \propto S^2$$

⊙ $p = C_2 S^2 \Rightarrow C_2 = \frac{p}{S^2}$

⊙ As spacing increases, no: of joints b/w roofing sheets increase and as a result cost of erection increases.

$$r = C_3 S \Rightarrow C_3 = \frac{r}{S}$$

$$x = t + p + r$$

$$x = \frac{C_1}{S} + C_2 S^2 + C_3 S$$

To have minimum cost of roof building,

$$\frac{dx}{dS} = 0$$

$$\frac{d}{dS}\left(\frac{C_1}{S} + C_2 S^2 + C_3 S\right) = 0.$$

$$-\frac{C_1}{S^2} + 2C_2 S + C_3 = 0$$

$$\frac{C_1}{S^2} = 2C_2 S + C_3.$$

$$\frac{tS}{S^2} = \frac{2p}{S^2} \times S + \frac{r}{S} \Rightarrow \boxed{t = 2p + r}$$

Cost of truss per unit area = 2 * cost of purlin per unit area + cost of roof covering per unit area.

l or s = $\frac{L}{3}$ to $\frac{L}{5}$

→ Design Loads on Roof truss

- design dead loads.
- design live (or) imposed loads.
- design wind loads.
- design snow loads.

* Design Dead Loads (IS 875 : 1987 Part I)

(i) Self weight of purlins.
(ii) Self weight of bracings.
(iii) Self weight of roof sheeting
(iv) Self weight of truss.

Self weight of truss = 100 N/m^2 to 150 N/m^2 Plan area

$= \left(\frac{L}{3} + 5\right) \times 10\ N/m^2$ Plan area.

(L = span of truss)

* Design Live (or) Imposed loads (IS 875 : 1987 Part II)

- Slope of roof, $\theta \leq 10$

LL = 1500 N/m^2 (If access is provided for repair & maintenance)

= 750 N/m^2 (if access is not provided for repair & maintenance)

- Slope of roof, $\theta > 10^\circ$

$$LL = (750 - 20(\theta - 10))\ N/m^2 \not< 400\ N/m^2$$

* **Design Snow Load.** (IS 875 : 1987 Part IV)

SL = 25 N/m^2 per every 'cm' depth of snow.
= 2.5 N/m^2 per every 'mm' depth of snow.

$\theta > 50^\circ$; Snow load need not to be considered.

5th sept, SUNDAY

* **Design Wind Load.** (IS 875 : 1987 Part III)

V_b = Basic wind speed in m/s at a height of 10m from MSL

V_z = Design wind speed in m/s at a height z.

$$V_z = K_1 K_2 K_3 V_b$$

where $K_1 \rightarrow$ probability (or) risk factor.
$K_2 \rightarrow$ size, shape and structure factor.
$K_3 \rightarrow$ topography factor.

P_z = Design wind pressure at a height z of a structure.

$$P_z = K \cdot V_z^2$$

$$P_z = 0.6\ V_z^2 \qquad (K = 0.6)$$

Design wind load = $(C_{pe} - C_{pi}) P_z \cdot A_e$.

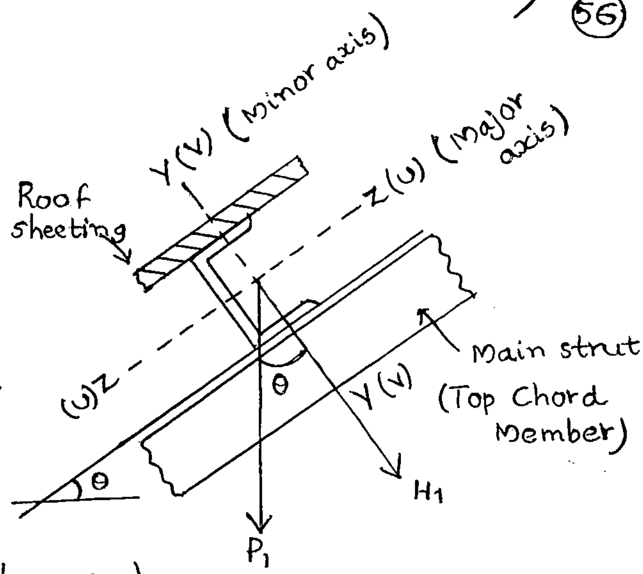
where $A_e \rightarrow$ exposed area.

$C_{pe} \rightarrow$ external wind pressure coeffecient (depends on slope of roof)

$C_{pi} \rightarrow$ internal wind pressure coeffecient (depends on degree of permeability (or) no. of openings in structure)

→ Design of Purlin

P_1 = Gravity load due to sheeting and live load. (in kN/m)



H_1 = load due to wind pressure in kN/m.

l = span of purlin (spacing b/w two adjacent trusses).

θ = slope of roof.

IS 800:2007 recommends to design a purlin as a continuous beam subjected to bi axial. (unsymmetrical) BMs.

Load along minor axis (YY axis)

$$P = \gamma_L (H_1 + P_1 \cos\theta) \longrightarrow M_{zz}$$

Load along major axis (zz axis)

$$H = \gamma_L (P_1 \sin\theta). \longrightarrow M_{yy}$$

Bending moment about major axis, $M_{zz} = \frac{PL^2}{10}$.

BM about minor axis, $M_{yy} = \frac{Hl^2}{10}$

* Deflection (or) Serviceability limits: (IS 800:2007)

(i) Brittle cladding (or sheet) $= \frac{L}{180}$
Eg: AC roofing sheet

(ii). Elastic cladding $= \frac{L}{150}$
Eg: GI, Plastic roofing sheet

- Design bending strength about major axis (M_{dz}).

$$M_{dz} = Z_{pz} \cdot \frac{f_y}{\gamma_{mo}}.$$

- Design bending strength about minor axis (M_{dy}).

$$M_{dy} = Z_{py} \cdot \frac{f_y}{\gamma_{mo}}$$

Z_{pz} & Z_{py} : Plastic section modulus of purlin about major & minor axis resptly.

- For safety of purlin, Interaction Equation as per IS 800 : 2007 must be satisfied:

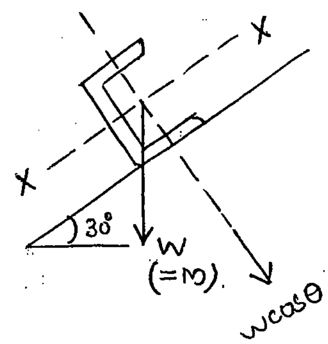
⊙ $\frac{M_{zz}}{M_{dz}} + \frac{M_{yy}}{M_{dy}} \leq 1.0$ $\qquad M_{dz} > M_{zz}$, $M_{dy} > M_{yy}$.

⊙ $\Delta_{cal} \leq \Delta_{limit}$; Δ_{limit} = limiting deflection.

2 For w, $M_{xx} = M$

For $w\cos 30$, $M_{xx} = M\cos 30$

$$= \frac{\sqrt{3}}{2} M$$



3. $M_{dz} = Z_{pz} \frac{f_y}{\gamma_{mo}}$

$M_{dy} = Z_{py} \frac{f_y}{\gamma_{mo}}.$

Section modulus (Z_{pz} & Z_{py}). is independent of orientation of sections.

04. As per IS 800 : 1984, angle iron purlins were used

* Assumptions :

(i) Slope, $\theta \leq 30$ (exposed area for wind force gets minimised).

(ii) Bending moment about minor axis neglected.

(iii) $LL = 750 \ N/mm^2$.

08 Slope $= 1$

$\tan\theta = 1 \Rightarrow \theta = 45^\circ$