Large span Halls

Lecture (3)

Design of Halls Structural Components

By:

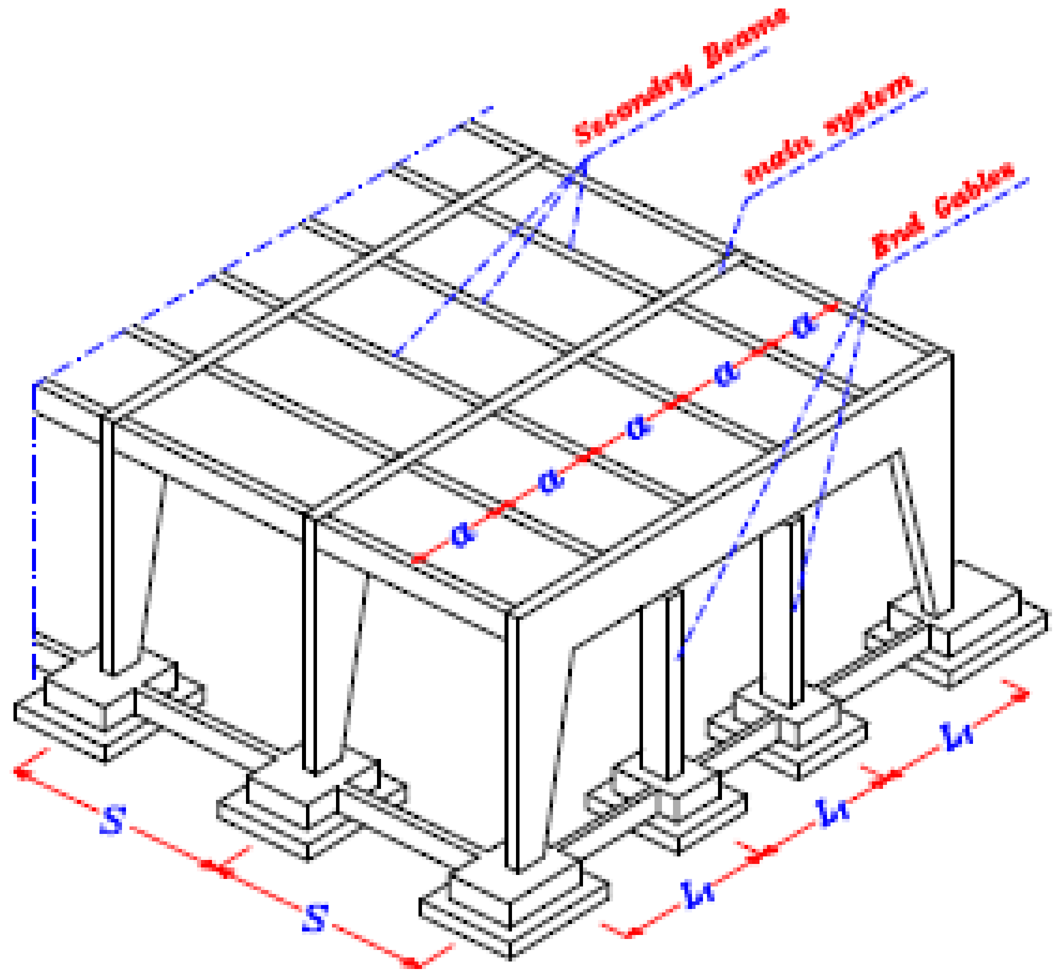
Dr. Islam M. El-Habbal

Design of Flat Roof Systems

1. Frame Based Halls.
2. Arch with a ties Based Halls

1. Design of Frame Based Halls

1. Design of Slabs.
2. Design of Secondary Beams.
3. Design of Frames.



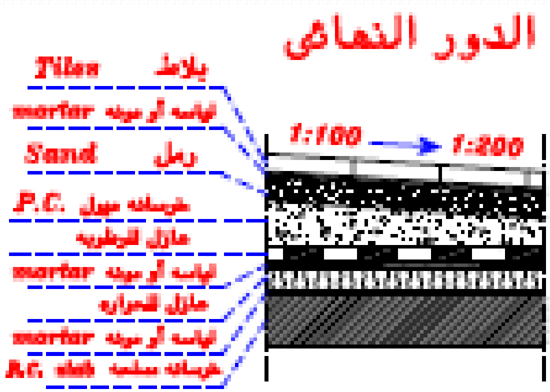
Secondry Beams
main system
End Gables
S
S
L1
L1
L1

Design of Slabs

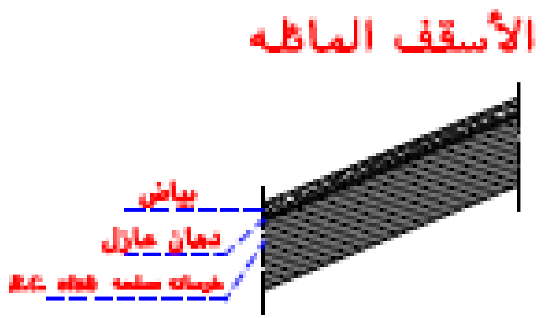
1. Loads

$$W_{D.L.} = W_{o.w.} + F.C.$$

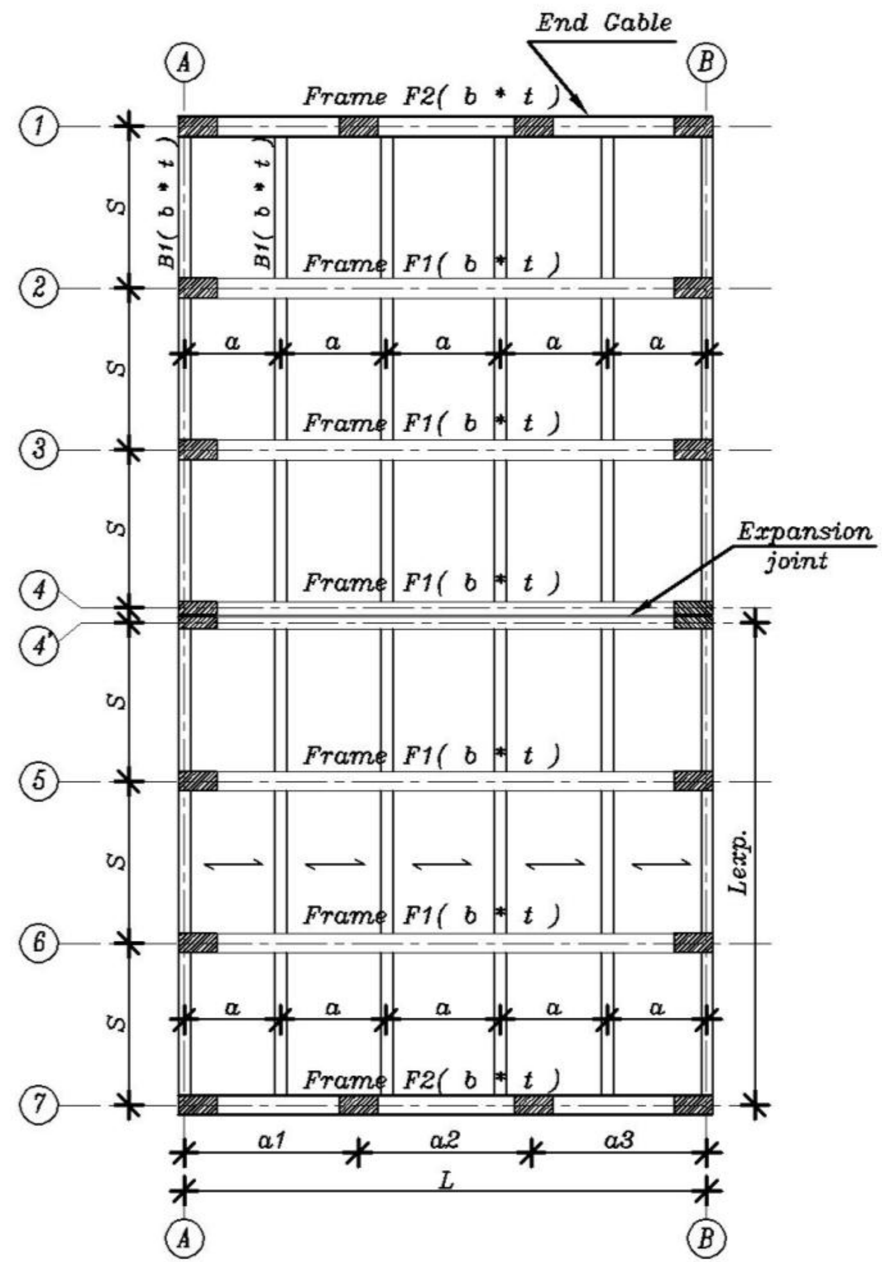
$$W_{o.w.} = \gamma_c \times t_s \Rightarrow t_s = a/35$$



$F.C. \simeq 3.0\ kN \backslash m^2$



$F.C. \simeq 0.5\ kN \backslash m^2$



② *Live Load.* (*L.L.*)

① *For Top roof.*

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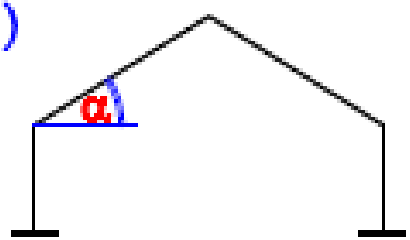


IF $\alpha > 20^\circ \longrightarrow L.L. = 0.5 \; kN\backslash m^2$

IF $\alpha \leq 20^\circ \longrightarrow L.L. = 1.0 \; kN\backslash m^2$

$$W_{su} = \text{max. of} \begin{cases} 1.40 \times W_{D.L.} + 1.60 \times W_{L.L.} \\ 1.50 \times (W_{D.L.} + W_{L.L.}) \end{cases}$$

Complete slab design as ordinary one way slab

Design of Secondary Beams B1(bxt)

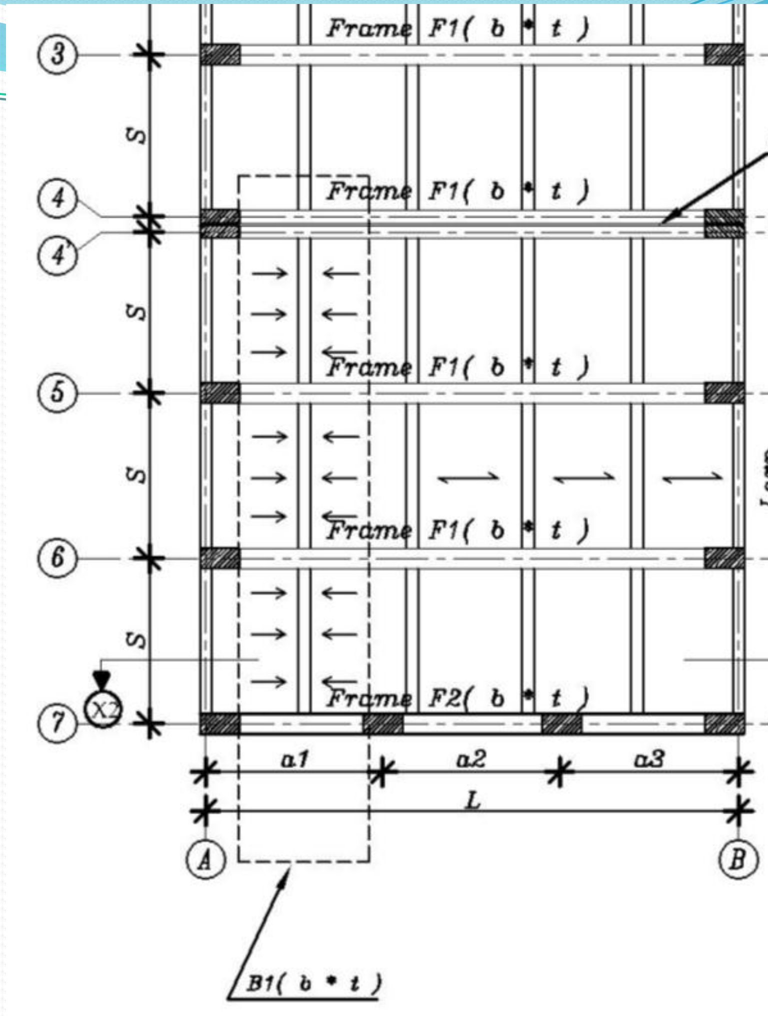
1. Loads

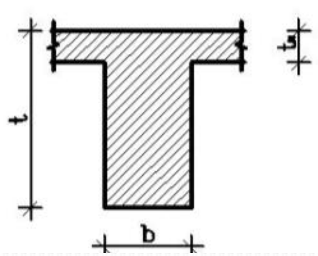
$$W_{bu} = 1.40 \times W_{o.w.} + W_{su} \times a$$

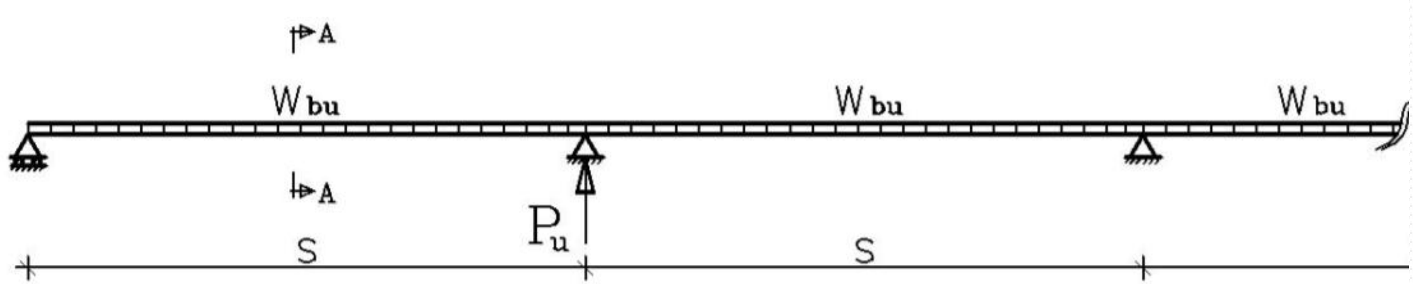
Where:

$$W_{o.w.} = \gamma_c \times b \times t$$

$$P_u = 1.10 \times W_{bu} \times S$$

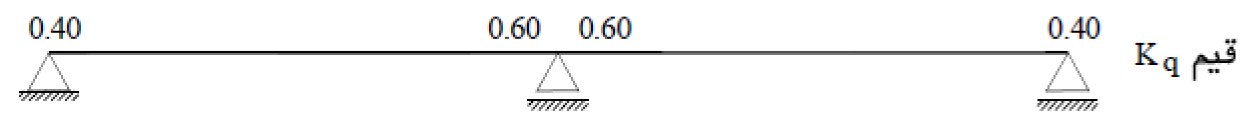




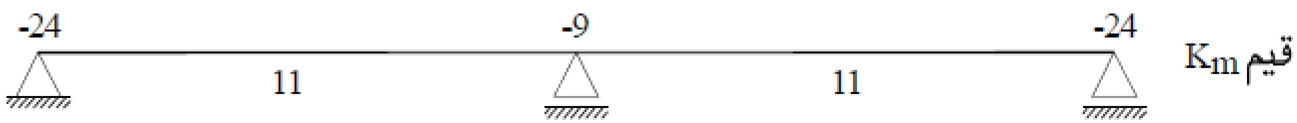


Straining Actions in Beams

$$Q_u = W_{bu} \times S * K_q$$

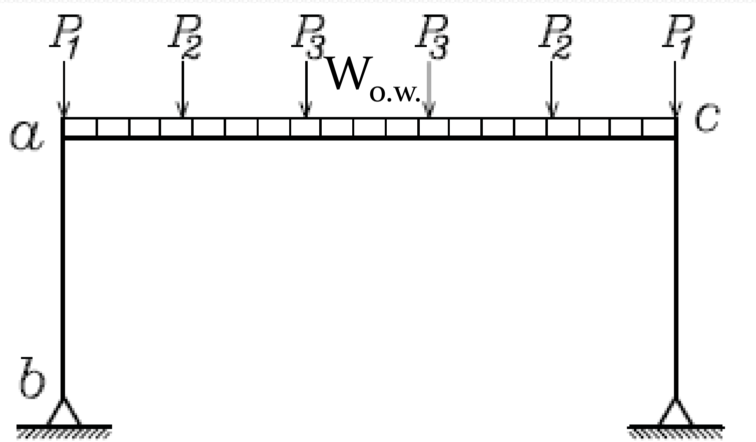


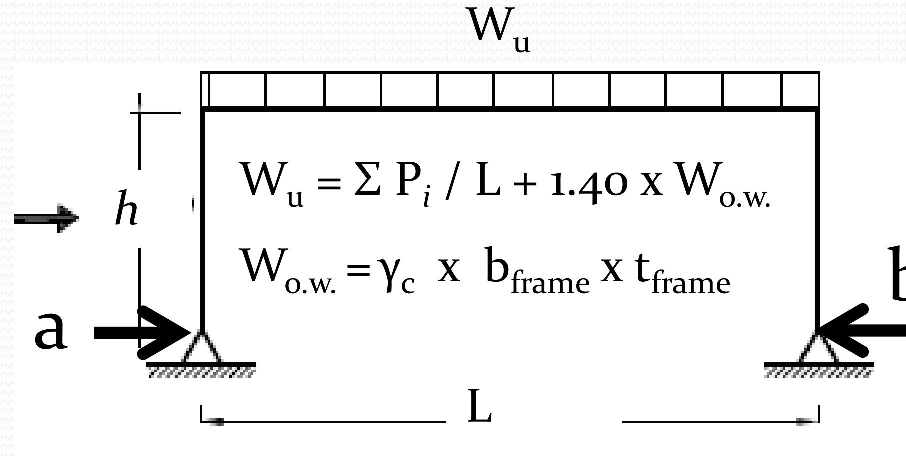
$$M_u = W_{bu} \times S^2 / K_m$$



Complete Design as a Continuous Beam Using C1-J Curve

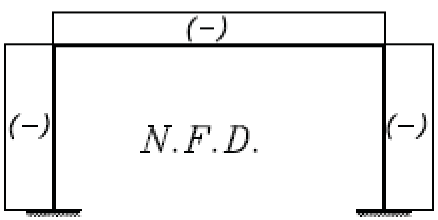
Design of Frame

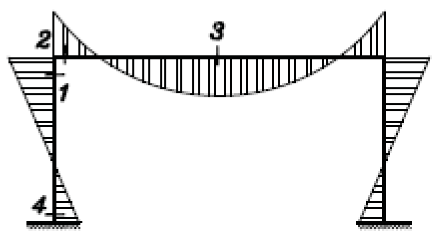




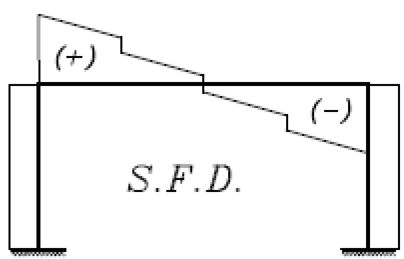
$$W_u = \Sigma P_i / L + 1.40 \times W_{o.w.}$$

$$W_{o.w.} = \gamma_c \times b_{frame} \times t_{frame}$$





Design Sections for Both M, N and get Required Shear Reinforcement



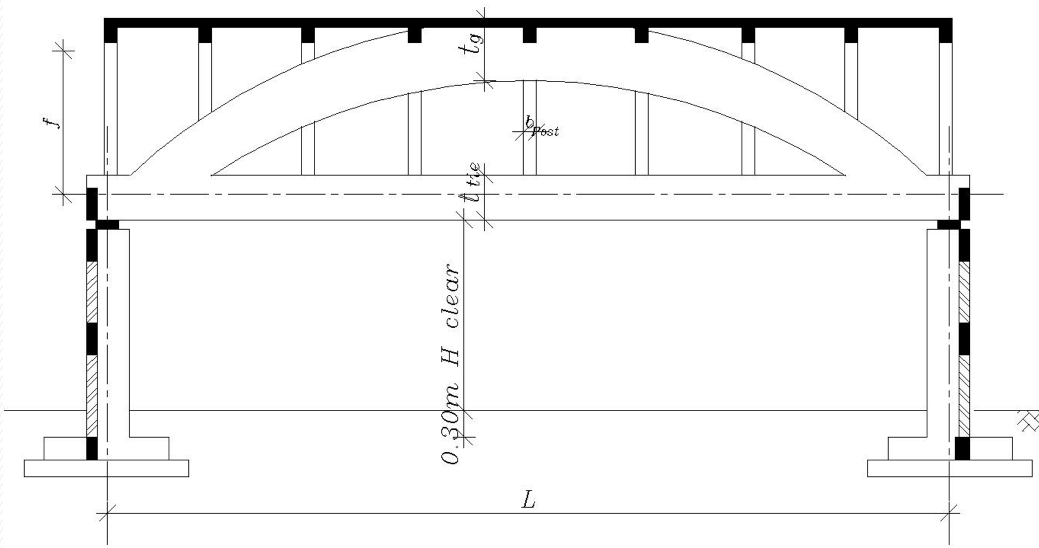
$$H_a = H_b = \frac{w_u \times L^2}{4 \times h \times N}$$

where $K = \frac{I_b}{I_c} \times \frac{h}{L}$ and $N = 2K + 3$

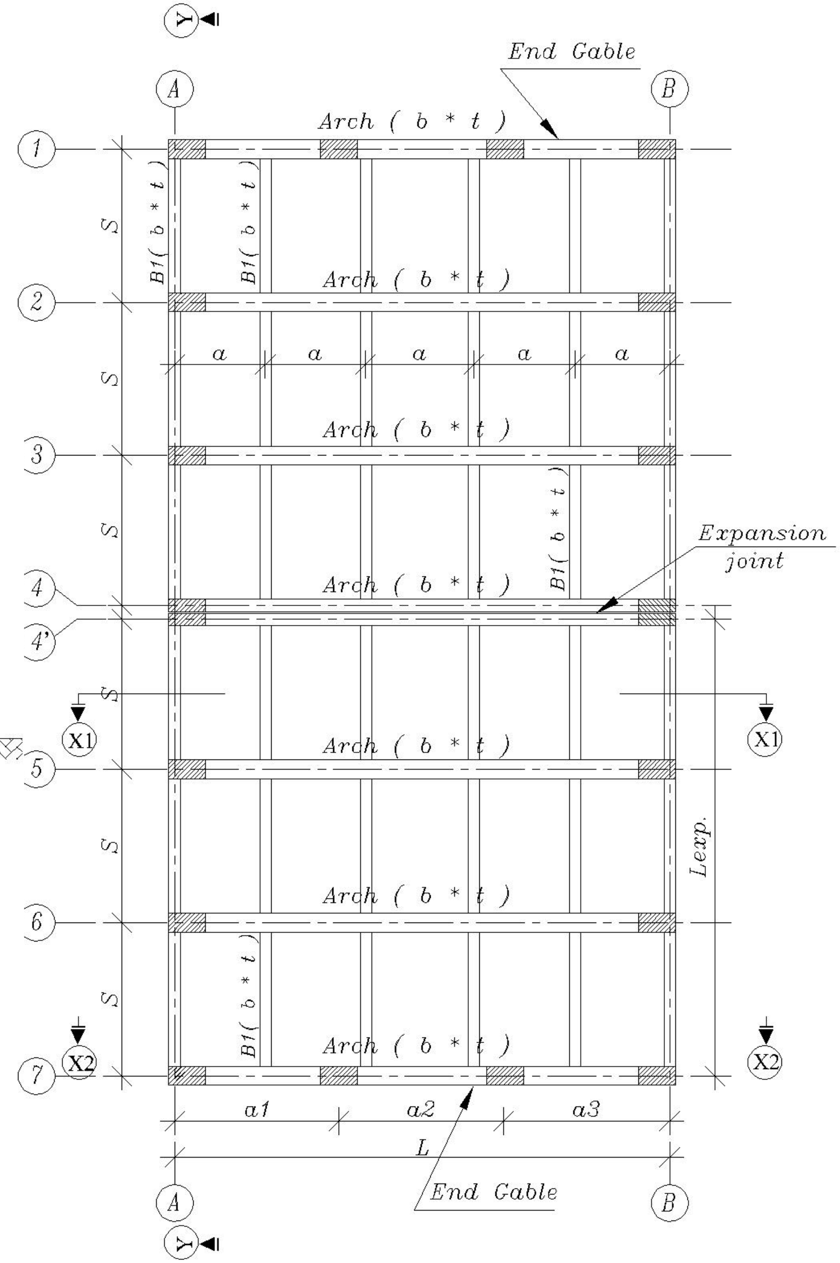
2. Design of Arch with a tie Based Halls

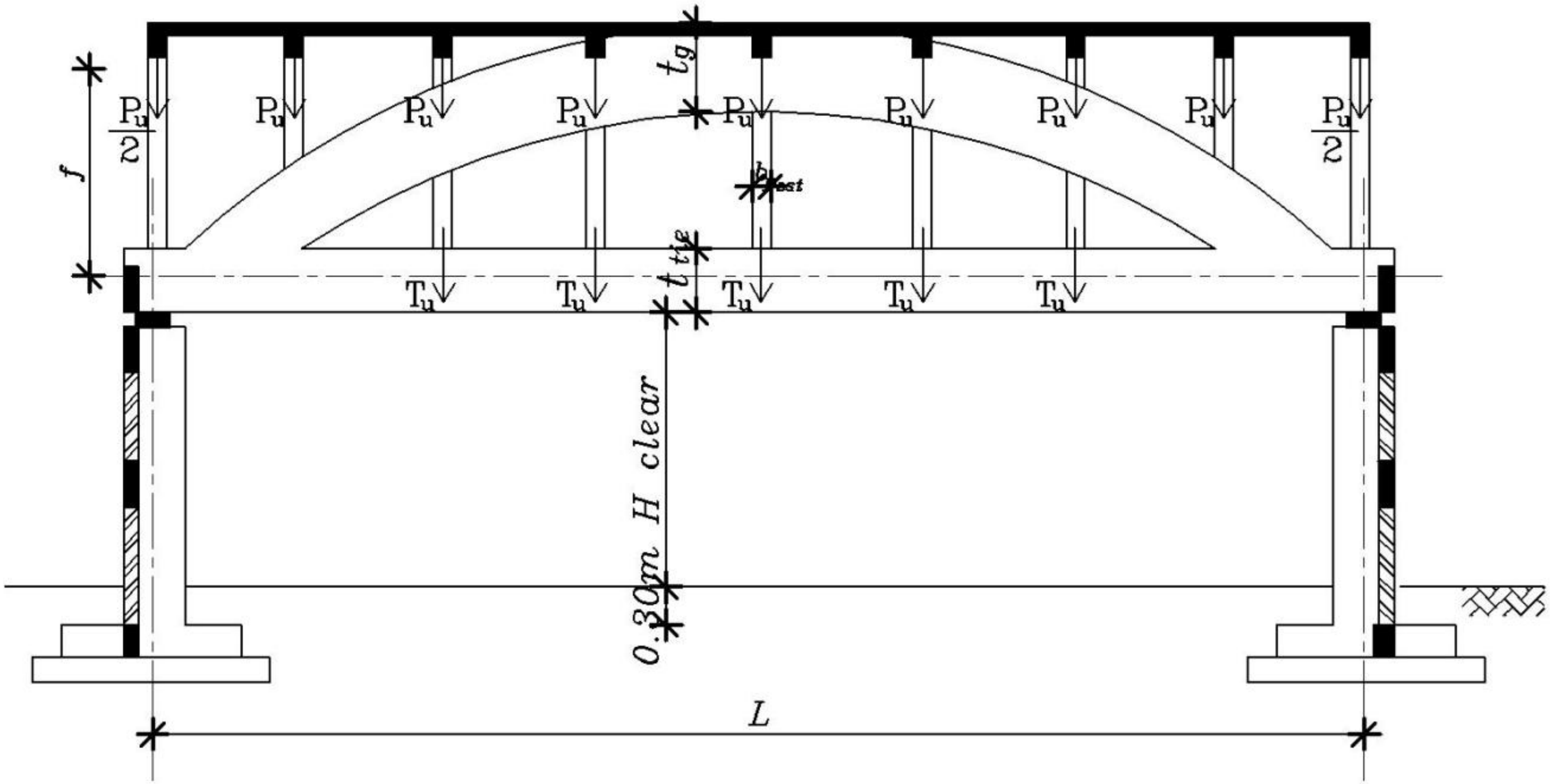
1. Design of Posts.
2. Design of Arch with a tie.

Arch with a tie Systems



Sec. (X1–X1) (Concrete Dimensions)

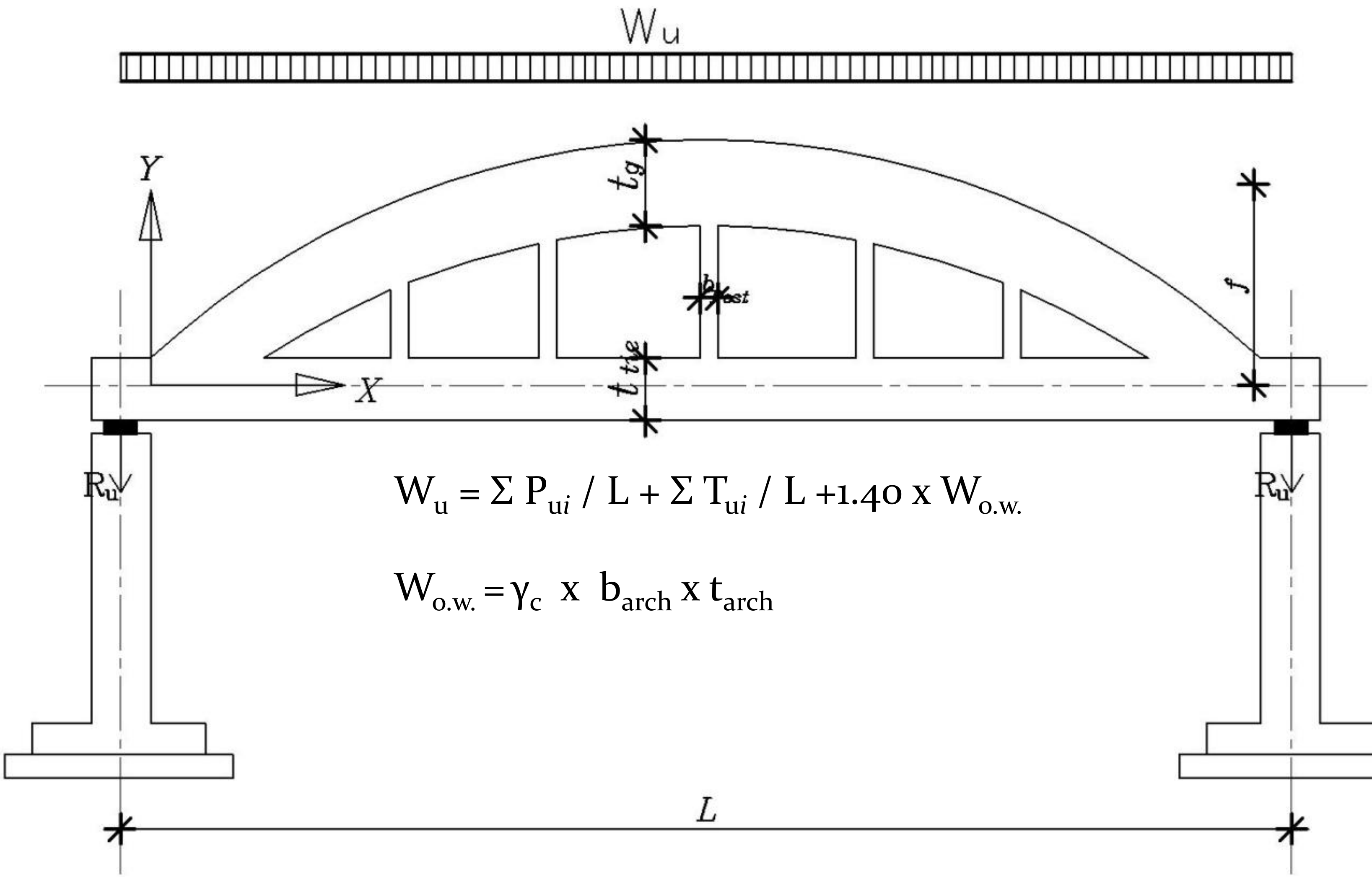




Loads Diagram on Arch With a Tie

$T_u = (\gamma_c \ x \ b_{tie} \ x \ t_{tie}) \ x \ a \ x \ 1.40$

Loads on Arch with a tie

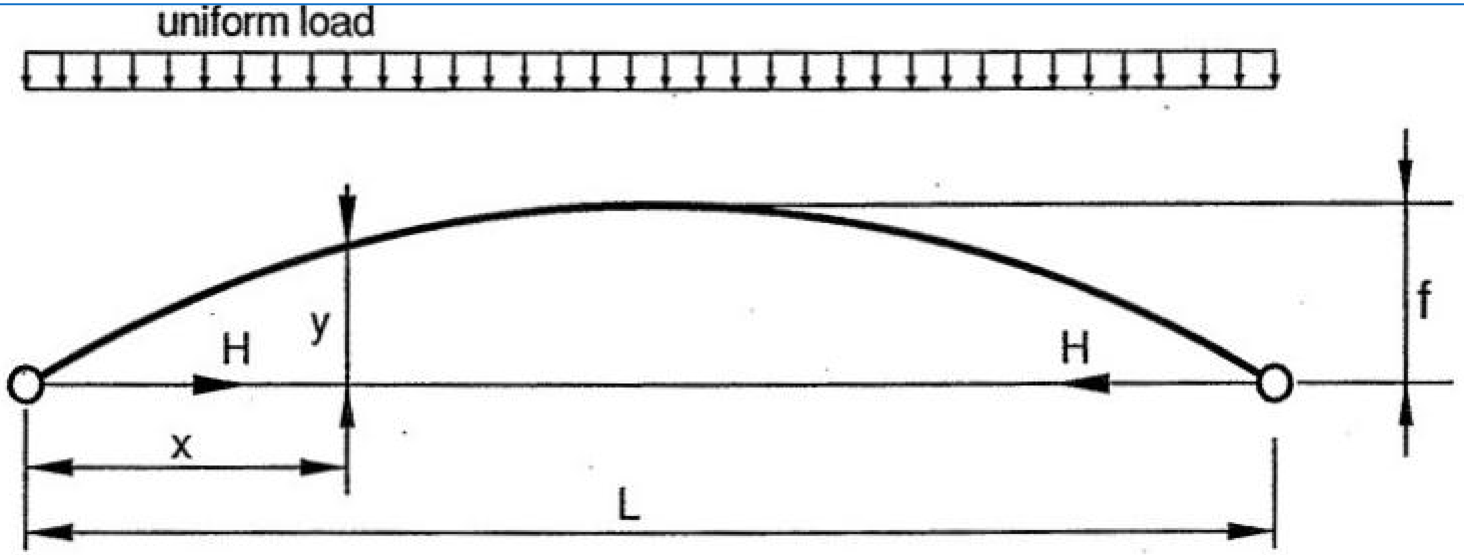


$$W_u = \Sigma P_{ui} / L + \Sigma T_{ui} / L + 1.40 \times W_{o.w.}$$

$$W_{o.w.} = \gamma_c \times b_{arch} \times t_{arch}$$

Loads on Arch with a tie

Structural Analysis of Arch with a tie



$$H \cong 0.95 \frac{w \times L^2}{8f}$$

A tension force in Tie
& a compression force
In Girder

$$M \cong 0.05 \frac{w \times L^2}{8}$$

Moment in Girder only

- Design Arch Girder as an Eccentric Section for M, N=H

- Design Arch Tie as follows:
  - Concrete dimensions should be specified to satisfy steel arrangement requirements.
  - $A_s = \frac{H}{f_y/\gamma_s}$

General Roles for Design of pure Tension members

Compression RC Post

P_u = Reaction of secondary beam

Design Compression Post as an Unbraced Column

Tension RC Post

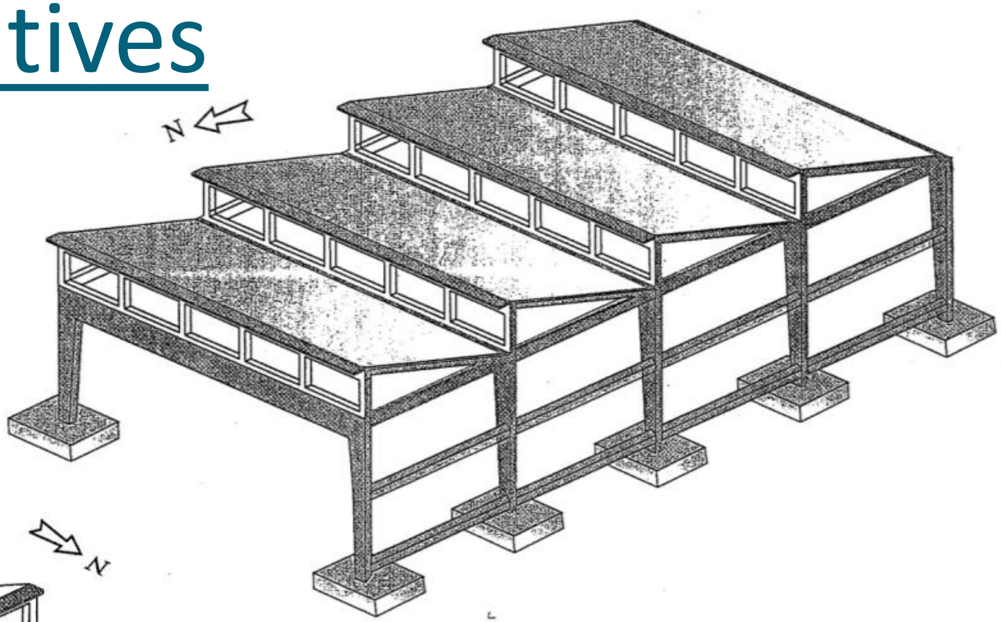
$T_u = (\gamma_c \times b_{tie} \times t_{tie}) \times a \times 1.40$

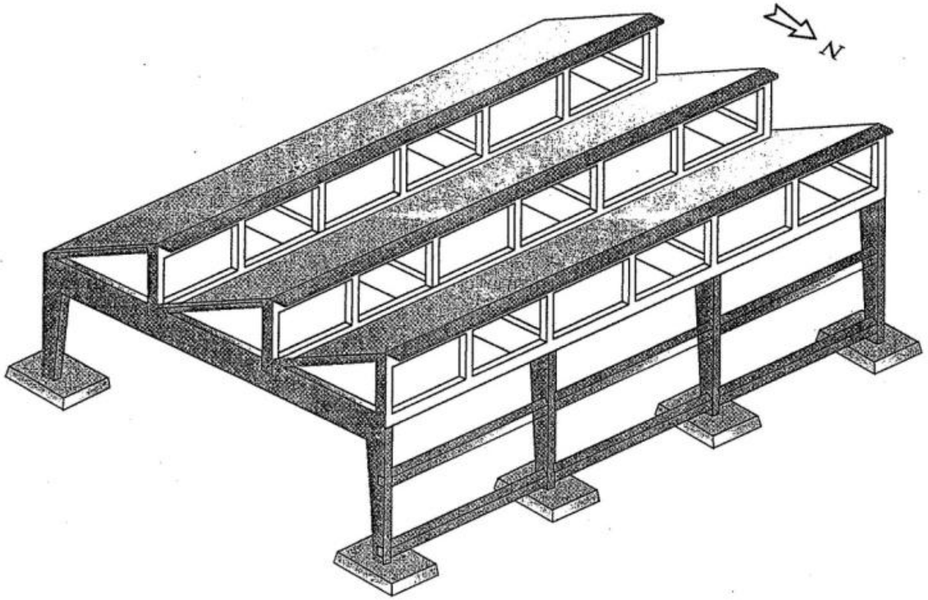
$A_s = \frac{T_u}{f_y/\gamma_s}$

Design of Saw Tooth Roof Systems

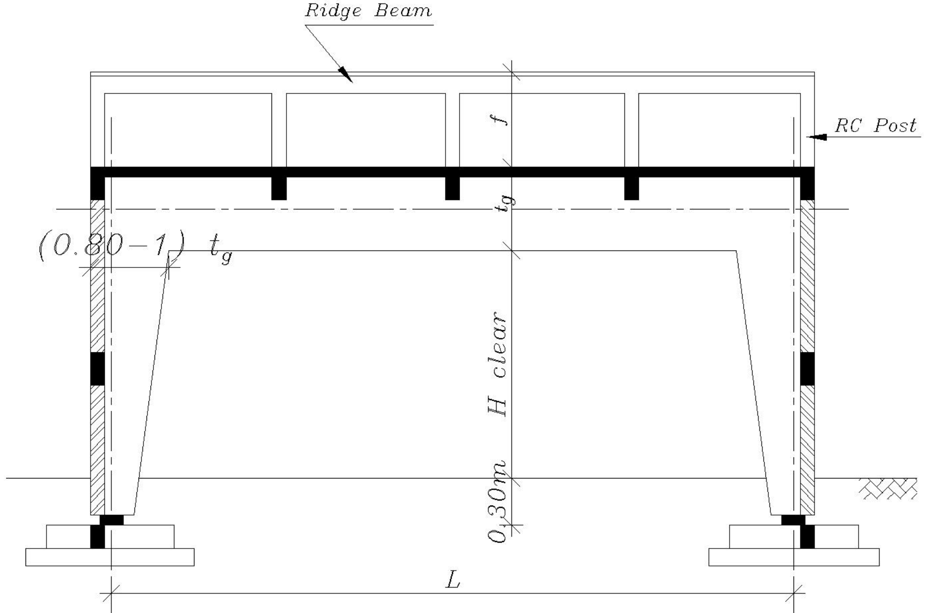
1. Frame Based Halls.
2. Arch with a ties Based Halls

Saw Tooth Alternatives

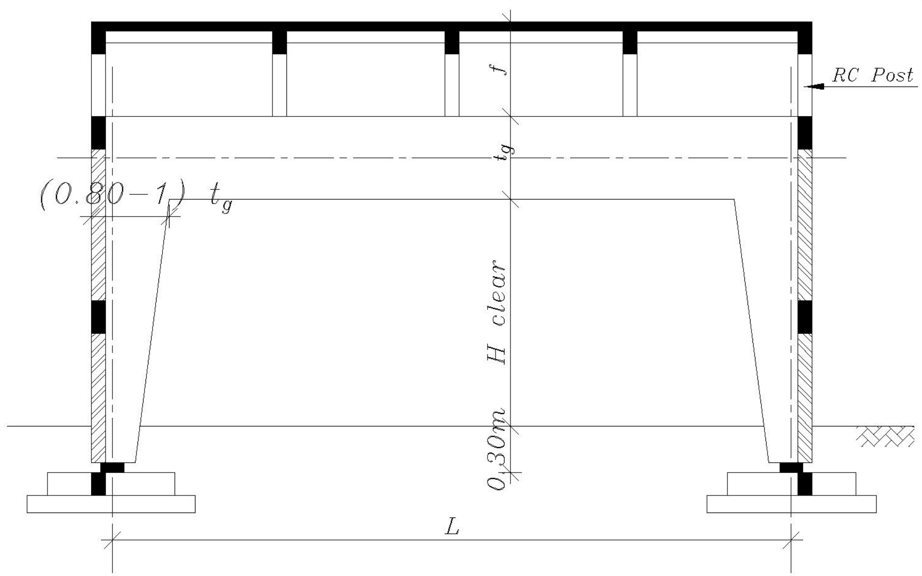




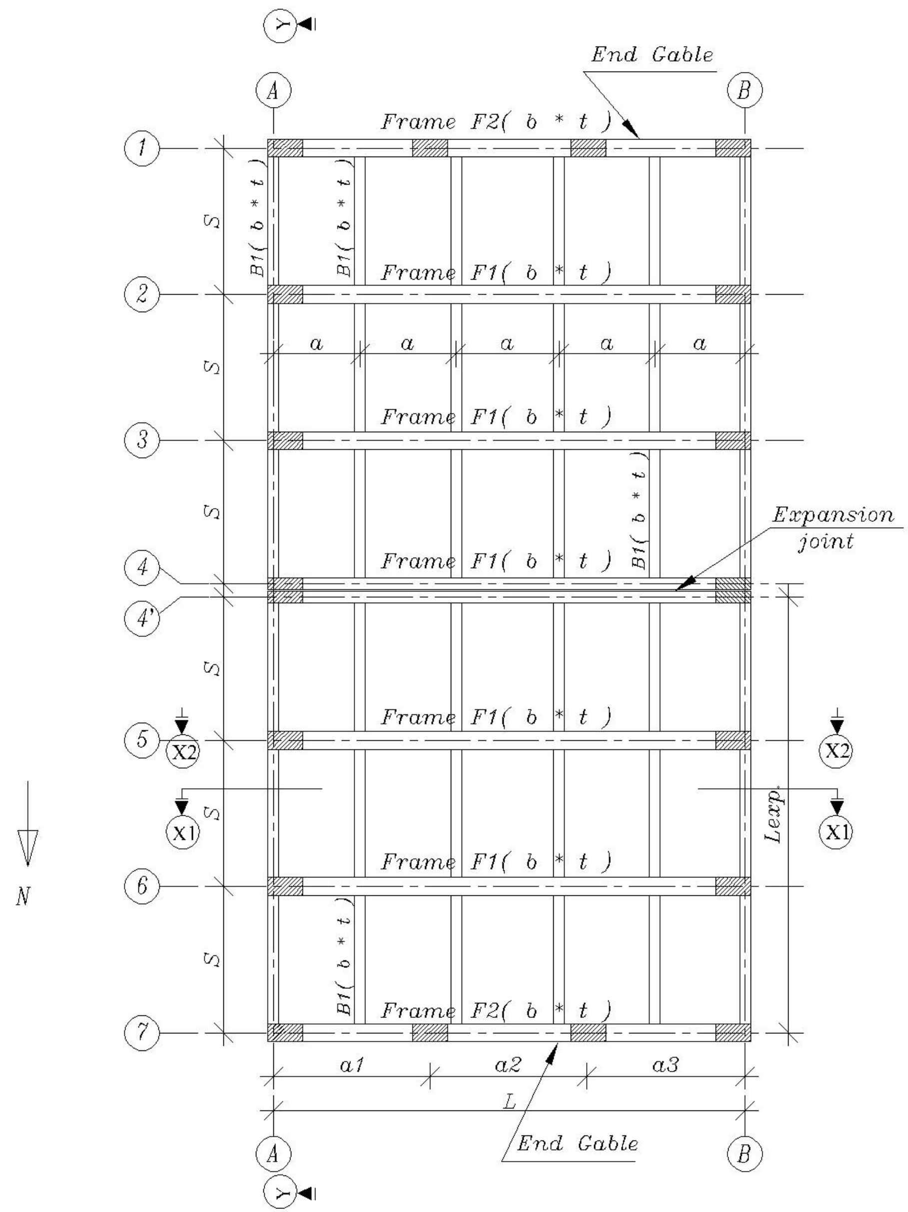
North Direction parallel to long direction

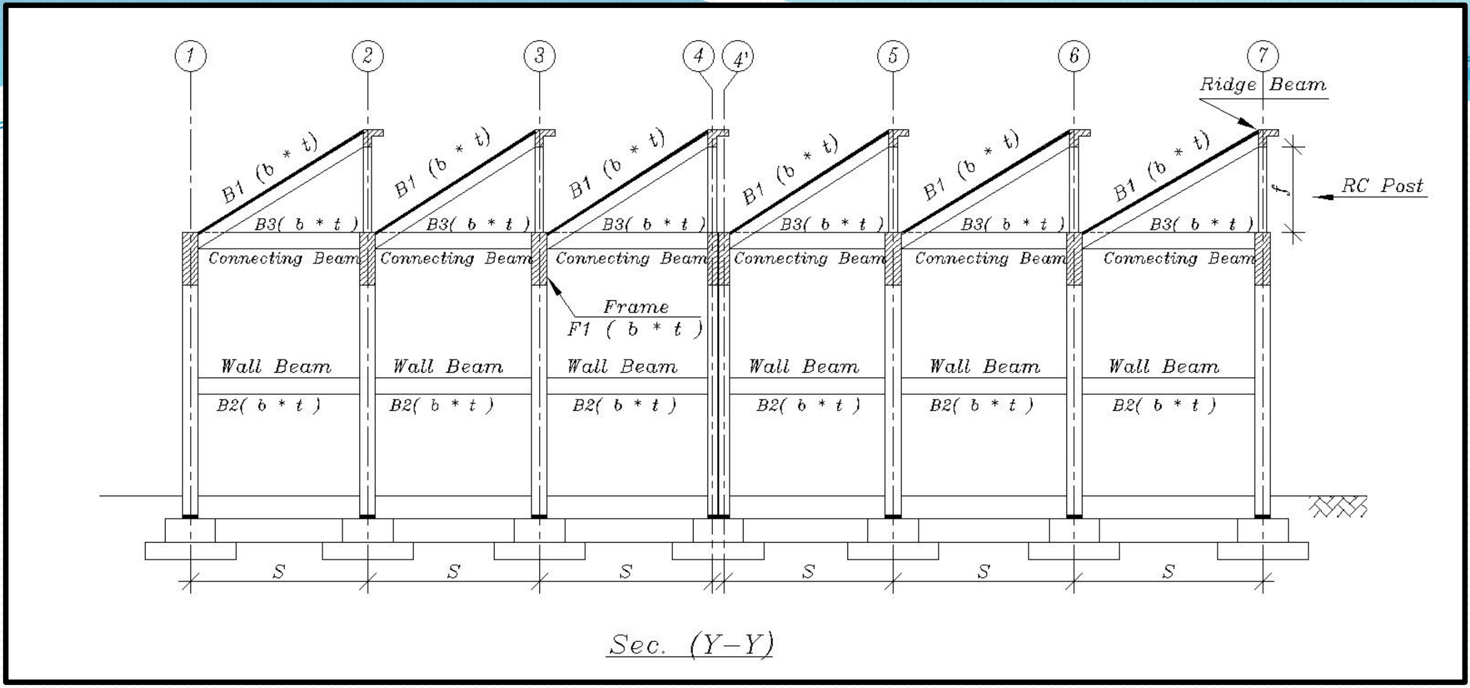


Sec. (X1–X1)



Sec. (X2–X2)





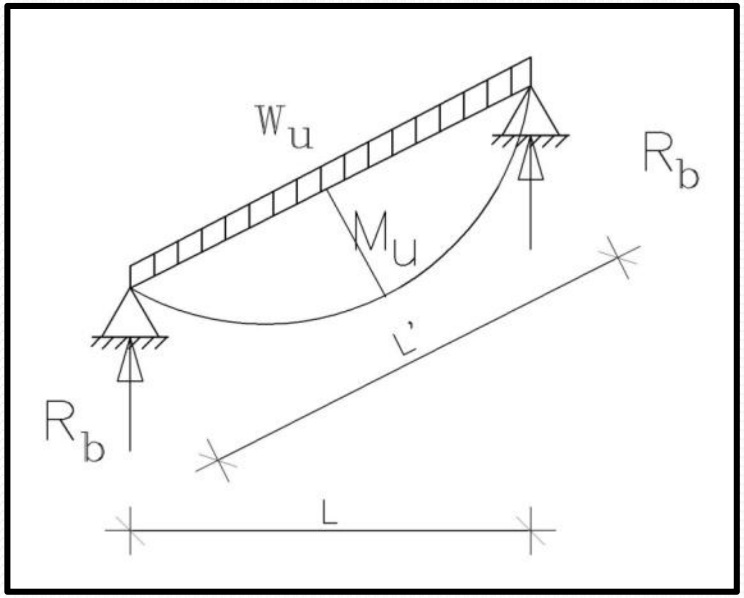
Secondary Beam

$W_u = 1.40 \times \gamma_c \times b \times t + W_{su} \times a$

$L' = \sqrt{L^2 + f^2}$

$M_u = \frac{w_u \times L \times L'}{8}$

$R_b = \frac{w_{u \times L'}}{2}$

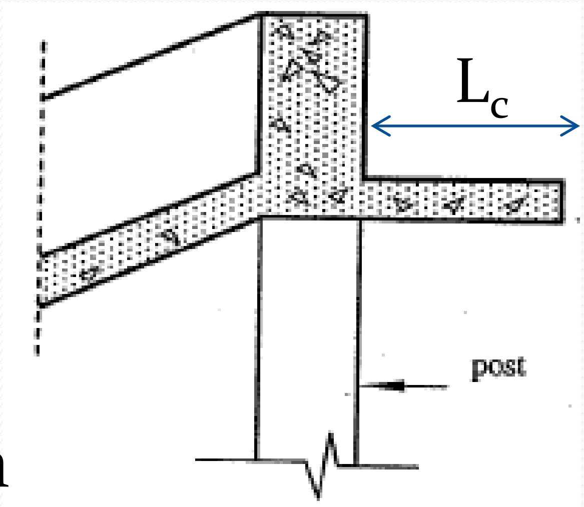


Ridge Beam

$W_u = 1.40 \times \gamma_c \times b \times t + W_{su} \times L_c$

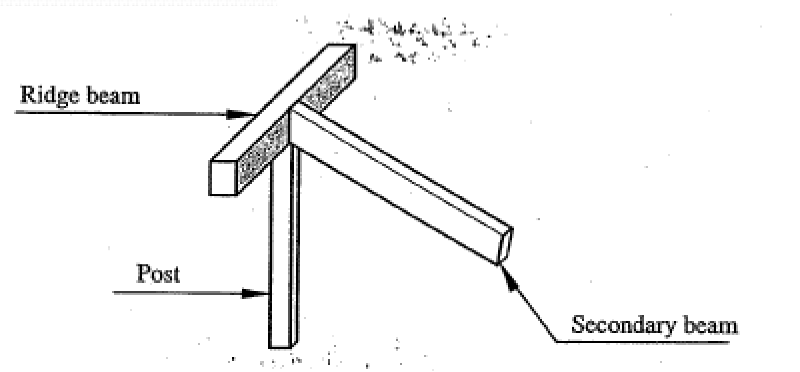
$M_u = \frac{w_u \times a^2}{10}$

$R_r = 1.10 \times W_u$



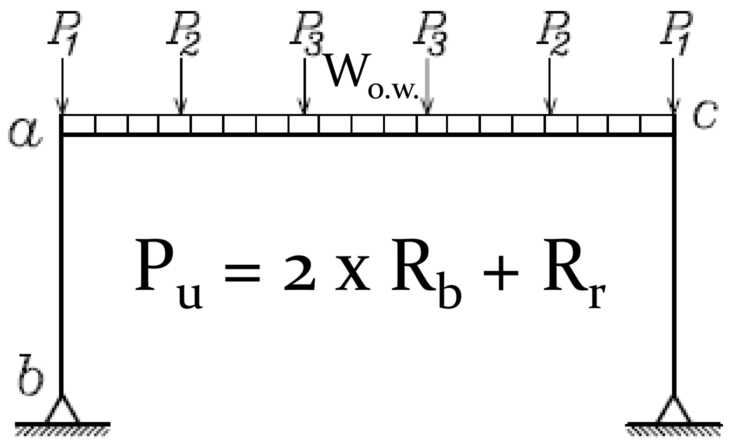
Design as a continuous beam with rectangular section

RC Post

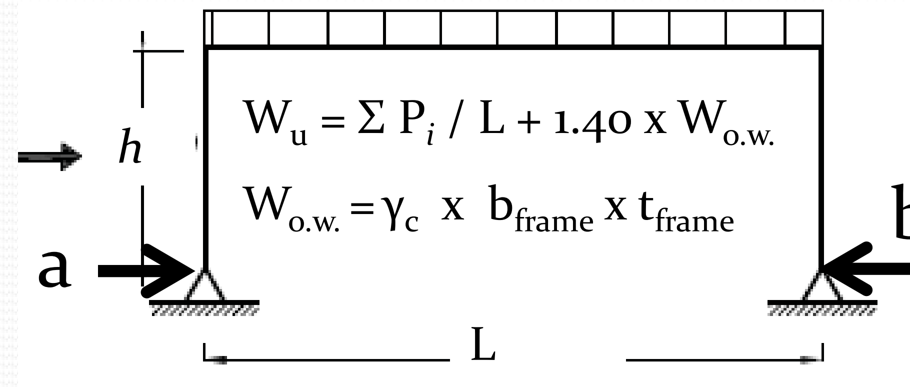


$P_u = R_b + R_r$

Design Compression Post as an Unbraced Column

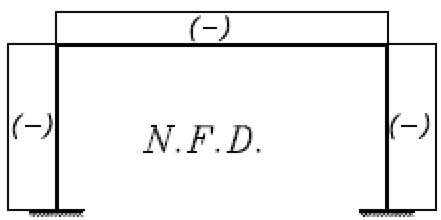


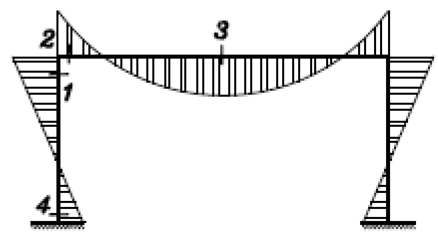
$$P_u = 2 \times R_b + R_r$$



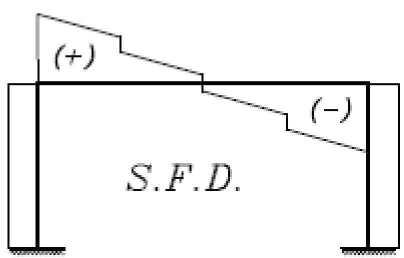
$$W_u = \Sigma P_i / L + 1.40 \times W_{o.w.}$$

$$W_{o.w.} = \gamma_c \times b_{frame} \times t_{frame}$$





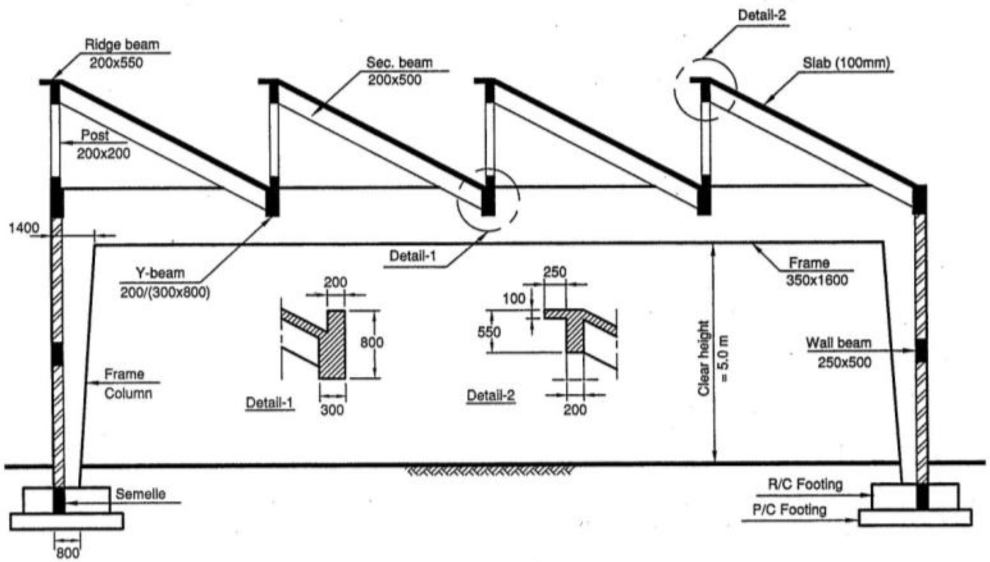
Design Sections for Both M, N and get Required Shear Reinforcement



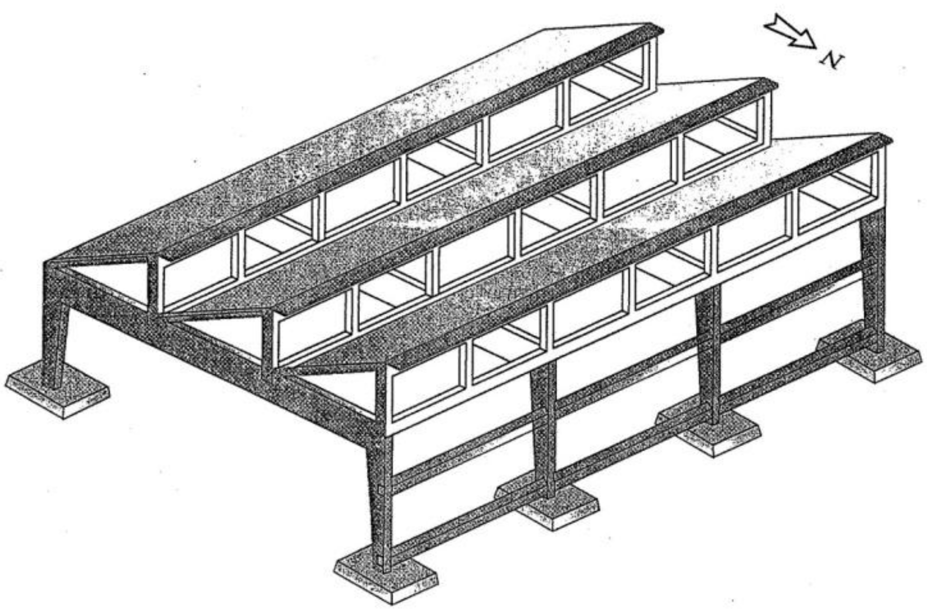
$$H_a = H_b = \frac{w_u \times L^2}{4 \times h \times N}$$

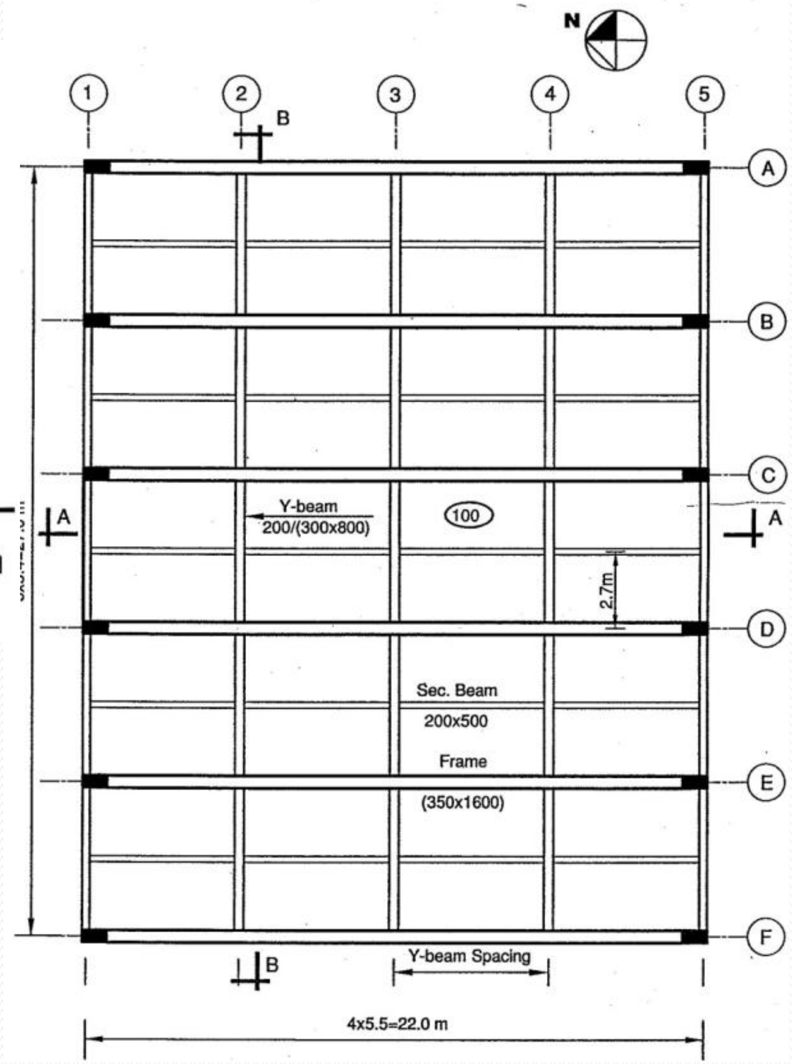
where $K = \frac{I_b}{I_c} \times \frac{h}{L}$ and $N = 2K + 3$

North Direction Normal to long direction

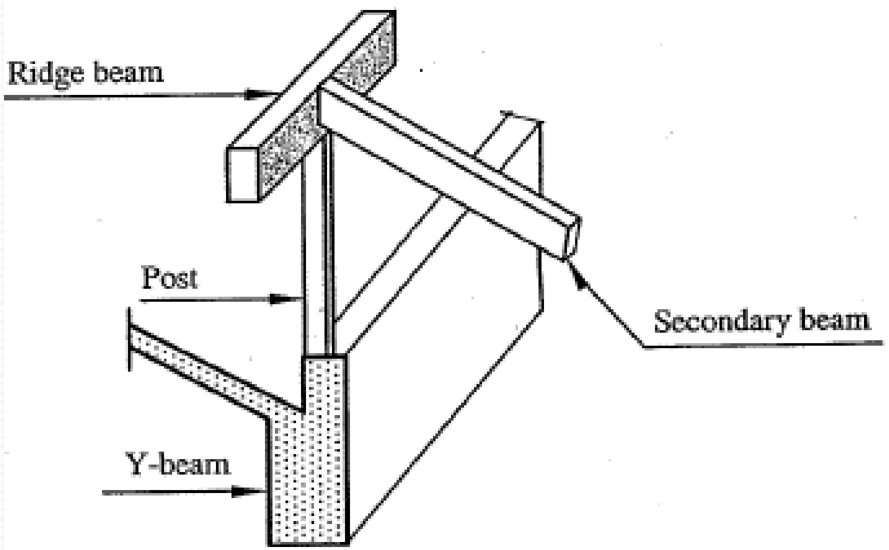


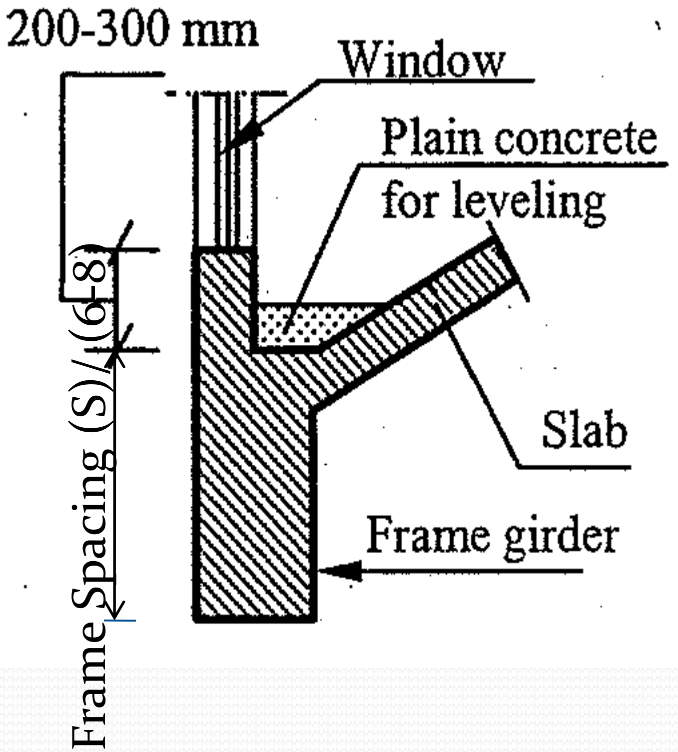
Section A-A

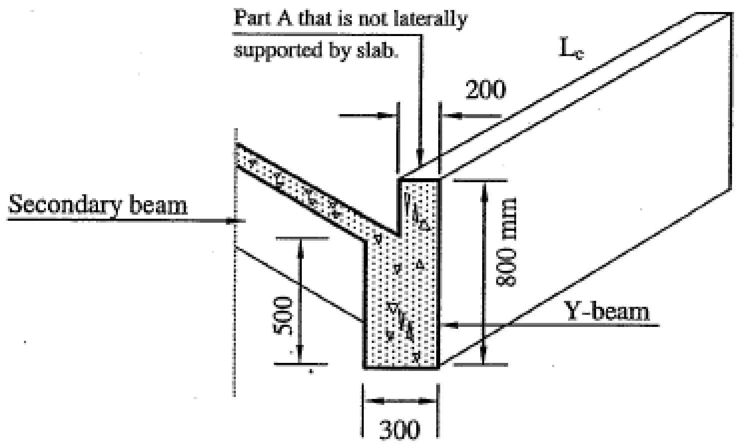


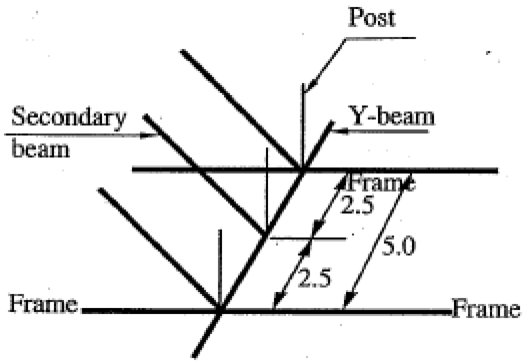


Design of Y-Beam

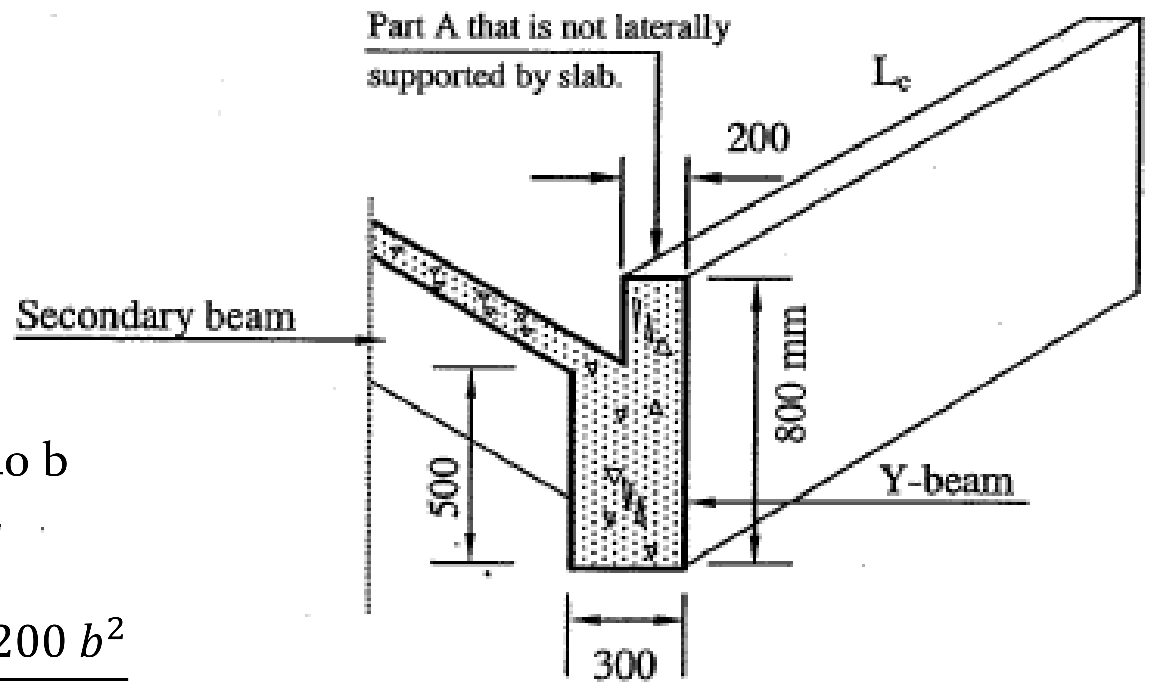


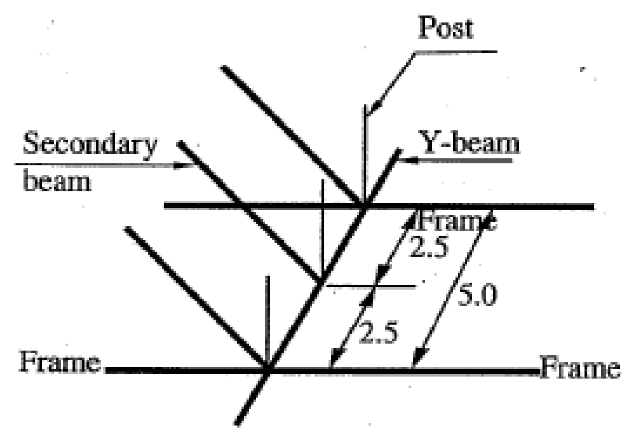




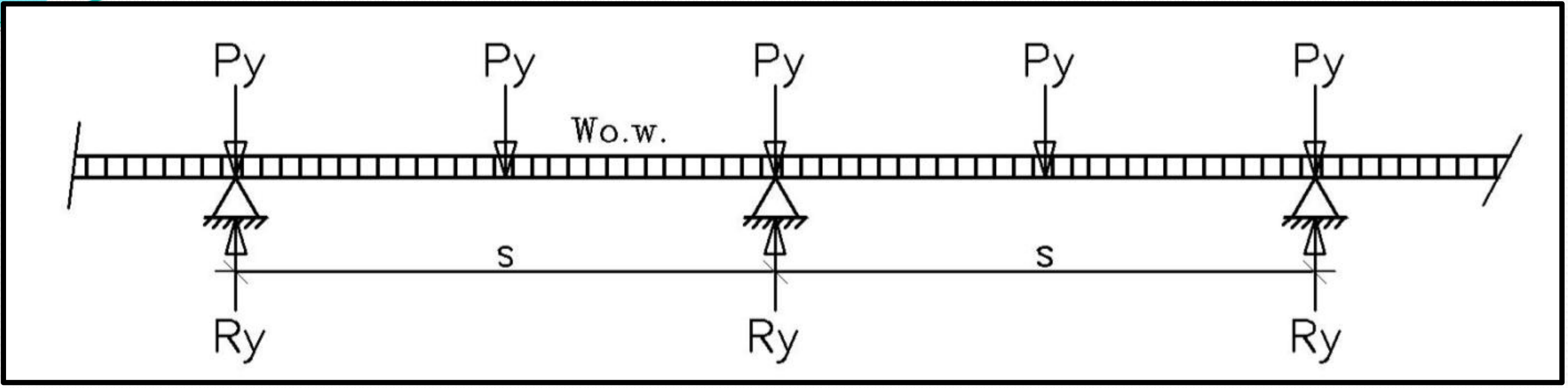


$$L_{c,max.} = \text{Smaller of} \begin{cases} 40\,b \\ \dfrac{200\,b^2}{d} \end{cases}$$





Loads on Y-Beam

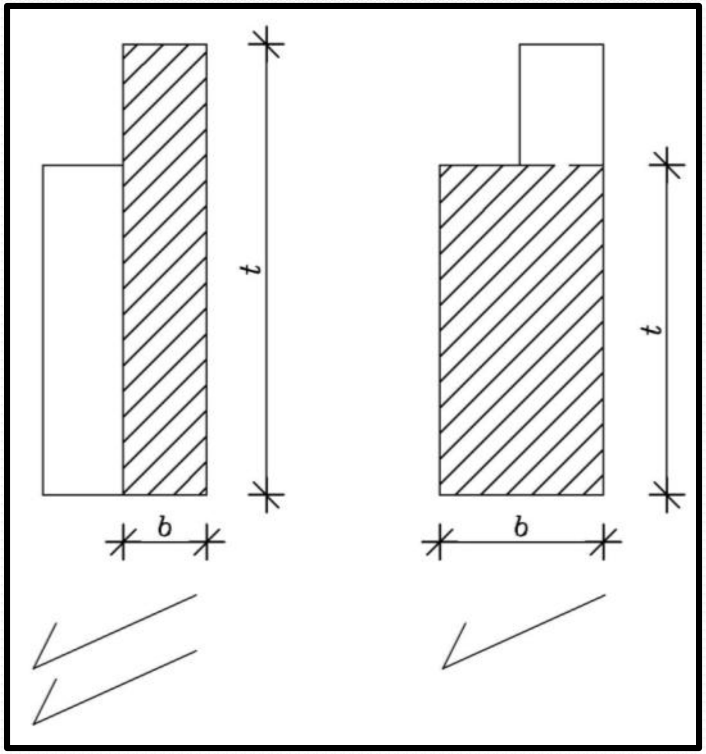


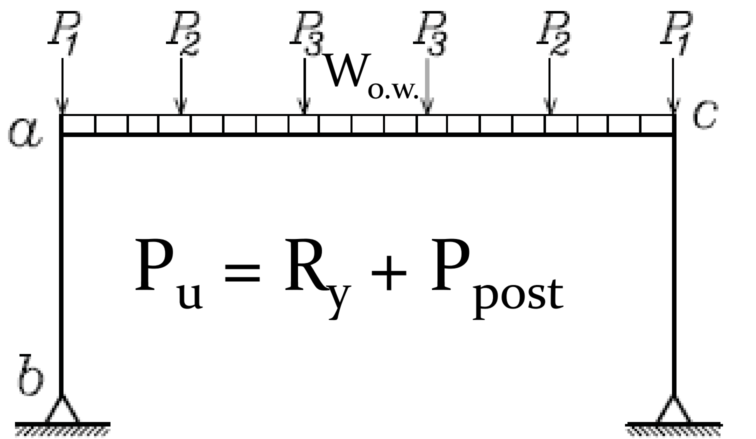
$$M_{+ve} = \frac{w_{o.w,u} \times S^2}{12} + \frac{P_u \times L}{5.89}$$

$$M_{-ve} = \frac{w_{o.w,u} \times S^2}{10} + \frac{P_u \times L}{6.22}$$

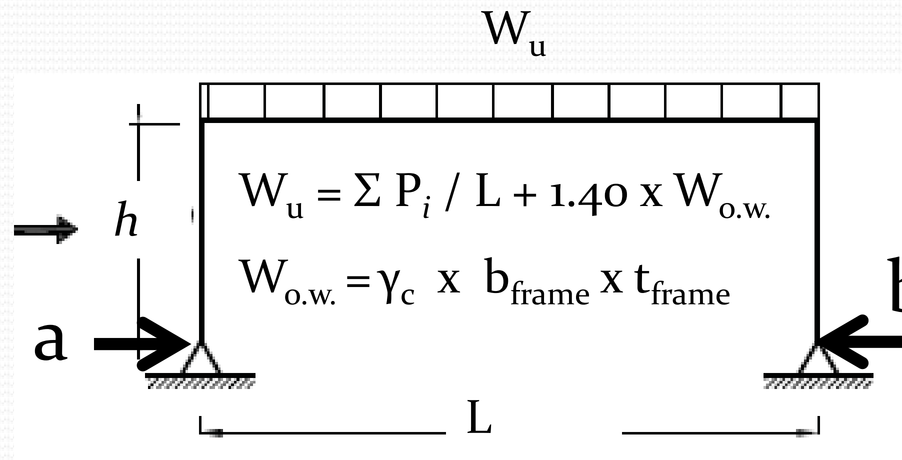
$$R_y = 1.1 \text{ x } w_{o.w,u} \text{ x } L + 2.15 \text{ x } P_y$$

$$Q_u = \frac{w_{o.w.,u} \times S}{2} + \frac{P_y}{2} + \frac{M_{-ve}}{S}$$



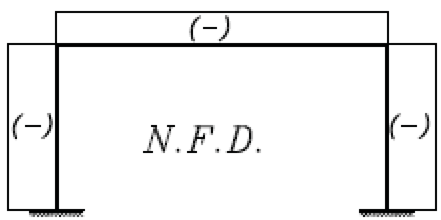


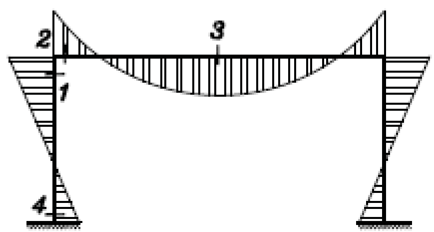
$$P_u = R_y + P_{post}$$



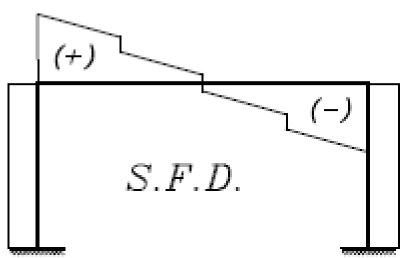
$$W_u = \Sigma P_i / L + 1.40 \times W_{o.w.}$$

$$W_{o.w.} = \gamma_c \times b_{frame} \times t_{frame}$$





Design Sections for Both M, N and get Required Shear Reinforcement



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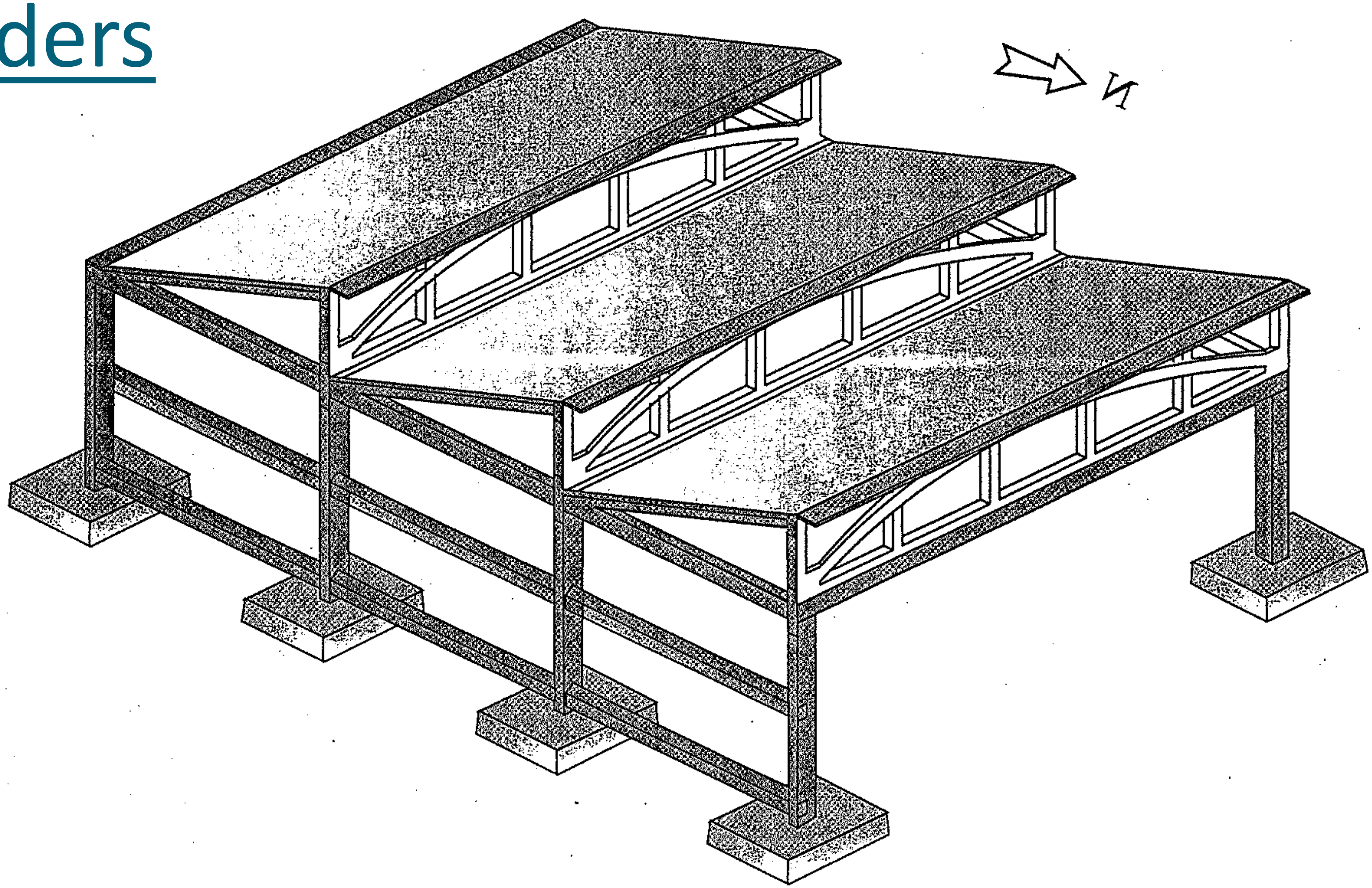
where $K = \frac{I_b}{I_c} \times \frac{h}{L}$ and $N = 2K + 3$

Saw Tooth in Arched Girders



Design of Hinged Base

$$\frac{N}{bt'} \langle f_b = 0.67 \frac{f_{cu}}{\gamma_c} \sqrt{\frac{A}{A'}} \quad \& \quad \sqrt{\frac{A}{A'}} \le 2$$

$$\frac{N}{bt'} \langle f_b = 0.67 \frac{f_{cu}}{\gamma_c} \sqrt{\frac{b \times t}{b \times t'}}$$

$$\frac{N}{bt'} \langle f_b = 0.67 \frac{f_{cu}}{\gamma_c} \sqrt{\frac{t}{t'}}$$

$$A_s = \frac{H}{0.8(f_y/\gamma_s)}$$

$$A_{st} = \frac{N/4}{f_y/\gamma_s}$$