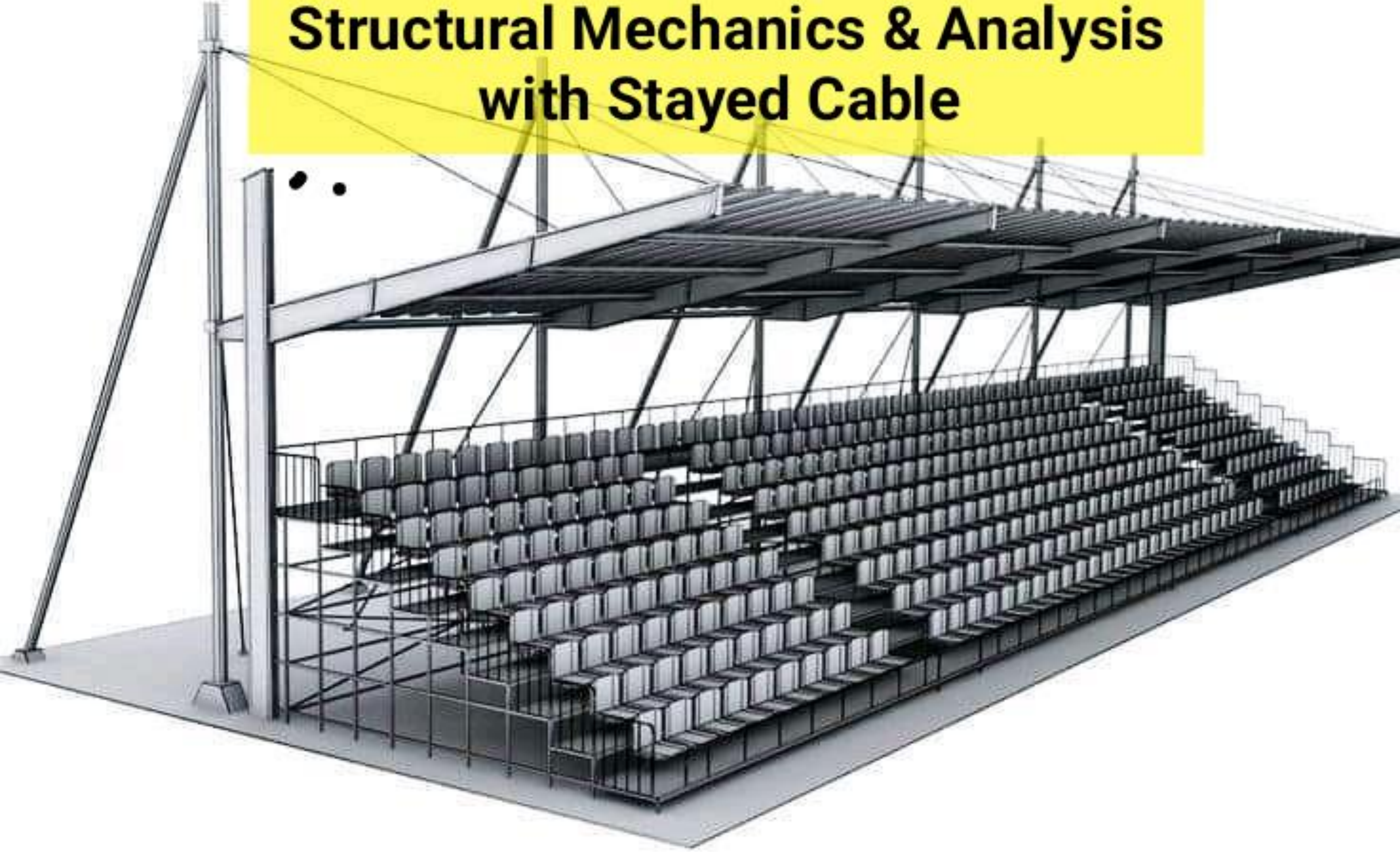
GRANDSTAND DESIGN

Cantilever Roof
Structural Mechanics & Analysis with Stayed Cable



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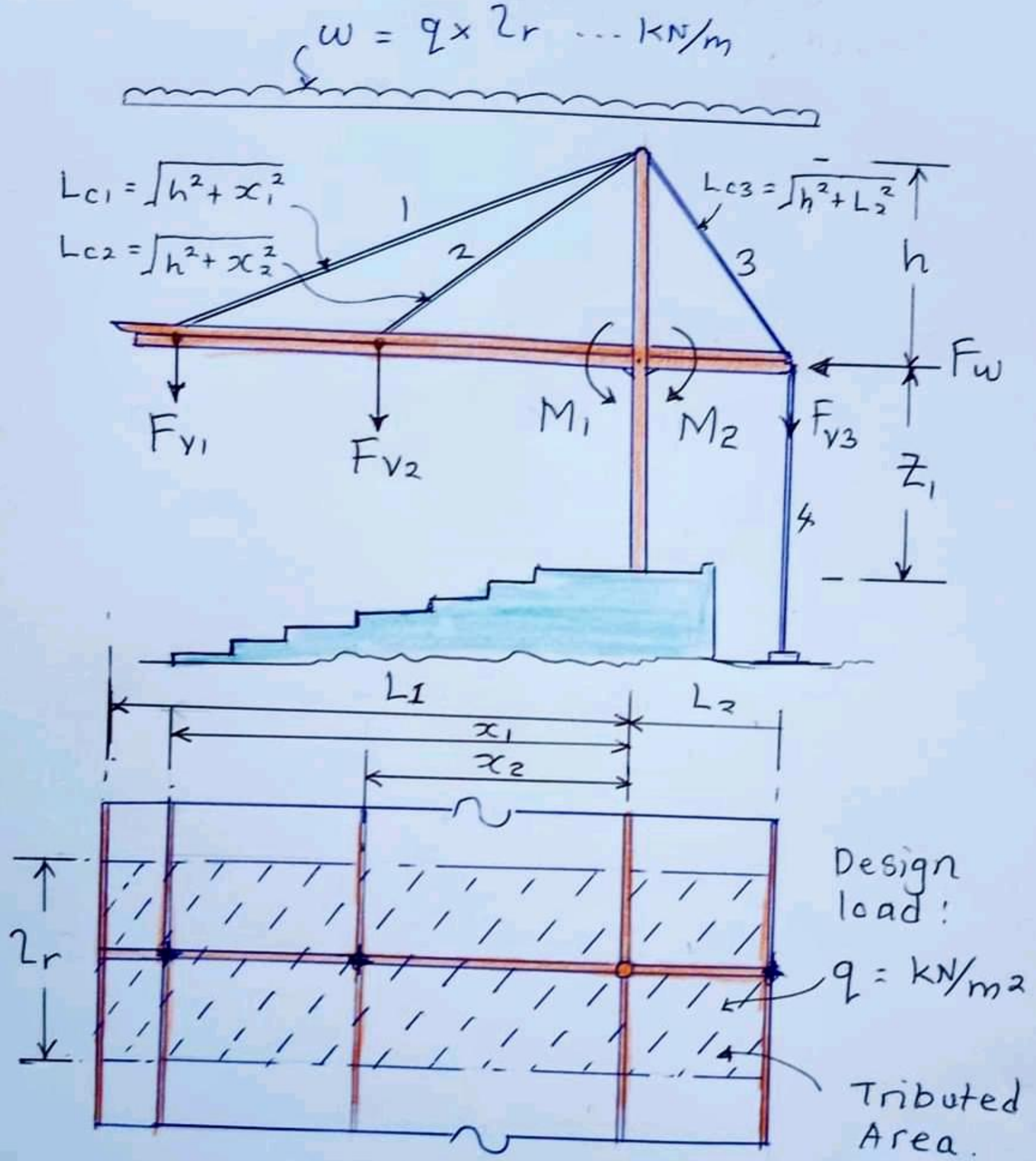
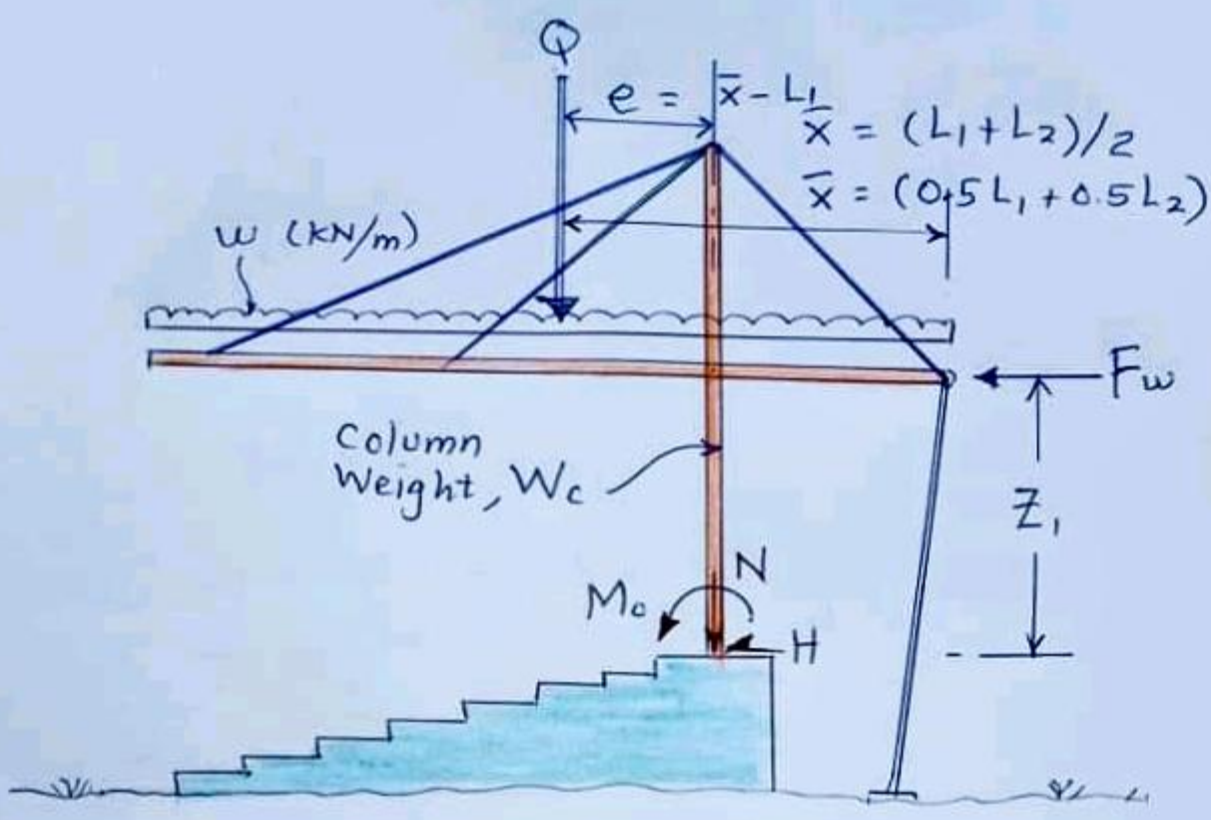
Note by: Shah Rizan Mohran   civil & structural knowledge.
Date: 10/3/2022.



Moment;

$$M_1 = \frac{wL_1^2}{2} \quad \& \quad M_2 = \frac{wL_2^2}{2}$$



Overturning Moment:

$$M_o = Q \cdot e \pm F_w \cdot Z_1 \quad \ldots \text{kNm}$$

Axial Load to column base:

$$N = Q + W_c = w(L_1 + L_2) + W_c$$

Shear or Horizontal Force at base:

$$H = \frac{M_o}{Z_1} \text{ (max.)} \ldots \text{kN}$$

where: $Q = w(L_1 + L_2)$

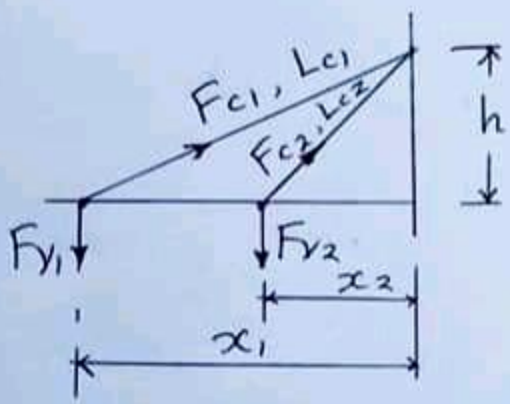
$$\bar{x} = \frac{(L_1 + L_2)}{2} \qquad e = \bar{x} - L_1$$

Vertical Force to Cable joint:-

$$F_{V1} = \frac{M_1 . x_1}{[x_1^2 + x_2^2]} \quad \ldots \text{kN}$$

$$F_{V2} = \frac{M_1 . x_2}{[x_1^2 + x_2^2]} \quad \ldots \text{kN}$$

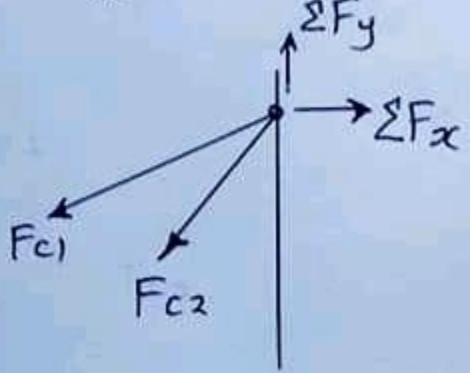
Tensile Force to stayed-Cable :-



$$F_{C1} = \frac{F_{V1}}{\cos\theta_1} = F_{V1} . \left(\frac{L_{C1}}{h}\right)$$

$$F_{C2} = \frac{F_{V2}}{\cos\theta_2} = F_{V2} . \left(\frac{L_{C2}}{h}\right)$$

Reaction at joint at tower:



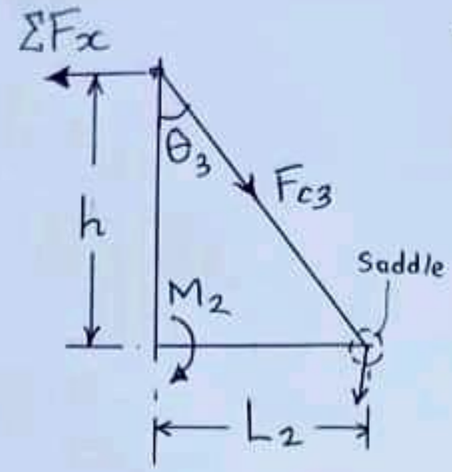
Vertical Force:-

$$\Sigma F_y = F_{V1} + F_{V2} \quad \ldots \text{kN}$$

Horizontal Force:-

$$\Sigma F_x = F_{C1} . \sin\theta_1 + F_{C2} . \sin\theta_2$$

$$\Sigma F_x = F_{C1} . \frac{x_1}{L_{C1}} + F_{C2} . \frac{x_2}{L_{C2}}$$

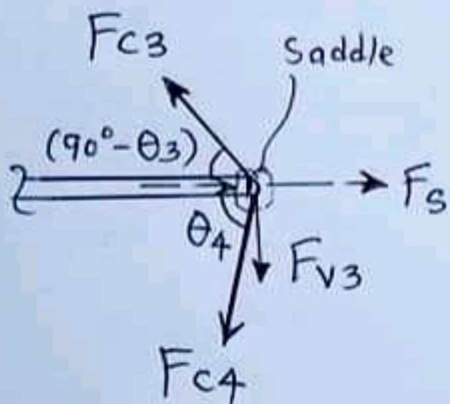


Tensile Force to Cable 3:

$$F_{C3} = \frac{\Sigma F_x}{\sin \theta_3}$$

$$F_{C3} = \Sigma F_x \left(\frac{L_{C3}}{L_2} \right) \quad \ldots \text{KN.}$$

Shear or Vertical Force at Saddle:



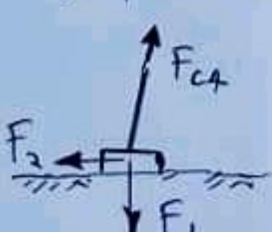
$$F_{V3} = \frac{M_2}{L_2} \quad \ldots \text{KN.}$$

Strut Force;

$$F_S = \frac{F_{C3} \cdot \sin(90° - \theta_3 + \theta_4)}{\sin(180° - \theta_4)}$$

So, Tensile Force to cable 4,

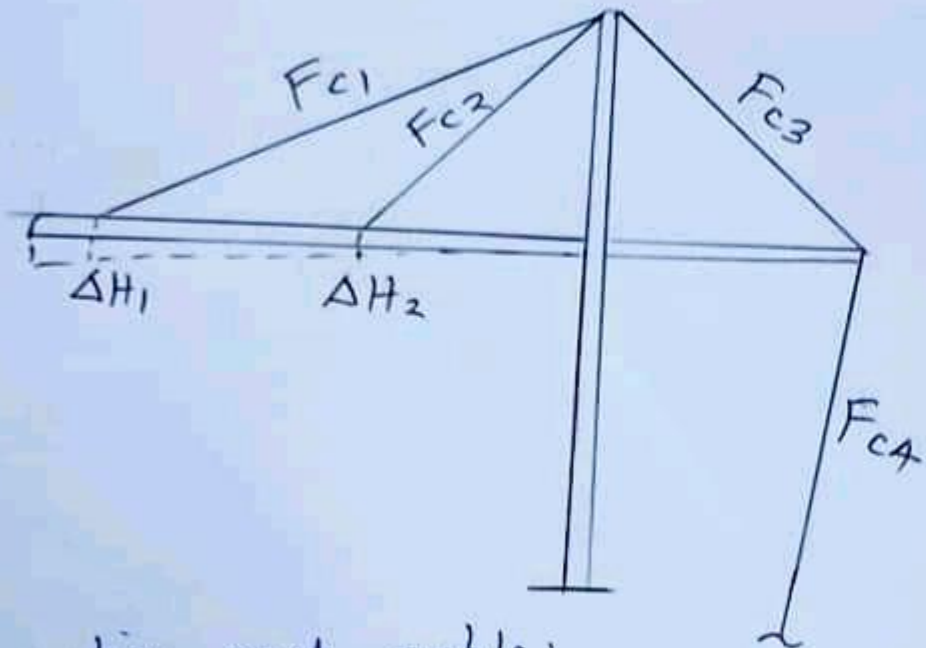
$$F_{C4} = \frac{F_{C3} \cdot \sin(90° + \theta_3)}{\sin(180° - \theta_4)} \quad \ldots \text{KN.}$$



$F_1 = F_{V3}$ & $F_2 = \sqrt{F_{C4}^2 - F_1^2}$

Elongation & displacement:

A_c : provide cross-area of cable.
E = Modulus Elasticity.



Elongation each cable:

$\Delta L_1 = \dfrac{F_{c1} \cdot L_{c1}}{A_c \cdot E}$; $\Delta L_2 = \dfrac{F_{c2} \cdot L_{c2}}{A_c \cdot E}$

$\Delta L_3 = \dfrac{F_{c3} \cdot L_{c3}}{A_c \cdot E}$; $\Delta L_4 = \dfrac{F_{c4} \cdot L_{c4}}{A_c \cdot E}$

Vertical Displacement:

$\Delta H_1 = \dfrac{F_{c1} \cdot L_{c1}^2}{A_c \cdot E \cdot h}$ & $\Delta H_2 = \dfrac{F_{c2} \cdot L_{c2}^2}{A_c \cdot E \cdot h}$

ELONGATION & VERTICAL DISPLACEMENT

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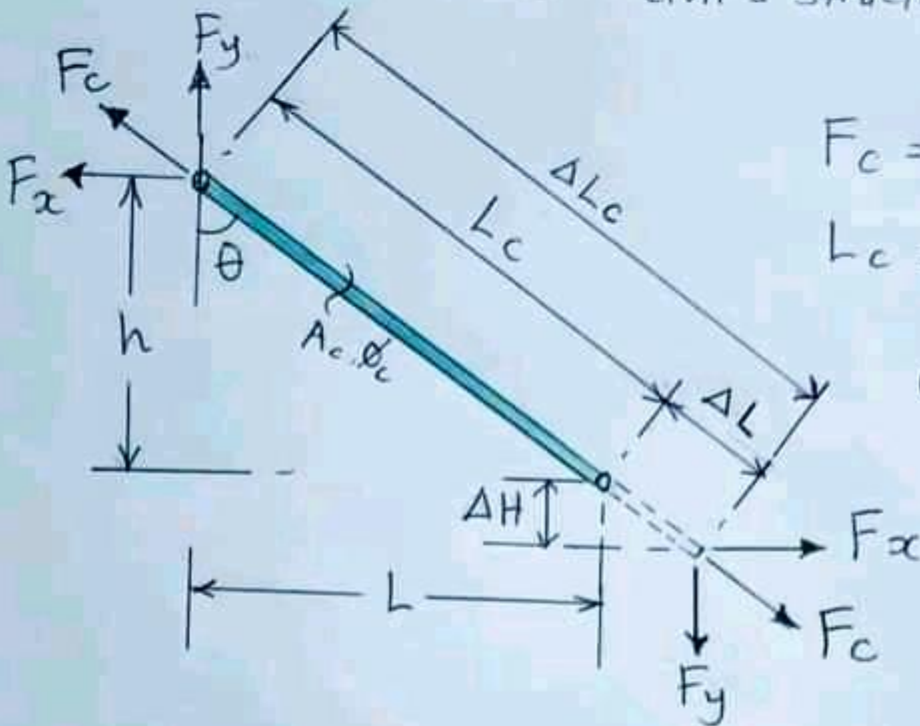


$$F_c = \sqrt{F_x^2 + F_y^2}$$

$$L_c = \sqrt{L^2 + h^2}$$

$$\cos\theta = \frac{h}{L_c}$$

Elongation of cable:

$$\Delta L = \frac{F_c \cdot L_c}{A_c \cdot E} \quad \ldots \text{mm}$$

Vertical Displacement (Deflection)

$$\Delta H = \frac{F_c \cdot L_c}{A_c \cdot E \cdot \cos\theta} = \frac{F_c \cdot L_c}{A_c \cdot E}\left(\frac{L_c}{h}\right)$$

$$\Delta H = \frac{F_c \cdot L_c^2}{A_c \cdot E \cdot h}$$

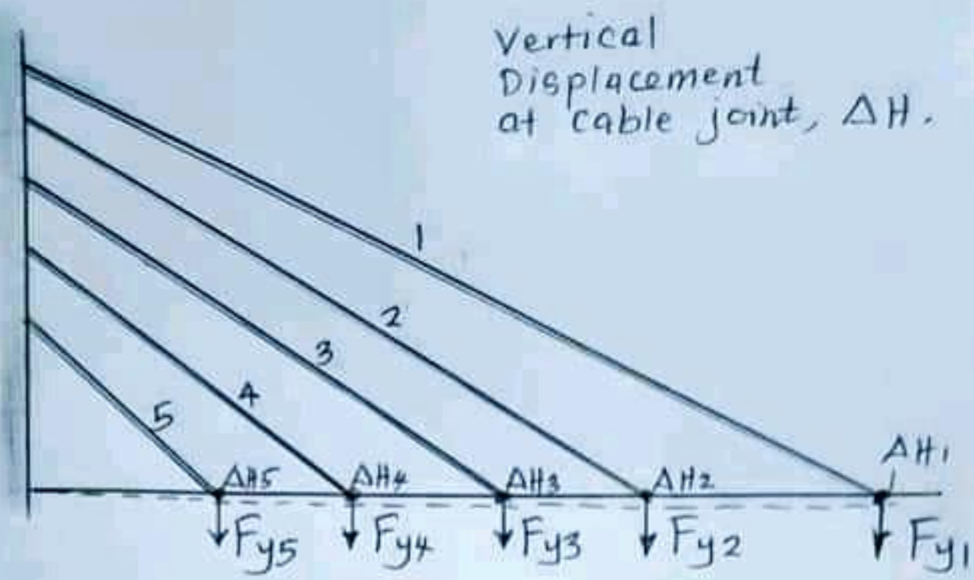


Table 1:

Data Input: Cable strength, f_{ut} = ________ N/mm^2

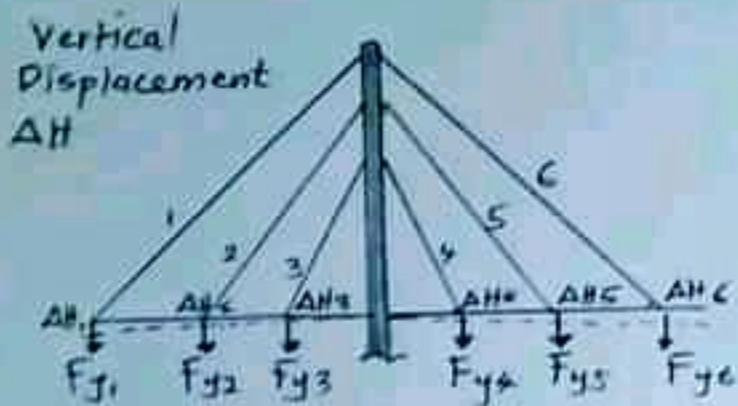
Modulus Elasticity, E = ________

Cable Ref.	Dimension			F_y	F_x	F_c	ΔL	ΔH
	h	L	L_c					
1								
2								
3								
4								
5								

where:

$$A_c = \frac{F_c}{f_{uT}} \quad \ldots \text{mm}^2 \quad \& \quad \varnothing_{c\,cal} = \sqrt{\frac{4 \cdot A_c}{\pi}}$$

(Diameter).



Cable Diameter, $\varnothing_{c\,cal} = \sqrt{\dfrac{4 \cdot F_c}{\pi \cdot f_{uT}}}$ mm

Table 2 :-

Input Data : f_{uT} = ____________

E = ____________

Cable Ref.	Dimension			F_y	F_x	F_c	Cable Size			ΔL	ΔH
	h	L	L_c				$\varnothing_{c\,cal}$	$\varnothing_c$	A_c		
1											
2											
3											
4											
5											
6											

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