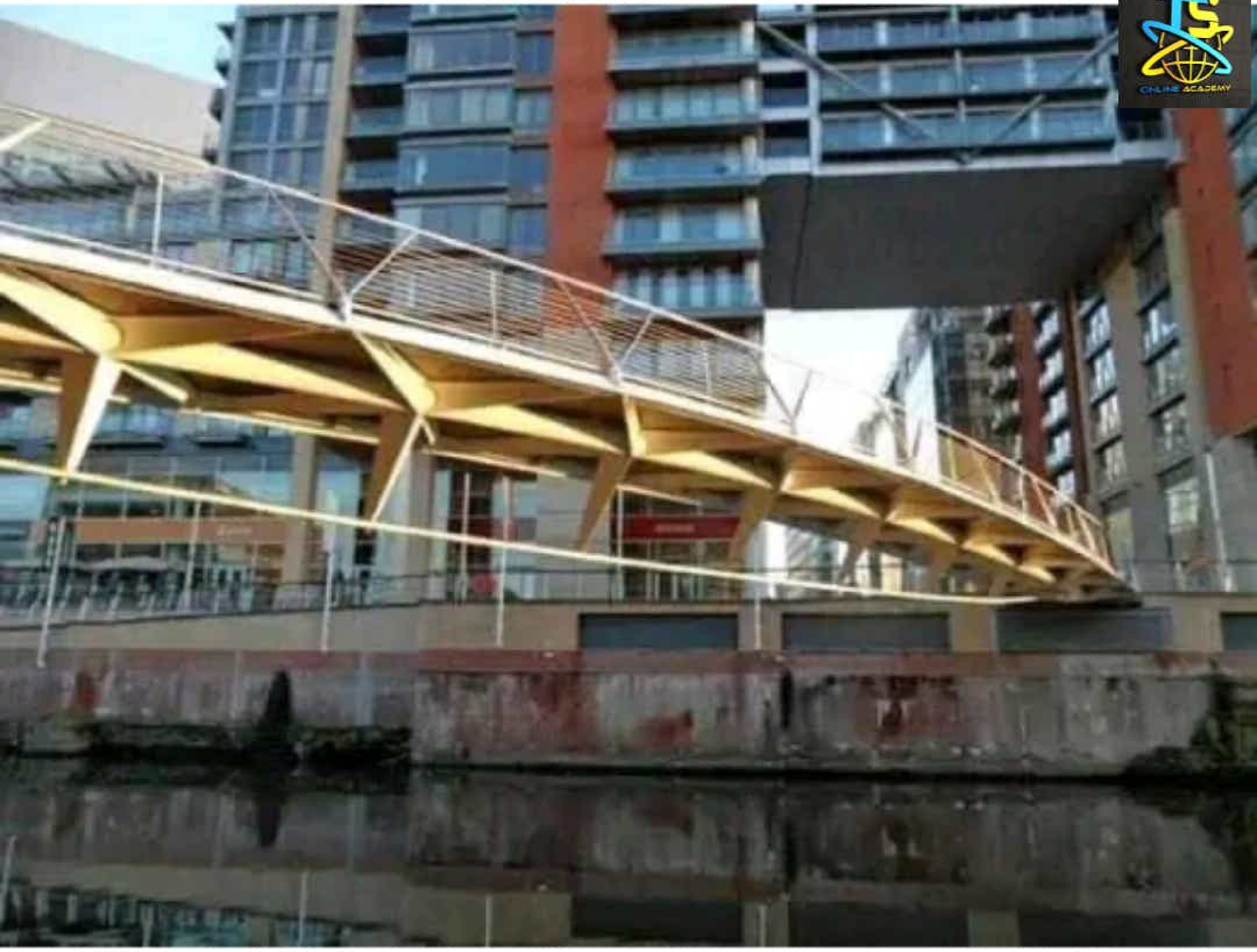
PEDESTRIAN BOWSTRING BRIDGE



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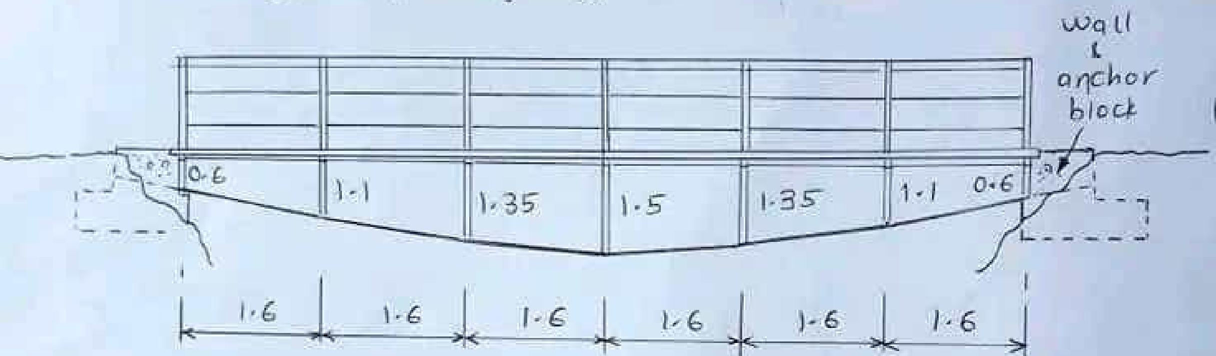
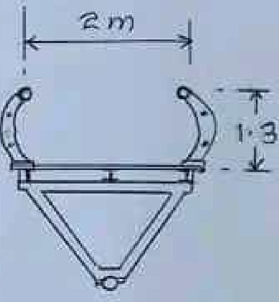
PEDESTRIAN BOWSTRING BRIDGE

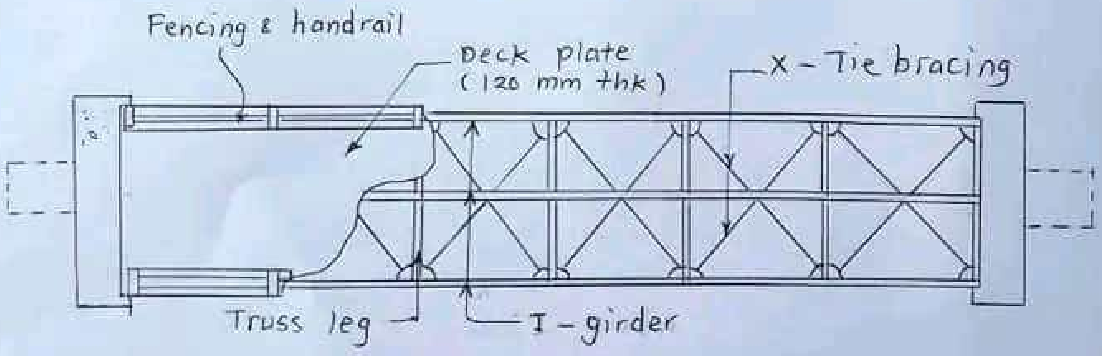
Prepared by: Shah Rizan Mahran
civil & structural knowledge
(Sarawak, Malaysia).

9/5/2024





Truss leg.



steel : $77\ KN/m^3$

girder, bracing, fencing & joist

$W = 16.8\ kg/m$

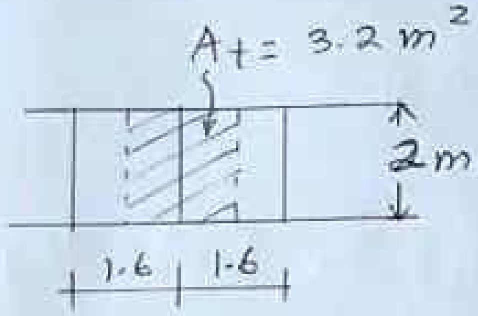
$1\ kg = 9.81\ N$

$1\ kg = 9.81 \times 10^{-3}\ KN$

1. Loading estimate

a. Deck plate ~ $77 \, KN/m^3 \times 0.12 = 9.24 \, KN/m^2$

b. Girder, $1.6 \times 3 = 4.8 \, m$



$$g_{K2} = \frac{4.8 \times 16.8 \times 9.81 \times 10^{-3}}{A_T = 3.2}$$

$$g_{K2} = 0.2472 \, KN/m^2$$

c. X-Tie bracing - length $L \sim 2 \times \sqrt{2^2 + 1.6^2}$

$$= 5.1225 \, m$$

$$g_{K3} = \frac{5.1225 \times 16.8 \times 9.81 \times 10^{-3}}{3.2 \, m^2}$$

$$g_{K3} = 0.2638 \, KN/m^2$$

d. Truss leg - $L = 2 + 2\sqrt{2^2/4 + 1.5^2}$

$$= 5.61 \, m$$

$$g_{K4} = 5.61 \times 16.8 \times 9.81 \times 10^{-3} / 3.2$$

$$g_{K4} = 0.289 \, KN/m^2$$

e. Fencing & handrail $L - 7.8 \, m$

$$g_{K5} = 7.8 \times 16.8 \times 9.81 \times 10^{-3} / 3.2$$

$$g_{K5} = 0.402 \, KN/m^2$$

Total dead load; $g_k = 10.442 \, KN/m^2$

Imposed load, $q_k = 4.5 \, KN/m^2$

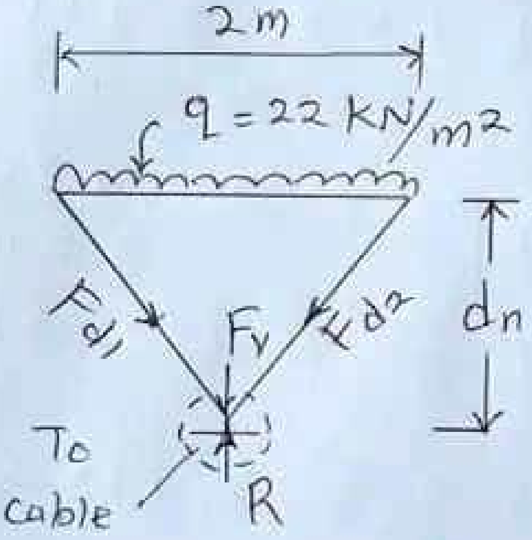
Design load, $q = 1.4 g_k + 1.6 q_k$

$= 1.4(10.442) + 1.6(4.5)$

$q = 21.818 \ KN/m^2$

$q \simeq 22 \ KN/m^2$

2. load transfer from deck to truss leg.



$F_v = q \times A_T$

$= 22 \times (1.6 \times 2)$

$F_v = 70.4 \ KN$

$\therefore R = P = F_v$

Compression Force to truss leg:

$$F_{d1} = \frac{F_v}{2}\left(\frac{L_{d1}}{d_n}\right) = \frac{F_v}{2} \cdot \frac{\sqrt{W_b^2/4 + d_n^2}}{d_n}$$

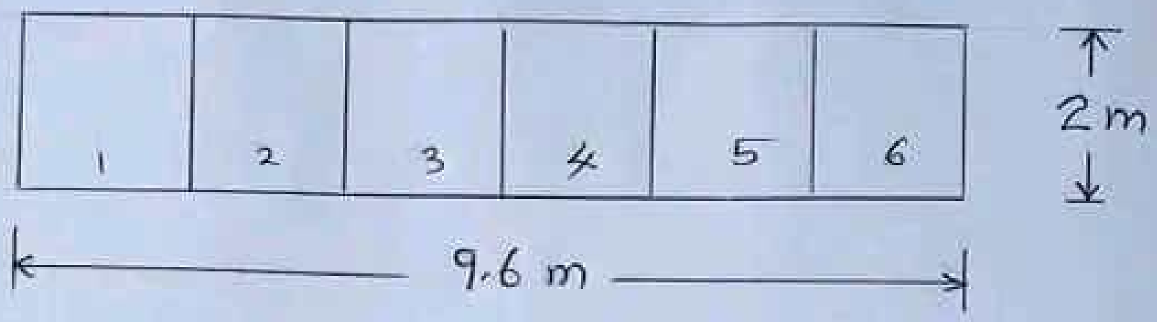
$$F_{d2} = \frac{F_v}{2}\left(\frac{L_{d2}}{d_n}\right) = \frac{F_v}{2} \cdot \frac{\sqrt{W_b^2/4 + d_n^2}}{d_n}$$

size of truss leg:

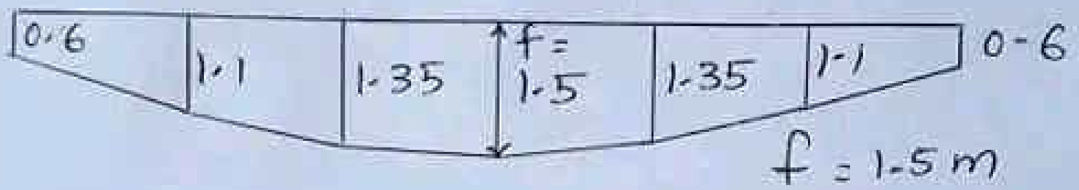
$A_m = F_{d\,max} / P_y \ \ldots \ cm^2$

3. load Transfer to cable :-

Node :



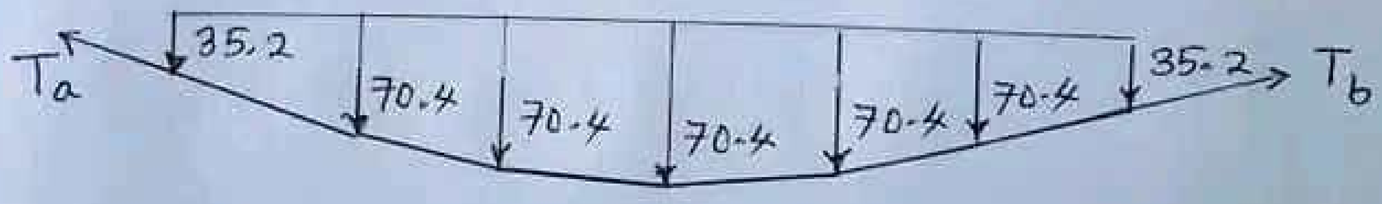
d_n :



Point load, $P = F_r = \dfrac{q \times W_b \times L}{N\ node}$

$P = \dfrac{22 \times 2 \times 9.6}{6} = 70.4$ KN

at end support ; P = 35.2 KN

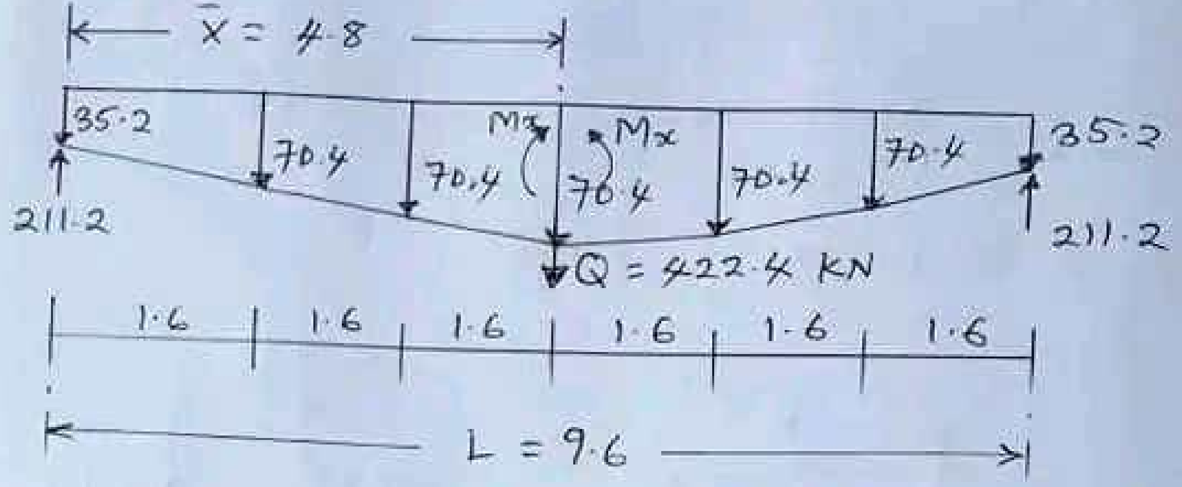


Total load, Q = 2 (35.2) + (5 × 70.4)

= 422.4 KN

Centroid, $\bar{x}$ = 4.8 metre.

Main cable analysis (see table)



Reaction at support a & b.

$$F_{ya} = \frac{Q(L-\bar{x})}{L} = 422.4\,(9.6-4.8)/L\text{-}4.8$$
$$= 211.2 \text{ KN}$$

$$F_{yb} = 4224 - 211.2 = 211.2 \text{ KN}$$

Moment, at $\bar{x}$

$$M_x = (211.2 - 35.2)4.8 - 70.4(3.2) - 70.4(1.6)$$

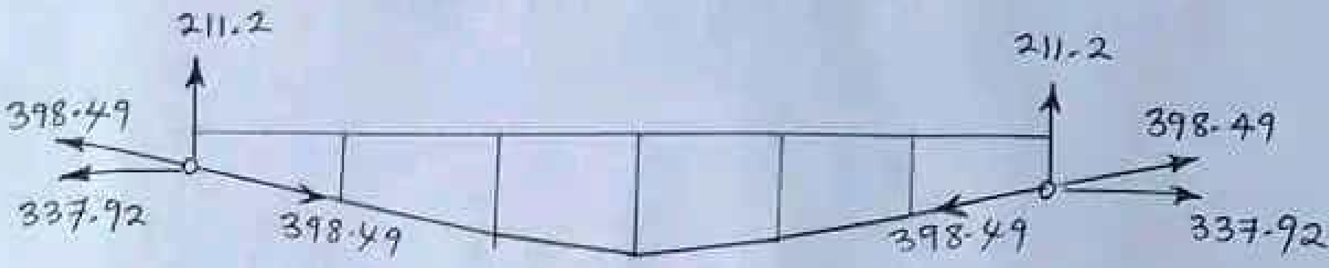
$$M_x = 506.88 \text{ KNm.}$$

$$F_{xa} = F_{xb} = \frac{M}{f} = \frac{506.88}{1.5} = 337.92 \text{ KN}$$

So, Tensile Force To main cable :-

$$T_a = \sqrt{337.92^2 + 211.2^2} = 398.49 \text{ KN}$$

$$T_b = \sqrt{337.92^2 + 211.2^2} = 398.49 \text{ KN}$$



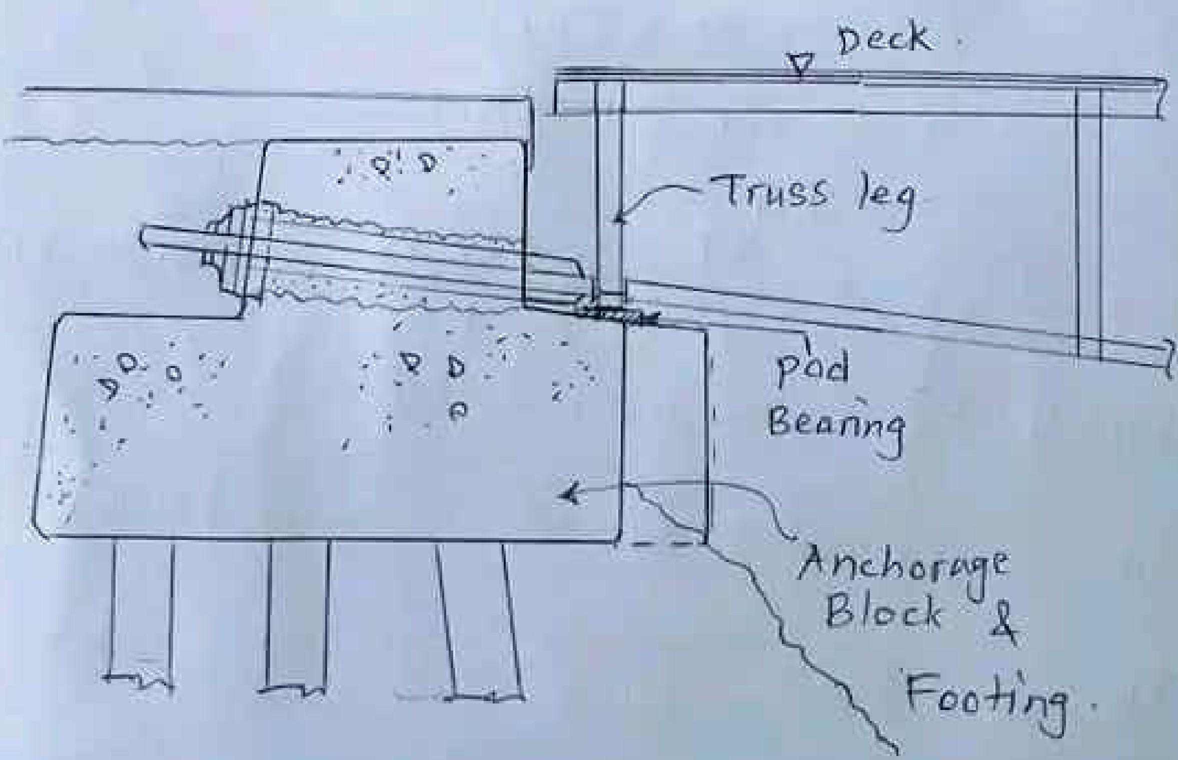
Force to anchorage block.

cable size & diameter:

$$\phi_c = \sqrt{\frac{4 \cdot T_{max}}{\pi \cdot f_{Tu}}}$$

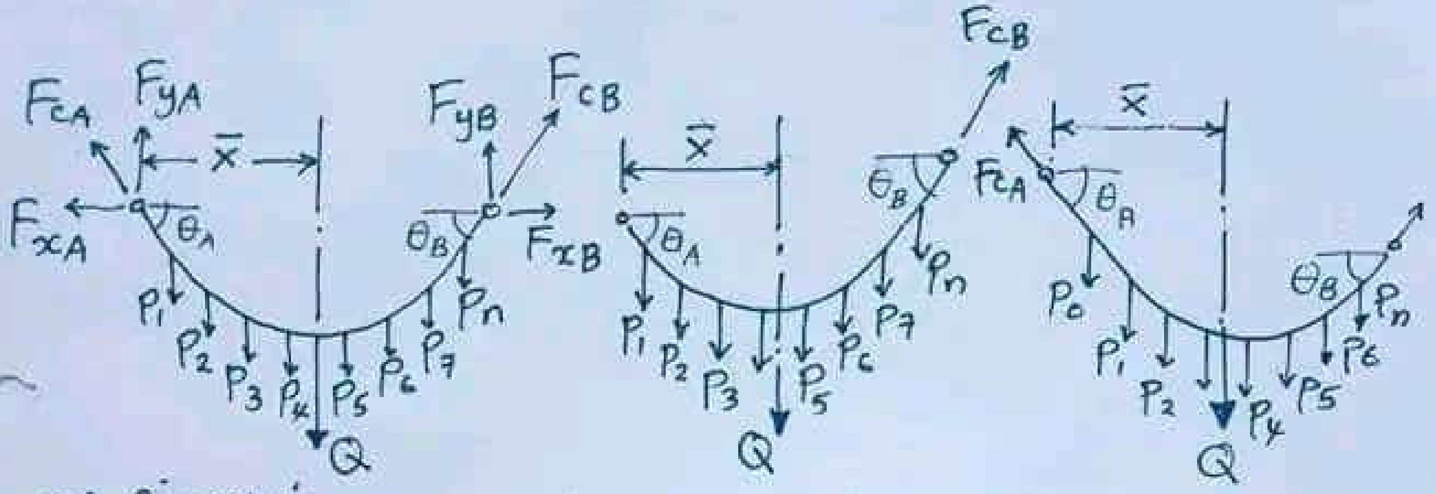
steel strength
$f_{Tu} \sim N/mm^2$.

Anchorage Block System



POLYGONAL CABLE ANALYSIS

Prepared by :
Shah Rizan Mahran
7/7/2020



(a) Simetry
($\theta_A = \theta_B$) same height & level

$F_{yA} = F_{yB}$
$F_{xA} = F_{xB}$
$F_{cA} = F_{cB}$
$T_{max} = F_{cA} = F_{cB}$

(b) not - simetry.

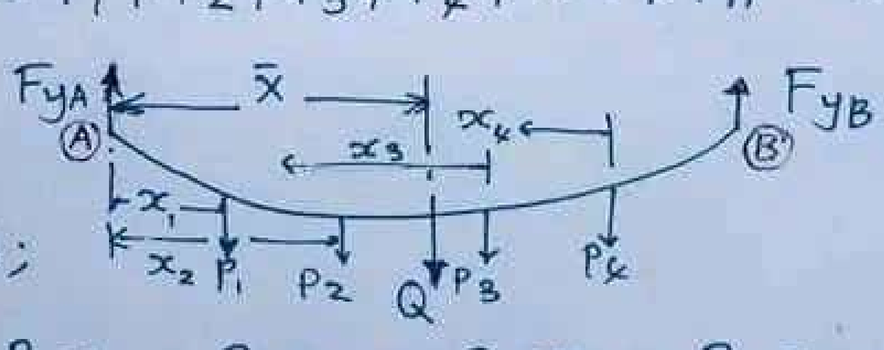
$F_{yA} < F_{yB}$	$F_{yA} > F_{yB}$
$F_{xA} < F_{xB}$	$F_{xA} > F_{xB}$
$F_{cA} < F_{cB}$	$F_{cA} > F_{cB}$
$T_{max} = F_{cB}$	$T_{max} = F_{cA}$

2. Loading

$P_1, P_2, P_3 \ldots P_n$ is suspension point load transfer from deck & platform. Total load:

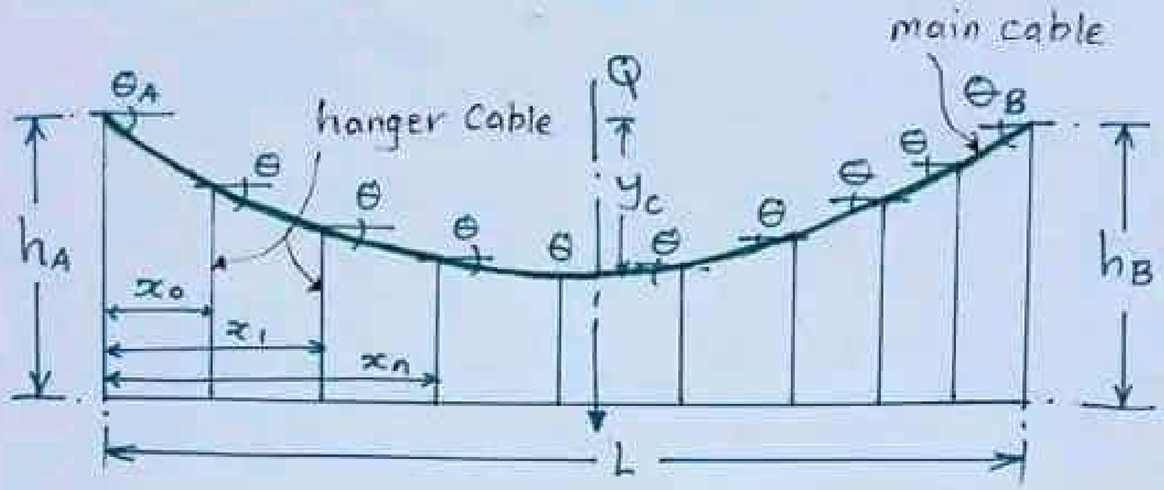
$$Q = P_1 + P_2 + P_3 + P_4 + \cdots + P_n \quad \ldots \text{kN.}$$

centroid;



$$\bar{x} = \frac{P_1 x_1 + P_2 \cdot x_2 + P_3 \cdot x_3 + P_4 \cdot x_4 + \cdots + P_n x_n}{Q}$$

3). Angel, θ_n at each joint



$$\tan \theta_n = \frac{4y_c}{L} - \frac{8y_c . x}{L^2}$$

— hanger
— main

To find $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \dots \theta_n$.

So, $\theta_n = \tan^{-1}\left[\frac{4y_c}{L} - \frac{8y_c . x}{L^2}\right]$

$$1 \text{ Radian} = \frac{180}{\pi} \text{ degree}$$

4). Length of hanger cable, Lc & main cable

For $h_A = h_B$ (Same height of tower)

Cable length, $L_c = h - y_x$

$$y_x = \frac{4y_c}{L}\left(x - \frac{x^2}{L}\right)$$

when distance $x_1, x_2, x_3, x_4 \dots x_n$ from left to right. so, length

$$L_c = h - \left[\frac{4y_c}{L}\left(x - \frac{x^2}{L}\right)\right] \quad \dots m.$$

main cable : $L_c = L + \frac{8}{3}\left(\frac{y_c^2}{L}\right) \dots m.$

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