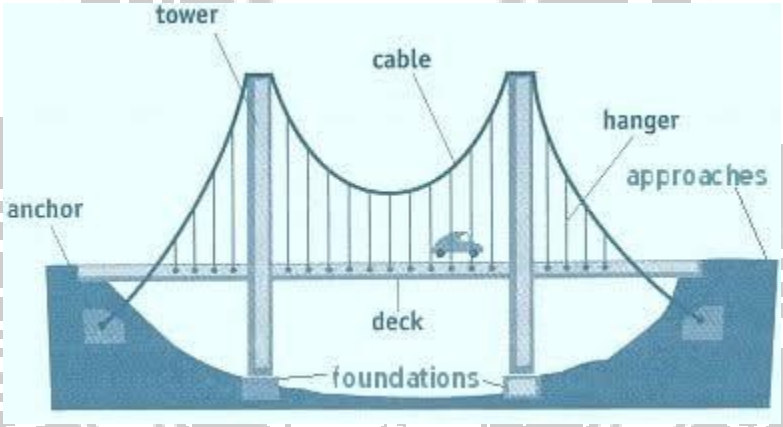
ANCHORAGE OF SUSPENSION CABLES

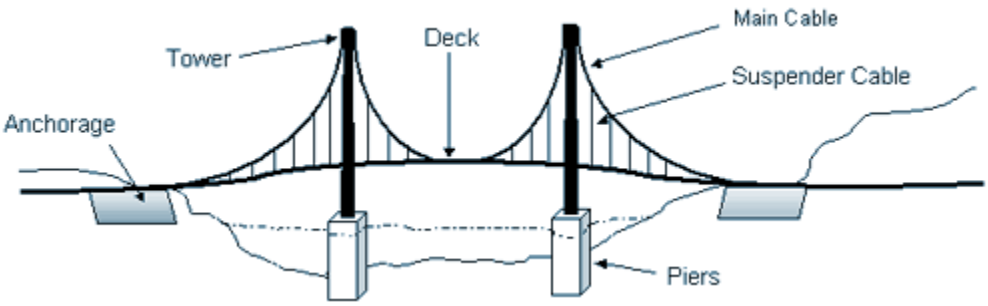
Anchor cable

The cable tension in suspension cable are of the order of several hundred tones and due to this reason, the anchoring of the suspension cable becomes a perplex task. The suspension cable are to be anchored to the bed rock, after they have been passed over the tall pylons.



Supporting towers

The supporting towers are basically designed for strength, stability and for architectural value of the structure. It provides foundation and glory to the bridge. The suspension cable is supported on the towers on its either sides and height of the tower is about 20 to 200m. For passing the suspension cable on the either side of the tower a saddle placed on rollers or a guide pulley is provided over the towers.

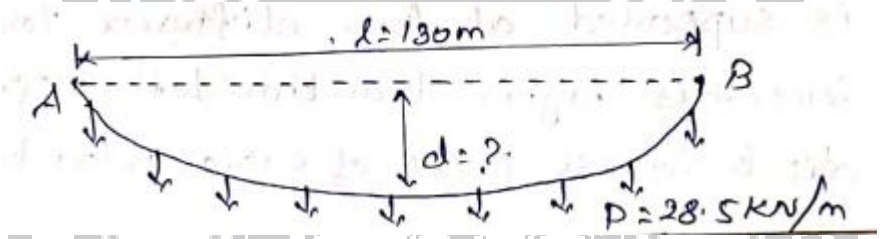


Suspenders

The suspenders are provided to transfer the traffic load on the deck slab to the suspension cable as a UDL. These suspenders are closely spaced.

Example :

A suspension cable of 130m horizontal span is supported at the same level it is subjected at to a uniformly distributed load of 28.5 KN/horizontal meter it the max tension in the cable is limited to 5000KN.calculated central dip needed.



Given:

span = 130m

UDL = 28.5KN/m

T_{max} = 5000KN

To find :

The central dip of cable

solution :

Vertical Reaction

VA =VB

$= P\,l / 2$

$= 28.5 \times 130 / 2$

$= 1852.5KN$

Horizontal pull (tension)

$H = p\,l^2 / 8\,d$

$= 28.5 \times 130^2 / 8d$

$= 60206.25 / d \ KN$

Max Tension

$Tmax = \sqrt{V^2+H^2}$

$5000 = \sqrt{185.5^2+(60206.25/d)^2}$

$5000^2 = 1852.5^2 + 60206.25^2 / d^2$

$(5000^2 - 1852.5^2) / 60206.25^2 = 1/d^2$

$5.95 \times 10^{-3} = 1/d^2$

$d^2 = 1 / 5.95 \times 10^{-3}$

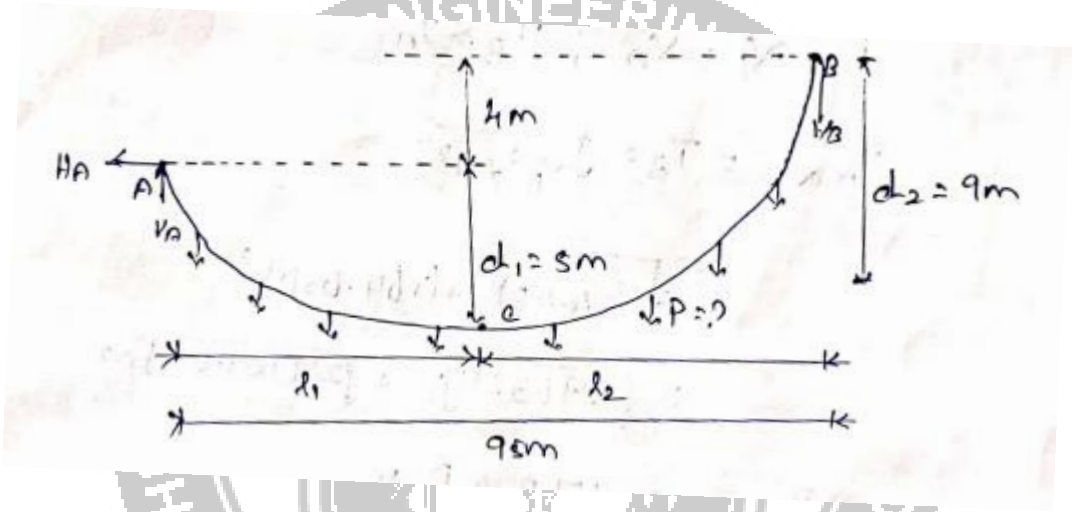
$d^2 = 168$

$d = \sqrt{168}$

$= 12.96m$

Example :

The suspension cable of horizontal span 95m is supported at two different level the right support is higher than left support by 4m. The dip to lowest point of cable below the left support 5m the cross sectional area of the cable is 3500mm^2. Find the uniformly distributed load that can be carried by the cable if the max stress is limited to 600N/mm^2



Given:

span 'l' =95m

d1 =5m

stress =600N/mm^2

A = 3500mm^2

To find :

Uniformly Distributed Load

SOLUTION:

Find Uniformly distributed load

VA = p l1

VB = p l2

L = l1 +l2

stress = T_{max} / A

Tmax = $\sqrt{(VA^2 + H^2}$

H = $\frac{Pl1^2}{2d1}$

H = $\frac{Pl2^2}{2d2}$

Find the length l_1 and l_2

$l_1 / l_2 = \sqrt{d1/d2}$

$l_1 / l_2 = \sqrt{5/9}$

l1 = 0.745 l2

L = l1+l2

95 =0.745 l2+ l2

95 = 1.745 l2

l_2 = 54.4 m

$l_1 = L - l2$

$= 95 - 54.4$

$= 40.56$ m

Vertical Reaction

$VA = p\, l_1$

$= 40.56\, p\, N$

$VB = p\, l_2$

$= 54.4\, P\, N$

Horizontal Pull

$H = pl_2^2 / 2d_2$

$= p(54.4)^2 / 2\times 9$

$H = 164.4\, P\, N$

Max tension will occur act right support

$VB > VA \qquad TB > TA$

$T_{max} = TB$

$= \sqrt{VB^2 + H^2}$

$=\sqrt{(54.4P)^2+(164.65P)^2}$

$= \sqrt{2963.71}\sqrt{p^2}+\sqrt{27109.62}\sqrt{p^2}$

T_{max} $=173.4\ p\ N$

stress $=T_{max} / A$

600 N/mm^2 $=173.4\ p / 3500\ mm^2$

P $= 12110\ N/m$

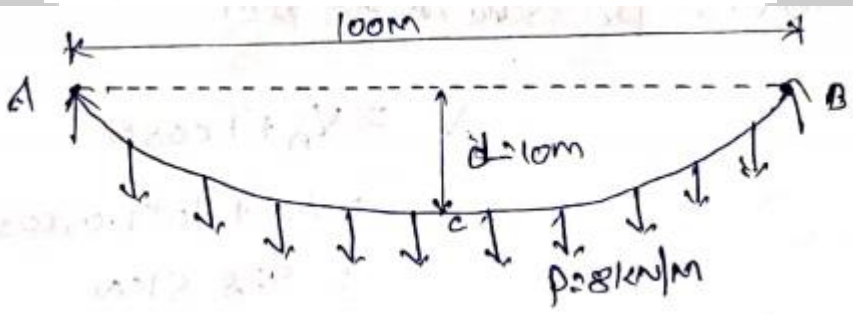
$= 12.11KN/m$

Example :

A suspension cable of span 100m and dip 10m carries a uniformly distributed load of 8KN/m of horizontal span over the full span. Find the vertical and horizontal forces transmitted to the supporting pylons.

a) If the cable is passed over a smooth pulley

b)If the cable is clamped to a saddle with roller the top of piers the anchor cable is make 30° the horizontal at a pylon



Given:

span l = 100m

dip d = 10 m

P = 8KN/m

Ø =30°

To find :

(i) vertical and horizontal forces

a) If the cable is passed over a smooth pulley

b)If the cable is clamped to a saddle with roller

Solution:

Vertical reaction

VA =VB

= Pl/2

= 8×100/2

=400 KN

Horizontal Pull

H $=Pl^2/8d$

$=8\times100^2/8\times10$

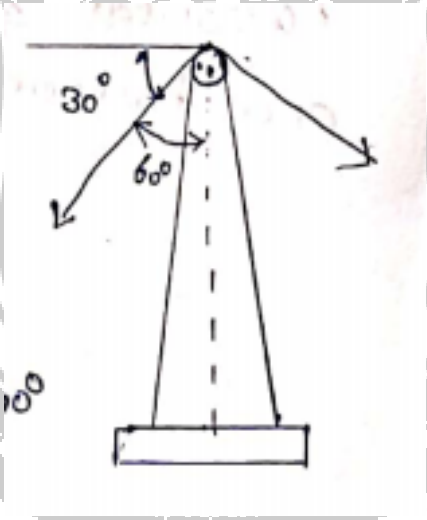
$= 1000$ KN

Tension in cable

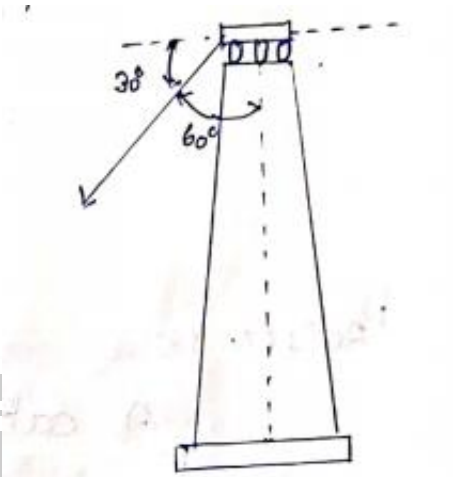
$T = \sqrt{V^2+H^2}$

$= \sqrt{400^2+1000^2}$

$T = 1077.03$ KN



a) Anchor cable passing over pulley



b) cable passing over saddle support

a) Anchor cable passing over pulley

vertical pressure on pier

V =VA + Tcos Ø

=400+1077.03 cos60°

=938.5 KN

Horizontal force at top of pylon

= H-T sin

= 1000-1077 sin60°

= 67.29 KN

b) cable passing over saddle support

T_1 = H/ sin60°

=1000/sin60°

=1154.7 KN

Vertical pressure

$=V+T_1 \cos 60°$

=977.35 KN

Example :

A suspension cable of horizontal span 210mm is supported at the same level and has a central dip of 20mm. Find the increase in dip of the cable if the cable is subjected to a rise in temperature of 28˚c. Take $\alpha=12\times10^{-6}$ per˚c.

Given data

Span 'l' = 210m

Dip 'd' = 20

't' = 28˚c

'α' $=12\times10^{-6}$ per˚c

To find :

Increase in dip of the cable

Solution

Change in dip

$$\Delta d = \frac{3l^2}{16d} \propto t$$

$$\frac{3\times 210^2}{16\times 20}\times 12\times 10^{-6}\times 28$$

$$= 0.138m$$

$$= 138mm$$

Example :

A cable supported at the same level on either end is of 140m horizontal span with a central dip of 14 mm. It carries a load of 15KN/m on the horizontal span. Calculate the change in the horizontal tension when the temperature rises through 28° c. Co-efficient of linear expansion of the cable materials. $\alpha=4\times10^{-6}/^{o}c$.

Given data

SPAN 'L' = 140m

'd' = 14m

'P' =15KN/M

't' =28°c

'α' $=4\times10^{-6}/^{\circ}c$

To find :

Change in the horizontal tension

SOLUTION:

$$H = \frac{pl^2}{8d}$$

$$H = \frac{15\times140^2}{8\times14}$$

$$= 2625 \text{ KN}$$

Change in horizontal tension

$$\Delta h = \frac{3l^2}{16d^2} \propto tH$$

$$= \frac{3\times140^2}{16\times14^2}\times4\times10^{-6}\times28\times2625$$

$$= -5.513$$