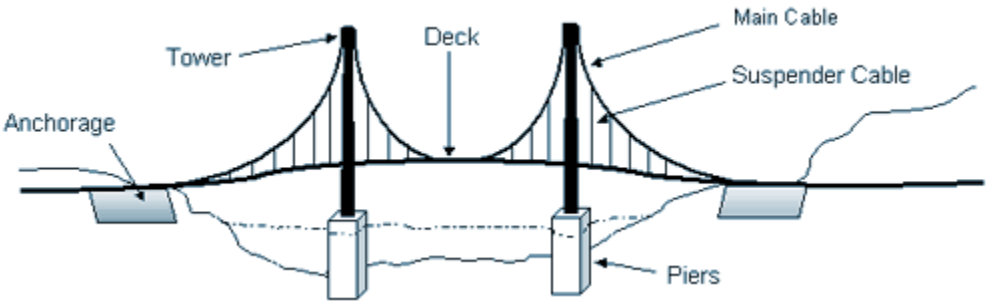
LENGTH OF CABLE

Cable

The cables are flexible structures which carry loads in tension only. The cables vary vertical loads and are suspended between the supports.



Range of central dip of a cable

The central dip of a cable ranges from 1/10 to 1/15 of the span.

Assumptions made in the analysis of cables

a. Cable is considered to be stable and flexible.
b. When external loads act on the cable, self weight of cable is not considered.
c. The length of cable is always constant and therefore it is assumed as a rigid body.
d. The force in the cable is tangential to the cable profile as it carries only axial tensile forces.
e. The load acting on the cable is assumed to be uniformly distributed even though if it is moving load.

Simple suspension bridge

Suspension bridge has got two cables which are stretched over the span. Each cable run over two towers and is anchored by anchor to have a firm foundation. Cable is

flexible throughout the span and its bending moment at every point is taken as zero. The load transferred by hangers or suspenders are assumed to be UDL. When the span is more than 200mts for a road way and 300mts for light way traffic suspension bridge is preferred.

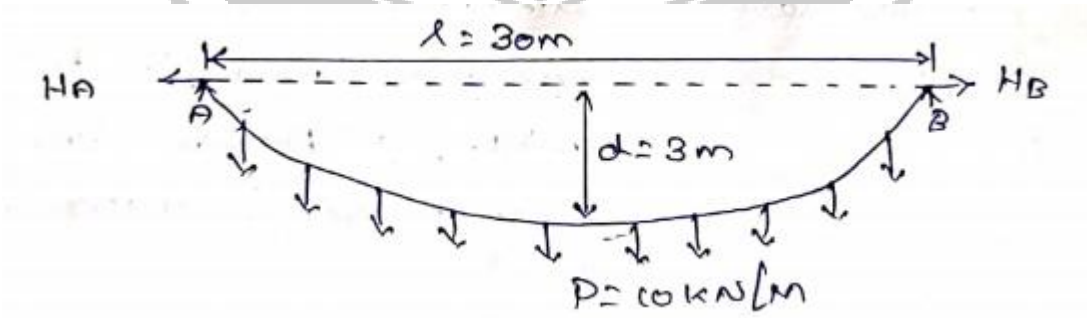
Stresses in suspended wires due to self weight

The dip is very small in suspended wire occurring at the centre. If 'w' is considered o be the weight of wire per unit length, then the horizontal tension in the wire given by,

$$H = wl^2 / 8d$$

Example :

A suspension cable having support at same level, has a span of 30m and a maximum dip of 3m. The cable is loaded with a UDL of 10KN/m throughout its length. Find the maximum tension in cable



Given data

Span 'l' = 30m

Dip 'd' = 30

UDL 'P' = 10 KN/m

To find

Max Tension in cable

Solution

Max Tension in cable

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

VA = VB = $\frac{PL}{2}$

Find Vertical Reaction

VA =VB = P l / 2

= (10× 30) / 2

=150KN

Horizontal pull in the cable

H = $pl^2/8d$

= $10\times30^2/8\times3$

= 375 KN

Find Max tension in cable

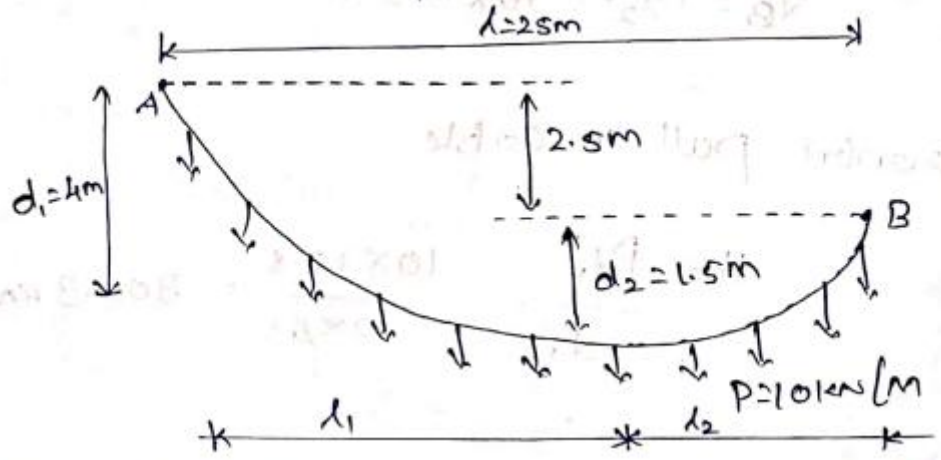
$T_{max} = \sqrt{VA^2 + H^2}$

$= \sqrt{150^2 + 375^2}$

$= 403.88KN$

Example :

A suspension cable is supported at two panel 25m apart the left support is 2.5m above the right support. The cable is loaded with a uniformly distributed load by 10KN/m throughout the span. The max dip in cable from the left support is 4m. Find maximum and minimum tension in cable.



Given data

UDL = 10KN/m

d1 = 4m

To find

Maximum and Minimum Tension in cable

SOLUTION:

Max Tension in cable

VA = p l1

VB = p l2

L = l1 +l2

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

Find the length

L1 and L2

l1 / l2 = √ d1 / d2

l1 = √ (4 / 1.5) × l2

l1 =1.63 x l2

L = l1 + l2

25 = 1.63 l2 + l2

25 = 2.63 x l2

l2 = 9.5m

l1 = L - l2

= 25 - 9.5

=15.5 m

Find Vertical Reaction

VA = P l1

= 10× 15.5

= 155 KN

VB = P l2

= 10× 9.5

= 95 KN

Horizontal pull in cable

H = P $l1^2$ / 2 d1

=10×15.5^2 / 2×4

=300.3 KN

H = P $l2^2$ / 2 d2

=10×9.495^2 / 2 ×1.5

=300.5KN

Find Tension in cable

$TA = \sqrt{VA^2+H^2}$

$= \sqrt{(155^2+300^2}$

$= 377.9$ KN

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

$= \sqrt{(300.3^2+95^2}$

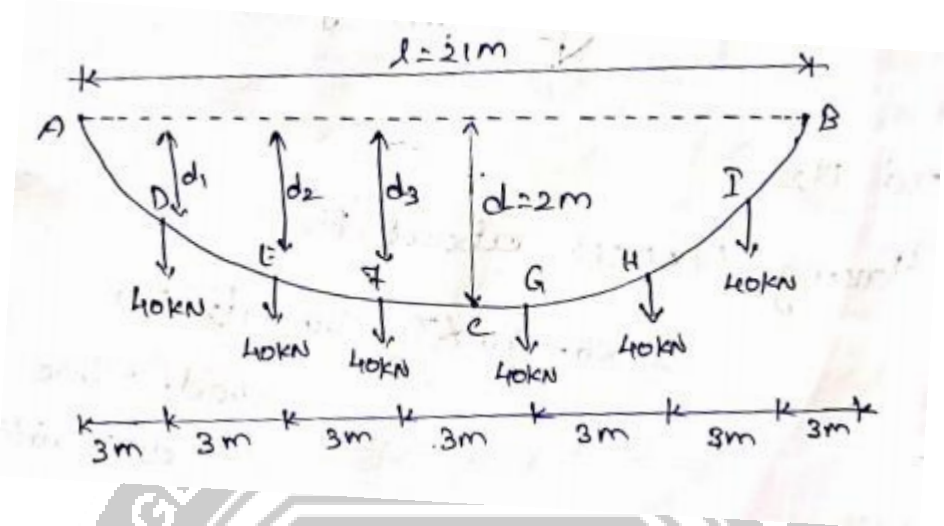
$=314.96$ KN

Max Tension = 337.9KN

Min Tension = 300.3 KN

Example :

A cable of horizontal span 21m is to be used to support six equal loads of 40KN each at 3m spacing the central dip of the cable is limited to 2m. Find the length of the cable required and also its sectional area if the safe tensile stress is $750N/mm^2$



Given:

span = 21m

dip 'd' = 2m

stress =750 N/mm^2

To find :

a. length of cable

b. sectional area

Solution:

Vertical reaction

VA =VB

= total load / 2

= 6×40 / 2

=120KN

Horizontal Pull

Taking moment about C

VA x 10.5 - 40×7.5 - 40×4.5 - 40×1.5 - H×2 =0

120×10.5 – 540 - 2H =0

720 =2H

H =360KN

Find d1

Taking moment about D

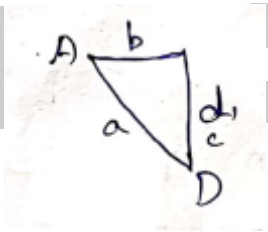
120×3 - 360×d1 =0

d1 = 1m

AD $=\sqrt{b^2+C^2}$

$=\sqrt{3^2+1^2}$

=3.16 m



Find d2

Taking moment about E

120×6 - 40×3 - 360×d2 =0

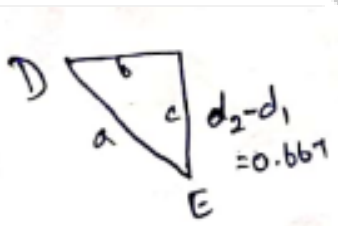
360d2 =600

d2 = 1.667 m

DE $=\sqrt{b^2+c^2}$

$=\sqrt{3^2+0.667^2}$

=3.073 m



Find d3

Taking moment about F

$120 \times 9 - 40\times6 - 40\times3 - 360\times d3 = 0$

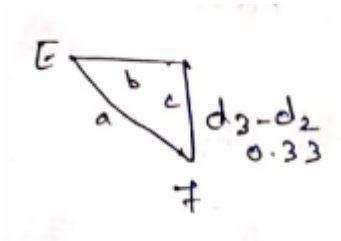
$720 - 360d3 = 0$

d3 = 2m

EF $=\sqrt{b^2+c^2}$

$=\sqrt{3^2+0.33^2}$

= 3.018 m



Find length of cable

length of cable =2(AD+DE+EF+FC)

=2(3.162+3.073+3.018+1.5)

=21.506m

Max Tension in cable

T_{max} $= \sqrt{V^2+H^2}$

$=\sqrt{120^2+360^2}$

=379.67 KN

Find Area

Stress $=T_{max} / A$

750 $=379.47\times10^3/A$

A $=0.505\ m^2$

A $=505\ mm^2$