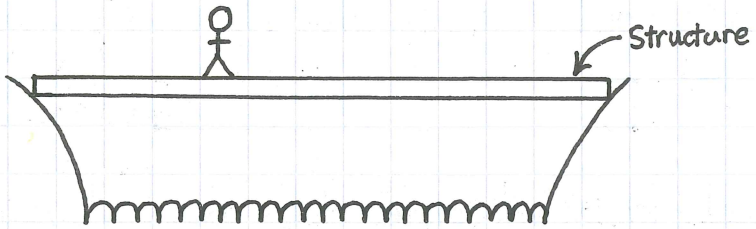
CIV102 - STRUCTURES and MATERIALS

Topic: Building Bridges

1) Structures

An object designed/intended to transmit forces from one place to another.

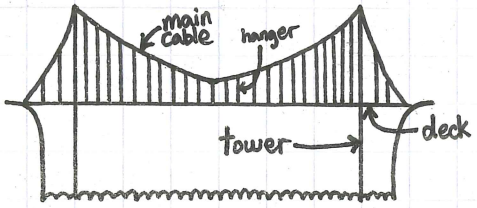
Example:



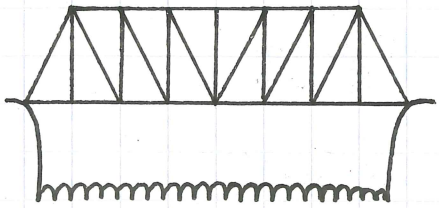
Component: Pieces assembled to make the structure.

Joints/Nodes: Locations where the components connect.
- Must be sufficiently strong and deformable

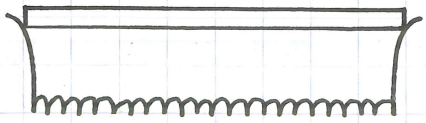
3 Primary Kinds of Bridges



Suspension Bridge



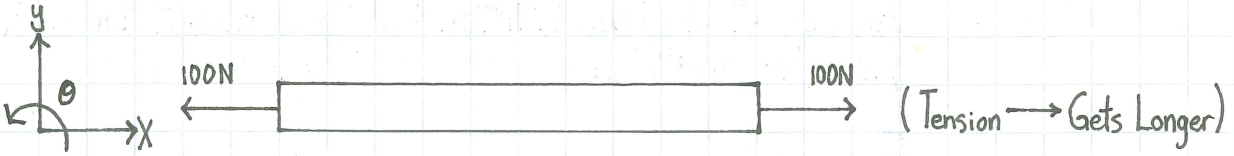
Truss Bridge



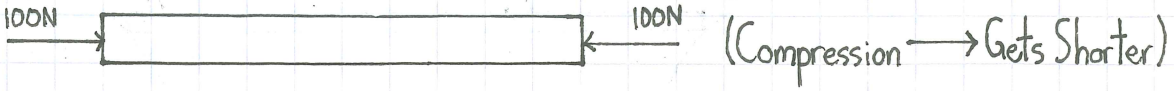
Beam Bridge

2) Tension and Compression

Push-in = Compression } With respect to the FBD
Pull Out = Tension }

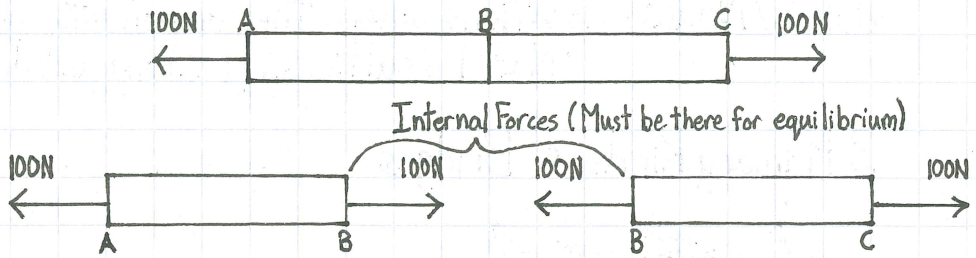


Resisting tension is an internal force. The act of pulling is an external force.



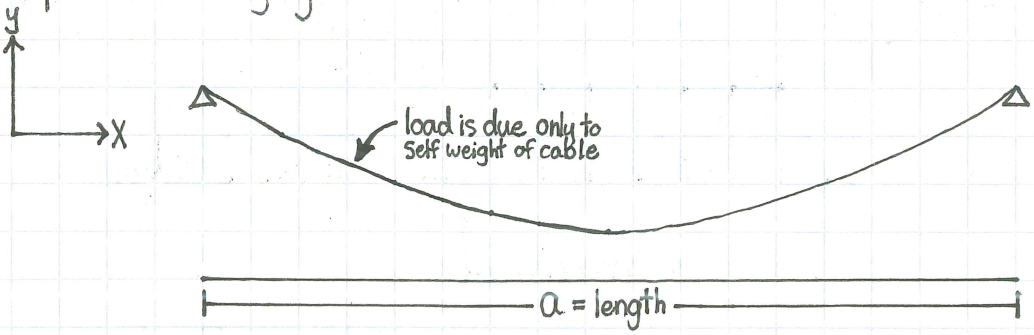
Axial Loads: Tension and compression are axial loads. Axial means they are aligned with the axis of the member.

What is the internal force?



$\Sigma F_x = 0$ $\Sigma F_x = 0$

3) Shape of a Hanging Cable



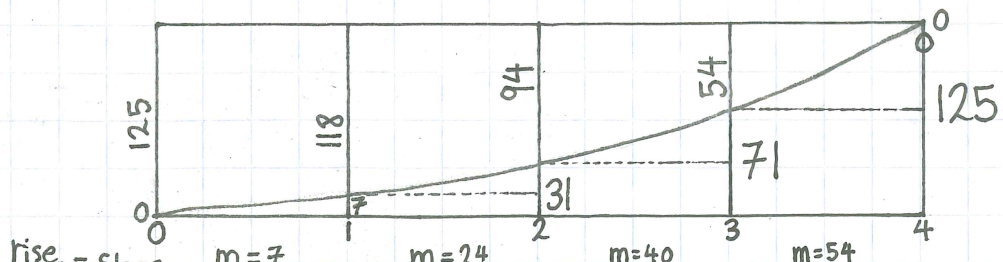
The shape of this curve is called a Catenery (pattern if load is only coming from the cable). The curve can be described by the following equations:

↳ load is distributed compared to the arc length

$y = a\cosh\left(\frac{x}{a}\right) + b$ } Same curve. Different mathematical notation
$y = \frac{a}{2}\left(e^{\frac{x}{a}} + e^{-\frac{x}{a}}\right) + b$ }

In suspension bridges, load is distributed uniformly compared to X-axis not the arc length. ∴ Shape is different

What is the shape?



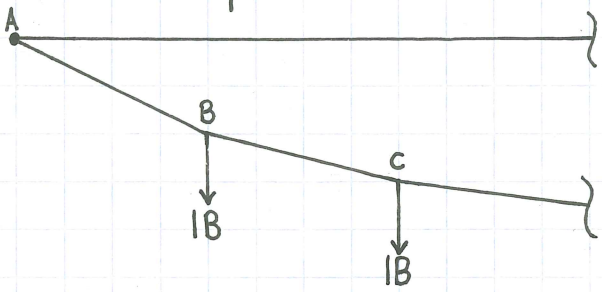
$\frac{\text{rise}}{\text{run}}$ = Slope

m = 7 m = 24 m = 40 m = 54

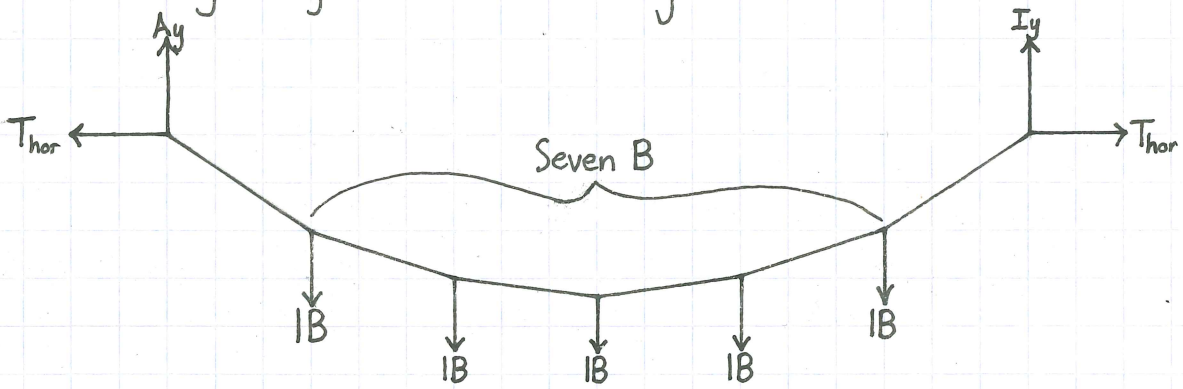
Δm = 17 Δm = 16 Δm = 14

almost the same

Parabolic Shape! Easier than cosh



Free Body Diagram of Whole Thing



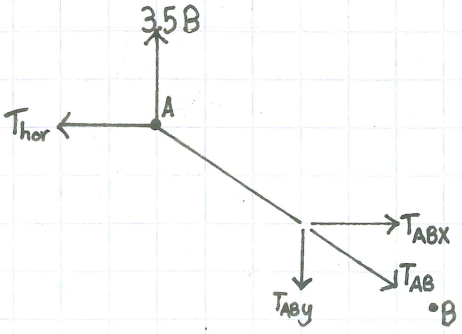
$$\Sigma F_y = 0$$

$$0 = A_y + I_y - 7 \cdot B$$

from symmetry $A_y = I_y$

$$A_y = 3.5B$$

Draw FBD from A → B



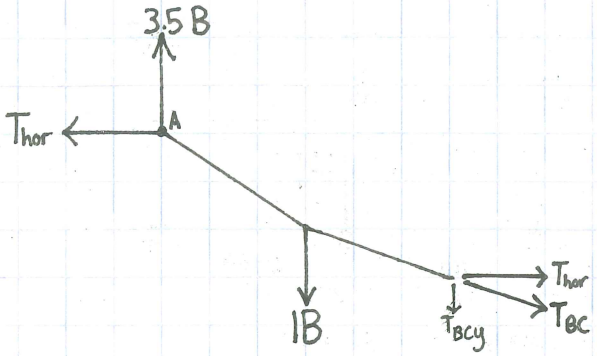
$$\Sigma F_y = 0$$

$$T_{ABy} = 3.5B$$

$$\Sigma F_x = 0$$

$$T_{ABX} = T_{hor}$$

Next One



$\Sigma F_y = 0$

$0 = 3.5B - B - T_{BCy}$

$T_{BCy} = 2.5B$

$\Sigma F_x = 0$

T_{hor} = Constant for all X values

Vertical Component ≠ Constant