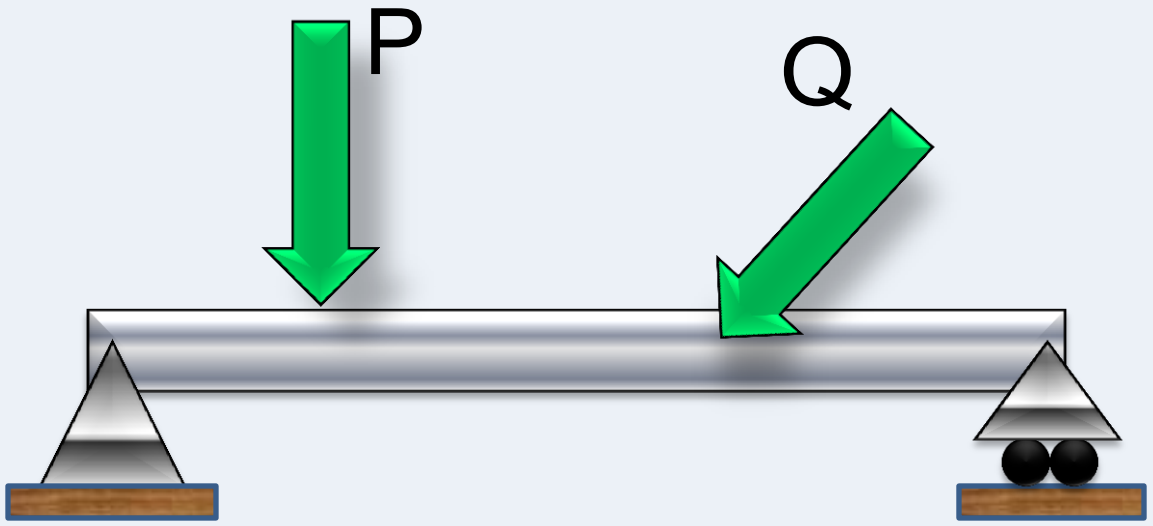
# EQUILIBRIUM OF RIGID BODY

Background Music: Chiquitita

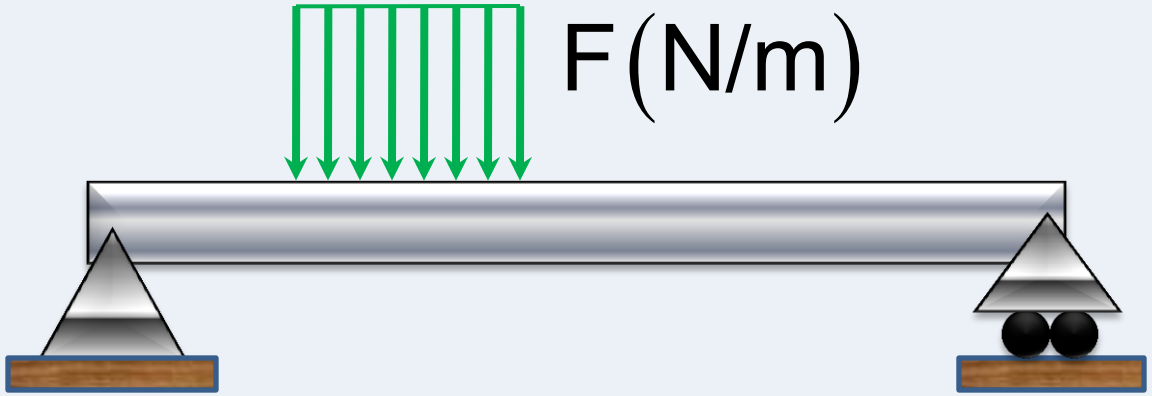
I hear and I forget,
I see and I remember,
I do and I understand
Chinese Proverb

# TYPES OF LOADING

# Concentrated Loads



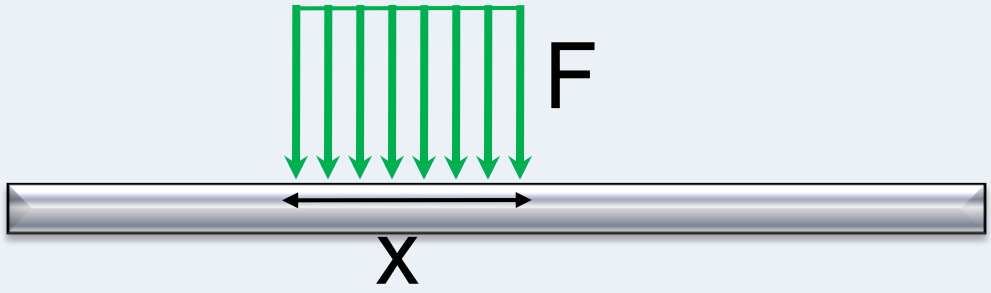
# Distributed Load

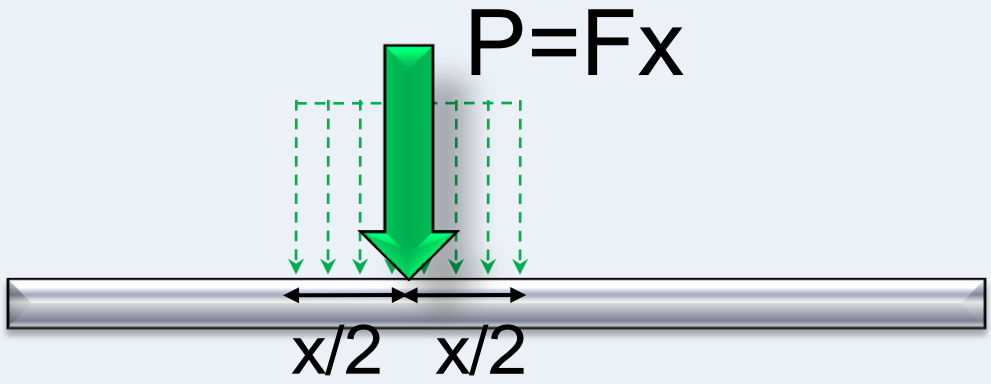



**The surface area of a body may be subjected to distributed loading such as those caused by wind, fluids, or simply the weight of material supported over the body.**

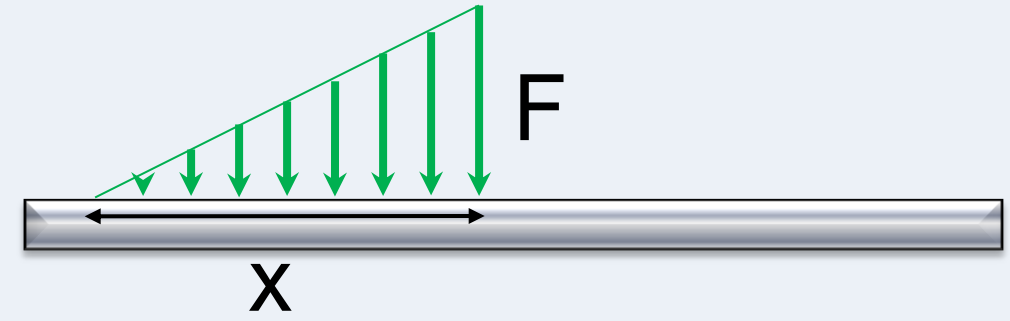
**The load F is in Newtons per unit meter length**

# Equivalent Concentrated Load (Rectangular Shapes)

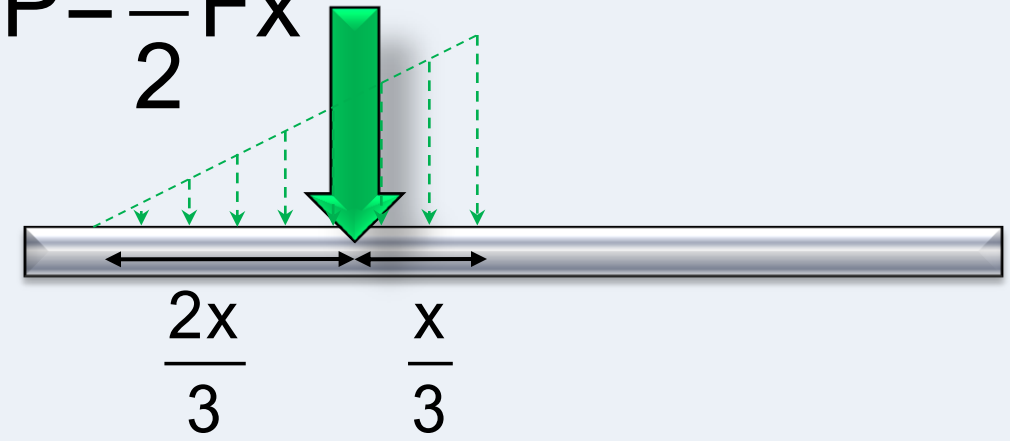


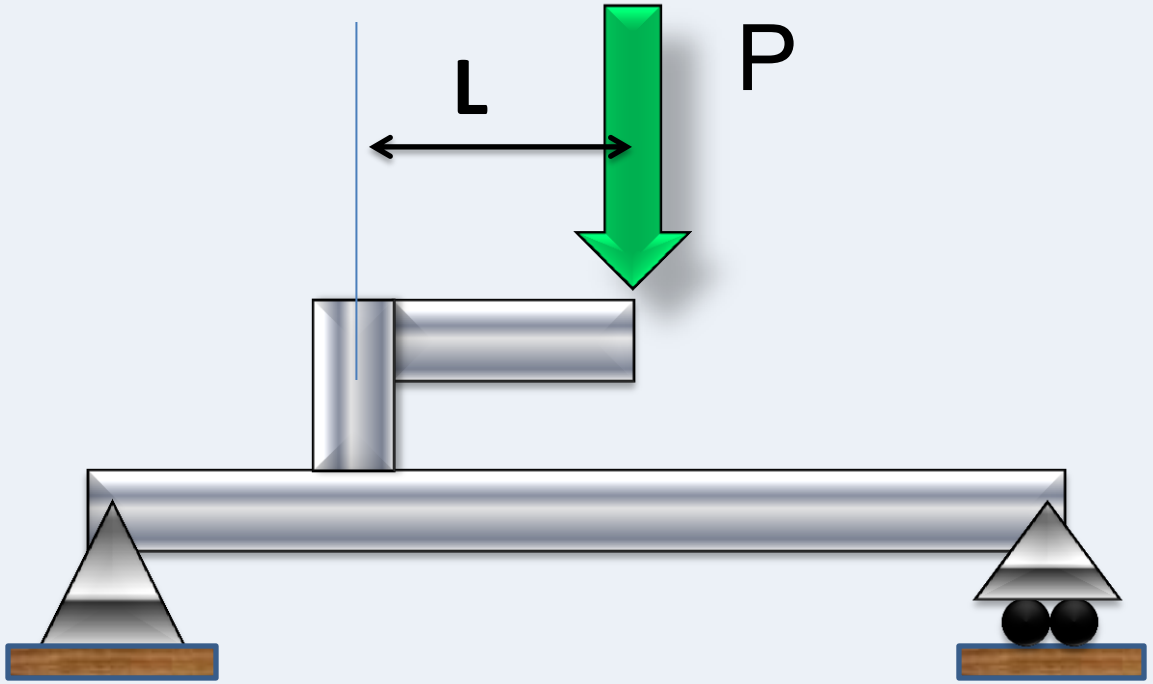
# Equivalent Concentrated Load ( Triangular Shapes)



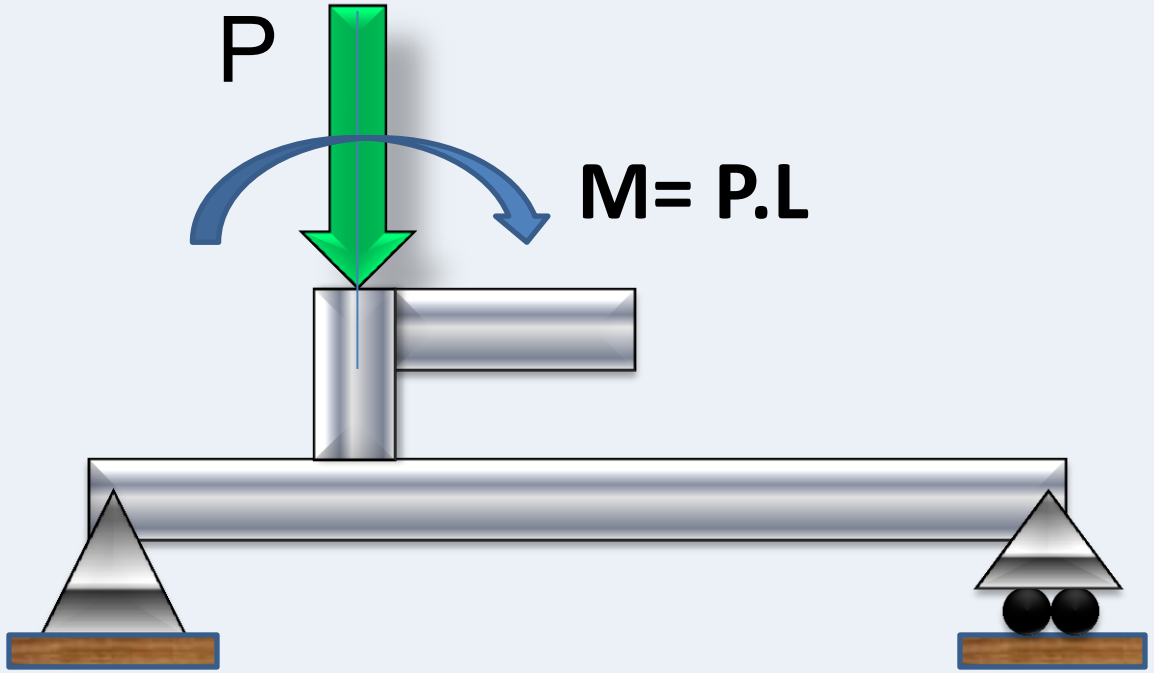

$$P = \frac{1}{2} F x$$



# Eccentric Loads

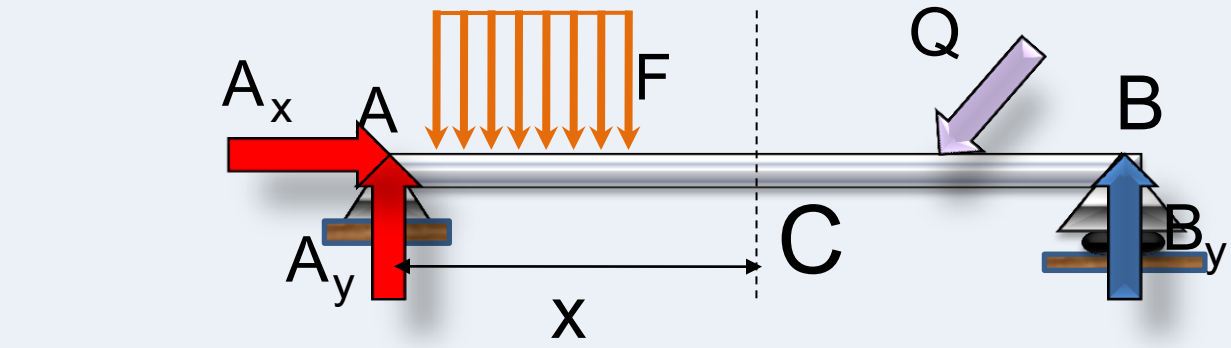


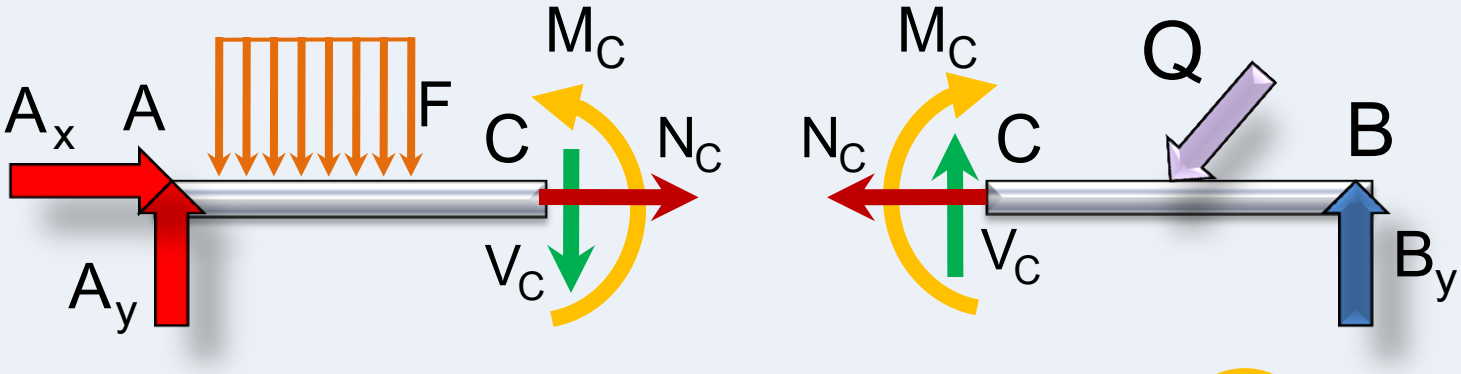
# Eccentric Loads



# Internal Forces In loaded Beams

We will now turn our attention to the forces and torque which develop in a loaded beam.




Axial (Normal) Force

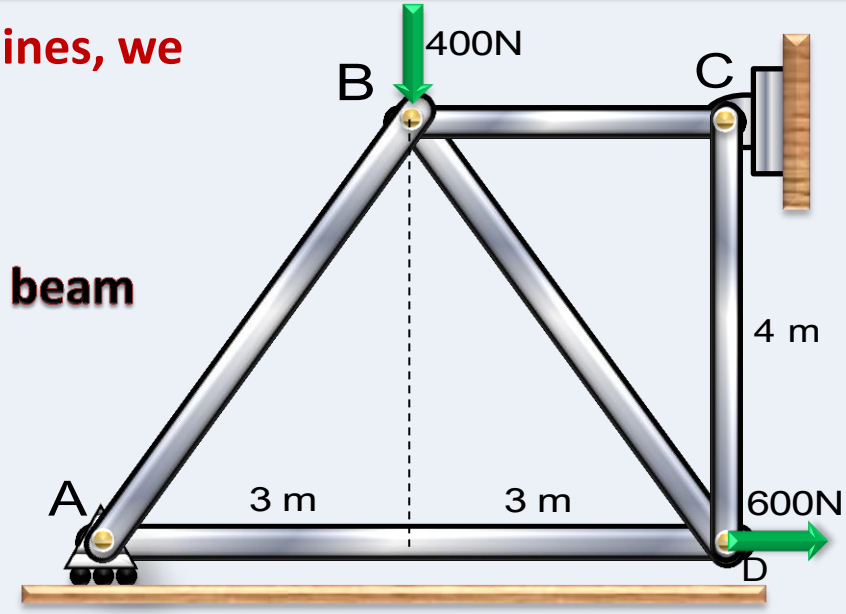
Shear Force

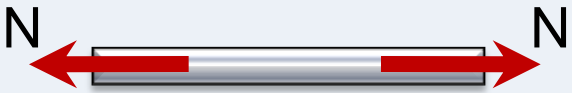
Bending Moment

In trusses, frames, and machines, we dealt with axial forces

## It's Function is to

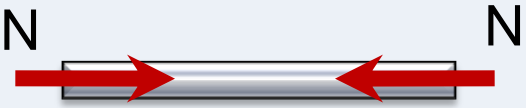
**Compresses or stretches the beam**




**When the beam is stretched, the axial (normal) force is,**

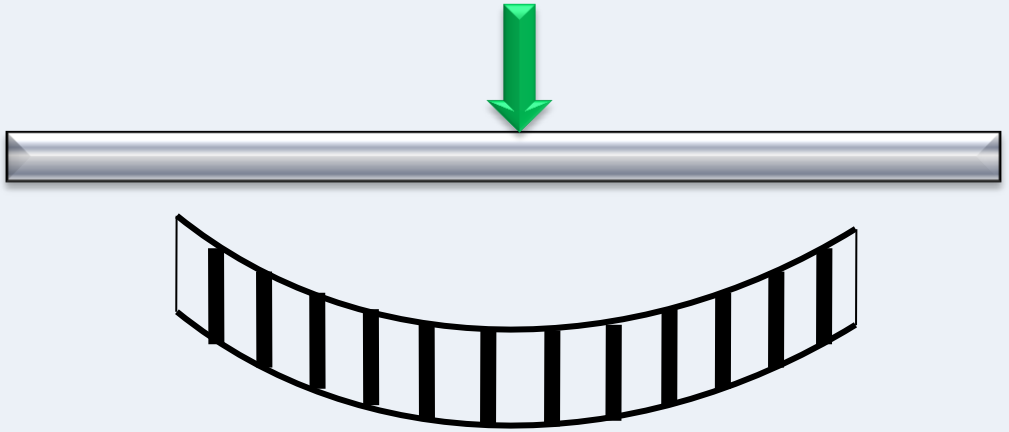
***A tension force , this is the positive sense***




**When the beam is compressed, the axial (normal) force is,**

***A compressionn force , this is the negative sense***

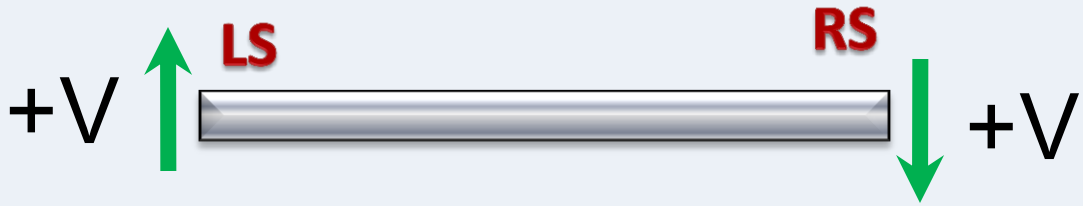
# The Shear Force



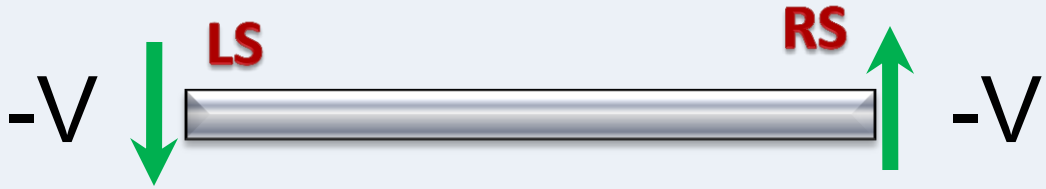
**Causes layers to slip over each other**

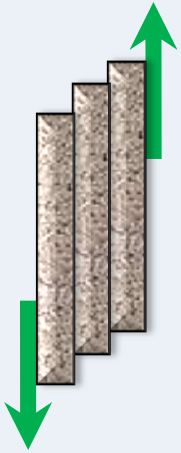
## Sign Convention

**A shear force acting downward on the right side, or upward on the left side is positive**

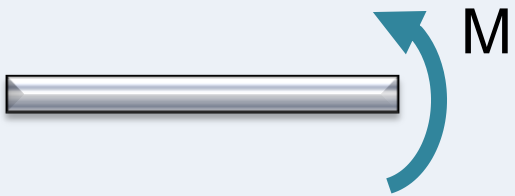



**A shear force acting upward on the right side, or downward on the left side is positive**



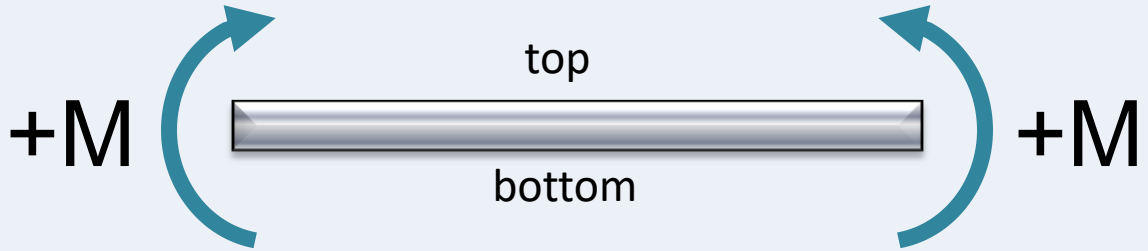
# Bending Moment

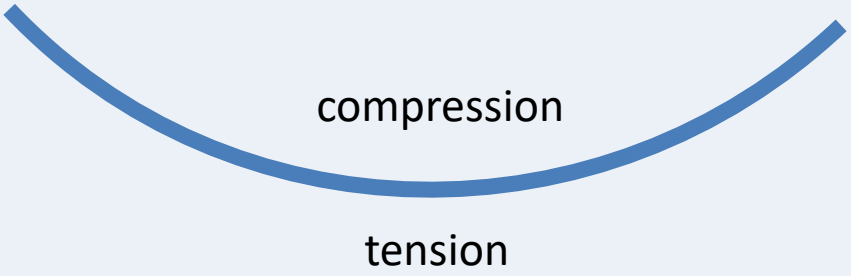



**The Bending Moment tends to bend the beam.**

# Sign Convention

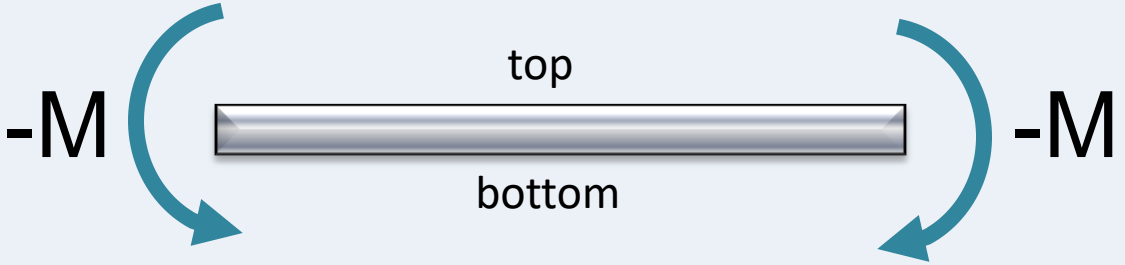
**The Bending Moment is POSITIVE if it tends to put the top of the beam into compression and the bottom of the beam into tension.**

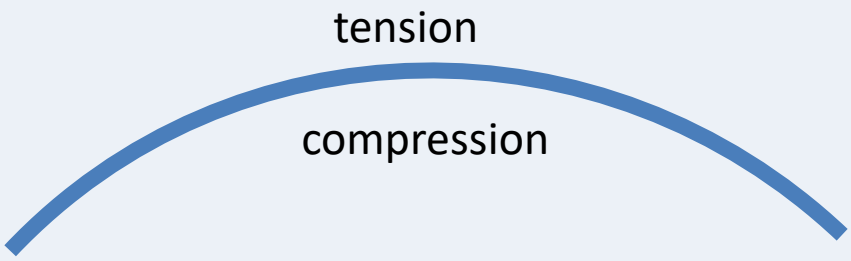



**sagging**

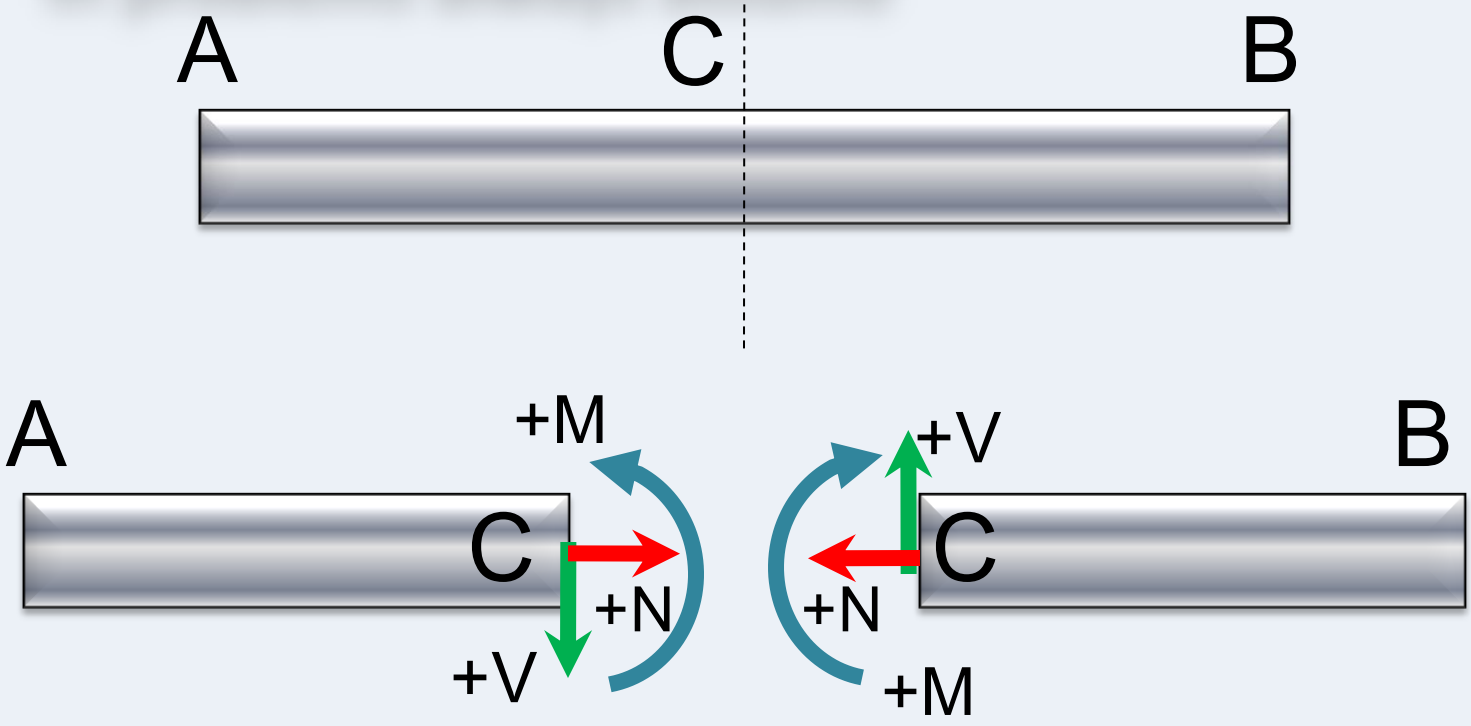
**The Bending Moment is NEGATIVE if it tends to put the top of the beam into tension and the bottom of the beam into compression.**




**hogging**

# In problems always assume

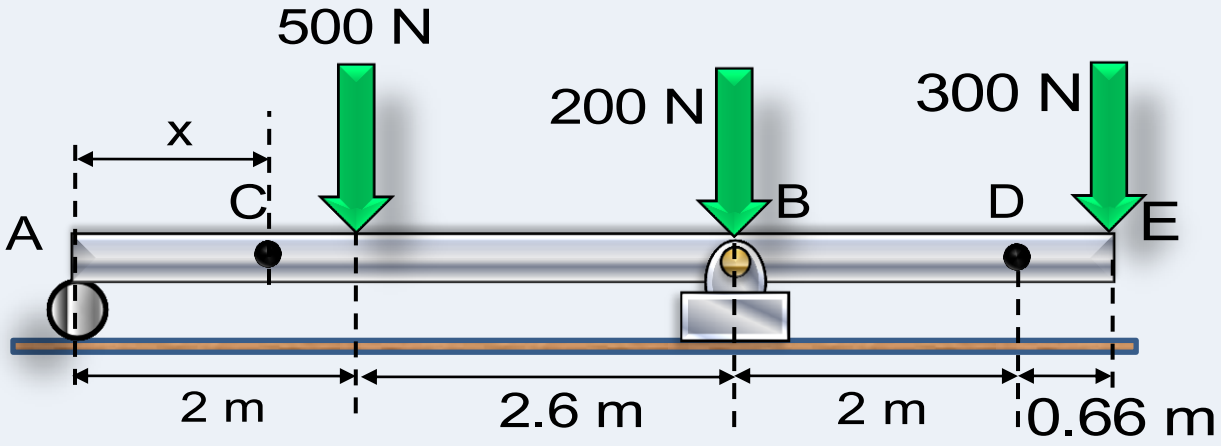



**For this section**
**C is on the right side**

**For this section**
**C is on the left side**

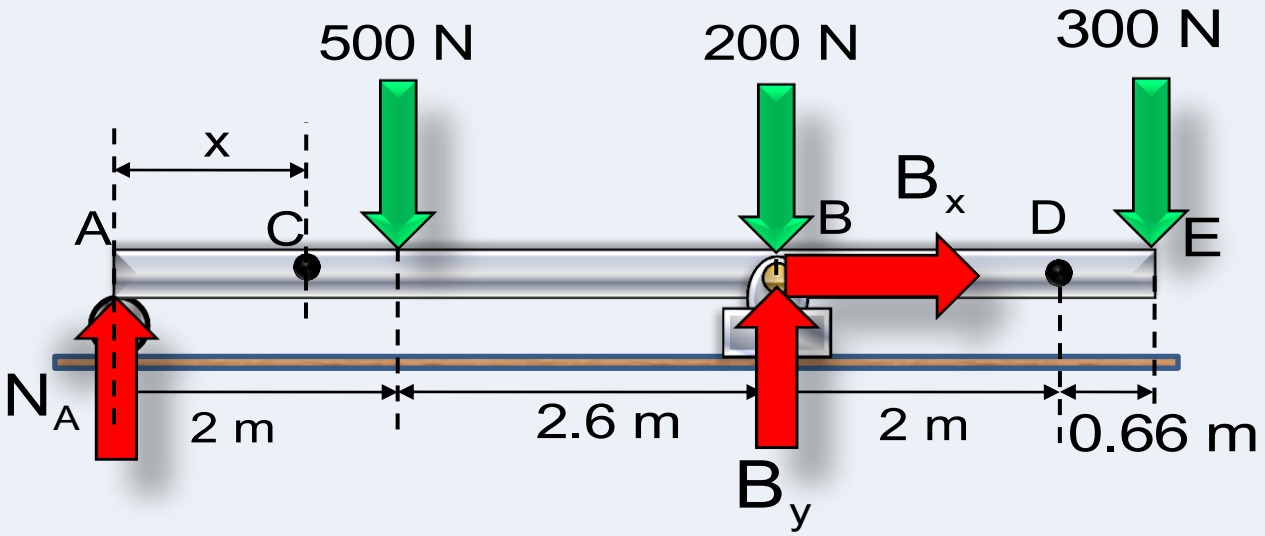
# EXAMPLE-5

Determine the normal (axial) force , shear force, and moment at a section passing through point C in the beam where $0 \le x \le 2$.



# SOLUTION

## Step One: reactions at the supports




$$R_x = B_x = 0$$

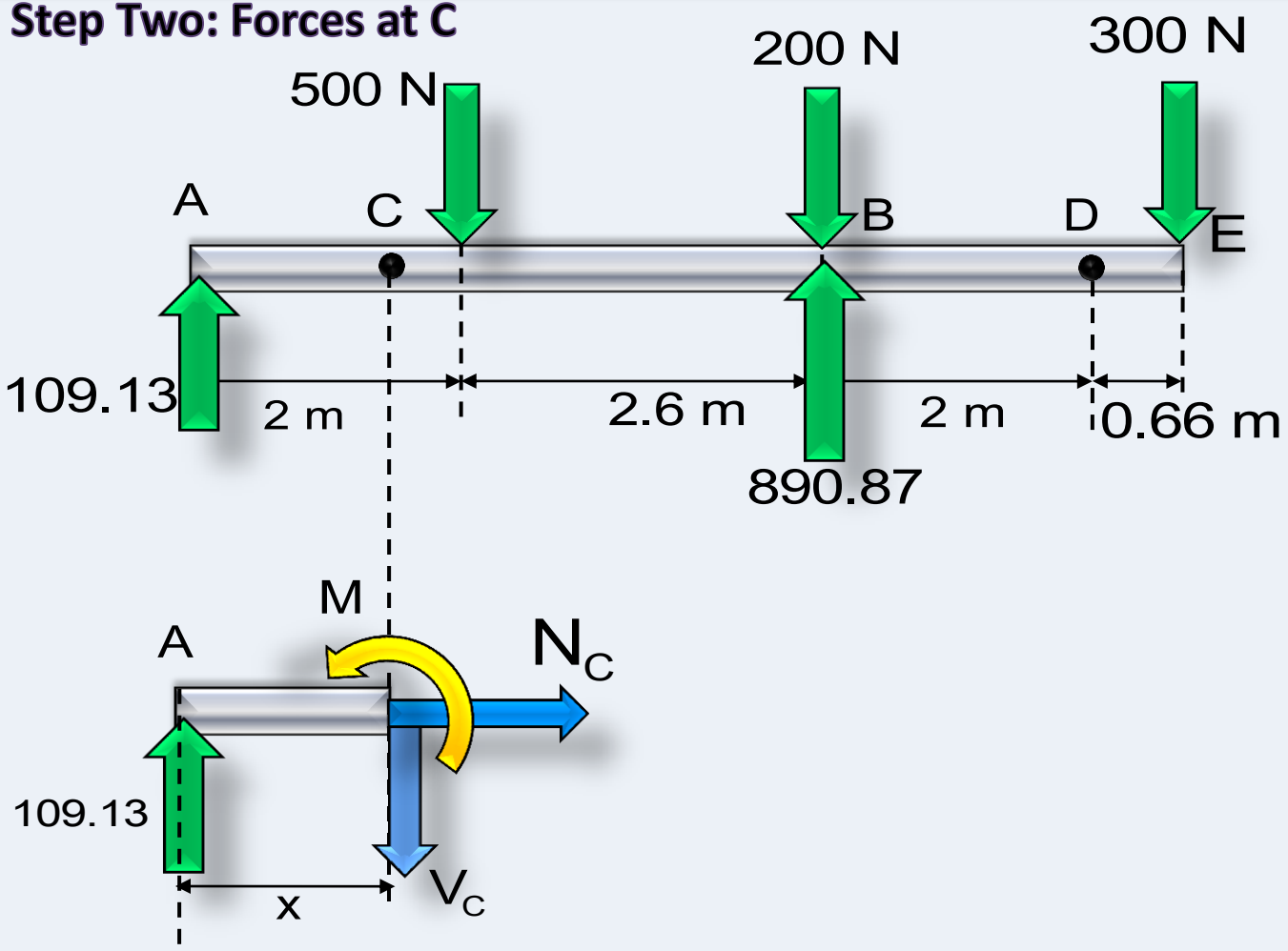
$$R_y = N_A - 500 - 200 + B_y - 300 = 0$$

$$M_B = -N_A(4.6) + 500(2.6) - 300(2.66) = 0$$

**Solving the above three equations yields**

$$N_A = 109.13 \text{ N}, \quad B_y = 890.87 \text{ N}$$

## Step Two: Forces at C

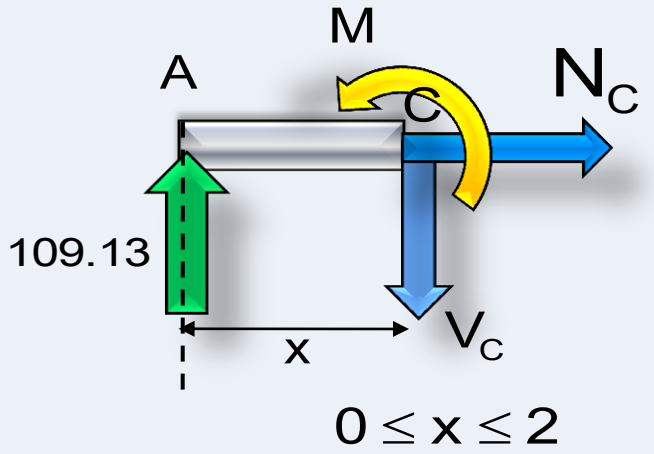


## Step Three: equilibrium equations

$$R_x = N_C = 0$$

$$R_y = 109.13 - V_C = 0$$

$$M_C = -109.13(x) + M = 0$$




**Solving yields**

$$V_C = 109.13 \text{ N}$$

$$M = 109.13x \text{ N-m}, \quad 0 \le x \le 2$$