MAE 343. Intermediate Mechanics

Chapter 3: Statics
Reactions and Internal Forces

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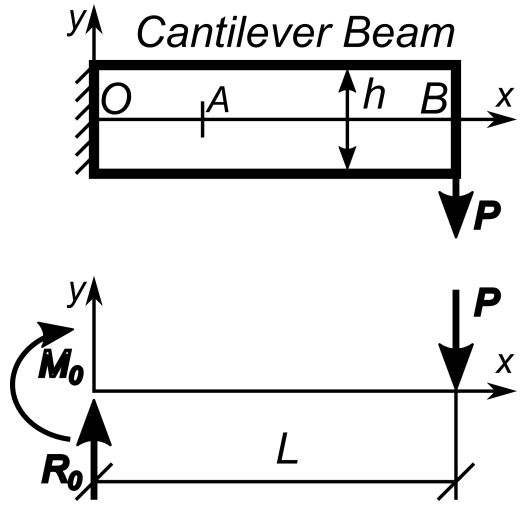
Example 1: Cantilever Beam.

- In 2D we have 3 eqns.

$$\sum F_x = 0; \quad \sum F_y = 0; \quad \sum M = 0$$

- Substitute forces R_0, M_0, for the supports. There is no sign convention. Choose the orientations the best you can. If something comes up to be negative, that would be positive in the opposite direction.



$$\sum F_y = 0 : R_0 - P = 0 : R_0 = P$$

- Choose point "O" to sum moments so that R_0 is not involved.

$$\sum M_O = 0 : M_O + PL = 0 : M_O = -PL$$

Internal Forces at point A

Internal forces and reactions are found with the same method, but now you have to draw a FBD. If you can, avoid computing the reactions. The FBD keeps the segment AB and discards OA.

- To equilibrate P, must add V and M, which are the forces exerted by segment OA on section AB at point A, looking from the left.

  @$x = x_A$

  $\sum F_y = 0 : V - P = 0 : V = P$

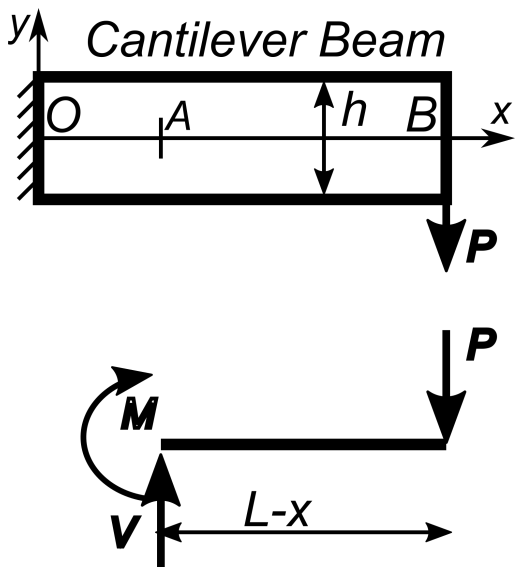
  @$x = x_A$

  $\sum M_A = 0 : M + P(L - x_A) = 0$

  $M = -P(L - x_A)$

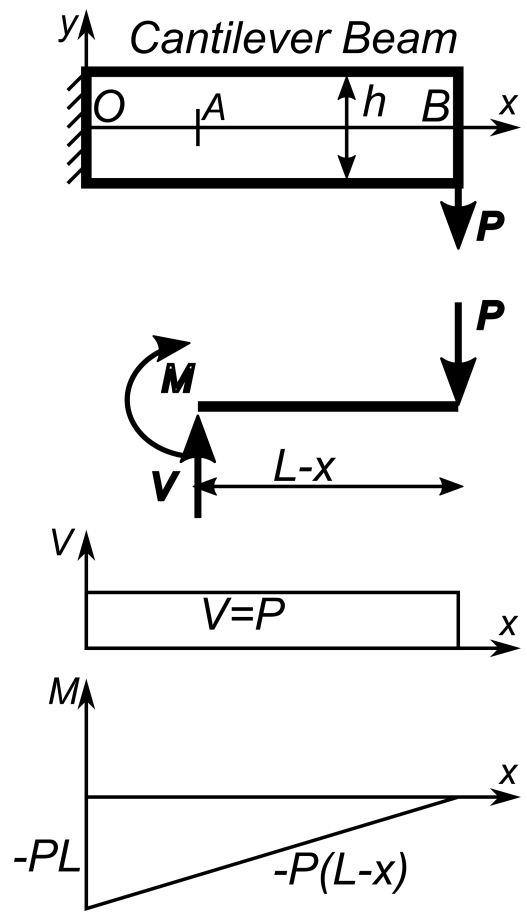
  @ any x

  $M = -P(L - x)$



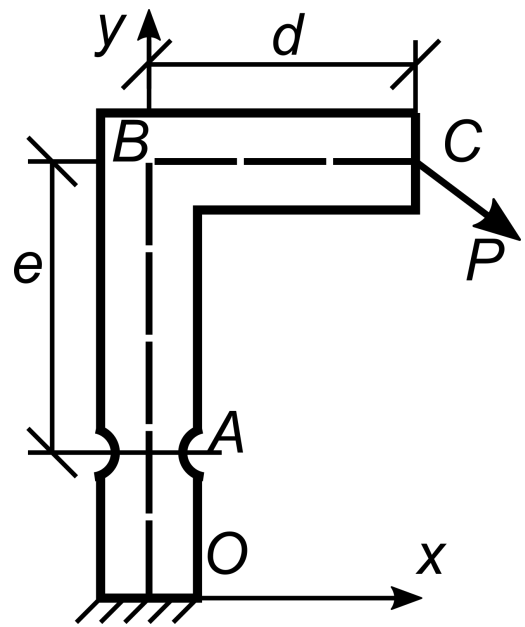
Internal Forces along the beam

Now we plot V and M as a function of x.
To get the correct sign on the V and M diagrams, I was careful to use the right sign convention, but to get reactions it is not really necessary. More about sign conventions later.



Example 2: The Lamp-post

Find internal forces at section A.
Why? Because the notch(es) at A create a stress concentration (Chapter 5), so we want to know the internal forces there, to calculate the nominal stress and from that use stress concentration factors (SCF) to calculate the peak stress.
Next, do a FBD, cutting at A, keeping the top part (ABC). I eliminate the bottom part (OA) so I don't have to calculate the reactions.



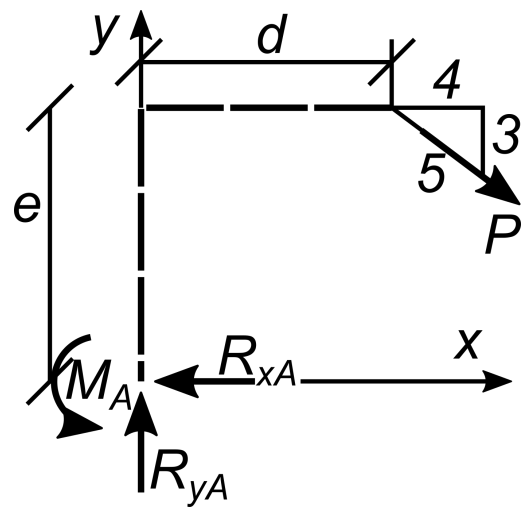
The lamp-post

With $P = 5$ lbf, the horizontal component is 4 and the vertical -3.

$$\sum F_x = 0 : 4 - R_{xA} = 0 : R_{xA} = 4$$

$$\sum F_y = 0 : -3 + R_{yA} = 0 : R_{yA} = 3$$

$$\sum M = 0 : M_A - 3d - 4e = 0 : M_A = 3d + 4e$$



Summary and Conclusions

- Reactions and internal forces are calculated in the same way, but calculation of internal forces requires a FBD.
- For now, there is not need for a sign convention. Once you draw an arrow, that is positive. If the answer comes out negative, we understand what it means.
- But later, to do diagrams, we will follow a sign convention.
- Homework is on WebWork
- Next lecture: Reactions and Internal Forces in Mechanical Components
- THANK YOU