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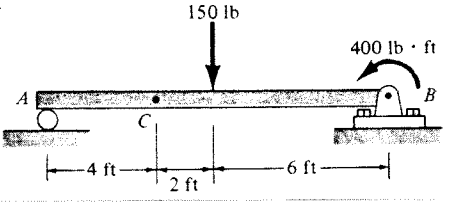
Examples
Internal Forces
(2-D)

Example 1:

Given:

The beam shown

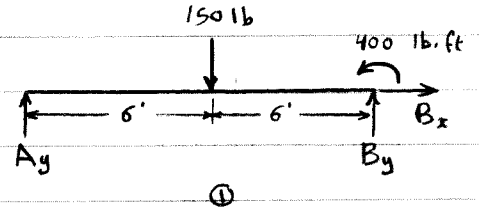


Req'd.:

The internal forces (axial force, shear force, and moment) at point C

Soln.:

First, the reactions are calculated from FBD ①.



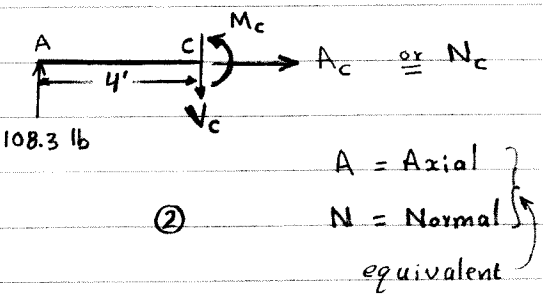
①

$+\circlearrowleft \Sigma M_B = 0 \Rightarrow$

$150(6) + 400 - 12\,A_y = 0$

$\Rightarrow A_y = 108.3$ lb

Note that no need to calculate the other reactions if the portion to the left of point C is chosen. Thus, FBD ② is drawn.



$\pm\rightarrow \Sigma F_x = 0 \Rightarrow$

$\boxed{A_c = 0}$

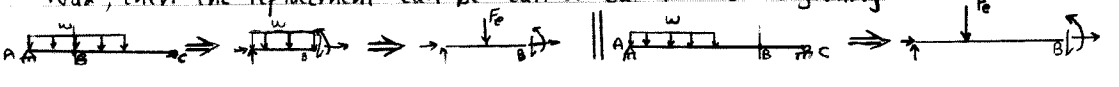
$+\uparrow \Sigma F_y = 0 \Rightarrow$

$108.3 - V_c = 0 \Rightarrow \boxed{V_c = 108 \text{ lb as shown}}$

$+\circlearrowleft \Sigma M_c = 0 \Rightarrow$

$M_c - 108.3(4) = 0 \Rightarrow \boxed{M_c = 433 \text{ lb-ft as shown}}$

Imp. Note: If there is a distributed load, and if the point of interest is within that load, then cut first and after that replace the distributed load on that portion by an equivalent concentrated load. If the point is not within the load, then the replacement can be carried out at the beginning.



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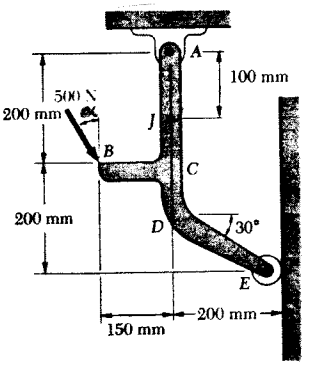
Example 2 :



Given :

The structure shown

$\alpha = 90°$

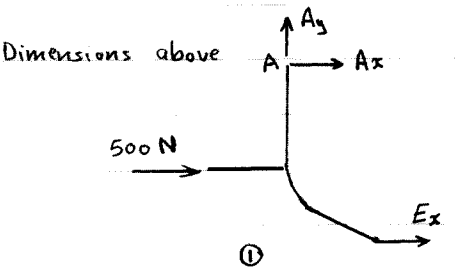
Req.d. :

The internal forces at J

Soln. :

In FBD ①, $+\uparrow \Sigma F_y = 0 \Rightarrow A_y = 0$

$+\circlearrowleft \Sigma M_E = 0 = -500(200) - 400\,A_x \Rightarrow A_x = 250\ N \leftarrow$



In FBD ②,

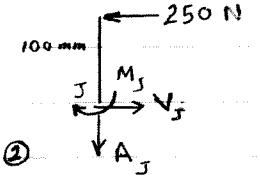
$+\uparrow \Sigma F_y = 0 \Rightarrow$ $\boxed{A_J = 0}$

$\pm\rightarrow \Sigma F_x = 0 \Rightarrow$

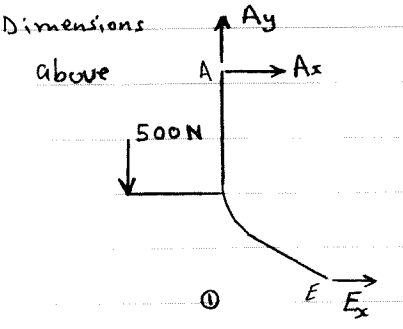
$V_J - 250 = 0 \Rightarrow$ $\boxed{V_J = 250 \text{ as shown}}$

$+\circlearrowleft \Sigma M_J = 0 \Rightarrow$

$250(0.1) - M_J = 0 \Rightarrow$ $\boxed{M_J = 25\ N.m \text{ as shown}}$



Example 3 :



Rework example 2 above if $\alpha = 0°$

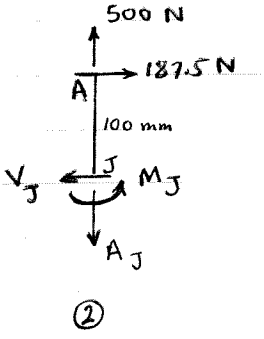
Soln. :

In FBD ①,

$+\uparrow \Sigma F_y = 0 \Rightarrow A_y = 500\ N$

$+\circlearrowleft \Sigma M_E = 0 \Rightarrow 500(350) - 400\,A_x - 500(200) = 0$

$\Rightarrow A_x = 187.5\ N$



In FBD ②,

$\pm\rightarrow \Sigma F_x = 0 \Rightarrow$ $\boxed{V_J = 187.5\ N \text{ as shown}}$

$+\uparrow \Sigma F_y = 0 \Rightarrow$ $\boxed{A_J = 500\ N \text{ as shown}}$

$+\circlearrowleft \Sigma M_J = 0 \Rightarrow$

$M_J - 187.5(0.1) = 0$

$\Rightarrow$ $\boxed{M_J = 18.75\ N.m \text{ as shown}}$