MAE 343. Intermediate Mechanics

Chapter 3: Statics
Internal Forces in Beams

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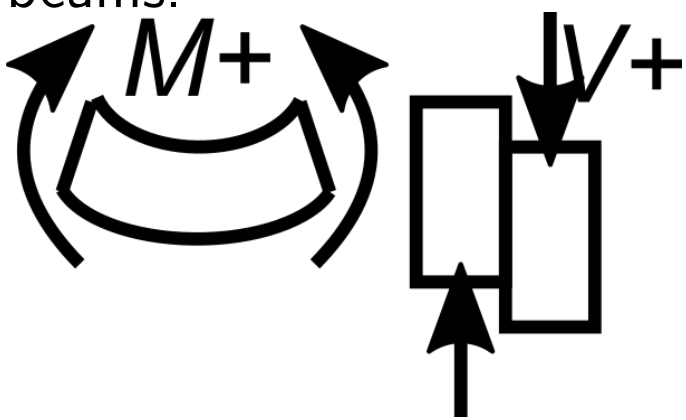
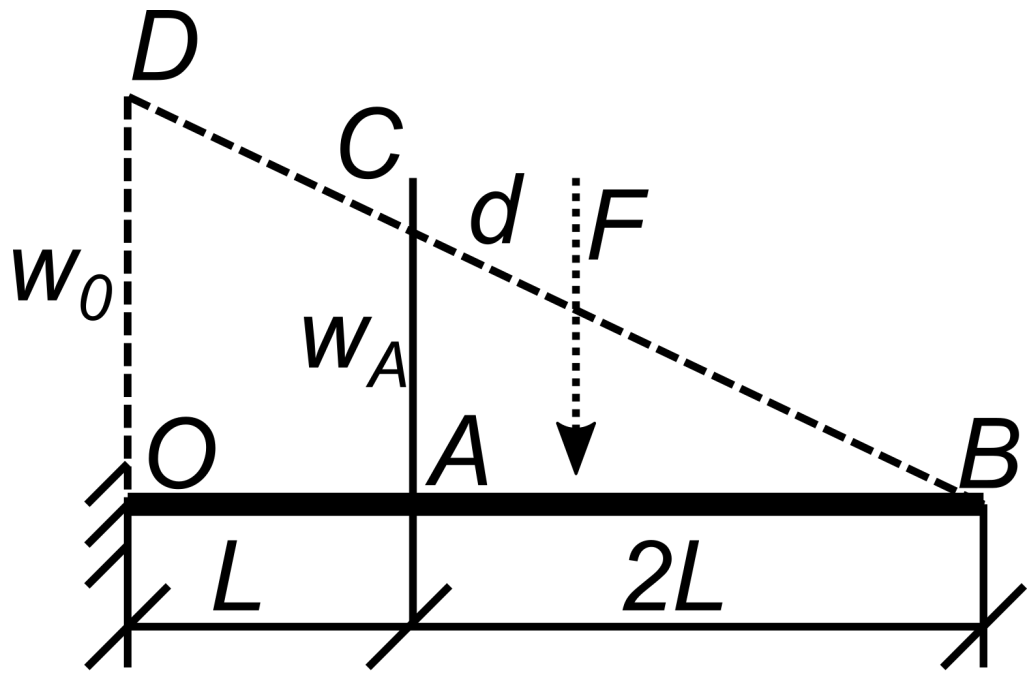
Example 1

A cantilever beam is loaded with a triangular-distributed load $w(x) = w_0(1 - \frac{x}{3L})$. Calculate the internal forces at $x = L$ using the sign convention for beams as shown in the figure.
OD=$w_0 = 240$ N/m, $L = 2.8$ m

Sign convention for beams.

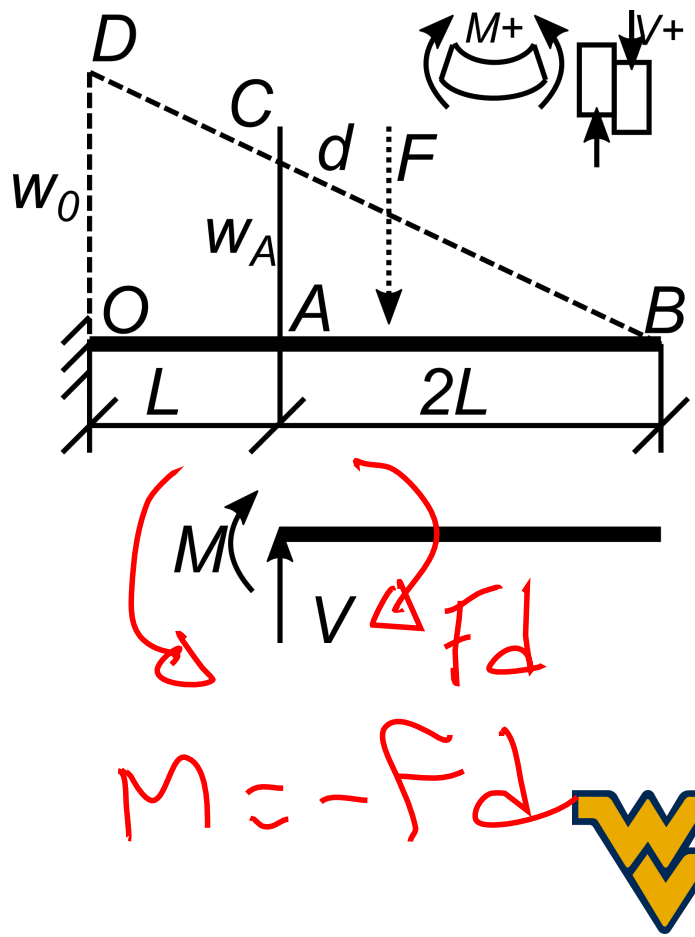




Example 1, cont'd.

OD=$w_0 = 240$ N/m, $L = 2.8$ m

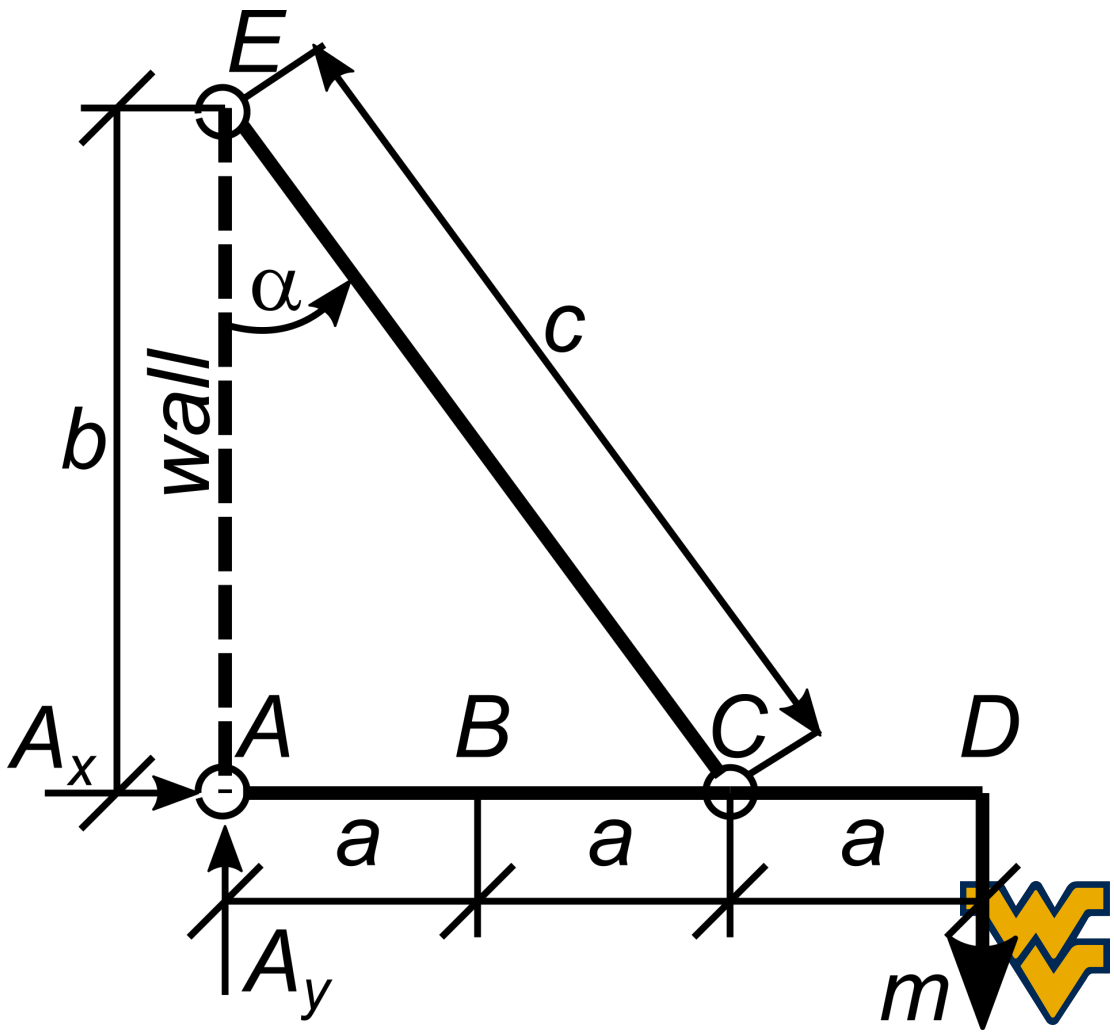
- Shear force at A = load on right of A
  AC=$w_A = 2/3 w_0 = 160$ N/m
  F = Area triangle
  $= 2Lw_A/2 = 2x2.8x160/2 = 448$ N
  $V = F = 448$ N $(+)$
- Bending moment at A
  Distance from A to CG of triangle
  $d = 2L/3 = 2x2.8/3 = 1.867$ m
  $M = -Fd = -448x1.867 = -836.3$ N.m
- Axial force $N = 0$



Example 2

The cantilever beam AD is loaded with hanging mass $m = 500$ kg at D, pin-supported at A, and held by strut CE. Calculate the internal forces at B.

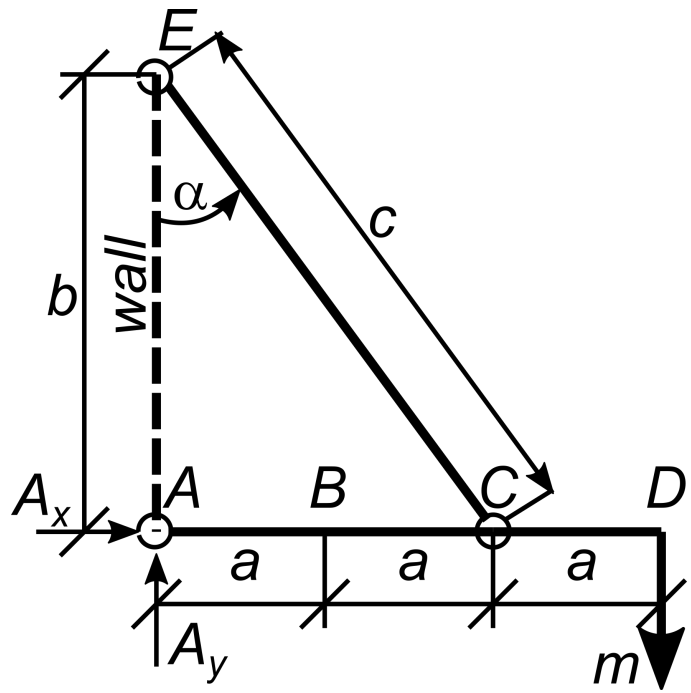
Dimensions $a = 0.5$ m, $b = 2.0$ m.
Points A, C, and E are pinned.
The strut EC is pinned at both ends.



Example 2, cont'd.

Calculate the internal forces at B.
Mass $m = 500$ kg. $a = 0.5$ m, $b = 2.0$ m.

$W = 9.81x500 = 4905$ N
$c = \sqrt{4a^2 + b^2} = 2.236$ m
$\cos\alpha = b/c = 2.0/2.236 = 0.8945$
$\sin\alpha = 2a/c = 2x0.5/2.236 = 0.4472$



Example 2, FBD

$\sum M_A = 0$: $3aW - 2aF_{CE}\cos\alpha = 0$

$F_{CE} = 8222$ N

$A_x = F_{CE}\sin\ = 3678$ N

$A_y = -F_{CE}\cos + W = -2452$ N

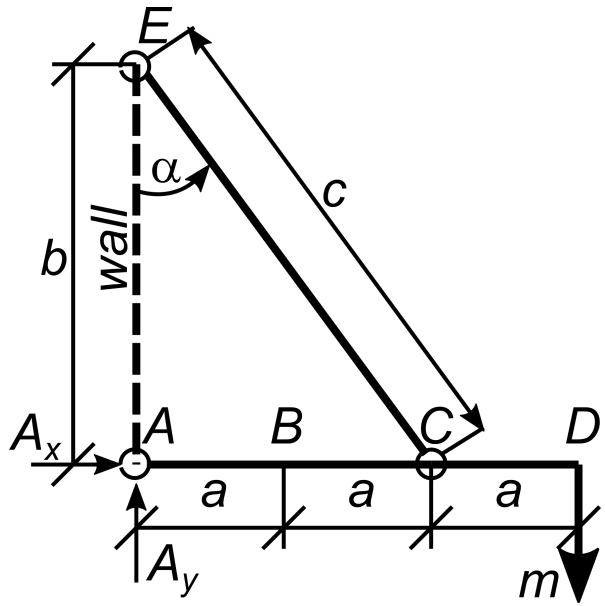
Internal forces at B:

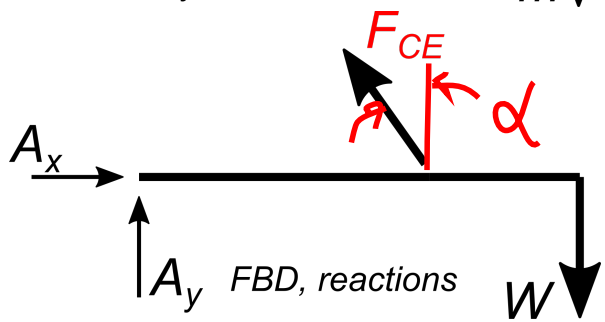
$N = -A_x = -3678$ N

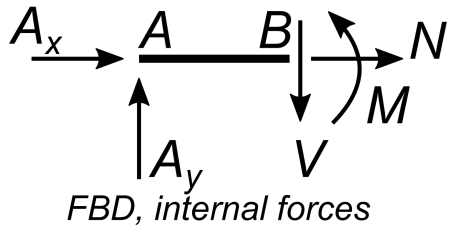
$V = A_y = -2452$ N

$M = A_y\ a =$ - 2452x0.5 = - 1226 N m

w/sign convention





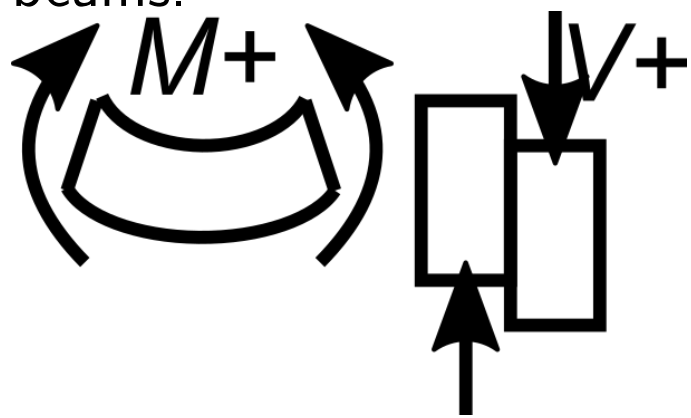


FBD, internal forces

Review Sign Convention

- The sign convention is such that M is positive for a simply supported beam under it's own weight.
- The sign of the shear is such that $V = dM/dx$
- You should try and draw the shear and bending moment diagrams for a simply supported beam under it's own weight, to convince yourself of these facts.
- Axial force N is positive in tension, negative in compression.

Sign convention for beams.



Conclusions

- Homework is on WebWork
- Next lecture: Shear and Bending-moment Diagrams
- THANK YOU