Announcements

- Quiz 4 this Friday (10/26) in class
- Concept Inventory & Visual Representation Study:
  - Next Thursday–Saturday (11/1–3) at CBTF
  - 2 assessments in 1 session
  - Must take both assessments to receive extra credit (1% of overall grade)

❑ Upcoming deadlines:

- Thursday (10/24)
  - PL HW16

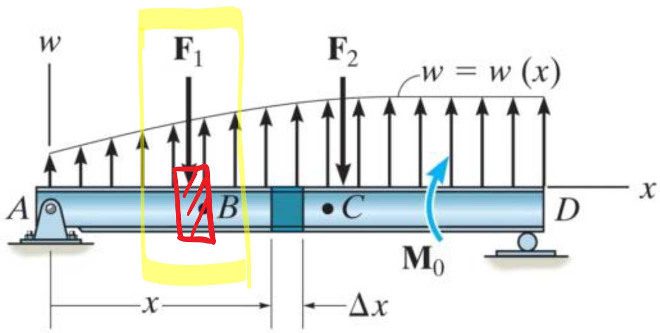
1

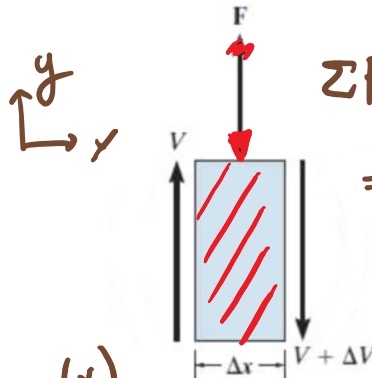
Objective

- Relations among external load (distributed force, concentrated force, couple moment) and internal load (shear force and bending moments)

2

Relations Among Load, Shear and Bending Moments



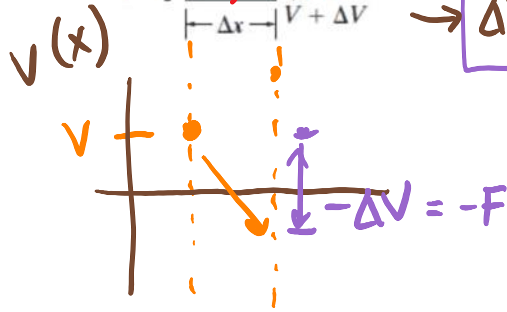


$\Sigma F_y = 0$

$= \cancel{V} - F$

$- (\cancel{V} + \Delta V)$

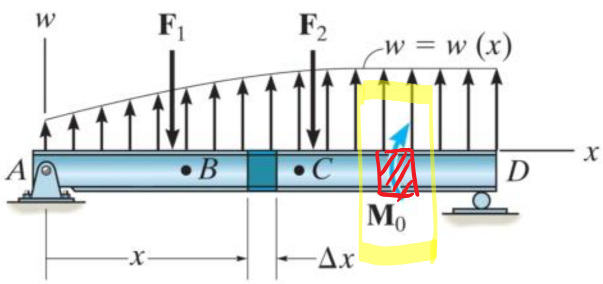
$\rightarrow \boxed{\Delta V = -F}$

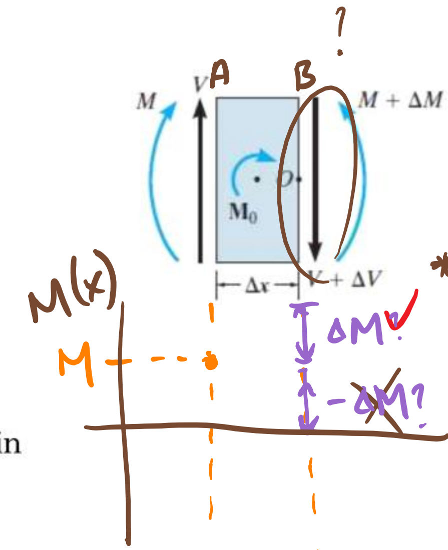


Wherever there is an external concentrated force, there will be a change (jump) in internal shear force.

3

Relations Among Load, Shear and Bending Moments





Wherever there is an external couple moment, there will be a change (jump) in internal bending moment.

* Clockwise couple moment creates positive jump in M(x)

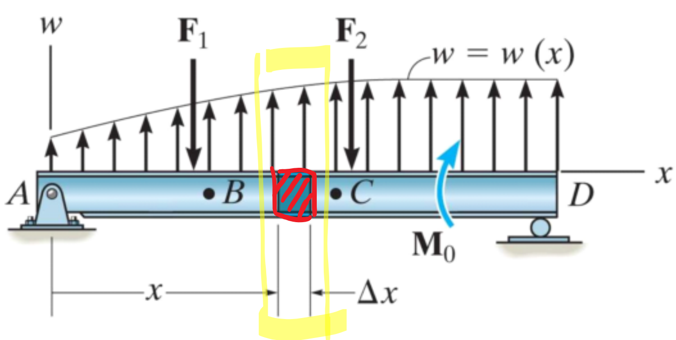
cut A & B such that $\Delta x \to 0$.

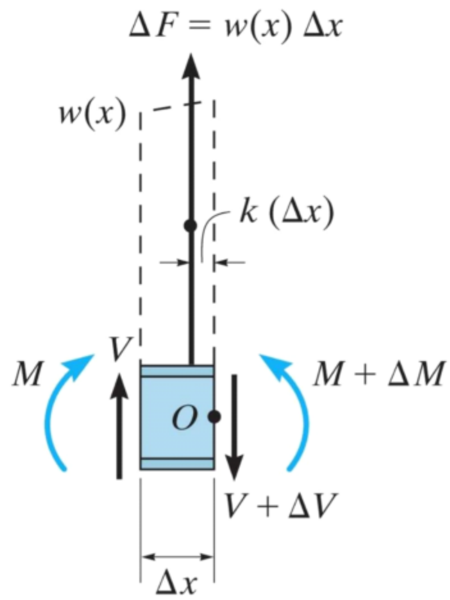
$$\Sigma M_A = -\cancel{M} + (\cancel{M} + \Delta M) - \cancel{(V+\Delta V)\Delta x} - M_0 = 0$$

$$\Delta M = +M_0$$

4

Relations Among Load, Shear and Bending Moments





Relationship between load and shear:

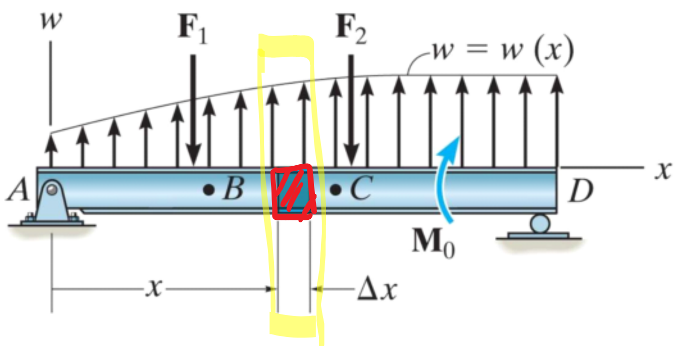
$$\sum F_y = 0: \quad V - (V + \Delta V) + w\Delta x = 0$$

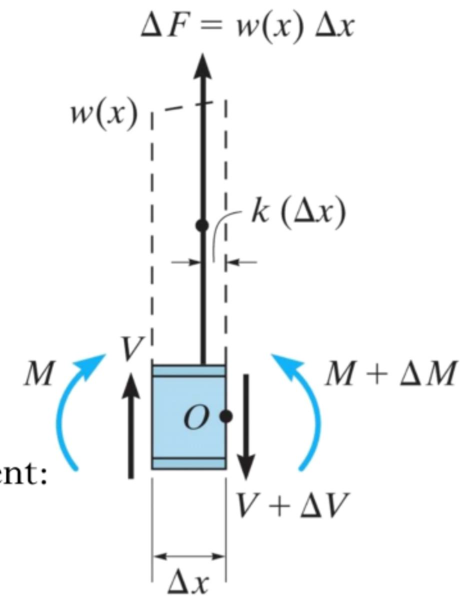
$$\Delta V = w\Delta x$$

Dividing by Δx and letting $\Delta x \to 0$, we get:

$\frac{\Delta V}{\Delta x} = W$ $$\frac{dV}{dx} = w \qquad \Delta V = \int w\, dx$$

Relations Among Load, Shear and Bending Moments





Relationship between shear and bending moment:

$$\sum M_O = 0: \quad (M+\Delta M) - M - V\,\Delta x - w\,\Delta x\,(k\,\Delta x) = 0$$

$$\Delta M = V\,\Delta x + w\,k\,(\Delta x)^2$$

Dividing by Δx and letting $\Delta x \rightarrow 0$, we get:

$$\frac{dM}{dx} = V \qquad \Delta M = \int V\,dx$$

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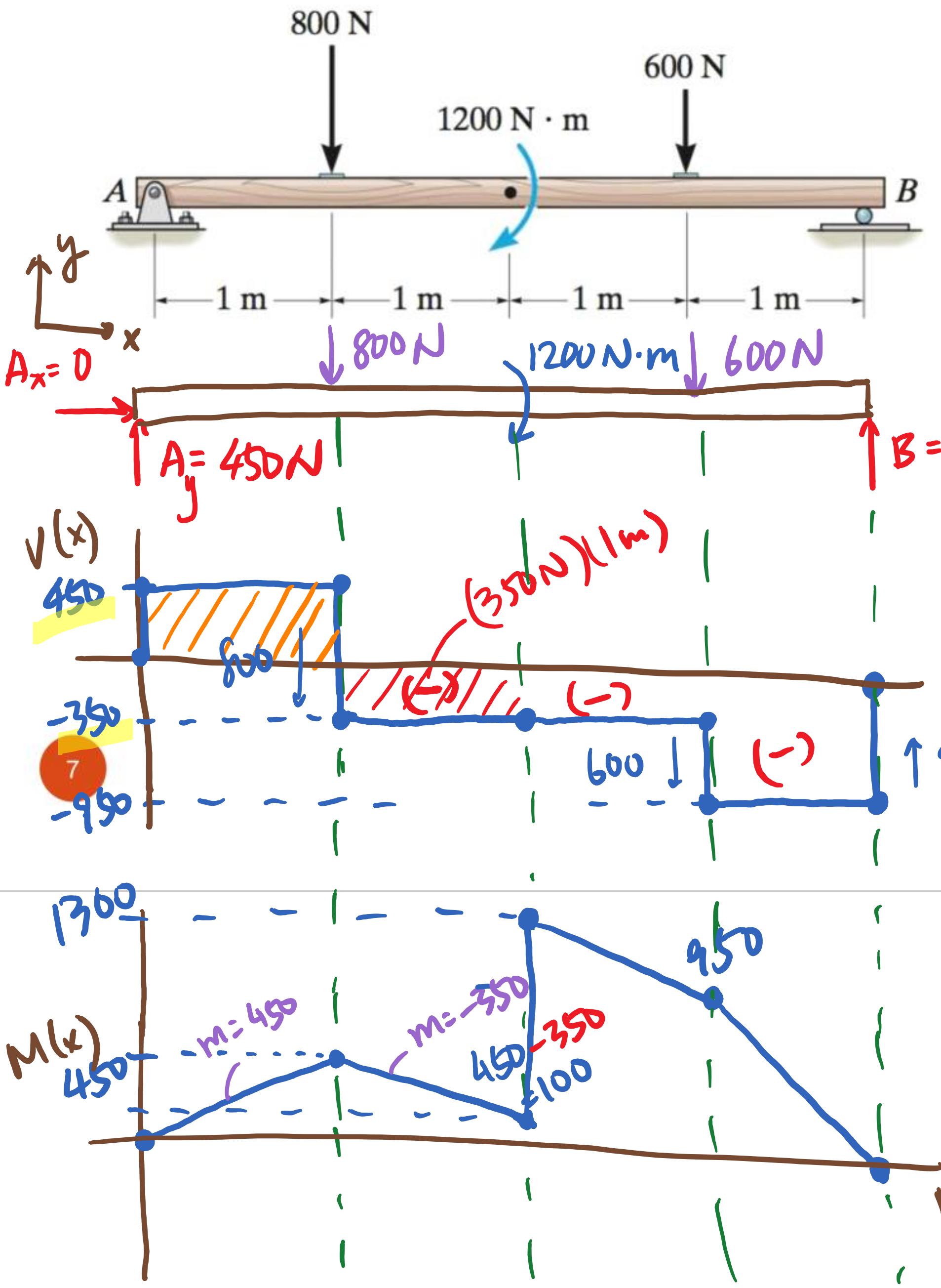
Example

Draw the shear and moment diagrams for the beam.



EoE for the beam

$$\Sigma F_y = A_y + B - 800N - 600N = 0$$

$$\Sigma M_A = -(800N)(1m) - 1200 N\cdot m - (600N)(3m) + B(4m) = 0$$

When V is constant:

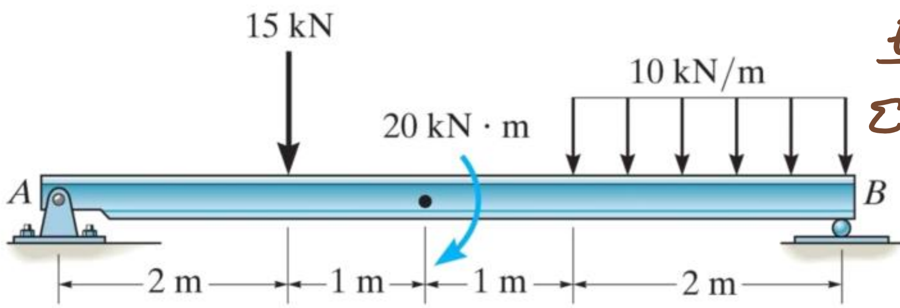
$$M = \int m\,dx = mx + C$$

$\Delta M = \int V\,dx$ = Area under the curve.

$$\Delta M = M(1m) - M(0m) = \int_0^1 V\,dx = (450\,N)(1m) = 450\ N\cdot m$$

Example

Draw the shear and moment diagrams for the beam.

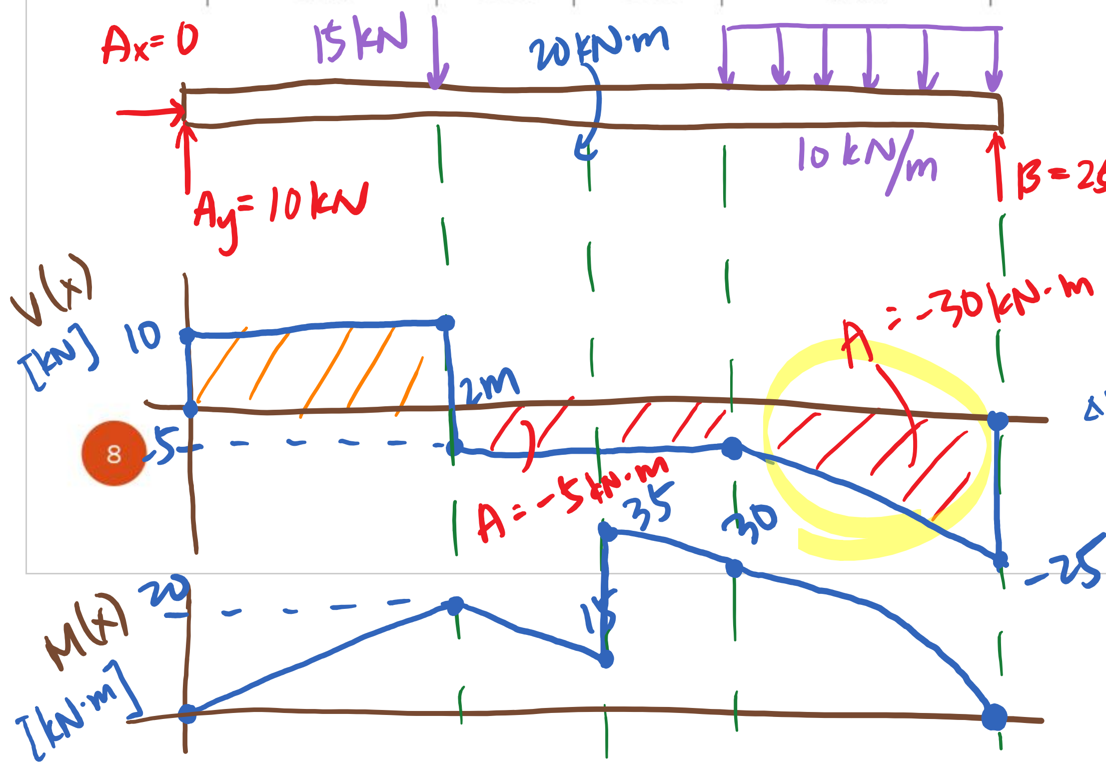


EoE for the beam

$\Sigma F_y = A_y + B - 15\,kN - (10\,kN/m)(2m) = 0$

$\Sigma M_A = -(15kN)(2m) - 20\,kN\cdot m - (10\,\frac{kN}{m})(2m)(5m) + B\,(6m) = 0$

$B = 25\,kN$

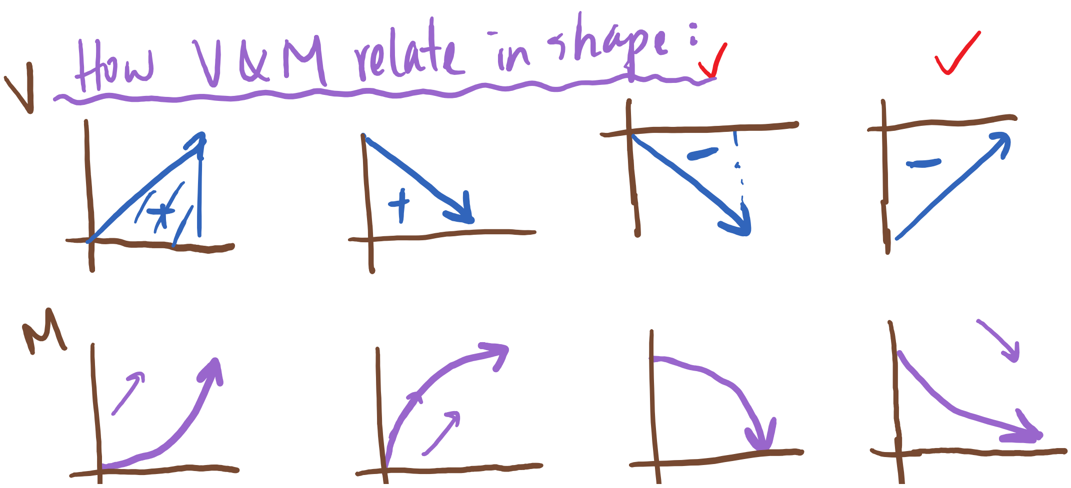


$\Delta V = \int -10\,dx = -10x$

" w "

from 4m to 6m, → $A = -20\,kN$

How V & M relate in shape:



$\Delta M = \int V\,dx$