Statics - TAM 211

Lecture 23

November 19, 2018

Chap 7.3

Announcements

- Upcoming deadlines:
- Tuesday (11/20)
  - Prairie Learn HW 9
- Friday (11/23)
  - Written Assignment 9
- **Prof. H-W office hours**
  - **Monday 3-5pm (Room C315 ZJUI Building)**
  - **Wednesday 7-8pm (Residential College Lobby)**

Chapter 7: Internal Forces

Goals and Objectives

- Determine the internal loadings in members using the method of sections

- Generalize this procedure and formulate equations that describe the internal shear force and bending moment throughout a member

- Be able to construct or identify shear a force nd bending moment diagrams for beams when distributed loads, concentrated forces, and/or concentrated couple moments are applied

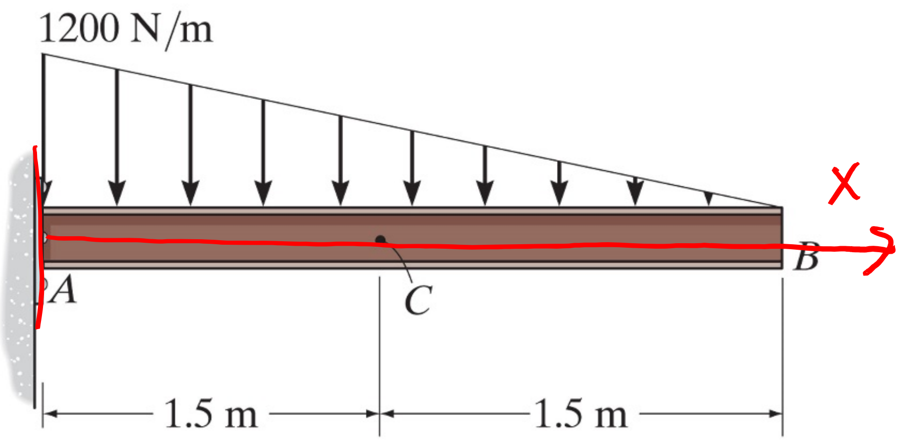
Recap: Shear Force and Bending Moment Diagrams

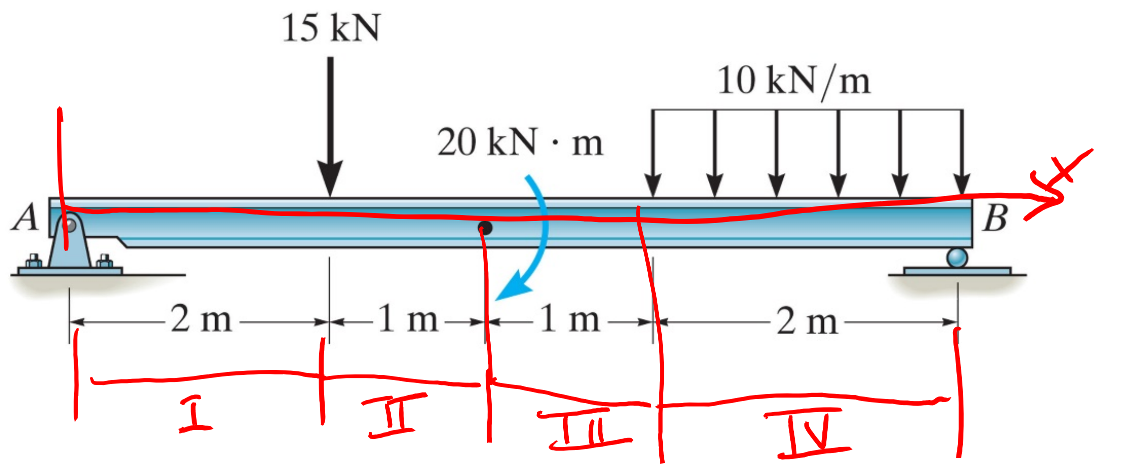
Goal: provide detailed knowledge of the variations of internal shear force and bending moments (V and M) throughout a beam when perpendicular distributed loads, concentrated forces, and/or concentrated couple moments are applied.

Normal forces (N) in such beams are zero, so we will not consider normal force diagrams

Procedure

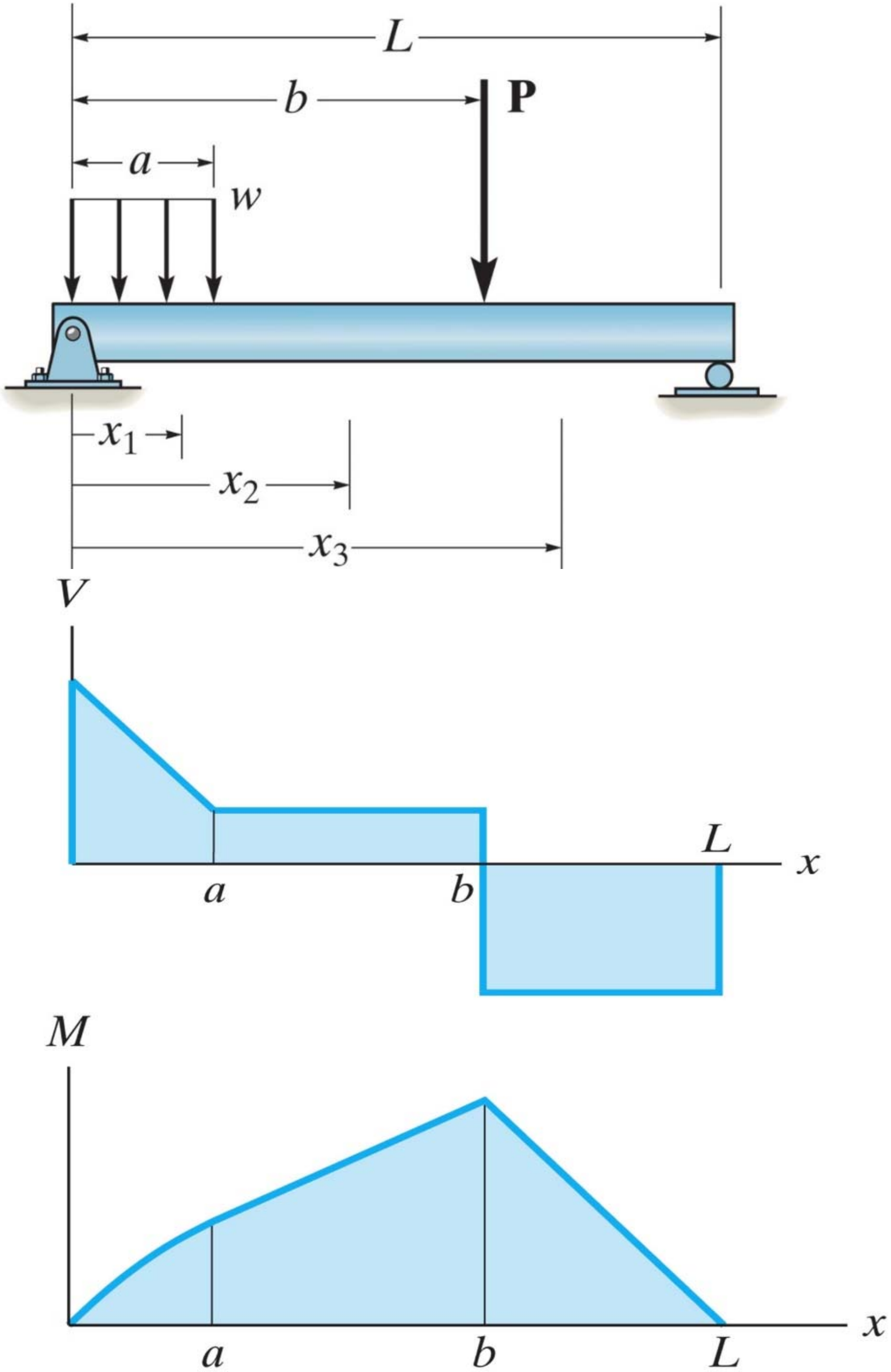
1. Find support reactions (free-body diagram of entire structure)
2. Specify coordinate *x* (start from left)
3. Divide the beam into sections according to loadings
4. Draw FBD of a section
5. Apply equations of equilibrium to derive V and M as functions of *x*: V(*x*), M(*x*)





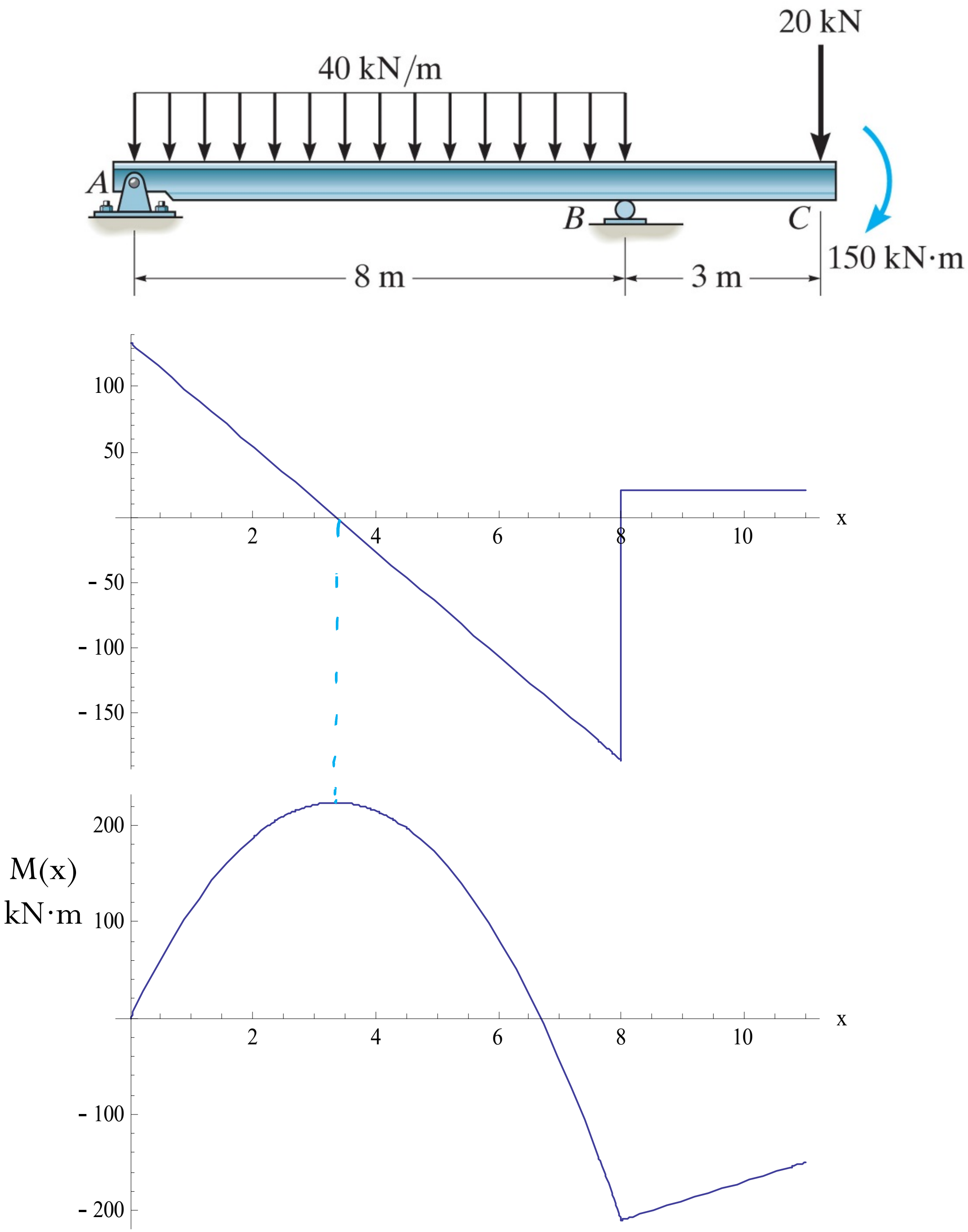
Explore and re-create the shear force and bending moment diagrams for the beam.

Example: single concentrated load, rectangular distributed load

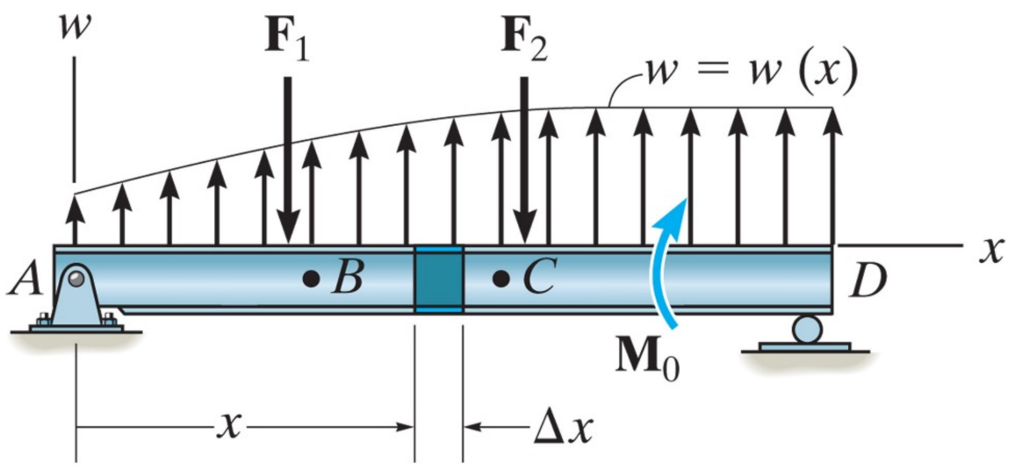


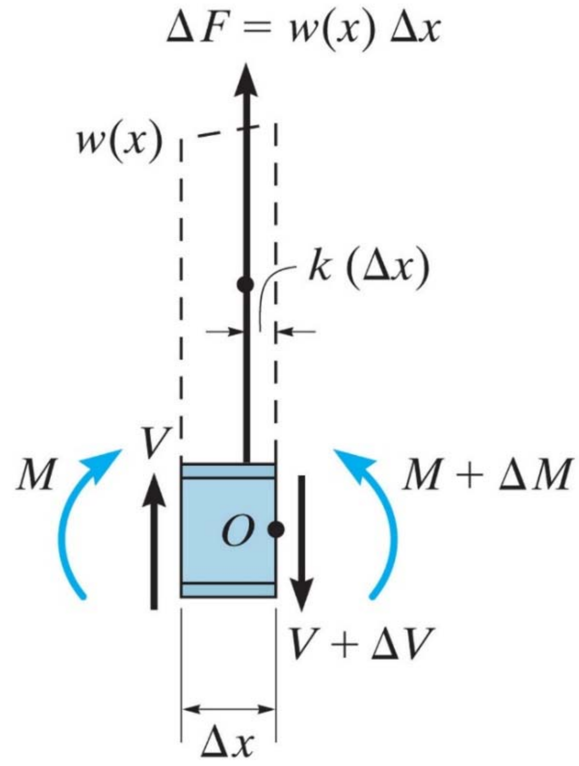
Explore and re-create the shear force and bending moment diagrams for the beam.

Example: concentrated load, rectangular distributed load, concentrated couple moment



Relations Among Distributed Load, Shear Force and Bending Moments





Relationship between <u>distributed load</u> and <u>shear</u>:

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

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

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

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

Relationship between <u>shear</u> and <u>bending moment</u>:

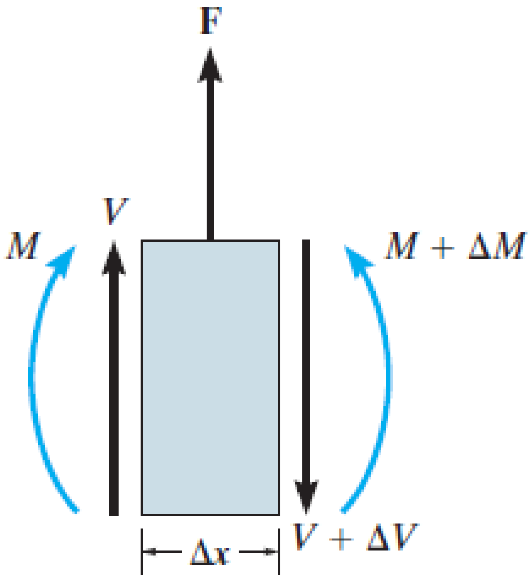
$$\sum M_O = 0: \quad (M + \Delta M) - M - V\,\Delta x - w\,\Delta x\,(k\,\Delta x) = 0$$

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

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

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

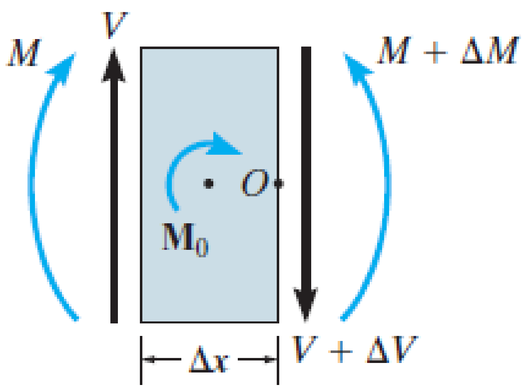
Wherever there is an external concentrated force or a concentrated moment, there will be a change (jump) in shear or moment, respectively.



ΣF_y:

$V + F - (V + \Delta V) = 0$

$\Delta V = \text{F}$



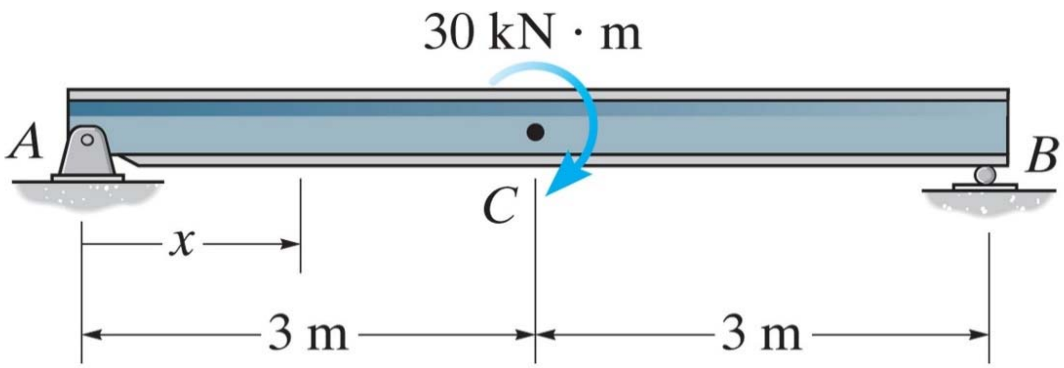
ΣM_O:

$(M + \Delta M) - M - M_O - V(\Delta x) = 0$

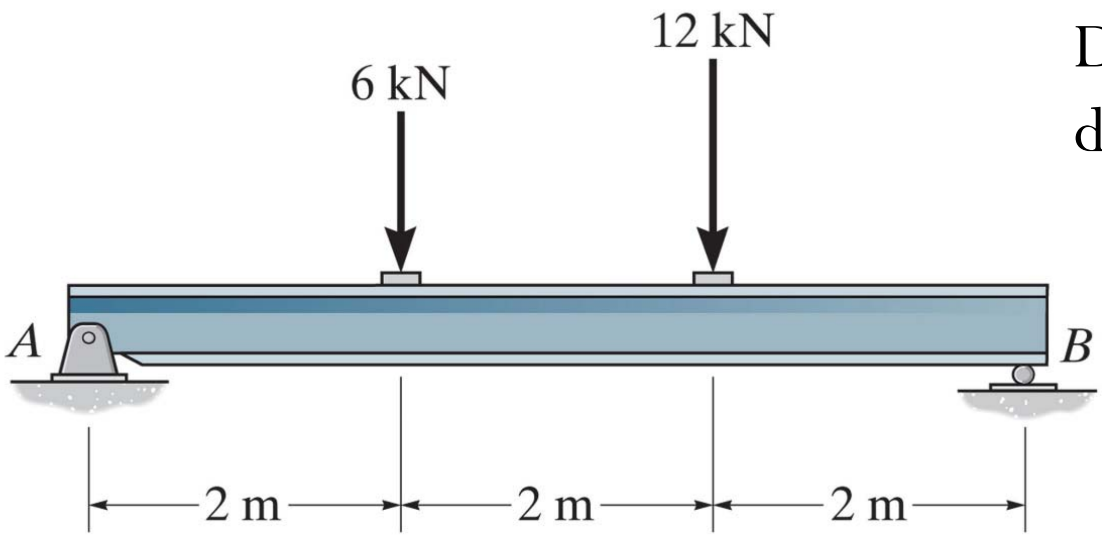
$\Delta M = M_O + V(\Delta x)$

$\Delta M = M_O$, when $\Delta x \rightarrow 0$

Note: the text, these notes, and convention assume that an applied concentrated moment **M_O in clockwise direction** results in a **positive change in $M(x)$**



Draw the shear force and moment diagrams for the beam.



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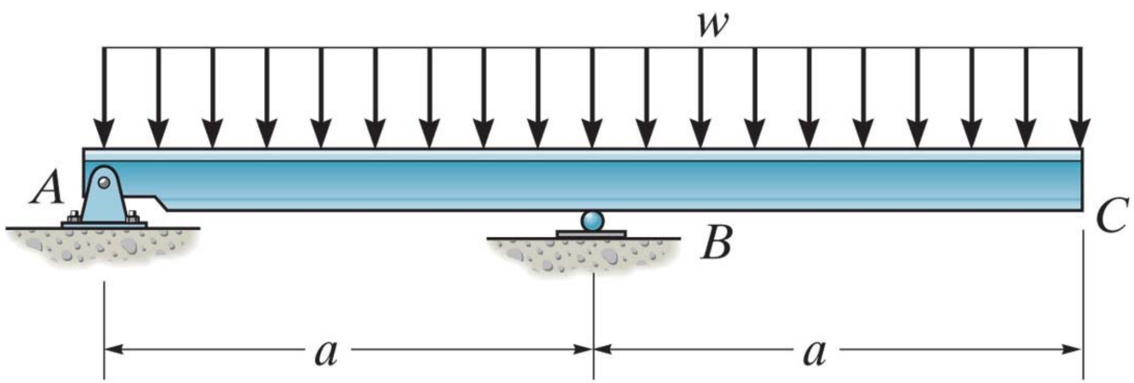

Draw the shear force and moment diagrams for the beam.

Draw the shear force and bending moment diagrams for the beam.

Example: concentrated load, rectangular distributed load, concentrated couple moment