Mechanics of Materials III:

Beam Bending

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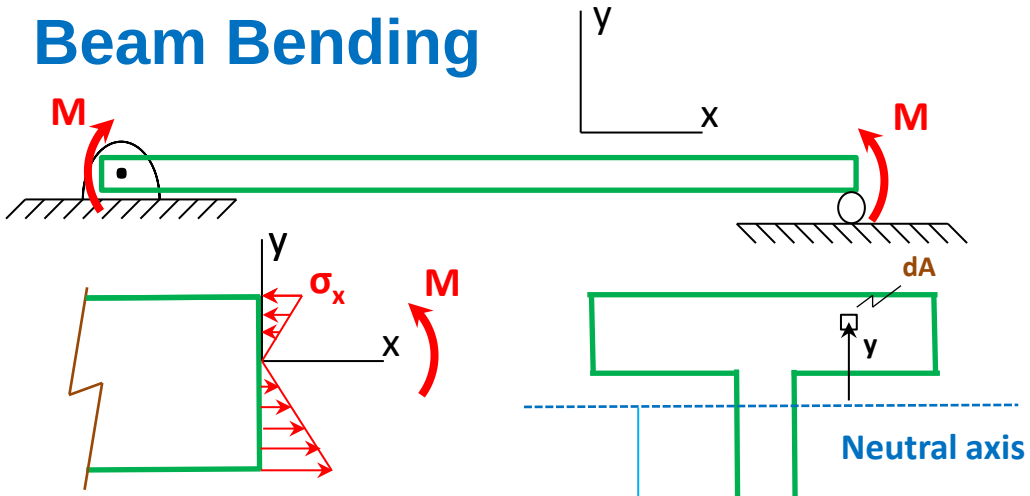
Module 13 Learning Outcome

- Solve an elastic beam bending problem for the maximum flexural stress in tension and compression.

Beam Bending



Elastic Flexural Formula

$$\sigma_x = -\frac{M\ y}{I}$$

Maximum Stress

$$\sigma_{MAX} = \frac{M\ c}{I}$$

c is the furthest distance on the cross section from the neutral axis

Elastic Beam Bending

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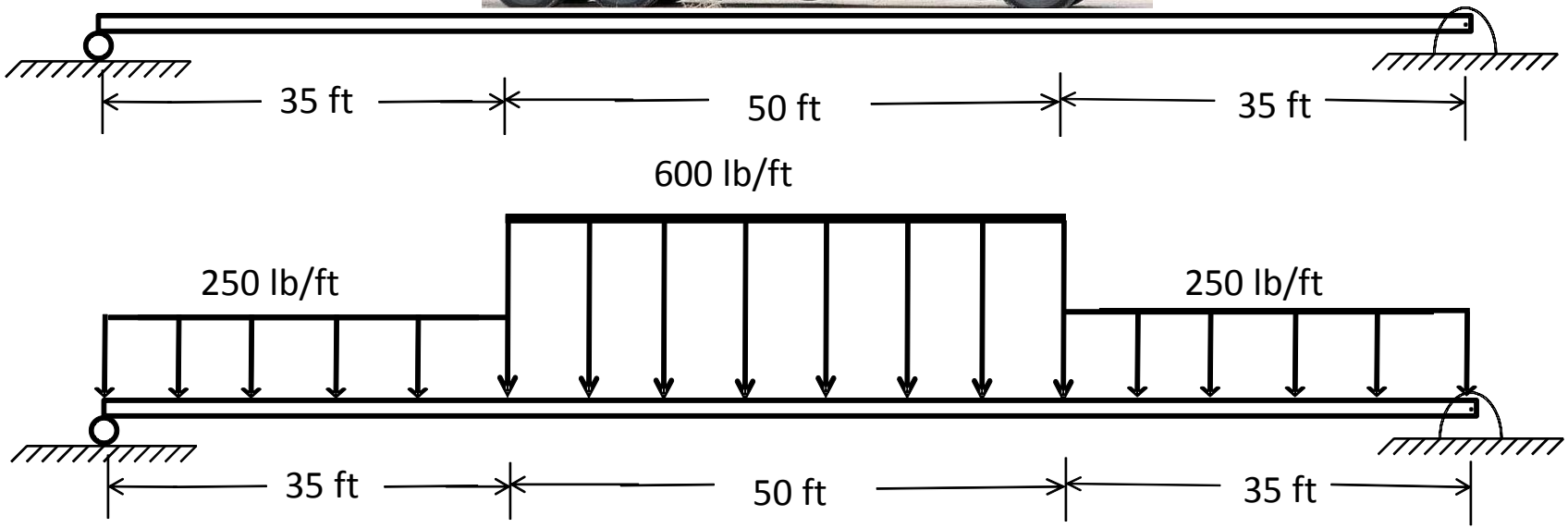
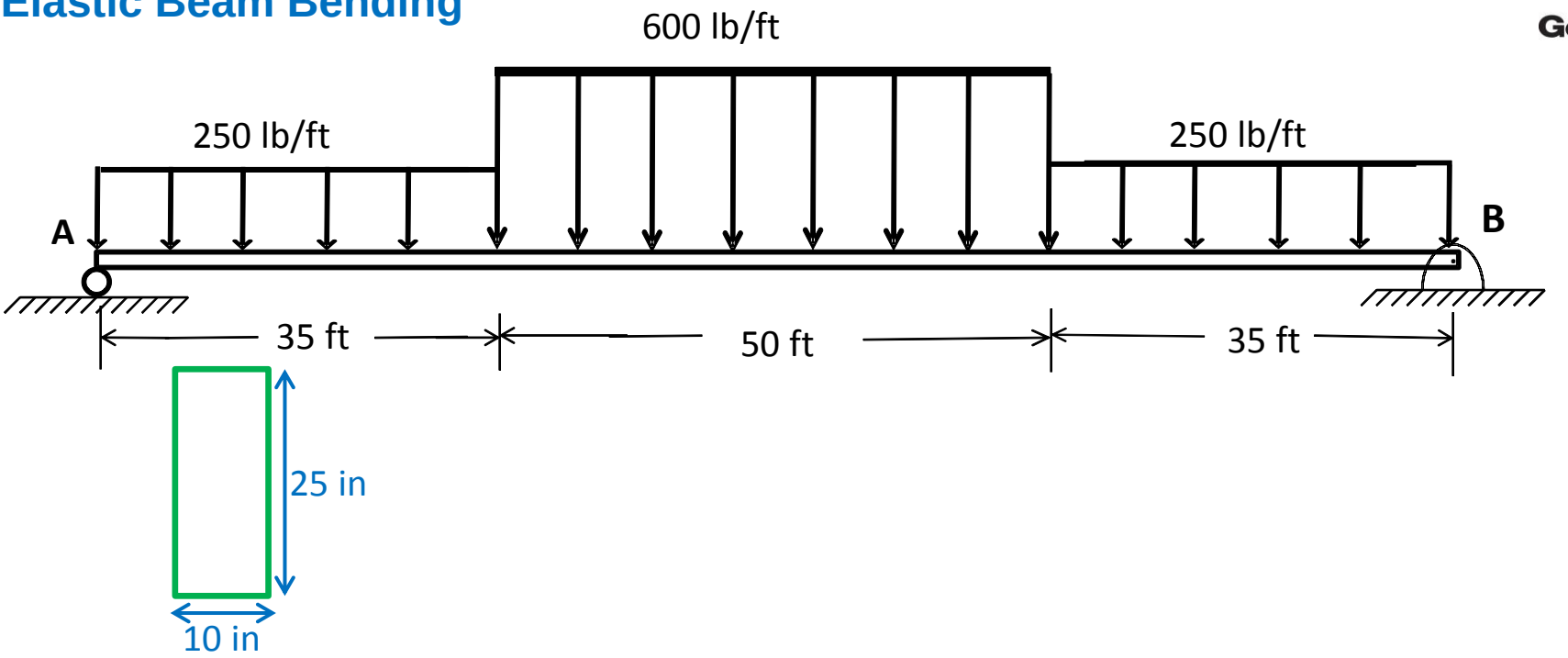


The beam and the structure it carries is estimated at 250 lb/ft. This constant load in bridge structures is not insignificant and is a big part of the design

We'll include an addition 350 lb/ft for the truck load. But it's not actually distributed. It's point loads. A tracked vehicle would be more distributed.

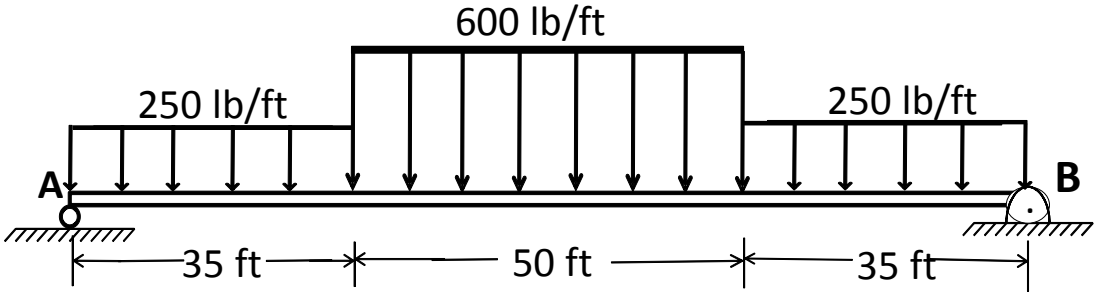
Elastic Beam Bending



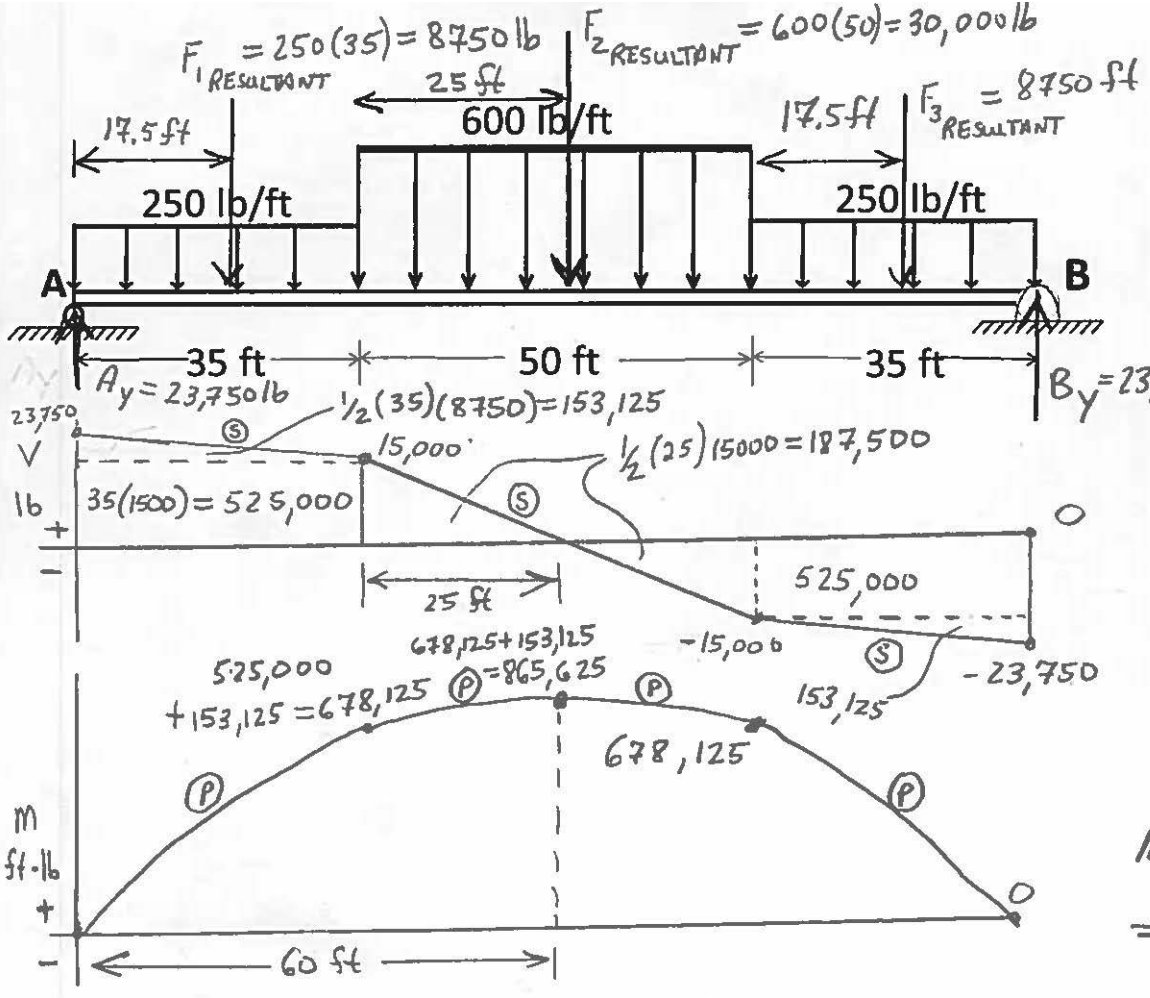
Worksheet: A steel beam is subject to a loading and has a cross section as shown above.

a) Draw a shear and moment diagram and determine the maximum moment and where is occurs on the beam
b) Determine the maximum flexural stress in tension and compression and where it occurs on the cross section.

Worksheet: a) **Draw a shear and moment diagram and determine the maximum moment and where is occurs on the beam**



Worksheet: a) **Draw a shear and moment diagram and determine the maximum moment and where is occurs on the beam**



FBD OF BEAM

$\circlearrowleft + \Sigma M_A = 0$

$B_y(120) - 8750(17.5) - 30,000(60) - 8750(102.5) = 0$

$B_y = 23,750\,lb$

$\uparrow + \Sigma F_y = 0$

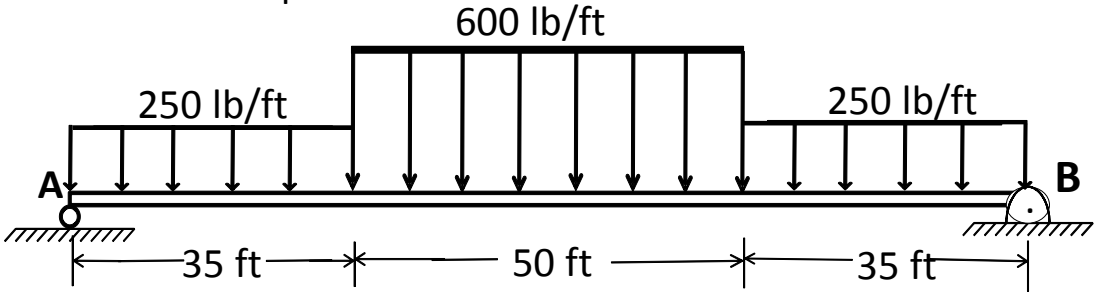
$A_y + B_y - 8750 - 30,000 - 8750 = 0$ (23,750)

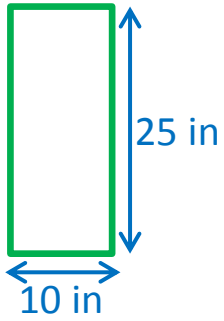
$A_y = 23,750\,lb$

$M_{MAX} = 865,625\,ft\text{-}lb$ at CENTER OF BEAM (60 ft from left edge)

ANS.

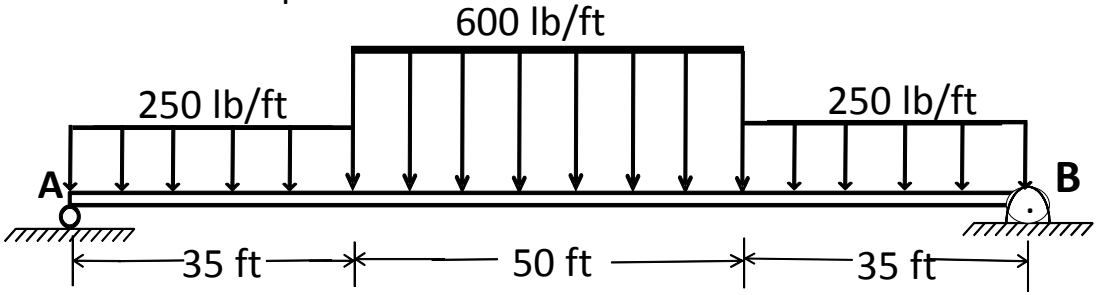
Worksheet: **b) Determine the maximum flexural stress in tension and compression and where it occurs on the cross section.**

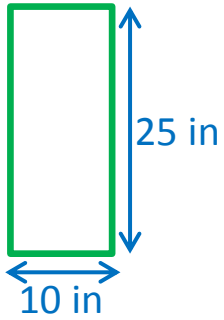




$$M_{MAX} = 865,625 \; ft - lb \; at \; center \; of \; beam$$

Worksheet: **b) Determine the maximum flexural stress in tension and compression and where it occurs on the cross section.**





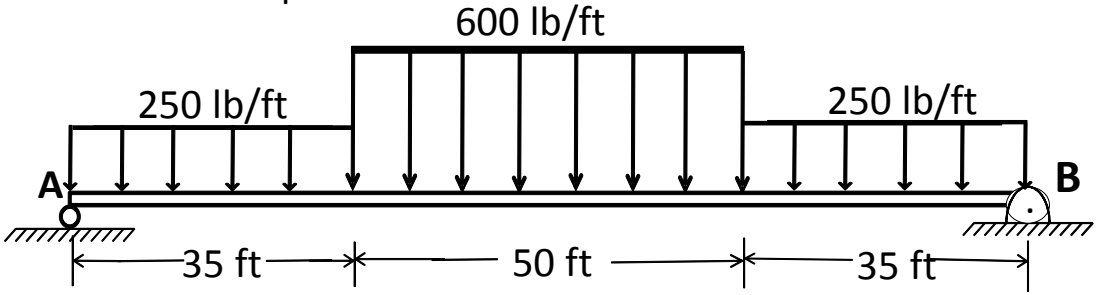
$$\sigma_{MAX} = \frac{M\ c}{I}$$

$$M_{MAX} = 865\ ,625\quad ft - lb\quad at\quad center\quad of\quad beam$$

$$c = 12\ .5\ in$$

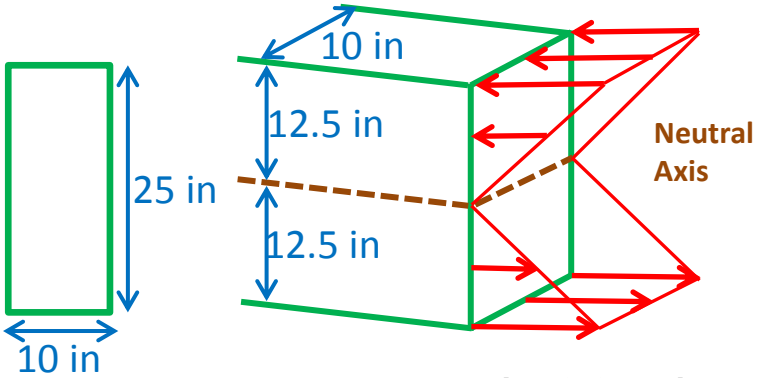
$$I = 13020\quad in^4$$

Worksheet: **b) Determine the maximum flexural stress in tension and compression and where it occurs on the cross section.**



$$\sigma_{MAX} = 9.972 \quad ksi \quad (C) \quad at \quad top \quad of \quad beam$$

ANS



$$\sigma_{MAX} = 9.972 \quad ksi \quad (T) \quad at \quad bottom \quad of \quad beam$$

ANS