

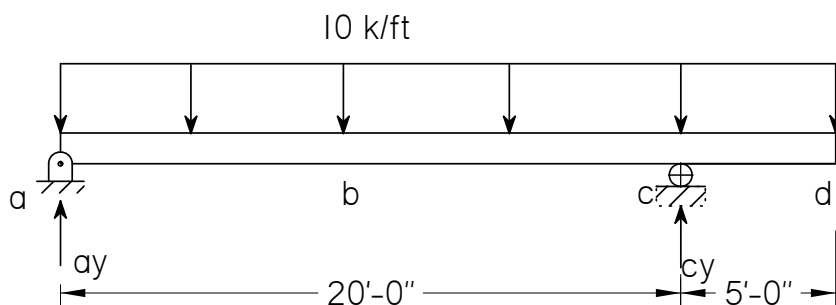
CE 343 - Fall 2001 - Final Exam
Problem 1, Solution
RJN 12/18/01

$$\text{kip} := 1000 \cdot \text{lbf}$$

Since the dead load cannot be arranged, the shears and moments due to the dead load on the entire span will be calculated.

Calculate reactions.

Freebody diagram:



$$\Sigma M_a = 0 \quad c_y \cdot 20 \cdot \text{ft} - 10 \cdot \frac{\text{kip}}{\text{ft}} \cdot 25 \cdot \text{ft} \cdot \frac{25}{2} \cdot \text{ft} = 0 \cdot \text{kip} \cdot \text{ft}$$

$$c_y := \frac{625}{4} \cdot \text{kip} \quad c_y = \frac{625}{4} \text{ kip}$$

$$\Sigma F_y = 0 \quad c_y + a_y - 10 \cdot \frac{\text{kip}}{\text{ft}} \cdot 25 \cdot \text{ft} = 0$$

$$a_y := -c_y + 250 \cdot \text{kip} \quad a_y = \frac{375}{4} \text{ kip}$$

From qualitative influence lines, we know that the maximum positive moment in the beam will occur at midspan. The maximum negative bending moment occurs at *c*.

Calculate the moment at midspan.

$$M_b - a_y \cdot 10 \cdot \text{ft} + 10 \cdot \frac{\text{kip}}{\text{ft}} \cdot 10 \cdot \text{ft} \cdot \frac{10}{2} \cdot \text{ft} = 0$$

$$M_{b_DL} := 10 \cdot a_y \cdot \text{ft} - 500 \cdot \text{kip} \cdot \text{ft} \quad M_{b_DL} = \frac{875}{2} \text{ kip} \cdot \text{ft}$$

Calculate the moment at the overhang.

$$M_{c_DL} := 10 \cdot \frac{\text{kip}}{\text{ft}} \cdot 5 \cdot \text{ft} \cdot \frac{5}{2} \cdot \text{ft} \quad M_{c_DL} = 125 \text{ kip} \cdot \text{ft}$$

Shear at a is the reaction a_y .

$$S_{a_DL} := a_y \qquad S_{a_DL} = \frac{375}{4} \text{ kip}$$

Calculate the shear at midspan

$$a_y - \frac{10 \cdot \text{kip}}{\text{ft}} \cdot 10 \cdot \text{ft} - S_b = 0$$

$$S_{b_DL} := a_y - 100 \cdot \text{kip} \qquad S_{b_DL} = -\frac{25}{4} \text{ kip}$$

Shear just to the left of the support

$$a_y - \frac{10 \cdot \text{kip}}{\text{ft}} \cdot 20 \cdot \text{ft} - S_{cL} = 0$$

$$S_{cL_DL} := a_y - 200 \cdot \text{kip} \qquad S_{cL_DL} = -\frac{425}{4} \text{ kip}$$

Shear just to the right of the support

$$S_{cR} - 10 \cdot \frac{\text{kip}}{\text{ft}} \cdot 5 \cdot \text{ft} = 0$$

$$S_{cR_DL} := 50 \cdot \text{kip}$$

Live Loads

Qualitative influence lines are again used to determine live load arrangement at the specified locations.

For maximum positive bending moment, load only span a-c and calculate moment at midspan.

Find reactions

$$a_y := 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 10 \cdot \text{ft} \qquad a_y = 150 \text{ kip}$$

$$M_b - a_y \cdot 10 \cdot \text{ft} + 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 10 \cdot \text{ft} \cdot \frac{10}{2} \cdot \text{ft} = 0$$

$$M_{b_LL} := 10 \cdot a_y \cdot \text{ft} - 500 \cdot \text{kip} \cdot \text{ft} \qquad M_{b_LL} = 1000 \text{ kip} \cdot \text{ft} \qquad M_{b_DL} = \frac{875}{2} \text{ kip} \cdot \text{ft}$$

For maximum negative bending moment load, load the overhang, and calculate the moment at c.

$$M_{c_LL} := 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 5 \cdot \text{ft} \cdot \frac{5}{2} \cdot \text{ft} \qquad M_{c_LL} = \frac{375}{2} \text{ kip} \cdot \text{ft} \qquad M_{c_DL} = 125 \text{ kip} \cdot \text{ft}$$

For maximum shear at a, load from a to c.

$$S_{a_LL} := a_y \qquad S_{a_LL} = 150 \text{ kip}$$

For maximum negative shear at midspan (also absolute max) load from a to b and from c to d.

Find reaction at a for this load.

$$\Sigma M_c = 0$$

$$-a_y \cdot 20 \cdot \text{ft} + 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 10 \cdot \text{ft} \cdot 15 \cdot \text{ft} - 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 5 \cdot \text{ft} \cdot \frac{5}{2} \cdot \text{ft} = 0$$

$$a_y := \frac{825}{8} \cdot \text{kip}$$

$$a_y = \frac{825}{8} \text{ kip}$$

$$\Sigma F_y = 0$$

$$a_y - 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 10 \cdot \text{ft} - S_b = 0$$

$$S_{b_LL} := a_y - 150 \cdot \text{kip} \qquad S_{b_LL} = -\frac{375}{8} \text{ kip}$$

For maximum shear to the left of c, load the entire span.

Find the reaction at a for this load

$$\Sigma M_c = 0$$

$$-a_y \cdot 20 \cdot \text{ft} + 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 25 \cdot \text{ft} \cdot (12.5 - 5) \cdot \text{ft} = 0$$

$$a_y := 140.625 \cdot \text{kip}$$

$$\Sigma F_y = 0$$

$$a_y - 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 20 \cdot \text{ft} - S_{cL} = 0$$

$$S_{cL_LL} := a_y - 300 \cdot \text{kip} \qquad S_{cL_LL} = -\frac{1275}{8} \text{ kip}$$

For maximum shear to the right of c, load the overhang.

$$S_{cR_LL} := 15 \cdot \frac{\text{kip}}{\text{ft}} \cdot 5 \cdot \text{ft} \qquad S_{cR_LL} = 75 \text{ kip}$$

Total moment

$$M_b := M_{b_DL} + M_{b_LL} \qquad M_b = 1437.5 \text{ kip} \cdot \text{ft}$$

$$M_c := M_{c_DL} + M_{c_LL} \qquad M_c = 312.5 \text{ kip} \cdot \text{ft}$$