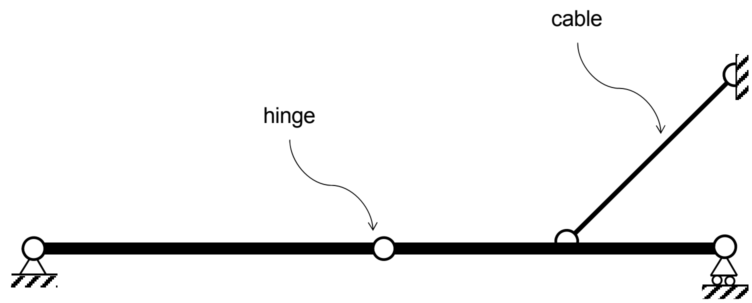
1) For each of the three structures shown below, answer the following questions.

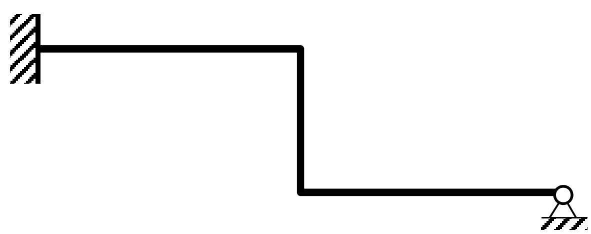
a) Is the structure stable or unstable? Explain your reasoning briefly.

b) If the structure is stable, is it statically determinate or indeterminate? If it is statically indeterminate, what is its degree of statical indeterminacy? Explain your reasoning briefly.

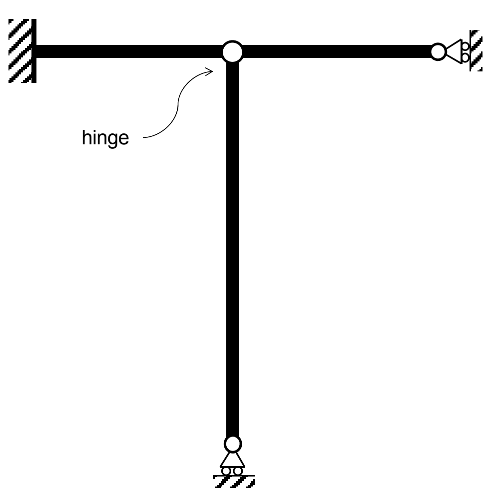
A)



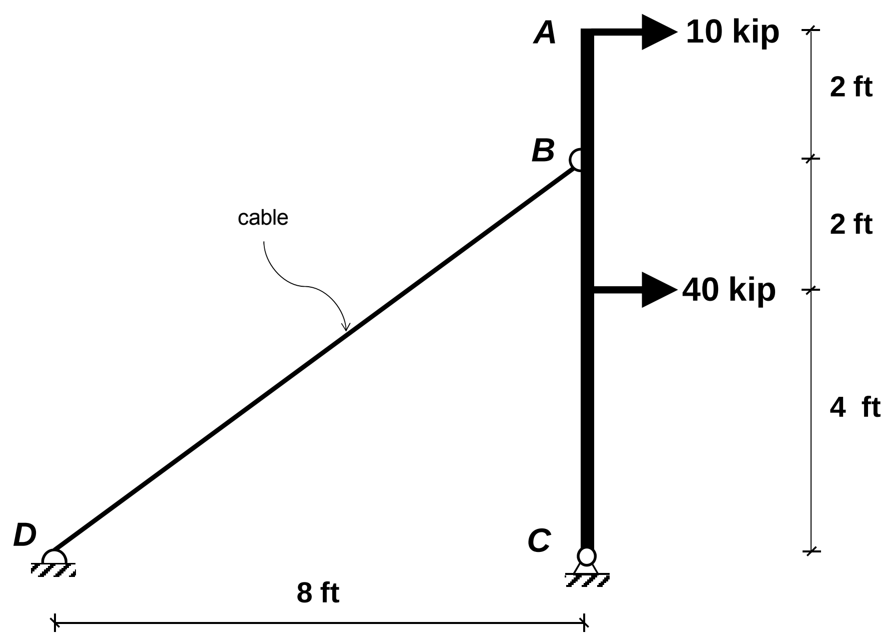
B)



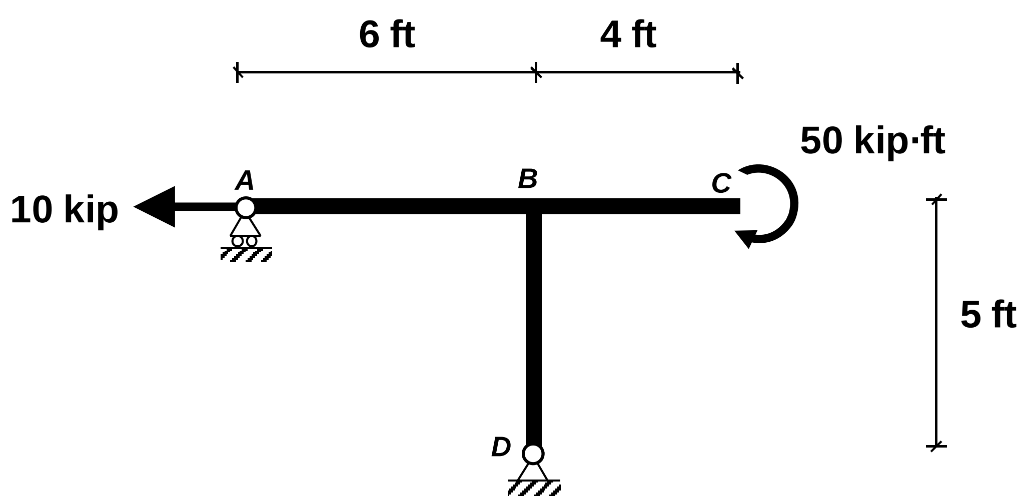
C)



2) Column *ABC* is supported by a pinned support at *C* and cable *DB*. A pair of 10 kip and 40 kip lateral loads is acting on the column. Find the support reactions. Find the force in cable.



3) Frame *ABCD* has a roller support at *A* and a pinned support at *D*. The joint at *B* is rigid. A leftward 10 kip horizontal load is acting on the frame at *A*. A 50 kip-ft clockwise moment is applied at the free end *C*. Find the support reactions.

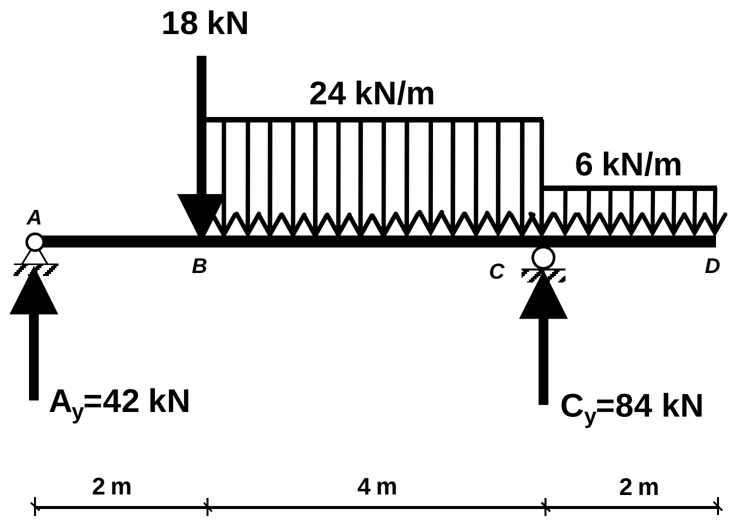


4) Beam *ABCD* shown below has a pinned support at *A* and a roller support at *C*. For the given loading, i.e. a downward concentrated load of 18 kN at *B* and downward distributed loads of 24 kN/m on segment *BC* and 6 kN/m on segment *CD*, the supports develop upward vertical reactions of 42 kN at *A* and 84 kN at *C*.

   a. Draw the shear force diagram.

   b. Draw the bending moment diagram.

   c. Sketch the deflected shape. Consider flexural response only.



5) Continuous frame *ABCDEF* has a pinned support at *C* and a roller support at *D*. Joints at *B* and *E* are rigid. A leftward 10 kip load is applied at *A* and a rightward 10 kip load is applied at *F*.

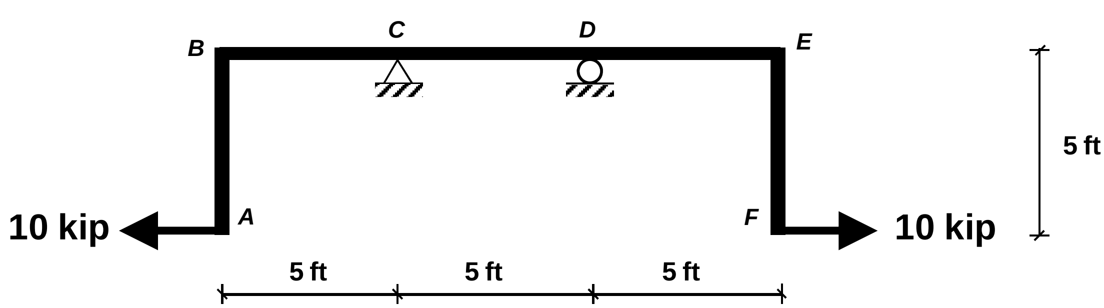
   a. Find the support reactions.

   b. Draw the axial force diagram.

   c. Draw the shear force diagram.

   d. Draw the bending moment diagram.

   e. Sketch the deflected shape. Consider flexural response only.

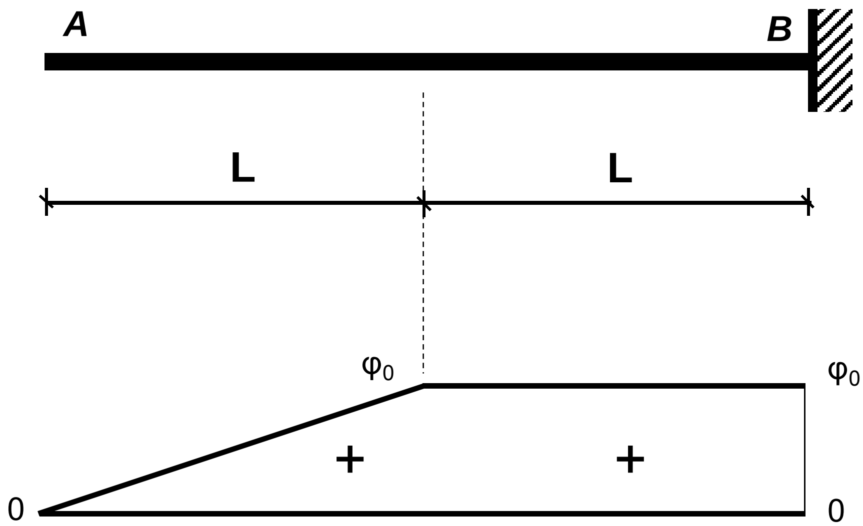


6) Cantilever beam *AB* has a fixed support at *B*. It develops the given curvature distribution under some loading (not shown). Positive curvature is concave up, i.e., the same convention we use in class.

   a. Sketch the deflected shape.

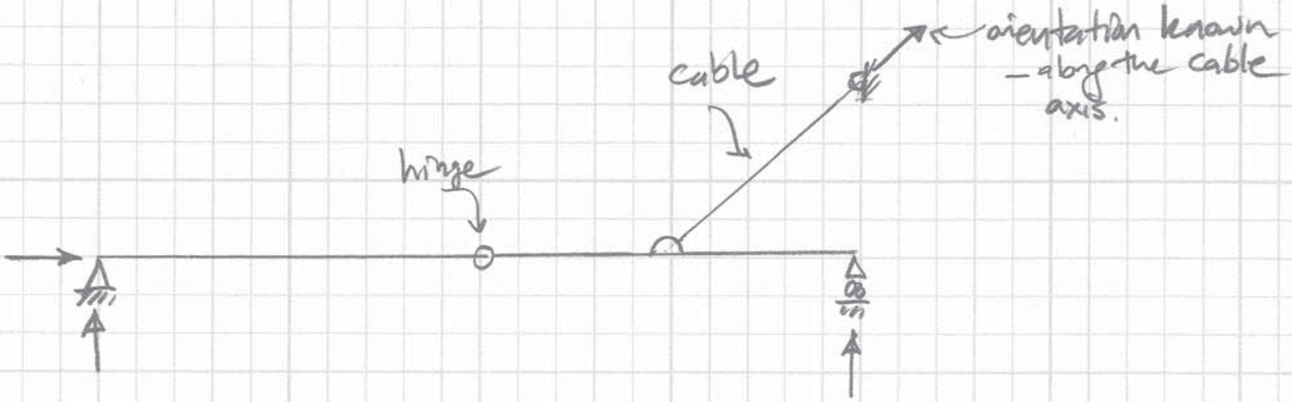
   b. Find the slope of the beam at the free end *A*.

   c. Find the displacement of the beam at *A*.



curvature diagram

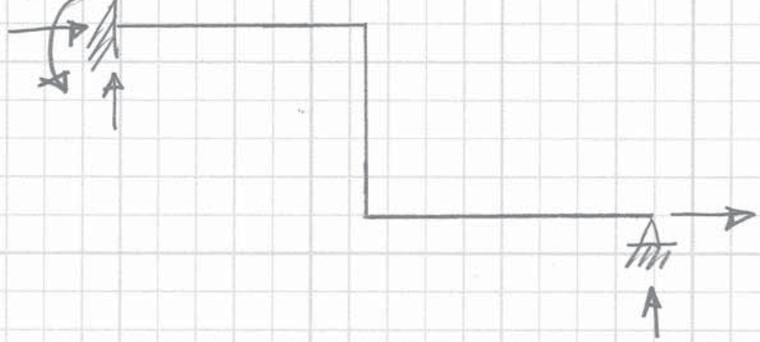
1) A) Cable resists loads only in tension → one unknown force.



Stable structure – * support reactions are not parallel or concurrent
* no partial or total collapse mechanism

Statically determinate – 4 support reactions
4 equilibrium eqns: 3 general equil eqns for the whole structure + 1 special eqn @ the internal hinge (moment is zero @ the hinge)

B)

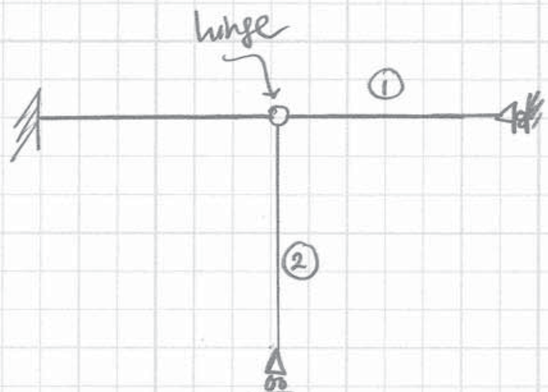


Stable – no concurrent or parallel support reactions

Statically indeterminate
- 5 reactions
- 3 equilibrium eqns

$5-3=2^{\circ}$ degree of statical indeterminacy

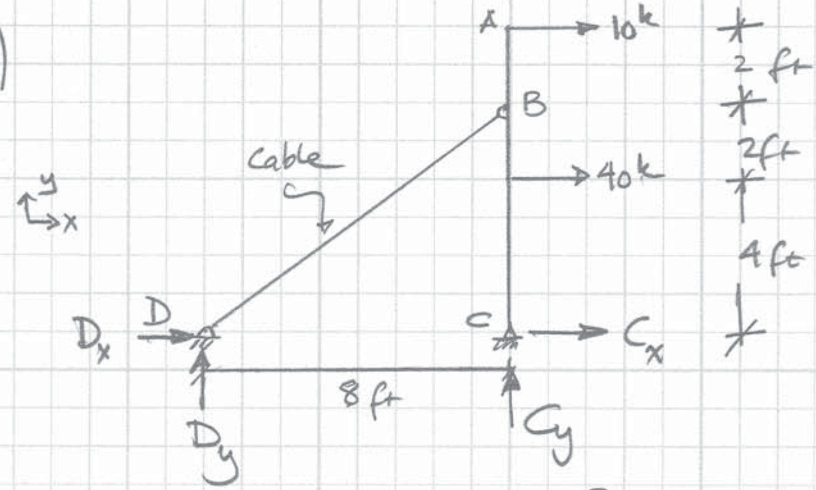
c)



unstable

segments 1 & 2 cannot satisfy moment equilibrium in case of transverse or moment loading

2)



take moments about C, $\overset{+}{\curvearrowright}\sum M_{\text{about } C} = 0$

$$\Rightarrow 10^k \times 8' + 40^k \times 4' + D_y \times 8' = 0$$

$$\Rightarrow D_y = -30^k \quad \text{, i.e. } D_y = 30^k \downarrow$$

DB is a cable so the reaction @ D should be along the cable

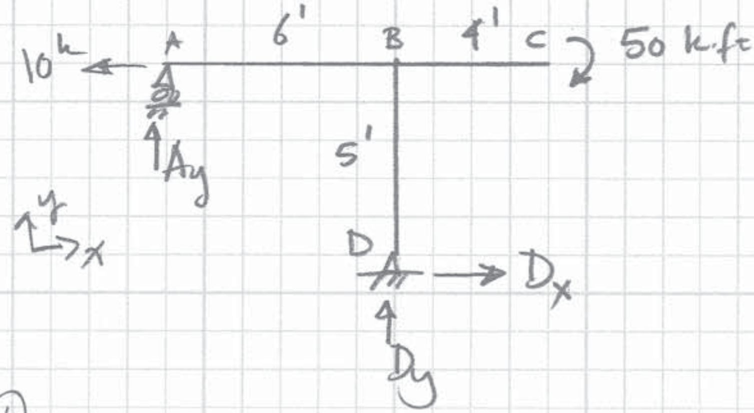
$$\therefore \; D_x = 40^k \leftarrow$$

$$\overset{+}{\rightarrow}\sum F_x = 0 \; : \; \overbrace{-40^k}^{D_x} + 10^k + 40^k + C_x = 0$$

$$\Rightarrow C_x = -10^k \quad \text{, i.e. } C_x = 10^k \leftarrow$$

$$\overset{\uparrow +}{\sum} F_y = 0 \; : \; \overbrace{-30^k}^{D_y} + C_y = 0 \Rightarrow C_y = 30^k \uparrow$$

3)



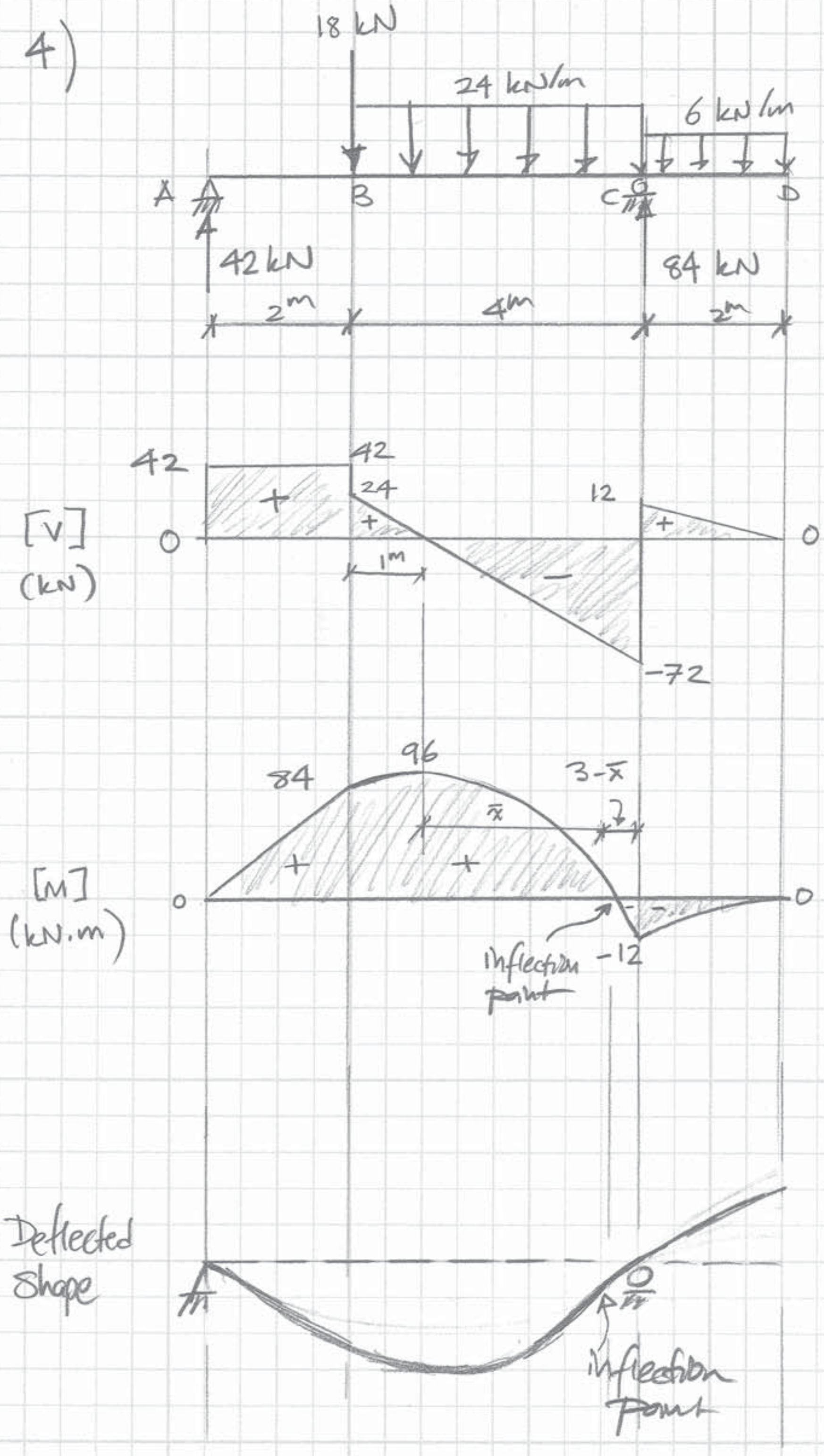
$$\overset{\curvearrowleft +}{\sum} M_{\text{about } D} = 0 \; ; \qquad 10^k \cdot 5' - A_y \cdot 6' - 50 \text{ k.ft} = 0$$

$$\Rightarrow A_y = 0$$

$$\overset{\uparrow +}{\sum} F_y = 0 \; ; \qquad \cancel{A_y}^{\,0} + D_y = 0 \Rightarrow D_y = 0$$

$$\overset{\rightarrow +}{\sum} F_x = 0 \; ; \qquad -10^k + D_x = 0 \Rightarrow D_x = 10^k \rightarrow$$

4)



Sign convention

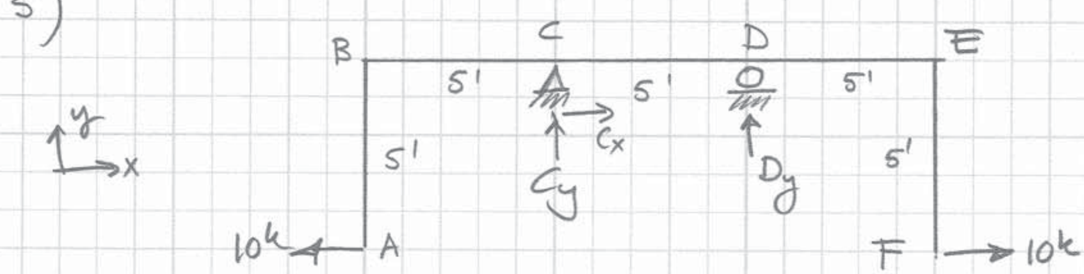
$$96 - \frac{\bar{x}\cdot 24\bar{x}}{2} = 0$$

$$96 - 12\bar{x}^2 = 0$$

$$\bar{x} = \sqrt{8} = 2\sqrt{2} \text{ m}$$

$$3-\bar{x} \cong 0.17 \text{ m}$$

5)



Reactions: $\overset{+}{\rightarrow}\sum F_x = 0 \;:\; C_x - 10 + 10 = 0 \Rightarrow C_x = 0$

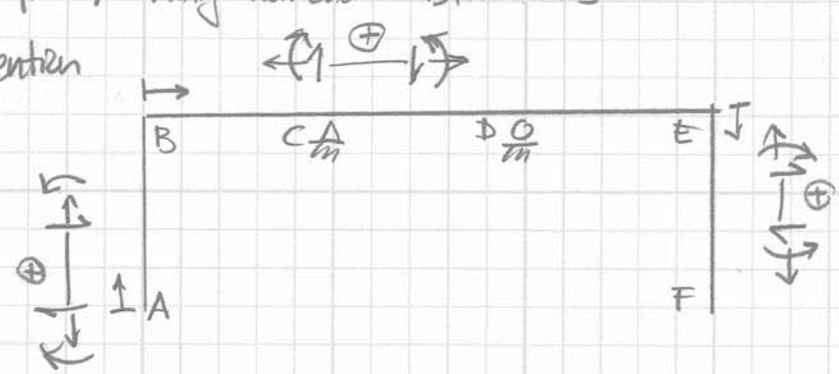
$\overset{\curvearrowleft +}{\sum} M_{about\ D} = 0 \;:\; -C_y \times 5' - 10^k \times 5' + 10^k \times 5' = 0 \Rightarrow C_y = 0$

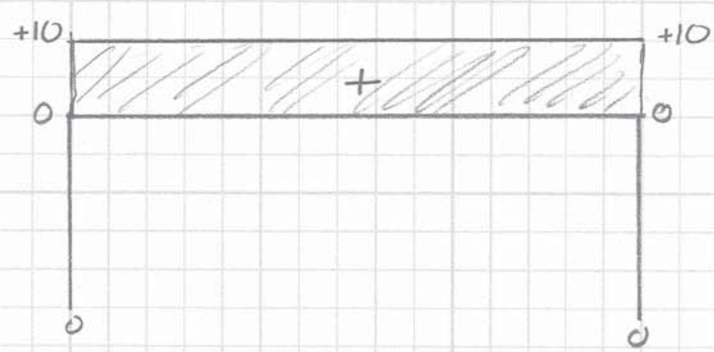
$\overset{\uparrow +}{\sum} F_y = 0 \;:\; \cancel{C_y}^{\,0} + D_y = 0 \Rightarrow D_y = 0$

no reaction!

Internal force/bending moment distributions

sign convention

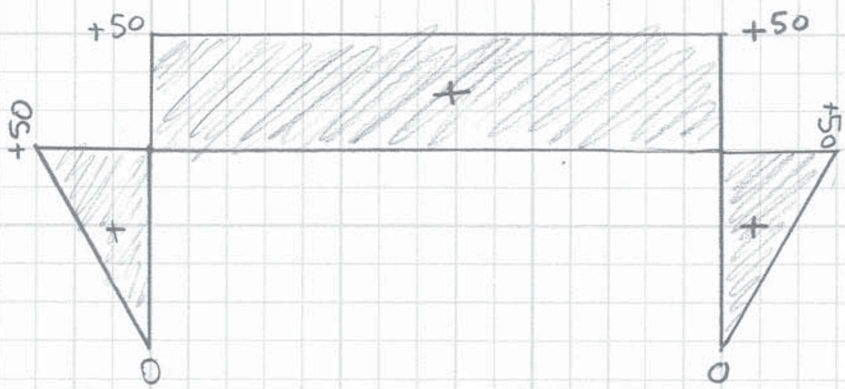




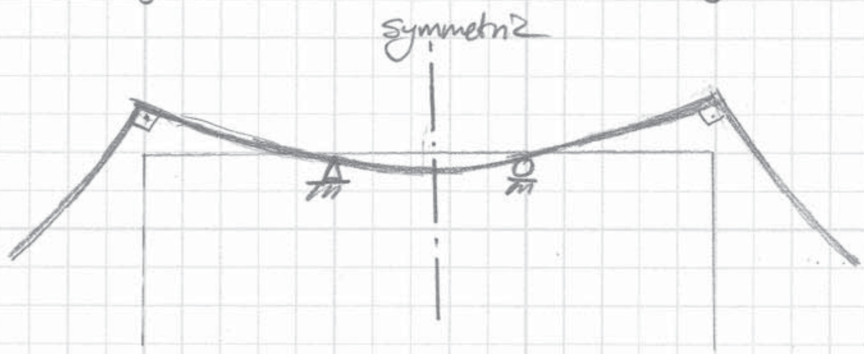
[N]
(kip)

[V]
(kip)

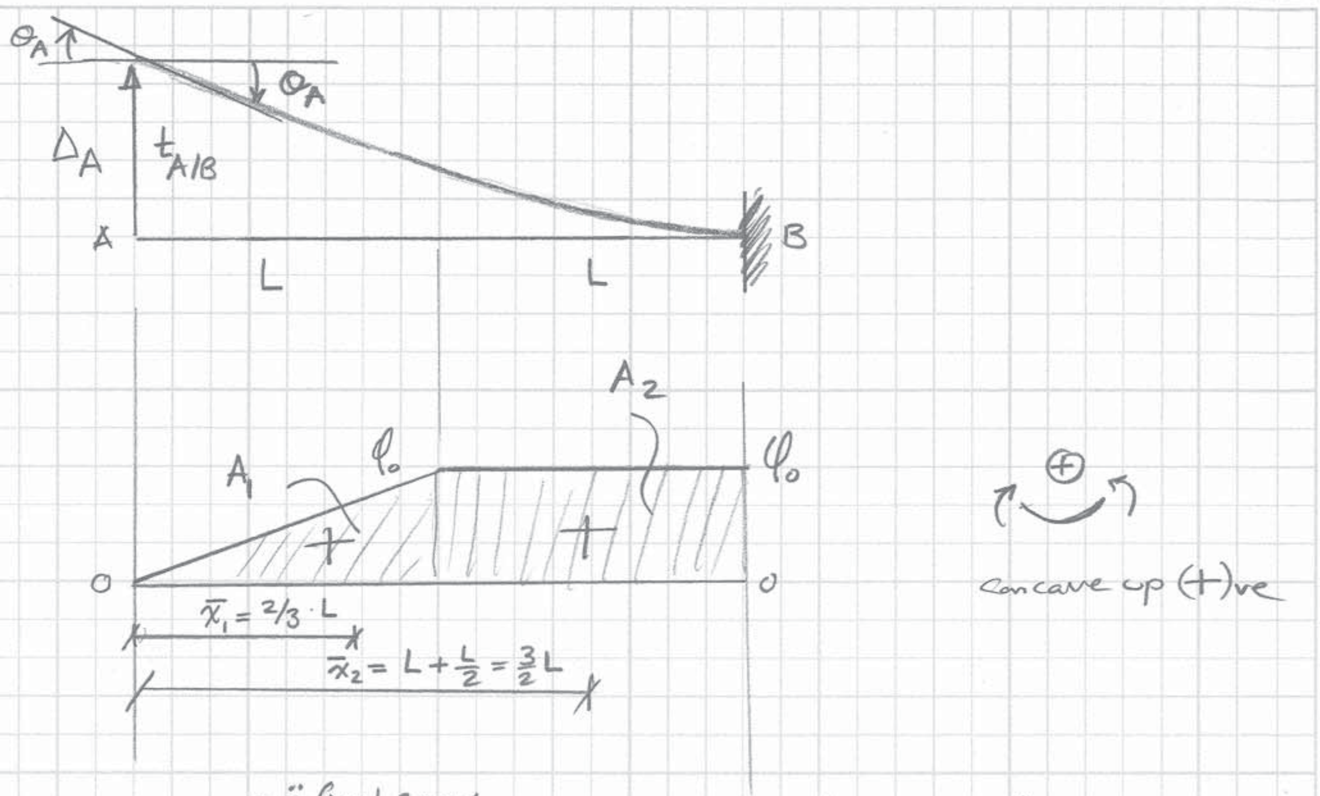
[M]
(kip.ft)



Deflected
Shape



6)



0 ∵ fixed support

$$\vec{\theta}_A = \cancel{\vec{\theta}_B} + \vec{\theta}_{A/B} = \int_B^A \varphi\, dx = \overbrace{\frac{1}{2}\cdot\varphi_0\cdot L}^{A_1} + \overbrace{\varphi_0\cdot L}^{A_2} = \frac{3}{2}\varphi_0 L \quad (CW)$$

$$\Delta_A = t_{A/B} = A_1\bar{x}_1 + A_2\bar{x}_2 = \frac{\varphi_0 L}{2}\cdot\frac{2}{3}L + \varphi_0\cdot L\cdot\frac{3}{2}L$$

∵ B is a fixed support

frm Thm #2 of moment-area method

$$\Rightarrow \quad \Delta_A = \frac{11}{6}\varphi_0 L^2 \uparrow$$