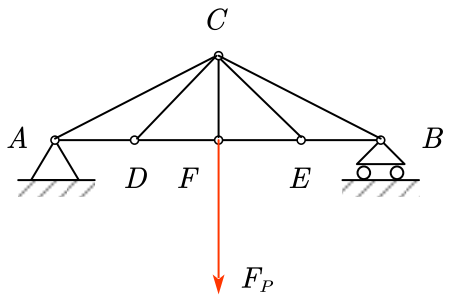
University of Maryland Fall 2018

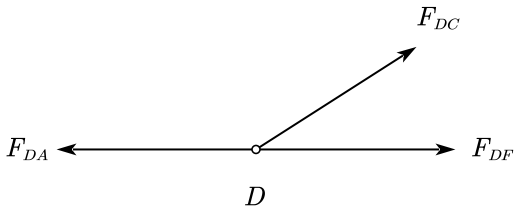
ENCE353: Introduction to Structural Analysis

Homework #2 Solution

Problem 1: Find the zero force members in the following truss structure.



Draw a free body diagram at joint D (assume all members are in compression):

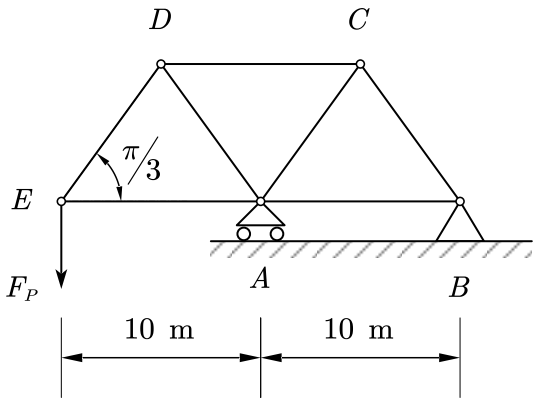


If there is a force in member DC (i.e. $F_{DC} \neq 0$), the $\sum F_y=0$ can NOT be accomplished because there are no other forces to balance the vertical component of F_{DC}. Therefore, the F_{DC} must be zero.

Similar logic can be applied in joint E.

Thus, members with zero force in the structure are **CD** and **CE**.

Problem 2: If the maximum force that any member can support is 12 kips in tension and 8 kips in compression, determine the maximum force F_P can be applied on the following structure (all the angles are $\pi/3$).

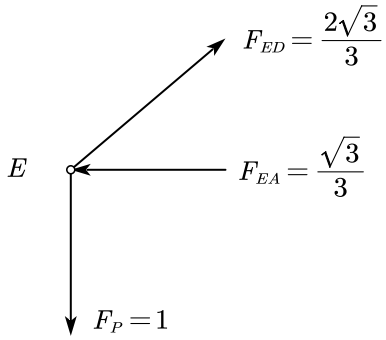


Use *method of superposition* for this linear elastic structure and assume F_p=1 kips, the vertical reaction forces at A and B are:

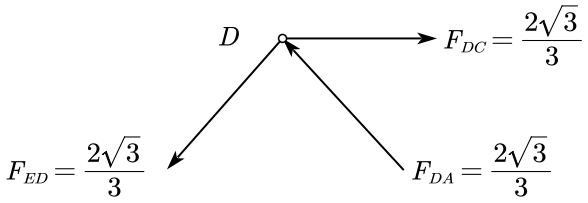
$$\sum M_A=0,\ F_p*10=V_B*10,\ V_B=F_p=1 \text{ kips } (\downarrow)$$

$$\sum F_y=0,\ -F_P+V_A-V_B=0,\ V_A=2 \text{ kips } (\uparrow)$$

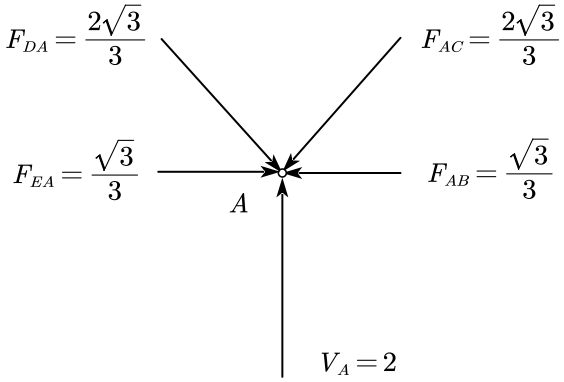
use *method of joint* to calculate the force in each member starting from joint E:



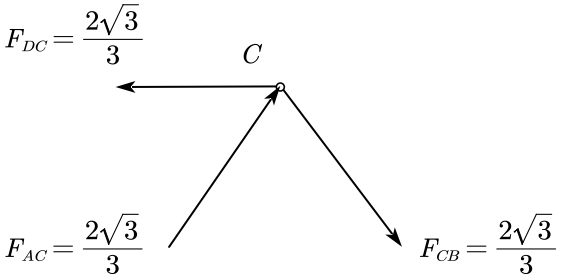
(1)



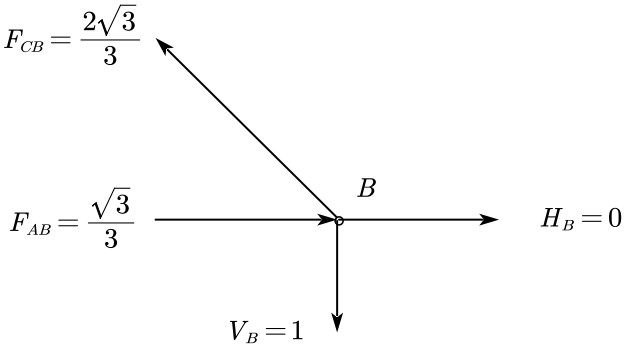
(2)



(3)



(4)



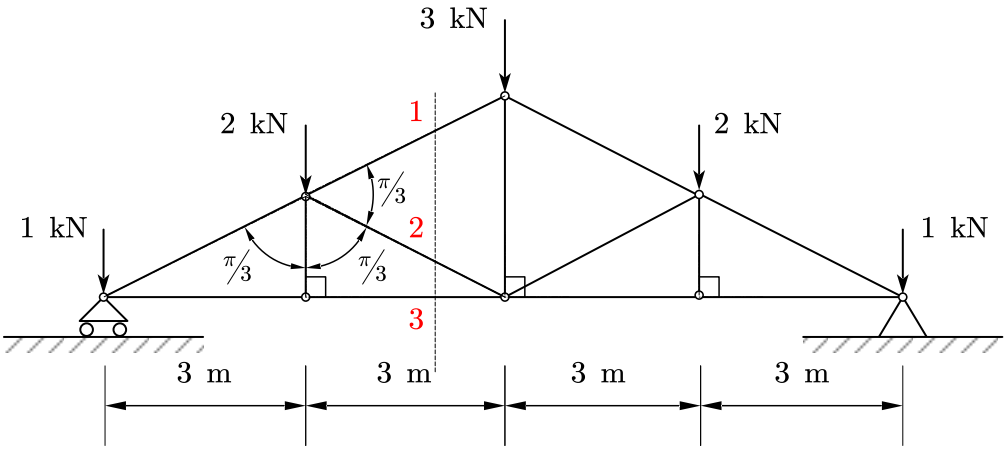
(5)

Thus, the maximum compression force will result in member AD, AC with a value of $2\sqrt{3}/3$;

The maximum tension force will result in member ED, CB with a value of $2\sqrt{3}/3$.

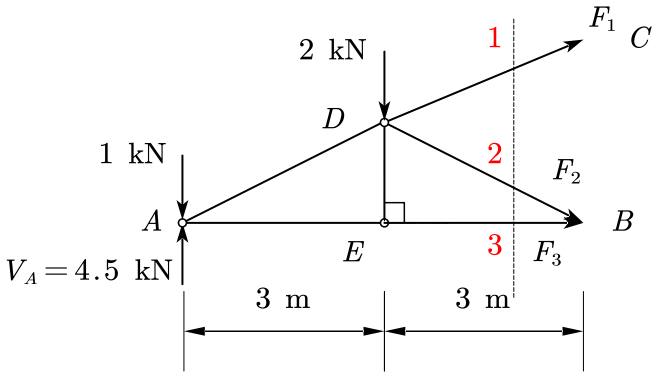
So, the compression controls, and the maximum $F_P=\frac{8\ \text{kips}}{2\sqrt{3}/3\ \text{kips}}\cdot 1\ \text{kips}=6.93\ \text{kips}$.

Problem 3: Use *method of section* to solve for the forces in members 1, 2 and 3.



(1) the structure is symmetric about the center line; thus, the vertical reaction forces are equal with a value of 9/2 kN and there will be no horizontal reaction force due to equilibrium.

(2) Use *method of section*; draw free body diagram as following assuming forces in member 1, 2 and 3 are in tension:



$$\sum M_B = 0,\ \ 1\times 6 + 2\times 3 = V_A \cdot 6 + F_1 \cdot d_1$$

$$\text{where, } d_1 = 3$$

$$\Rightarrow F_1 = -5 \text{ kN}$$

$$\sum M_D = 0,\ \ 1\times 3 + F_3 \cdot d_2 = V_A \cdot 3$$

$$\text{where, } d_2 = \sqrt{3}$$

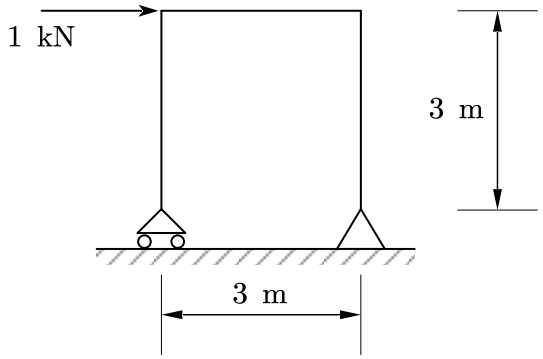
$$\Rightarrow F_3 = \frac{10.5}{\sqrt{3}} = 6.06 \text{ kN}$$

$$\sum M_E = 0,\ \ 1\times 3 = V_A \cdot 3 + F_1 \cdot d_3 + F_2 \cdot d_4$$

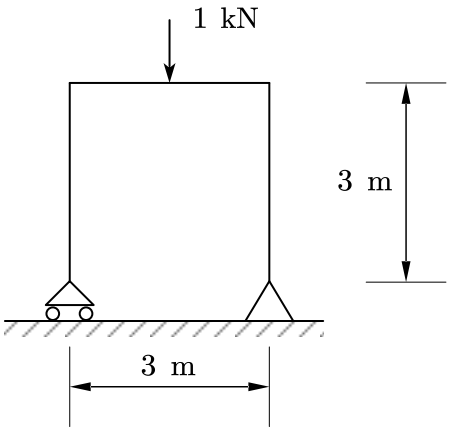
$$\text{where, } d_3 = \frac{3}{2},\ d_4 = \frac{3}{2}$$

$$\Rightarrow F_2 = -2 \text{ kN}$$

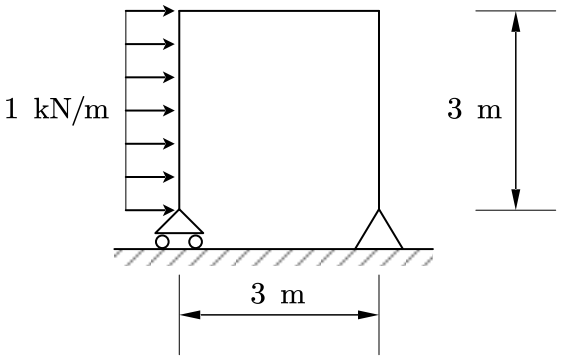
Problem 4: Plot the moment diagram for the following structures. Please include essential calculation details.



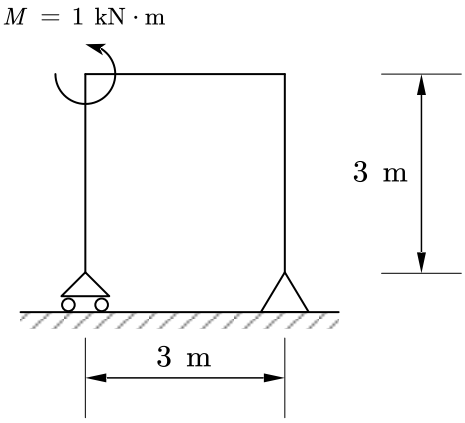
(a)



(b)

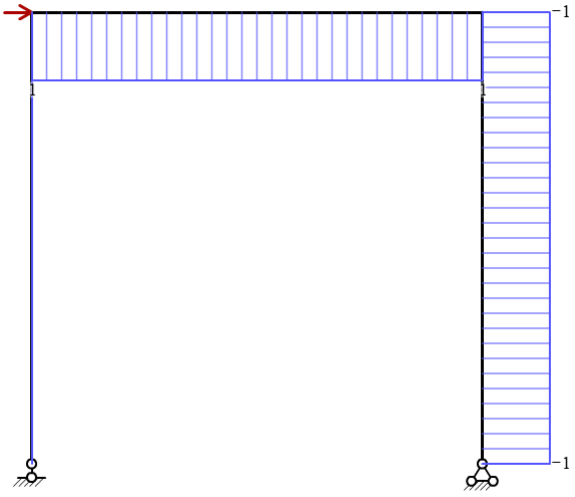


(c)

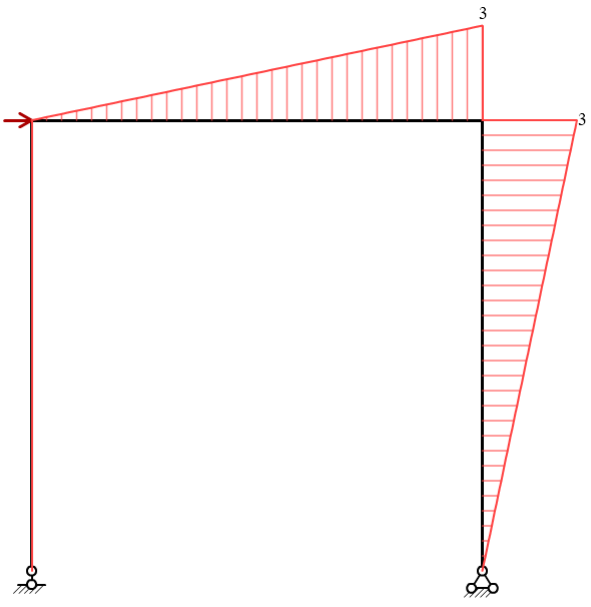


(d)

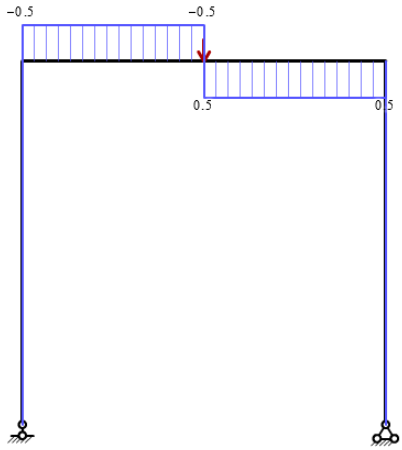
(a) Shear Force Diagram (SFD):



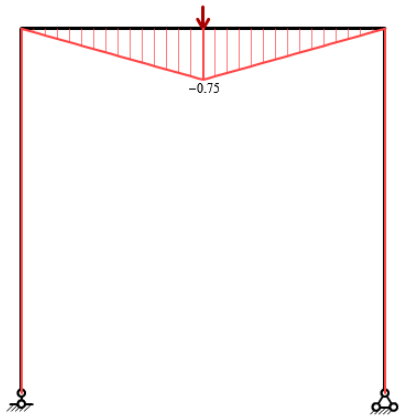
Bending Moment Diagram (BMD):



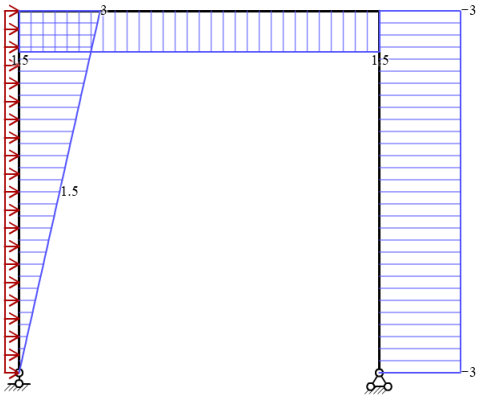
(b) Shear Force Diagram (SFD):



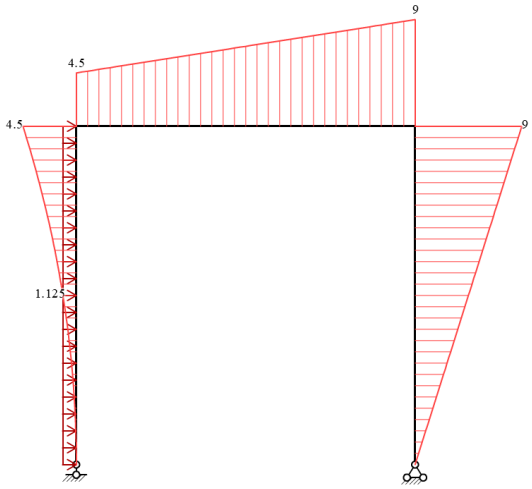
Bending Moment Diagram (BMD):



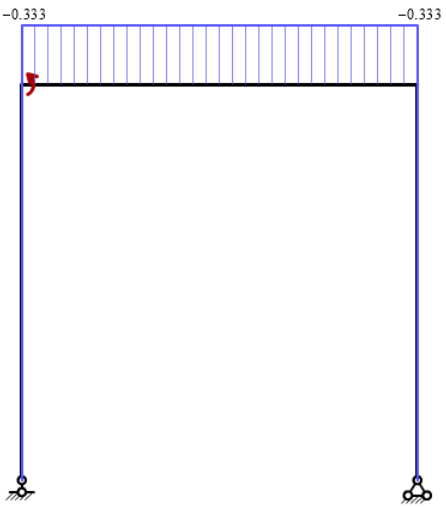
(c) Shear Force Diagram (SFD):



Bending Moment Diagram (BMD):



(d) Shear Force Diagram (SFD):



Bending Moment Diagram (BMD):