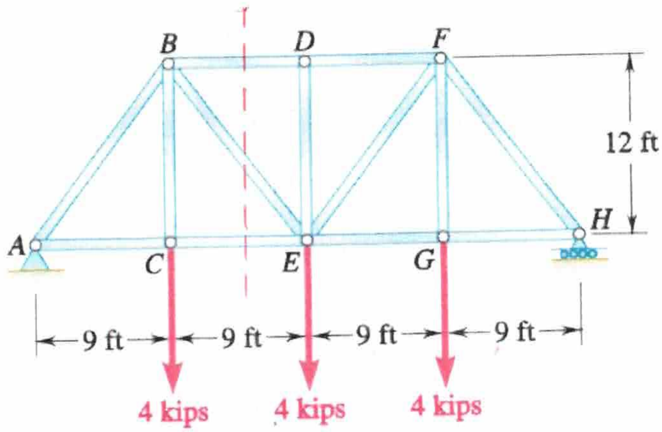
Solutions.

AEM 2011 Exam #2 Wednesday, April 12

A non-communicating calculator is allowed. Full credit will only be given if all steps used are clearly communicated (free body diagrams, algebra, etc).

1. (35 points) You are an engineer tasked with replacing key components in an existing truss structure with applied loads shown below.

Cut for (c)



Member BD will be replaced with a new material which can safely handle 3 *kips* in tension and 5 *kips* in compression. The other members will be unchanged and are already certified as safe for the given loading.

(a) What method should you use to find the force along member BD without solving for all intermediate member forces? method of sections

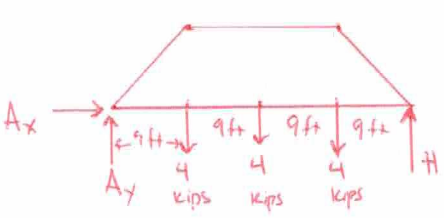
(b) What method would you use if you needed to find the load in all members? method of joints

(c) Use the method you listed in part (a) to find the force in member BD. Is the new BD material suitable for the given loading?

(d) Use method from part (b) to find the internal forces along members AB and AC. State whether they are in tension or compression.

(e) There is a zero-force member present for the given truss loading. Identify this zero-force member.

(c) Find reaction at A & H: use entire structure



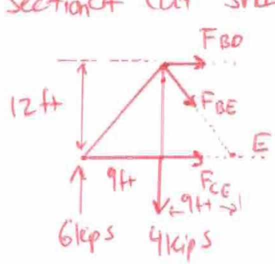
ΣF_y ... not needed yet

$\circlearrowleft \Sigma M_H: \ 0 = 4 \text{ kips}(9 ft + 18 ft + 27 ft) - A_y \, 36 ft$

$A_y = 6.0$ kips

$\Sigma F_x: \ A_x = 0$

Analyze Left section of cut shown above



chosen to remove effect of other two unknown forces

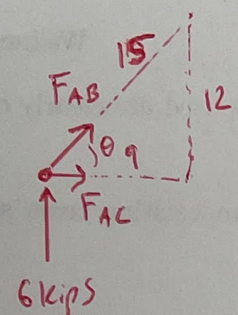
$\circlearrowleft \Sigma M_E: \ 0 = (-F_{BD}) \, 12 ft - (6 \text{ kips}) \, 18 ft + (4 \text{ kips}) \, 9 ft$

$F_{BD} = -6$ kips or Member BD is in compression w/ 6 kips of load.

~~F_{BD}~~

Not suitable since 6 kips > safe compression

(d) Analyze joint A:



$$+\uparrow \sum F_y : 0 = 6 \text{ kips} + F_{AB} \overbrace{\frac{12}{15}}^{\sin\theta}$$

$$F_{AB} = -7.5 \text{ kips}$$

$$\overset{+}{\rightarrow} \sum F_x : 0 = F_{AC} + F_{AB} \cdot \overbrace{\frac{9}{15}}^{\cos\theta}$$

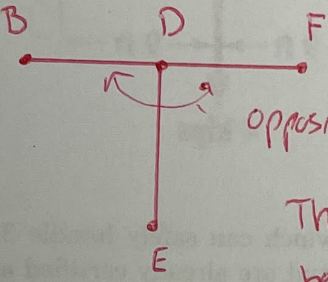
$$F_{AC} = - F_{AB} \cdot \frac{9}{15}$$

$$= 4.5 \text{ kips}$$

So member AB has 7.5 kips load, in compression.

member AC has 4.5 kips load in tension.

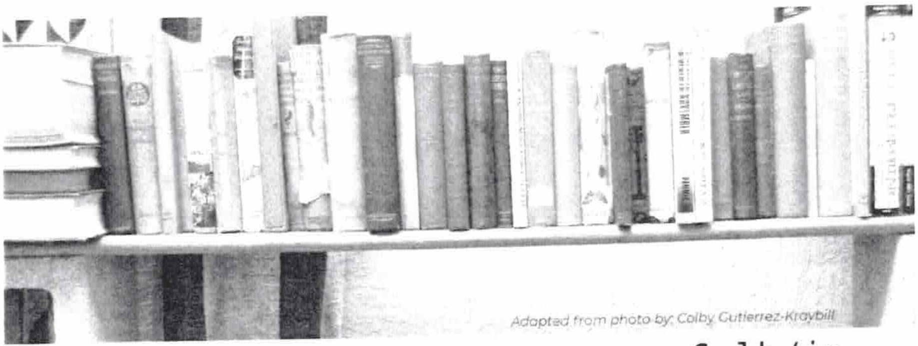
(e) Looking at

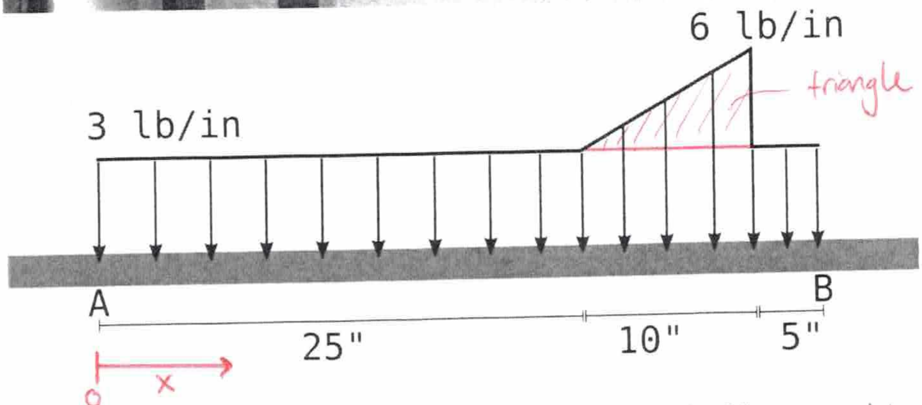


opposite members.

Thus, member DE must be a zero-force member.

2. (20 points) Consider the bookshelf below.





The loading on the shelf can be approximated as the shown distributed load between points A and B.

(a) What is the magnitude of resultant of the distributed load?

(b) What is the location of resultant of the distributed load?

see coord. sys above.

Solve for both simultaneously:

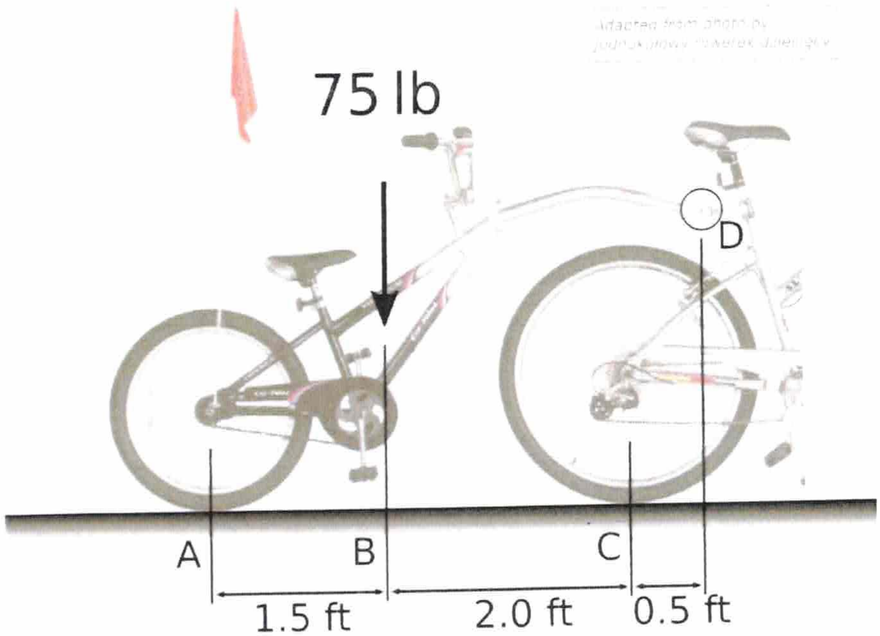
	(or area) Force$_i$	$\bar{x}_i$ (in)	$\bar{x}_i F_i$ (lb·in)
rectangle	$\left(3\frac{lb}{in}\right)\cdot 40in = 120\ lb$	20 in	2400.0
triangle	$\frac{1}{2}(10")\left(6\frac{lb}{in} - 3\frac{lb}{in}\right) = 15\ lb$	$\left(35 - \frac{1}{3}10\right) = 31.7$ in	475.0
total	135 lb		2875.0

$$\bar{x} = \frac{\Sigma \bar{x}_i F_i}{\Sigma F_i} = 21.3\ in$$

so (a): 135 lb down

(b): acting down at $x = 21.3$ in (coord system shown above)

3. (30 points) Consider a seatpost mounted trailer bike. The combined weight of the trailer bike and the tag along rider is 75 lbs and acts between the seat and the handlebars, as shown. The trailer bike connects to the lead bike by a pin joint at point D. The bikes are at rest so you may assume there are no horizontal reaction forces at the joint D.

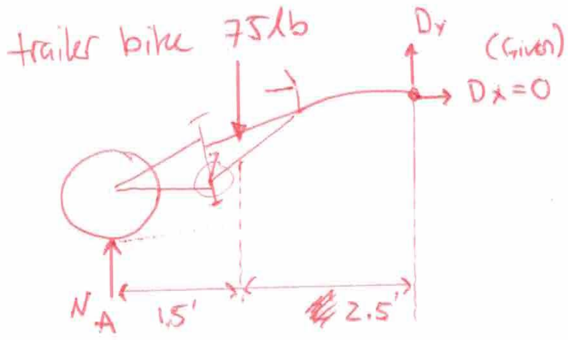


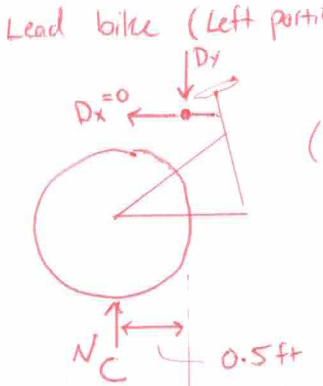
(a) Draw separate free body diagrams for the trailer bike and the (left-hand portion) of the lead bike. Clearly label the reaction force at D on both of your diagrams.

(b) What is the reaction force at joint D?

(c) The horizontal link connecting the lead-bike seatpost to joint D is 3 *in* long. What is the moment applied to the lead-bike seatpost when the trailer bike is attached? Give both the magnitude and direction.

(a)



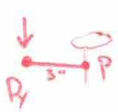


(b) Must analyze trailer bike since missing info about lead bike.

$$\circlearrowleft + \sum M_A : 0 = (-75\,lb)(1.5') + (D_y)(4\,ft)$$

$$D_y = 28.125\ lb \uparrow$$

(c)



~~$\circlearrowleft \sum M_P$~~: moment: $(D_y)(3") = 84.375\ lb \cdot in$ $\circlearrowleft$ (causes lead bike to pitch up)

4. (15 points) A beam experiences three different loading scenarios. Draw lines connecting each beam-load scenario to the matching shear and bending-moment diagram.