TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Arch314
STRUCTURES I

Fall 2024
Recitation

FACULTY: Prof. Peter von Bülow
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Welcome to Recitation session 09/20

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Office hours:

By appointment

Click here to Schedule

Please feel free to ask questions.

Welcome to Recitation session 09/20

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(Homework 4, 5)**
- Answering student’s questions
- Lab: **Equilibrium**

Please feel free to ask questions.

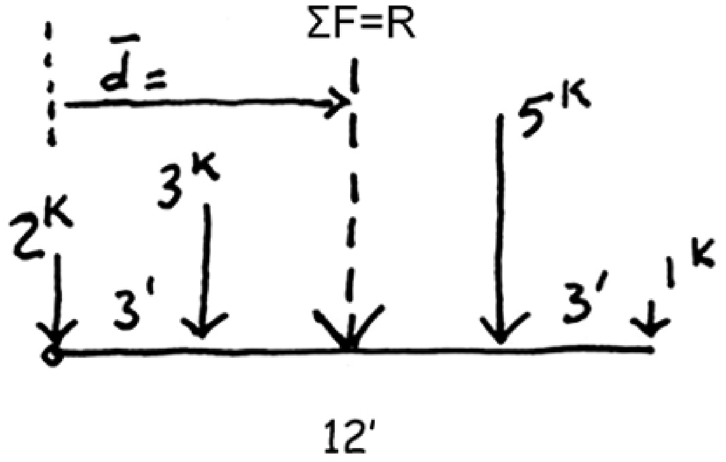
Contact: Mohsenv@umich.edu

Recap of the week

Parallel Force Resultant

The resultant is a single force that has the same effect as a group of forces.

Since the resultant is equivalent to the group of forces, it can be used in place of the group.

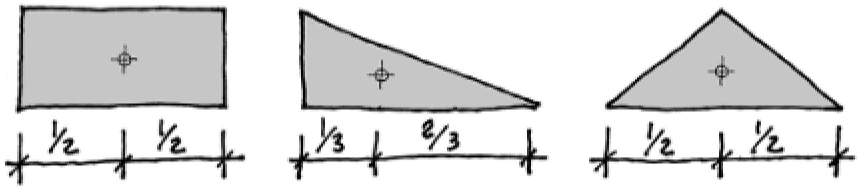


$$\sum(\mathbf{F}\times d)=\mathbf{R}\times\bar{d}$$

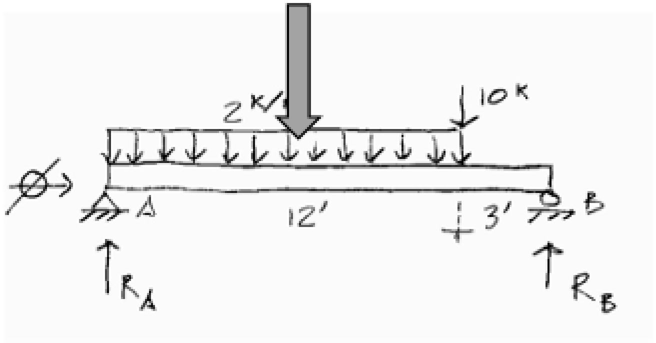
$$\mathbf{R}=\sum\mathbf{F}$$

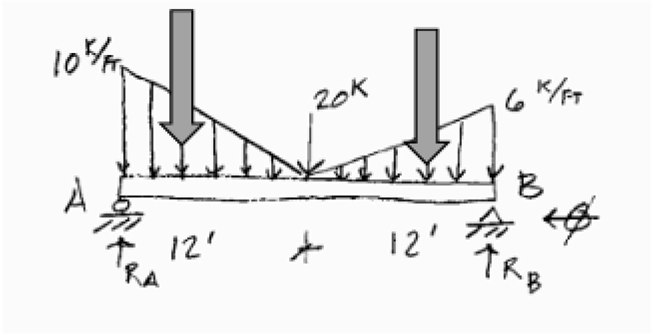
$$\bar{d}=\frac{\sum(\mathbf{F}\times d)}{\sum\mathbf{F}}$$

Recap of the week



Load Distribution through the Centroid





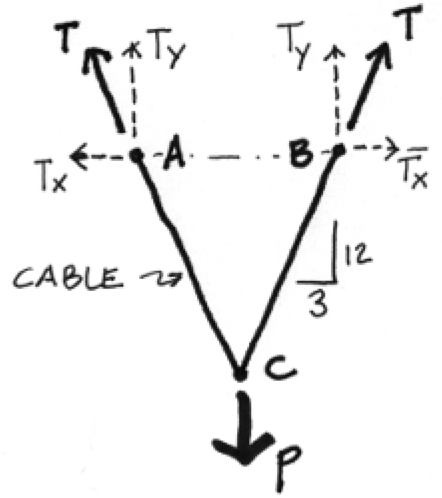
Recap of the week

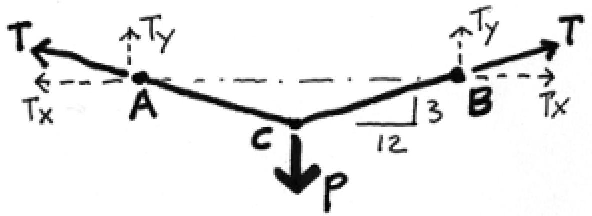
Cables

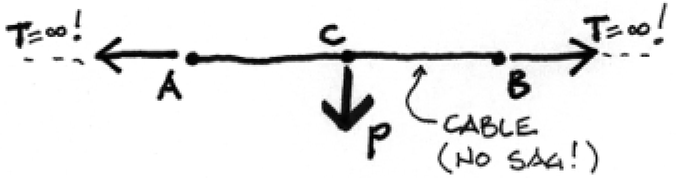
Both the sag and the load determine the force in the cable.

The less the sag, the higher the force in the cable.

The vertical component of the cable force in the case shown remains constant . Ty=P/2 But since the resultant follows the direction of the cable, Tx becomes greater as sag decreases. With no sag, Tx is infinite !







Recap of the week

Solving Cables Forces

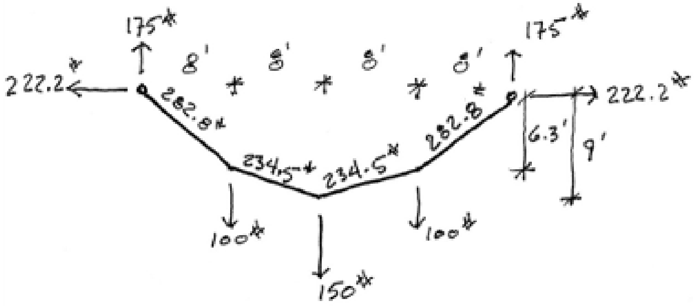
even supports – symmetric loading
Procedure:

1. Solve all external forces (reactions)

- If symmetric, then the reactions at each end are equal
- Use 3 equilibrium equations to solve

$$\sum Fx = 0 \quad \sum Fy = 0 \quad \sum M = 0$$

- The moment is also 0 at any point in the cable since the cable cannot support flexure,



2. Start at reactions and move inward

- Draw FBD of system from reaction inward
- Slope is proportional to forces
- Use force equations to solve at cut
- Find forces and slope of each section

$$\sum Fx = 0$$
$$\sum Fy = 0$$

Provide the solution for the assignment – HW4

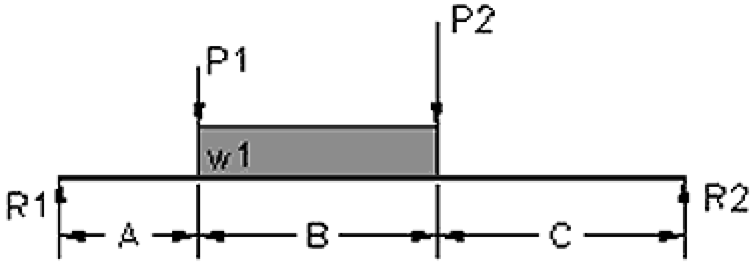
5. Parallel Force Systems

Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

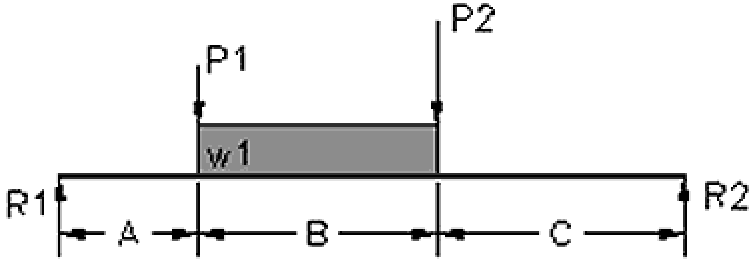
Distance A	7 FT
Distance B	5 FT
Distance C	11 FT
Force P1	1 KIPS
Force P2	5 KIPS
Force w1	0.55 KLF

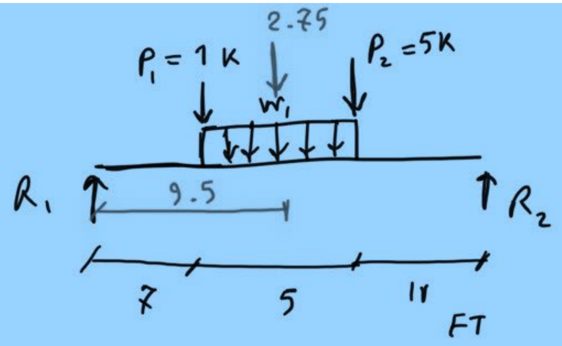
- Problem:



#	Question	Your Response
1	Total force from distributed load: W1	KIPS
2	Distance of total load W1 from left reaction	FT
3	Total applied downward force	KIPS
4	Left End Reaction (R1)	KIPS
5	Right End Reaction (R2)	KIPS

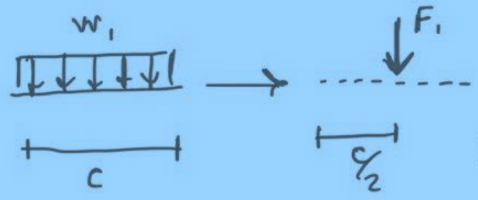
Provide the solution for the assignment- HW4





w_1 : distributed load

0.55 KLF



① point load $= 0.55 \times 5 = 2.75$ K

② distance $= 7 + \frac{5}{2} = 9.5$ FT

③ Total applied downward Force : $1 + 2.75 + 5 = 8.75$ K

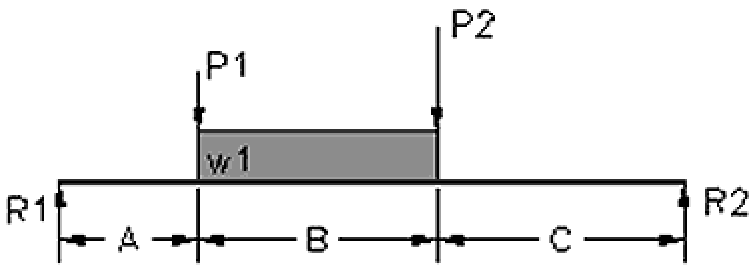
④ $\sum M_{@2} = 0$

$$R_1 \times (11+5+7) - P_1 \times (11+5) - F_1 \times (11+\frac{5}{2}) - P_2 \times (11) = 0$$

$$R_1 \times 23 - 1 \times 16 - 2.75 \times 13.5 - 5 \times 11 = 0$$

$$\rightarrow R_1 = 4.70109$$

Provide the solution for the assignment- HW4



(5) $\Sigma M_{@1} = 0$

$P_1 \times A + F_1 \times (A + \frac{B}{2}) + P_2 \times (A + B) - R_2 (A + B + C) = 0$

$1 \times (7) + 2.75 \times (9.5) + 5 \times (12) - R_2 (23) = 0$

$\longrightarrow \boxed{R_2 = 4.0489}$

(6) Check the sum of vertical forces

$\Sigma F_y = 0$

$R_1 - P_1 - F_1 - P_2 + R_2 = 0$

$4.70 - 1 - 2.75 - 5 + 4.0489 = 0$ ✓

Provide the solution for the assignment – HW5

6. Equilibrium of Rigid Bodies

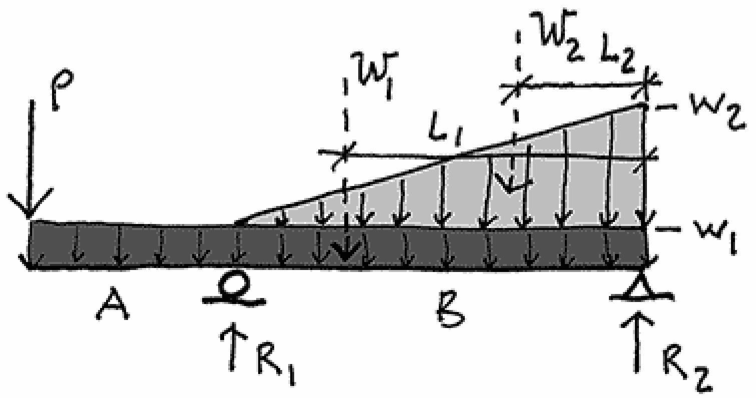
Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

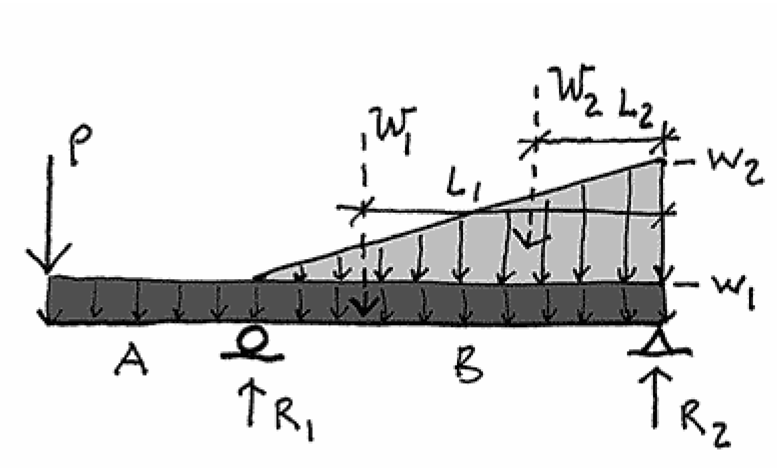
Point Load, P	4.5 KIPS
Uniform Load, w1	198 PLF
Triangular Load, w2	347.6 PLF
Length A	4.8 FT
Length B	12 FT

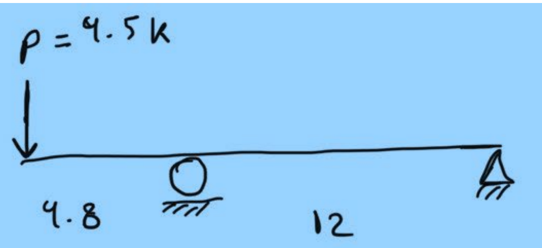
#	Question	Your Response
1	TOTAL force of the uniform load: W1	KIPS
2	Distance from centroid of the uniform load to R2: (L1)	FT
3	TOTAL force of the triangular load: W2	KIPS
4	Distance from centroid of the triangular load to R2: (L2)	FT
5	TOTAL load on the member	KIPS
6	Reaction force: R1 (down is - : up is +)	KIPS
7	Reaction force: R2 (down is - : up is +)	KIPS

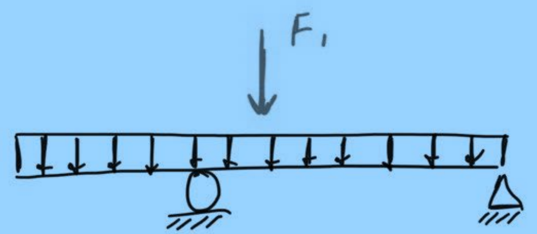
- Problem:



Provide the solution for the assignment- HW5







$w_1 = 198$ PLF
uniform load

① $F_1 = 198 \times (A + B)$

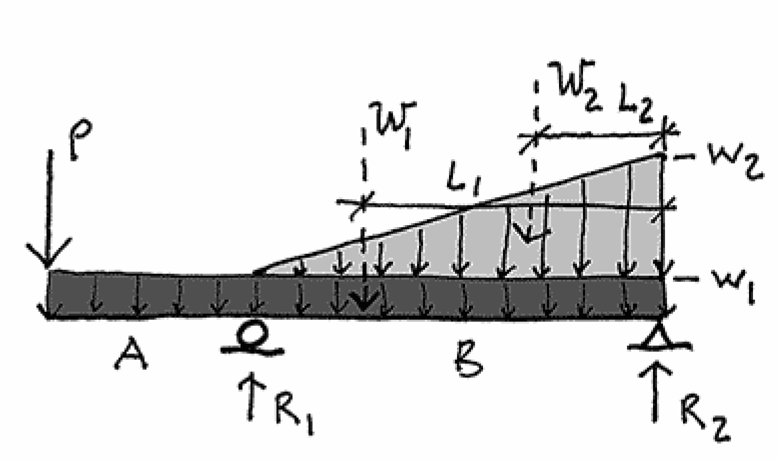
$= 198 \times (4.8 + 12) = 3326.4$ LBS

$= 3.3264$ KIPS

② distance of F_1

$\frac{A+B}{2} = \frac{4.8+12}{2} = 8.4$

Provide the solution for the assignment- HW5



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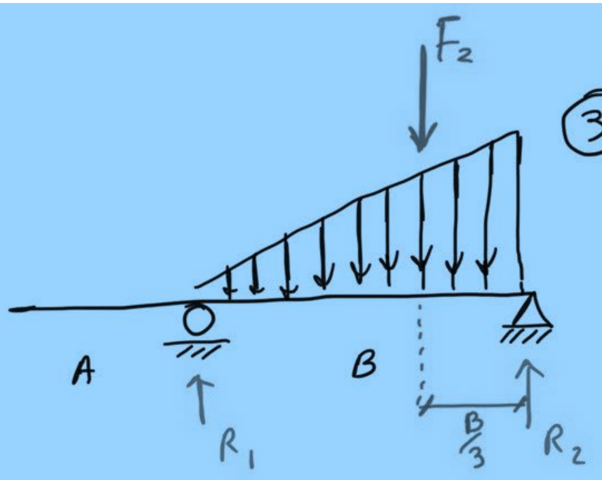


③ $w_2 = 347.6$ pLF
Triangular Load

$$F_2 = \frac{B \times w_2}{2} = \frac{12 \times 347.6}{2} = 2085.6 \text{ LBS}$$

2.0856 KIPS

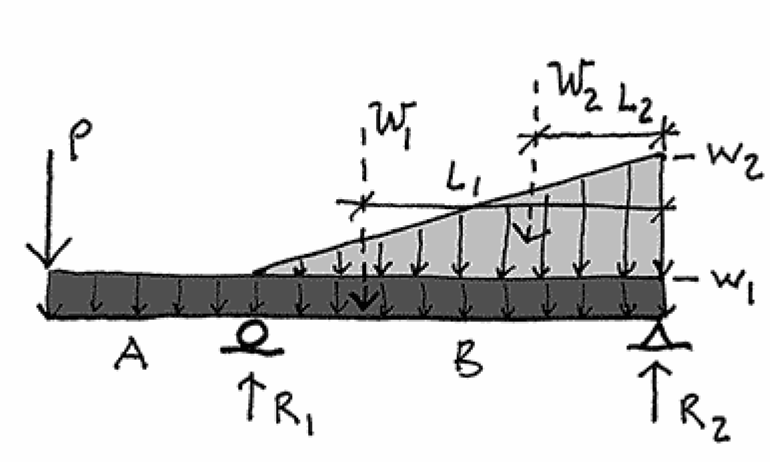
Note:

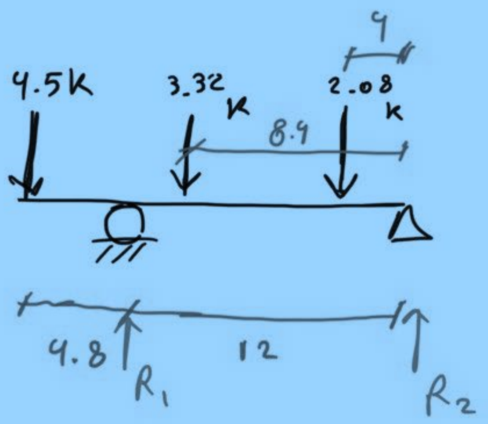
1 KIPS = 1000 LBS

④ distance of F_2

$$\frac{B}{3} = \frac{12}{3} = 4 \text{ FT}$$

Provide the solution for the assignment- HW5



- 

⑤ Total Load on the member

$$= P + F_1 + F_2$$

$$= 4.5 + 3.32 + 2.08 = 9.9\ K$$

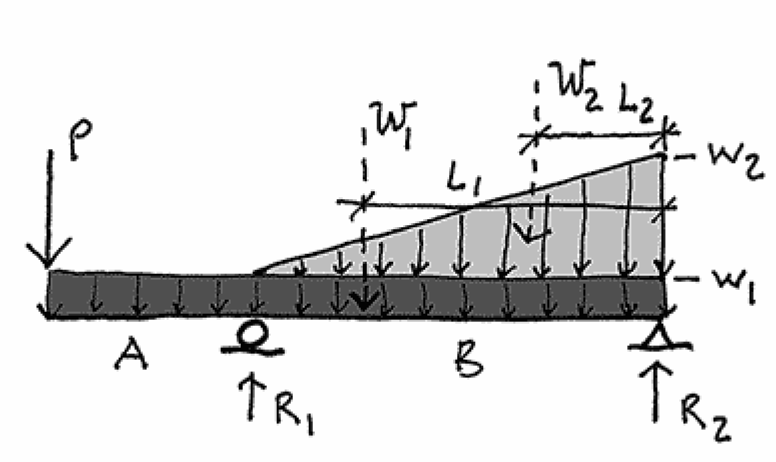
⑥ $\Sigma M_{@2} = 0$

$$-F_2 \times 4 - F_1 \times \left(\frac{12+4.8}{2}\right) + R_1 \times 12 - 4.5\,(12+4.8) = 0$$

$$-2.08\,(4) - 3.32\,(8.4) + R_1 \times 12 - 4.5\,(16.8) = 0$$

$$\longrightarrow \boxed{R_1 = 9.3173}\ k$$

Provide the solution for the assignment- HW5



$\Sigma M_{@1} = 0$

$-4.5 \times 4.8 + 3.32\,(12 - 8.4) + 2.08\,(12 - 4) - R_2 \times 12 = 0$

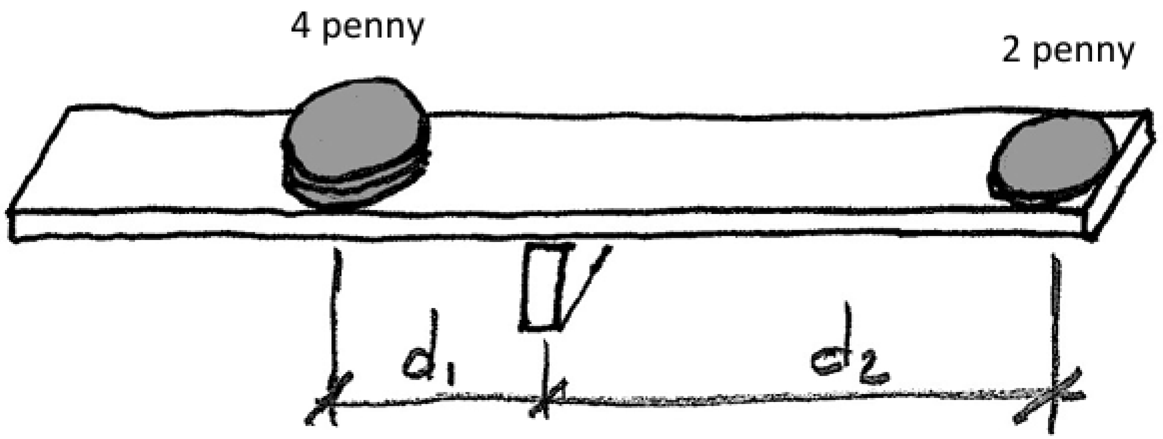
$6.992 = R_2 \times 12 \longrightarrow R_2 = 0.5827$

(2) check $\Sigma F_y = 0$

$R_1 + R_2 \overset{?}{=}$ Total load on member

$9.3173 + 0.58 = 9.9^{k}$ o.k ✓

Lab: Equilibrium



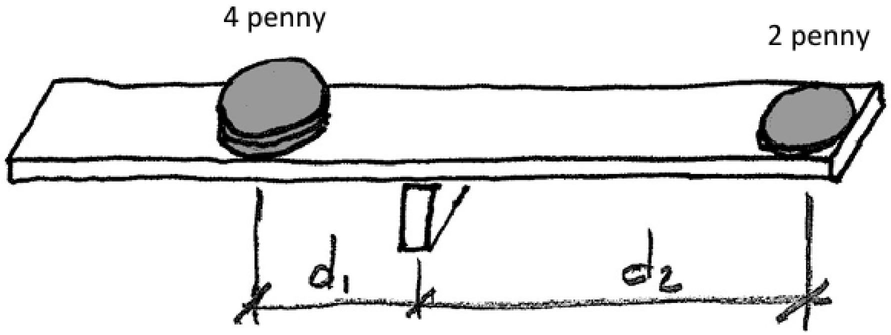
Description

This project provides opportunity to experiment with the equilibrium of a balanced beam. It makes use of Archimedes' equations for forces on a lever to determine end reactions.

Goals

To observe balanced conditions using a beam balance.
To experiment with different combinations of balanced forces
To calculate the balanced forces using Archimedes' method

Lab: Equilibrium



Procedure

1. Set up the beam balance with the fulcrum block at the center balance point.
2. Place 2 penny weights at one end. Use the ruled scale at the bottom of this page to measure the distance from the fulcrum to the center of the stack of pennies (d2). You can adjust the pennies to an even distance.
3. Calculate a point on the opposite side of the balance (d1) were 4 pennies will balance the 2 using Archimedes' equation. d2 x 2 = d1 x 4 so, d1 = d2 x 2/4
4. Place 4 pennies at your calculated distance d1 and verify that they balance the 2 pennies.
5. Calculate the moment caused by each stack of pennies around the fulcrum (in US pennyweight-inches).
6. Now, leaving the 2 penny stack at one end, spread the 4 pennies out next to each other and again find the balance point.
7. Observe that the center of the line of pennies still lies at d1 when the beam is balanced.
8. Finally, for the inverted case (point load on a simple beam) with P = 6 pwt at 2" from one end of the 12" beam, what would each end reaction be. Show this in a sketch.

Thank you.

Any question?

Please feel free to ask questions.

Contact: Mohsenv@umich.edu