

Arch 314

Structures I

Fall 2025 Recitation 004

Peter von Bülow
Amely Wackerbauer

Recitation 004

Welcome to session 3!

- Quick Recap of this week's lectures
- Homework Review (#4 Parallel Force Systems & #5 Equilibrium of Rigid Bodies)
- Lab: Equilibrium

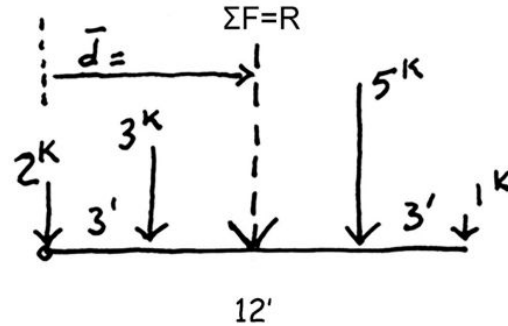
Feel free to ask questions anytime

Lecture: Equilibrium of Rigid Bodies (9/15)

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.



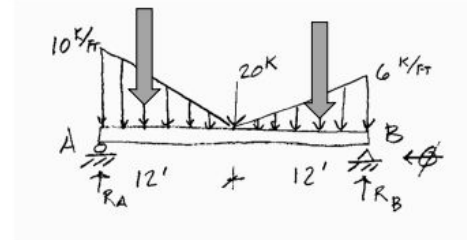
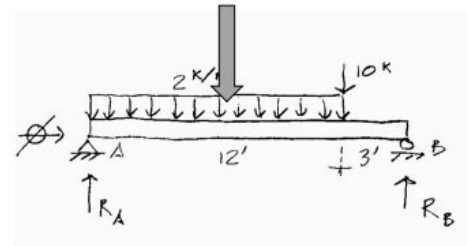
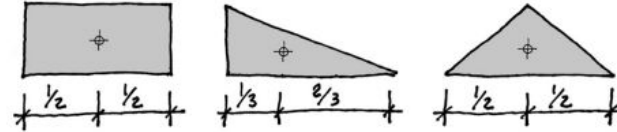
$$\sum (\mathbf{F} \times d) = \mathbf{R} \times \bar{d}$$

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

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

Lecture: Equilibrium of Rigid Bodies (9/15)

Load distribution through the Centroid



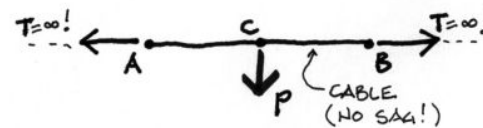
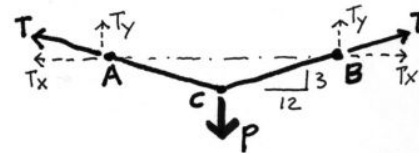
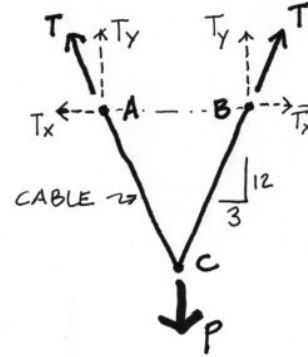
Lecture: Cable Systems (9/17)

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. $T_y = P/2$
But since the resultant follows the direction of the cable, T_x becomes greater as sag decreases. With no sag, T_x is infinite!



Lecture: Cable Systems (9/17)

Solving Cables Forces

even supports – symmetric loading

Procedure:

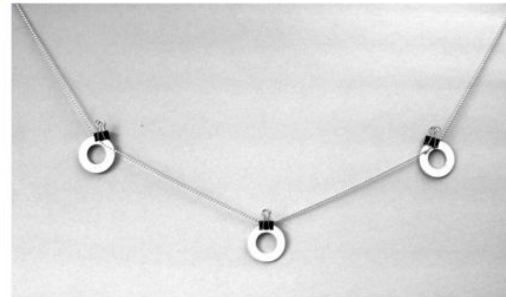
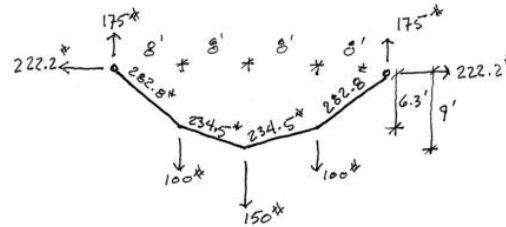
1. Solve all external forces (reactions)
 - If symmetric, then the reactions at each end are equal
 - Use 3 equilibrium equations to solve

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum M = 0$$

- 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

$$\boxed{\begin{aligned} \sum F_x &= 0 \\ \sum F_y &= 0 \end{aligned}}$$

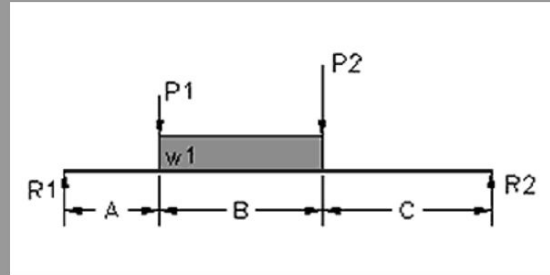


HW #4: Parallel Force Systems

4. 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	12 FT	
Distance B	12 FT	
Distance C	8 FT	
Force P1	5 KIPS	
Force P2	2 KIPS	
Force w1	0.82 KLF	

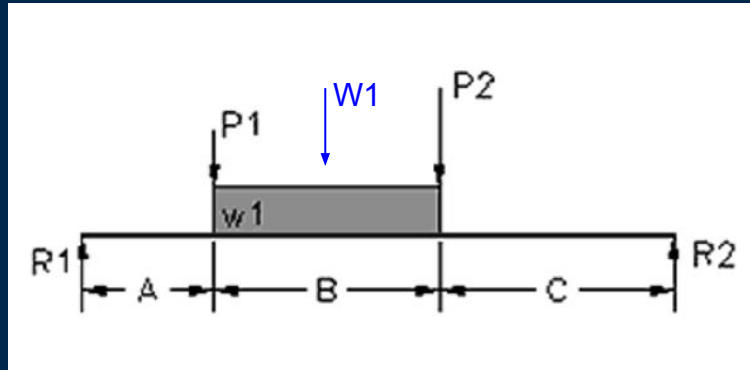


Your answer was correct.
You scored 5 points.

#	Question	Your Response	Correct Answer	Score
1	Total force from distributed load: W1	9.84 KIPS	9.84 KIPS	
2	Distance of total load W1 from left reaction	18 FT	18 FT	
3	Total applied downward force	16.84 KIPS	16.84 KIPS	
4	Left End Reaction (R1)	7.93 KIPS	7.93 KIPS	
5	Right End Reaction (R2)	8.91 KIPS	8.91 KIPS	

HW #4: Parallel Force Systems

Distance A	12 FT
Distance B	12 FT
Distance C	8 FT
Force P1	5 KIPS
Force P2	2 KIPS
Force w1	0.82 KLF



1. Total Force from distributed load: W_1

$$\begin{aligned} W &= w_1 \times B \\ &= 0.82 (12') \\ &= \boxed{9.84 \text{ KIPS}} \end{aligned}$$

2. Distance of total load W_1 from left reaction

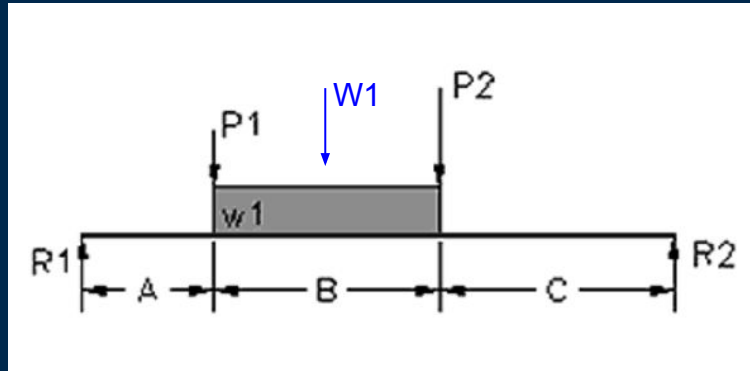
$$\begin{aligned} \text{Distance} &= A + \frac{B}{2} \\ &= 12 + \frac{12}{2} \\ &= \boxed{18'} \end{aligned}$$

3. Total applied downward force

$$\begin{aligned} \Sigma F &= P_1 + P_2 + W_1 \text{ — calculated in \#1} \\ &= 5 \text{ kips} + 2 \text{ kips} + 9.84 \text{ kips} \\ &= \boxed{16.84 \text{ KIPS}} \end{aligned}$$

HW #4: Parallel Force Systems

Distance A	12 FT
Distance B	12 FT
Distance C	8 FT
Force P1	5 KIPS
Force P2	2 KIPS
Force w1	0.82 KLF



4. Left End Reaction (R1)

$$\sum M_{R1} = 0 \quad (+\curvearrowright)$$

$$\sum M_{R2} = 0 \quad (-\curvearrowright)$$

$$M_{R1} = 0 = +P_1(A) + W1\left(A + \frac{B}{2}\right) + P_2(A+B) - R_2(A+B+C)$$

* get R2 on left side alone *

$$R_2 = \frac{+P_1(A) + W1\left(A + \frac{B}{2}\right) + P_2(A+B)}{A+B+C}$$

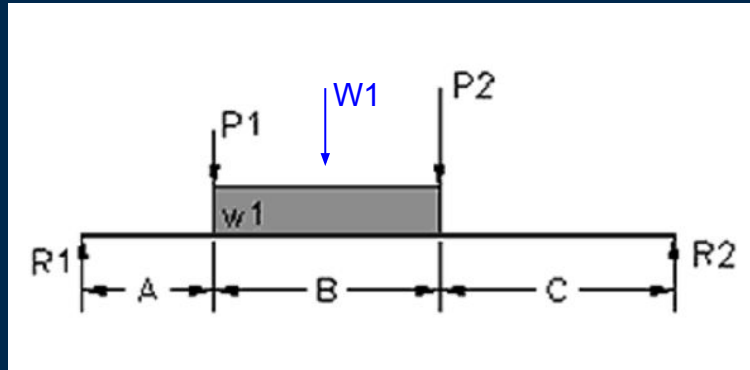
$$= \frac{5(12) + 9.84\left(12 + \frac{12'}{2}\right) + 2(12+12)}{12' + 12' + 8'}$$

$$R_2 = \boxed{8.91 \text{ KIPS}}$$

#5!

HW #4: Parallel Force Systems

Distance A	12 FT
Distance B	12 FT
Distance C	8 FT
Force P1	5 KIPS
Force P2	2 KIPS
Force w1	0.82 KLF



5. Right End Reaction (R_2)

$$R_1 = P_1 + P_2 + W1 - R_2$$

$$= 5 + 2 + 9.84 - 8.91 \leftarrow \text{calc in \#4}$$

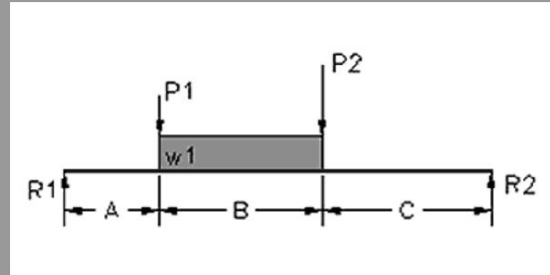
$$R_1 = \boxed{7.93 \text{ KIPS}}$$

HW #4: Parallel Force Systems

4. 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	12 FT	
Distance B	12 FT	
Distance C	8 FT	
Force P1	5 KIPS	
Force P2	2 KIPS	
Force w1	0.82 KLF	

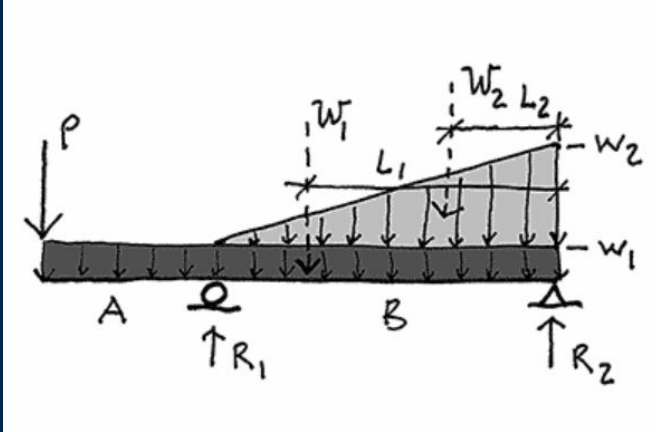


Your answer was correct.
You scored 5 points.

#	Question	Your Response	Correct Answer	Score
1	Total force from distributed load: W1	9.84 KIPS	9.84 KIPS	
2	Distance of total load W1 from left reaction	18 FT	18 FT	
3	Total applied downward force	16.84 KIPS	16.84 KIPS	
4	Left End Reaction (R1)	7.93 KIPS	7.93 KIPS	
5	Right End Reaction (R2)	8.91 KIPS	8.91 KIPS	

HW #5: Equilibrium of Rigid Bodies

Point Load: P	1.2 KIPS
Uniform Load: w1	32 PLF
Triangular Load: w2	58.7 PLF
Length A	8.4 FT
Length B	21 FT



1. Total force of the uniform load: W_1

$$\begin{aligned} W_1 &= w_1 \times (A+B) \\ &= 32 (8.4+21) \\ &= \underline{940.8 \text{ lbs}} \\ &\quad 1000 \leftarrow \text{convert to kips} \\ &= \boxed{0.9408} \end{aligned}$$

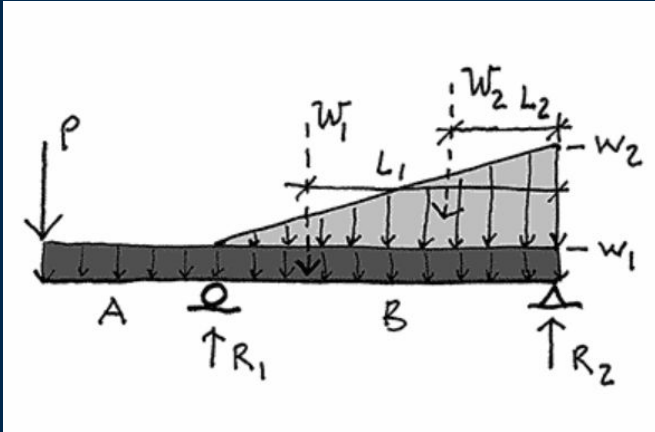
2. Distance from centroid of the uniform load to R_2 (L_1):

$$L_1 = \frac{A+B}{2} = \frac{8.4'+21'}{2} = \boxed{14.7'}$$

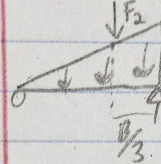
Middle of rect. load

HW #5: Equilibrium of Rigid Bodies

Point Load: P	1.2 KIPS
Uniform Load: w1	32 PLF
Triangular Load: w2	58.7 PLF
Length A	8.4 FT
Length B	21 FT



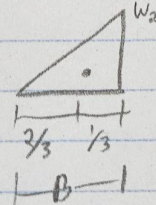
3. Total force of the triangular load: W_2



$$F_2 = \frac{B \times w_2}{2} = \frac{21(58.7)}{2}$$
$$= \frac{616.35 \text{ lbs}}{1000} = \boxed{0.6164 \text{ kips}}$$

← convert!

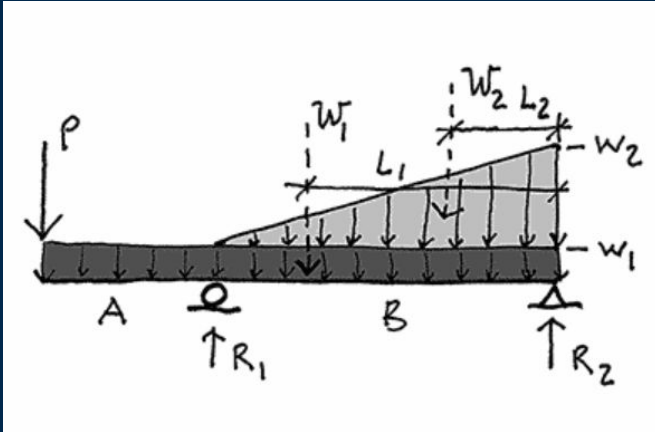
4. Distance from centroid of the triangular load to R_2 : L_2



$$L_2 = \frac{1}{3}B = \frac{21}{3} = \boxed{7'}$$

HW #5: Equilibrium of Rigid Bodies

Point Load: P	1.2 KIPS
Uniform Load: w1	32 PLF
Triangular Load: w2	58.7 PLF
Length A	8.4 FT
Length B	21 FT



5. Total load on member

$$\text{Load} = P + W_1 + W_2$$

$$= 1.2 + 0.9408 + 0.6164$$

$$= \boxed{2.7572 \text{ kips}}$$

6. Reaction force: R1

$$\sum M_0 = 0$$

$$\sum M_0 = 0 = +P_1(A+B) + W_1(L_1) + W_2(L_2) - R_1(B)$$

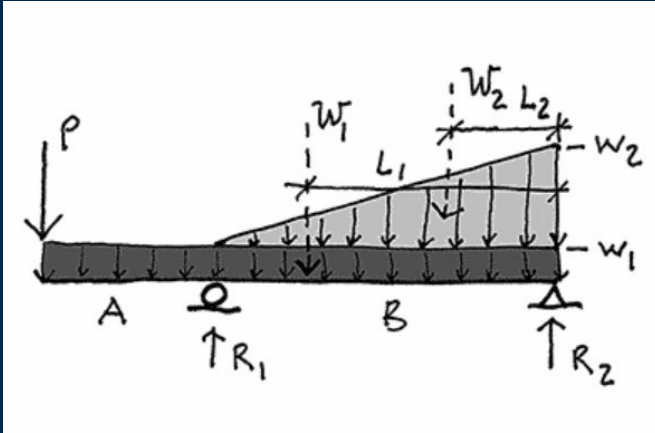
$$R_1 = \frac{P_1(A+B) + W_1(L_1) + W_2(L_2)}{B}$$

$$= \frac{1.2(8.4' + 21') + 0.94(14.7') + 0.62(7')}{21'}$$

$$R_1 = \boxed{2.544 \text{ kips}}$$

HW #5: Equilibrium of Rigid Bodies

Point Load: P	1.2 KIPS
Uniform Load: w1	32 PLF
Triangular Load: w2	58.7 PLF
Length A	8.4 FT
Length B	21 FT



9. Reaction force: R2

$$\Sigma F_v = 0$$

$$\Sigma F_v = -P - W_1 - W_2 + R_2 + R_1$$

$$-R_2 = -P - W_1 - W_2 + R_1 \quad \#6$$

$$-R_2 = -1.2 - 0.94 - 0.62 + 2.544$$

$$-R_2 = -0.2132$$

$$R_2 = \boxed{0.2132 \text{ kips}}$$

LAB!