TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Arch314
STRUCTURES I

Fall 2025
Recitation

FACULTY: Prof. Peter von Bülow
Mohsen Vatandoost

Welcome to Recitation session 12/05

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Office: Room 3128
hours:
Wed: 11:30 – 12:30
Mon, Fri: 11:30 - 12:00
walk-ins welcome!

Please feel free to ask questions.

Welcome to Recitation session 12/05

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(Homework 14)**
- Answering student's questions
- Lab: **Beam Deflection**

Please feel free to ask questions.

Contact: Mohsenv@umich.edu

Recap of the week

Integral

Derivation

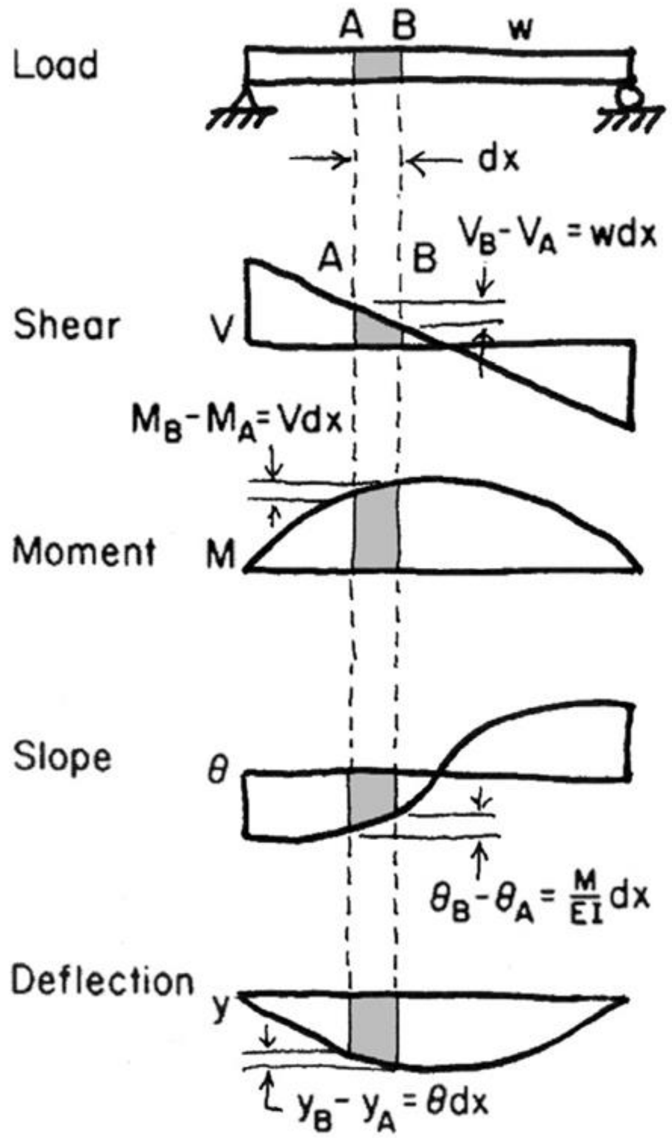
w

$V = \int w\,dx$

$M = \int V\,dx$

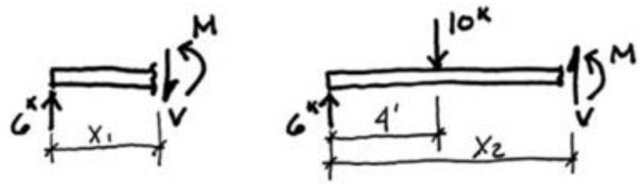
$\theta = \int \frac{M}{EI}\,dx$

$y = \int \theta\,dx$



Recap of the week

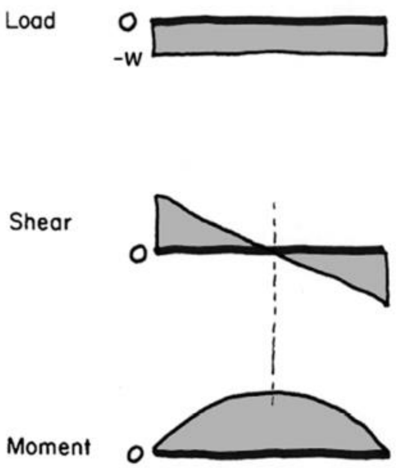
1. Equilibrium Method - example



$-w$

$$V = \int w dx$$
$$V = -wx + C$$
$$V = -wx + \frac{wl}{2}$$

$$M = \int V dx$$
$$M = -\frac{w}{2}x^2 + \frac{wl}{2}x + C$$
$$M = -\frac{w}{2}x^2 + \frac{wl}{2}x$$



Methods to Determine Values of Shear and Moment

1. Equilibrium Method
   - Select a point along the beam
   - Cut a section and draw the FBD
   - Solve for the internal shear and moment forces at the section
2. Integration of Equations
   - Write the equation of the load function
   - Integrate load equation to get shear equation
   - Solve integration constant (use end reaction)
   - Integrate shear equation to get moment equation
   - Solve integration constant (use point with zero moment, e.g. end point)
3. Semi-graphical Method
   - Draw load diagram and solve end reactions with equilibrium equations.
   - Start at left and construct the shear diagram using point loads and areas on load diagram
   - Calculate areas of shear diagram to find change in value on moment diagram
   - Find points of zero moment to begin moment diagram, e.g. end points
4. Superposition of Equations
   - Break the loading into standard cases
   - Use given equations to solve shear and moment for each case
   - Add the cases to get combined values of original loading

Provide the solution for the assignment – **HW14**

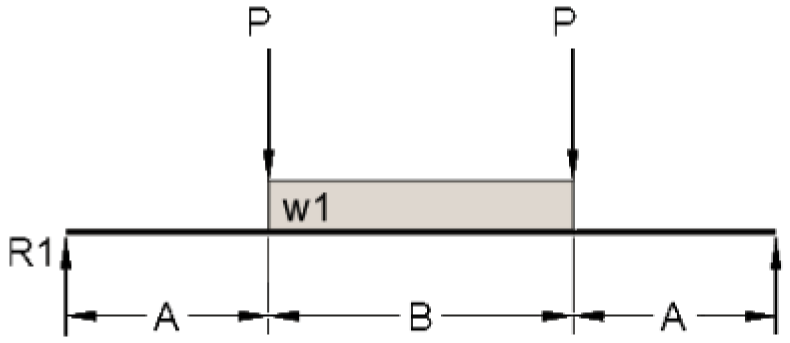
- Problem:

16. Beam Deflection

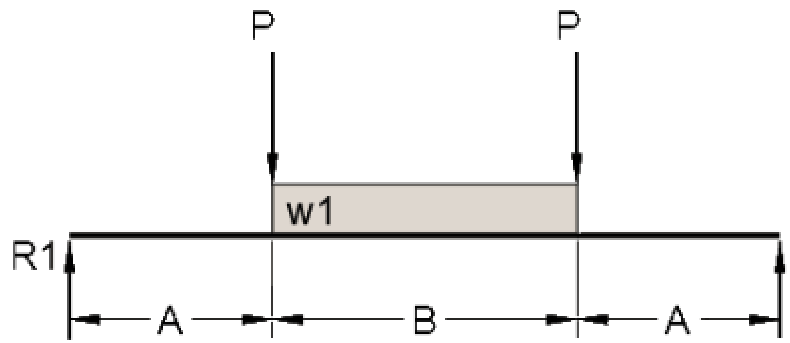
For the given simple span beam, use shear, moment, slope and deflection diagrams to determine the slope at each end, the deflection at points A and B distance from left, and the maximum deflection at the centerline. Remember to divide out EI to get deflection in inches. Be sure to correct errors at each step to maintain accuracy.

DATASET: 1 -2- -3-

Length A	9 FT
Length B	9 FT
Point Load P	9 KIPS
Uniform Load w	1 KLF
Modulus of Elasticity	29000 KSI
Moment of Inertia	430 IN^4



Provide the solution for the assignment – **HW14**



#	Question	Your Response	
1	R1 (+ = upward)		KIPS
2	Shear at reaction (V1)		KIPS
3	Shear at point load (V2)		KIPS
4	Moment at point load (M1)		KIP-FT
5	Moment at center line (M2)		KIP-FT
6	Area under moment diagram (MA1)		KIP-FT^2
7	Area under moment diagram (MA2)		KIP-FT^2
8	Area under moment diagram (MA3)		KIP-FT^2
9	Slope(EI) at reaction (S1). Give absolute value.		KIP-FT^2
10	Slope(EI) at point load (S1). Give absolute value.		KIP-FT^2
11	Area under slope(EI) diagram (SA1)		KIP-FT^3
12	Area under slope(EI) diagram (SA2)		KIP-FT^3
13	Area under slope(EI) diagram (SA3)		KIP-FT^3
14	Centerline deflection. Give absolute value in INCHES.		INCHES

Provide the solution for the assignment – **HW14**

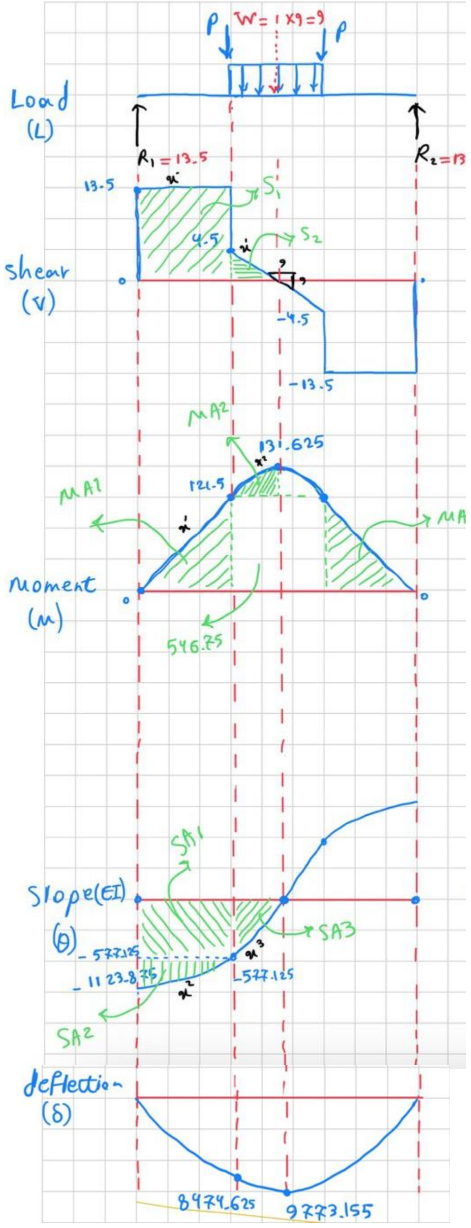
Note 1:
At the concentraited load there is always a jump in shear diagram.

Note 2:
when there is no load in between two section of beam, shear is constant.

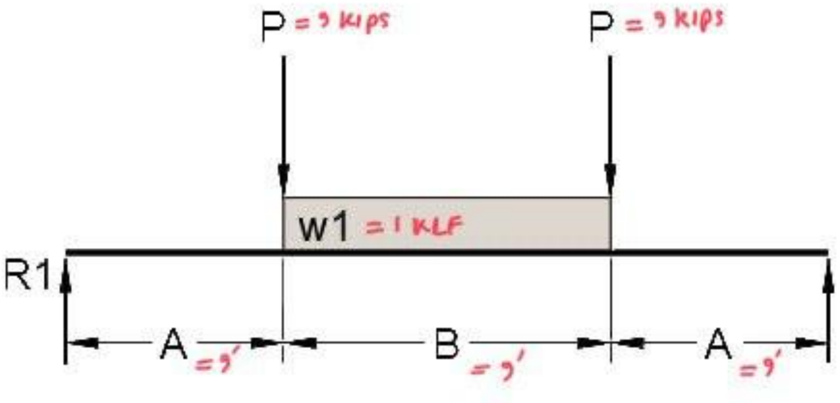
Note 3:
Load and shear are related. The result of a uniform load (w) is (vx+c)

Note 4:
where shear is zero in shear diagram, the moment is maximum.

Note 5:
where moment is max, slope is zero.



Provide the solution for the assignment – **HW14**



Step 1: External Reactions

$$\sum M_{@1} = 0$$

$$P \times A + W \times \left(A + \frac{B}{2}\right) + P \times (A+B) - R_2 (A+B+A) = 0$$

$$9 \times 9 + 9 \times \left(9 + \frac{9}{2}\right) + 9 \times (9+9) - R_2 (9+9+9) = 0$$

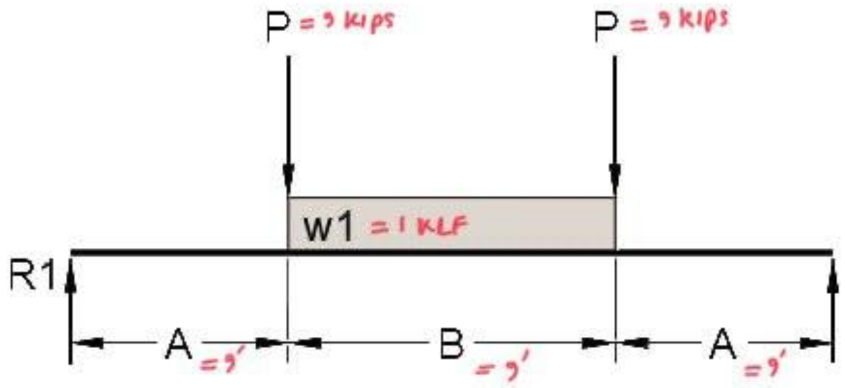
$$\rightarrow \boxed{R_2 = 13.5 \text{ KIPS}}$$

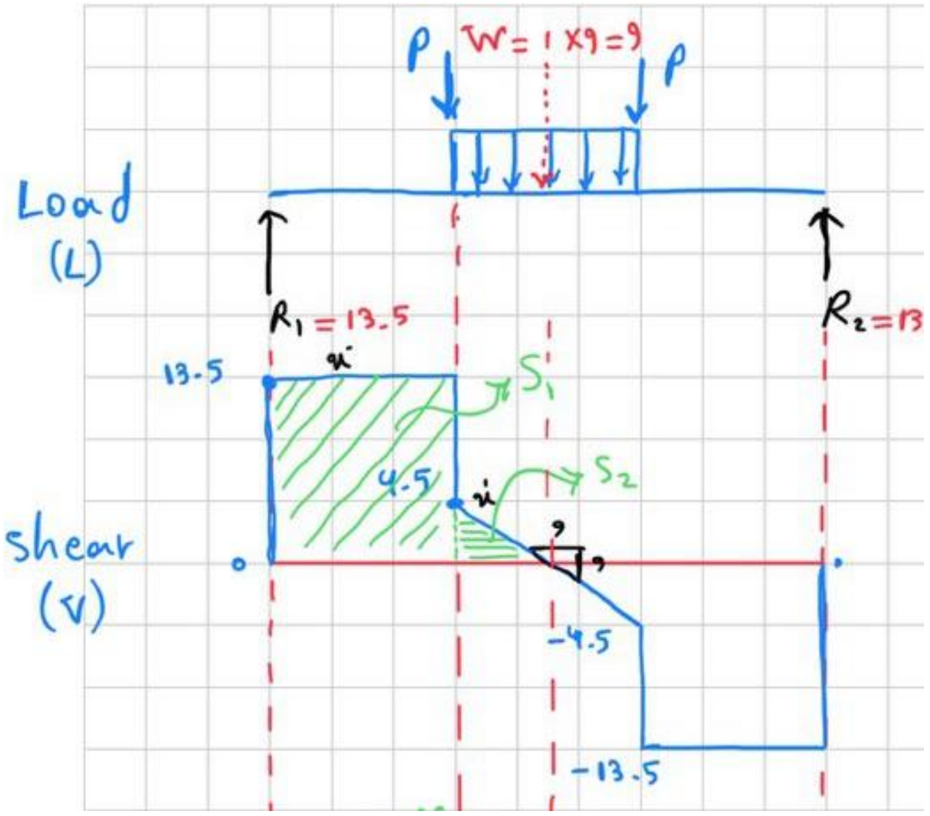
$$\sum F_y = 0$$

$$R_1 - P - W - P + R_2 = 0$$

$$R_1 - 9 - 9 - 9 + 13.5 = 0 \rightarrow \boxed{R_1 = 13.5 \text{ KIPS}}$$

Provide the solution for the assignment – **HW14**





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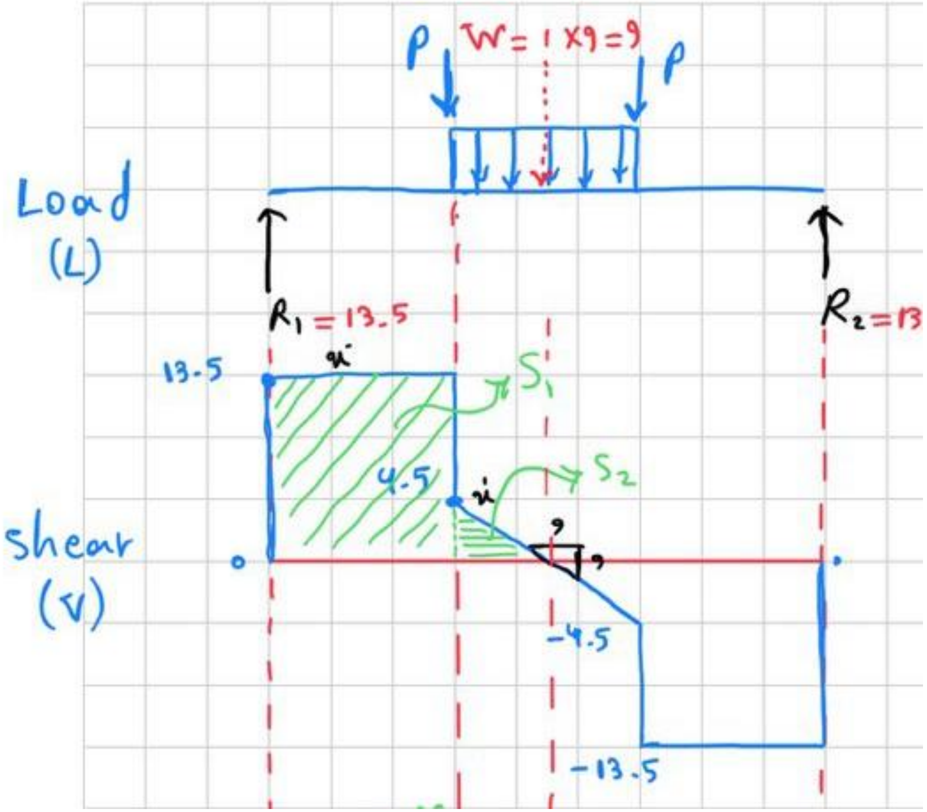


Moment @ P:

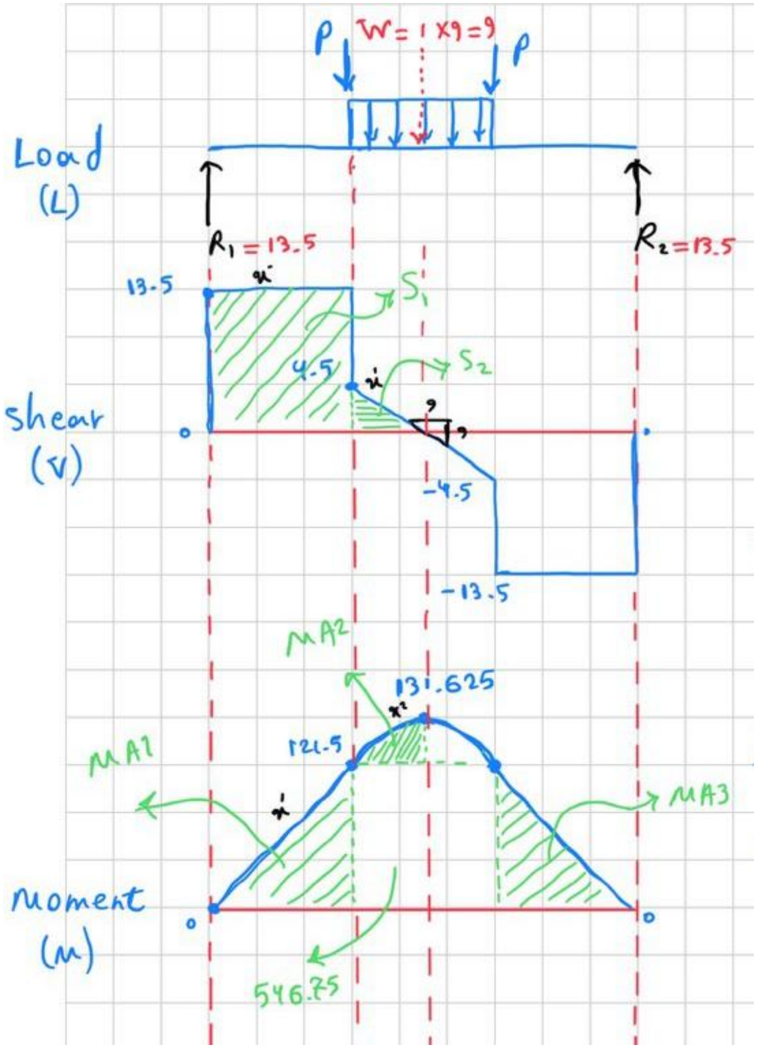
$M_1 = S_1 = 13.5 \times 9 = 121.5$ KIPS-FT

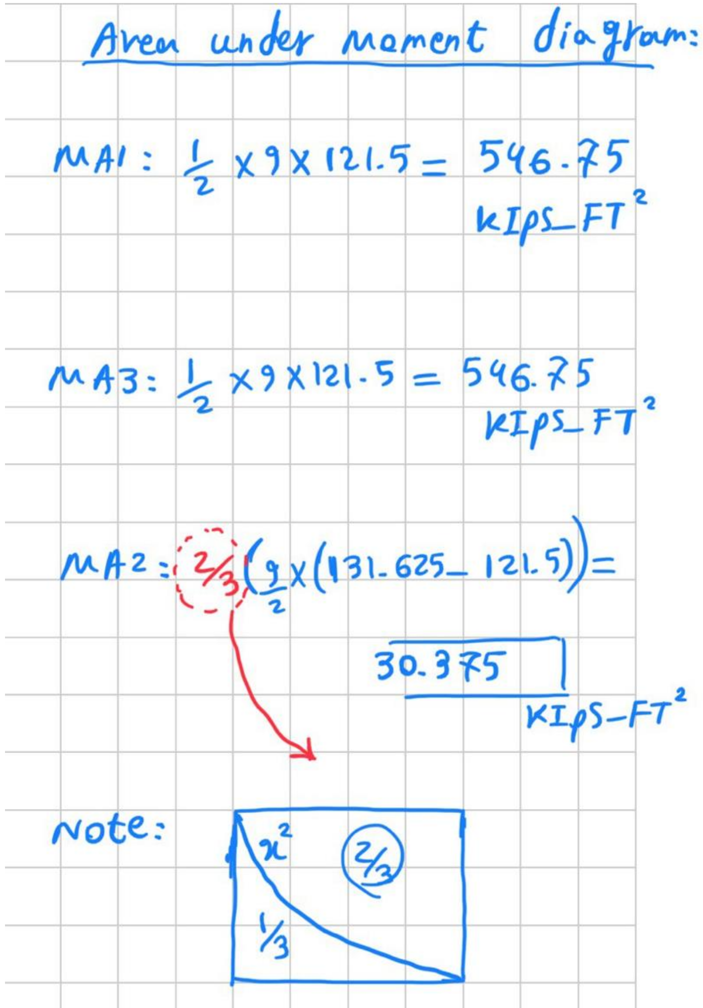
Moment @ Center line:

$M_2 = S_1 + S_2$

$= 121.5 + \frac{1}{2} \times 4.5 \times 4.5 = 131.625$ KIPS-FT

Provide the solution for the assignment – **HW14**





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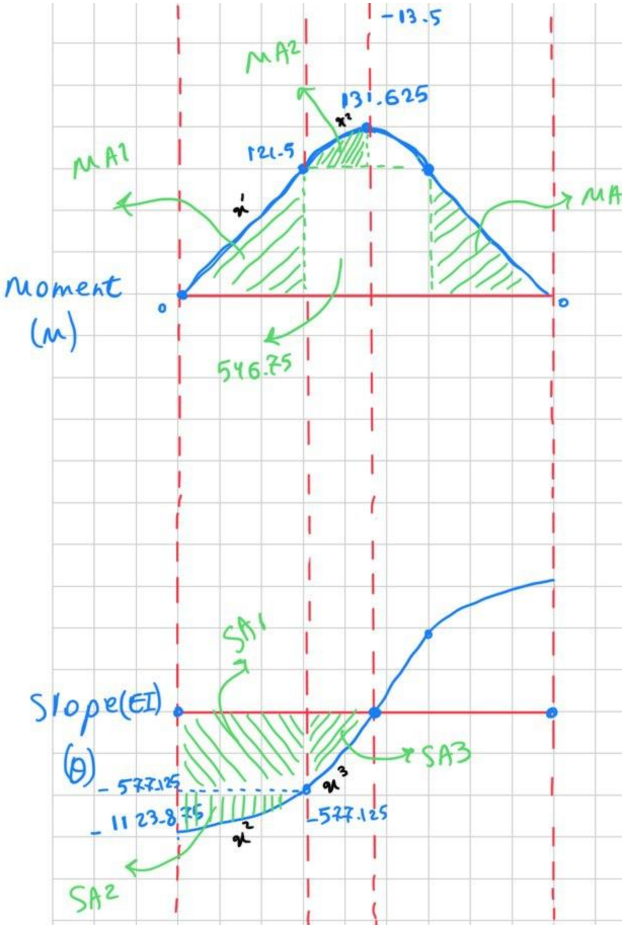


SA1:

$9 \times 577.125 = \boxed{5194.125}$ KIPS.FT^3

SA2:

$\frac{2}{3} \times 9 \times (1123.875 - 577.125) = \boxed{3280.5}$ KIPS.FT^3

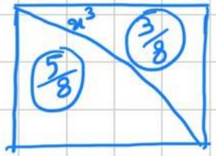
SA3:

$\frac{5}{8}\left(\frac{9}{2} \times 577.125\right) = \boxed{1623.16}$

$\frac{1}{2}\left(\frac{9}{2} \times 577.125\right) = 1298.53$

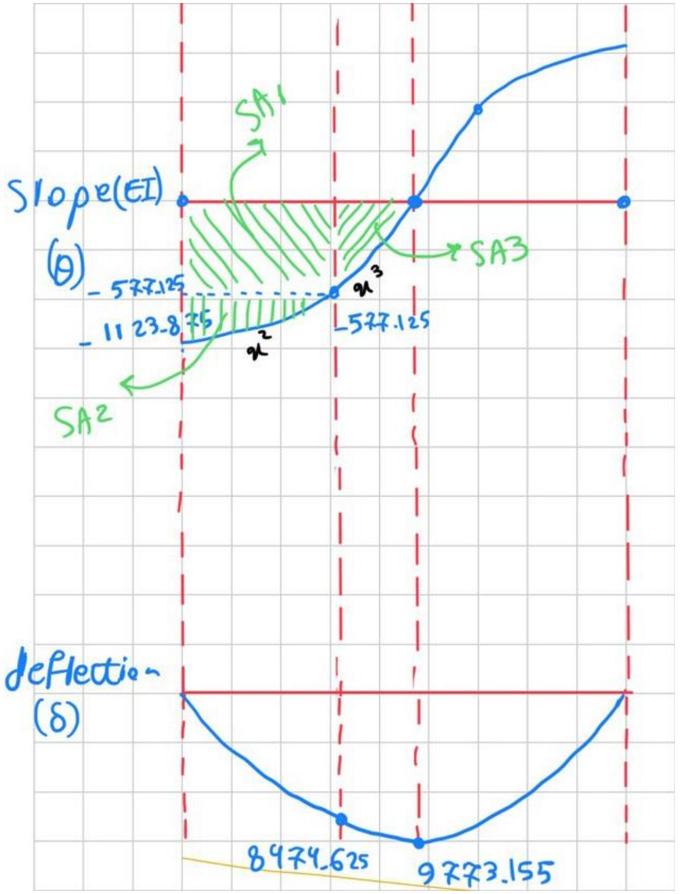
For the sake of simplicity calculated as triangle

Note:



For slope diagram, we start from middle

Provide the solution for the assignment – **HW14**

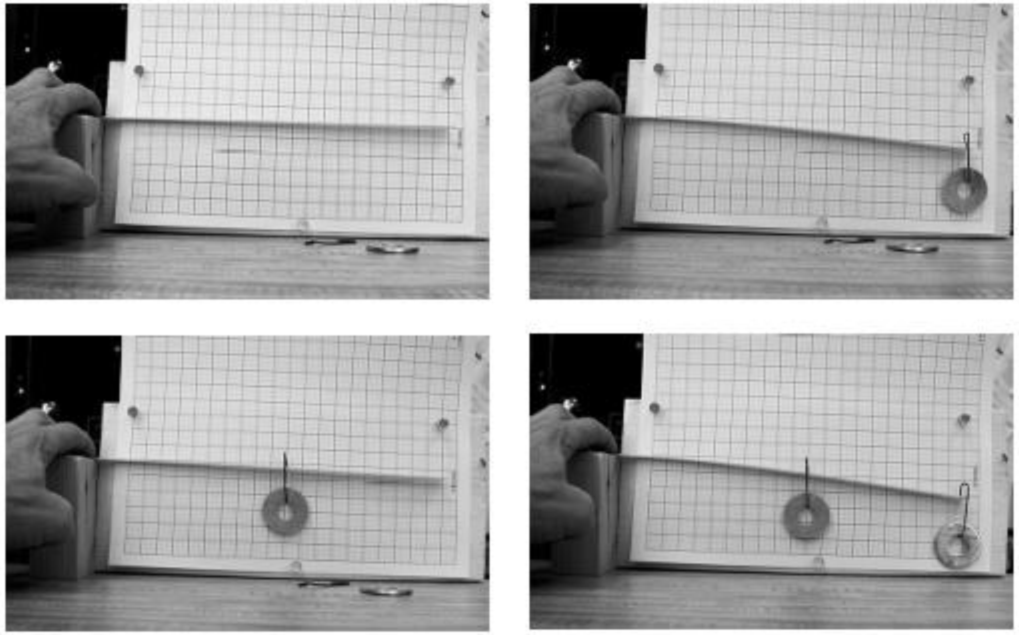


Centerline Deflection:

$$\delta = \frac{9773.155 \times 12^3}{EI}$$

$$\delta = \frac{9773.155 \times 1728 \ \text{KIPS}\cdot\text{IN}^3}{(29000 \ \frac{\text{KIPS}}{\text{IN}^2})(430 \ \text{IN}^4)} = \boxed{1.35429 \ \text{IN}}$$

Lab: Beam Deflection



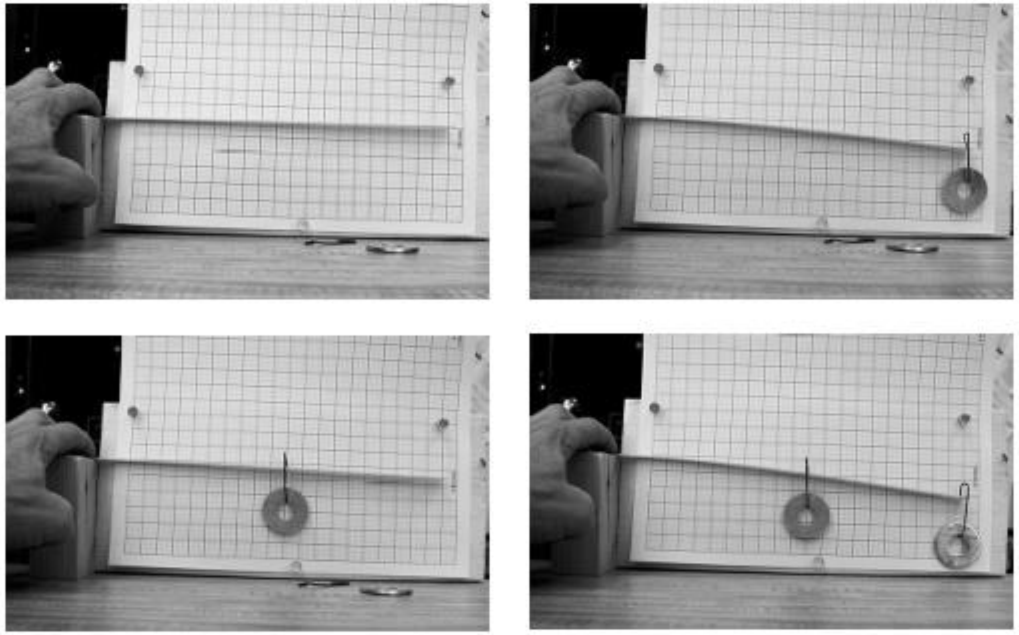
Description

This project uses observation and calculation to understand how a cantilever member deflects under load.

Goals

To observe the bending behavior of a cantilever through physical modeling.
To find the deflection using the diagram method.
To verify the deflection using beam equations.

Lab: Horizontal Shear Stress



Basswood Properties

$E = 1{,}650{,}000.$ psi

$I_y = 0.0000102$ in^4

$P_1 = 0.035$ lbs.

$L = 10.5$ in

Equations:

$$I = \frac{bd^3}{12} \qquad \delta = \frac{Pl^3}{3EI}$$

Procedure

1. Hold the 1/16”x1/2” basswood stick flatwise on the 2x4 support as shown.
2. Load first the free end, and measure the deflection against the graph paper (small squares = 0.1 inch).
3. Repeat the procedure for a load at the half point and at both points.
4. For each load measure and record a deflection.
5. Use the diagram method to calculate the deflection for the point load at the end.
6. Finally, calculate the deflection for the end load case with the equation below.

Thank you.

Any question?

Please feel free to ask questions.

Contact: Mohsenv@umich.edu