ARCH 314
STRUCTURE I

RECITATION SESSION 9

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TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Welcome to recitation session

Introduction:

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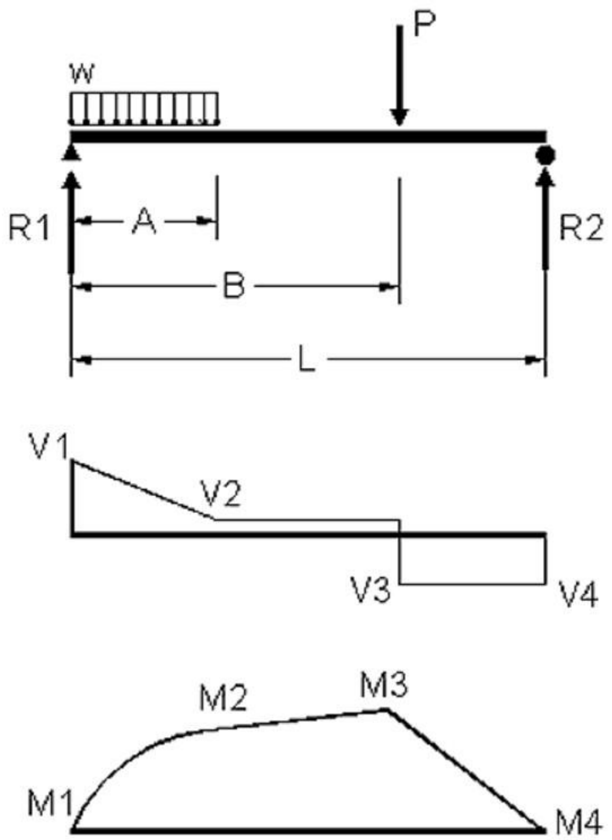
Outline:

Quick Recap
Provide the solution for the assignment
Answering student's questions
Recitation lab

Problem Set



12. Shear and Moment Diagrams

Calculate end reactions and construct the shear & moment diagrams for the loading shown.

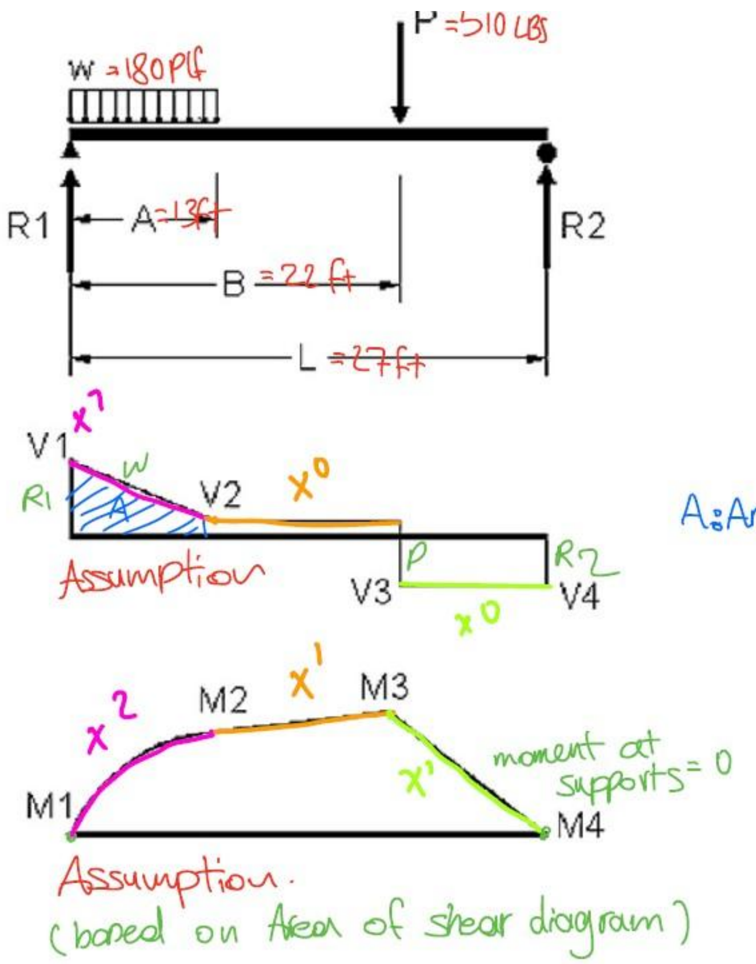
DATASET: 1 -2- -3-

Total Span L	27 FT
Length A	13 FT
Length B	22 FT
Uniform Load on Length A (w)	180 PLF
Point Load (P)	510 LBS

Problem Set

#	Question
1	Left Reaction (R1) (+ is upward; - is downward)
2	Right Reaction (R2) (+ is upward; - is downward)
3	Peak Shear value at R1 (V1) (use + or - sign)
4	Moment value at R1 (M1)
5	Shear value at A distance from R1 (V2) (use + or - sign)
6	Moment value at A dist. from R1 (M2 tension on bottom is +)
7	Peak Shear value at B distance from R1 (V3) (use + or - sign)
8	Moment value at B dist. from R1 (M3 tension on bottom is +)
9	Peak Shear value at R2 (V4) (use + or - sign)
10	Moment value at R2 (M4)
11	Maximum Moment (tension on bottom is +)
12	Distance from Left to Max. Moment in (decimal)

Problem Set

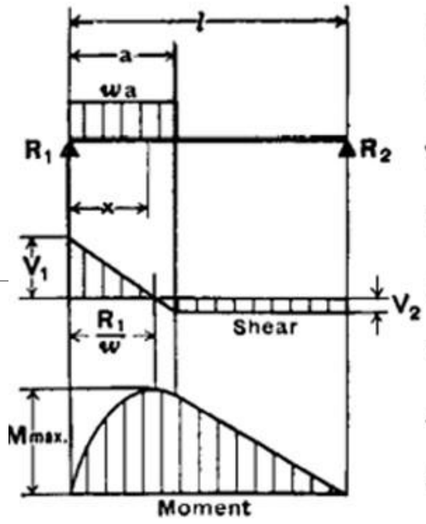


A: Area → gives us M_2
(Difference between M_1 and M_2)

! we can use the code formula and based on super position rules combine them together

Problem Set

5. SIMPLE BEAM—UNIFORM LOAD PARTIALLY DISTRIBUTED AT ONE END



$R_1 = V_1$ max. . . . . $= \frac{wa}{2l}(2l - a)$

$R_2 = V_2$ . . . . $= \frac{wa^2}{2l}$

$V_x \quad \left(\text{when } x < a\right)$ . . . . . . $= R_1 - wx$

M max. $\left(\text{at } x = \frac{R_1}{w}\right)$ . . . . . . $= \frac{R_1^2}{2w}$

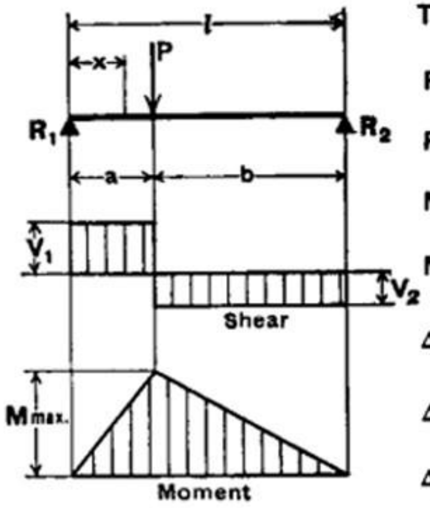
$M_x \quad \left(\text{when } x < a\right)$ . . . . . . $= R_1 x - \frac{wx^2}{2}$

$M_x \quad \left(\text{when } x > a\right)$ . . . . . . $= R_2(l - x)$

$\Delta x \quad \left(\text{when } x < a\right)$ . . . . . . $= \frac{wx}{24EIl}\left(a^2(2l-a)^2 - 2ax^2(2l-a) + lx^3\right)$

$\Delta x \quad \left(\text{when } x > a\right)$ . . . . . . $= \frac{wa^2(l-x)}{24EIl}(4xl - 2x^2 - a^2)$

8. SIMPLE BEAM—CONCENTRATED LOAD AT ANY POINT



Total Equiv. Uniform Load . . . . . . $= \frac{8\,Pab}{l^2}$

$R_1 = V_1 \left(\text{max. when } a < b\right)$ . . . . . $= \frac{Pb}{l}$

$R_2 = V_2 \left(\text{max. when } a > b\right)$ . . . . . $= \frac{Pa}{l}$

M max. $\left(\text{at point of load}\right)$ . . . . . $= \frac{Pab}{l}$

$M_x \quad \left(\text{when } x < a\right)$ . . . . . $= \frac{Pbx}{l}$

Δmax. $\left(\text{at } x = \sqrt{\frac{a(a+2b)}{3}} \text{ when } a > b\right)$ $= \frac{Pab\,(a+2b)\,\sqrt{3a\,(a+2b)}}{27\,EI\,l}$

$\Delta a \quad \left(\text{at point of load}\right)$ . . . . . $= \frac{Pa^2b^2}{3EI\,l}$

$\Delta x \quad \left(\text{when } x < a\right)$ . . . . . $= \frac{Pbx}{6EI\,l}(l^2 - b^2 - x^2)$

Problem Set

Calculate End Reactions:

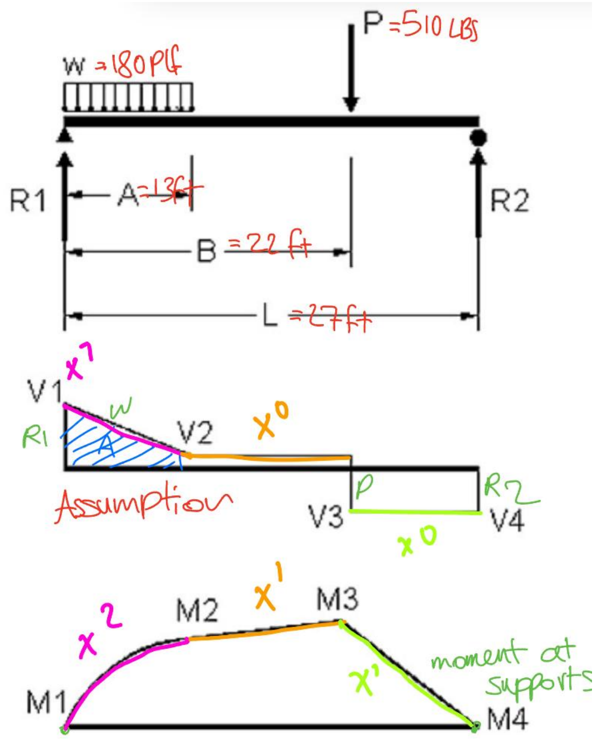
uniform load →

$$R_{1u} = \frac{wa}{2L}(2L-a) = \frac{(180)(13)}{2(27)}(54-13) = 1776.66$$

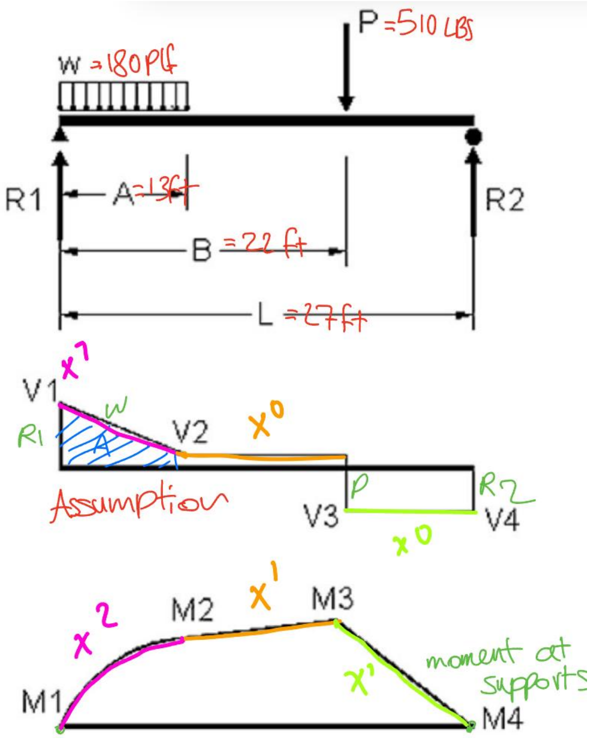
Point load →

$$R_{1p} = \frac{PB}{L} = \frac{510(27-22)}{27} = 94.44$$

$$R_1 = R_{1u} + R_{1p} = 1871.10$$



Problem Set



$$R_{2u} = \frac{wa^2}{2L} = \frac{(180)(13)^2}{2(27)} = \frac{30420}{54} = 563.33$$

$$R_{2p} = \frac{Pa}{L} = \frac{(180)(22)}{27} = 146.66$$

$$R_2 = R_{2u} + R_{2p} = 709.99$$

- **Peak shear value at $R_1(V_1)$**

uniform load →

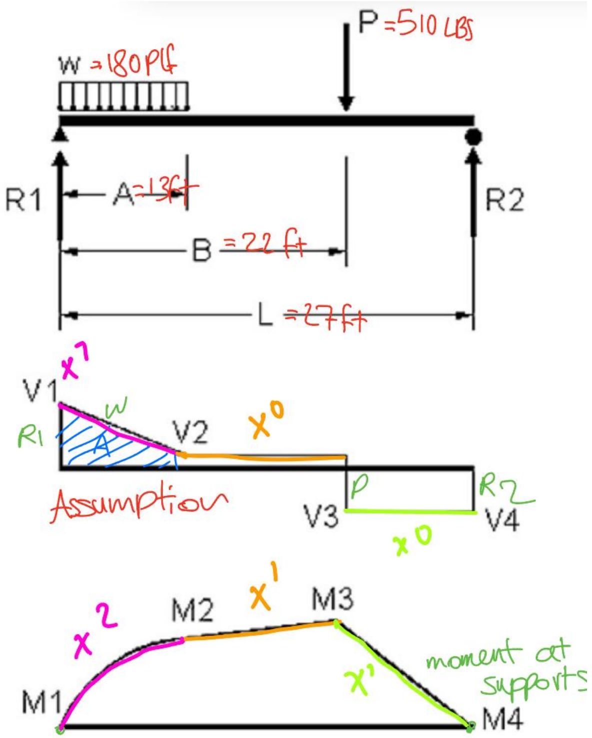
$V_x = R_1 - wx$

$V_1 : x = 0 \rightarrow V_1 = R_1 = 1871.10$

- Shear value at the distance $A = 13$ (V_2):

$V_x = R_1 - wx = 1871.10 - (180)(13) = -468.9$

Problem Set



Moment value at A=13:

uniform load →

1. M_x (when $x>a$) $= R_{2u}(L - x) = 563.33(27-13) = 7886.62$

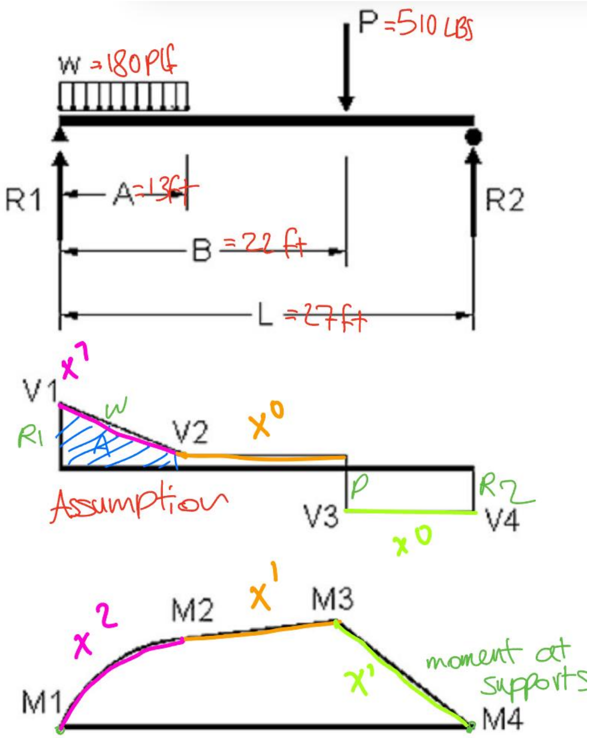
2. M_x (when $x<a$) $= R_{1u}x - \dfrac{wx^2}{2}$

Concentrated load →

M_x (when $x<a$) $= \dfrac{Pbx}{l} = \dfrac{(510)(27-22)(14)}{27} = 1322.22$

At A=14 → $M_x = M_{xu} + M_{xp} = 9208.84$

Problem Set



At $x = 22$: Shear

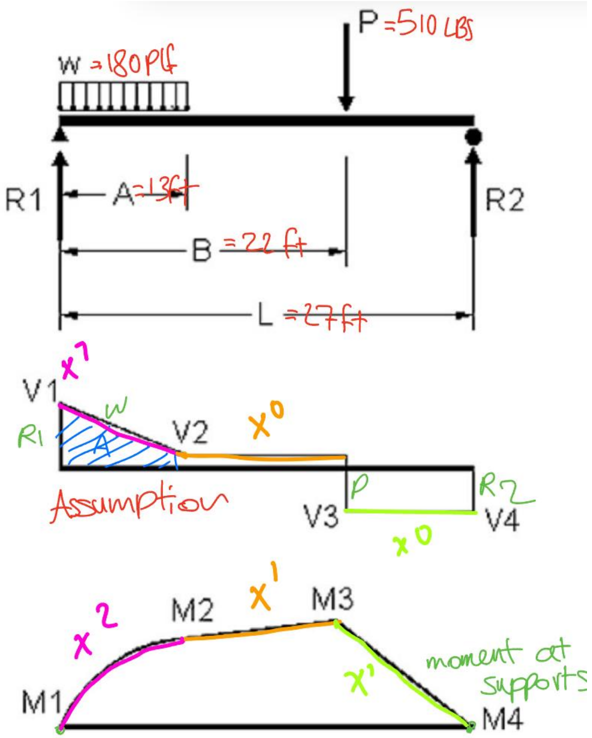
Point load →

$$V_u = \frac{-wa^2}{2L} = \frac{-180(13)^2}{2(27)} = -563.33$$

$$V_p = \frac{-Pa}{\ell} = \frac{-510(22)}{27} = -415.55$$

$$V_3 = V_u + V_p = -978.88$$

Problem Set



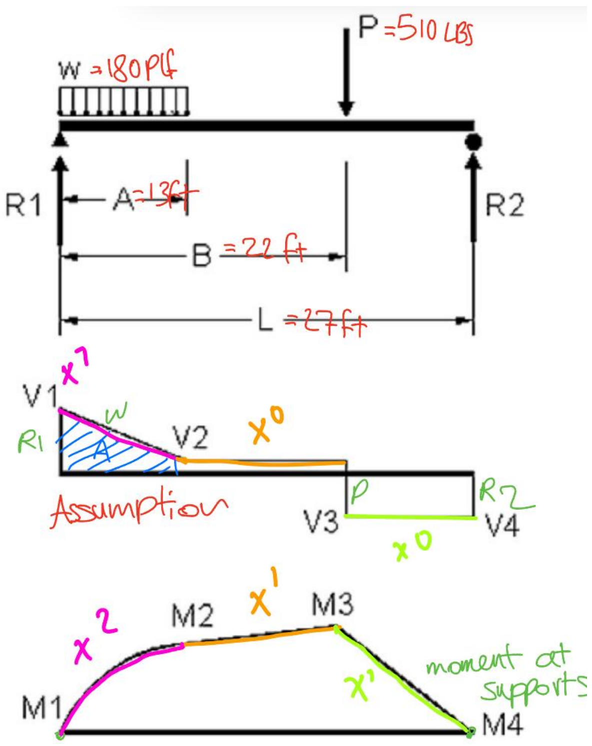
At $x = 26$: moment →

$$M_u \text{ (when } x > a) = R_{2u}(L - x) = 563.33(27 - 26) = 563.33$$

$$M_p \text{ (at point of load)} = \frac{Pab}{L} = \frac{510(22)(27-22)}{27} = 2077.7$$

$$M_3 = M_u + M_p = 2641.03$$

Problem Set



Peak shear value at R_2 (V_4):

$V_4 = -R_2 = -709.99$

Moment value at R_2 (M_4): $x = L = 27$

$M_x = R_2(L - x) = 0$

$\rightarrow M = 0$

$M_P = 0$

Max Moment is when $V = 0$

Structures I | Name 1 ____________________

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Name 3 ____________________

Moment Diagrams

Description

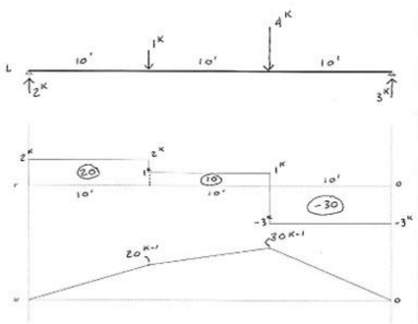
This project compares a calculated moment diagram with one constructed with a weighted string.

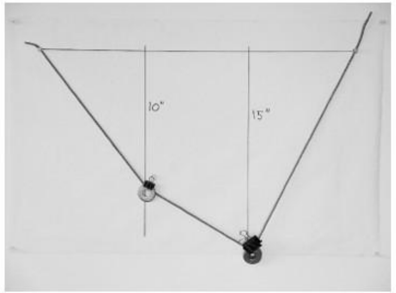
Goals

To measure the distances to the weights on a catenary model.
To compare the scaled height of the string model with the calculate heights on the diagram.

Procedure

1. Check the shear and moment diagrams for the beam below.
2. Place the same load on the string and measure the deflection at the weights.
3. Compare the string model with the moment diagram and determine the scale factors.





Scale factors

$$\frac{A\ in}{B\ in} : \frac{20\ k-ft}{30\ k-ft}$$

Scale = 1 in. to __________ k-ft

Scale = 1 in. to __________ k-ft