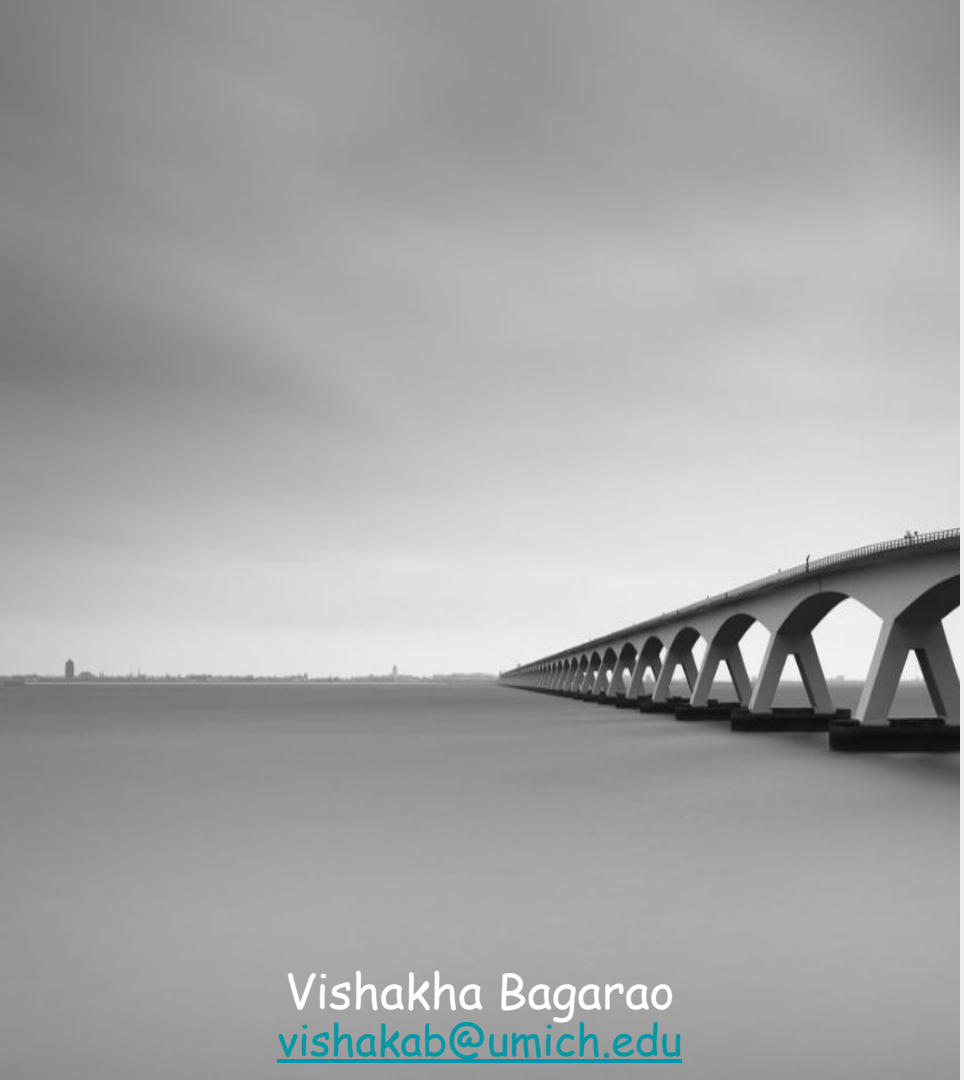
Arch 314- Structures I

Recitation 006

Vishakha Bagarao

15th Nov 2024



Vishakha Bagarao
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Contents

- Quick Recap
  - Shear and Bending forces
    - Problem Set 12- V & M diagrams
- Lab 10- Moment Diagrams

Final Bridge Report:

- Due- 25th Nov

NOV 15	Recitation **10. Moment Diagrams**		
	Topic Quiz 12		12. V & M Diagrams (11.17)
NOV 18	Bending Stresses	Ch. 8.1-8.2: pp. 365-381	
NOV 20	Shear Stresses	Ch. 8.1-8.2: pp. 365-381	
NOV 22	Recitation **11. Shear Stress**		
	Topic Quiz 13		13. Horizontal Shear (11.24)
NOV 25	video "When Engineering Fails"	**(final bridge report due – 11.25)**	
NOV 27	****** THANKSGIVING RECESS ******	THANKSGIVING RECESS ******	THANKSGIVING RECESS ******

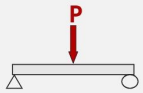
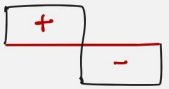
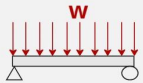
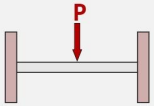
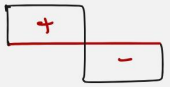
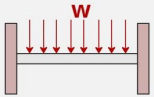
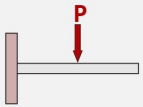
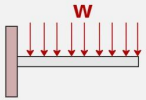
- Link to bridge report examples

FINAL REPORT REQUIREMENTS	**150**	
Preliminary Design Development	**20**	
How initial (preliminary) bridge design was developed	4	
How initial (preliminary) member sizes were chosen	4	
Why bridge design was or was not adjusted from preliminary design	4	
Why member sizes were or were not adjusted from preliminary design	4	
Discussion of how pre-analysis of initial bridge impacted the final design	4	
Revised Bridge Design Analysis	**50**	
Internal axial force calculations/modeling (with proper design loading indicated) (Dr. Frame acceptable)	10	
Derivation of member cross-sectional areas from axial forces	10	
Member size selection from available stock	4	
Est. weight calculation of bridge - including members, glue & fasteners	6	
Method of joints/sections calculation for at least 1 joint (@ reaction is usually easiest based on truss geometry, but could be done elsewhere)	10	
Member crushing calculations/check (show work) using $F'_c=P/A$	4	
Prediction of capacity of bridge and mode of failure	6	
Illustration of Tested (Revised from Preliminary) Design	**20**	
Cross-section of bridge	4	
Elevation(s) of bridge	4	
Dimensions and units labeled in elevation and cross-section	4	
Member sizes labeled (with dimensions)	4	
Member stresses labeled (with units)	4	
Testing Results	**30**	
Weight and height of bridge	5	
Capacity of bridge	5	
Observations of testing	6	
Description of mode of failure	5	
Images of failure	5	
Following the guidelines	4	
Post-Testing Analysis	**30**	
Comparison of testing with predicted capacity and modes of failure	10	
Discussion of discrepancies between results	10	
Suggested improvements for future designs with reasoning discussed	10	
FINAL GRADE	**250**	

Load, Shear, and Moment Diagrams:

General considerations for drawing shear and moment diagrams:

- When all loads and reactions are known, the shear and moment at the ends of the beam can be determined by inspection.
  - At a simply supported or pinned end, the shear must equal the end reaction, and the moment must be zero.
  - Both shear and moment are zero at a free end of a beam (cantilever beam or overhang beam).
  - At a built-in or fixed-end beam, the reactions are equal to the shear and moment values.
- When positive directions are chosen as upward and to the right, a uniformly distributed load acting downward will give a negative slope in the shear diagram, and a positive distributed load (one acting upward) will result in a positive slope.
- A concentrated force produces an abrupt change in shear.

Beams with Loadings	SFD	BMD
Simply Supported beam with Point load: 		
Simply Supported beam with uniformly distributed load: 		
Fixed beam with Point load: 		
Fixed beam with uniformly distributed load: 		
Cantilever beam with Point load: 		
Cantilever beam with uniformly distributed load: 		

Load, Shear, and Moment Diagrams:

General considerations for drawing shear and moment diagrams:

- The change in shear between any two sections is given by the area under the load diagram between the same two sections.
- The change of shear at a concentrated force is equal to the concentrated force.
- The slope at any point on the moment diagram is given by the shear at the corresponding point on the shear diagram: A positive shear represents a positive slope, and a negative shear represents a negative slope.
- The rate of increase or decrease in the moment diagram slope is determined by the increasing or decreasing areas in the shear diagram.
- The change in moment between any two sections is given by the area under the shear diagram between corresponding sections.

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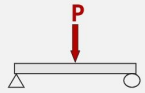
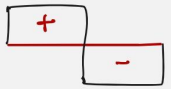
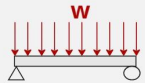
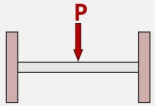
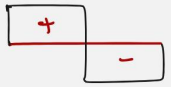
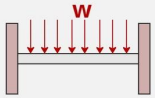
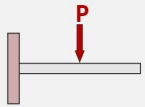
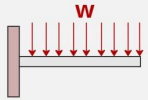
Simply Supported beam with Point load: 		
Simply Supported beam with uniformly distributed load: 		
Fixed beam with Point load: 		
Fixed beam with uniformly distributed load: 		
Cantilever beam with Point load: 		
Cantilever beam with uniformly distributed load: 		

Problem Set 12

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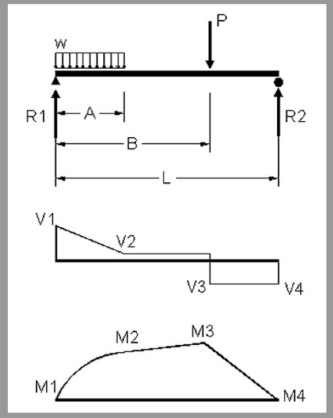
12. Shear and Moment Diagrams

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



DATASET: 3 -1- -2-

Total Span L	31 FT
Length A	16 FT
Length B	21 FT
Uniform Load on Length A (w)	240 PLF
Point Load (P)	600 LBS

#	Question	Your Response	Correct Answer	Score
1	Left Reaction (R1) (+ is upward; - is downward)	3042.58 LBS	3042.58 LBS	5
2	Right Reaction (R2) (+ is upward; - is downward)	1397.42 LBS	1397.42 LBS	5
3	Peak Shear value at R1 (V1) (use + or - sign)	3042.58 LBS	3042.58 LBS	5
4	Moment value at R1 (M1)	0 FT-LBS	0 FT-LBS	5
5	Shear value at A distance from R1 (V2) (use + or - sign)	-797.42 LBS	-797.419 LBS	5
6	Moment value at A dist. from R1 (M2 tension on bottom is +)	17961.3 FT-LBS	17961.3 FT-LBS	5
7	Peak Shear value at B distance from R1 (V3) (use + or - sign)	-1397.42 LBS	-1397.42 LBS	5
8	Moment value at B dist. from R1 (M3 tension on bottom is +)	13974.2 FT-LBS	13974.2 FT-LBS	5
9	Peak Shear value at R2 (V4) (use + or - sign)	-1397.42 LBS	-1397.42 LBS	5
10	Moment value at R2 (M4)	0 FT-LBS	0 FT-LBS	5
11	Maximum Moment (tension on bottom is +)	19286 FT-LBS	19286 FT-LBS	5
12	Distance from Left to Max. Moment in (decimal)	12.6774 FT	12.68 FT	5

Current Score: 60 / 60

Problem Menu

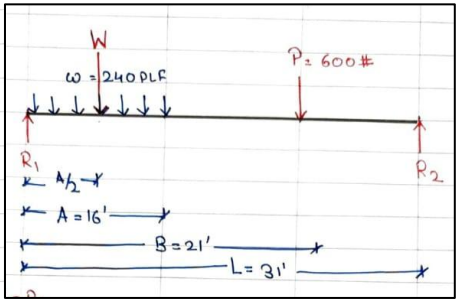
Logout

Shear & Moment Diagrams:

Step 1: End Reactions:

#1, #2. Left Reaction (R_1) ; Right Reaction (R_2)
(+ is upward ; - is downward).

$W = \omega \times A$
$= 240 \times 16$
$\therefore W = 3840$ LBS.



$\Sigma M_{@R_1} = 0 = W\left(\frac{A}{2}\right) + P(B) - R_2(L)$

$0 = 3840 \times 8 + 600 \times 21 - 31R_2$

$\therefore R_2 = 1397.42$ LBS.

$\Sigma V = 0 = R_1 - W - P + R_2$

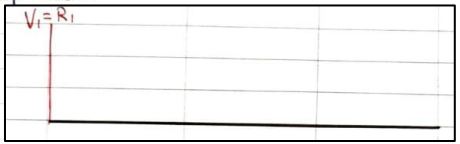
$0 = R_1 - 3840 - 600 + 1397.42$

$\therefore R_1 = 3042.58$ LBS.

Step 2: Shear values: (3, 5, 7, 9).

#3. Peak shear value at R_1 (V_1):

Since R_1 is end reaction & pushing beam upwards.



$V_1 = R_1$

$\therefore V_1 = 3042.58$ LBS.

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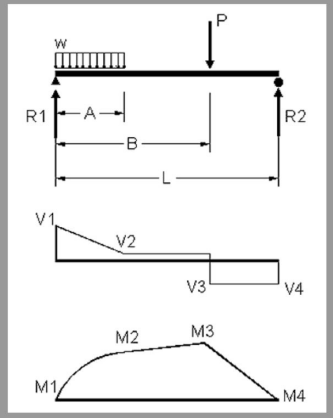

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#5. Shear value at A distance from R_1 (V_2):

R_1 is acting upward; W is acting downwards.

$$V_2 = R_1 - W$$
$$= 3042.58 - 3840$$
$$\therefore V_2 = -797.42 \text{ LBS}$$

#7. Peak shear value at B distance from R_1 (V_3):

V_2 is constant; Point Load (P) at B is acting downwards.

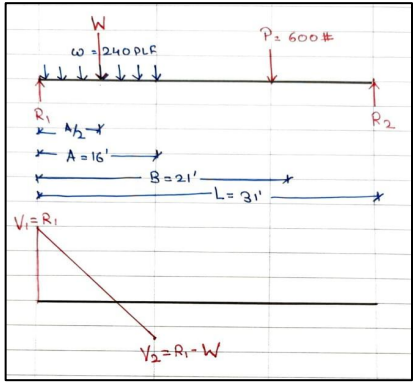
$$V_3 = V_2 - P$$
$$= -797.42 - 600$$
$$\therefore V_3 = -1397.42 \text{ LBS.}$$

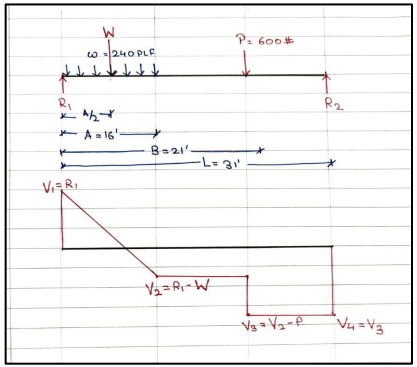
(Note: $|V_3|$ should be equal to R_2).

#9. Peak shear value at R_2 (V_4):

R_2 brings shear value to zero.

$$V_4 = V_3$$
$$\therefore V_4 = -1397.42 \text{ LBS.}$$





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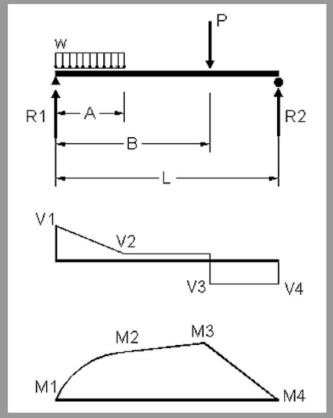

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Step 3: Moment values: (4, 6, 8, 10)

Moments at the end reactions is zero ($\Sigma M = 0$)

3.1: #4, #10. Moment value at R_1 and R_2.

4. Moment value at R_1 (M_1)

$\therefore M_1 = 0$

10. Moment value at R_2 (M_4)

$\therefore M_4 = 0$

3.2: Finding Areas:

$\Sigma V = 0$

$0 = R_1 - (w * x)$

$\therefore x = \frac{R_1}{w}$

$= \frac{3042.58}{240.}$

$\therefore x = 12.6774$ Ft

Area 1: Triangular area:

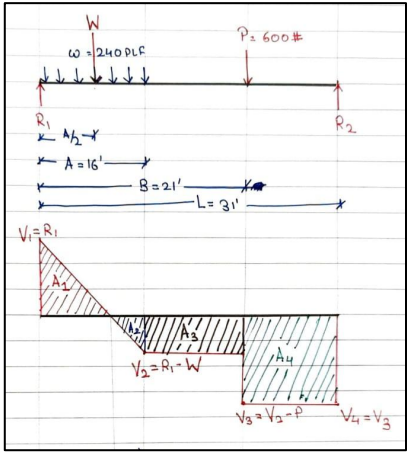
$A_1 = \frac{V_1 x}{2}$

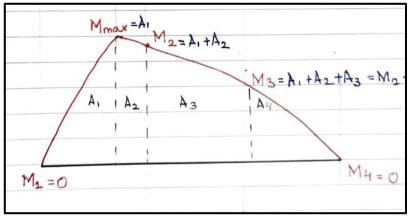
$= \frac{3042.58 \times 12.6774}{2}$

$\therefore A_1 = 19286.001$ FT-LBS

$A_2 = \frac{V_2 (A - x)}{2} = \frac{-797.42 (16 - 12.68)}{2}$

$\therefore A_2 = -1324.75$ FT-LBS





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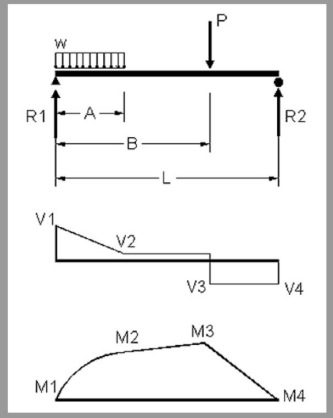

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Area 2: Rectangular Area:

$A_3 = V_2 (B - A)$

$= -797.42 (21 - 16)$

$\therefore A_3 = -3987.1$ FT-LBS

3.3. Moments:

#6. Moment value at A dist. from R_1 (M_2)

$M_2 = A_1 + A_2$

$= 19286.00 + (-1324.75)$

$\therefore M_2 = 17961.25$ FT-LBS

#8. Moment value at B dist. from R_1 (M_3)

$M_3 = M_2 + A_3$

$= 17961.25 + (-3987.1)$

$\therefore M_3 = 13974.15$ FT-LBS

Step 4: Determining maximum moment & distance from left to max. moment.

#11. Maximum moment (M_{max}):

$M_{max} = A_1$

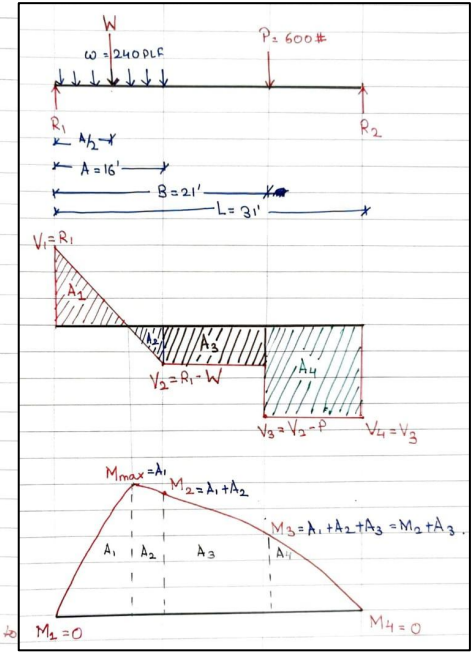
(point at which shear diagram intersects).

$\therefore M_{max} = 19286$ FT LBS.

#12. Distance from left to max moment (d)

$d = x$

$\therefore d = 12.6774$ FT



Problem Set 12

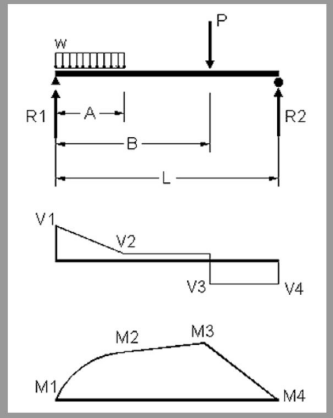
MICHIGAN Architecture — Structures Problems

Contact | Schedule | Lectures | Recitation | Bridges1 | Bridges2 | Problems

Logged in as: Vishakha Bagarao

12. Shear and Moment Diagrams

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



DATASET: 3 -1- -2-

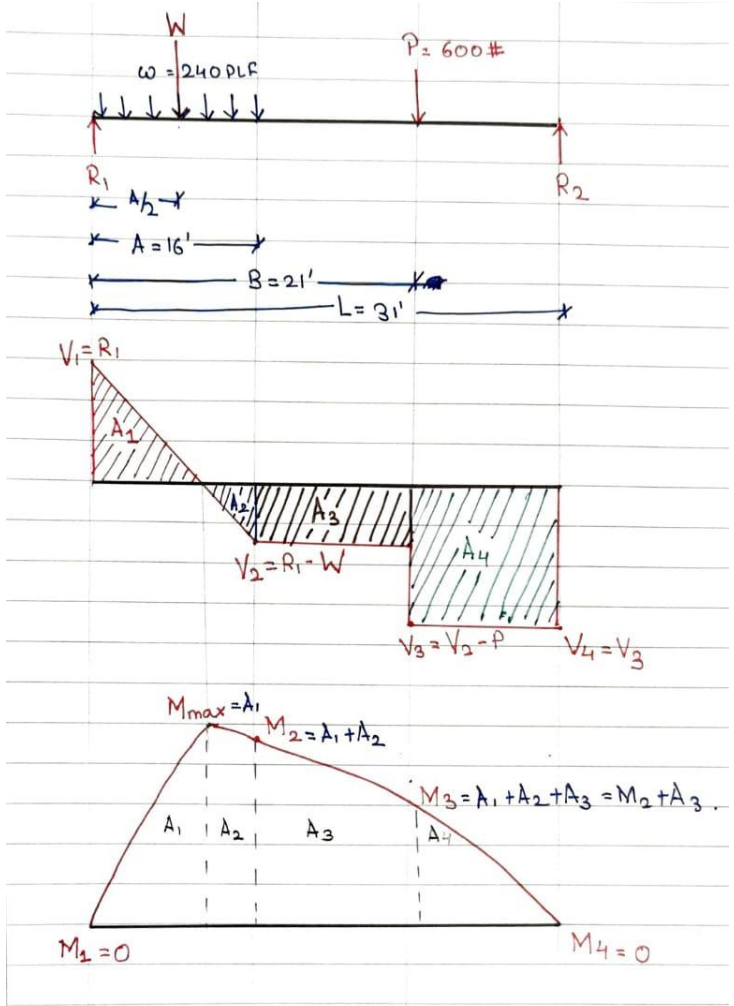
Total Span L	31 FT
Length A	16 FT
Length B	21 FT
Uniform Load on Length A (w)	240 PLF
Point Load (P)	600 LBS

#	Question	Your Response	Correct Answer	Score
1	Left Reaction (R1) (+ is upward; - is downward)	3042.58 LBS	3042.58 LBS	5
2	Right Reaction (R2) (+ is upward; - is downward)	1397.42 LBS	1397.42 LBS	5
3	Peak Shear value at R1 (V1) (use + or - sign)	3042.58 LBS	3042.58 LBS	5
4	Moment value at R1 (M1)	0 FT-LBS	0 FT-LBS	5
5	Shear value at A distance from R1 (V2) (use + or - sign)	-797.42 LBS	-797.419 LBS	5
6	Moment value at A dist. from R1 (M2 tension on bottom is +)	17961.3 FT-LBS	17961.3 FT-LBS	5
7	Peak Shear value at B distance from R1 (V3) (use + or - sign)	-1397.42 LBS	-1397.42 LBS	5
8	Moment value at B dist. from R1 (M3 tension on bottom is +)	13974.2 FT-LBS	13974.2 FT-LBS	5
9	Peak Shear value at R2 (V4) (use + or - sign)	-1397.42 LBS	-1397.42 LBS	5
10	Moment value at R2 (M4)	0 FT-LBS	0 FT-LBS	5
11	Maximum Moment (tension on bottom is +)	19286 FT-LBS	19286 FT-LBS	5
12	Distance from Left to Max. Moment in (decimal)	12.6774 FT	12.68 FT	5

Current Score: 60 / 60

Problem Menu

Logout



Lab 10 Moment Diagram

Structures I

Arch 314

Name 1 _____

Name 2 _____

Name 3 _____

Moment Diagrams

Description

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

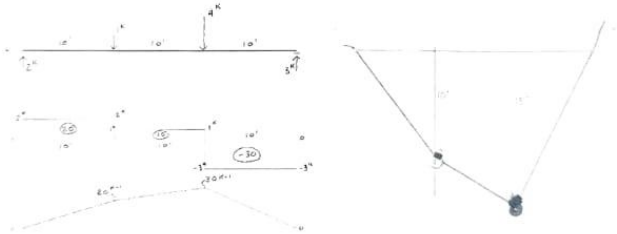
Goals

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