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 11/22

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Office: Room 3128
hours:
Wed: 11:30 – 12:30
Mon, Fri: 11:30 - 13:00
walk-ins welcome!

Please feel free to ask questions.

Welcome to Recitation session 11/21

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(Homework 13)**
- Answering student's questions
- Lab: **Horizontal Shear Stress**
- **Bridge** project (Prepare the Final Report)

Please feel free to ask questions.

Contact: Mohsenv@umich.edu

Bridge Project_ Final Report

- Pay Particular attention to the Tally sheet and requirements. (We Don't want you to lose points!)
- Look at the examples provided in the course website.
- It is not finished yet! Prepare your report Properly.

PRELIMINARY REPORT (re-submit original)	40
TESTING	60
FINAL REPORT REQUIREMENTS	150

Recap of the week

At any particular point in the beam, both horizontal and vertical shear stress are equal.

Depending on the material, either horizontal or vertical shear may be critical.

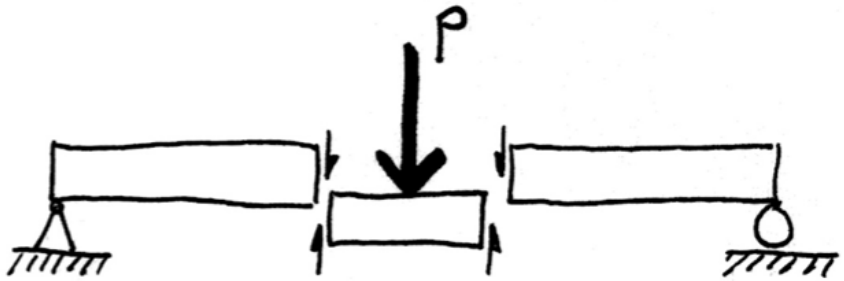
Critical Shear Location

The critical location of shear stress can be found by using the stress equation.

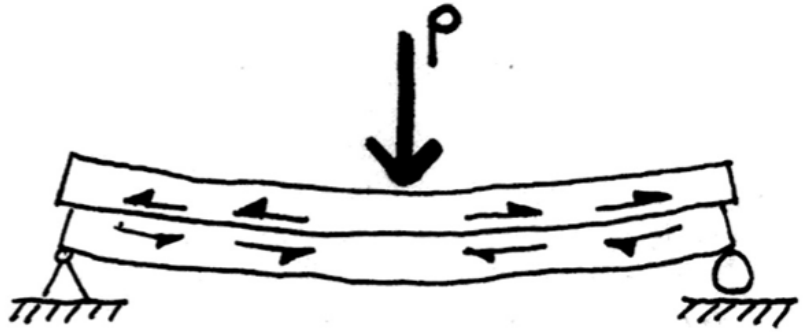
$$f_v = \frac{VQ}{Ib}$$

Shear stress will be maximum at locations where:

V is high	(usually reactions)
Q is high	(at neutral axis, $A\bar{x}$)
b is low	(in a thinner web)
I is low	(in a less stiff section)



TRANSVERSE SHEAR



LONGITUDINAL SHEAR

Provide the solution for the assignment – **HW13**

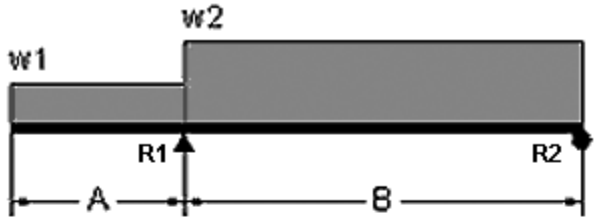
- Problem:

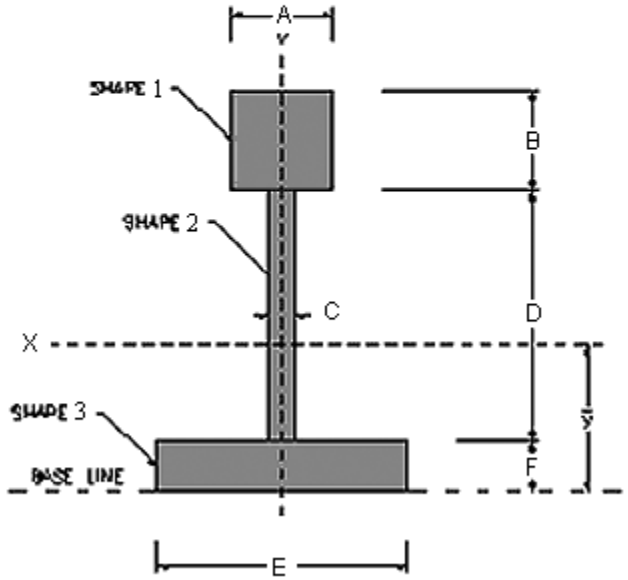
15. Horizontal Shear

Determine the maximum overall shear force and the horizontal shear stress at that location. Then find the horizontal shear stress at each end of the center web (top and bottom).

DATASET: 1 -2- -3-

Section dimension A	5 IN
Section dimension B	2 IN
Section dimension C	2 IN
Section dimension D	7 IN
Section dimension E	10 IN
Section dimension F	2 IN
Beam span A	12 FT
Beam span B	20 FT
Beam load w1	32 PLF
Beam load w2	16 PLF

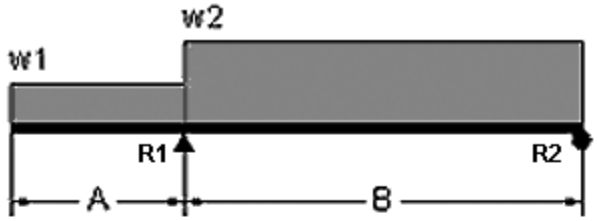


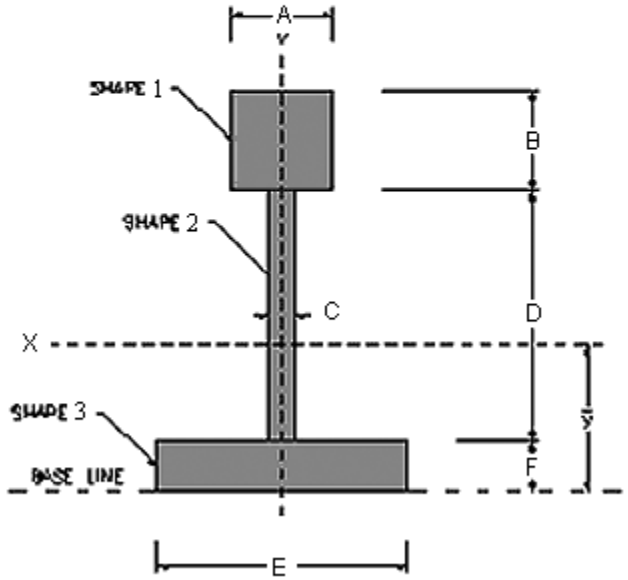


Provide the solution for the assignment – **HW13**

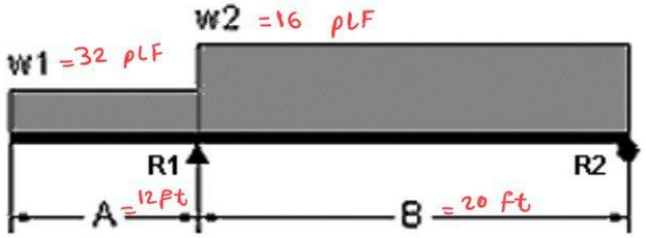
- Problem:

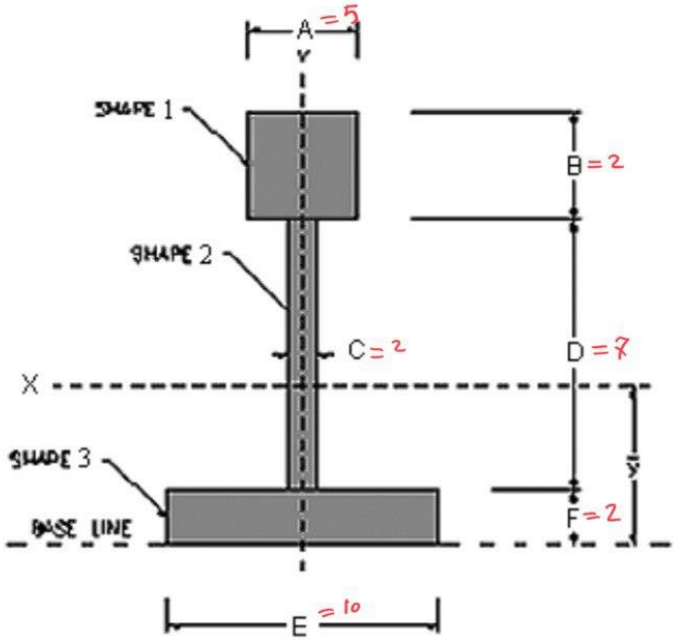
#	Question	Your Response	
1	Beam reaction R1 (upward is +)		LBS
2	Beam reaction R2 (upward is +)		LBS
3	Negative shear at R1 (use - sign)		LBS
4	Positive shear at R1		LBS
5	Shear at R2 (use - or + sign)		LBS
6	Maximum shear force (absolute value)		LBS
7	Static Moment (Q) at top of shape 2		IN^3
8	Static Moment (Q) at bottom of shape 2		IN^3
9	Static Moment (Q) at the neutral axis		IN^3
10	Moment of Inertia about the neutral axis		IN^4
11	Section width at the neutral axis		IN
12	Horizontal shear stress at the top of shape 2 for Vmax		PSI
13	Horizontal shear stress at the bottom of shape 2 for Vmax		PSI
14	Horizontal shear stress at the neutral axis for Vmax		PSI

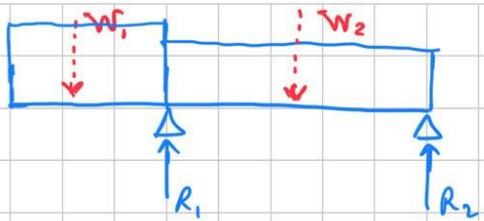




Provide the solution for the assignment – **HW13**







$W_1 = w_1 A = 32 \times 12 = 384$ lbs

$W_2 = w_2 B = 16 \times 20 = 320$ lbs

$\sum M_{@2} = 0$

$-W_2\left(\frac{B}{2}\right) + R_1(B) - W_1\left(\frac{A}{2} + B\right) = 0$

$-320\left(\frac{20}{2}\right) + R_1(20) - 384\left(\frac{12}{2} + 20\right) = 0$

$\rightarrow R_1 = 659.2$ lbs

Q1

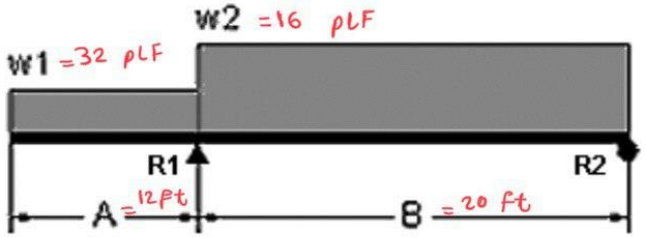
$\sum F_y = 0 \rightarrow R_1 + R_2 - W_1 - W_2 = 0$

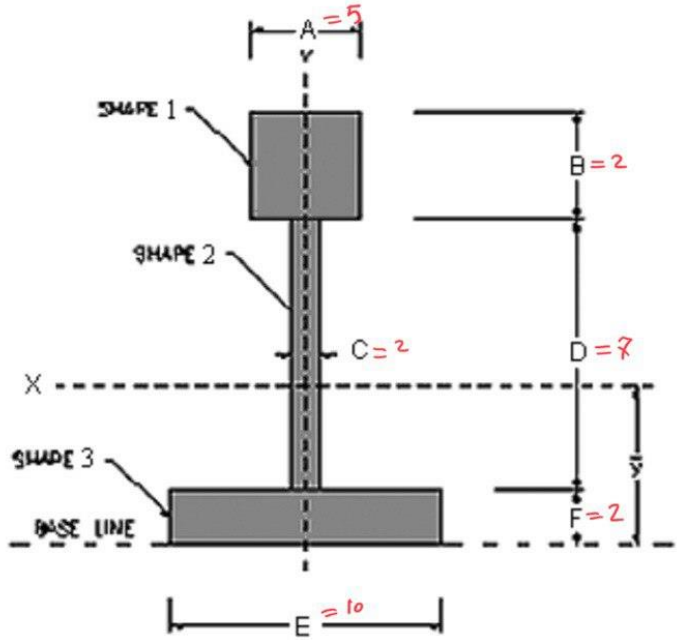
$659.2 + R_2 - 384 - 320 = 0$

$\rightarrow R_2 = 44.8$ lbs

Q2

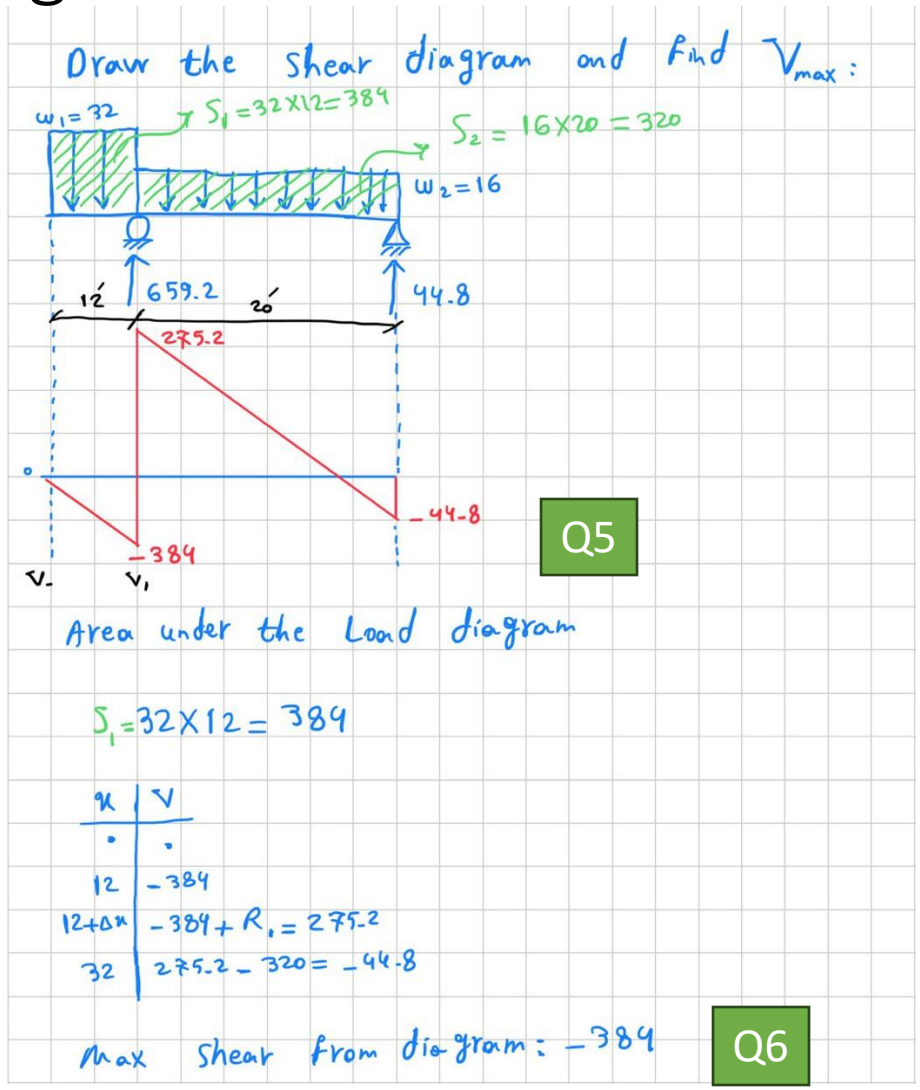
Provide the solution for the assignment – **HW13**





Q4

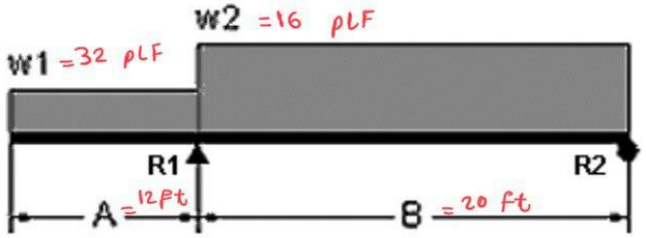
Q3

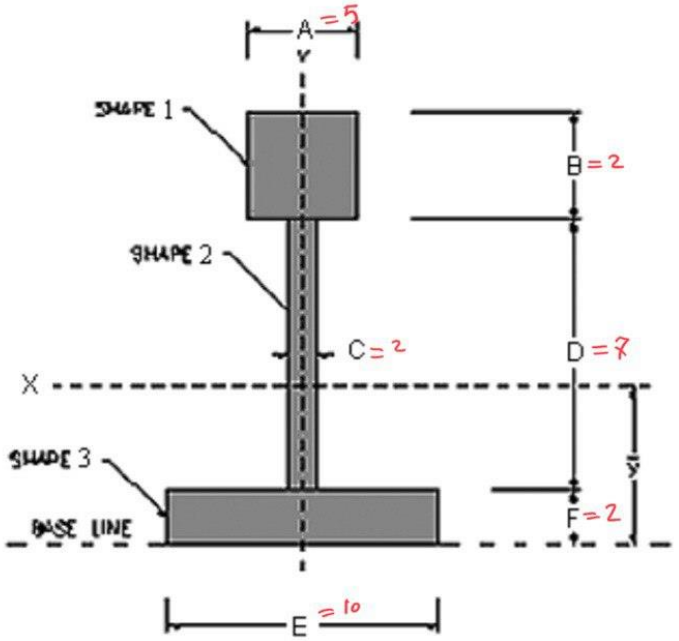


Q5

Q6

Provide the solution for the assignment – **HW13**



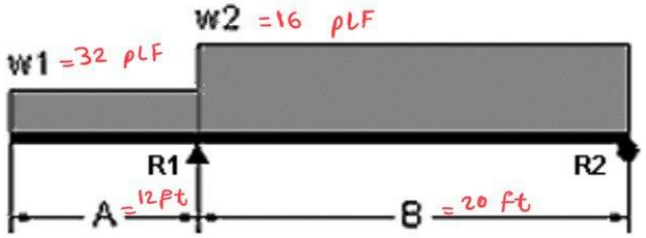


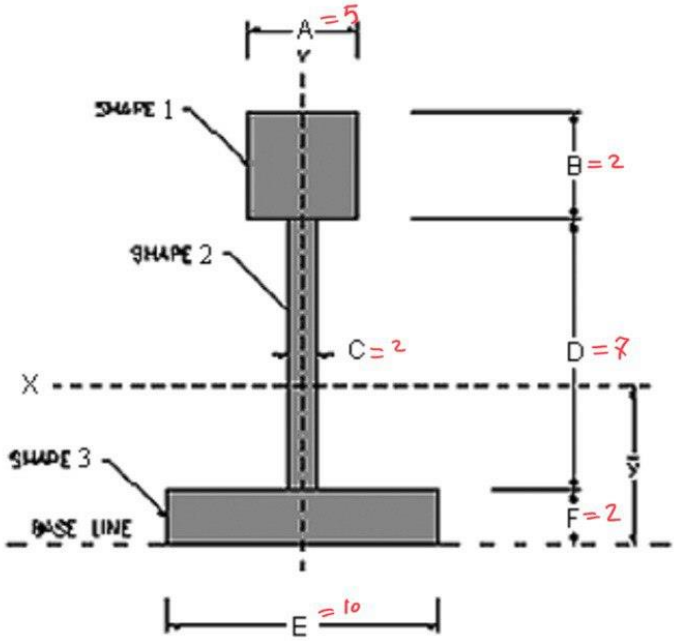
Calculation of Centeroid

	A	d (y)	Axd
shape 1	5x2=10	10	100
Shape 2	7x2=14	5.5	77
Shape 3	10x2=20	1	20
Sum	44	—	197

$$\bar{y} = \frac{\sum A \times d}{\sum A} = \frac{197}{44} = 4.47 \text{ in}$$

Provide the solution for the assignment – **HW13**





Static moment calculation (Q)

Top of shape-2

	A	y (distance from centroid)	Axy
Shape-1	5x2 = 10	10 − 4.47 = 5.53	55.3
Sum	10	—	553

Q_1 = 553 in^3

Q7

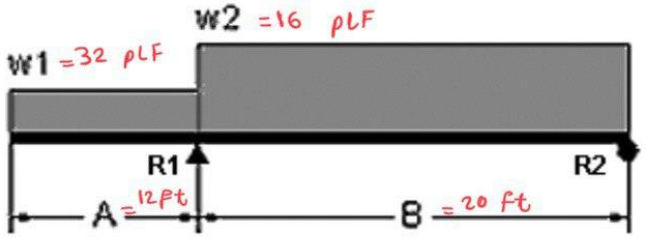
Bot of shape-2

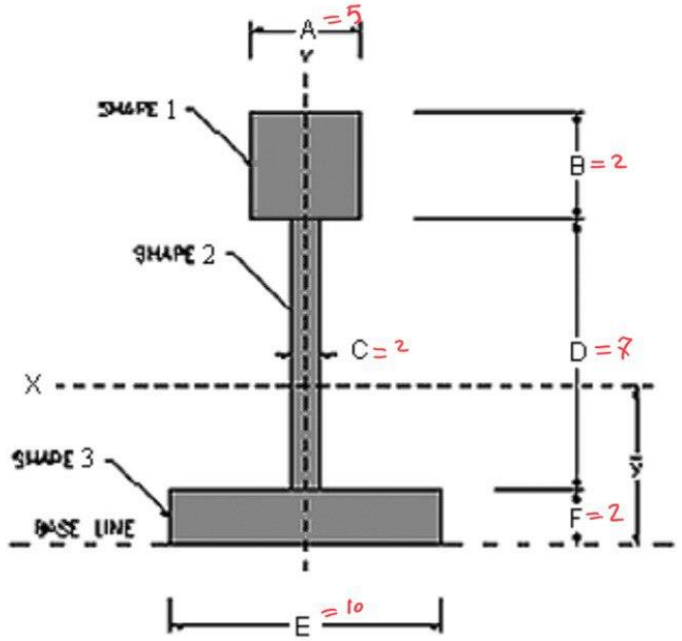
	A	y (distance from centroid)	Axy
Shape-1	5x2 = 10	10 − 4.47 = 5.53	55.3
shape-2	2x7 = 14	5.5 − 4.47 = 1.03	14.42
Sum	—	—	69.72

Q_2 = 69.72

Q8

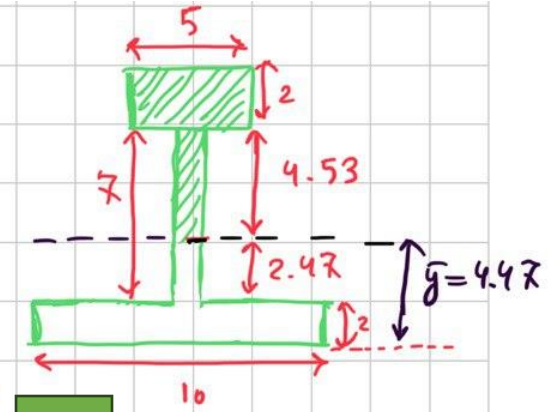
Provide the solution for the assignment – **HW13**





Q at neutral axis :

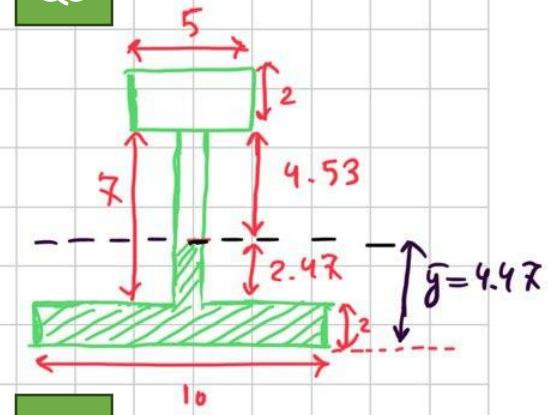
	A	y → distance from centeroid	A x y
Shape-1	5x2 = 10	5.53	55.3
shape-2	2x4.53	2.265	20.52
Sum	—	—	75.82 in^3



Q9

or

	A	y → distance from centeroid	A x y in^3
Shape-3	2x10 = 20	3.47	69.4
shape-2	2x2.47	1.235	6.10
Sum	—	—	75.50



Q9

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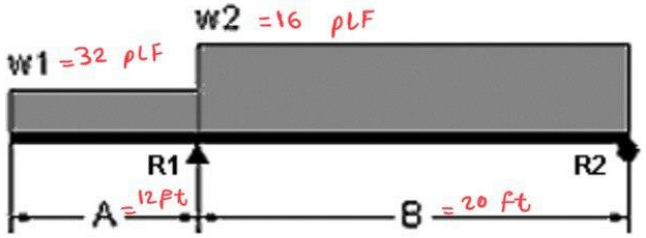
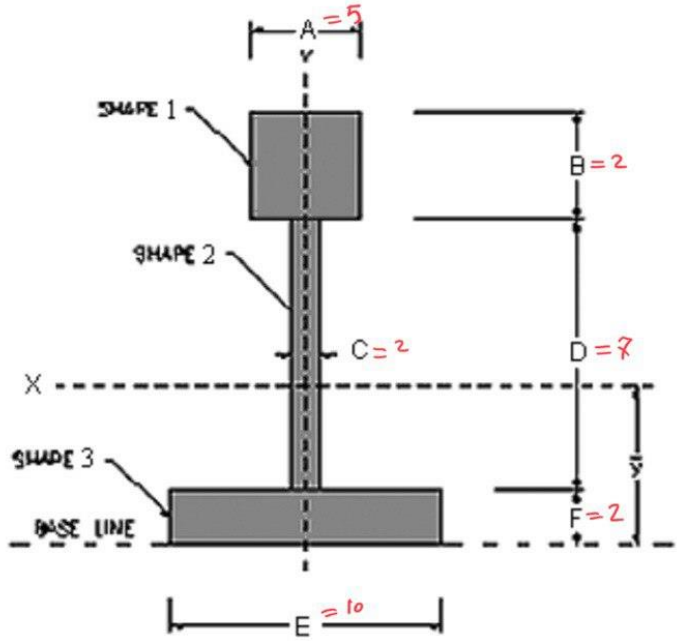




Calculation of moment of Inertia:

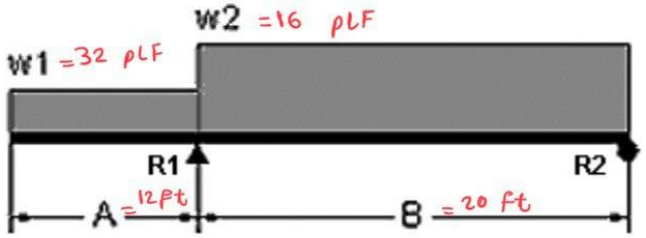
$\frac{bh^3}{12}$ → I_x (IN⁴)

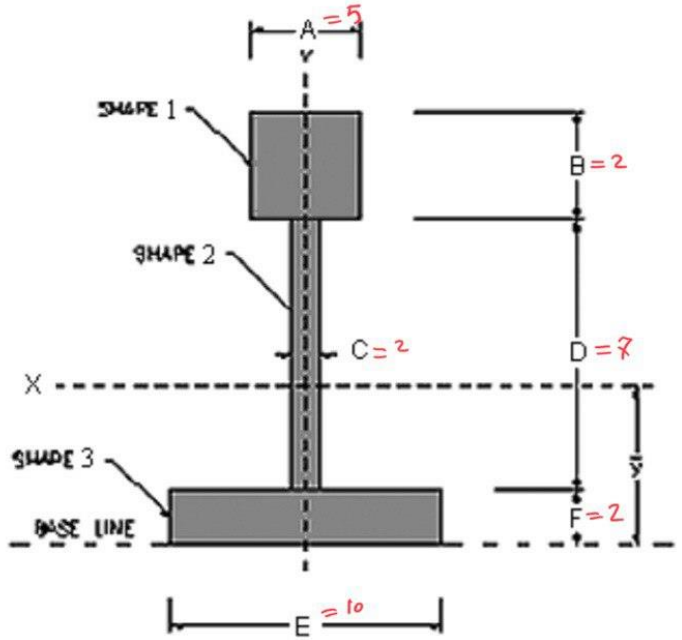
Centroid of shape to the centroid of whole shape → d (in)

	I_x (IN⁴)	A (IN²)	d (in)	Axd^2 (IN⁴)	$I_x + Ad^2$
Shape1	$\frac{5x2^3}{12}$ = 3.33	5X2 = 10	10−4.47=5.53	305.80	309.13
Shape2	$\frac{2x7^3}{12}$ = 57.16	2X7 = 14	5.5−4.47=1.03	14.85	72.01
Shape3	$\frac{10x2^3}{12}$ = 6.67	10X2=20	1−4.47=−3.47	240.82	247.49
Sum	67.16	44 IN²	—	561.47 (IN⁴)	628.63 (IN⁴)

Q10

Provide the solution for the assignment – **HW13**





From V diagram = 384

$$f_v = \frac{VQ}{Ib}$$

628.63

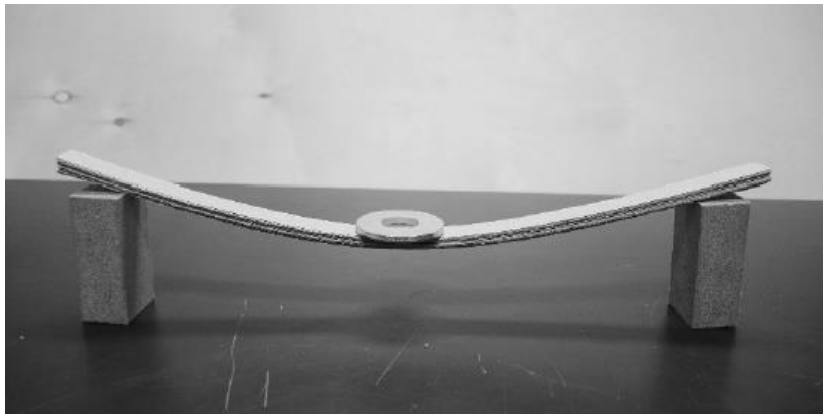
	Q in^3	b in	f_v lb/in^2
Top of Sh_2	55.3	2	16.89
Bot Sh_2	69.72	2	21.29
neutral Axis	75.82	2	23.15

Q12

Q13

Q14

Lab: Horizontal Shear Stress



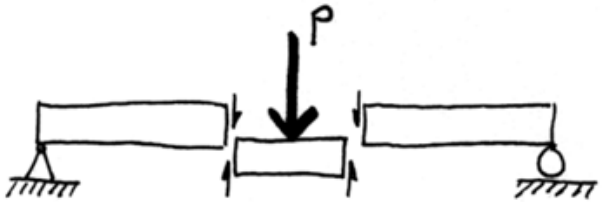
Description

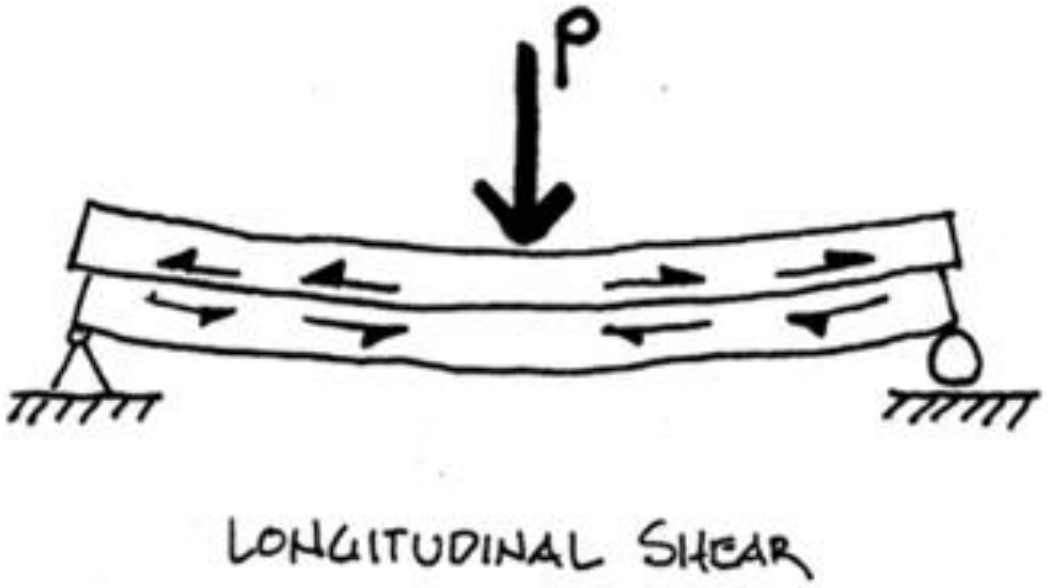
This project examines horizontal shear in a simple beam.

Goals

To observe an example of shear force in an element.
To gage the effect of shear stiffness.
To observe horizontal shear failure.

Lab: Horizontal Shear Stress





Procedure

1. Place the clips at each end of the beam and position it on the supports.
2. Add the washer weight and measure the deflection.
3. Remove the clips and repeat the loading and again measure the deflection.
4. Note the slippage of the planes particularly at each end.
5. Compare the deflections of the two tests.

Thank you.

Any question?

Please feel free to ask questions.

Contact: Mohsenv@umich.edu