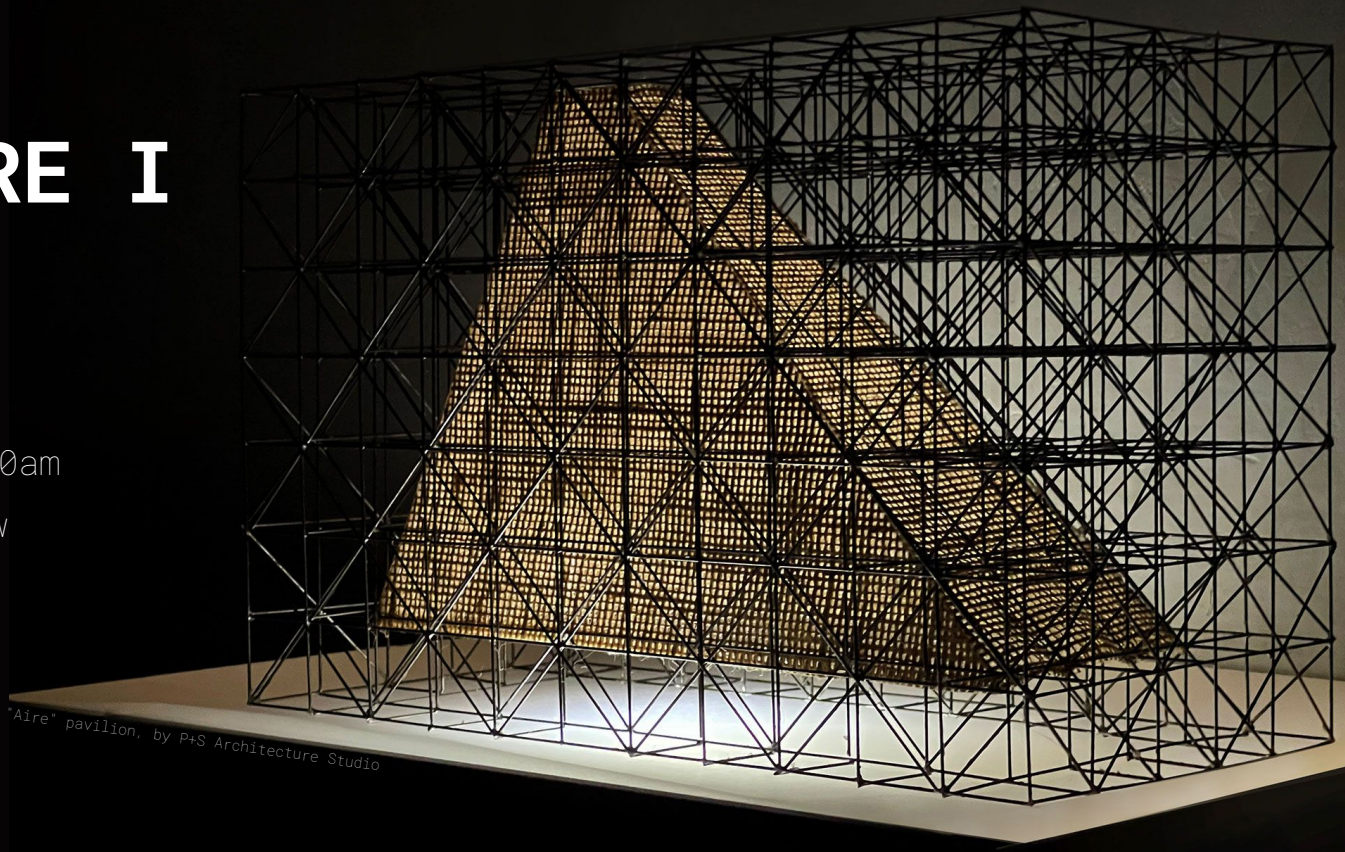
STRUCTURE I

ARCH-314

9:30am - 10:30am

East Review


"Aire" pavilion, by P+S Architecture Studio

Today:

- Final Reports (Due 11/25)
- Problem No.13: Horizontal Shear
- Lab 11: Horizontal Shear Stress

Final Report Guidelines

1. **No calculations are to be hand written**. Microsoft Word has a function for typing very legible and professional-looking equations. In Word, go to Insert and select Equation. In just a few minutes you should be able to become proficient in producing equations. It's pretty simple to use. If not using Word, there are other alternatives available on the web to effectively and clearly type equations.

2. **No screenshots of digital models**. All drawings should be digitally generated as polished line-drawings from programs such as Illustrator, AutoCAD, or similar to produce dimensioned drawings of your models. You can for example use the Make2D function in Rhino. Photographs of your final model before and/or after testing will be required in addition to drawings.

3. **Submit reports on 8-1/2" x 11" paper only.** Reports on 11x17 paper are not acceptable.

4. **Failure to produce a clean, polished, and professional report will result in up to 10% off of your final report points.** Write clearly, legibly, and with good grammar. Proofread your reports before turning them in. Use appropriate professional language in your report. The mark of a good report is one that is easy to understand by someone not familiar with the project.

5. **Turn in the ORIGINAL graded copy of your Preliminary Report with your Final Report.**

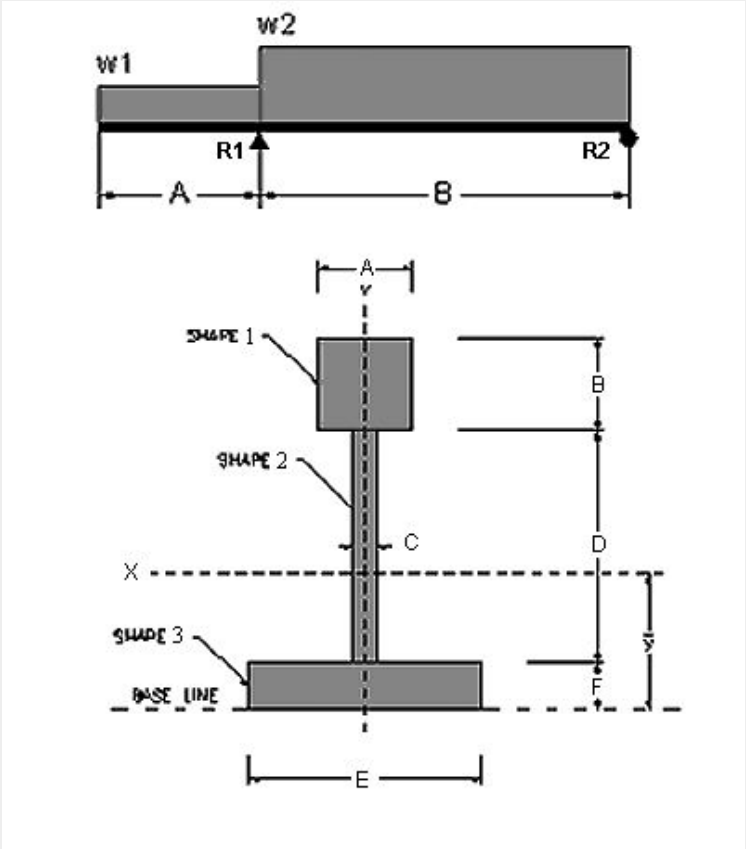
6. In the Pre-Analysis section of the Final Report, do all of the listed calculations for your model, as tested. That is, you should re-analyzing the model that you actually built and tested. We expect that certain changes were made during your development of a final design, based on the feedback given on your preliminary report which then require this re-analysis.

7. Throughout your analysis, verify that calculated values are reasonable. For instance, if your calculations produce a predicted load capacity of 70 kips, you have probably done something wrong, and should work to correct this before submitting your report.

PRELIMINARY REPORT (re-submit original)	**40**	
Explanation	5	
Illustrations: section (5), elevation (5), 3d view (5)	15	
Analysis: forces (5), sizing (5), weight estimate (5), load capacity (5)	20	
TESTING	**60**	
Bridge < 4 oz is 8 pts and holds at least 50 lbs is 8 pts (else pts scaled down)	16	
Correct materials – wood and glue – solid deck (no holes)	14	
Points awarded (out of 30) based on class rank using formula: [(4/weight OZ)*50 + (load in LBS/50)*9]	30	
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**	

PROBLEM NO.13

DATASET: 1 -2- -3-	
Section dimension A	8 IN
Section dimension B	2 IN
Section dimension C	1 IN
Section dimension D	8 IN
Section dimension E	4 IN
Section dimension F	1 IN
Beam span A	5 FT
Beam span B	17 FT
Beam load w1	38 PLF
Beam load w2	15 PLF



PROBLEM NO.12

Question 1: **Beam reaction R1 (upward is +)**

$W_1 = w_1 \times Beam\ Span\ A$

$W_1 = 38 \times 5$

$W_1 = 190\ lbs$

$W_2 = w_2 \times Beam\ Span\ B$

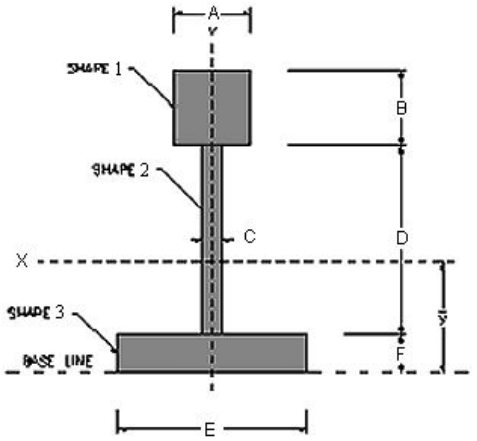
$W_2 = 15 \times 17$

$W_2 = 255\ lbs$

$$\sum_{R2} = 0 \quad -W_2 \times \left(\frac{Beam\ Span\ B}{2}\right) + R_1 \times B - W_1 \times \left(\frac{Beam\ Span\ A}{2} + Beam\ Span\ B\right) = 0$$

$$-255 \times \frac{17}{2} + R_1 \times 17 - 190 \times \left(\frac{5}{2} + 17\right) = 0$$

$$R_1 = 345.44\ lbs$$



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PROBLEM NO.12

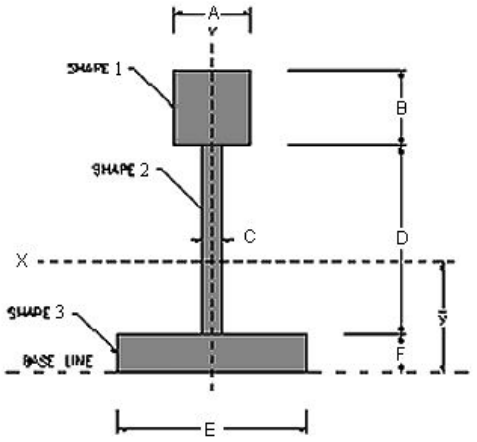
Question 2: **Beam reaction R2 (upward is +)**

$$\sum_{Fy} = 0$$

$$R_1(Question1) + R_2 - W_1 - W_2 = 0$$

$$345.44 + R_2 - 190 - 255 = 0$$

$$R_2 = 99.56\ lbs$$



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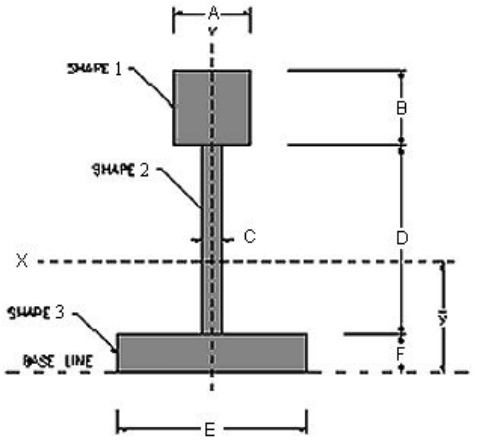
PROBLEM NO.12

Question 3: **Negative shear at R1 (use - sign)**

$$Negative\ V_{R_1} = -w_1 \times Beam\ Span\ A$$

$$Negative\ V_{R_1} = -38 \times 5$$

$$\boxed{Negative\ V_{R_1} = -190\ lbs}$$



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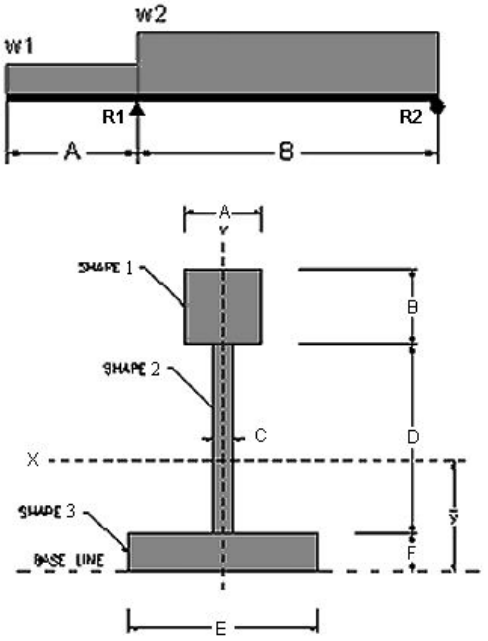
PROBLEM NO.12

Question 4: **Positive shear at R1**

$$Positive\ V_{R_1} = \left(-w_1 \times Beam\ Span\ A \right) (\ Questtion3) + R_1 (\ Question1)$$

$$Positive\ V_{R_1} = -190 + 345.44$$

$$Positive\ V_{R_1} = 155.44\ lbs$$



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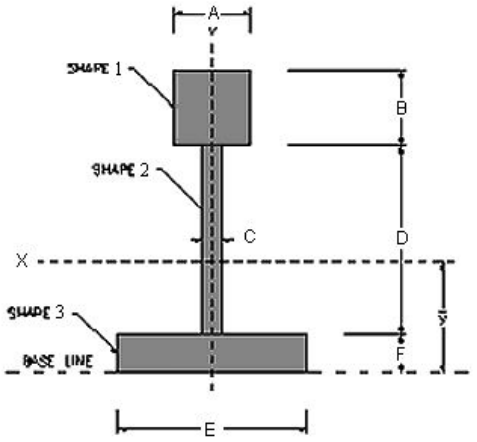
PROBLEM NO.12

Question 5: **Shear at R2 (use - or + sign)**

$$V_{R_2} = -R_2(\ Question2)$$

$$\boxed{V_{R_2} = -99.56}$$



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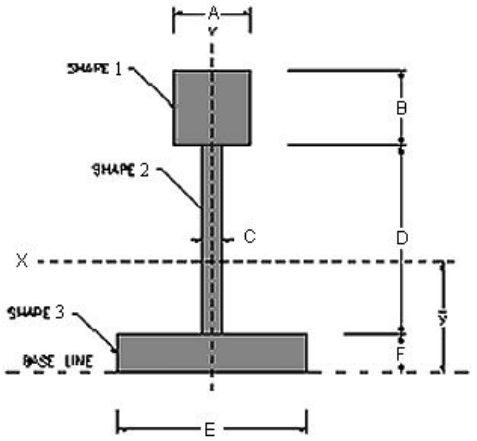
PROBLEM NO.12

Question 6: **Maximum shear force (absolute value)**

$V_{max} = \text{negative } V_{R_1}$ (*Question* 4)

$V_{max} = 190\ lbs$



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PROBLEM NO.12

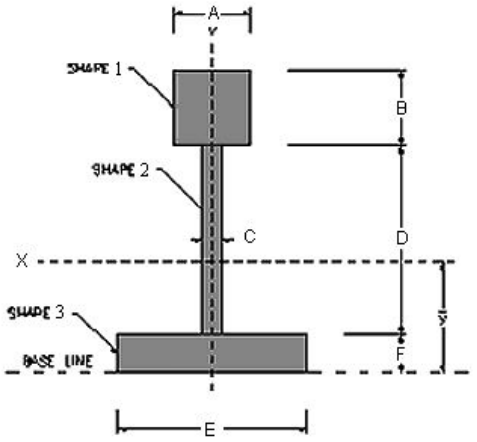
Question 7: Static Moment (Q) at top of shape 2

Centroid of whole geometry

$$\bar{y} = \frac{\sum_{a \times d}}{\sum_{a}} = \frac{(A \times B) \times \left(\frac{B}{2} + D + F\right) + (C \times D) \times \left(\frac{D}{2} + F\right) + (E \times F) \times \left(\frac{F}{2}\right)}{(A \times B) + (C \times D) + (E \times F)}$$

$$\bar{y} = \frac{(8 \times 2) \times \left(\frac{2}{2} + 8 + 1\right) + (1 \times 8) \times \left(\frac{8}{2} + 1\right) + (4 \times 1) \times \left(\frac{1}{2}\right)}{(8 \times 12) + (1 \times 8) + (4 \times 1)}$$

$\bar{y} = 7.21\ in$ *centroid of whole shape from base line*



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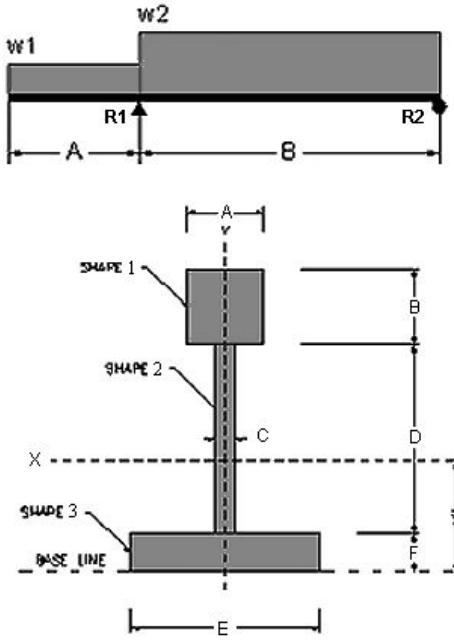
PROBLEM NO.12

Question 7: **Static Moment (Q) at top of shape 2**

$$Q_{top} = A \times B \times \left(\frac{B}{2} + D + F - (\bar{y}) \right)$$

$$Q_{top} = 8 \times 2 \times \left(\frac{2}{2} + 8 + 1 - (7.21) \right)$$

$$Q_{top} = 44.64\ in^3$$



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Beam load w1	38 PLF
Beam load w2	15 PLF

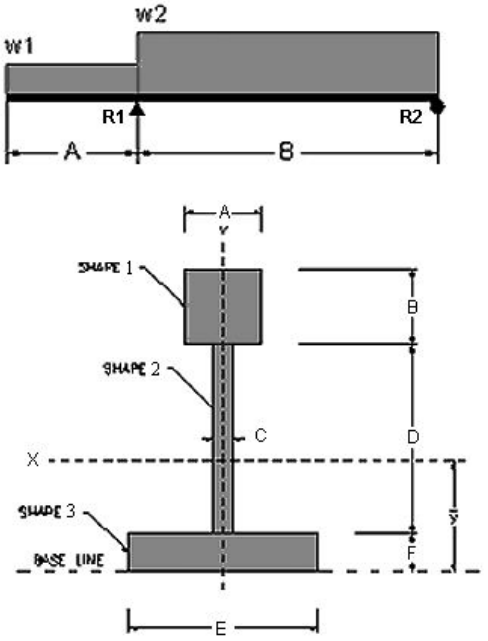
PROBLEM NO.12

Question 8: **Static Moment (Q) at bottom of shape 2**

$$Q_{bottom} = F \times E \times \left(\frac{F}{2} + (\bar{y} - F) \right)$$

$$Q_{bottom} = 4 \times 1 \times \left(\frac{1}{2} + (7.21 - 1) \right)$$

$$Q_{bottom} = 26.84\ in^3$$



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Beam load w1		38 PLF
Beam load w2		15 PLF

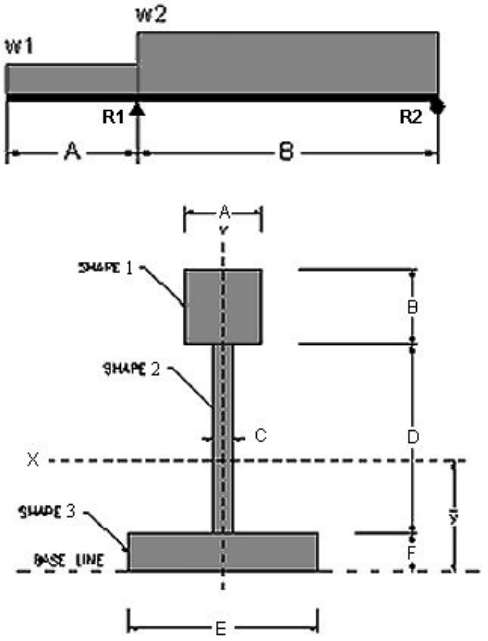
PROBLEM NO.12

Question 9: **Static Moment (Q) at the neutral axis**

$$Q_{na} = E \times F \times \left(y - \frac{F}{2} \right) + C \times (y - F) \times \frac{(y - F)}{2}$$

$$Q_{na} = 1 \times 4 \times \left(7.21 - \frac{1}{2} \right) + 1 \times (7.21 - 1) \times \frac{7.21 - 1}{2}$$

$$Q_{na} = 46.12\ in^3$$



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PROBLEM NO.12

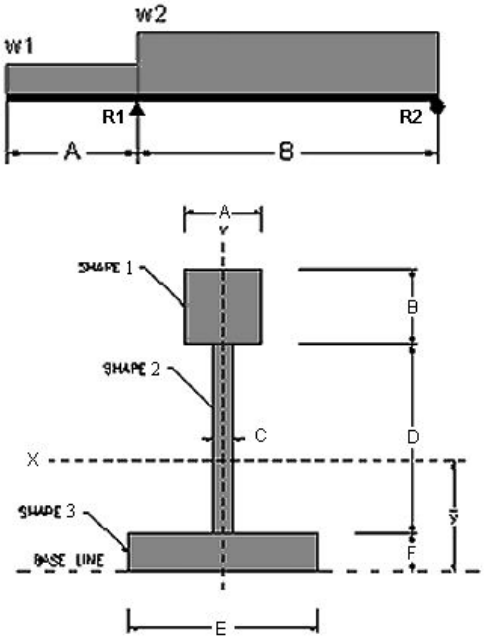
Question 10: **Moment of Inertia about the neutral axis**

$$I_x = I_{xx_1} + A_1 \times y_1^2 + I_{xx_2} + A_2 \times y_2^2 + I_{xx_3} + A_3 \times y_3^2$$

$$I_x = \frac{A \times B^2}{12} + A \times B \times y_1^2 + \frac{C \times D^2}{12} + C \times D \times y_2^2 + \frac{E \times F^2}{12} \times E \times F \times y_3^2$$

$$I_x = 129.48 + 81.87 + 180.64$$

$$I_x = 392.00\ in^4$$



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Beam span A		5 FT
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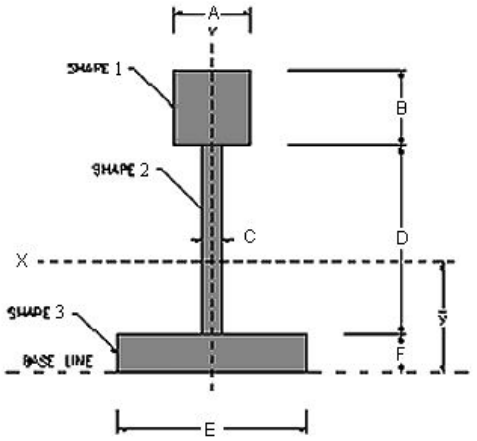
Beam load w1		38 PLF
Beam load w2		15 PLF

PROBLEM NO.12

Question 11: **Section width at the neutral axis**

$$C = 1\ in$$



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Beam load w1	38 PLF
Beam load w2	15 PLF

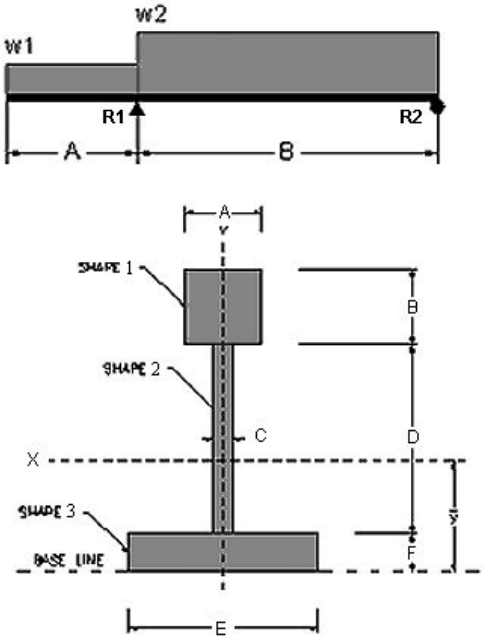
PROBLEM NO.12

Question 12: **Horizontal shear stress at the top of shape 2 for Vmax**

$$f_{v_{top}} = \frac{V_{max}\,(Question6) \times Q_{top}\,(Question7)}{I(Question10) \times C}$$

$$f_{v_{top}} = \frac{190 \times 44.64}{392 \times 1}$$

$$f_{v_{top}} = 21.60\ PSI$$



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Beam load w1	38 PLF
Beam load w2	15 PLF

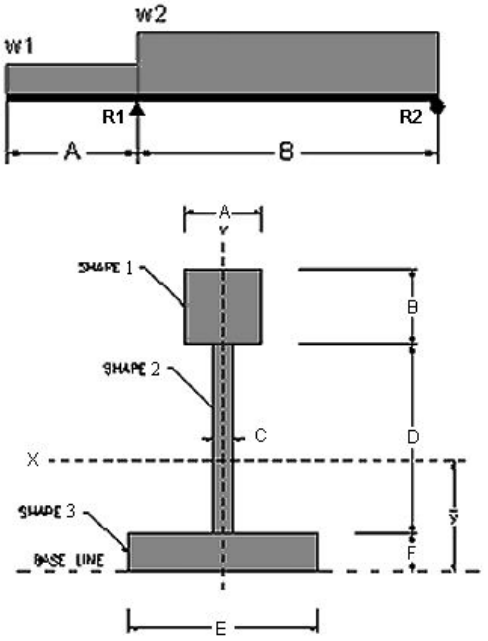
PROBLEM NO.12

Question 13: **Horizontal shear stress at the bottom of shape 2 for Vmax**

$$f_{v_{top}} = \frac{V_{max}\,(Question6) \times Q_{bottom}\,(Question8)}{I(Question10) \times C}$$

$$f_{v_{top}} = \frac{190 \times 26.84}{392 \times 1}$$

$$f_{v_{top}} = 13.01\ PSI$$



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Beam span B	17 FT
Beam load w1	38 PLF
Beam load w2	15 PLF

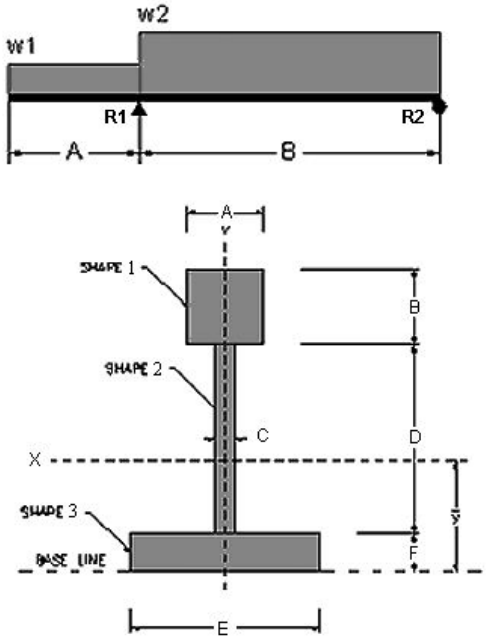
PROBLEM NO.12

Question 14: **Horizontal shear stress at the neutral axis for Vmax**

$$f_{v_{top}} = \frac{V_{max}\,(Question6) \times Q_{ne}\,(Question9)}{I(Question10) \times C}$$

$$f_{v_{top}} = \frac{190 \times 46.12}{392 \times 1}$$

$$f_{v_{top}} = 22.35\ PSI$$



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Beam span B	17 FT
Beam load w1	38 PLF
Beam load w2	15 PLF

Lab 11: 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.