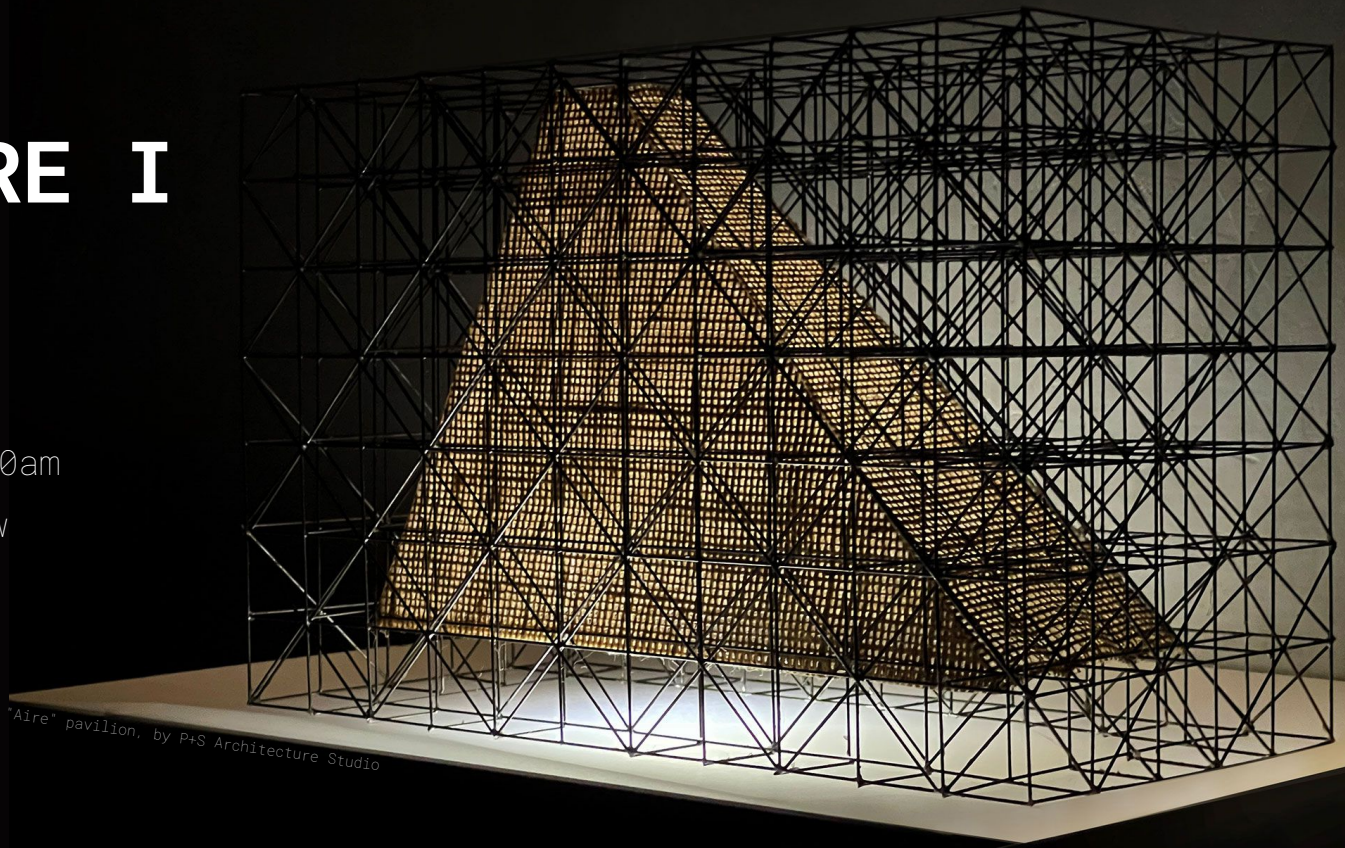
STRUCTURE I

ARCH-314

9:30am - 10:30am

East Review



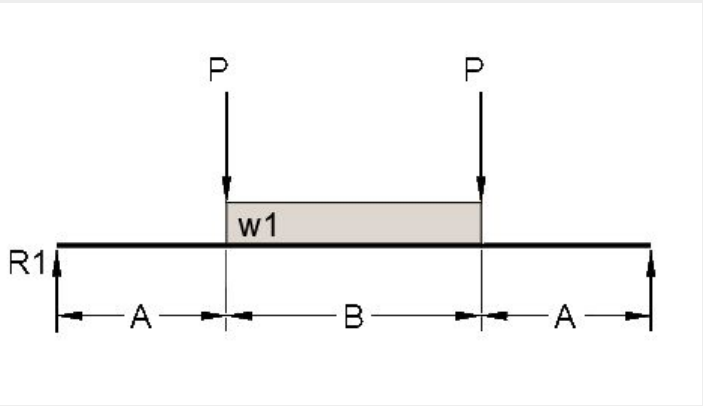
"Aire" pavilion, by P+S Architecture Studio

Today:

- Problem No.14: Beam Deflection
- Lab 12: Beam Deflection

PROBLEM NO.14

DATASET: 1 -2- -3-	
Length A	7 FT
Length B	13 FT
Point Load P	10 KIPS
Uniform Load w	1 KLF
Modulus of Elasticity	29000 KSI
Moment of Inertia	460 IN^4



PROBLEM NO.14

Question 1: **R1 (+ = upward)**

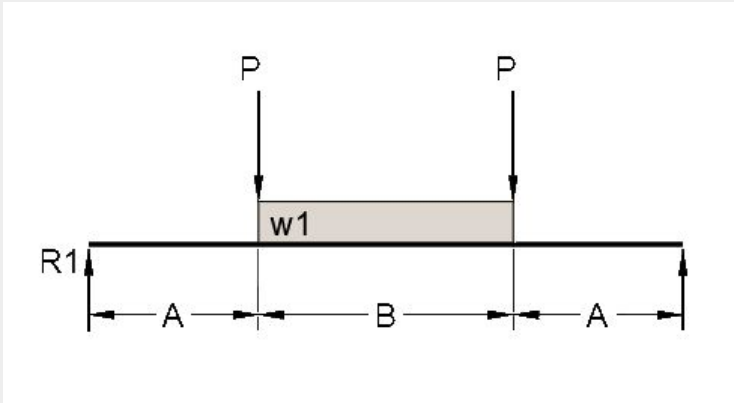
$$\sum_{R_2} = 0$$

$$-P \times A - (w \times B) \times \left(\frac{B}{2} + A\right) - P \times (B + A) + R_1 \times (A + B + A) = 0$$

$$-10 \times 7 - (1 \times 13) \times \left(\frac{13}{2} + 7\right) - 10 \times (7 + 13) + R_1 \times (7 + 13 + 7) = 0$$

$$-70 - 175.5 - 200 + R_1 \times 27 = 0$$

$$R_1 = 16.5 \; KIPS$$



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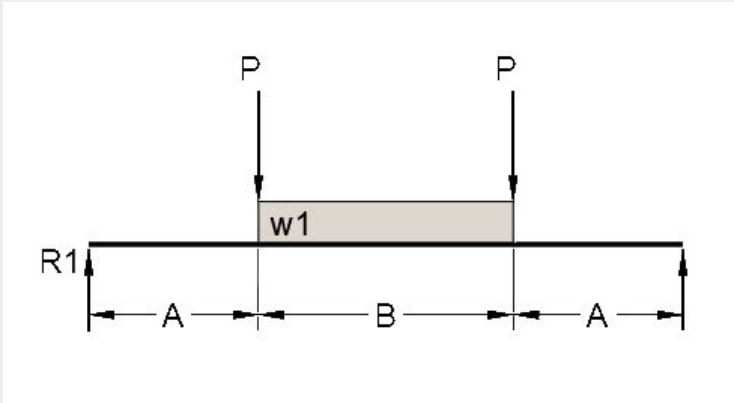
PROBLEM NO.14

Question 2: **Shear at reaction (V1)**

$V_1 = R_1 (\ Question\ 1)$

$V_1 = 16.5\ KIPS$



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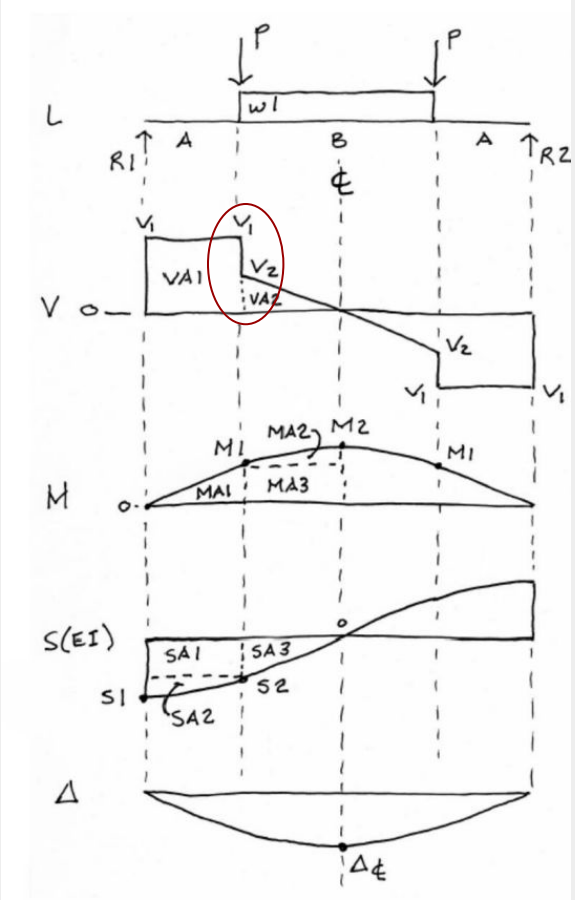
PROBLEM NO.14

Question 3: **Shear at point load (V2)**

$$V_2 = V_1(\text{Question 2}) - P$$

$$V_2 = 16.5 - 10$$

$$\boxed{V_2 = 6.5\ KIPS}$$



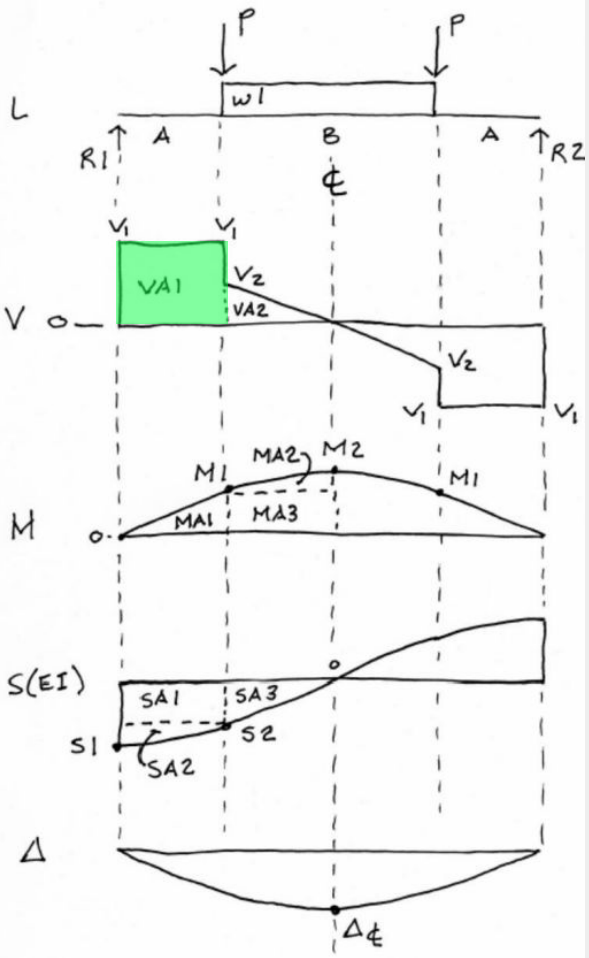
PROBLEM NO.14

Question 4: **Moment at point load (M1)**

$$M_1 = R_1(\ Question\ 1) \times A$$

$$M_1 = 16.5 \times 7$$

$$M_1 = 115.5\ KIP - FT$$



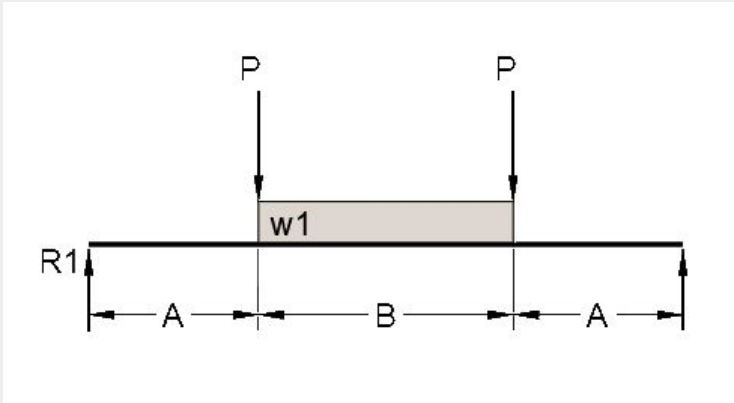
PROBLEM NO.14

Question 5: **Moment at center line (M2)**

$$M_2 = R1(Question1) \times (A + \frac{B}{2}) - P \times \frac{B}{2} - W(\frac{B}{2}) \times (\frac{\frac{B}{2}}{2})$$

$$M_2 = 16.5 \times \left(7 + \frac{13}{2}\right) - 10 \times \frac{13}{2} - 1 \times \left(\frac{13}{2}\right) \times \left(\frac{\frac{13}{2}}{2}\right)$$

$$M_2 = 136.625\ KIP - FT$$



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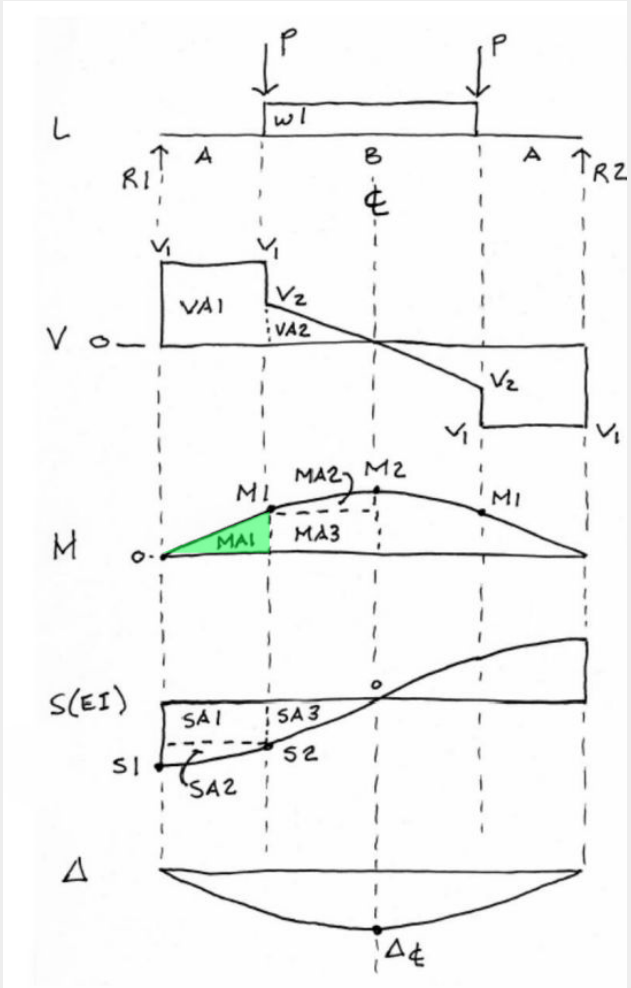
PROBLEM NO.14

Question 6: **Area under moment diagram (MA1)**

$$MA_1 = \frac{1}{2} \times M_1(Question 4) \times A$$

$$MA_1 = \frac{1}{2} \times 115.5 \times 7$$

$$MA_1 = 404.25\ KIP - FT^2$$



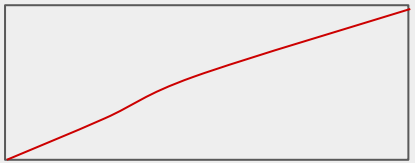
PROBLEM NO.14

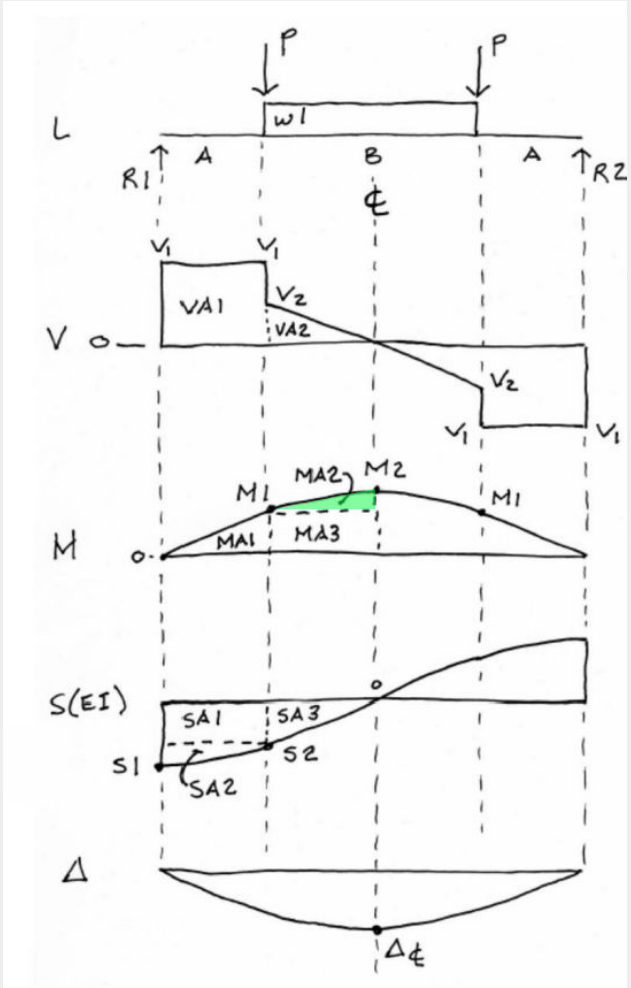
Question 7: **Area under moment diagram (MA2)**

$$MA_2 = \left(\frac{2}{3}\right) \times \left(M_2(question5) - M_1(question4)\right) \times \left(\frac{B}{2}\right)$$

$$MA_2 = \left(\frac{2}{3}\right) \times (136.625 - 115.5) \times \left(\frac{13}{2}\right)$$

$$MA_2 = 91.541\ KIP - FT^2$$





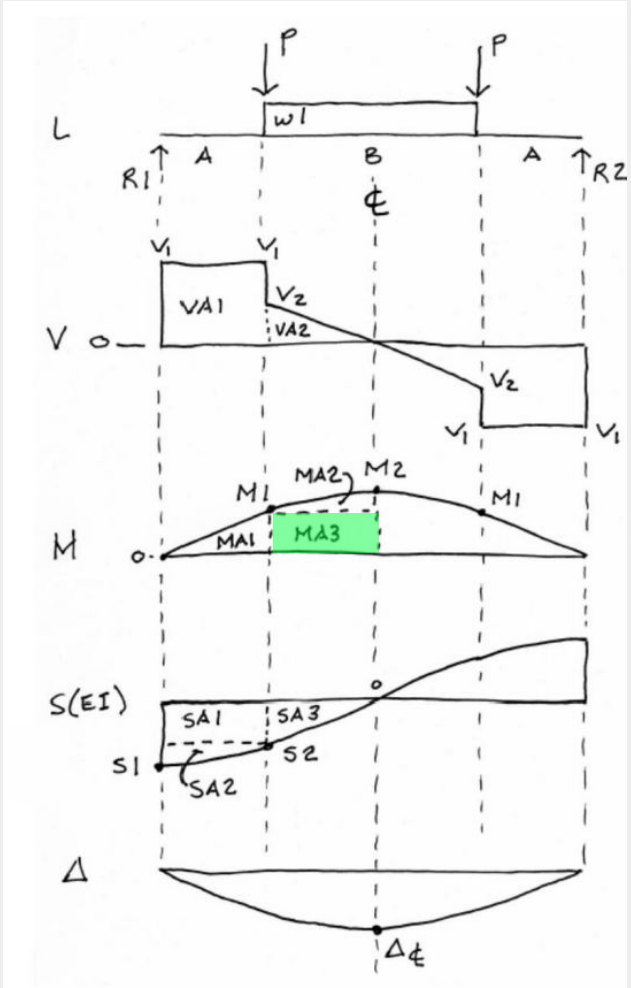
PROBLEM NO.14

Question 8: **Area under moment diagram (MA3)**

$$MA_3 = M_1(Question4) \times \left(\frac{B}{2}\right)$$

$$MA_3 = 115.5 \times \left(\frac{13}{2}\right)$$

$$MA_3 = 750.75\ KIP - FT^2$$



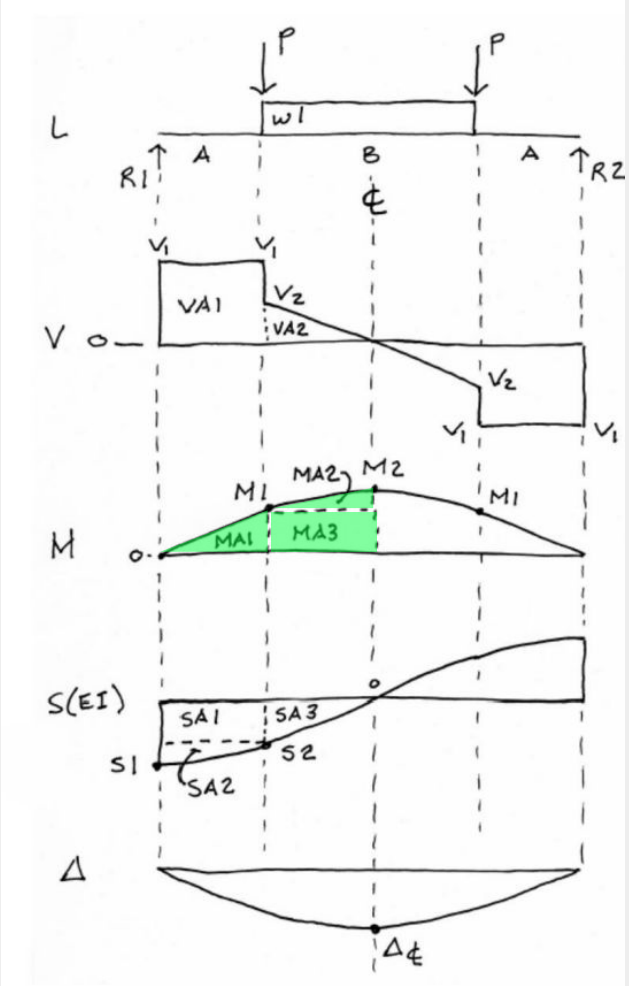
PROBLEM NO.14

Question 9: **Slope(EI) at reaction (S1). Give absolute value.**

$$S_1 = MA_1(Question6) + MA_2(Question7) + MA_3(Question8)$$

$$S_1 = 404.25 + 91.54166667 + 750.75$$

$$S_1 = 1246.54\ KIP - FT^2$$



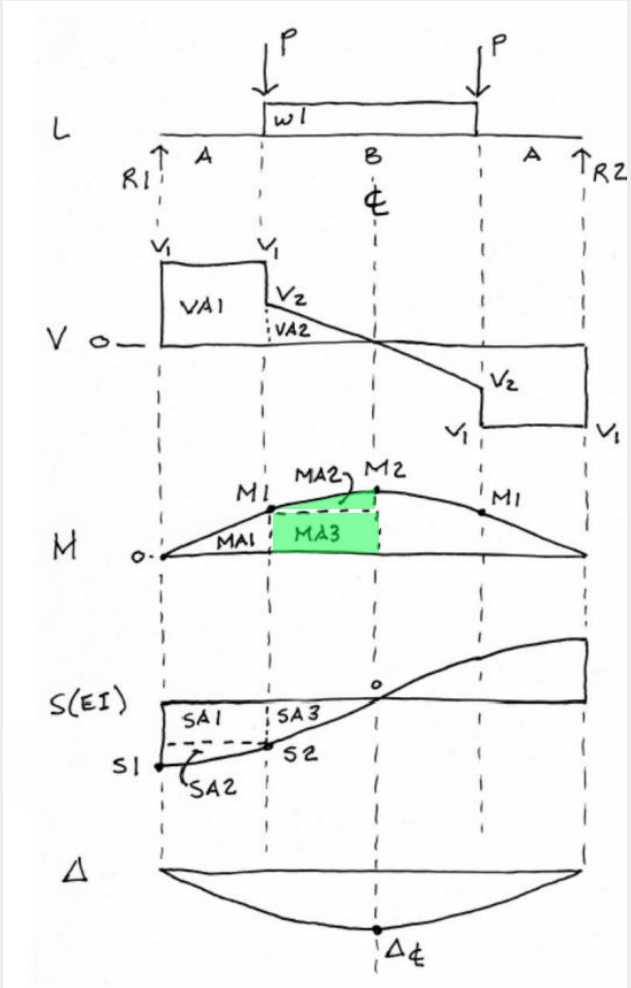
PROBLEM NO.14

Question 10: **Slope(EI) at point load (S2). Give absolute value.**

$$S_2 = MA_2\,(Question7) + MA_3\,(Question8)$$

$$S_2 = 91.54 + 750.75$$

$$S_2 = 842.29\ KIP - FT^2$$



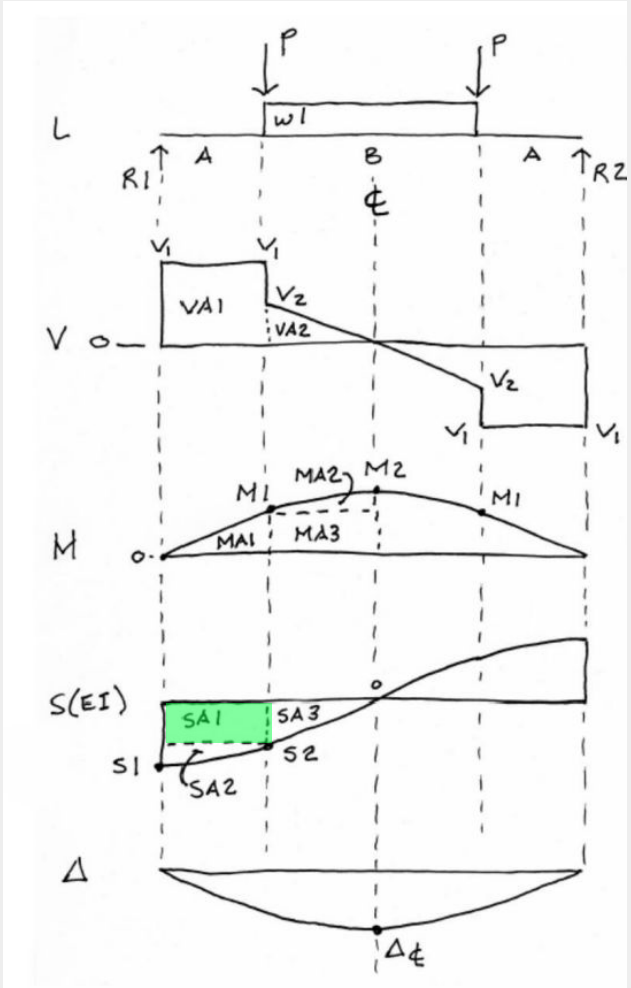
PROBLEM NO.14

Question 11: **Area under slope(EI) diagram (SA1)**

$$SA_1 = S_2(Question\,10) \times A$$

$$SA_1 = 842.29 \times 7$$

$$SA_1 = 5896.041\ KIP - FT^3$$



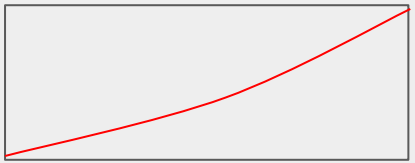
PROBLEM NO.14

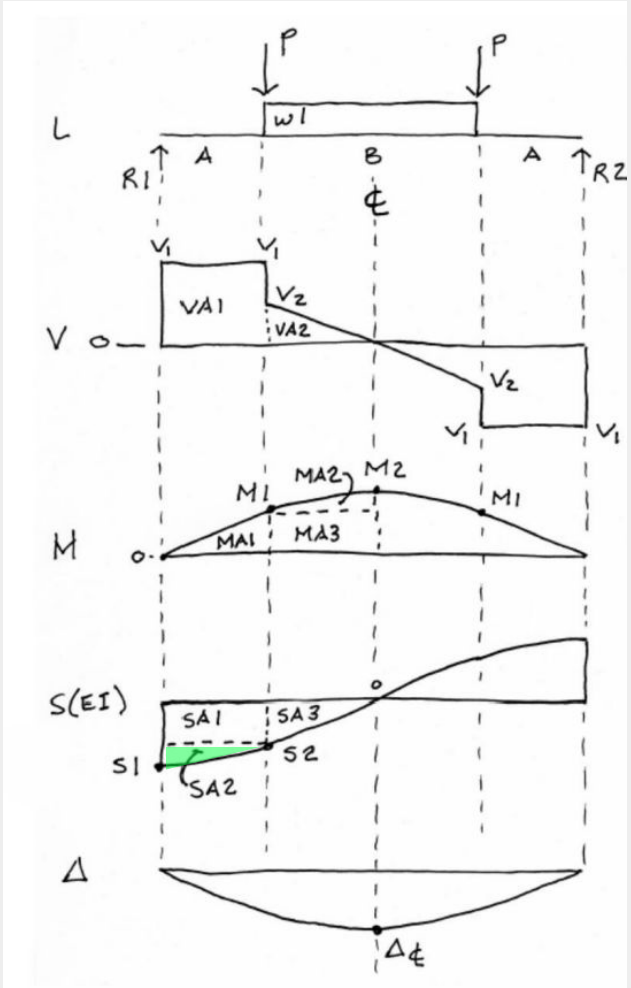
Question 12: **Area under slope(EI) diagram (SA2)**

$$SA_2 = \left(\frac{2}{3}\right) \times \left(S_1(Question9) - S_2(Question10) \right) \times A$$

$$SA_2 = \frac{2}{3} \times (1246.54 - 842.29) \times 7$$

$$SA_2 = 1886.5\ KIP - FT^3$$





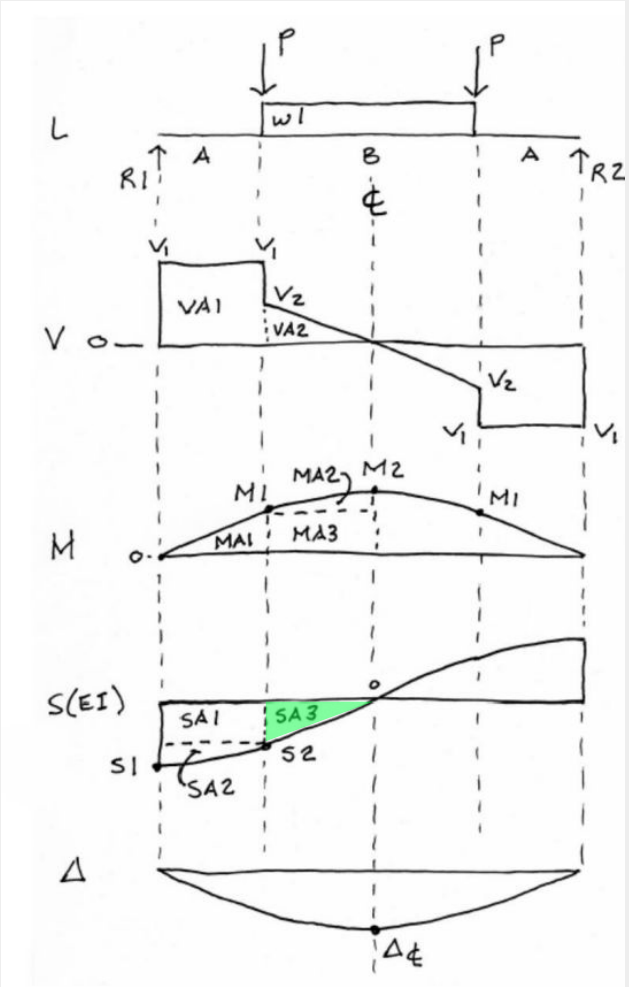
PROBLEM NO.14

Question 13: **Area under slope(EI) diagram (SA3)**

$$SA_3 = \left(\frac{1}{2}\right) \times S_2(Question\,10) \times \left(\frac{B}{2}\right)$$

$$SA_3 = \frac{1}{2} \times 842.29 \times \frac{13}{2}$$

$$\boxed{SA_3 = 2737.44\ KIP - FT^3}$$



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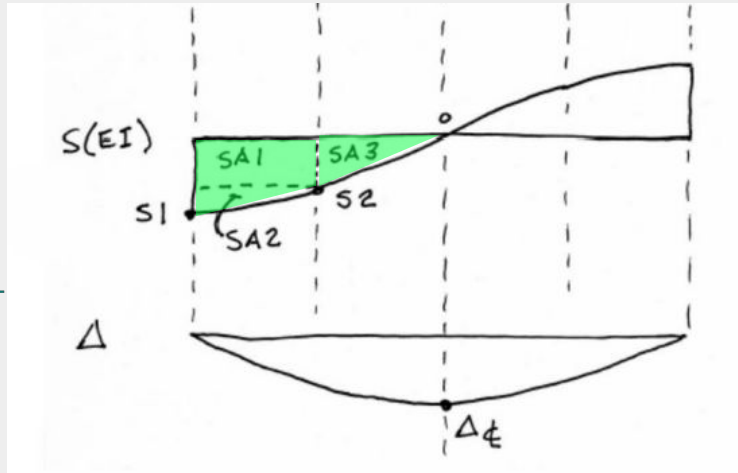
Question 14: **Centerline deflection. Give absolute value in INCHES.**

$$\Delta = \frac{(SA_1(Question\,11) + SA_2(Question\,12) + SA_3(Question\,13)) \times (12x\ 12x\ 12)}{Modulus\ of\ Elasticity \times Moment\ of\ Inertia}$$

$$\Delta = \frac{(5896.04 + 1886.5 + 2737.44) \times 12^3}{29000 \times 460}$$

$$\Delta = 1.362\ in$$



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Lab 12: Beam Deflection

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.

Basswood Properties

E = 1,650,000. psi

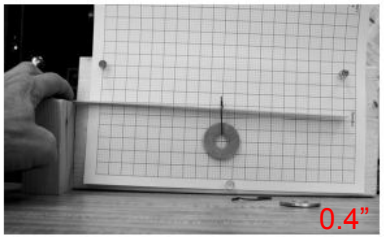
I_y = 0.0000102 in^4

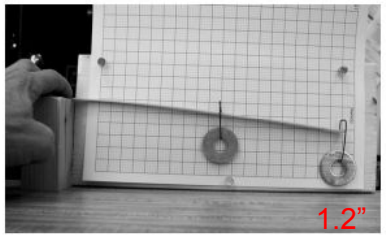
P_1 = 0.035 lbs.

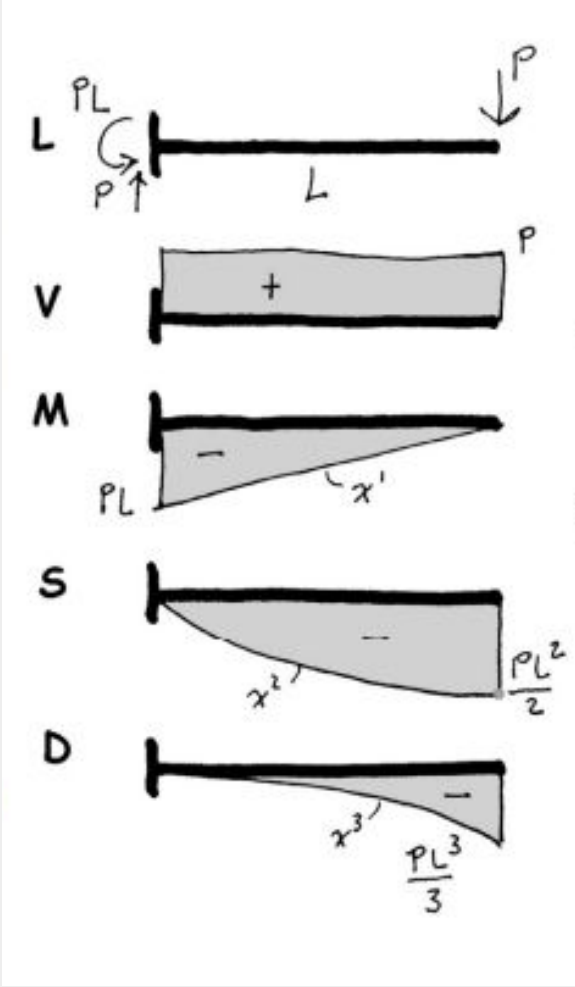
L = 10.5 in

Equations:

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







$P \times L$

$(P \times L) \times \frac{L}{2}$

$\frac{2}{3} \times \left((P \times L) \times \frac{L}{2} \right) \times L$