Design for a beam Section

Topics

1- Solved problem - Part (a) plastic analysis
10.1 Mccormac

Completed

(b) apply 0.90 rule

⇒ Use ASD

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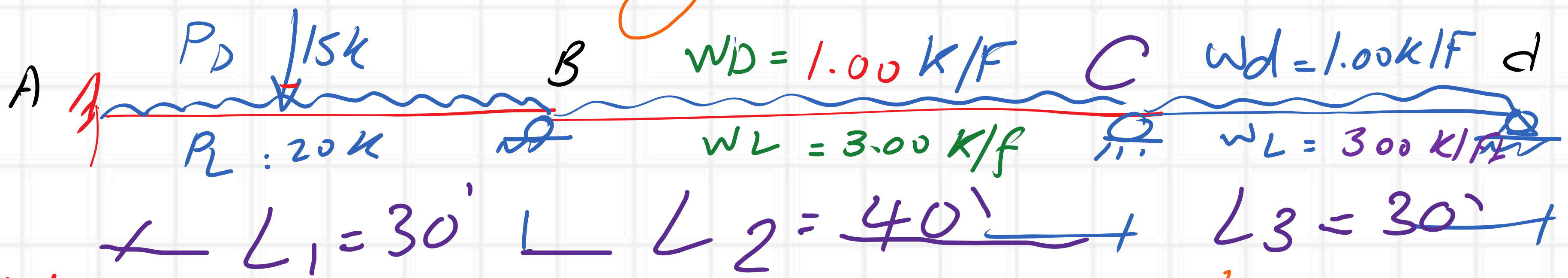
Analysis using 0.90 rule for Continuous beam

ASD



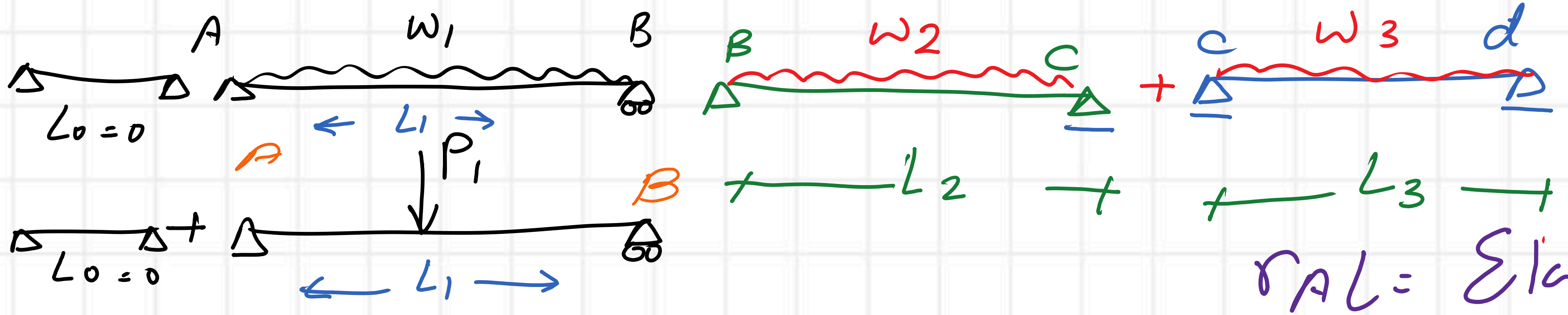
Solution :

Using the three moments equation → Three moment Equation

No. of Unkowns = 3 M_A, M_B, M_C will obtained, knowing that $M_c = 0$

$Md = 0$

For matrix



r_{AL} = Elastic moment at A left

$$0 + 2M_A(L_0 + L_1) + M_B(L_1) = -6r_{AL} - 6r_{Ar}$$

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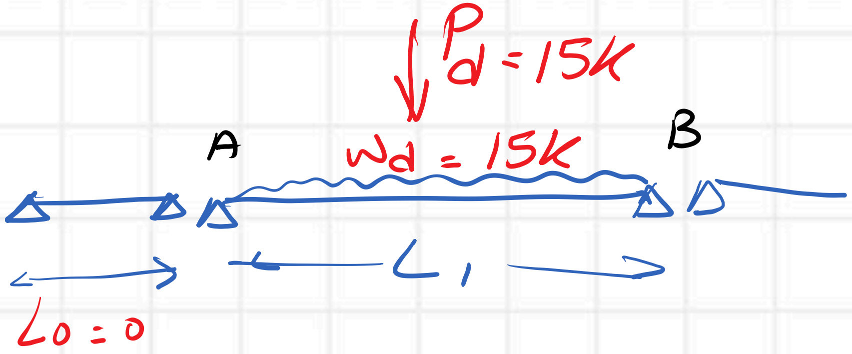

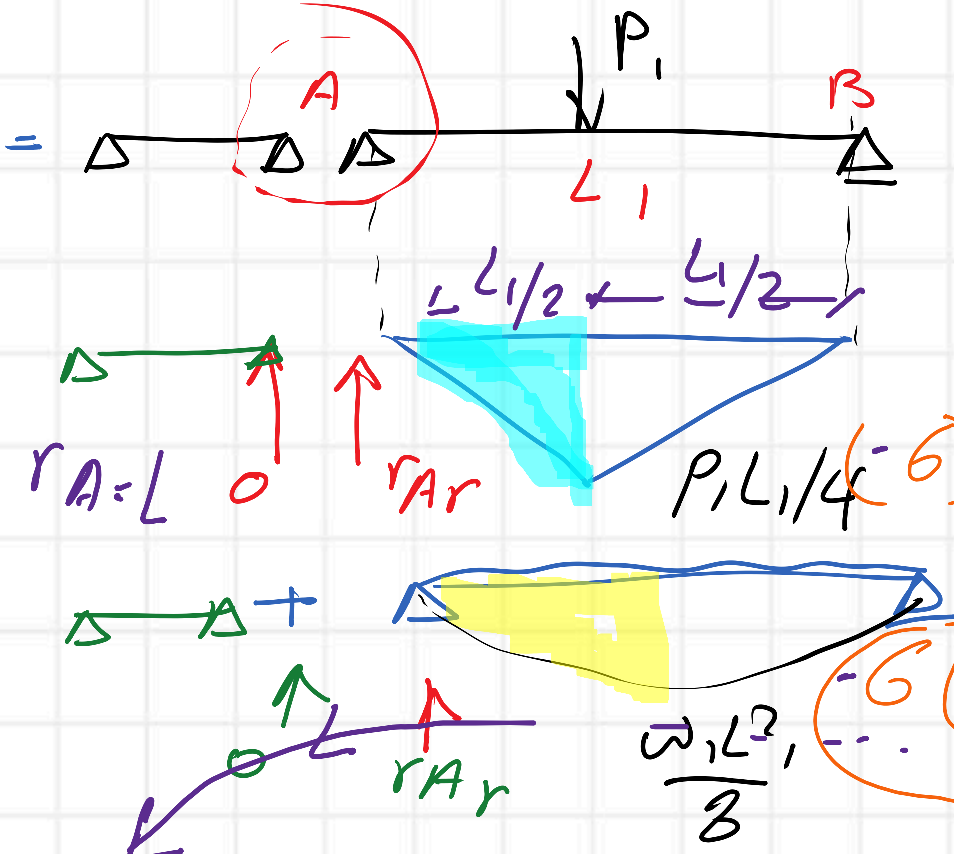

Dead loads

First span

$r_{A_L} = 0$

$-(6)\, r_{Ar} = \frac{P_1 L_1}{2(4)} \frac{L_1}{2}$

$-(6)\, r_{Ar} = \frac{2}{3} \frac{w_1 L_1^2 L_1}{2(8)}$

$= \frac{1}{24} w_1 L_1^3$

Taking Moment at A

$+2M_A(0 + L_1) + M_B(L_1)$

$= -6\, r_{A_L} - 6\, r_{Ar}$

$= -6\left(\frac{P_1 L_1^2}{16}\right) - 6\left(\frac{w_1 L_1^3}{24}\right)$

$$\begin{bmatrix} 2L_1 & L_1 & 0 & 0 \end{bmatrix} \begin{bmatrix} M_A \\ M_B \\ M_C \\ M_d \end{bmatrix} = \begin{bmatrix} -\frac{1}{4} L_1^3 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ W_4 \end{bmatrix} + \begin{bmatrix} -\frac{3}{8} L_1^2 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

Solve matrices

$6 r_{A_r}$ in terms of w

$6 r_{A_r}$ in terms of P

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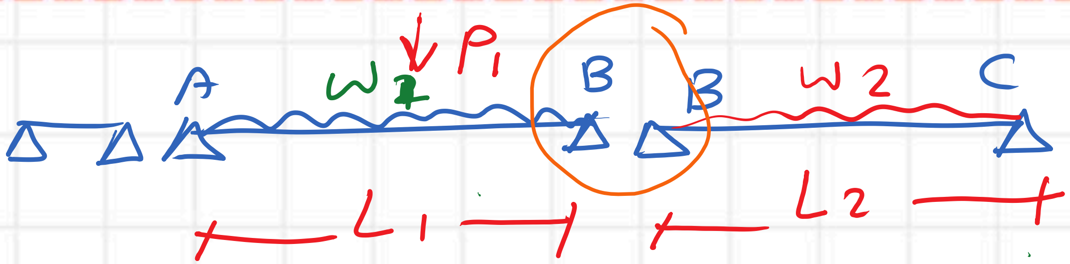
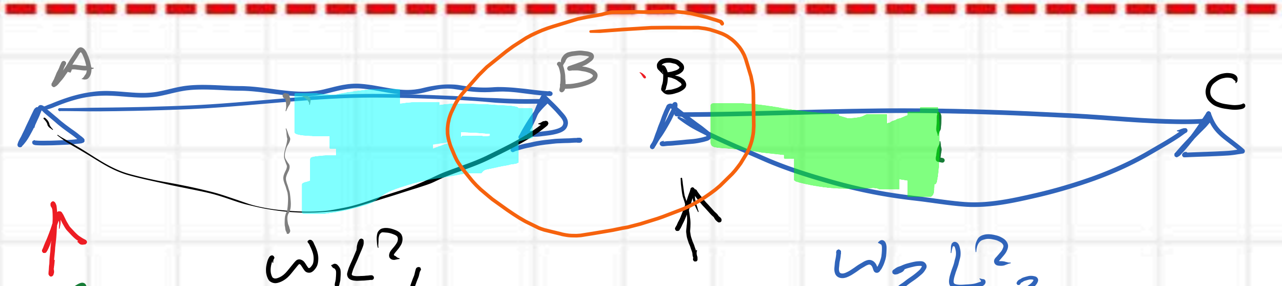




$\frac{w_1 L_1^2}{8}$ $\frac{w_2 L_2^2}{8}$

Taking moment at B

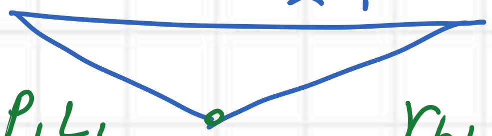
$$M_A(L_1) + 2M_b(L_1+L_2) + M_c(L_2)$$

$$= -6(r_{bL}) - 6(r_{br})$$

$$= -6\left(\frac{w_1 L_1^3}{24} + \frac{P_1 L_1^2}{16}\right) - 6\left(\frac{w_2 L_2^3}{24}\right)$$

$(-6)\, r_{bL} = \frac{2}{3}\left(\frac{w_1 L_1^2}{8}\right)\frac{L_1}{2}$ $(-6)\, r_{br} = \frac{2}{3}\frac{w_2 L_2^2}{8}\cdot\frac{L_2}{2}$

$(-6)\, r_b = w_1 \frac{L_1^3}{24}$ $(-6)\, r_{br} = \frac{w_2 L_2^3}{3(8)}$



$\frac{P_1 L_1}{4}$ $r_{bL} = \frac{P_1 L_1^2}{8}$

$$\begin{bmatrix} L_1 & 2L_1+2L_2 & L_2 & 0 \end{bmatrix}\begin{bmatrix} M_A \\ M_b \\ M_C \\ M_d \end{bmatrix} = \begin{bmatrix} -\frac{L_1^3}{4} & -\frac{L_2^3}{4} & 0 & 0 \end{bmatrix}\begin{Bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{Bmatrix} + \begin{bmatrix} -\frac{3}{8}L_1^2 & 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

$-6r_b$ terms of w $-6r_B$ in terms of P

Equation of M

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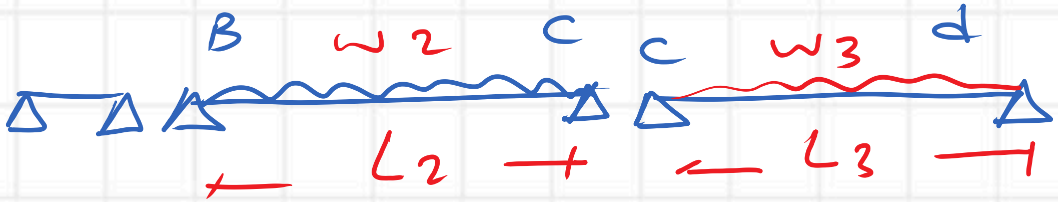

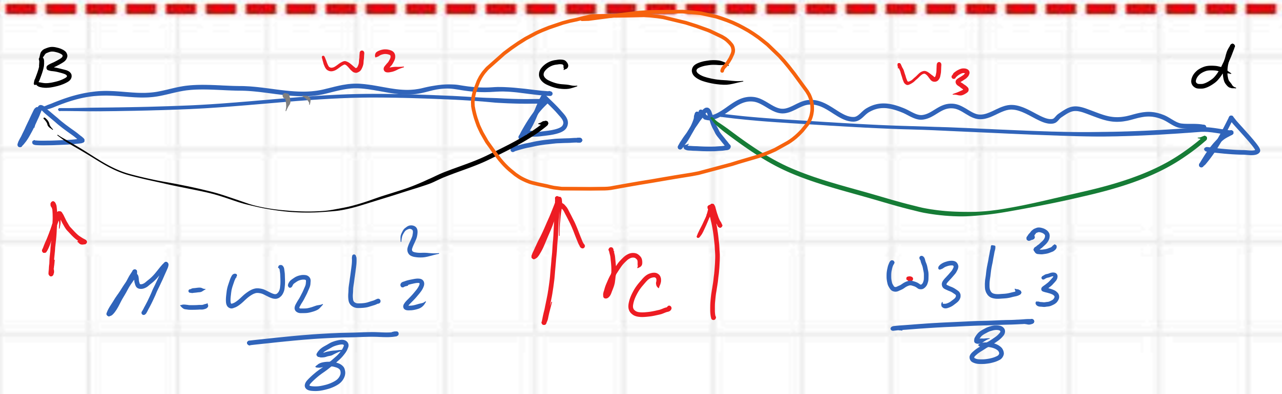

Taking moment at C

$$M_b(L_2) + 2M_c(L_2+L_3) + M_d(0) = \left(-\frac{1}{4} w_2 L_2^3 - \frac{1}{4} w_3 L_3^3\right]$$

U.L

$$\begin{bmatrix} 0 & L_2 & 2(L_2+L_3) + & 0 \end{bmatrix} \begin{bmatrix} M_A \\ M_B \\ M_C \\ M_d \end{bmatrix} = \begin{bmatrix} 0 & -\frac{L_2^3}{4} & -\frac{L_3^3}{4} & 0 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

Moments Left side Equation

$6r_C$ in terms of w

C.L

$6r_C$

in terms of P

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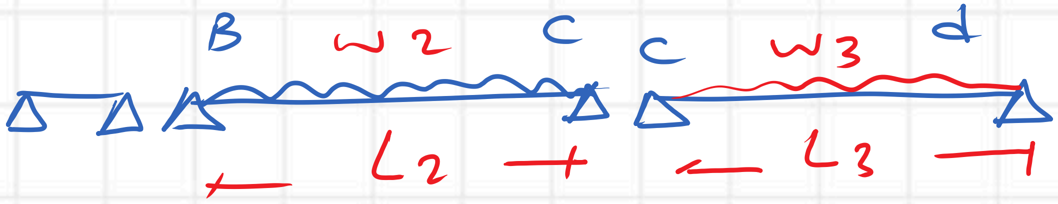

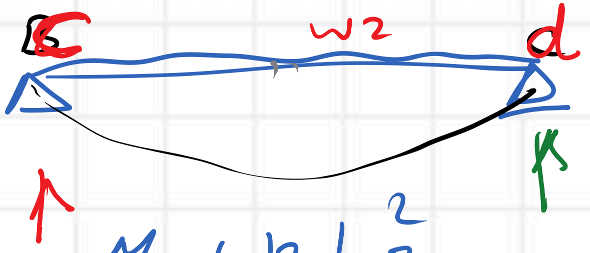

Last span

$Y_d = 0$

$$M = \frac{w_2 L_2^2}{8}$$

$M_d = 0$

For matrix

$$\begin{bmatrix} 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} M_A \\ M_B \\ M_C \\ M_d \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

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Final

$$\begin{bmatrix} 2L_1 & L_2 & 0 & 0 \\ L_1 & 2(L_1+L_2) & L_2 & 0 \\ 0 & L_2 & 2(L_2+L_3) & L_3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} M_A \\ M_B \\ M_C \\ M_d \end{bmatrix} = \begin{bmatrix} -\frac{L_1^3}{4} & 0 & 0 & 0 \\ -\frac{L_1^3}{4} & -\frac{L_2^3}{4} & 0 & 0 \\ 0 & -\frac{L_2^3}{4} & -\frac{L_3^3}{4} & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{bmatrix}$$

$$+$$

$$= \begin{bmatrix} -\frac{3}{8}L_1^2 & 0 & 0 & 0 \\ -\frac{3}{8}L_1^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

$\Downarrow$ Substitute by L values

$L_1 = 30'$

$L_2 = 40'$

$L_3 = 30'$

$$\begin{bmatrix} 60 & 40 & 0 & 0 \\ 30 & 140 & 40 & 0 \\ 0 & 40 & 140 & 30 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$-\frac{L_1^3}{4} = -\frac{30^3}{4}$

$-\frac{L_2^3}{4} = -\frac{40^3}{4}$, $-\frac{L_3^3}{4} = -\frac{30^3}{4}$, $-\frac{3}{8}L_1^2 = -\frac{3}{8}(30)^2$

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