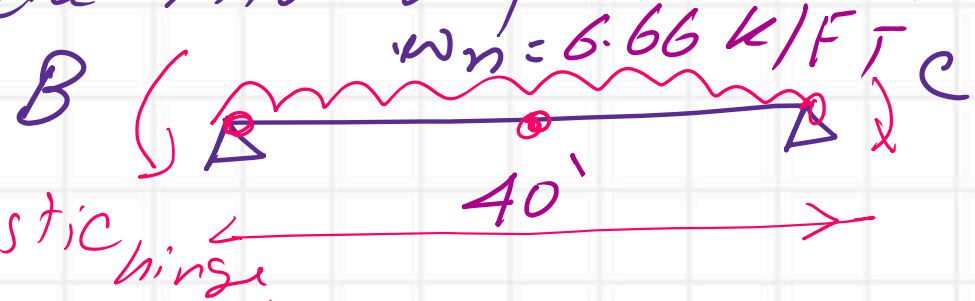
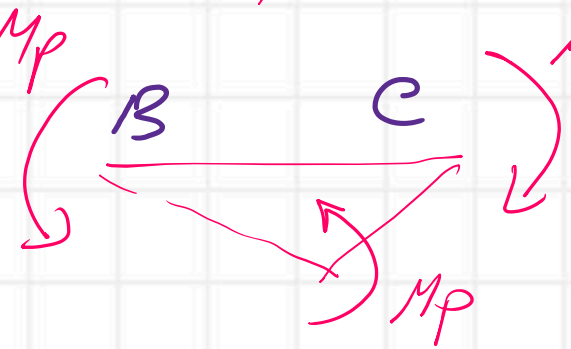
For the middle part



Part (a) use plastic analysis

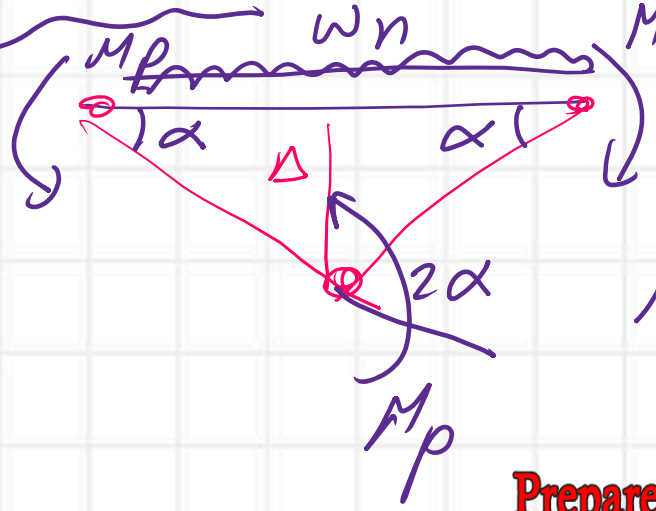


Static Method

$$M_p = M_n \Rightarrow w_n \frac{\ell^2}{8} = 2M_p \Rightarrow M_p = \frac{6.66(40)^2}{8(2)}$$

$$M_p = 666 \text{ FT. kips}$$

Upper bound



$$\alpha = \frac{\Delta}{20}$$

$$4\alpha = \frac{\Delta}{20}(4)$$

$$We = w_n \ell \frac{\Delta}{2} = 6.66(20)\Delta$$

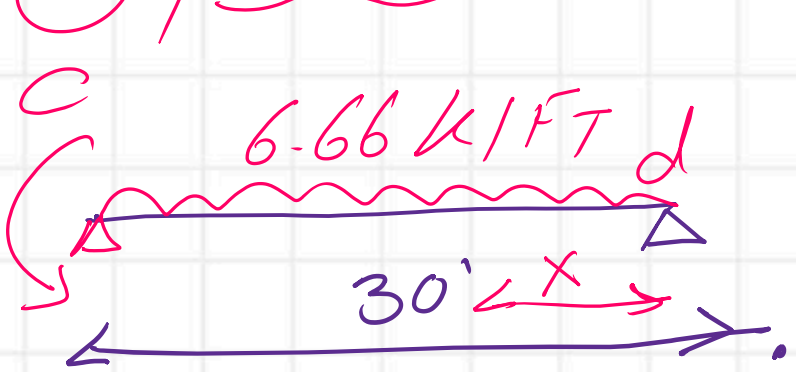
$$Wi = 4M_p(\alpha) = 4\frac{\Delta M_p}{20}$$

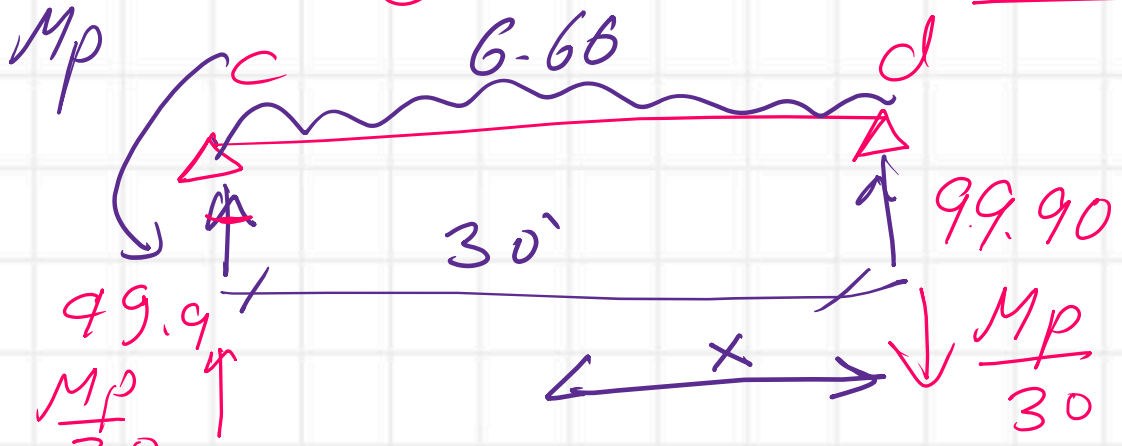
$$M_p \frac{\Delta}{5} = 6.66(20)\Delta$$

$$M_p = 666 \text{ FT. kips}$$

@ part a use plastic analysis

3rd span

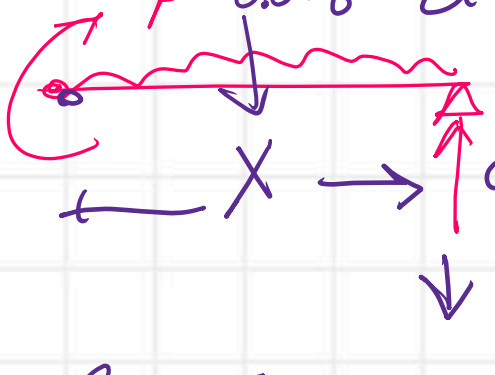




Static Method

$\sum F_y = 0 \quad 99.90 - \frac{M_p}{30} - 6.66x = 0$ (I)

Find x From C → Zero shear



$\sum M_d = 0 \quad 6.66\left(\frac{x^2}{2}\right) = M_p \Rightarrow M_p = 3.33x^2$ (II)

$99.90 - 3.33\frac{x^2}{30} - 6.66x = 0 \quad (-30)$

$3.33x^2 + 199.8x - 2997 = 0$

$x^2 + 60x - 900 = 0$

@ Part a use plastic analysis

3rd span Cd

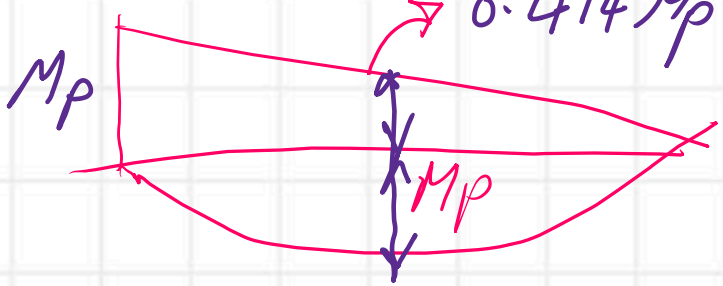
$$x^2 + 60x - 900 = 0$$

$$x = \frac{-60 \pm \sqrt{(60)^2 + 4(900)}}{2}$$

$x = 12.426'$

Find M at $x = 12.426' \Rightarrow M_p$

$M_p = 3.33 x^2 = 3.33 (12.426)^2 = 514.204$ FT.kip



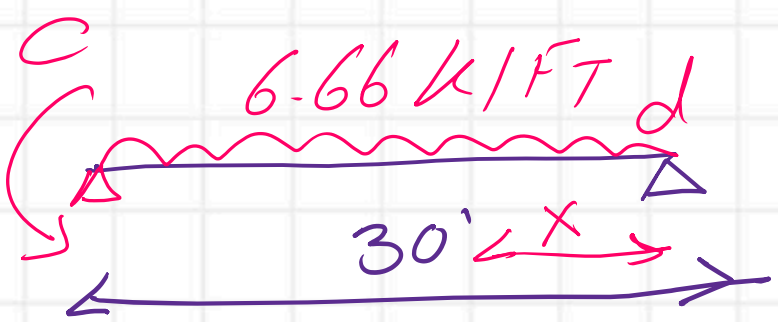
or

$0.414 M_p + M_p = 749.25$

$M_p = 514.204$ FT.kip

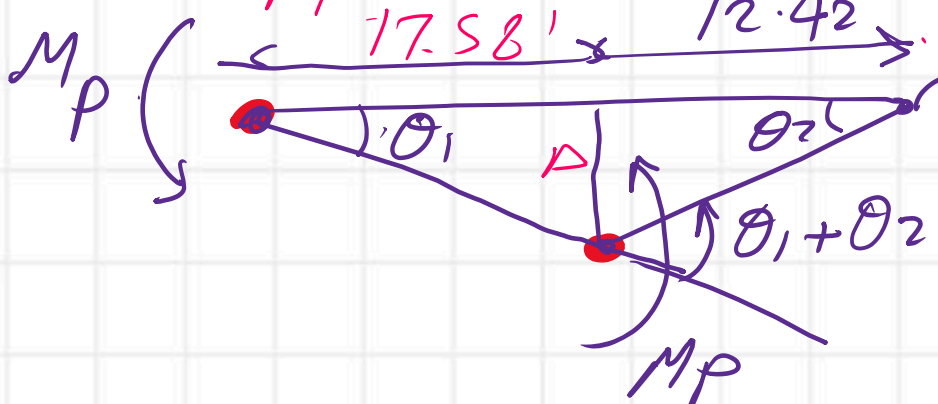
$$\frac{w_n L^2}{8} = \frac{6.66 (30)^2}{8} = 749.25$$

@ part a use plastic analysis (upper bound)



$X = 0.414\,\ell = 0.414(30) = 12.42'$

upper bound



$\theta_1 = \frac{\Delta}{17.58}$

$\theta_2 = \frac{\Delta}{12.42}$

$2\theta_1 + \theta_2 = \Delta\left(\frac{2}{17.58} + \frac{1}{12.42}\right)$

$= \Delta\left(\frac{42.42}{218.3436}\right)$

$W_e = 6.66(30)\frac{\Delta}{2} = 99.9$

$W_i = M_p(\theta_1 + (\theta_1+\theta_2) = M_p\left(\frac{42.42}{218.3436}\right)$

$M_p = 514.20$ FT. kips

Select the highest value = $M_p = 666$ Ft. Kips

$M_{ult} = 0.90(666) = 599.4$ Ft.K

$M_{ult} \cong 600$ Ft. Kips

$M_n = M_p = f_y Z_x$

$Z_x = \frac{666 \times 12}{50} = 159.84$ inch^3

$M_{ult} = \phi F_y Z_x$

F_y

Use Table 3-2

Convert $M_p \Rightarrow M_{ult}$

Z_x

Table 3-2 (continued)

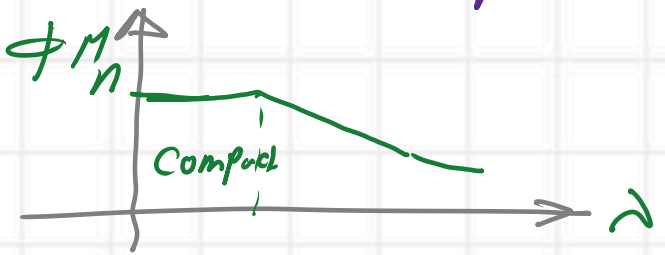
W-Shapes

Selection by Z_x

$F_y = 50$ ksi

Shape	Z_x	M_{px}/Ω_b	$\phi_b M_{px}$	M_{rx}/Ω_b	$\phi_b M_{rx}$	BF/Ω_b	$\phi_b BF$	L_p	L_r	I_x	V_{nx}/Ω_v	$\phi_v V_{nx}$
	in.^{3}	kip-ft ASD	kip-ft LRFD	kip-ft ASD	kip-ft LRFD	kips ASD	kips LRFD	ft	ft	in.^{4}	kips ASD	kips LRFD
W21×68	160	399	600	245	368	12.5	18.8	6.36	18.7	1480	181	272
W14×90	157	392	574	250	375	4.82	7.26	15.1	42.5	999	123	185

$M_{ult} = \phi M_n$



W21 X 68

$Z_x = 160$ inch^3

Z_x For W21 X 68 = 160 inch^3

$\phi_b M_p = 600$ Ft.K = M_{ult}