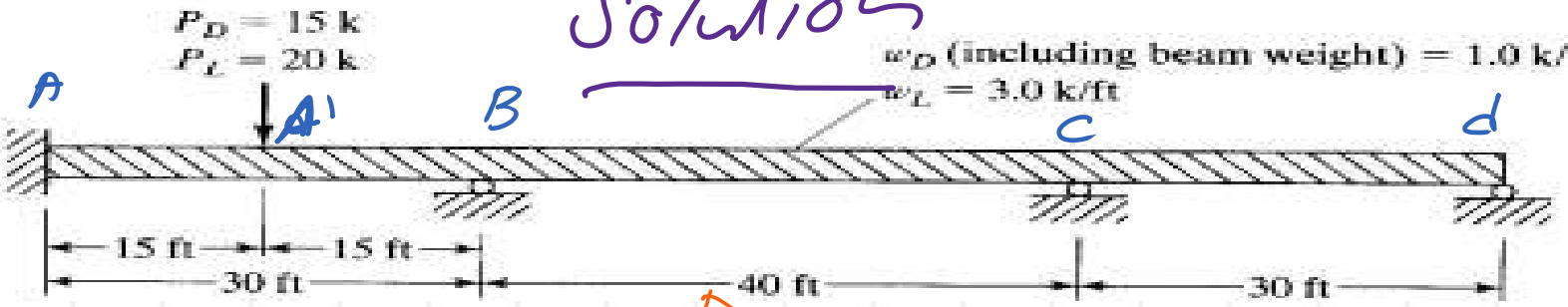
Example 10-1

The beam shown in Fig. 10.1 is assumed to consist of 50 ksi steel. (a) Select the lightest W section available, using plastic analysis and assuming that full lateral support is provided for its compression flanges. (b) Design the beam, using elastic analysis with the service loads and the 0.9 rule, and assuming that full lateral support is provided for both the flanges.

→ Design
→ Fully braced



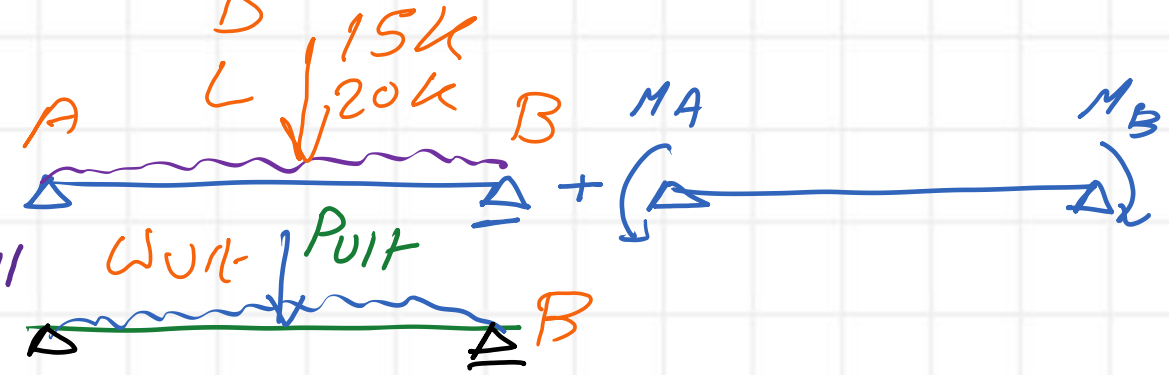
Solution

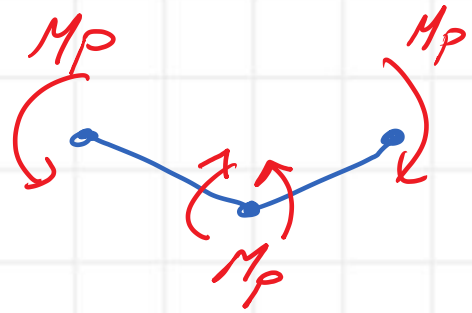
Part @ Using plastic analysis

$F_y = 50$ ksi

Find P_{ult} & w_{ul}

END Span





$P_{UL} = 1.2(15) + 1.6(20) = 18 + 32 = 50$ k

$w_{ult} = 1.2(1.00) + 1.6(3.0)$

$= 1.2 + 4.80 = 6$ k/ft

Span A – B

Find P_{ult} w_{ult}

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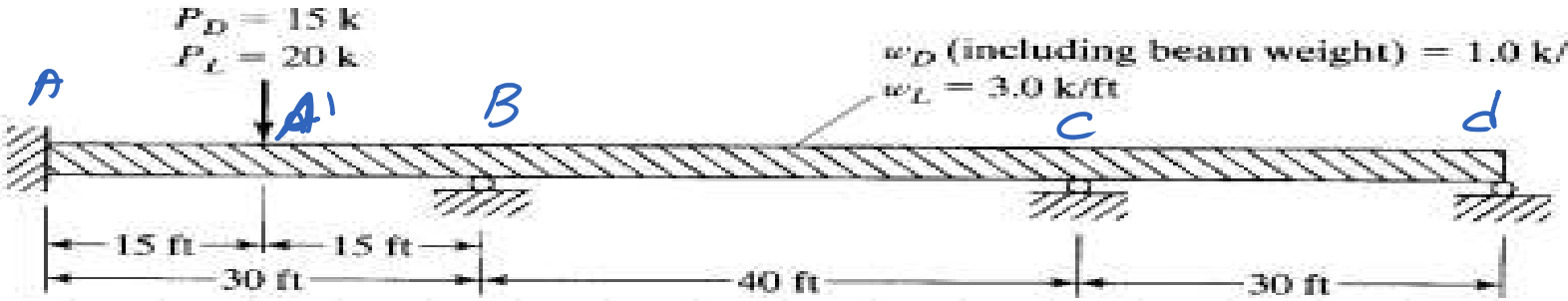
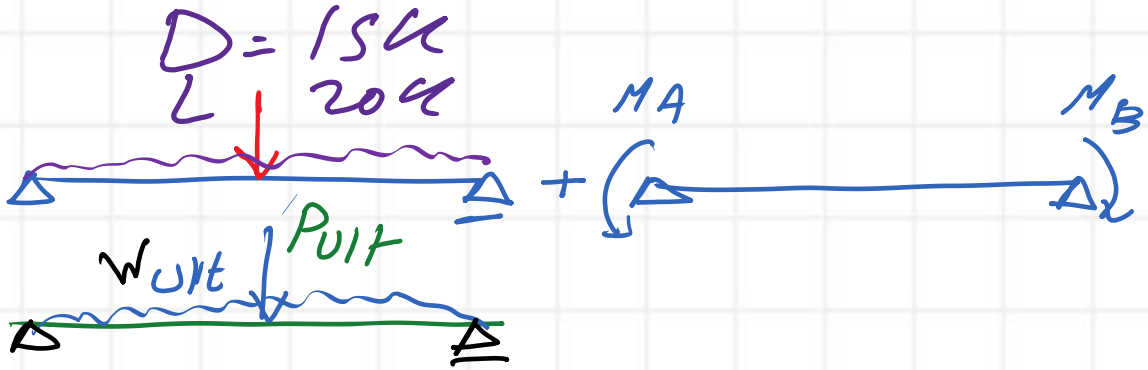


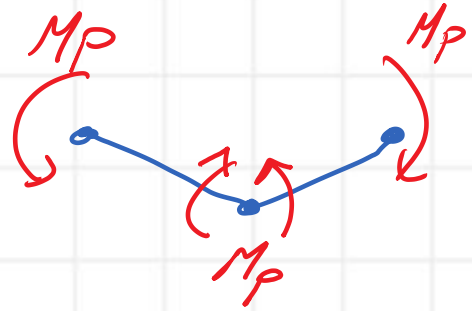
Convert P_{ULT}, w_{ULT} ⇒ Nominal Load w_n

Solution

$f_y = 50$ ksi;

END Span





$P_{UL} = 50$ k
$W_{ULT} = 6$ k
} Ultimate

$\phi_b = 0.90$ since LRFD

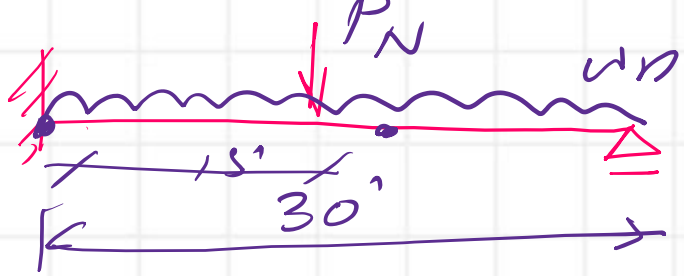
→ For plastic analysis Convert to nominal Loads

$P_N = 50 / 0.90 = 55.55$ kips

$W_N = \frac{6}{0.90} = 6.66 \frac{Kip}{ft}$

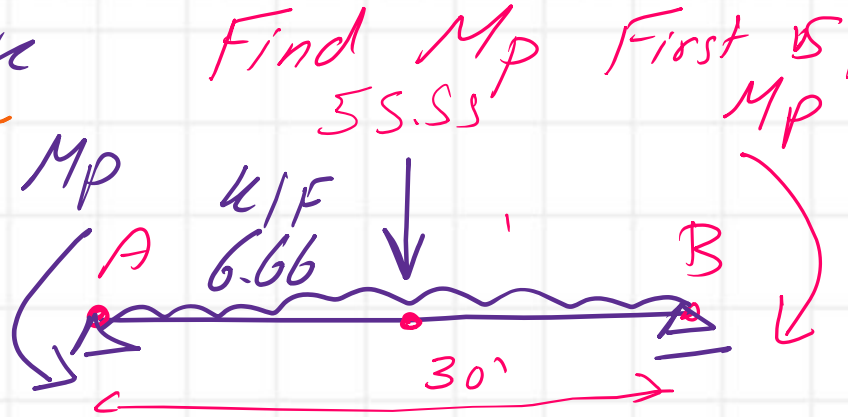
End span AB

$P_N = 55.55$ k

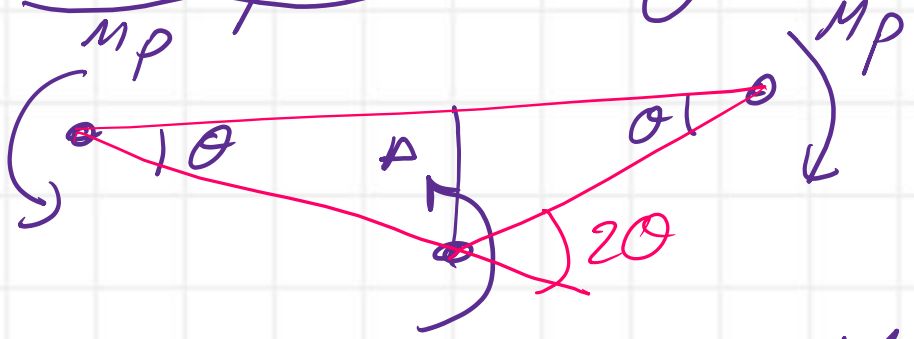


$w_D = 6.66$ k/FT

Find M_p First Span



Three plastic hinges



$$W_e = 55.5\,\Delta + 6.66(30)\frac{\Delta}{2}$$

$$= 155.4S\,\Delta$$

$$W_i = M_n(2\theta + 2\theta) = M_p(4\theta) = \frac{4}{15}M_p\,\Delta$$

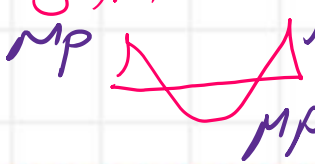
$$M_p\,\Delta\left(\frac{4}{15}\right) = 155.4S\,\Delta$$

$$M_p = 155.4S\left(\frac{15}{4}\right) = 582.94 \approx 583 \text{ F.k}$$

$$\theta = \frac{\Delta}{15}$$

$$4\theta = \frac{4}{15}\Delta$$

Similar to



$$2M_p = P_n\frac{\ell}{4} + \omega_n\frac{L^2}{8} = 55.55\left(\frac{30}{4}\right) + 6.66\frac{(30)^2}{8}$$

$M_p = 583$ FT. k, ps