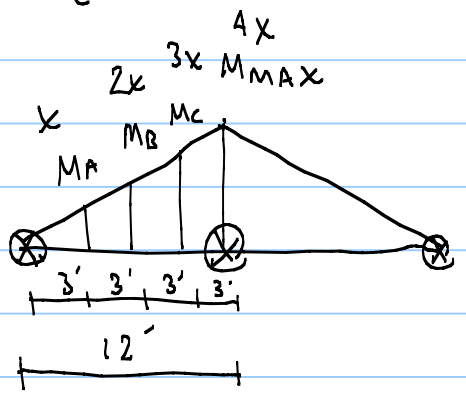
Note Title 5/3/2007

C_b (b)



$$C_b = \frac{12.5 M_{MAX}}{2.5 M_{MAX} + 3M_A + 4M_B + 3M_C}$$

$$C_b = \frac{12.5(4x)}{2.5(4x) + 3(x) + 4(2x) + 3(3x)}$$

$$C_b = \frac{50x}{30x} = 1.67$$

(4) Calculate Capacity:

$$\phi M_n = C_b\left[\phi M_p - BF\left(L_b - L_p\right)\right] \leq \phi M_p$$

$\phi M_p = 698$ ft-kips

$BF = 11.9$ kips

$L_p = 9.29'$

(a) $\phi M_n = 1.316\left[698 - 11.9(24 - 9.29)\right] = 688$ ft-kips < 698

$\phi M_n = 688$ ft-kips

(b) $\phi M_n = 1.67\left[698 - 11.9(12 - 9.29)\right] = 1111$ ft-k > 698 ft-kips

$\phi M_n = 698$ ft-kips

Example 2:

Find Capacity of: 16' simply-supported beam
W14x99
Grade 50
Lateral bracing @ end only

Solution:

(1) Slenderness Checks:

Flange Slenderness: $\frac{bf}{2tf} = 9.34$

$\lambda_p = 0.38\sqrt{\frac{29000}{50}} = 9.15$

$\lambda_r = 0.83\sqrt{E/F_L} = 22.3$

$F_L = 50 - 10 = 40$

✓ Web Slenderness: $\frac{h}{tw} = 23.5 < \lambda_p = 3.76\sqrt{\frac{29000}{50}} = 91$

Lateral Bracing: $L_b = 16'$ $L_p = 13.5$ $L_r = 40.6$

∴ Need to check FLB and LTB

(2) Determine Governing Equations

take Minimum

FLB: $\lambda_p < \lambda < \lambda_r$ $\quad \phi M_n = \phi M_p - \phi(M_p - M_r)\left(\frac{\lambda - \lambda_p}{\lambda_r - \lambda_p}\right)$

LTB: $L_p < L_b < L_r$ $\quad \phi M_n = C_b\left[\phi M_p - \phi(M_p - M_r)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \leq \phi M_p$

(3) Calculate C_b : $C_b = 1.0$

(4) Calculate Capacity

$$\phi M_{n(FLB)} = 649 - (649 - 471)\left(\frac{9.34 - 9.15}{22.3 - 9.15}\right) = 646 \text{ ft-kips}$$

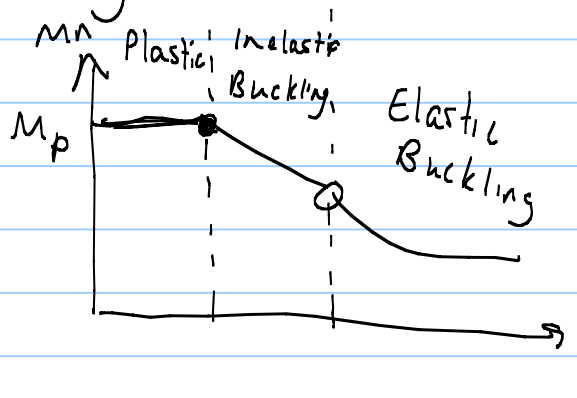
$$\phi M_{n(LTB)} = C_b \left[\phi M_p - BF(L_b - L_p) \right] \leq \phi M_p$$

$$= 1.0 \left[649 - 6.56(16 - 13.5) \right] \leq 649$$

$$= 633 \text{ ft-kips} \leq 649 \text{ ft-kips}$$

$\boxed{\phi M_n = 633 \text{ ft-kips}}$ (LTB Governs)

Beam Design Charts - For Beams w/ Intermittent Lateral Support



340 ft-kips
$L_b = 8'$
} W21×48

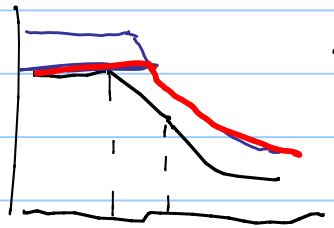
- Use of Beam Design Charts, with $C_b = 1.0$

  - Enter chart with L_b and required ϕM_n

  - Choose section above and to the right (solid line is most economical)

  - Also gives capacity at L_b

  - Checks? → No, gives actual moment capacity.



- Use of Beam Design Charts for $C_b \neq 1.0$

$$\phi M_n = C_b \left[\begin{array}{c} \text{capacity given} \\ \text{by chart} \end{array} \right] \leq \phi M_p$$

Design Chart Approach

1. Enter chart w/ $\frac{M_u}{C_b}$
2. Check to make sure predicted capacity $\leq \phi M_p$
3. Check to make sure section is compact.

these give minimums

Zx tables Approach

1. Use Zx table to get trial section
2. Check w/ design charts or equations

Design Example Beam Design Charts

Design a beam for : $M_u = 865$ ft-kips
Grade 50 steel
$L_b = 17'$

(a) $C_b = 1.0 \rightarrow$ W30 x 99

(b) $C_b = 1.2$

(c) $C_b = 1.67$

Solution - $C_b = 1.2$

Design Chart : $\frac{M_u}{C_b} = \frac{865}{1.2} = 721$ ft-kips

Possible Sections: W30 × 90
W27 × 94

Z_x tables: W27 × 84
W30 × 90

Check W30 × 90: $\phi M_n = C_b \left(\begin{matrix} 800 \\ \phi M_p = 1060 \end{matrix} \right) = \underline{960} > 865$ ✓

Use W30 × 90.

(c) $C_b = 1.67$

Design Charts: $\frac{M_u}{C_b} = \frac{865}{1.67} = 518$

Possible Sections: W18 x 76 ($\phi M_p = 611 < 865$ x)
W24 x 76 ($\phi M_p = 750 < 865$ x)

2x tables: lightest w $\phi M_p > 865$ → W27x84

$$\phi M_n = C_b \left(692 \right) \leq \phi M_p$$
$$1156 \leq 915$$

$\phi M_n = 915 > 865$ ✓

Use W27 x 84