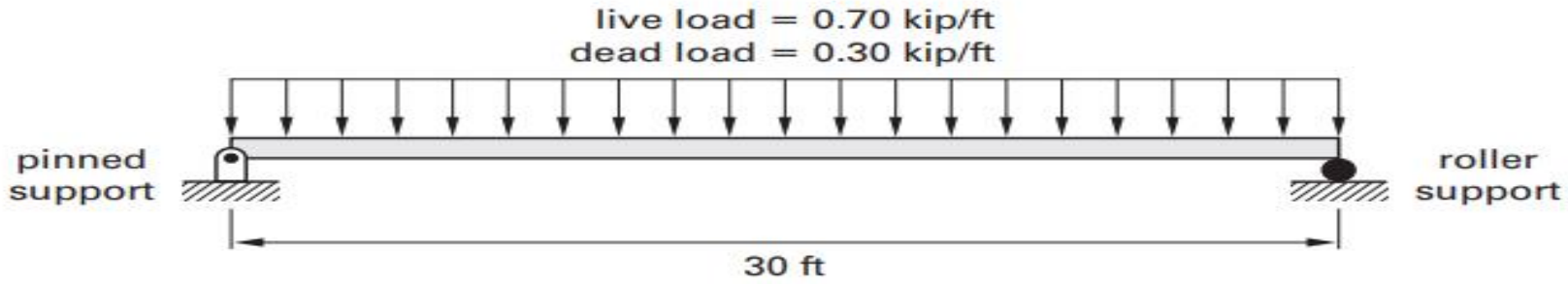
From Steel Design for Civil PE

Example 5.1
Zone 1 Bending

The 30 ft beam shown is laterally supported for its entire length. The beam supports a uniform dead load including the beam weight of 0.30 kip/ft and a uniform live load of 0.70 kip/ft.



Part @ LRFD → Find Factored Uniform Load

D = 0.30 K/F

L = 0.70 K/F

1.4D = 1.4(0.3) = 0.42 K/F

1.2D + 1.6L = 1.2(0.3) + 1.6(0.70)

W ult = 0.36 + 1.12 = 1.48 K/F

Estimate Max Moment (Mult)

$$M_{ult} = W_{ult}\left(\frac{L^2}{8}\right) = \frac{1.48}{8}(30)^2 = 166.5 \text{ Ft.kips} \Rightarrow 1998 \text{ in.kip}$$

(12)

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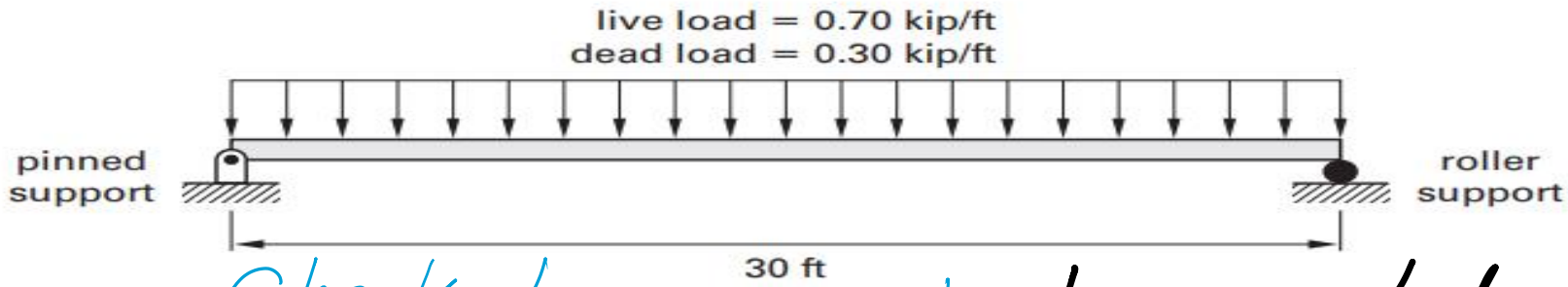

Check beam compactness, $L_b = 0$ Laterally supported For entire Length

Part @ LRFD $\lambda = \lambda_p$

given $F_y = 50$ ksi

$F_u = 65$ ksi

$M_{ult} = 1998$ inch.kip

$M_n = F_y Z_x$

$\phi = 0.90$

$M_{ult} \leq \phi M_n$

$\leq 0.90 (F_y)(Z_x)$

$\leq 0.90 (50)(Z_x)$

Find Z_x

$45 Z_x = 1998$

$Z_x = \frac{1998}{45} = 44.40$ inch^3

Select W-Section

Table 3-2

$Z_x = 44.40\ in^3$ Estimated

@ LRFD

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	$\phi_v V_{nx}$
		kip-ft	kip-ft	kip-ft	kip-ft	kips	kips				kips	kips
	$in.^3$	ASD	LRFD	ASD	LRFD	ASD	LRFD	ft	ft	$in.^4$	ASD	LRFD
W8×48	49.0	122	184	75.4	113	1.67	2.55	7.35	35.2	184	68.0	102
W14×30	**47.3**	**118**	**177**	**73.4**	**110**	**4.63**	**6.95**	**5.26**	**14.9**	**291**	**74.5**	**112**
W10×39	46.8	117	176	73.5	111	2.53	3.78	6.99	24.2	209	62.5	93.7
W16×26	**44.2**	**110**	**166**	**67.1**	**101**	**5.93**	**8.98**	**3.96**	**11.2**	**301**	**70.5**	**106**
W12×30	43.1	108	162	67.4	101	3.97	5.96	5.37	15.6	238	64.0	95.9

Select W14×30 determine data for W14×30 From Table 1-1 Ireq From ASD deflection

But Estimate Ix req

Deflection

Estimate required Ix - based on total Load

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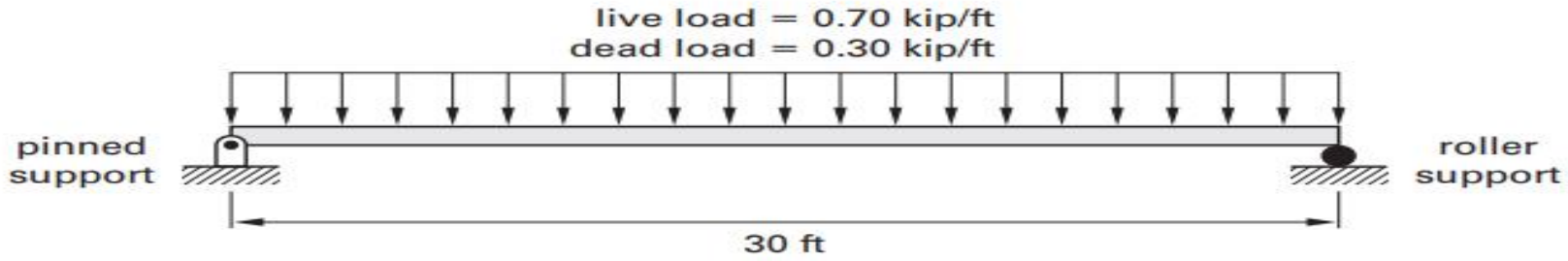


$D = 0.30$ K/F
$L = 0.70$ K/F
$\}$ $D + L = 1.00$ K/F

$$M_T = \omega_T \cdot \frac{\ell^2}{8}$$

$$= 1.00(30)^2/8 = 112.50 \text{ Ft.kips}$$

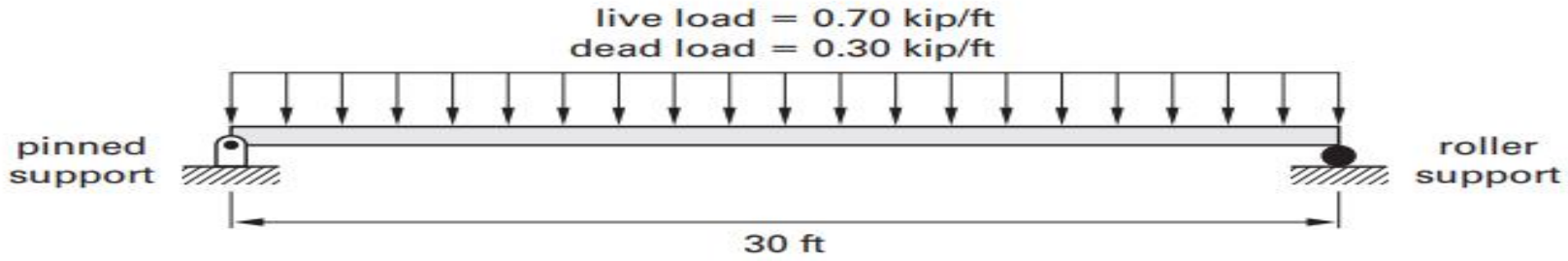
Deflection

Estimate required Ix – based on L.L

Example 5.1

Zone 1 Bending

The 30 ft beam shown is laterally supported for its entire length. The beam supports a uniform dead load including the beam weight of 0.30 kip/ft and a uniform live load of 0.70 kip/ft.



$D = 0.30$ K/F
$L = 0.70$ K/F
$\Big\}$ $W_L = 0.70$ F/K

$$M_L = w_L \cdot \frac{\ell^2}{8}$$

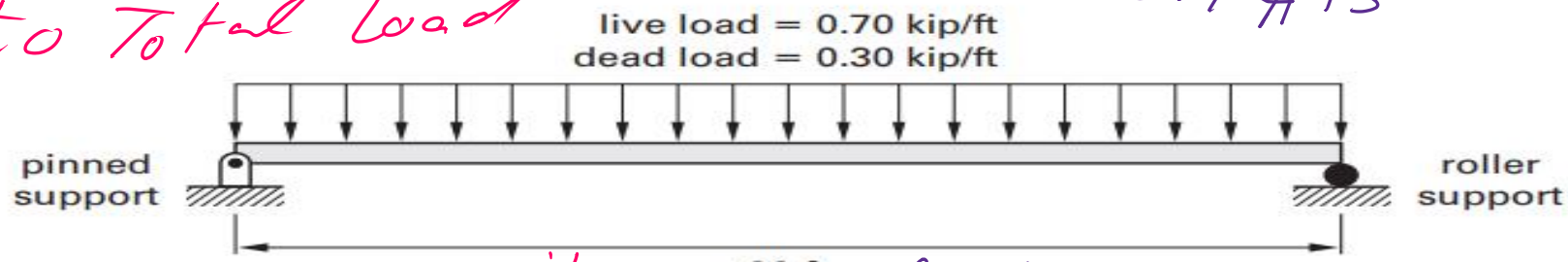
$$= 0.70(30)^2/8 = 78.75 \text{ Ft.kips}$$

Example 5.1
Zone 1 Bending

The 30 ft beam shown is laterally supported for its entire length. The beam supports a uniform dead load including the beam weight of 0.30 kip/ft and a uniform live load of 0.70 kip/ft.

Δ due to Total Load

CM #15 $\Delta = \frac{ML^2}{C_1 I_x}$



We Consider Servicability (ASD)

$\Delta = \frac{L}{240}$ Total Load

$M_T = 112.50$ FT. kips

$C_1 = 161$

$\Delta = \frac{30(12)}{240} = 1.56"$

$\Delta = \frac{ML^2}{161 I_x}$

$I_x = \frac{112.50(30)^2}{161(1.5)} = 419.25$ inch^4

Table 5.2 Deflection Limitations in the International Building Code

Deflection Limitations — Live only — D+L

construction	live load, L	snow load, S, or wind load, W	dead load plus live load, D + L
roof members			
supporting plaster ceiling	L/360	L/360	L/240
supporting nonplaster ceiling	L/240	L/240	L/180
not supporting ceiling	L/180	L/180	L/120
floor members	L/360	–	L/240

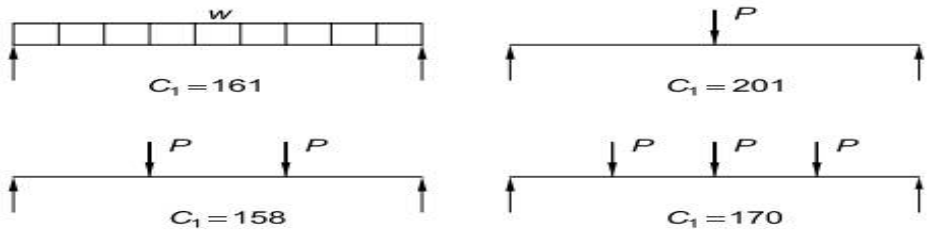


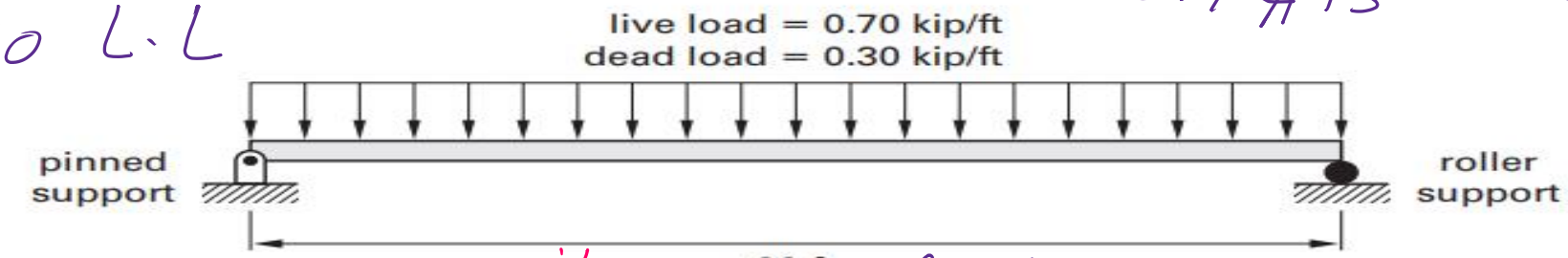
Fig. 3-2. Loading constants for use in determining simple beam deflections.

Example 5.1
Zone 1 Bending

The 30 ft beam shown is laterally supported for its entire length. The beam supports a uniform dead load including the beam weight of 0.30 kip/ft and a uniform live load of 0.70 kip/ft.

CM #15 $\Delta = \frac{ML^2}{C_1 I_x}$

Δ due to L.L



We Consider Servicability (ASD)

$\Delta_L = \frac{L}{360} = \frac{30(12)}{360} = 1"$

$M_L = 78.75$ FT. kips

$C_1 = 161$

$\Delta = \frac{ML^2}{161 I_x}$

$I_x = \frac{78.75 (30)^2}{161 (1.0)} = 440.22$ inch^4

Deflection Limitations

Table 3.2 Deflection Limitations in the International Building Code

construction	Live only: live load, L	snow load, S, or wind load, W	D+L: dead load plus live load, $D + L$
roof members			
supporting plaster ceiling	$L/360$	$L/360$	$L/240$
supporting nonplaster ceiling	$L/240$	$L/240$	$L/180$
not supporting ceiling	$L/180$	$L/180$	$L/120$
→ floor members	$L/360$ ←	–	$L/240$ ⇐

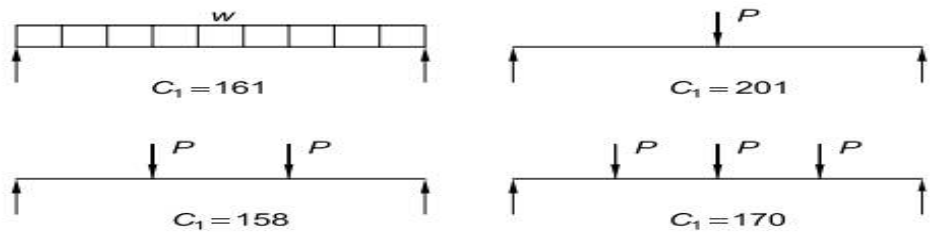


Fig. 3-2. Loading constants for use in determining simple beam deflections.

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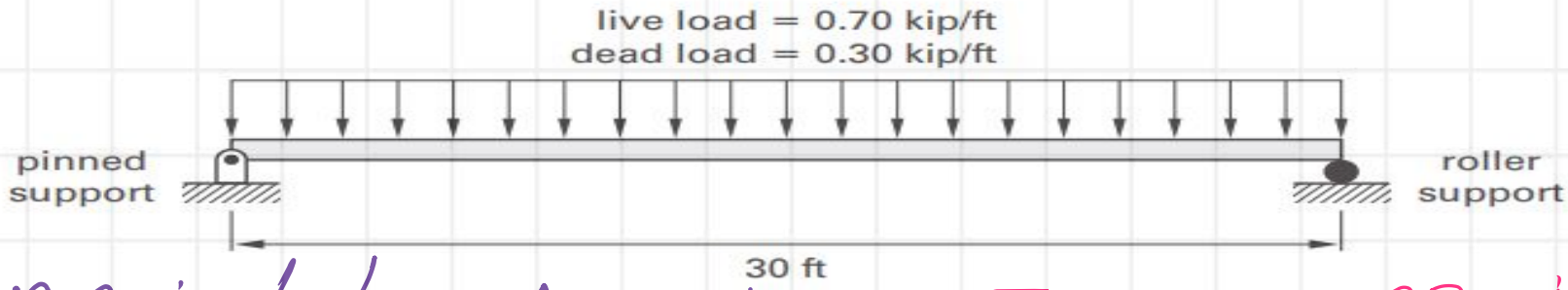

I_x required by Δ $w_L \Rightarrow I_x = 440.22\ inch^4$

I_x required by Δ $w_D + w_L \Rightarrow I_x = 419.25\ inch^4$

Select $I_x\ max = 440.22 \simeq 440\ inch^4$