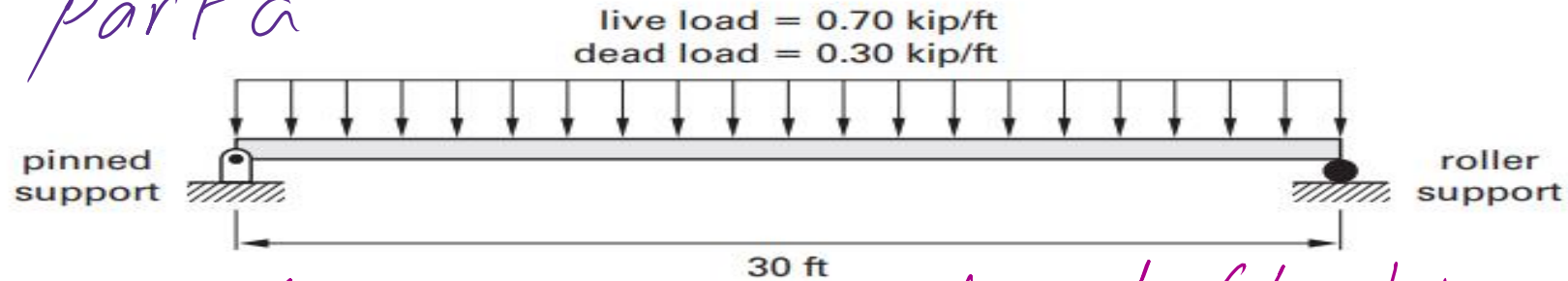


Example 5.1

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.

LRFD part a



I_x required = 440 in⁴ by deflection

W14x30 $Z_x = 44.40$ in

DIMENSIONS AND PROPERTIES TABLES

1-27

$I_x = 291.00$ in⁴ - without deflection
< 440 in⁴

Revise Selection

Table 1-1 (continued)
W-Shapes
Properties



Nom- inal Wt. lb/ft	Compact Section Criteria		Axis X-X				Axis Y-Y				r_{ts}	h_o	Torsional Properties	
			I	S	r	Z	I	S	r	Z			J	C_w
	b_f 2 t_f	h t_w	in. ⁴	in. ³	in.	in. ³	in. ⁴	in. ³	in.	in. ³	in.	in.	in. ⁴	in. ⁶
38	6.57	39.6	385	54.6	5.87	61.5	26.7	7.88	1.55	12.1	1.82	13.6	0.798	1230
34	7.41	43.1	340	48.6	5.83	54.6	23.3	6.91	1.53	10.6	1.80	13.5	0.569	1070
30	8.74	45.4	291	42.0	5.73	47.3	19.6	5.82	1.49	8.99	1.77	13.4	0.380	887

Example 5.1

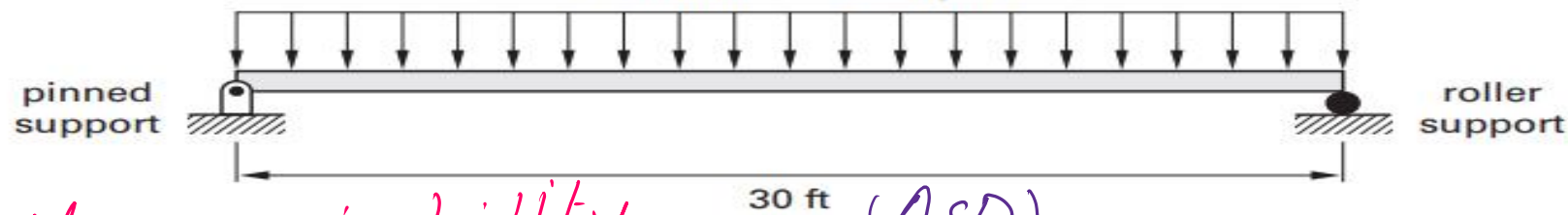
Zone 1 Bending

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

live load = 0.70 kip/ft
dead load = 0.30 kip/ft

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



We Consider Serviceability (ASD)

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

$M_T = 112.50$ FT. kips

$C_1 = 161$

$\Delta = \frac{30(12)}{240} = 1.50"$

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

$I_x = \frac{112.50(30)^2}{161(1.5)} = 419.25$ inch⁴

Table 5.2 Deflection Limitations in the International Building Code

	live only live load, L	snow load, S, or wind load, W	D+L dead load plus live load, D + L
construction			
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

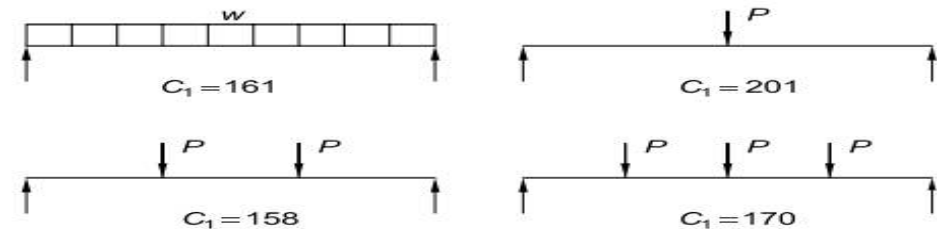


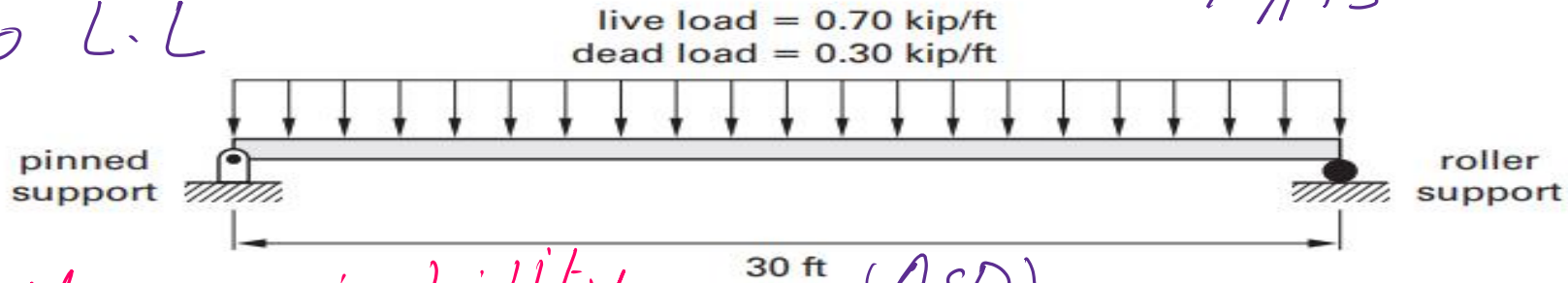
Fig. 3-2. Loading constants for use in determining simple beam deflections.

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.

Δ due to L.L



We Consider Serviceability (ASD)

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

$$M_L = 78.75 \text{ FT. kip}$$

$$C_1 = 161$$

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

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

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

Table 5.2 Deflection Limitations in the International Building Code

	live load, L	snow load, S, or wind load, W	dead load plus live load, D + L
construction			
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

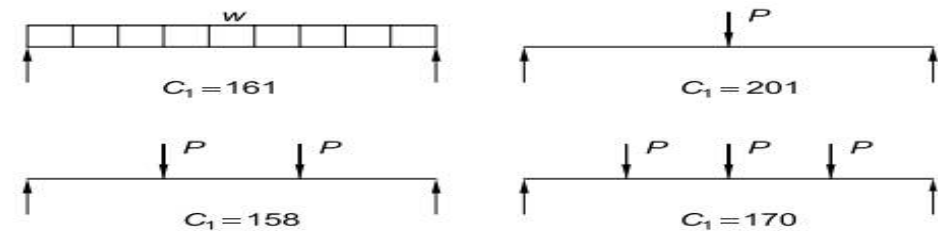


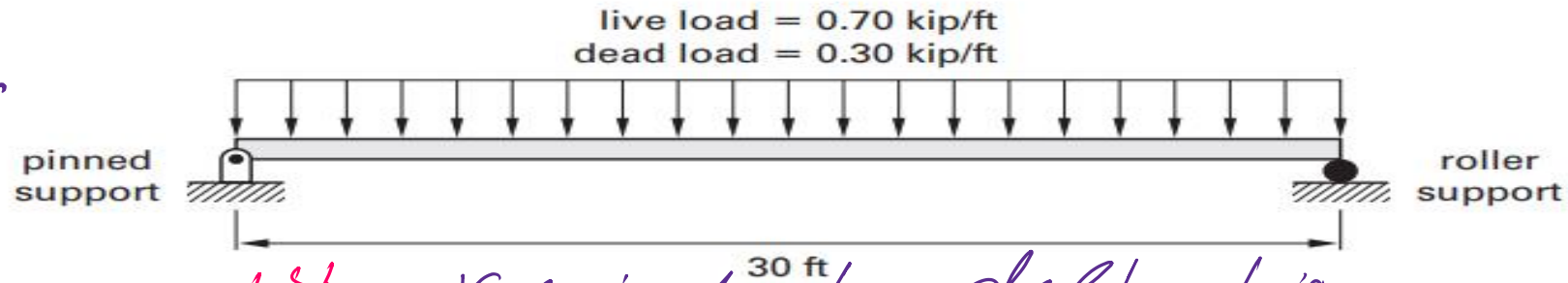
Fig. 3-2. Loading constants for use in determining simple beam deflections.

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.

LRFD



$I_x = 440 \text{ inch}^4$ required by deflection

$Z_x = 44.4 \text{ inch}^3$ $\rightarrow$ by Moment

Use Table 3-3 $\Rightarrow I_x$ to Find Final section

LRFD

$$F_y = 50 \text{ ksi}$$

$$\phi M_n = \phi F_y Z_x$$

part a

$$M_{ult} = 166.50 \text{ FT. kips}$$

Table 3-3 (continued)
W-Shapes
 Selection by I_x

 I_x

Shape	I_x in. ⁴	Shape	I_x in. ⁴	Shape	I_x in. ⁴	Shape	I_x in. ⁴
W27×84	2850	W21×55	1140	W18×35	510	W12×16	103
W18×143	2750	W16×77	1110	W14×48	484	W8×28	98.0
W12×252 ^h	2720	W14×99	1110	W12×58	475	W10×19	96.3
W24×94	2700	W18×65	1070	W10×77	455	W12×14	88.6
W21×111	2670	W12×120	1070	W16×36	448	W8×24	82.7
W14×211	2660	W14×90	999	W14×43	428	W10×17	81.9
W18×130	2460	W21×50	994	W12×53	425	W10×14	75.2

First Four W Sections
 That have

$$I_x > 440 \text{ in ch}^4$$

make
 analysis

Sections From Table 3-3

	I_x inch ⁴
W18x35	510

W14x48	484
--------	-----

W12x58	475
--------	-----

W10x77	455
--------	-----

Table 1-1

Z_x inch ³
66.50

78.40

86.40

97.60

$Z_{x, req} = 44.40$ inch³

$I_{x, req} = 440$ inch⁴

W18x35 has the least Z_x value = 66.50 inch³
 $I_x = 510$ inch⁴ > 440 inch⁴

Select W12 x 35 $I_x = 510.0 \text{ inch}^4$

$$Z_x = 66.50 \text{ inch}^3 > 44.4 \text{ inch}^3$$

From Table 1-1 $\phi M_n = 0.90 (66.50) \left(\frac{50}{12} \right) = 249.38 \text{ FT.kips}$
 $> 166.50 \text{ kips}$

$$\phi M_n = \phi_b F_y Z_x$$

$$= 0.90 (50) (66.50) = 2992.50 \text{ inch.kips}$$

$$\div 12$$

$$\Rightarrow 249.40 \approx 249 \text{ FT.kips}$$

$$M_{ult} = 166.50 \text{ FT.kips}$$

$$\phi_b M_n > M_{ult} \text{ ok}$$

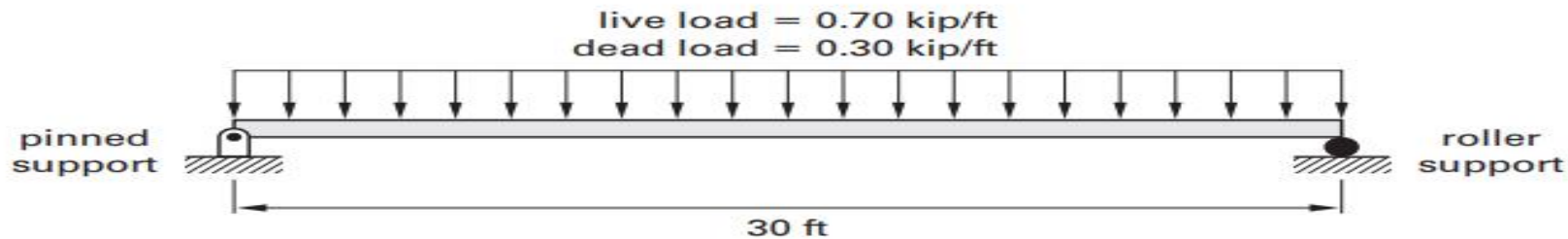
Part b: ASD Design

Estimate Z_x

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.



Find Total Service Load

$$D = 0.30 \text{ k/F} \quad D + L = 0.30 + 0.7 = 1.0 \text{ kip/Ft}$$

$$L = 0.70 \text{ k/F} \quad \text{Estimate } M_{\max}$$

$$\Omega = 1.67$$

$$M_{\max} = W_T \frac{\ell^2}{8} = 1.0 \left(\frac{30}{8} \right)^2 = 112.50 \text{ FT.kips}$$

Total

$$= 1350 \text{ inch.kips.}$$

$$M_T \leq \frac{Z_x \cdot F_y}{\Omega}$$

$$1350 \leq \frac{Z_x (50)}{1.67}$$

$$Z_x = \frac{1.67 (1350)}{50} = 45.09 \text{ inch}^3$$

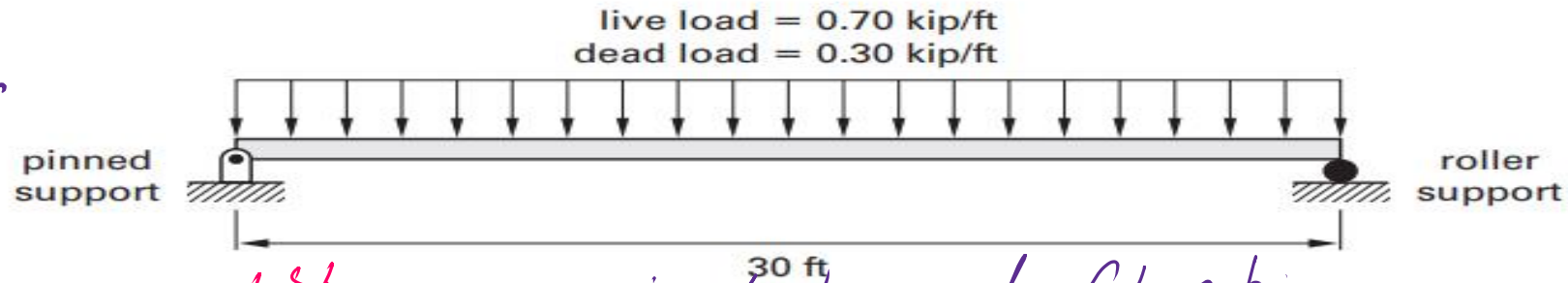
Prepared by Eng. Maged Kamel.

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.

ASD



$I_x = 440 \text{ inch}^4$ required by deflection

$Z_x = 45.09 \text{ inch}^3$ $\rightarrow$ by Moment

Use Table 3-3 $\Rightarrow I_x$ to select Final W-section
based on deflection requirements

ASD

$$F_y = 50 \text{ ksi} \quad \frac{1}{\Omega} M_n = \frac{1}{\Omega} F_y Z_x$$

$$\Omega = 1.67$$

$$M_T = 112.50$$

FT. kips

Table 3-3 (continued)
W-Shapes
Selection by I_x

 I_x

Select W18 x 35

Shape	I_x in. ⁴	Shape	I_x in. ⁴	Shape	I_x in. ⁴	Shape	I_x in. ⁴
W27×84	2850	W21×55	1140	W18×35	510	W12×16	103
W18×143	2750	W16×77	1110	W14×48	484	W8×28	98.0
W12×252 ^h	2720	W14×99	1110	W12×58	475	W10×19	96.3
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W21×111	2670	W12×120	1070	W16×36	448	W8×24	82.7
W14×211	2660	W14×90	999	W14×43	428	W10×17	81.9
W18×130	2460	W14×50	904	W12×53	425	W10×14	75.2

W18 x 35

From Table 1-1

$$I_x = 510.0 \text{ inch}^4$$

$$Z_x = 66.50 \text{ inch}^3 > 44.4 \text{ inch}^3$$

$$M_n = \frac{1}{1.67} (66.50) \left(\frac{50}{12} \right) = 166 \text{ FT. kips} > 112.50 \text{ FT. kips}$$

Prepared by Eng.Maged Kamel.