5.6-1 A W12 × 65(**W310 × 97**) is used as a simply supported, uniformly loaded beam with a span length of 50 feet (**15,250 mm**) and continuous lateral support. The yield stress, F_y , is 50 ksi (**345 MPa**) . If the ratio of live load to dead load is 3 , compute the available strength and determine the maximum total service load, in kips/ft (**kN/m**) , that can be supported.

FROM TABLE 1-1 (1-26)

$d = 12.1\ \text{in}$ $t_f = 0.605\ \text{in}$

$\frac{b_f}{2t_f} = 9.92$ $\frac{h}{t_w} = 24.9$ $S_x = 87.9\ \text{in}^3$

$Z_x = 96.8\ \text{in}^3$ $I_y = 174\ \text{in}^4$ $r_y = 3.02\ \text{in}$

$r_{ts} = 3.38\ \text{in}$ $h_o = 11.5\ \text{in}$ $J = 2.18\ \text{in}^4$

$C_w = 5780\ \text{in}^6$

CHECK FOR COMPACTNESS

FLANGE $\frac{b_f}{2t_f} = 9.92 > 0.38\sqrt{E/F_y} = 9.15$ NONCOMPACT

WEB $\frac{h}{t_w} = 24.9 < 3.76\sqrt{E/F_y} = 90.55$ COMPACT ✓

* COMPUTE STRENGTH BASED ON FLANGE BUCKLING

$\lambda_p = 0.38\sqrt{E/F_y} = 9.15$ $\lambda_r = 1.0\sqrt{E/F_y} = 24.08$

$\therefore \lambda_p < \lambda < \lambda_r$

$M_p = F_y Z_x = (50\text{ksi})(96.8\text{in}^3) = 4{,}840\ \text{k}\cdot\text{in}$

5.6-1

$$M_n = M_p - (M_p - 0.7F_y S_x)\left[\frac{\lambda - \lambda_{pf}}{\lambda_{rf} \lambda_{pf}}\right]$$

$$= 4{,}840\,\text{kin} - (4{,}840\,\text{kin} - 0.7(50\,\text{ksi})(87.9\,\text{in}^3))\left[\frac{9.92 - 9.15}{24.08 - 9.15}\right]$$

$$= 4{,}749.04\,\text{k}\cdot\text{in} = \underline{395.75\,\text{kft}}$$

$$\phi_b M_n = 0.9(395.75\,\text{kft}) = 356.18\,\text{kft}$$

LRFD

LOADS $\quad L = 3D \quad W_U = 1.2W_D + 1.6(3W_D) = 6W_D$

$$M_{MAX} = \frac{WL^2}{8} = \frac{6W_D(50\,\text{ft})^2}{8} = 1{,}875\,W_D\,\text{kft}$$

$$\therefore\ 356.18\,\text{kft} = 1{,}875\,W_D\,\text{kft} \qquad \underline{W_D = 0.19\,\text{k/ft}}$$

$$\underline{W_L = 0.57\,\text{k/ft}}$$

$$W = W_D + W_L = \underline{0.76\,\text{k/ft}}$$

ASD

$$M_a = \frac{M_n}{\Omega_b} = \frac{395.75\,\text{kft}}{1.67} = \underline{236.98\,\text{kft}}$$

$$W = W_D + W_L = W_D + 3W_D = 4W_D$$

$$M_{MAX} = \frac{WL^2}{8} = \frac{4W_D(50\,\text{ft})^2}{8} = 1{,}250\,W_D\,\text{kft}$$

$$1{,}250\,W_D\,\text{kft} = 236.98\,\text{kft} \quad \therefore\ W_D = 0.19\,\text{k/ft}$$

$$\Rightarrow \underline{W = 0.758\,\text{k/ft}}$$