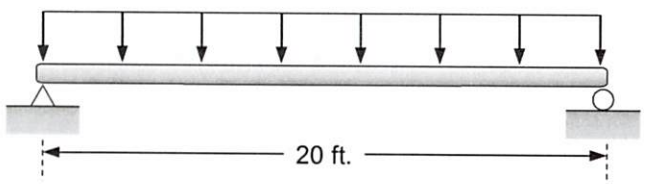
Classroom Problem 5.10-1: Select a **W** section of **A992** steel (F_y = 50 *ksi*; F = 65 *ksi*) for the beam shown below. The beam has continuous lateral support and must support a uniform dead load of 0.2 *k/ft* and a live load of 0.8 k/ft.



$$W_U = 1.2W_D + 1.6W_L = 1.2(0.2k/ft) + 1.6(0.8k/ft) = 1.52k/ft$$

$$M_U = \frac{W_U L^2}{8} = \frac{1.52k/ft(20ft)^2}{8} = 76k\cdot ft$$

$$\phi M_n = \phi_b F_y Z_x = M_U \Rightarrow \text{REQUIRED } Z_x = \frac{M_U}{\phi F_y} = \frac{76k\cdot ft(12in/ft)}{0.90(50ksi)} = 20.3in^3$$

* FROM "Z_x TABLE" TABLE 3-2 (3-26)

- TRY W10 x 19 $\quad Z_x = 21.6in^3 > 20.3in^3$

ADD BEAM WT, $\quad W_D = (0.2k/ft + 0.019k/ft) = 0.219k/ft$

$$W_U = 1.2(0.219k/ft) + 1.6(0.8k/ft) = 1.5428\ k/ft$$

$$M_U = \frac{W_U L^2}{8} = \frac{1.5428k/ft(20ft)^2}{8} = 77.41\ kft$$

$$\phi M_n = \phi F_y Z_x = 0.90(50ksi)\,21.6in^3 = 972k\cdot in = 81kft > M_U$$

O.K.

CHECK SHEAR

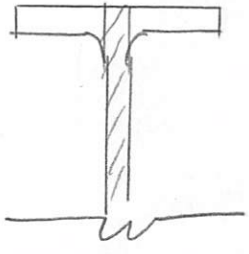
TABLE 1-1 $d = 10.2\text{ in}$, $t_w = 0.25\text{ in}$

$$V_u = \frac{w_u L}{2} = \frac{1.542\text{ k/ft}\,(20\text{ ft})}{2} = 15.43^{k}$$

$h/t = 35.4$ (TABLE 1-1)

$$2.24\sqrt{E/F_y} = 2.24\sqrt{\frac{29{,}000\text{ ksi}}{50\text{ ksi}}} = 54.0$$

SINCE $h/t < 2.24\sqrt{E/F_y}$ $\quad \phi_v = 1.0$ $\quad C_{v_1} = 1.0$



$$\phi V_n = \phi(0.6) F_y A_w C_{v_1}$$

$$= 1.0(0.6)50\text{ksi}(10.2\text{ in})0.25\text{in}(1.0)$$

$$= 76.5^{k}$$

$\phi V_n > V_u$ $\quad$ O.K.

USE W 10 x 19