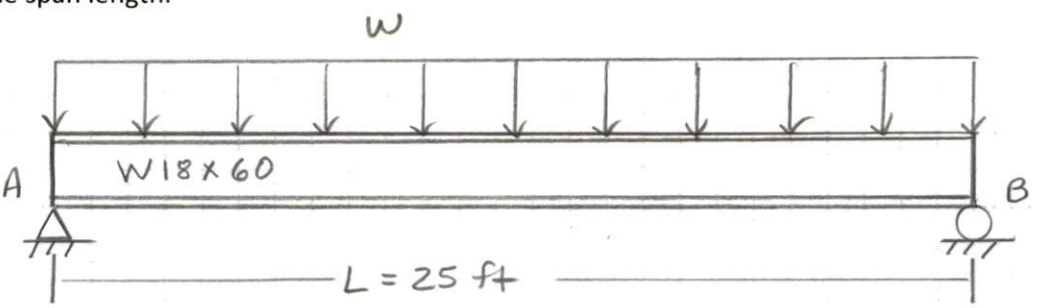
16-13

A W18 x 60 steel section is used in a 25-ft simple span. Determine the maximum allowable uniform load w that the beam can carry if the allowable flexural stress is 24 ksi, the allowable shear stress is 15 ksi, and the allowable deflection is 1/360 of the span length.

Solution.



W18x60

Table A-1(a)

$S = 108\ in.^3$

$I = 984\ in.^4$

$A = 17.6\ in.^2$

$d = 18.24\ in.$

$t_w = 0.415\ in.$

Table 13-1, case 4

$$M_{MAX} = \frac{wL^2}{8}$$

$$V_{MAX} = \frac{wL}{2}$$

$\sigma_{allow} = 24\ ksi$

$\tau_{allow} = 15\ ksi$

$\delta_{allow} = \frac{L}{360}$

$L = 25\ ft\left(\frac{12\ in}{ft}\right) = 300\ in.$

Flexural Stress (Bending)

$$\sigma_{MAX} = \frac{M}{S} = \frac{wL^2}{8S}$$

$$w = \frac{8S\sigma_{MAX}}{L^2} = \frac{8(108\ in.^3)(24\ kip/in.^2)}{(300\ in)^2} = 0.2304\ kip/in\left(\frac{12\ in}{ft}\right) = 2.8\ kip/ft$$

Deflection Table 16-1, case 7

$$\delta_{MAX} = \frac{5wL^4}{384EI}$$

$$w = \frac{384EI\delta_{allow}}{5L^4} = \frac{384EIL}{5L^4(360)} = \frac{384EI}{1800L^3}$$

$$= \frac{384(30\,000\ ksi)(984\ in.^4)}{1800\ (300\ in)^3} = 0.233\ kip/in\left(\frac{12\ in}{ft}\right) = 2.8\ kip/ft$$

Check Shear

$$V_{MAX} = \frac{wL}{2} = \frac{2.8\ kip/ft\ (25\ ft)}{2} = 35\ kips$$

$$\tau_{avg} = \frac{V_{MAX}}{d\,t_w} = \frac{35\ kips}{(18.24\ in)(0.415\ in)} = 4.6\ ksi < \tau_{allow} = 15\ ksi$$ ✓ ok

$$\boxed{w_{allow} = 2.8\ kip/ft}$$