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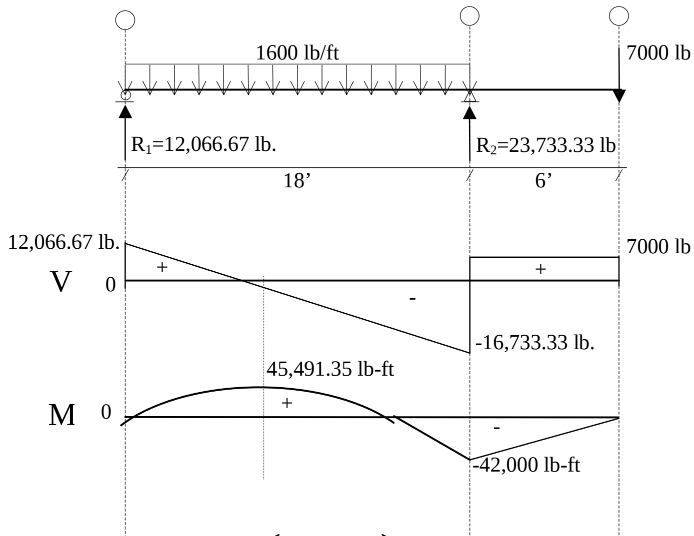
Beam Deflection

Problem #1.



a.) $+\uparrow \quad F_y = 0 = \left(-1600\frac{lb}{ft}\right)(18ft) - 7000lb + R_1 + R_2$

$$0 = -35,800 lbs + R_1 + R_2$$

$$R_1 + R_2 = 35,800 lbs$$

$-\circlearrowright \quad M_1 = 0 = w_{12} l_{12} d_{12} + F_{2y} d_2 + F_{3y} d_3$

$$0 = \left(-1600\frac{lb}{ft}\right)(18ft)\left(\frac{18}{2}ft\right) + \left[(R_2)(18ft)\right] + \left[-7000lb(24ft)\right]$$

$R_2 = 23,733.33$ lb. ; *plug* R_2 *into above* $R_1 + R_2$,

$R_1 = 12,066.67$ lb.

b.) see the above shear force diagram (numbers may vary due to approximations)

c.) see the above bending moment diagram (numbers may vary due to approximations)

d.) $f_b = \frac{\mathrm{Mc}}{\mathrm{I}} = \frac{\mathrm{M}}{\mathrm{S}}$

$$\mathrm{S} = \frac{\mathrm{M}}{f_b} = \frac{(45,431.35 lb\text{-}ft)\left(12\frac{in}{ft}\right)}{24,000 psi}$$

$= 22.75 \text{ in}^3$

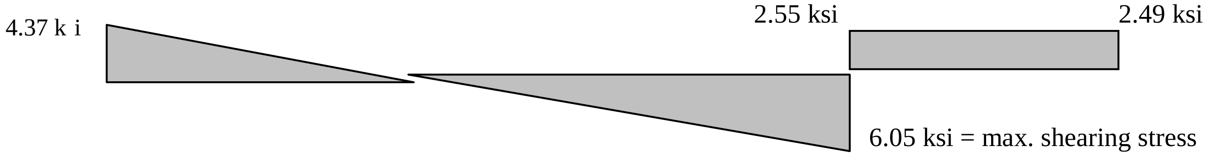
therefore, sections with S > 22.75 in^3

e.) W12x26

$\frac{\Delta_{mid-span}}{L} = \left(\frac{0.398in}{18ft}\right)\left(\frac{ft}{12in}\right)$ $\qquad\qquad$ $\frac{\Delta_{max}}{L} = \left(\frac{0.401in}{18ft}\right)\left(\frac{ft}{12in}\right)$

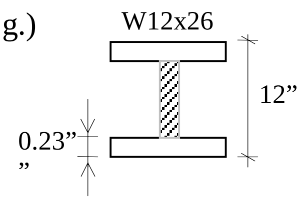
$$= 0.001843 < \frac{1}{360} \qquad\qquad = 0.001856 < \frac{1}{360}$$

f.) W12x26 shear-stress diagram



Ref. From multi MultiFrame shear-force diagram, max. shearing force, V = 16.993 kip

g.)

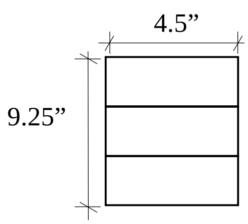


$$f_v = \frac{V}{A_{web}} = \frac{16{,}993_{lb}}{(.23_{in})(12_{in} - 2(.23_{in}))}$$

$$= 6{,}402_{psi} = 6.402_{ksi}$$

comparing with the *MultiFrame* calculation, both calculation results are pretty similar to each other, with a 5.6% - 5.8% difference.

Problem #2



Three 2x10 wood floor beams translates to a single 4.5” x 9.25”

a.) Shearing Stress

$$f_v = 1.5\left(\frac{V}{bd}\right)$$

$$f_v = 180\frac{lb}{in^2} = 25{,}920\frac{lb}{ft^2}$$

$$V_{\max} = \frac{wl}{2} = \frac{1}{2}\left(700\frac{lb}{ft}\right)(x_{ft}) = 350x \text{ lb}$$

$$25{,}920\frac{lb}{ft^2} = 1.5\frac{350x_{lb}}{\left(\frac{4.5_{in}}{12\frac{in}{ft}}\right)\left(\frac{9.25_{in}}{12\frac{in}{ft}}\right)}$$

x = 14.27 ft

b.) Bending Stress

$$f_b = \frac{\text{Mc}}{\text{I}} \qquad M_{\max} = \frac{wx^2}{8} = \frac{700x^2}{8} = 87.5x^2 \text{ lb-ft}$$

$$I = \frac{1}{12}bh^3 = \frac{1}{12}(4.5in)(9.25in)^3 = 296.79in^4$$

$$1200_{psi} = \frac{(87.5\text{x}^2 \text{ lb}\cdot\text{ft})\left(12\frac{in}{ft}\right)\left|\frac{9.25in}{2}\right|}{296.79 \text{ in}^4}$$

x = 8.56 ft

c.) Deflection

$$\Delta_{\max} = \frac{5wL^4}{384EI} = \frac{L}{360}$$

$$= \frac{5\left(700\frac{lb}{ft}\right)(x_{ft})^4}{384(1,500,000_{psi})(296.79_{in^4})\left|\frac{ft}{12_{in}}\right|} = \frac{x_{ft}}{360}$$

x = 9.80 ft

Problem #3.

a.) $V = \frac{wl}{2} = \frac{1}{2}\left(500\frac{lb}{ft}\right)(14_{ft}) = 3500 \text{ lb}$

$$f_v = 1.5\frac{V}{bd} = 1.5\left|\frac{3,500_{lb}}{(4)(10)_{in^2}}\right| = 131.25\frac{lb}{in^2}$$

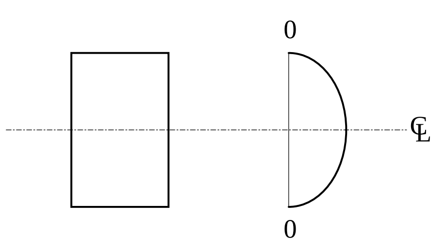
b.) $f_v = \frac{VQ}{Ib}$

Q = (4*in*)(4 *in*)(3 *in*) = 48 *in*^{4}

$$I = \frac{1}{12}(4_{in})(10_{in})^3$$

$$= \frac{(3500_{lb})(48i_{in^3})}{(333.33_{in^4})(4_{in})} = 126\frac{lb}{in^2}$$

c.)



$\theta = Ay$

"A" value is Ø and θ value is Ø.

So, f_v = Ø

therefore $f_v = \frac{VQ}{Ib}$

Shear-stress diagram (to the left)