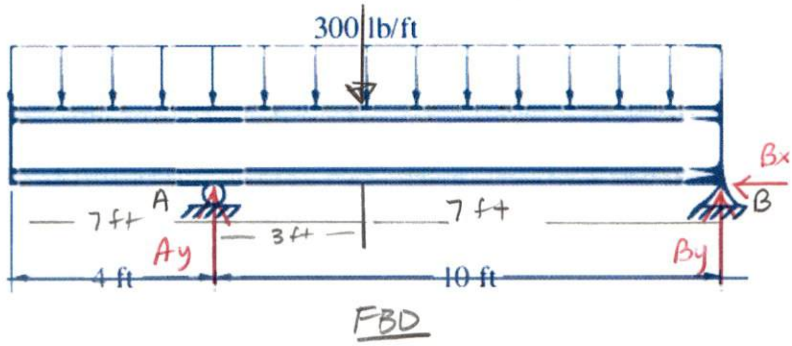
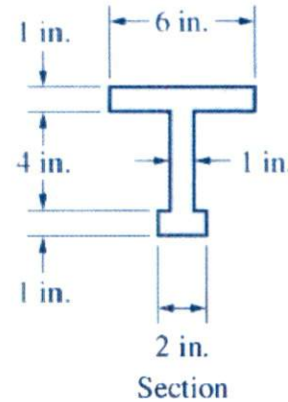
14-13

$300\ \text{lb/ft}(14\ \text{ft}) = 4200\ \text{lb}$

See Fig. P14-13. Determine the maximum tensile and compressive stresses in the beam due to the loading shown.





Solution.

Equilibrium Equations

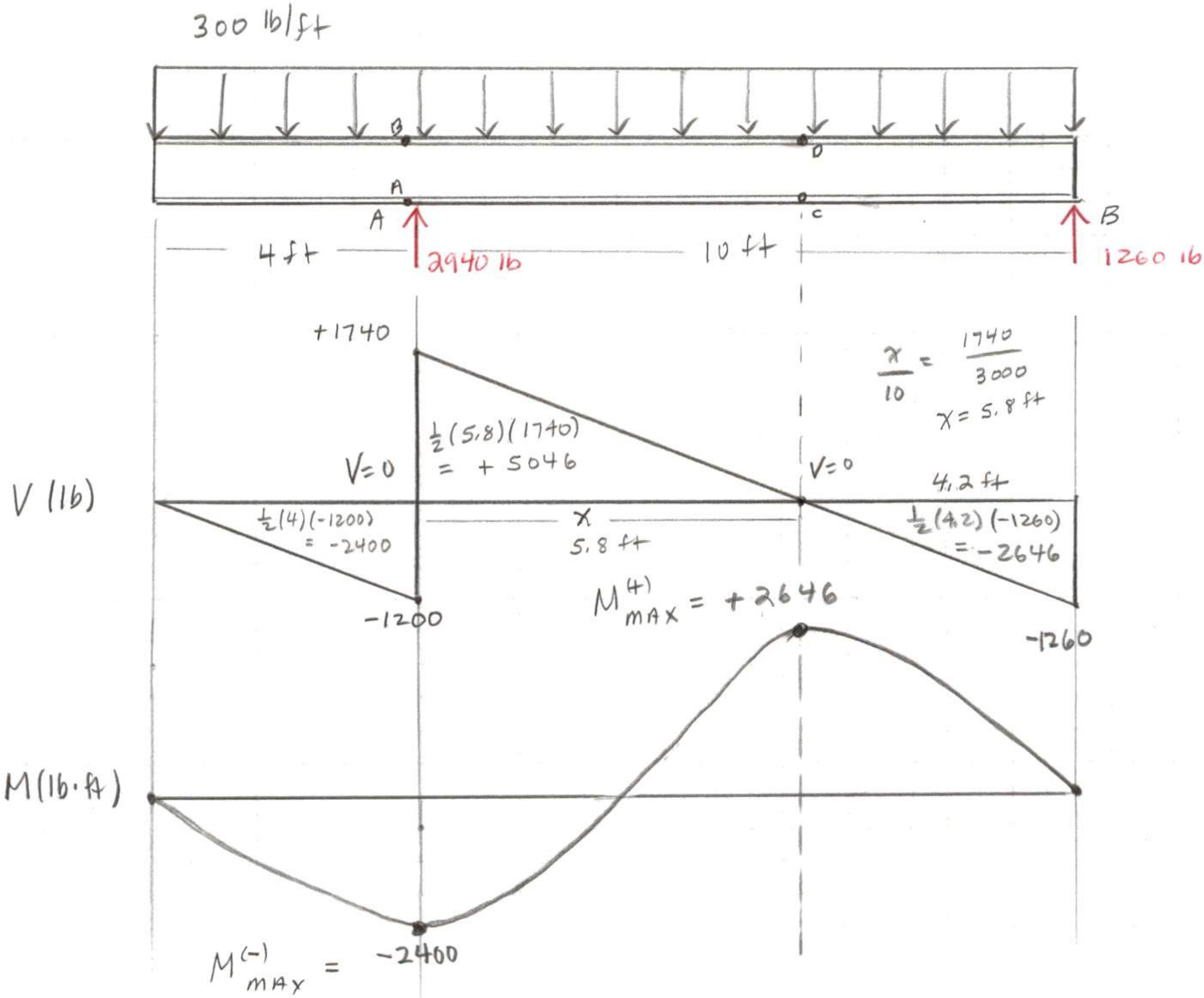
$[\Sigma F_x = 0]\quad B_x = 0$

$+\circlearrowleft [\Sigma M_B = 0]\quad -A_y(10\ \text{ft}) - 4200\ \text{lb}(7\ \text{ft}) = 0$

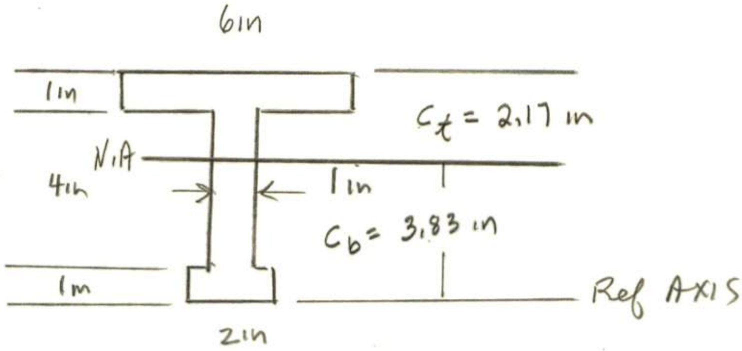
$A_y = \dfrac{29{,}400\ \text{lb}\cdot\text{ft}}{10\ \text{ft}} = 2940\ \text{lb}\uparrow$

$(\Sigma F_y = 0)\quad A_y - 4200\ \text{lb} + B_y = 0$

$B_y = 4200\ \text{lb} - 2940\ \text{lb} = 1260\ \text{lb}\uparrow$



Find the moment of Inertia of the section



Shape	Area	y	Ay	$\bar{y}-y$	$A(\bar{y}-y)^2$	I
A1	2×1=2	.5	1	3.33	22.18	$\frac{2(1)^3}{12} = 0.167$
A2	1×4=4	3	12	0.83	2.76	$\frac{1(4)^3}{12} = 5.33$
A3	6×1=6	5.5	33	-1.67	16.73	$\frac{6(1)^3}{12} = 0.5$
	12		46		41.67	6.0

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{46}{12} = 3.83 \text{ in.}$$

$$\bar{I}_x = \Sigma\left[I + A(\bar{y}-y)^2\right] = 6.0 \text{ in}^4 + 41.67 \text{ in.}^4 = 47.7 \text{ in}^4$$

Flexural stress at $M^{(-)}_{MAX}$

Max tensile stress occurs at B (TOP Fibers) $\sigma_B = \frac{M^{(-)}_{MAX}\, C_t}{I} = \frac{2400 \text{ lb.ft}\left(\frac{12 \text{in}}{\text{ft}}\right)(2.17 \text{in})}{47.7 \text{ in}^4} = 1310 \text{ psi (T)}$

MAX Compressive Stress occurs at A (Bottom Fibers) $\sigma_A = \frac{M^{(-)}_{MAX}\, C_b}{I} = \frac{2400 \text{ lb.ft}\left(\frac{12 \text{in}}{\text{ft}}\right)(3.83 \text{in})}{47.7 \text{ in}^4} = 2310 \text{ psi (C)}$

Flexural stress at $M^{(+)}_{MAX}$

MAX tensile Stress occurs at C (Bottom Fibers) $\sigma_C = \frac{M^{(+)}_{MAX}\, C_b}{I} = \frac{2646 \text{ lb.ft}(12)(3.83)}{47.7} = 2550 \text{ psi (T)}$

MAX compressive stress occurs at D (TOP Fibers) $\sigma_D = \frac{M^{(+)}_{MAX}\, C_t}{I} = \frac{2646(12)(2.17)}{47.7} = 1440 \text{ psi (C)}$

MAX Tensile Flexural Stress

$$\sigma^{(T)}_{MAX} = 2550 \text{ psi}$$

MAX Compressive Flex Stress

$$\sigma^{(C)}_{MAX} = 2310 \text{ psi}$$