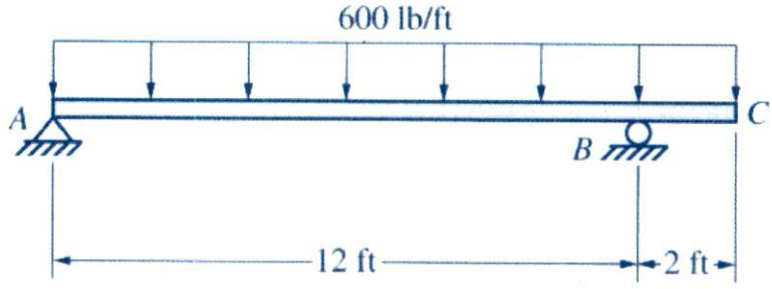
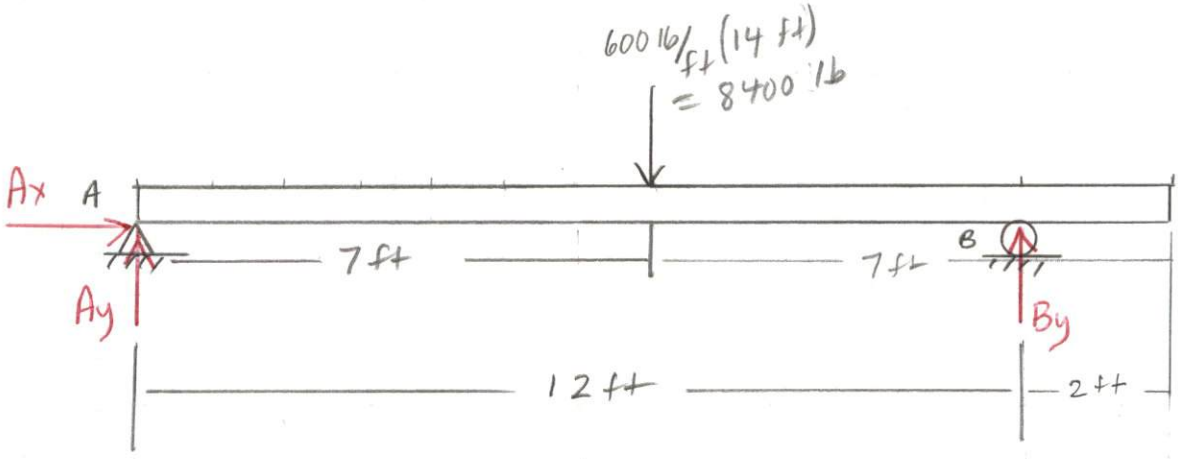
15-14

Select the lightest, rectangular California redwood section for an overhanging beam with the superimposed uniform load shown in Fig. P15-14.



Solution.

Solve for the reactions at the supports A and B



FBD- Entire Beam

Equilibrium Equations

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

$+\circlearrowleft [\Sigma M_A = 0] \quad -8400\ \text{lb}(7\ \text{ft}) + B_y(12\ \text{ft}) = 0$

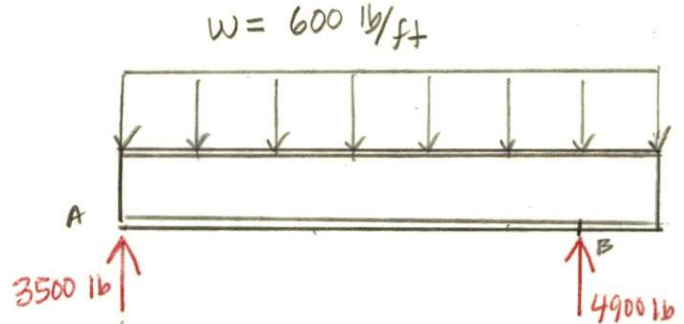
$B_y = \frac{58{,}800\ \text{lb}\cdot\text{ft}}{12\ \text{ft}} = 4900\ \text{lb} \uparrow$

$[\Sigma F_y = 0] \quad A_y - 8400\ \text{lb} + 4900\ \text{lb} = 0$

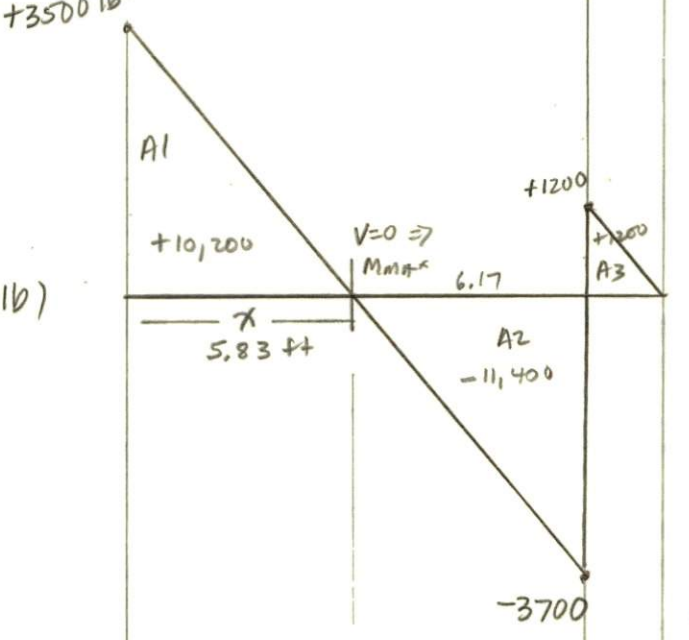
$A_y = 8400\ \text{lb} - 4900\ \text{lb} = 3500\ \text{lb} \uparrow$

Draw V & M Diagrams

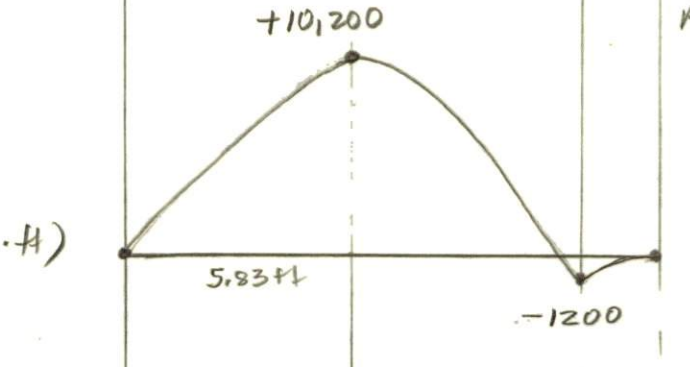
Loading Diagram



V(lb)



M(lb·ft)



$\frac{x}{3500} = \frac{12}{7200}$

$x = \frac{12(3500)}{7200} = 5.83$ ft

A1 $\frac{1}{2}(5.83)(3500) = 10,200$

A2 $\frac{1}{2}(6.17)(-3700) = -11,400$

A3 $\frac{1}{2}(2)(1200) = 1200$

$V_{max} = 3700$ lb

$M_{max} = 10,200$ lb·ft

Step 1. CA Redwood $\sigma_{allow} = 1350$ psi

$\tau_{allow} = 100$ psi

Step 2.

$V_{MAX} = 3700$ lb

$M_{MAX} = 10{,}200$ lb·ft $\left(\frac{12\text{ in}}{\text{ft}}\right) = 122{,}400$ lb·in

Step 3. $$S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{122\,400 \text{ lb·in}}{1350 \text{ psi}} = 90.7 \text{ in}^3$$

Step 4. $$A_{req} = \frac{1.5\, V_{MAX}}{\tau_{allow}} = \frac{1.5(3700 \text{ lb})}{100 \text{ psi}} = 55.5 \text{ in}^2$$

Step 5. Table A-6(a)

6 × 12	$S = 121$ in.^{3}	$A = 63.3$ in.^{2}	wt = 17.6 lb/ft
8 × 10	$S = 113$ in.^{3}	$A = 71.3$ in.^{2}	wt = 19.8 lb/ft
10 × 10	$S = 143$ in.^{3}	$A = 90.3$ in.^{2}	wt = 25.1 lb/ft

Select 6 × 12

Check,

$$\frac{\text{wt of beam}}{\text{load}} = \frac{17.6 \text{ lb/ft}}{600 \text{ lb/ft}} = 0.029 = 2.9\%$$

$$\frac{\text{Extra } S}{S_{req}} = \frac{121 \text{ in.}^3 - 90.7 \text{ in.}^3}{90.7 \text{ in}^3} = 0.334 = 33.4\% > 2.9\%$$

Bending ✓

$$\frac{\text{Extra } A}{A_{req}} = \frac{63.3 \text{ in}^2 - 55.5 \text{ in}^2}{55.5 \text{ in}^2} = 0.141 = 14.1\% > 2.9\%$$

Shear ✓

Use, 6 × 12 Rectangular Section