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ARCH 324 - Structures 2, Winter 2009

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Reactions:
\[ \Sigma M_{R_1} = 0 = 7.2(12) - R_2(24) + 6(28) \]
\[ R_2 = \frac{10.6}{6} \, k \]
\[ \Sigma M_{R_2} = 0 = R_1(24) - 7.2(12) + 6(4) \]
\[ R_1 = 2.6 \, k \]

Check: \[ \Sigma F_y = 10.6 + 2.6 - 7.2 - 6 = 0 \]

Shear:
\[ 2.6^2 \]
\[ \frac{11.267}{8.67} \]

Moment:
\[ \frac{11.267}{4.88} K \cdot m \]

Design moment = 24.0 K \cdot m
STRAIN COMPATIBILITY:

Assume wood controls strain:

\[ \frac{e_f}{e_e} = \frac{15}{20000} = 0.00075 \]

\[ e_f = 30000(0.00075) = 22.5 \text{ in} \]

Steel and wood have balanced strain as is.

Find moment carried by wood:

\[ M_{wood} = 1.5 \left( 4 \frac{(12)^2}{6} \right) = 144 \text{ k-in} \]

\[ = 12 \text{ k-ft} \]

Find moment carried by steel:

\[ M_{steel} = M_{total} - M_{wood} = 24 - 12 = 12 \text{ k-ft} \]

Find b of steel plates:

Two plates

\[ M_5 = f_s S' = f \left( \frac{b \cdot d^2}{6} \right) \times 2 = 22.5 \left( \frac{b \cdot (12)^2}{6} \right) \times 2 \]

\[ b = 1.33 \text{ in} \]

Find length of plates (see moment diagram):

Wood will carry 12 k-ft alone, therefore find portion of moment diagram > 12 k-ft.

On cantilever:

\[ 6 \times l_1 = 12 \quad l_1 = 2 \text{ ft} \]

Between supports:

\[ 12 = l_2 (4.6 - 3l_2) + l_2 (3l_2) \]

\[ 0 = -0.15l_2^2 + 4.6l_2 - 12 \]

\[ l_2 = \frac{4.6 \pm \sqrt{4.6^2 - 4(15)12}}{2(-1.5)} = 2.879 \text{ ft} \]

\[ L_{total} = L_1 + l_2 = 2 + 2.88 = 4.88 \text{ ft} \]