ARCH 324 - Structures 2, Winter 2009

von Buelow, Peter

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The beam is underreinforced so $f_c$ is the actual stress and not the allowable.

By similar triangles from stress diagram:

\[ \frac{f_c}{x} = \frac{2.247 \text{ ksi}}{20-x} \quad \Rightarrow \quad f_c = \frac{2.247 x}{20-x} \]

by substitution

\[ R_c = \frac{f_c B x}{2} = \left( \frac{2.247 x}{20-x} \right) (12) (x) = \frac{13.482 x^2}{20-x} \]

\[ 600'' = R_c (20-x/3) = \left( \frac{13.482 x^2}{20-x} \right) (20-x/3) \]

\[ 12000 - 600x = 269.64 x^2 - 4.494 x^2 \]

Solve by trial and error $x \approx 6''$

\[ 600'' = R_t (20-x/3) = A_0 f_s (20-x/3) \]

\[ 600'' = (A_0) (20 \text{ ksi}) (20-x/3) \]

\[ A_0 = 1.64 \text{ in}^2 \]