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#### 4 - Calculate the FRP system design material properties

Environmental reduction factor  $C_E$

$$C_E = \boxed{0.95} \quad (\text{ACI 440.2R-08, Table 9.1})$$

$$\begin{aligned} f_{\text{u}} &= C_E f_{\text{u}}^* \\ f_{\text{u}} &= 237.5 \text{ ksi} \end{aligned}$$

$$\begin{aligned} \epsilon_{\text{u}} &= C_E \cdot \epsilon_{\text{u}}^* \\ \epsilon_{\text{u}} &= 0.0124 \text{ ksi} \end{aligned}$$

#### 5 - Existing Beam Properties

$\beta_1$  from ACI 318-11, § 10.2.7.3:

$$\beta_1 = \begin{cases} \text{for } 2500 \text{ psi} \leq f'_c \leq 4000 \text{ psi}, \beta_1 = 0.85 \\ \text{for } f'_c > 4000 \text{ psi}, \beta_1 = 0.85 - 0.05 \left( \frac{f'_c - 4000}{1000} \right) \\ \text{but } \beta_1 \text{ shall not be less than 0.65} \end{cases}$$

therefore,  $\beta_1 = 0.8$

Modulus of Elasticity of Normal Weight Concrete,  $E_c$

$$\begin{aligned} E_c &= 57,000 \sqrt{f'_{\text{c}}} \quad (\text{ACI-318-11, § 8.5.1}) \\ E_c &= 4030.5 \text{ ksi} \end{aligned}$$

The modular ratio of elasticity between steel and concrete,  $n_s$

$$\begin{aligned} n_s &= \frac{E_s}{E_c} \\ n_s &= 7.2 \end{aligned}$$

#### 6 - Existing strain on the beam soffit

Using cracked beam analysis, calculate the depth to the neutral axis,  $y$ , and the moment of inertia of the cracked section,  $I_\sigma$

Ratio of steel reinforcing to the concrete section

$$\begin{aligned} \rho_s &= \frac{A_s}{b \cdot d} \\ \rho_s &= 0.01163 \end{aligned}$$

Ratio of FRP reinforcing to the concrete section

$$\begin{aligned} \rho_f &= \frac{A_f}{b \cdot h} \\ \rho_f &= 0.00186 \end{aligned}$$

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