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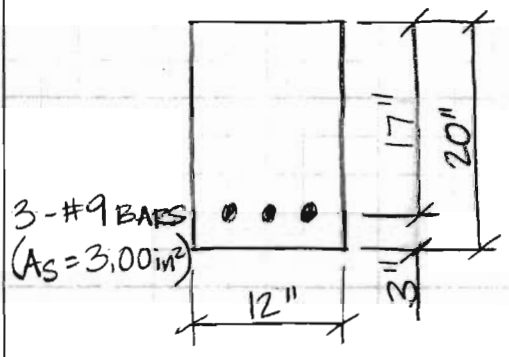
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EXAMPLE: CONCRETE BEAM ANALYSIS WORKING STRESS METHOD

CALCULATE THE BENDING CAPACITY OF THE FOLLOWING BEAM:



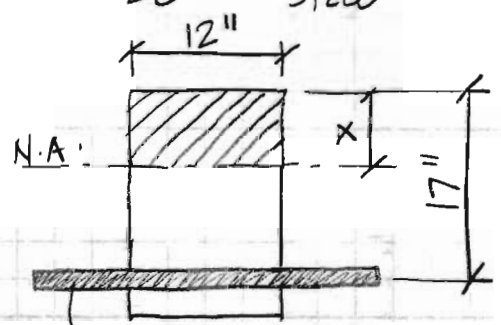
$$E_s = 29,000 \text{ ksi}, f_s = 20 \text{ ksi}$$

$$E_c = 3,220 \text{ ksi}, f_c = 1.8 \text{ ksi}$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

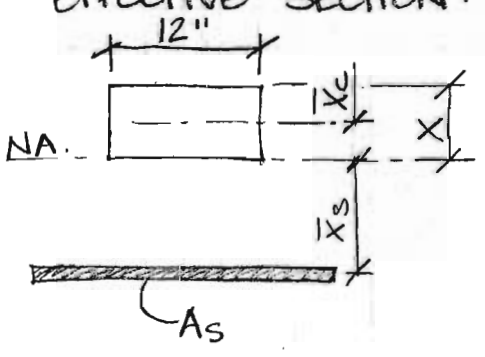
1. TRANSFORM SECTION:

$$n = \frac{E_s}{E_c} = \frac{29,000}{3,220} = 9$$



$$A_{TR} = (3 \text{ in}^2)(9) = 27 \text{ in}^2$$

2. DETERMINE NEUTRAL AXIS OF EFFECTIVE SECTION:



$$A_c \bar{x}_c = A_s \bar{x}_s$$

$$(12" * x) \left(\frac{x}{2}\right) = (27 \text{ in}^2)(17-x)$$

$$6x^2 = 459 - 27x$$

$$0 = 6x^2 + 27x - 459$$

$$0 = x^2 + 4.5x - 76.5$$

SOLVE WITH QUADRATIC EQUATION: $0 = ax^2 + bx + c$

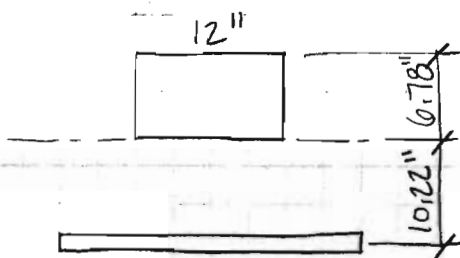
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

2. NEUTRAL AXIS, CONT'D...

$$x = \frac{-4.5 \pm \sqrt{(4.5)^2 - 4(1)(-76.5)}}{2(1)} = 6.78'' \text{ or } -11.25$$

(IGNORE NEGATIVE ANSWER)

3. FIND TRANSFORMED MOMENT OF INERTIA:



$$I_c = \frac{bd^3}{3} = \frac{(12'')(6.78'')^3}{3} = 1247 \text{ in}^4$$

$$I_s = A\bar{x}^2 = (27 \text{ in}^2)(10.22'')^2 = 2820 \text{ in}^4$$

(ASSUME MINUTE THICKNESS OF STEEL \rightarrow NO $\frac{bh^3}{12}$) $I_{TR} = 4067 \text{ in}^4$

4. RESISTING CAPACITY OF CONCRETE AND STEEL:

CONCRETE: $f_c = 1.8 \text{ ksi}$

$$M = \frac{f_c I_{TR}}{c} = \frac{(1.8 \text{ ksi})(4067 \text{ in}^4)}{6.78''} = 1080 \text{ in}\cdot\text{k} = \underline{90 \text{ k}}$$

STEEL: $f_s = 20 \text{ ksi}$

$$M = \frac{f_s I_{TR}}{c_n} = \frac{(20 \text{ ksi})(4067 \text{ in}^4)}{(10.22'')(9)} = 884 \text{ in}\cdot\text{k} = \underline{74 \text{ k}}$$

90 < 74 \rightarrow STEEL GOVERNS

BEAM CAPACITY = 74 k

5. FIND ACTUAL STRESSES IN STEEL & CONCRETE:

STEEL: MOMENT-RESISTING CAPACITY GOVERNS

STRESS IN STEEL = ALLOWABLE = 20 ksi

CONCRETE: $f = \frac{M c}{I_{TR}} = \frac{(74 \text{ k} * 12'')(6.78'')}{4067 \text{ in}^4} = \underline{1.48 \text{ ksi}}$