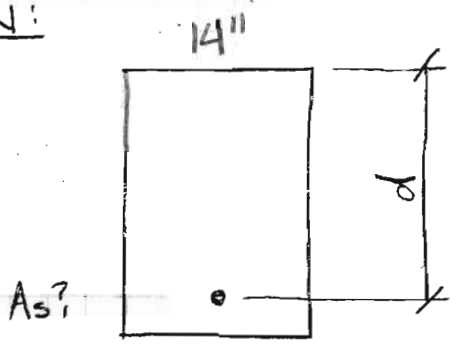
open.michigan

EXAMPLE: CONCRETE BEAM DESIGN
WORKING STRESS METHOD

GIVEN:



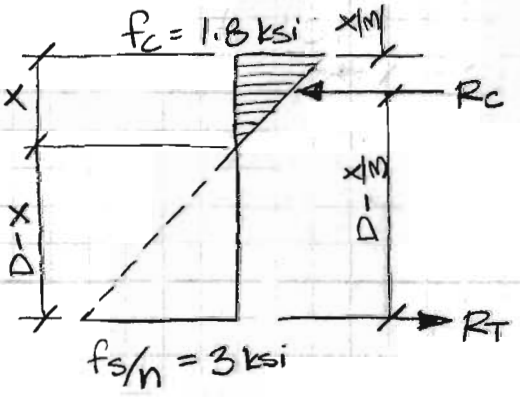
$M = 200^{IK}$

$E_S = 29{,}000$ ksi, $f_S = 24$ ksi
$E_C = 3{,}625$ ksi, $f_C = 1.8$ ksi

DESIGN THE SECTION SO THAT IT IS EXACTLY BALANCED.

1. MODULAR RATIO: $n = \frac{E_S}{E_C} = \frac{29{,}000}{3{,}625} = 8$

2. FIND DEPTH, D, SO THAT BOTH MATERIALS ARE STRESSED TO ALLOWABLE:



$$\frac{1.8}{x} = \frac{3}{D-x}$$

$$\rightarrow 1.8D - 1.8x = 3x$$

$$D = 2.67x$$

CONSIDERING THE INTERNAL COUPLE: $M = R_C(D - \frac{x}{3})$

$$R_C = \frac{f_C(B)(x)}{2} = \frac{(1.8\text{ksi})(14")(x)}{2} = 12.6x$$

$$M = R_C(D - \tfrac{x}{3})$$

$$200^{IK} * 12"/1 = 12.6x(2.67x - \tfrac{x}{3})$$

$$2400^{IK} = 33.64x^2 - 4.20x^2$$

$$= 29.44x^2$$

$$\rightarrow x = 9.0"$$

$$D = 2.67x = 2.67(9") = \underline{\underline{24.1"}}$$

3. FIND AREA OF STEEL:

$$R_C = \frac{f_c (B)(x)}{2} = 12.6\,x$$

$$= 12.6\,(9.0")$$

$$= 113.4^k$$

$$R_T = R_C$$

$$R_T = A_s f_s$$

$$113.4^k = A_s (24 ksi) \longrightarrow \underline{A_s = 4.73\ in^2}$$