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Flexural Analysis and Design of Beams

Solutions of Examples and Exercise of "Design of Concrete Structures" — Arthur H. Nilson, David Darwin, Charles W. Dolan.

Example 3.1
A rectangular beam has the dimensions $b = 10$ in, $h = 25$ in and is reinforced with three No. 8 bars so that $A_s = 2.37$ in². The concrete cylinder strength f_c is 4000 psi and the tensile strength in bending is 475 psi. The yield point of the steel f_y is 40,000 psi, the stress-strain curves of the materials being of those of Fig. 1.1.8. Determine the stress caused by a bending moment $M = 45$ kip-ft.

We know, modular ratio, $n = \frac{E_s}{E_c} = \frac{29 \times 10^6}{3.8 \times 10^6} \left(\frac{f_y}{f_c} \right) = 5.055 \approx 5$
transform area $(n \cdot) A_s = (5 \cdot) \times 2.37 = 11.825$ in²
 $A_c = 25 \times 10 = 250$ in²
Centroid from top $\bar{y} = \frac{250 \times 12.5 + 11.825 \times 23}{250 + 11.825} = 13.15$
Moment of Inertia $I = \frac{b h^3}{12} + A \bar{y}^2 = \frac{10 \times 25^3}{12} + 2.37 \times (23 - 13.15)^2$
 $= 14,630.44$ in⁴

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