Flexural Behavior of RC Beams: Uncracked Stage:

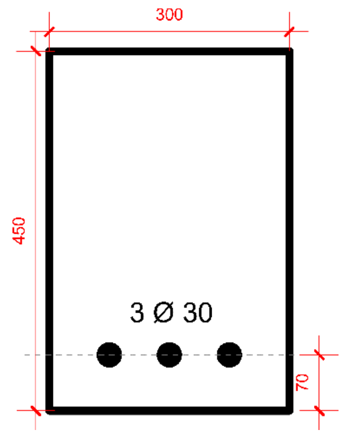
$$I_g = \frac{bh^3}{12} \qquad \rightarrow Moment\ of\ interia\ for\ rectangle$$

$$f = \frac{My_t}{I_g} \qquad \rightarrow Bending\ stress\ at\ maximum\ tension\ finber$$

$$f_r = \frac{M_{cr}y_t}{I_g} \qquad \rightarrow Modulus\ of\ rupture$$

$$f_r = 0.62\lambda\sqrt{f_c'} \qquad \rightarrow Section\ 19.2.3.1, SBC\ 304-18\ (\lambda = 1)$$

$$M_{cr} = \frac{f_r I_g}{y_t} \qquad \rightarrow Cracking\ moment$$



a) Assuming the concrete is un-cracked, compute the bending stresses in the extreme fibers of the beam above for a bending moment of 25 kN.m. The concrete has an $f'c$ of 25 MPa.

b) Check if the un-cracked assumption is correct.

c) Determine the cracking moment of the section.

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a) since the beam is un-cracked, it is assumed to be homogeneous with neutral axis on the centroid of the beam section (i.e., y_t = h/2) and we can use gross moment of inertia (i.e., $I = I_g$).

1- Find moment of inertia of the beam section:

$$I_g = \frac{bh^3}{12} = \frac{300 \times 450^3}{12} = 2.278 \times 10^9 \; mm^4$$

2- Find the bending stress:

$$f = \frac{My_t}{I_g} = \frac{25 \times 10^6 N.mm \times 225mm}{2.278 \times 10^9 \; mm^4} = 2.469 \frac{N}{mm^2} = 2.469 \; MPa$$

b) Crack happens when $f > f_r$

Find modulus of rupture:

$$f_r = 0.62\lambda\sqrt{f_c'} = 0.62 \times 1\sqrt{25} = 3.1 \; MPa$$

$f < f_r$ ➔ section did not crack.

c) Cracking moment happens at bending stress equal of above modulus of rupture.

$$M_{cr} = \frac{f_r I_g}{y_t} = \frac{3.1 \; N/mm^2 \times 2.278 \times 10^9 \; mm^4}{225 \; mm} = 31{,}387{,}500 \; N.mm$$

$$M_{cr} = 31.387 \; kN.m$$

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