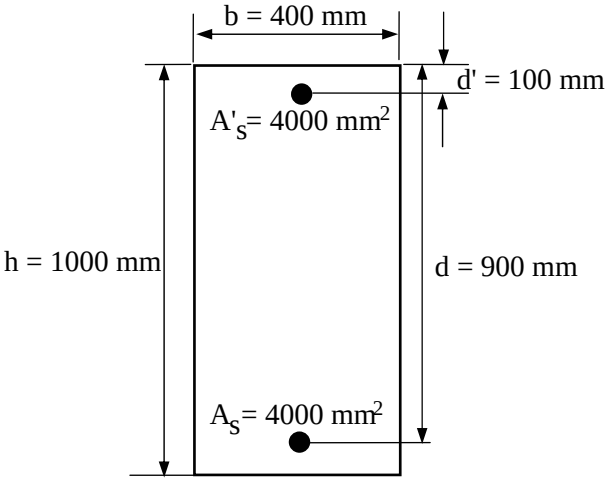
2005.5.16

Mechanics of Structural Concrete

ASSIGNMENT No. 1

The following RC cross-section is given. The dimensions and material properties are also given. Referring the comments, calculate the following moments in **kN-m** unit.

(1) Cracking moment, M_{cr}.
(2) Yielding moment, M_y.
(3) Ultimate moment, M_{u1} based on the equivalent stress block.
(4) Ultimate moment, M_{u2} based on the stress-strain relationship.



Dimensions and material properties:

h = 1000 mm, b = 400 mm, d= 900 mm,
d'= 100 mm
As = A's = 4000 mm^2,
fy = f'y = 400 N/mm^2
Es= 200 kN/mm^2, Ec= 25 kN/mm^2
f'c = 30 N/mm^2, fb = 4.5 N/mm^2
ε'_{cu} = 0.0035, ε'_o = 0.002

Comments:

(1) Use the flexural strength, fb. The contribution of reinforcing bars can be neglected.
(2) The contribution of concrete for tension can be neglected. Concrete in compression can be treated as an elastic body. Need to check the strain of compressive reinforcing bar.
(3) The equivalent stress block ($0.85f'c \times 0.8x$, Whitney's block) can be used. It can be assumed that the strain of concrete in the extreme compressive fiber is equal to ε'_{cu}. Check the strain of reinforcing bars.
(4) In this case, the following stress-strain relationship has to be used.

$$0 \le \varepsilon'_c \le \varepsilon'_o \qquad \sigma'_c = 0.85 f_c' \left[2\left(\frac{\varepsilon'_c}{\varepsilon'_o}\right) - \left(\frac{\varepsilon'_c}{\varepsilon'_o}\right)^2 \right]$$

$$\varepsilon'_o < \varepsilon'_c \le \varepsilon'_{cu} \qquad \sigma'_c = 0.85 f'_c$$

Calculate the difference between M_{u1} and M_{u2} and evaluate the effectiveness of the equivalent stress block.