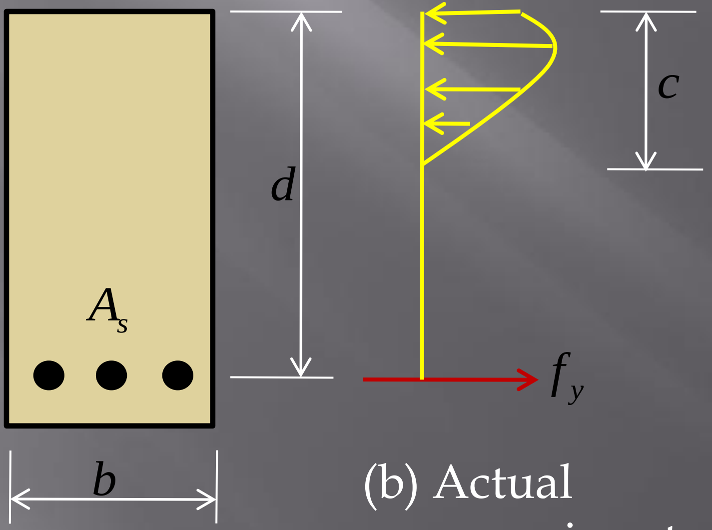
REINFORCED CONCRETE-I

(Flexural Analysis of Beams Contd.)

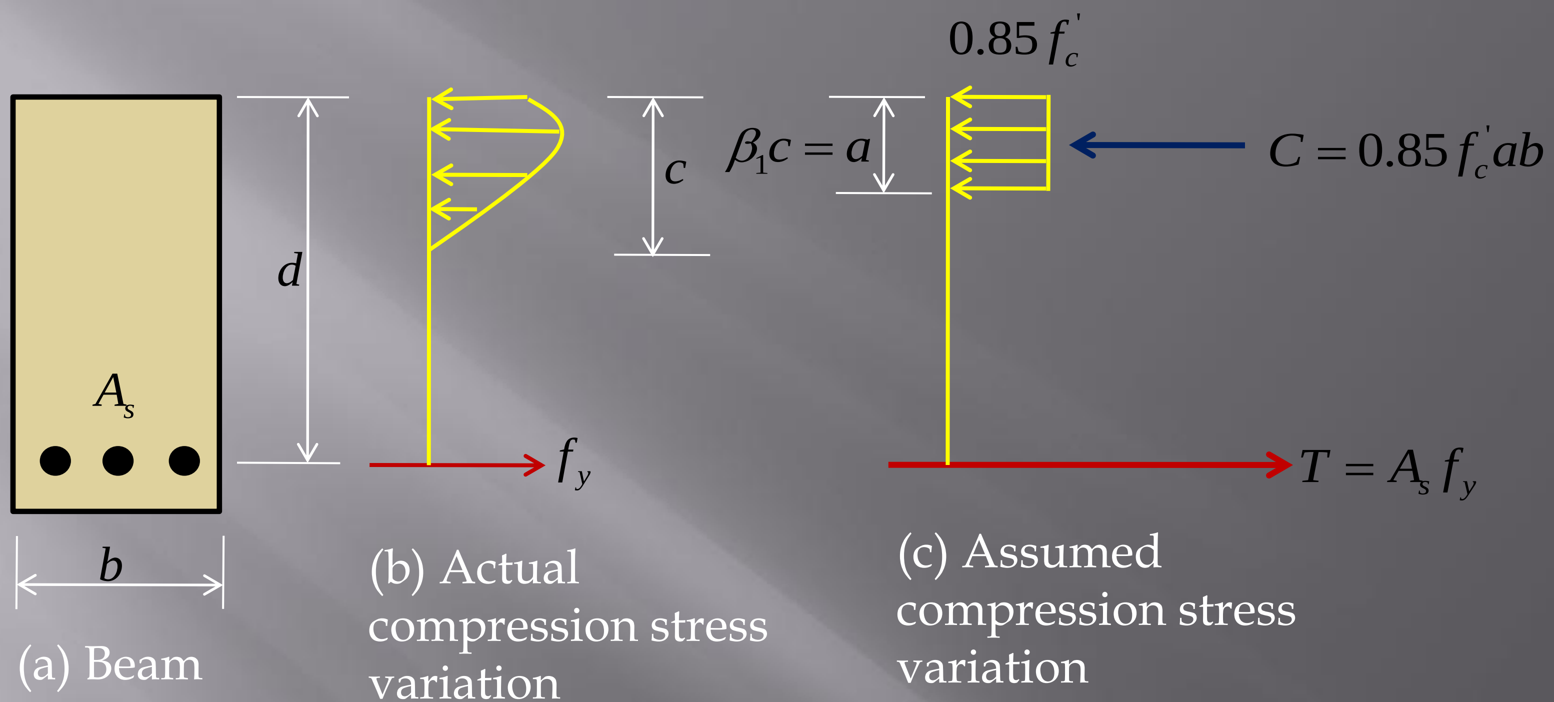
Ultimate or Nominal Flexural Moments

- After the concrete compression stresses exceed about 0.50 f_c', they no longer vary directly as a straight line. Rather they vary much as shown in Fig. (b).



(a) Beam

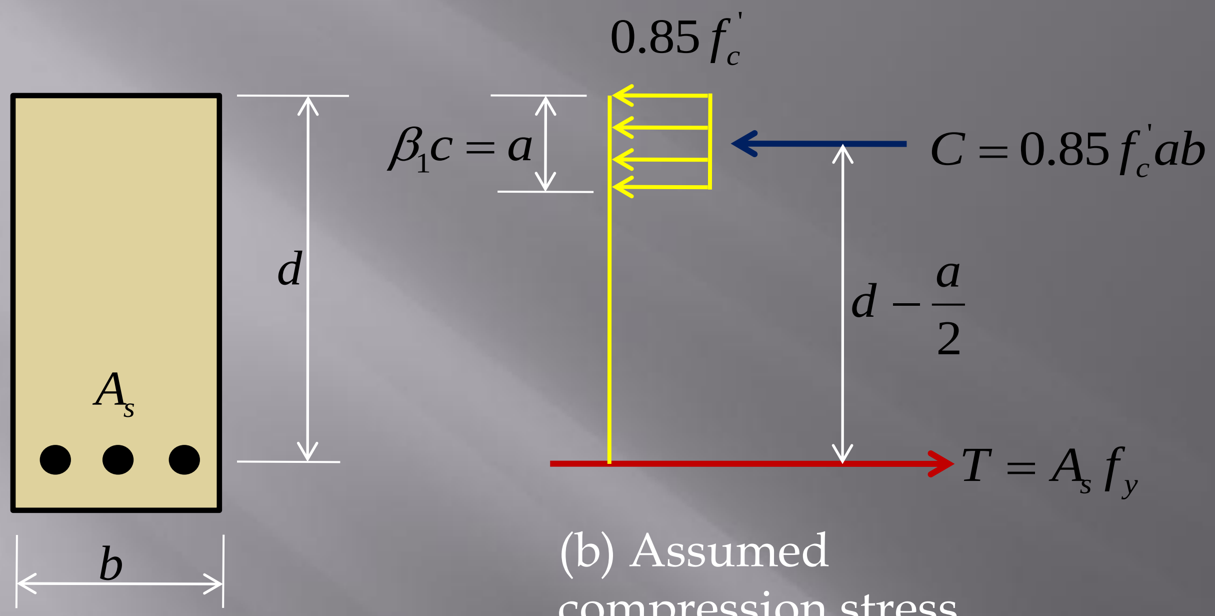
(b) Actual compression stress variation



Assumptions made in the derivation of M_n

The curved compression diagram can be replaced by a rectangular one with a constant stress of 0.85 f_c'.

The rectangular diagram of stress block depth a is assumed to have the same centre of gravity and total magnitude as the curved diagram.



(a) Beam

(b) Assumed compression stress variation

1. Compute the total tensile force $T = A_s f_y$.

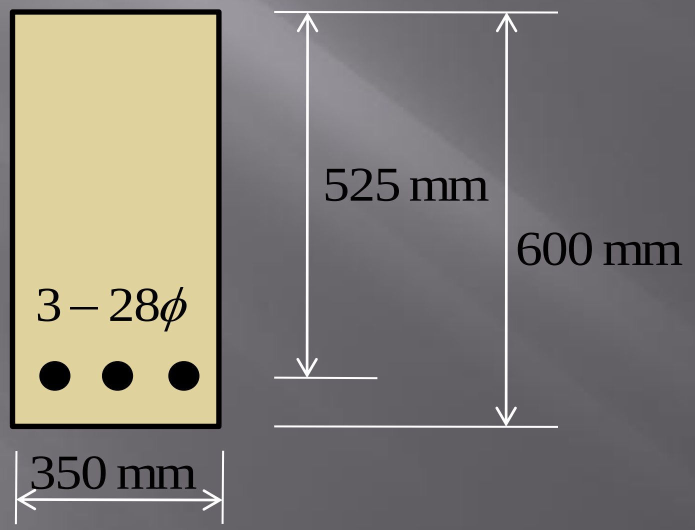
2. Equate total compression force C ($= 0.85 f_c' ab$) to T ($= A_s f_y$) and solve for a.

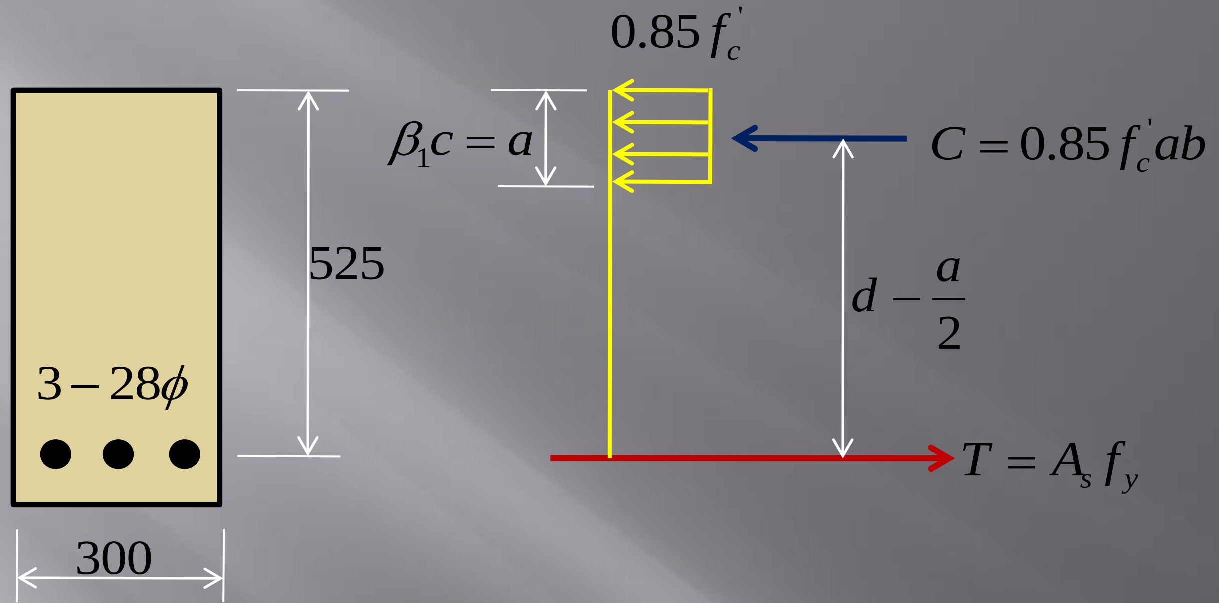
3. Calculate the distance between the centers of gravity of T and C. (For rectangular cross section it equals d-a/2).

4. Determine $M_n = C \text{ (or } T) \times \left(d - \frac{a}{2} \right)$

Example

Determine M_n the nominal or theoretical ultimate moment strength of the beam section shown below, if f_c' = 20 MPa and f_y = 420 MPa





Solution

Calculate tensile and compressive forces T and C :

$$T = A_s f_y = \left(3 \times \frac{\pi}{4} \times 28^2\right) \times 420 = 775454.4 \text{ N}$$

$$C = 0.85 f_c' ab = 0.85 \times 20 \times a \times 350 = 5950a$$

Equating T and C for equilibrium and solving for a :

$$C = T \Rightarrow 5950a = 775454.4 \Rightarrow a = \frac{775454.4}{5950} = 130.3 \text{ mm}$$

Compute M_n :

$$M_n = T\left(d - \frac{a}{2}\right) = 775454.4 \times \left(525 - \frac{130.3}{2}\right) = 356.6 \times 10^6 \text{ Nmm} = \underline{\underline{356.6 \text{ kN.m}}}$$