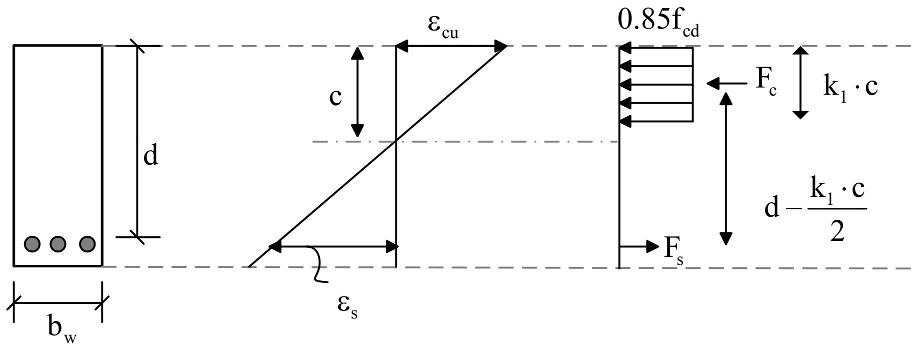
Derivation of K_b



$$\rightarrow \quad \sum F = 0 \Rightarrow F_s - F_c = 0$$

$$A_s \cdot f_{yd} - 0.85 f_{cd} \cdot 0.85c \cdot b_w = 0 \qquad (1)$$

$$\rightarrow \quad \sum M = 0 \Rightarrow F_s \cdot (Z)$$

$$M = A_s \cdot f_{yd} \cdot \left(d \cdot \frac{0.85c}{2} \right) \qquad (2)$$

@ balanced case

$$\frac{0.003}{c_b} = \frac{\varepsilon_{sy}}{d - c_b} \qquad \Rightarrow 0.003d - 0.003c_b = \varepsilon_{sy} \cdot c_b$$

$$\Rightarrow 0.003d = c_b (0.003 + \varepsilon_{sy})$$

$$\Rightarrow \frac{c_b}{d} = \frac{0.003}{0.003 + \varepsilon_{sy}} = \frac{0.003E_s}{0.003E_s + f_{yd}}$$

$$A_{sb} = 0.85 \cdot \frac{f_{cd}}{f_{yd}} \cdot 0.85 c_b \cdot b_w \qquad (3)$$

Dividing both sides of Equation 3 by ($b_w \cdot d$)

$$\frac{A_{sb}}{b_w \cdot d} = \rho_b = 0.85 \cdot \frac{f_{cd}}{f_{yd}} \cdot 0.85 \cdot \frac{c_b}{d}$$

$$\rho_b = 0.85 \cdot \frac{f_{cd}}{f_{yd}} \cdot 0.85 \cdot \left[\frac{0.003E_s}{0.003E_s + f_{yd}} \right]$$

Dividing both sides of Equation2 by ($b_w \cdot d^2$)

$$\frac{M_b}{b_w \cdot d^2} = \frac{A_{sb}}{b_w \cdot d^2} \cdot f_{yd} \left(d - \frac{0.85 \cdot c_b}{2} \right)$$

$$= \frac{A_{sb}}{b_w \cdot d} \cdot f_{yd} \cdot \left(1 - \frac{0.85}{2} \cdot \frac{c_b}{d} \right) = \rho_b \cdot f_{yd} \cdot \left(1 - \frac{0.85c_b}{2d} \right)$$

Let us call $j_b = 1 - \frac{0.85c_b}{2d} = 1 - \frac{0.85}{2} \cdot \frac{0.003E_s}{0.003E_s + f_{yd}}$

$$\frac{M_b}{b_w \cdot d^2} = \rho_b \cdot f_{yd} \cdot j_b \Rightarrow \frac{b_w \cdot d^2}{M_b} = \frac{1}{\rho_b \cdot f_{yd} \cdot j_b}$$

Let us call $\frac{1}{\rho_b \cdot f_{yd} \cdot j_b} = K_b$ where all the parameters are known

$$K_b = \frac{b_w \cdot d^2}{M_b} = \frac{1}{\ell_b \cdot f_{yd} \cdot j_b}$$