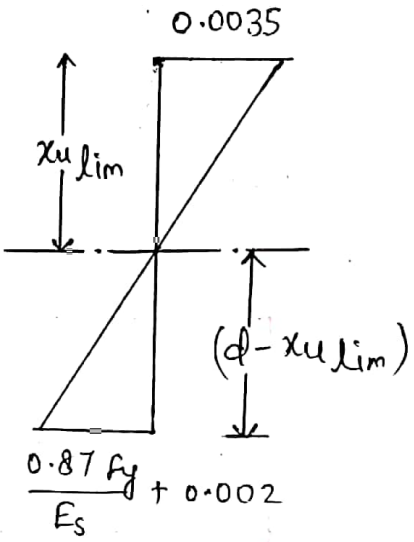
Limiting Depth of NA —

In strain diagram,



By similar triangle,

$$\frac{x_{u\,lim.}}{0.0035} = \frac{d - x_{u\,lim}}{\frac{0.87 f_y}{E_s} + 0.002}$$

$$\frac{\frac{0.87 f_y}{E_s} + 0.002}{0.0035} = \frac{d - x_{u\,lim.}}{x_{u\,lim}}$$

$$\frac{\frac{0.87 f_y}{E_s} + 0.002}{0.0035} + 1 = \frac{d}{x_{u\,lim}}$$

$$\frac{\frac{0.87 f_y}{E_s} + 0.0055}{0.0035} = \frac{d}{x_{u\,lim.}}$$

$$\frac{0.0035}{\frac{0.87 f_y}{E_s} + 0.0055} = \frac{x_{u\,lim}}{d}$$

$$x_{u\,lim.} = \frac{0.0035 \times d}{\frac{0.87 f_y}{E_s} d + 0.0055}$$

$\because$ $E_s = 2 \times 10^5$ N/mm² (For all steel grades)

or, $$x_{u\,lim.} = \frac{0.0035 \times d}{\frac{0.87 f_y}{2 \times 10^5} + 0.0055}$$

or, $$x_{u\,lim.} = \frac{0.0035 \times d}{\frac{0.87 f_y + 1100}{2 \times 10^5}}$$

or, $$x_{u\,lim.} = \frac{0.0035 \times d \times 2 \times 10^5}{0.87 f_y + 1100}$$

$$\boxed{x_{u\,lim.} = \left[\frac{700}{0.87 f_y + 1100}\right] \times d}$$

or, $$x_{u\,lim.} = K_u \cdot d$$

K_u = Limiting depth factor, जो grade of steel पर depend करता है।

Values of K_u for different grades of steel —

For Fe-250 ⟶ $f_y = 250$ N/mm²

$$K_u = \frac{700}{0.87 f_y + 1100} = \frac{700}{0.87 \times 250 + 1100}$$

$$\boxed{K_u = 0.53}$$

For Fe-415 $\longrightarrow$ $f_y = 415\ N/mm^2$

$$K_u = \frac{700}{0.87 f_y + 1100} = \frac{700}{0.87 \times 415 + 1100}$$

$$\boxed{K_u = 0.48}$$

For Fe-500 $\longrightarrow$ $f_y = 500\ N/mm^2$

$$K_u = \frac{700}{0.87 f_y + 1100} = \frac{700}{0.87 \times 500 + 1100}$$

$$\boxed{K_u = 0.46}$$

Moment of Resistance

$$M_u = (C_u \text{ or } T_u) \times Z$$

$$M_{uc} = C_u \times Z$$

$$\boxed{M_{uc} = 0.36\, f_{ck}.\, x_u.\, b.\, (d - 0.42\, x_u)}$$

$$M_{uT} = T_u \times Z$$

$$\boxed{M_{uT} = 0.87\, f_y.\, A_{st}.\, (d - 0.42\, x_u)}$$