LIMIT STATE METHOD
PART-II

DEPT. OF TECHNICAL EDUCATION U.P.

GOVT. POLYTECHNIC SHAHJAHANPUR

PRESENTED BY

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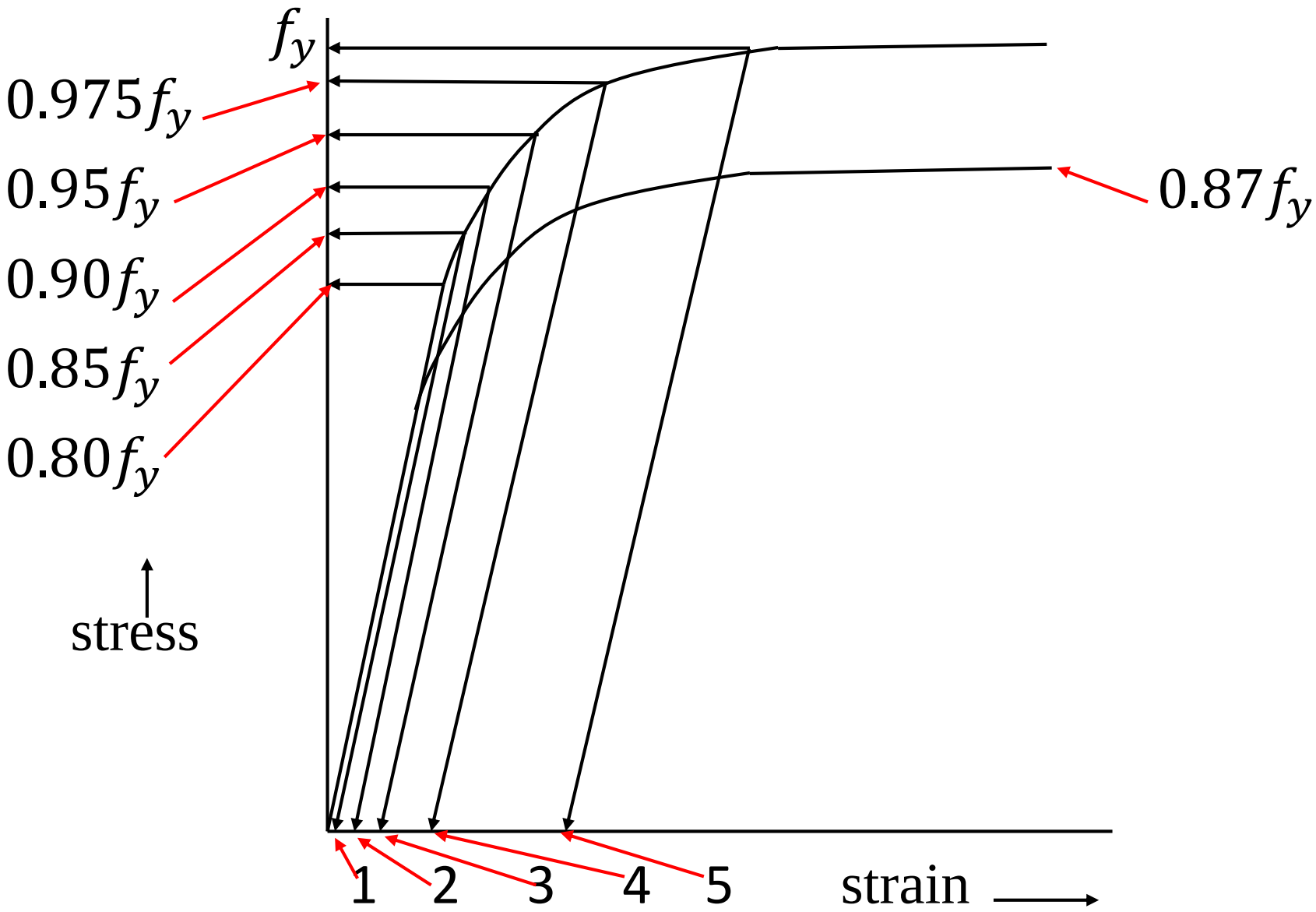
H.O.D. CIVIL ENGINEERING

IDEAL CURVE FOR Fe 415 / Fe500 STEEL



STRESS IN STEEL GRADE Fe415

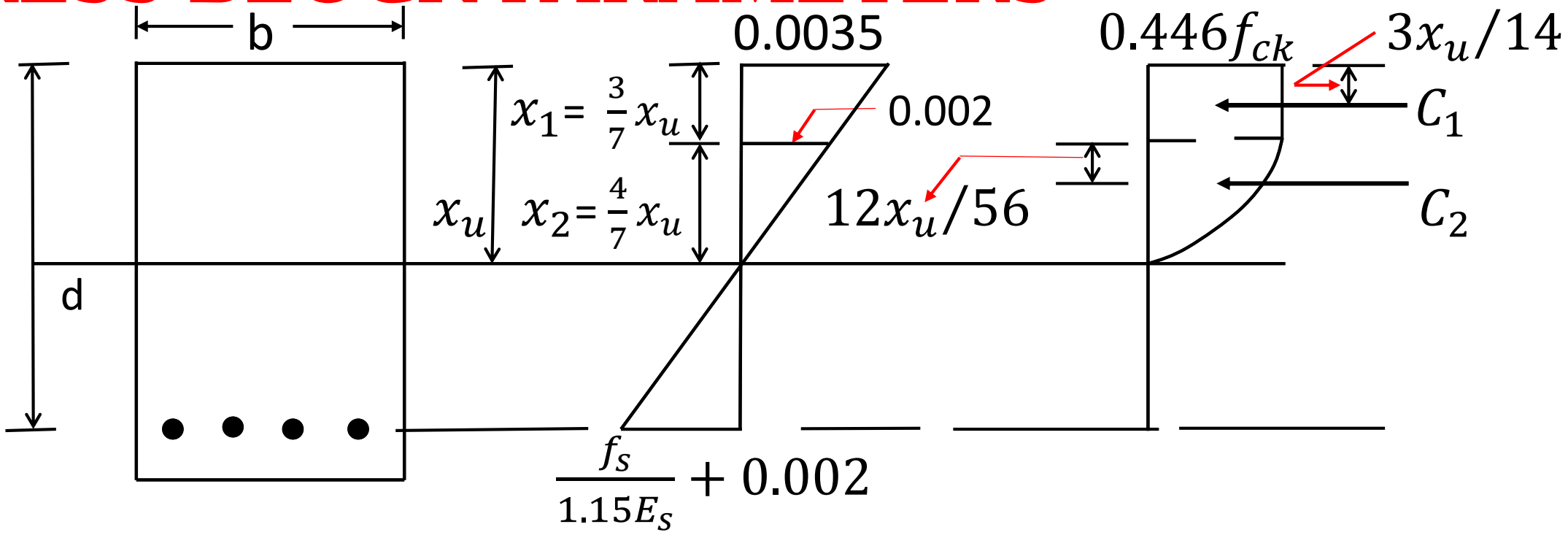
S.NO	STRESS N/mm^2	ELASTIC STRAIN $e = \frac{f_s}{E}$ $E = 2 * 10^5$	INELASTIC STRAIN	TOTAL STRAIN
1	0.80*0.87*415= 288.4	0.00144	0.00	0.00144
2	0.85*0.87*415= 306.89	0.00153	0.0001	0.00163
3	0.90*0.87*415= 324.95	0.00162	0,0003	0.00192
4	0.95*0.87*415= 343.00	0.00171	0.0007	0.00241
5	0.975*0.87*415= 352.00	0.00176	0.001	0.00276
6	0.87*415= 361.05	0.00180	0.002	0.0038

ASSUMPTIONS

- Plane section before bending remains plane after bending
- Maximum strain in outermost fiber of concrete is 0.0035
- Stress diagram can be of any shape
- Tensile strength of concrete is ignored
- Stress in steel can be determined from stress strain curve
- Maximum strain in steel at failure must be greater than or equal to

$$e_{s\,max} \geq \frac{0.87 f_y}{E_s} + 0.002$$

STRESS BLOCK PARAMETERS

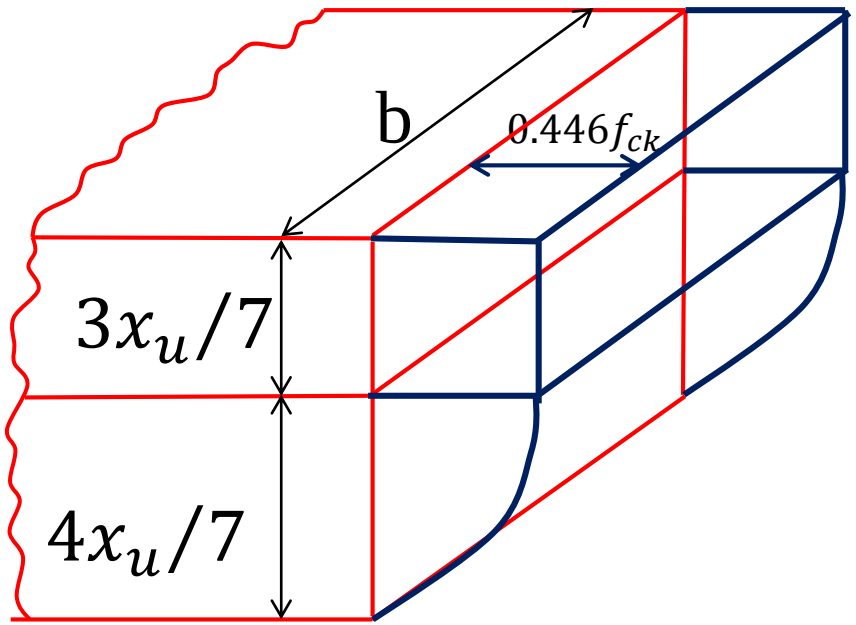


Let x_u be the depth of neutral axis from the top fiber

$$\frac{x_2}{x_u} = \frac{0.002}{0.0035}$$

$$\therefore \quad x_2 = \frac{4}{7}x_u$$

- $$x_1 = x_u - x_2$$
$$x_1 = \frac{3}{7}x_u$$



Compressive force = area * stress

Compressive force $C_1 = \frac{3}{7}x_u \times b \times 0.446f_{ck}$

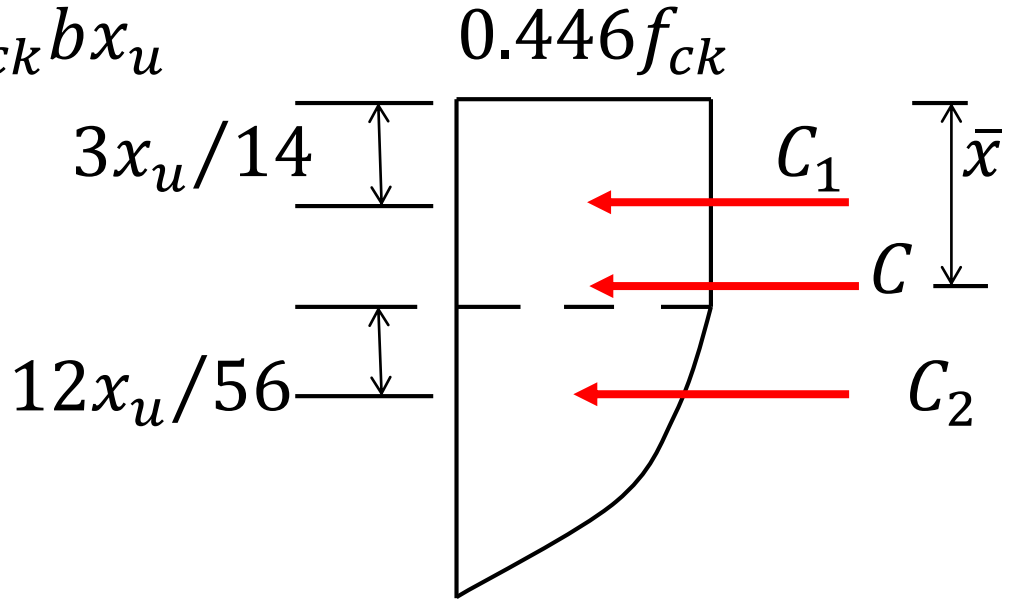
$= 0.19f_{ck}bx_u$

Compressive force $C_2 = \frac{2}{3} \times \frac{4}{7}x_u \times b \times 0.446f_{ck}$

$= 0.17f_{ck}bx_u$

Total force $C = C_1 + C_2$

$C = 0.36 f_{ck} b x_u$



to find point of action of C

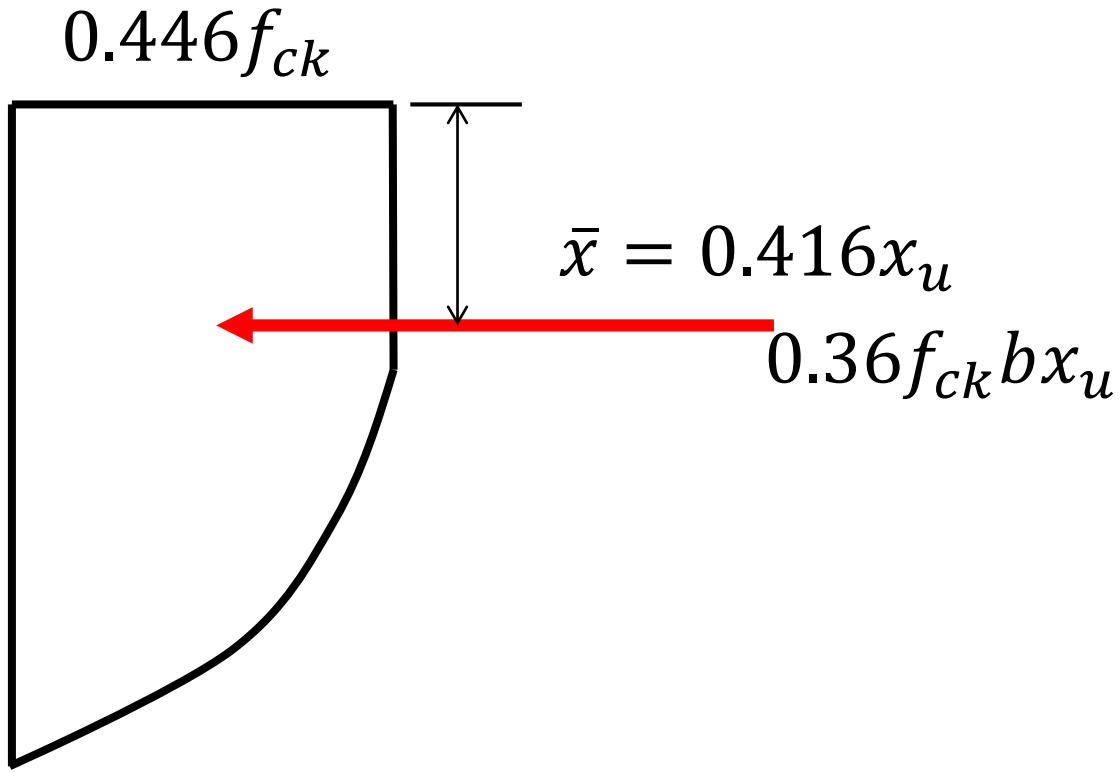
taking moment of forces about top edge

$$C \times \bar{x} = C_1 \times \frac{3}{14} x_u + C_2 \times \left(\frac{3}{7} x_u + \frac{12}{56} x_u \right)$$

$$0.36f_{ck}bx_u \times \bar{x} = 0.19f_{ck}bx_u \times \frac{3}{14}x_u + 0.17f_{ck}bx_u \times \left(\frac{3}{7}x_u + \frac{12}{56}x_u\right)$$

$$\therefore \bar{x} = 0.416x_u$$

Stress block parameters are shown below



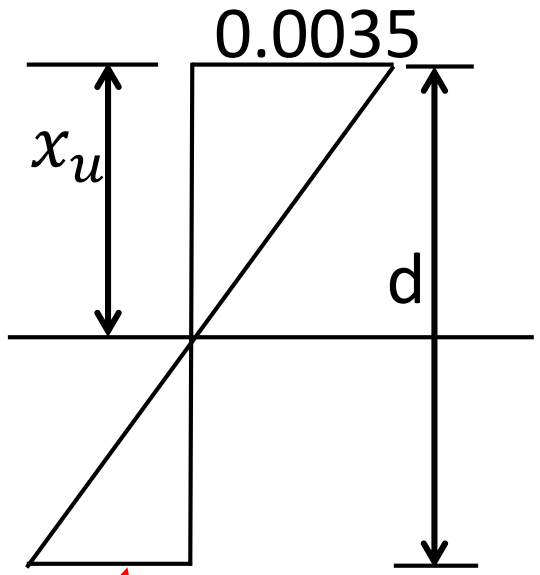
NEUTRAL AXIS

- Equivalent area is used to find neutral axis in working stress method
- In limit state compressive and tensile forces are equated

$$C = T$$

$$0.36 f_{ck} b x_u = 0.87\ f_y \times A_{st}$$

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b x_u}$$



$$\frac{f_s}{1.15 E_s} + 0.002$$

- Depth of neutral axis for balanced section

$$\frac{x_{u\,lim}}{d-x_{u\,lim}} = \frac{0.0035}{\frac{f_y}{1.15E_S}+0.002}$$

Putting $E_s = 2 \times 10^5 \ N/mm^2$

$$x_{u\,lim} = \frac{700\,d}{1100 + 0.87f_y}$$

f_y= 250 N/mm^2 , $x_{u\,lim}$= 0.53d

f_y= 415 N/mm^2 , $x_{u\,lim}$= 0.48d

f_y= 500 N/mm^2 , $x_{u\,lim}$= 0.46d

MOMENT OF RESISTANCE

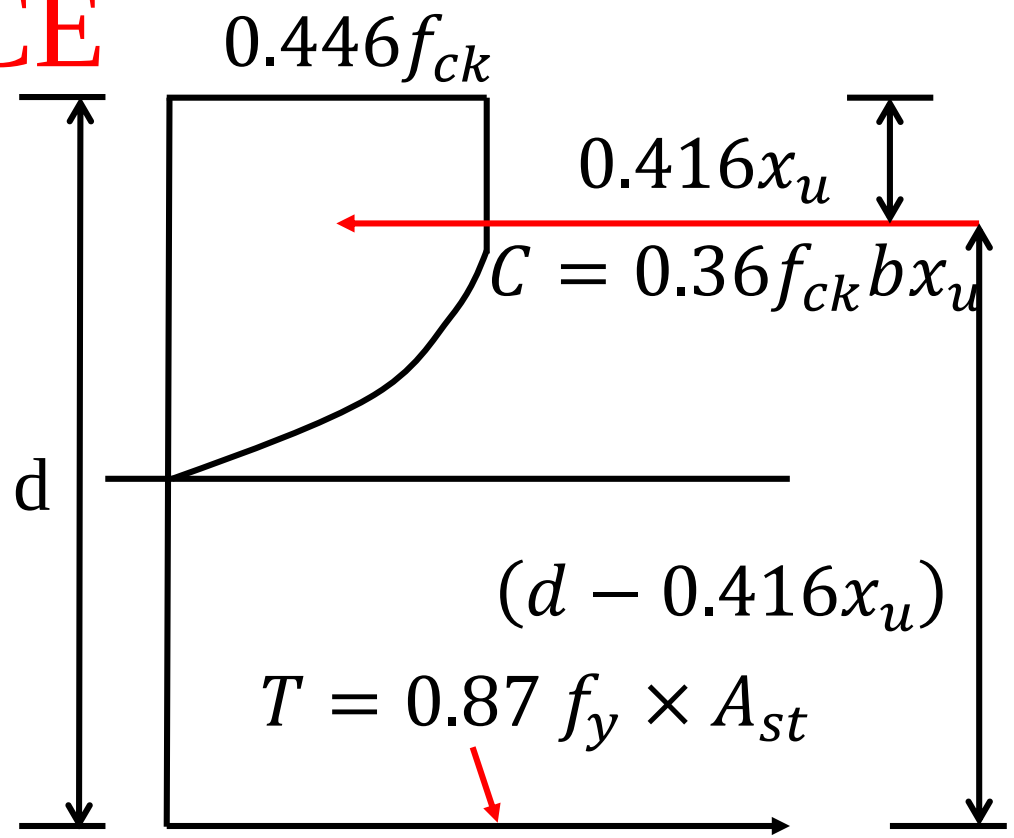
MR = compressive force * lever arm

= tensile force * lever arm

$$MR = 0.36 f_{ck} b x_u (d - 0.416 x_u)$$

$$MR = 0.87\ f_y \times A_{st}\ (d - 0.416 x_u)$$

where $x_u \leq x_{u\ lim}$



THANK YOU