DEPARTMENT OF CIVIL ENGINEERING

KATIHAR ENGINEERING COLLEGE KATIHAR

COURSE: DESIGN OF CONCRETE STRUCTURE-I

TOPIC: DESIGN OF COLUMN BY LSM

LECTURE: 06

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⇒ Design of Column subjected to Axial load + Uniaxial Bending

If a column is to be designed for

(i) Axial load = Pu

(ii) Moment = Mu

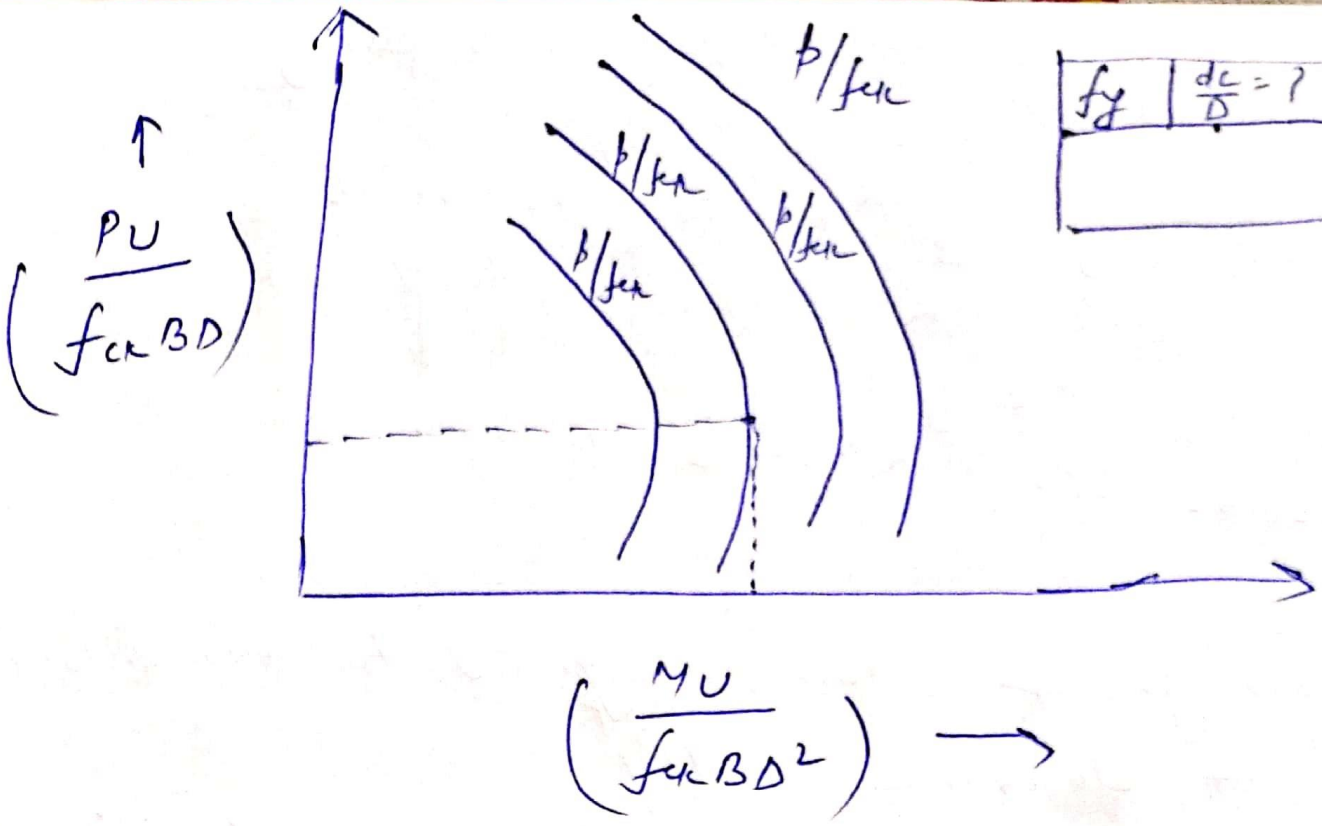
[Mu & Mumin]

Mumin = Pu x emin

→ Interaction diagram are used as per SP-16 (Design Aids for Reinforced Concrete : IS 456 : 1978)

Interaction Curve: A/c to IS 456 : 1978 (SP-16)

It is the Curve b/w Non dimensional load ($\frac{Pu}{f_{ck}bD}$) on the Y-axis and Non-dimensional moment on the X-axis ($\frac{Mu}{f_{ck}bD^2}$)



In SP:16 Chart 27 to chart 32)

Non dimensional moment $= \frac{MU}{f_{ck} B D^2}$

Where MU → factored Bending moment

f_{ck} → characteristics compressive strength of concrete at 28 days

B → Width of the column

D → Gross/total Depth of column

Non-dimensional load → $\left(\frac{PU}{f_{ck} BD}\right)$

Pu → factored Axial load.

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With the help of $\left(\frac{Pu}{f_{ck}BD}\right)$ and $\left(\frac{Mu}{f_{ck}BD^2}\right)$, Grade of steel ($f_y$) and $\left(\frac{d_c}{D}\right)$ We can select Interaction Curve (chart 27 to chart 82)

$$\frac{p}{f_{ck}} = \text{---} k$$

$$p = (k \cdot f_{ck})\ \%$$

Where $p \rightarrow$ % age of steel

$$A_{sc} = \frac{p \times BD}{100}$$

Design of stirrups is same

1. Calculate $\frac{Pu}{f_{ck}BD} \rightarrow$ Y-value
2. Calculate $\frac{Mu}{f_{ck}BD^2} \rightarrow$ X-value
3. Reach the value of $\frac{p}{f_{ck}} = k$ value

   Get Percentage of steel (p) = $k \cdot f_{ck}$

(4) Compute $A_{sc} = \frac{p \times BD}{100}$

(5) Design of stirrups → same

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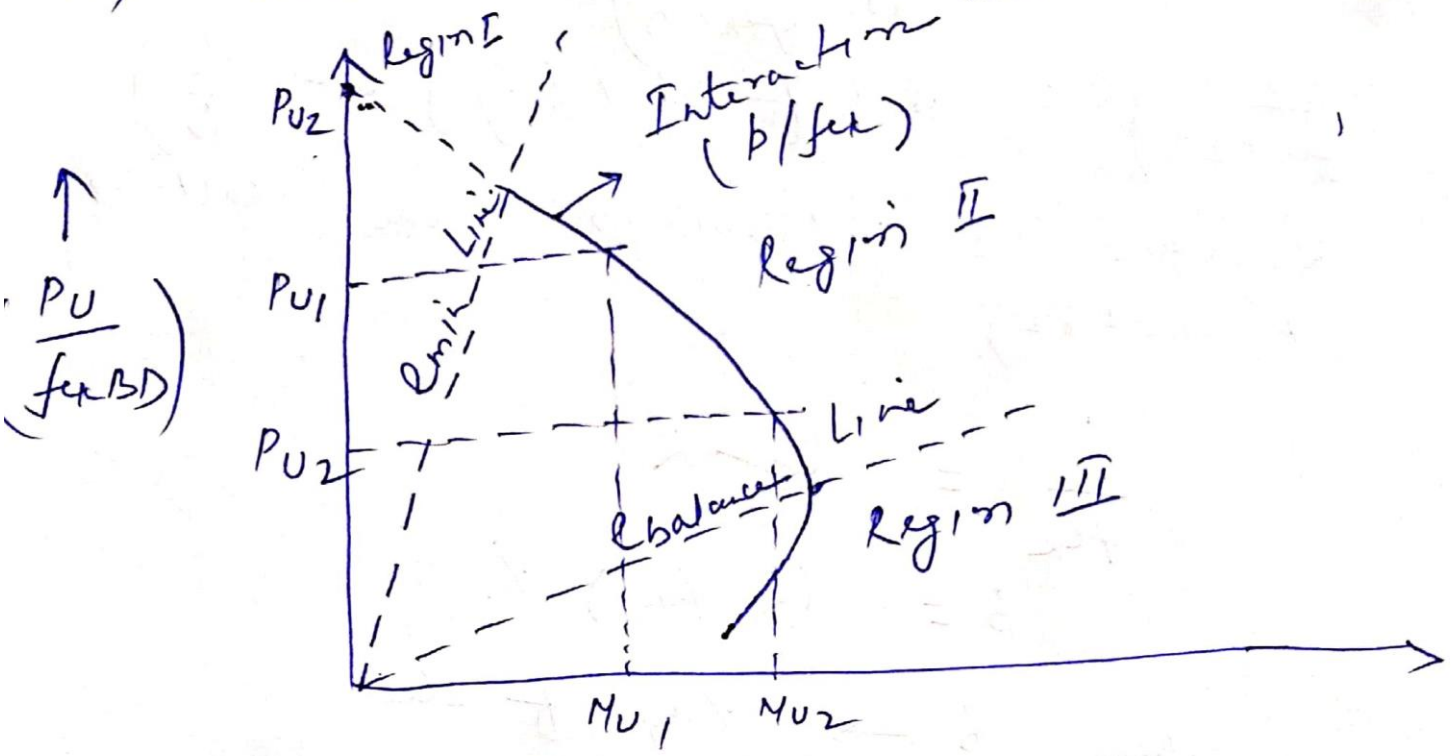
⇒ Interaction Curve



Region I (Minm eccentricity Region)
(when e < emin)

→ Column can't be designed for this value.

→ Ist point shows Pu2 value

Pu2 → Ultimated load carrying capacity of Column.

$$P_{u2} = 0.45 f_{ck} A_c + 0.75 f_y A_{sc}$$

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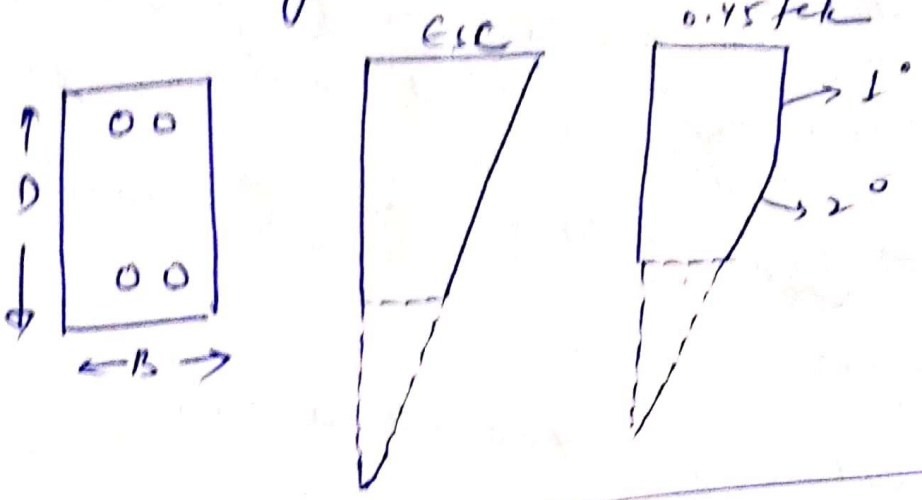
(2) Compression Control region

In this region - effect of load & moment both are equally high.

→ Mostly column is in Compression.



$$\epsilon_{LC} = \frac{0.0035}{0.75} \epsilon_{LC}$$

→ When N.A is formed outside column section if no tension is developed ($x_u > D$)

(3) Tension Control region

→ When load is very less as compared to effect of moment.

→ Tension is developed in the column.

→ Neutral axis will be within the column section ($x_u < D$)

→ Maximum strain in concrete = 0.0035.

→ In this region moment carrying capacity get reduced if the load on the column is reduced.

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P-1. For a rectangular column of size 400 mm × 400 mm, the value of $\frac{p}{f_{ck}}$ is taken 0.10 for using interaction curve of column as given in SP-16. The grade of concrete is M20 & the grade of steel is Fe415. The area of steel will be equal to

(a) 4000 mm² (b) 3200 mm² (c) 2400 mm²

(d) 1600 mm²

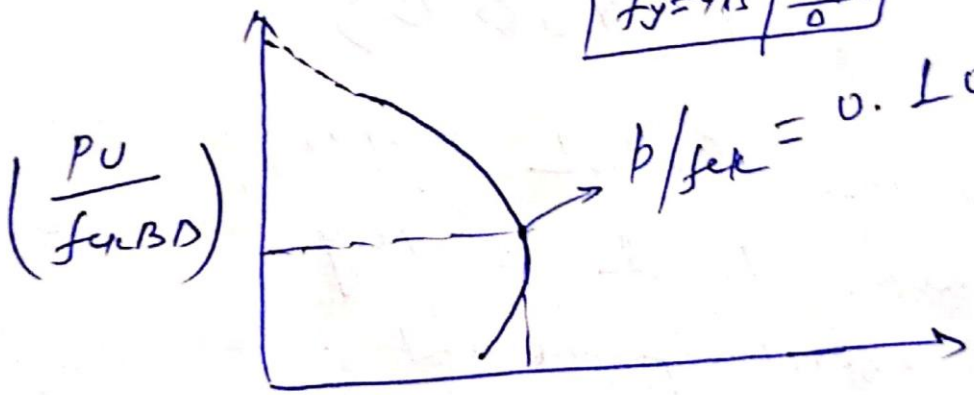
Solution: Size of the column = 400 × 400 mm

B = 400 mm

D = 400 mm

For Given f_y = 415 & $\frac{d_c}{D}$ = ?

f_y=415	$\frac{d_c}{D}$=?



$$\frac{p}{f_{ck}} = 0.10$$

$$p = 0.10 \times f_{ck} = 0.1 \times 20 = 2$$

$$A_{sc} = \frac{p \times BD}{100} = \frac{2 \times 400 \times 400}{100}$$

$$= 3200 \text{ mm}^2$$

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P-2. A rectangular column of size 400 x 400 mm is loaded with P_u = 1200 kN and M_{u_x} = 50 kN-m. For using interaction curve of column, the dimensional form of load & Moment will be (M20 grade of concrete)

Solution (a) 0.375 and 0.039 respectively

(b) 0.375 and 0.049 respectively

(c) 0.469 and 0.039 respectively

(d) 0.469 and 0.049 respectively.

Solution.

B = 400 mm

D = 400 mm

P_u = 1200 kN

M_{ux} = 50 kN-m

Non-dimensional load $\left(\frac{P_u}{f_{ck}BD}\right)$ = $\frac{1200 \times 10^3}{20 \times 400 \times 400}$ = 0.375

Non-Dimensional moment $\left(\frac{M_u}{f_{ck}BD^2}\right)$ = $\frac{50 \times 10^6}{20 \times 400 \times 400^2}$ = 0.039

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