INTERACTION DIAGRAM FOR L-SHAPED COLUMN WITH UNEQUAL SPACING OF REINFORCEMENT

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ABSTRACT

Design of reinforced concrete column for rectangular section is based on IS 456-2000 and Interaction curve is develop for the same in SP16. But for arbitrary shaped like T section, L section etc..is not specified by IS 456-2000. This paper deals with development of Interaction curve for L section with specific parameters as cover and depth ratio (d'/D) and many more. Axial load and Uni axial bending moment is calculated and Interaction diagram is generated. P-M Interaction curve of column section gives the idea about failure pattern of section. So it is easy to design different shaped column with the help of interaction curve.

Keyword : *P-M Interaction Curve , L section column , axial load and uni axial bending.*

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1. INTRODUCTION

In design of reinforced concrete column, many parameters are taken for designing purpose. So that RCC column is somewhat difficult to design and for that reason Interaction curve is used in column section. Interaction diagram is graphical representation of Axial load acting on column and Axial or bi axial moment generated due to eccentricity of loading. It also represent failure mode of column . In this paper L section column is taken and P-M interaction diagram is generated for the same with different parameters as percentage of reinforcement (p), Position of reinforcement, grade of concrete etc.

For the calculation of Pu and Mu that is ultimate load and ultimate moment stress - strain relationship for steel and concrete is to be known. Because as reinforcement is used in column at different position then stress and strain value for particular position of reinforcement is different. The concept of stress and strain is important while calculating axial load for steel.

1.1 Concept of Stress - Strain curve

For any type of RCC member (Beam , Column) stress and strain relationship for concrete and also for steel should be known. The fig shows the stress and strain diagram for concrete. The maximum strain in concrete at outermost fiber is 0.0035, after that concrete cannot be worked. The same for steel bars. IS 456:2000 cl 39.1 has recommended some assumption for design of limit state of collapse in compression. It states as…

- The plane section normal to the axis of column before deformation remain plane after deformation that means the strain at any point is proportional to its distance from the N.A.
- The max. compressive strain in concrete at the outer most compression fiber is taken as 0.0035 in bending when N.A. lies within the section.
- The tensile strength of concrete is ignored.

- The relationship between compressive stress distribution in concrete and strain in concrete may be assumed to be rectangular, trapezoidal, parabola and any other shape according to N.A. condition. For the design purpose the compressive strength of concrete is assume to be 0.67 time Fck. But the design strength of concrete is taken as 0.446 Fck.

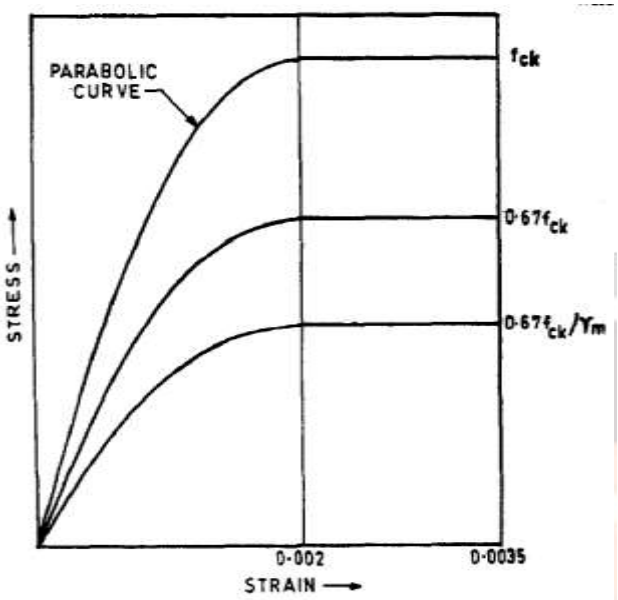

Figure 1 stress-strain diagram for concrete

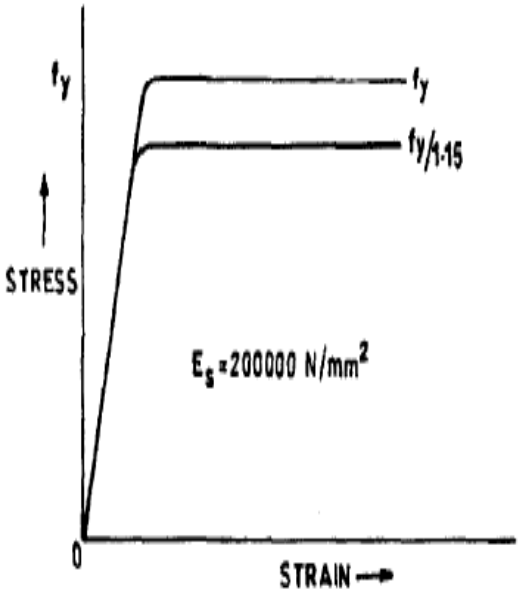

Figure 2 stress strain curve for steel

- The max. compressive strain in concrete in axial compression is taken 0.002.
- The maximum compressive strain at the highly compressed extreme fibre in concrete subjected to axial compression and bending and when there is no tension on the section shall be 0.0035 minus 0.75 times the strain at the least compressed extreme fibre.

1.2 Introduction of Interaction diagram

The different combination of Pu-Mu for each failure mode of given section are determined and plotted, the resulting curve is known as Interaction curve. The interaction curve of section represent for non dimensional section and it also gives area of steel for the section according to given specification and member can design easily. The fig. shows typical Interaction curve with direction of mode of failure.

According eccentricity generated in column various failure pattern generated in column and if it reaches at its ultimate point then at that point column will fail. This failure patter is classified as,

- **Tension Failure** : As the eccentricity goes on increasing in section tension failure occurs. For this case NA lies inside the section and xu < D where xu is depth of NA and D is total depth of section.
- **Balance Failure** : In this case eccentricity is almost equal to balance eccentricity and position of Na (xu) is equal to total depth of section (D).
- **Compression Failure** : As eccentricity decreases , compression occurs in the section. here xu > D and all reinforcement are in compression and concrete is in compression.

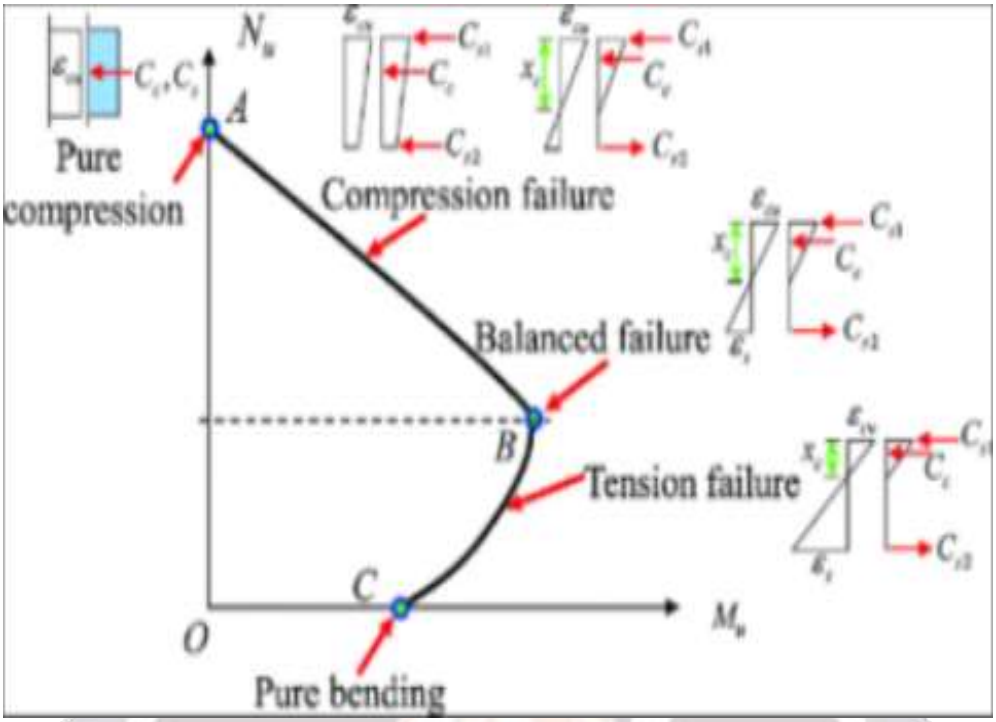

Figure 3 Typical Interaction curve

2. METHODOLOGY FOR CALCULATION

For the calculation of ultimate axial load (Pu) and ultimate bending moment (Mu) can be determine according to IS 456-2000.

i. NA Inside the section (xu < D) :-

$$Pu = Pc + Ps$$

$$Pu = 0.361 * fck * b * xu + \sum_{i=1}^{n} Asti * (fsi - fci)$$

$$Mu = Pc * \big(CG - (0.416 * xu)\big) + \sum_{i=1}^{n} Asti * (fsi - fci) * Yi$$

ii. NA outside the section (xu > D) :-

$$Pu = c1 * fck * b * D + \sum_{i=1}^{n} Asti * (fsi - fci)$$

$$Mu = Pc * (CG - c2) * D + \sum_{i=1}^{n} Asti * (fsi - fci) * Yi$$

Where Pu = Ultimate Load
Mu = Ultimate Moment
Pc = Load carrying capacity of concrete
Ps = Load carrying capacity of steel
Fsi = stress in steel in ith row
Fci = stress in concrete in ith row
c1 & c2 = parameters from SP 16 Tabel H.

2.1 L - Section column :

For development of Interaction curve of given L shaped column some parameters are taken before calculation such are derived below.

Table -1: Specification for section

Parameters detail	Value
d'/D	0.05
fck	20 MPa
Fy	415

Chosen section is equal in both leg and reinforcement detail is shown in below fig.

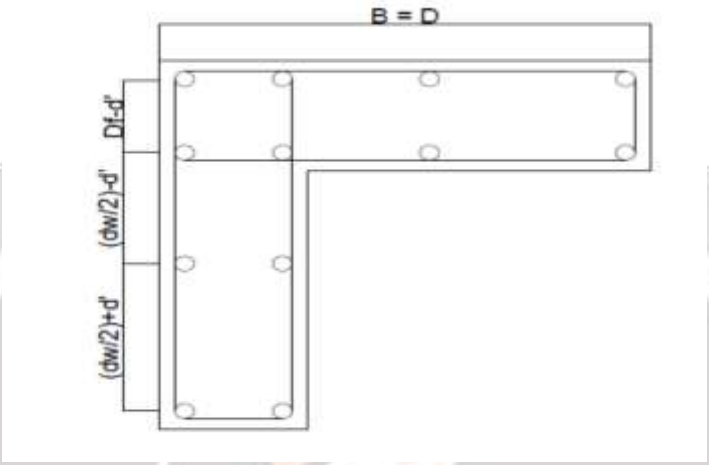

Figure 4 L shaped column with reinforcement placement

- Interaction curve for section

Table 2 : Value of L section Interaction curve

K = (xu / D)	Mu / fck * Ag *D	Pu / fck * Ag
pure tension	0	-0.14442
0.1	0.067784783	-0.018673709
0.2	0.105754114	0.063556867
0.3	0.138496406	0.152025054
0.4	0.151884822	0.201616569
0.5	0.164715795	0.261749413
0.6	0.173980025	0.30766409
0.7	0.172642765	0.362671386
0.8	0.165415173	0.406791382
0.9	0.158127442	0.445870754
1	0.151084079	0.486896238
1.5	0.070883967	0.542966442
2	0.062651467	0.558053117
3	0.053808199	0.573660826
4	0.053106368	0.574826365
Pure comp.	0	0.576080965

From the above value of table Interaction graph is ploted in terms of P-M.

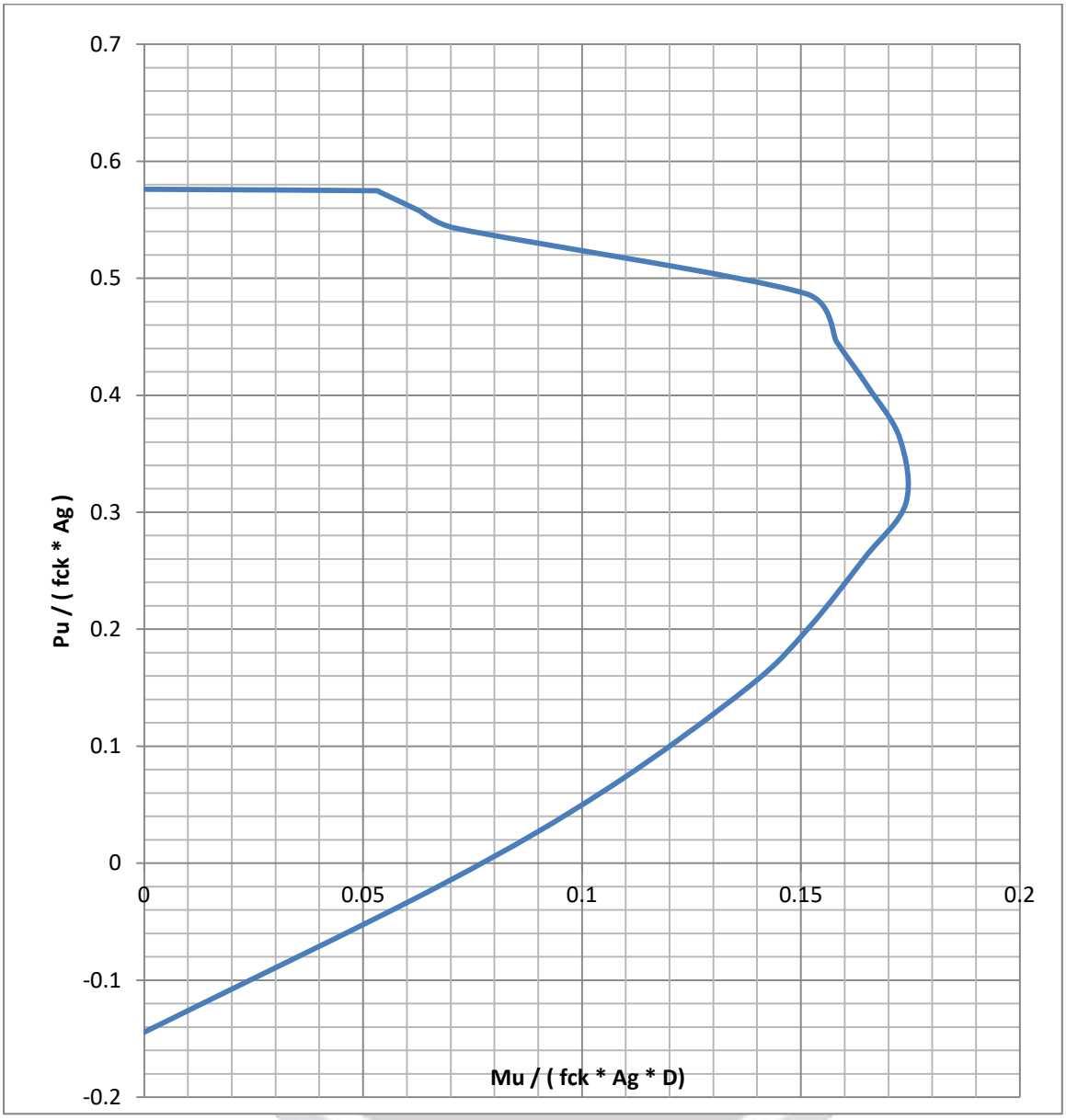

Figure 5 Interaction diagram for L section

The above Interaction curve is for particular section of ,

B = 1000 mm

D = 1000 mm

Df = bw = 300 mm

Dia. of bar = 20 mm equal reinforcement

Now the general Interaction diagram for M20, Fe 415 with Non - Dimensional result. Which is given in below fig. and with different p/fck ratio.

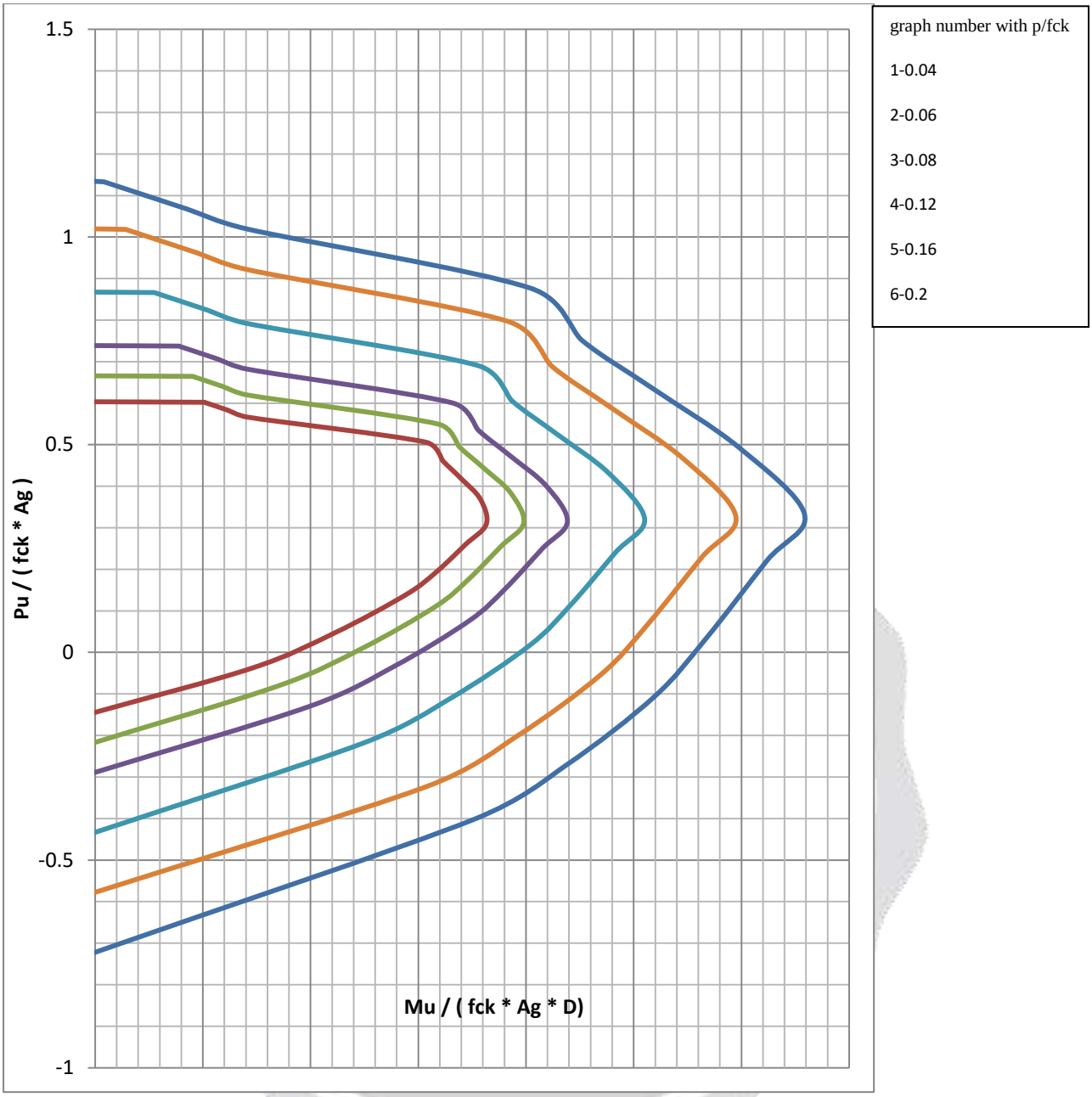

Figure 6 Non-dimension Interaction curve for L section

3. CONCLUSIONS

From the above graph of section we can say that any L shaped column is not design as rectangular column because of the section contain flange and web portion with no. of reinforcement. S o that the stress - strain value will change according to NA and the load in concrete will also change alone with it. Also we can say Ultimate load carrying capacity (Pu) and ultimate moment carrying capacity (Mu) is more than rectangular section. With the use of Interaction curve design of L section column will be very easy and time saving. Only from one parameter any one can get Pu and Mu value as per required percentage of reinforcement.

4. REFERENCES

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