Unequal Distribution of Reinforcement in Rectangular Sections

Dr.Savita Maru[1],Anamikatedia[2]
[1]*(Reader, Deptt Of Civil Engg.UECU,Ujjain)*
[2]*(Assistant Professor, Deptt Of Civil Engg.AIT, Ujjain)*

ABSTRACT: At present BIS in SP-16 has given design aids for the design of column subjected to Biaxial bending Moments with equal distribution of reinforcement. The main objective of the project is to develop Design chart for non uniform reinforcement distribution on two or four faces in rectangular section. In practice many column are subjected to bending about both the axes simultaneously specially the corner column of column of building. Column located at the corners of a multistoried building with rigidly connected beams at right angles ,develop biaxial moments together with the axial compression load transmitted from beams.

I. INTRODUCTION

The column section subjected to the axial compressive load Pu and the moments Mux and Muy about The major X-axis and major Y-axis respectively. Shows the axis of bending and resultant moment Mu acts about this axis inclined to the principle axis.The resultant eccentricity is computed.e=Mu/Pu This can also be expressed $e=((ex)^2+(ey)^2)^2$.The equilibrium of load and moments about both the axis.To overcome the difficulties of and error procedure in the design of column subjected to biaxial moment.

II. LITERATURE REVIEW

Many authors have given their different approaches for design charts,on the basis of certain assumptions. Some of these are not used now-a-days. But Breselers3 approach is widely used as design aid and adopted by IS-456-2000.Some of authors have given their suggestions also such as Weber,Meek Reynolds,C.K.Wang, and soloman.

Interaction Surface Approach:- In the case of biaxial eccentricity we get interaction ot failure Surfaces.each point of this surfaces reperests one particular set of axial load MUx moment Muy about , the major axis and Muy about the minor axis which will combine to produce failure A generalized expression for contours at various level of axial load or a reinforced concrete column which bends and twists especially due to the beam column effect cannot be easily derived.This is because the shape is sensitive to the geometry, strength of concrete and steel used arrangement and quantity of steel near Periphery and the level of the axial load yet attempt have been made by several authors panel,resselers,

Ramamurthy furlong,Weber, Meek.In all the approach pursed by besseler has been adopted by the IS-456 2000 code besseler has in fact suggested two methods.The first method is indeed the most useful for preliminary designs.In the first methods the (1/Nue) intersaction curve was given Prominenece.In the
Second methods,besslers has utiliezed the PM interaction surface.Bressler reduces the case of biaxial bending and axial load to several application of surface Bressler reduces the case of biaxial bending and axial load to several application of surface bressler reduces the case of biaxial bending and axial load to several application of surface bressler reduces the case of biaxial bending and axial load of several application of surface Bresseler reduces the case of biaxial bending and axial load to several application Of simple Bending and axial load at eccentricity ex and ey and Px and Py are the Maximum axial load When ex=ey=0 for section under biaxial flexure the following approximate relationship (Mx/Muz)+(My/Muy)<1When Mx and My are external moments and Mux and Muy are the flexural strength in the corresponding Planes.This expressions may also be used for axially loaded members.

A typical PM interaction curve is given SP-16 (Design aids for Reinforced concrete to IS 456 2000)..It can been seen that these curves have the same general form as the ACI curves but the various curves Are required for different types of steel further more, the curves are provided for certain values of percentage steel and one has to interpolate for the in between values Fy represents the state of stress In steel in the last compressed edge.

Cp110 Approach:- The axial load on a short column without significant moments is given by N=0.45FckAc+0.67fyAsc ACI code recommends the set of assumption. The Parameters B1,B2,B3 are factors. Theirs value depends on the nominal cylinder stress fy. For cross section of uniform width B3=0.85 and B2 =B1/2For a cross section,B2 also depends on the shape. These value are Determined by means of compression with test results. The code also permits any other reasonable assumption for the compression stress Distribution that has been verified by comprehensive tests.

Ceb Assumption: Like ACI code , the European concrete Committee accepts any reasonable shape for the concrete Committee accepts any reasonable shape for the concrete stress distribution in compression the

CEB Specially recommends three alternative distributions viz. Rectangular , parabolic to the neutral axial And a combination of both. For the maximum a value of 0.0035. The British code CP110;1972 recommends the use of the interaction equation.The constants M and N depend on the column properties Where m=n=1.0 at low axial load levels and increasing linearly up to 2.0 at high axial load levels.This gives a simple conservative approach.Other suggestions for the shape interaction surface have been made By panel Furlong and meek. They have suggested that curved interaction lines at constant ultimate load Can be replaced by few straight lines. Weber has produced s series of design charts for square column Bending about a diagonal which allows the design or analysis of a section by linear interaction between Bending about a diagonal.This approach is similar to Meek's suggestion and appears to be the most practical Design method available.Row and paulay have improved the accuracy of this process by using

More accuracy concrete compressive stress.In a general design problem, It is very difficult to find the value of percentage reinforcement "P" acting at eccentricity ex and ey from the plane of symmetry.This condition is statistically equivalent to considering the element under the action of load 'P' acting on the

Centroid of overall cross section, accompanied by two moments Mx=Pex, My=Pey for an element of known section, eccentricities and reinforcement distribution.If it is possible to apply the basic procedure Of section, for an assumed position of neutral axis , the load is obtained by summation of internal forces, And moment s are taken with repect toX and Y axis. If the eccentricities ex=Mx/p and ey=My/p are Sufficiently close to give eccentricities. This method is laborious , therefore,impractical to use towards The correct solution because the values of ex and ey are very sensitive to small changes in the position of neutral axis. Simple approaches have been proposed for routine among these the one proposed by besselers reduces the case of biaxial bending the axial load to several applications of simple bending and Axial load by using the following interaction equation:

$1/PU = 1/PX + 1/PY - 1/P_O$

Pu= Maximum axial load at ex and ey Px, P = Maximum axial load under compression with uniaxial eccentricities, ex and ey respectively ex and ey respectively.Po= Maximum load when ex =ey=0 for symmetrical elements , with the normal force acting on any Point is the cross section of the locus of maximum values of axial loads in an interaction surface suchAs in fig.01 the interaction diagram obtained previously for uniaxial loading are the intersection of the Surface with the P –Mx and P-My planes, this equation is valid for the values of P0/Pu large then 0.15 And applicable for tension loads.Aajakoben has proposed another simplified procedure in which for any two eccentricities ex and ey , an equivalent eccentricity is taken as((ex2+ey2))2 from which the load Pu is Computed if it was acting about one axis only. For section under biaxial flexure the following approximate relationship may be used.

(Mx/Mux)+(My/Muy)<1 where, Mx and My are external moments and Mux and Muy are the flexural Strengths in the corresponding planes.This expression may also be used for axially loaded members in which Po/Pu is less than 0.15 .It is clear that the direct approaches to find the working and service load Capacity of biaxial eccentricity loaded reinforced concrete column. Its result bounces to a approximate In case of uniaxial approximate eccentricity.

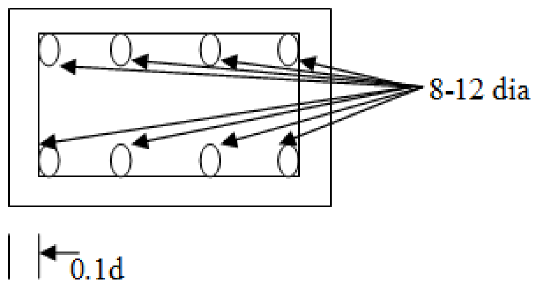
In case of biaxial eccentricity of interaction or failure surface, each point on the surface ,each point On the surface represent s one particular set of axial point Nu, Moment Mux, about the major axis and Muy about the minor axis which will combine to produce failure. Interaction curve is a complete graphical reperesentation of the design strength of uniaxial eccentricity loaded column of given proportions each point on the curve correspond of the design strength values of Pur and Mur associated With specific eccentricity of loading. Using the interaction curve for a given column section. Quick judgments as to whether or not the section is safe under a factor load effect combination.In other word Interaction curves serves as failure envelopes.

Sample Problem:-M20 Grade of concrete ,Fe 415 ,Section 200 x500 , Reinforcement= 8-12 dia. ,P=700 KN ,Mux =40 KNm Muy=20KNm Safety margin using SP 16 approach

Ast=8π122/4=904.78

Percentage of steel = (Ast/Bd)x 100=905

P/fckBd=700/(20x500x200)=0.35



Mux 1=0.75 x20x200x5002x10-6 = 75knm

Muy 1=0.75 x20x200x5002x10-6 = 30knm

P/Pz= 700/1181.61

αn =0.667+1.667P/Pz

(Mux/Mux1)αn+(Muy/Muy1)αn < 1
(40/75)1.667 +(20/30)1.667 <1
0.86<1
Safety margin using approach developed in the work
Mux1 =0.082 x20x200x5002x10-6 =82 kNm
Muy1 =0.0625 x20x200x5002x10-6 =25 kNm
(40/82)1.667 +(20/25)$^{1.667}$ <1
0.99<1

III. RESULTS AND DISCUSSION

1. These charts will enable the designer to use his own arrangement of reinforcement according to design need i.e. Mx,My,Py magnitude .normally the bending moment along one axis is greater
Than the other axis and designer would prefer more reinforcement along the axis than the other axis.
2. However if one choose to prefer the SP-16 charts he has to distribute the reinforcement equally
On the faces. Then the design would be uneconomical.
3. In cases where designer is using the design charts provide by SP-16 for equal reinforcement on all faces but provide them unequally on all faces the design way prove out to be unsafe as shown in the sample problem solved.
4. Provision of unequal reinforcement will be economical when the moment two directions are much different.

IV. CONCLUSIONS

1. Design chart have been presently for some possible cases of unequal distribution of reinforcement
In column.
2. These charts will facilitate the design of such columns having unequal distribution of reinforcement.
3. In some problem the design done by SP-16 may be unsafe, if the assumption of equal distribution
Is not followed in practice.
4. The design on the basis of this work with unequal distribution of reinforcement may prove out to be economical.

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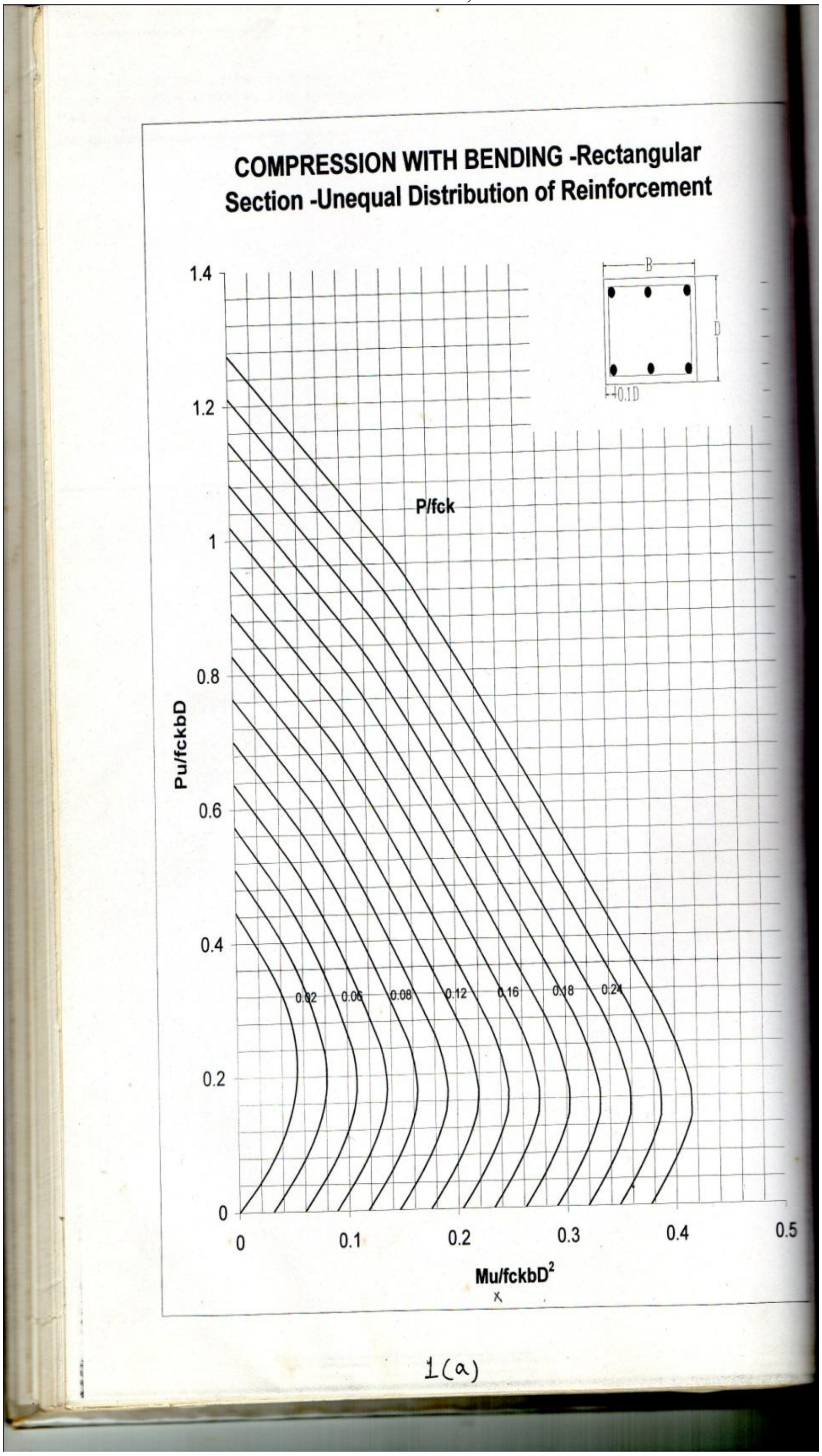

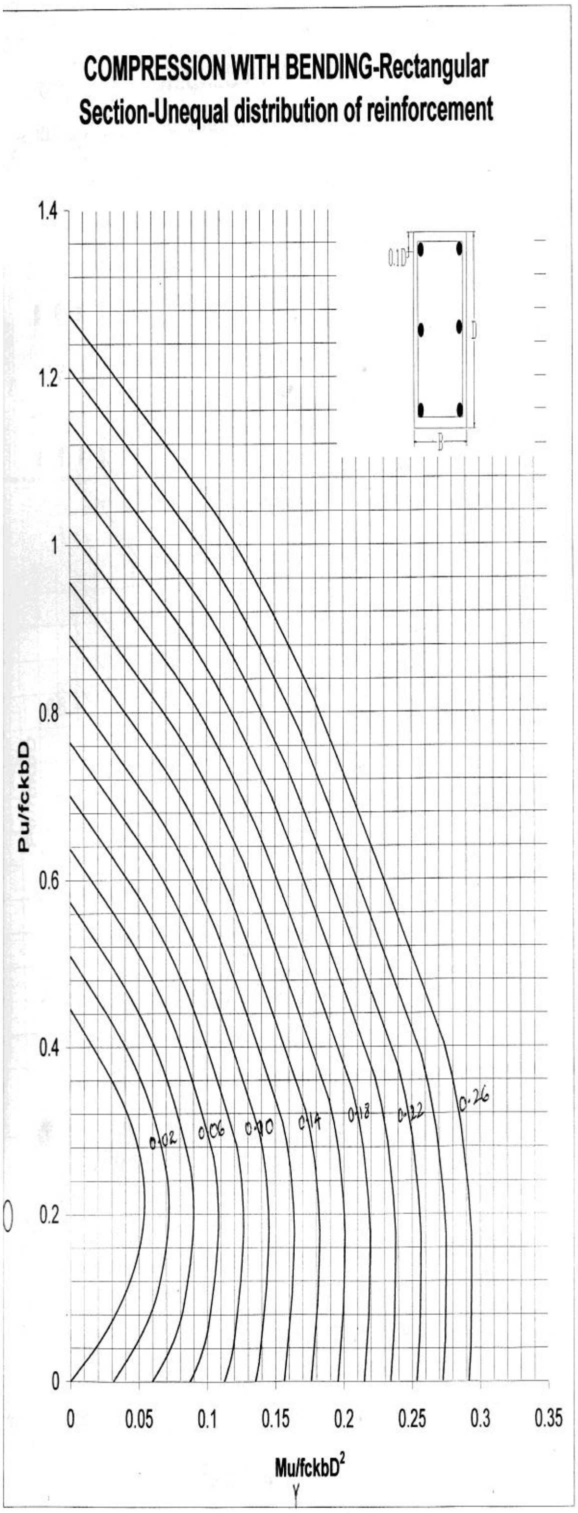
COMPRESSION WITH BENDING-Rectangular
Section-Unequal distribution of reinforcement
Pu/fckbD
Mu/fckbD²
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.02
0.06
0.10
0.14
0.18
0.22
0.26
0.1D
D
B

1(b)