ANALYTICAL STUDY ON BEHAVIOR OF CIRCULAR COLUMN WITH STIRRUPS DENSIFICATION

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Abstract - *A stirrup is a closed loop of reinforcement bar that is used to hold the main reinforcement has together in R.C.C column. Stirrups are placed diagonally and often vertically as well. This is done to prevent shear failure which is usually diagonal incase of cracks in beam. The top and bottom of the spacing of lateral ties were reduced to enhance the confinement pressure and thus prevent the early crushing of the ends. The effect of stirrups on the behavior of building is a great concern. This thesis deals with a finite element investigation for stirrup densification at top and bottom of column and behavior along the height of column on ultimate capacity of circular reinforced concrete columns (diameter 200mm) with different slenderness ratio. For an existing high rise buildings, within the limit, how can we increase the load carrying capacity with based on the stirrup densification factor*

***KeyWords*: Stirrups, Densification, (RC) columns, Slenderness ratio, Load capacity**

1. INTRODUCTION

The parameters that affect columns behaviors depend on stirrups form and spacing, steel bar diameter, cross-section of the column, concrete quality, percentage of longitudinal bar reinforcement, slenderness ratio and other parameters. From previous parameters slenderness ratio becomes an important factor to be considered in design of columns. The present study deals with the effect of stirrups densification at top and bottom of columns on rectangular and circular columns subjected to lateral loads in addition to axial loads, with different slenderness ratio tested under axial loads.

Stirrups are elements that are used in columns and beams as transverse reinforcement and as a means to provide strength against shear forces. This means that the bending resistance of elements is increased. Moreover, they are used to improve ductility of densification and prevent buckling in longitudinal reinforcement. Various experimental studies about the use and arrangement of stirrups are available. According to the stirrup arrangement affects the system behavior under lateral loads; when arranged properly, stirrups improve the horizontal displacement capacity, ductility, energy consumption ability, and lateral load capacity of the system. With the densification of stirrups, the buckling length in columns and beams decreases and an instantaneous brittle failure is prevented.

1.1 OBJECTIVES

i) To simulate the effect of stirrups densification on the behavior of circular reinforced concrete (RC) columns with different slenderness ratio (λ).

ii) To determine of failure modes for circular columns with different stirrups densification.

1.2 SCOPE OF THE WORK

The effect of stirrups on the behavior of building is of great concern. Stirrups are placed at proper intervals to beam and column to prevent them from buckling. Also they protect R.C.C structures from collapsing during seismic activities. For an existing high rise buildings, within the limit, how can we increase the load carrying capacity with based on the stirrup densification factor. This project set out to investigate the behavior of circular reinforced columns with stirrup densification

2. FINITE ELEMENT ANALYSIS

2.1 GENERAL

The finite element models performed with numerical analysis usingANSYS16.0 predict strictly the analysis and discussion effective of stirrups densification in capacity and slenderness ratio for reinforced concrete columns. This parametric study depends on variation of percentage stirrups densification height at top and bottom of column to total column height=[Δ / h] (0%,20%,33% 50% and 100) as well as columns without stirrups densification at top and bottom with different slenderness ratio (λ)

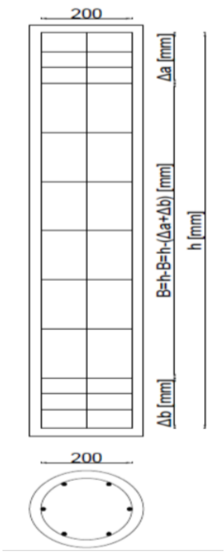


Fig-2.1: Show details of stirrups densification columns

h = Total column height(mm)

b= cross section width (mm)

t= Length of cross section column (mm)

Δ_a = Stirrups densification height at top of column (mm)

Δ_b= Stirrups densification height at bottom of column (mm)

Δ = Stirrups densification height at top and bottom of column (mm)

= [$\Delta_a + \Delta_b$]

Λ =Total column height / width of cross section column =[h /b]

2.2 METHODOLOGY

There are five main stages to model columns specimen:-
i. Defining element types, real constants, and material properties.
ii. Modelling the geometry of column specimens.
iii. Meshing the specimen geometry.
iv. Applying boundary conditions and loads on specimen.
v. Loading procedure and analysis of the results

2.2.1 MODEL OF CONCRETE

The concrete is modeled using hexahedral elements (SOLID 65) type with eight corner nodes having three translation degrees of freedom at each node. The Young's modulus for concrete was taken 31117 MPa and Poisson's ratio was taken to be (0.2). The stress- strain curve was defined for concrete element in "ANSYS" program with f_{cu}= 40MPa.

2.2.2MODEL OF LONGITUDINAL AND TRANSVERSE REINFORCEMENT STEEL ELEMENTS

The longitudinal and transverse steel is modelled using LINK180 element type. Both yielding and strain-hardening failure modes can be accounted. The yield stress, F_y = 415 MPa. The Young's modulus for reinforcement was taken 2.0 x 10^5 MPa and Poisson's ratio was taken to be (0.3).

2.2.3 APPLYING BOUNDARY CONDITIONS AND LOADS ON SPECIMEN

The boundary conditions were chosen to resembling the experimental conditions. This was done by restraining the horizontal translations of all base joints in the three directions

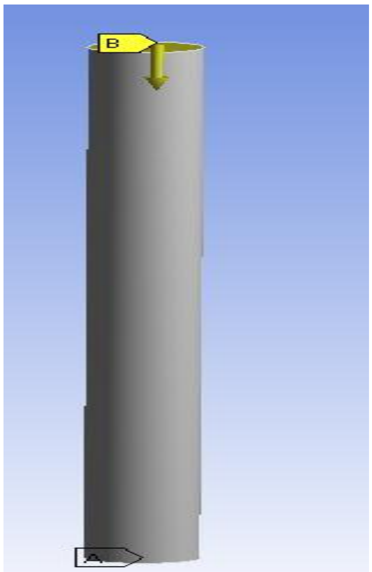


Fig-2.2: Specimen model and Boundary condition

3. RESULTS AND DISCUSSION

3.1 COLUMN – 0% H

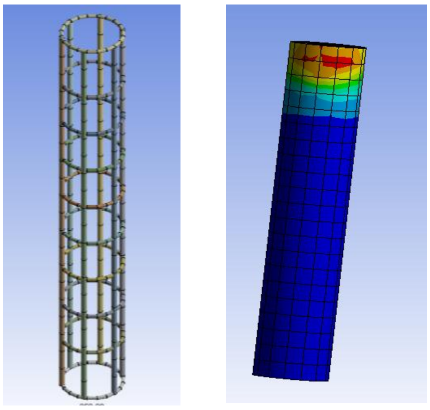


Fig-3.1: Deformation of columns(C1000)and the failure modes obtained from (FEA) for group 1 with no perentage of stirrup densification with slendernes ratio 5 .

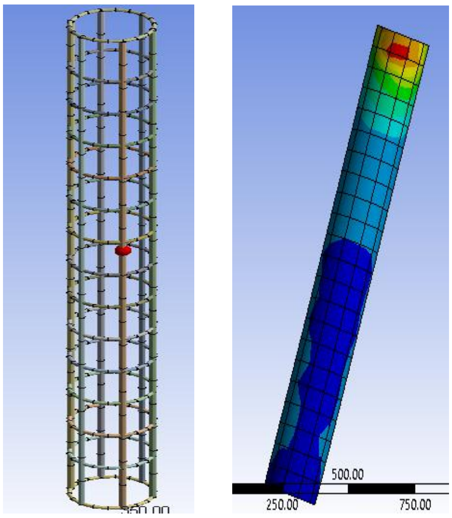


Fig-3.2: Deformation of columns(C1500,)and the failure modes obtained from (FEA) for group 1 with no perentage of stirrup densification with slendernes ratio 7.

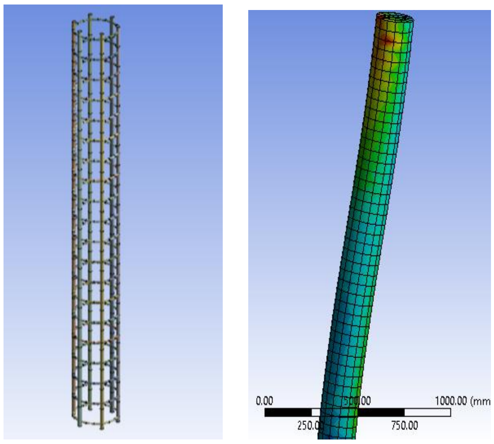


Fig-3.3: Deformation of columns(C2000,)and the failure modes obtained from (FEA) for group 1 with no perentage of stirrup densification and the slendernes ratio is 10

3.2 COLUMN -20%H

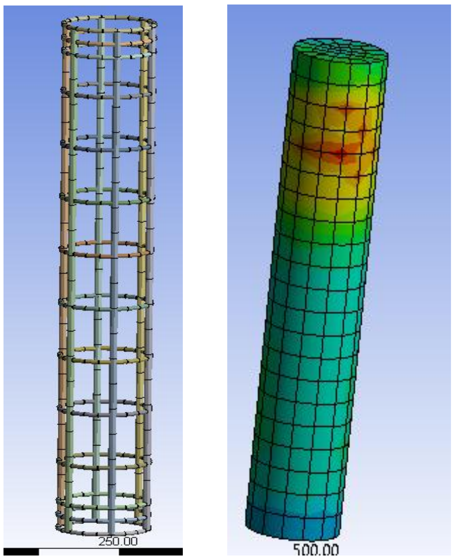


Fig-3.4: Deformation of columns(C1000)and the failure modes obtained from (FEA) for group 2 with 20% perentage of stirrup densification with slendernes ratio 5 .

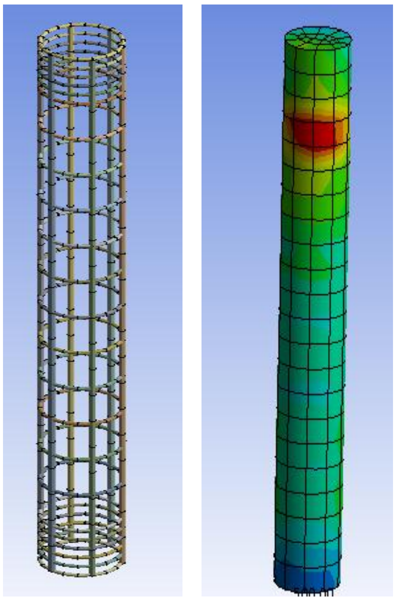
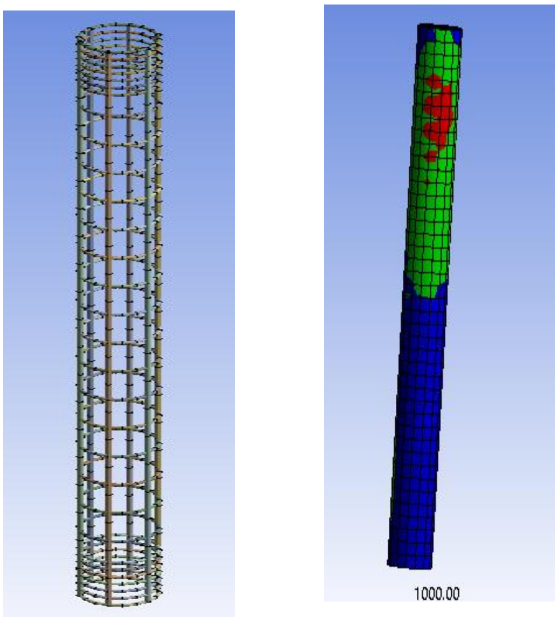


Fig-3.5: Deformation of columns(C1500)and the failure modes obtained from (FEA) for group 2 with 20% perentage of stirrup densification with slendernes ratio 7 .



Fi-3.6: Deformation of columns(C2000)and the failure modes obtained from (FEA) for group 2 with 20% perentage of stirrup densification with slendernes ratio 10.

3.3 COLUMN -33%H

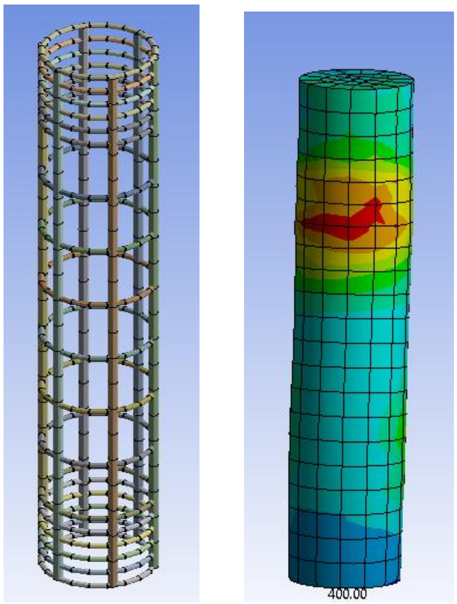


Fig-3.7: Deformation of columns(C1000)and the failure modes obtained from (FEA) for group 3with 33% perentage of stirrup densification with slendernes ratio 5

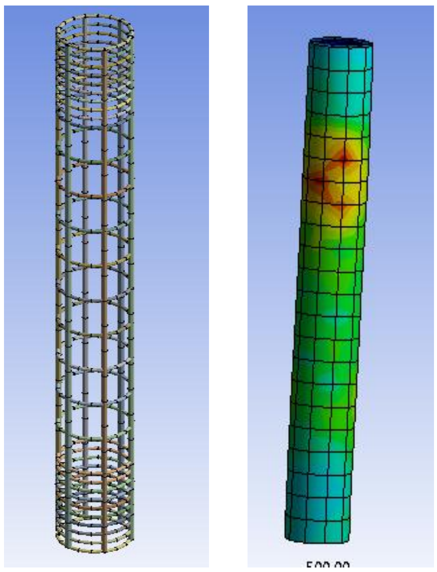


Fig-3.8: Deformation of columns(C1500)and the failure modes obtained from (FEA) for group 3 with 33% perentage of stirrup densification with slendernes ratio 7

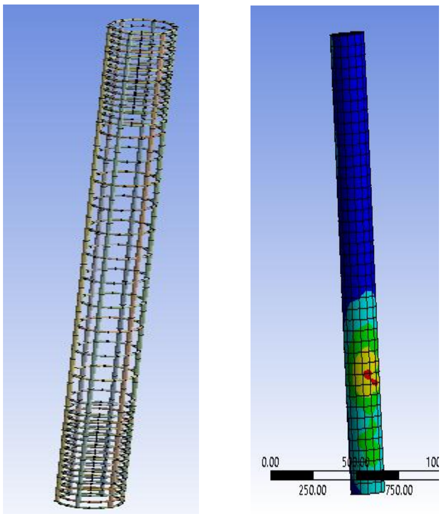


Fig-3.9: Deformation of columns(C2000)and the failure modes obtained from (FEA) for group 3 with 33% perentage of stirrup densification with slendernes ratio 10

3.4 COLUMN -50%H

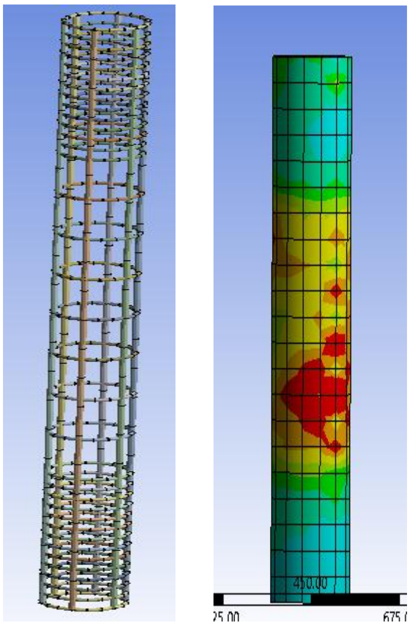


Fig-3.10: Deformation of columns(C1000)and the failure modes obtained from (FEA) for group 4 with 50% perentage of stirrup densification with slendernes ratio 5

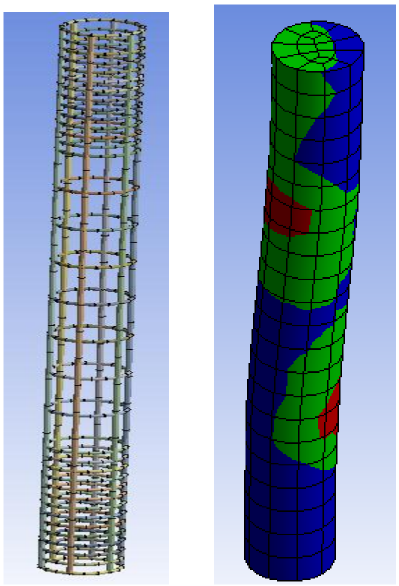


Fig-3.11: Deformation of columns(C1500)and the failure modes obtained from (FEA) for group 4 with 50% perentage of stirrup densification with slendernes ratio 7.5

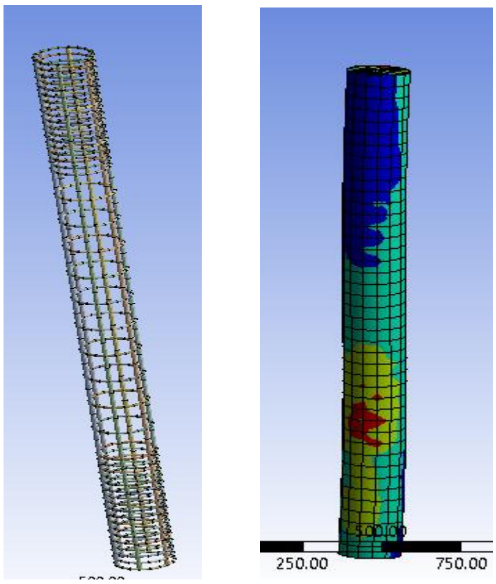


Fig-3.12: Deformation of columns(C2000)and the failure modes obtained from (FEA) for group 4 with 50% perentage of stirrup densification with slendernes ratio 10

3.6 DISCUSSION

Table-3: Failure loads from (FEA)for columns with variation in percentage of stirrups densification height / total column height

Grup No.	Column No.	Column dimensions		Slenderness ratio h/b	% of stirrups densification Height/total column height(%)	Failure load(FEA) (kN)
		dia (mm)	Height (mm)			
1	C1000	200	1000	5	-	1557
	C1500		1500	7.5		1467
	C2000		2000	10		1411
2	C1000-20%H	200	1000	5	20%	1569
	C1500-20%H		1500	7.5		1538
	C2000-20%H		2000	10		1435
3	C1000-33%H	200	1000	5	33%	1580
	C1500-33%H		1500	7.5		1560
	C2000-33%H		2000	10		1476
4	C1000-50%H	200	1000	5	50%	1595
	C1500-50%H		1500	7.5		1577
	C2000-50%H		2000	10		1483
5	C1000-100%	200	1000	5	100%	1744
	C1500-100%		1500	7.5		1657
	C2000-100%		2000	10		1526

Table.3 shows the failure load obtained for cirular columns with or without variation in perentage of stirrups densification at top and bottom of columns.

However an increase in the load carrying capacity is obtained with increasing percentage of stirrups densification height/total height. By increasing the load the stirrups started to yield and vertical crack appeared and propagated directly after to stirrups densification zone as well as the vertical reinforcement bars buckled.. From figures; it has been noticed generally, that cracked and/or crushed concrete were located directly after to stirrups densification obtained from (FEA)

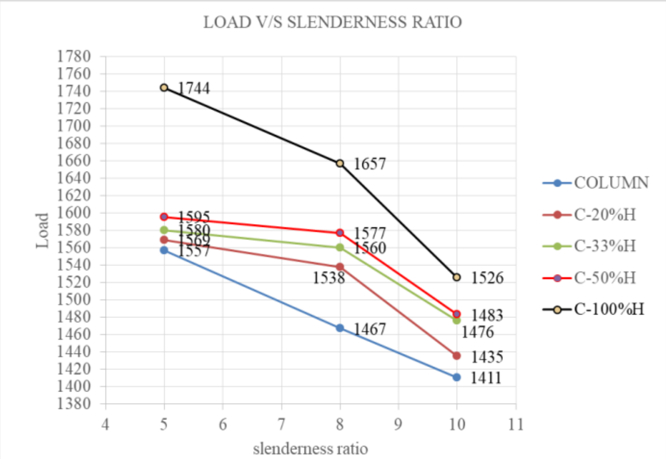


Chart-3.1: Loadv/s slenderness ratio

(chart 3) shows the relationship between failure load v/s slenderness ratio ,However, derease in the load carrying capacity is obtained with increasing slenderness ratio. Slenderness ratio is the ratio of the length of a column and the least radius of gyration of its cross section. More the slenderness ratio, more is the tendency of column to fail by buckling effect in that direction, a higher slenderness ratio means a lower critical stress that will cause buckling, conversely a lower slenderness ratio results in a higher critical stress (but still within the elastic range of the material). Column sections with large r-values are the more resistant to buckling

3.7 DISCUSSION

From the comparison graph studies, In the 20% densification at the top and bottom / total height, compared to middle zone stirrups densification, However the load carrying capacity is more at top and bottom/ total height. But coming to 33% densification, the long column turns to buckling effect and it will cause to the sudden fail of column. In 33% and 50% densification at top and bottom/ total height is not effective. To overcome the buckling failure, the middle zone densification is more effective. By which the load carrying capacity can be increased through the middle zone densification in long column

4. CONCLUSION

The present day deals with the effect of stirrups densification on ultimate capacity of circular reinforced concrete columns. From the study we obtained that the cracks and failure are located directly after to stirrups densification. However, an increase in the load carrying capacity from 8%-13% with respect to increasing percentage of stirrup densification height/ total column height. The effect of slenderness ratio is slightly effect on column carrying capacity with densification of stirrups at top and bottom of the column. The failure load decreases with increasing slenderness ratio. And also we can say that stirrups densification along the length of column is more active than stirrups densification at top and bottom of column

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