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Effect of confinement through MS Rings on Lateral Deformations of Circular RCC Columns Subjected to axial Compression Loads

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ABSTRACT
The metal confinement of RCC columns has been widely in use from long time like concrete-filled steel tube (CFST) columns etc. In this paper based on experimental work, it is aimed to improve the axial compression strength and lateral deformation characteristics of circular RCC columns confined by mild steel (MS) rings. The MS rings confined circular RCC columns were experimentally studied for different cases (i) varying % of column steel (ii) varying thickness of MS rings (iii) varying spacing of MS rings, in different column specimens. It was found that the ring confinement effectively improved the axial compressive load capacity of circular RCC columns and also helped in reducing lateral deformation of column specimens.

KEYWORDS
M-20, RCC, Circular column, Mild steel ring, Confinement.

INTRODUCTION

Confinement of the concrete had been an area of key interest of various researchers from long time. As it is prime objective of engineers to achieve higher strength from a particular given cross section, there have been many techniques [1] [6] which are being tried in this field.

As columns are the important part of building which becomes further more important during earthquake, therefore the circular RCC columns has been taken up in this experimental work. Instead of continuous confinement like tube confinement [4] [7], mild steel (MS) rings have been adopted as a confinement material.

Based on the earlier research for continuous confinement and confinement through cross ties, a guidance regarding selection of thickness of MS rings, and ratio (Length/Dia.) of column specimens has been adapted [2]. For the various percentages of vertical main steel bars in column, IS 456:2000 norms of minimum and maximum percentage of steel have been taken as guidance [3].

MATERIAL SPECIFICATIONS AND METHOD

(i) Material specification-

For the concrete mix used, the following specifications are followed -

1.Cement (OPC 43 Grade)

2.Sand-Narmada River sand

3.Coarse aggregate-Maxi. Size of aggregate is 12 mm.

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The mix M-20 grade is used for the work.

For column Reinforcement-Deformed reinforcing bars with yield strength (fy) of 415 Mpa are used. The three different cage categories used were 6 nos. of 8 mm dia., 10 mm dia. &12mm dia. Bars as vertical reinforcement (R/F) of column. Lateral ties of 8mm dia. deformed bars were at 130 mm c/c spacing.
For confinement Mild steel rings (Fy 250 Mpa) of different thicknesses (3 mm and 4 mm) & of 15 mm width are used in the work.

(ii) METHOD-

The R.C. concrete circular column specimens of 150 mm dia. and 300 mm height were prepared [1]. Total 45 no. of specimens were prepared for M-20 grade of concrete. The different variables were-
(i) Ring thickness (3 mm and 4 mm) [5]
(ii) Different % of steel-The three categories of cages were binded. As per recommendations of IS 456 minimum, 6 bars were used in circular column specimens. In CAGE CATEGORY I main vertical R/F as 6 nos. of 8 mm dia. Bars, in CAGE CATEGORY II main vertical R/F as 6 nos. of 10 mm dia. Bars, in CAGE CATEGORY III main vertical R/F as 6 nos. of 12mm dia. Bars. (These represent different % of steel in column specimens.)
(iii) Different spacing between Mild steel rings-Two types of spacing are used.2 rings at 130 mm spacing and 3 rings at 100mm spacing are used in 300 mm high specimens.
Default Specimens i.e. specimens without confinement were also cast. For each of variable three specimens were prepared. These specimens are tested under axial compression loading.

NOMENCLATURE SYSTEM

In the nomenclature system first two digits are used for grade of concrete i.e. 20.After' – ', Next digit shows cage categorization by indicating dia. of reinforcing column bars i.e.8, 10 and 12 mm.

Next digit shows confining MS ring thickness (in case of default specimens it will be 0, indicating specimen without confinement).Next digit indicates the no. of MS rings used as confinement in the specimens.

For example 20-8-0 indicates M-20 grade concrete specimens carrying 8 mm dia. column bars and without MS rings confinement. And 20-12-3-2 indicates M-20 grade concrete specimens carrying 12mm dia. column bars and with 3 mm thick MS rings 2 in nos. as confinement.

RESULT & DISCUSSION

The several observations were recorded for different specimens. For the specified categories, the observations are averaged for all the three specimens in the category.

FIG 1.TESTING OF SPECIMEN

FIG 2.TESTED SPECIMEN

The average of the three specimens in each category has been mentioned in Table 1.

The load at collapse was recorded as ultimate load. Corresponding lateral deformations were also recorded, as mentioned in Table 1.

The observations for different specimens are grouped as below-

TABLE 1. Ultimate load and Lateral deformation

Sample Type	P (Ultimate Load) in kN	Lateral Deformation in mm	Ratio (LD^S/ LD^{UC})
20-8-0	160	1.5	1.0
20-8-3-2	477	1.45	0.967
20-8-3-3	509	1.42	0.947
20-8-4-2	503	1.16	0.773
20-8-4-3	576	1.12	0.747
20-10-0	207	1.14	1.0
20-10-3-2	356	1.12	0.982
20-10-3-3	426	1.11	0.974
20-10-4-2	401	1.08	0.947
20-10-4-3	429	1.06	0.93
20-12-0	277	1.42	1.0
20-12-3-2	339	1.28	0.901
20-12-3-3	388	1.19	0.838
20-12-4-2	433	1.23	0.866
20-12-4-3	452	1.21	0.852

LD^S =Lateral Deformation of specimen (confined),

LD^{UC}=Lateral Deformation of unconfined specimen

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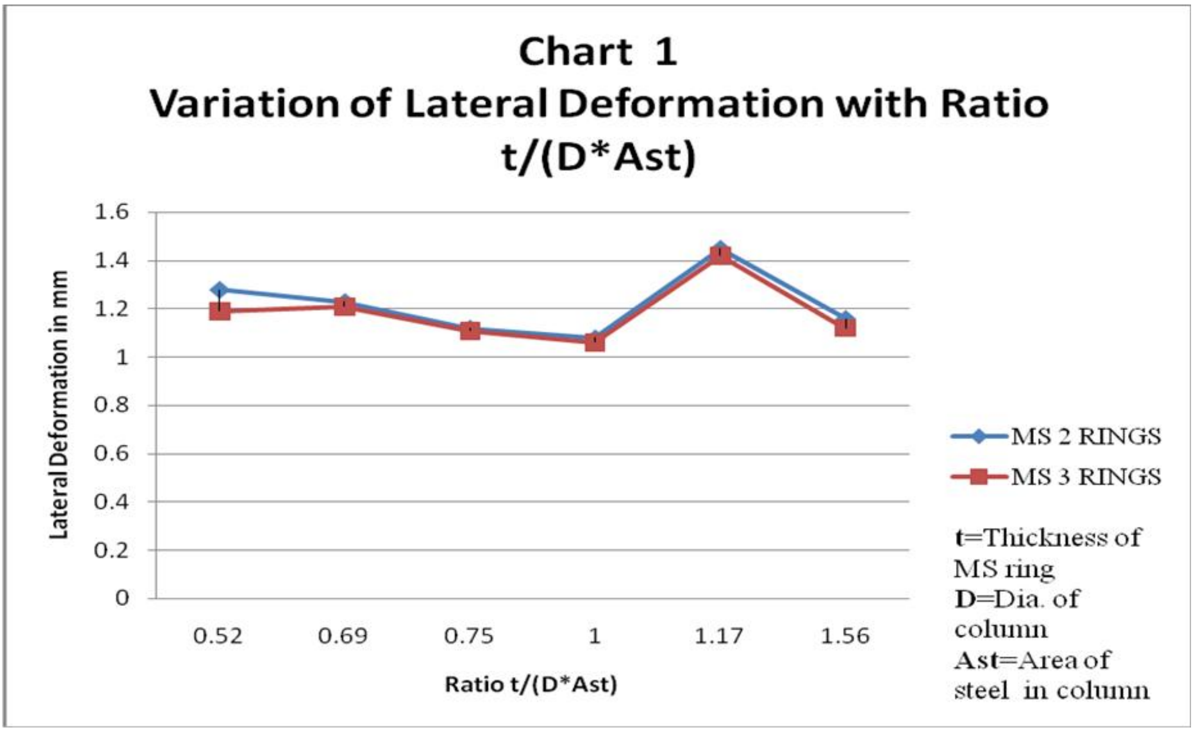

CONCLUSION

Based on the above observation and results, the following conclusions are drawn-

1. The confinement through rings helps effectively in reducing lateral deformation even with the sizable increase in ultimate load. It increases axial load capacity of columns also.
2. Generally, as spacing of MS rings decreases the lateral deformation also decreases.
3. As thickness of MS rings increases from 3 mm to 4 mm, the lateral deformation decreases.
4. The Ratio t/ (D*Ast) is found to be of great importance in the study of this confinement system.
5. As Ratio t/ (D*Ast) in columns reaches 1.56, it is observed that there is sizable reduction of lateral deformation.

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