Effect of MS Rings' Confinement on Lateral Deformations of M 25 Grade Circular RCC Columns under Axial Compression Loads

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Abstract: Confinement has been always a key concern area for researchers in present and in past also. The metal confinement of RCC columns has been extensively used from long time like concrete-filled steel tube (CFST) columns etc. In the present work mild steel rings have been used as confining material. 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. Total 45 nos. of specimen of size 150 mm dia. and 300 mm height were prepared during the experimental work. These specimen were tested and results were analyzed.These MS rings confined circular RCC columns of M 25 grade concrete were experimentally studied for different variables like (i) % of column main vertical steel bars (ii) thickness of MS rings (iii) spacing of MS rings. It was found that the MS ring confinement effectively helped in reducing lateral deformation of circular RCC column specimen resulting in improved axial compressive load capacity of circular RCC columns also. As MS rings are made up of conventional material i.e. mild steel pipes, the technique has a vast application area. In rural part of India this technique can be conviniently used for the efficient confinement of RCC columns.

Keywords : RCC, M-25, Circular column, Confinement, Mild steel ring.

I. INTRODUCTION

Confinement of RCC works is a vast area of research from long time. It has been an objective to get maximum strength using lesser resources i.e. to have an economical solution of an engineering problem. There are many confining techniques which are developed to achieve effective confinement of concrete. [1] [6] In RCC structures, its frame is of vital importance during earthquake. The beams and columns constitute important parts of frame. Because of their importance a lot of research work on confinement of these elements like tube confinement [4] [7] has been done .In the present work MS rings have been adopted as a confinement media. Broader Guide lines for selection of thicknesses of MS rings, and (Length/Dia.) ratios of column specimens has been referred from earlier researches on continuous confinement and confinement by cross ties [2]. While selecting the various percentages of vertical main steel bars in column, IS 456:2000 clauses for minimum and maximum percentage of steel have been referred [3].

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II. METHODOLOGY

In the experimental work, total 45 nos. of RCC circular column specimen were prepared covering all the variables(for each variable 3 samples) which were the parts of the study.The specimen were cast as per the material specifications mentioned as below-

A. Material Specifications

(a) Concrete-

The constituent materials of M 25 concrete were of the following specifications –

1.Cement (OPC 43 Grade)
2.Sand-Narmada River sand
3.Coarse aggregate-Maxi. Size of aggregate is 12 mm.
4. Water –Narmada River water (which is supplied for drinking)

(b) Reinforcement-

For column's main vertical bars and lateral ties; deformed HYSD reinforcing bars of yield strength (fy) of 415 Mpa were used. The different reinforcement cage categories selected were (i) 6 nos. of 8 mm dia., (ii) 6 nos. of 10 mm dia. & (iii) 6 nos. of 12mm dia. bars as main vertical bars of column. 8mm dia. deformed HYSD bars at 130 mm c/c spacing were used as Lateral ties.

(c) MS rings-

15 mm wide rings of Mild steel (Fy 250 Mpa) of 3 mm and 4 mm thicknesses were used in the work.

B. METHOD

The RCC circular column specimens of size 150 mm dia. and 300 mm height of M 25 grade of concrete were prepared [1]. Default Specimens i.e. specimens without confinement were cast first. In the work; different variables adopted were-

(i) Different Ring thicknesses i.e. 3 mm and 4 mm [5]
(ii) Different % of steel- Three categories of cages were used while making specimens. As recommended in IS 456; minimum 6 bars were used in circular column specimens. Three cage categories were used in the work (these represented different % of steel).In CAGE CATEGORY I; 6 nos. of 8 mm dia. main vertical bars, in CAGE CATEGORY II ;6 nos. of 10 mm dia. main vertical bars, in CAGE CATEGORY III ;6 nos. of 12mm dia. main vertical bars were used.

(iii) Intermediate spacing between Mild steel rings-Two types of spacing were used.2 rings at 130 mm spacing and 3 rings at 100mm spacing were used in 300 mm high specimens.

For each of variables; three specimens were prepared. Total 45 no. of specimens were prepared. These specimens were tested under axial compression loading.

III. NOMENCLATURE SYSTEM

As large number of samples were prepared so it was necessary to adopt a proper nomenclature system so as to specify each and every specimen category. The nomenclature system followed the format 'Grade of concrete—Main bar dia.—thickness of confining ring --- Nos. of MS rings'. First two digits are used for grade of concrete i.e. 25. Next digit stands for dia. of main vertical reinforcing column bars i.e.8, 10 and 12 mm.

Next digit stands for thicknesses of confining MS ring confinement (in case of default specimens it will be 0, specifying that specimen bears NO confinement. 3 mm and 4 mm thicknesses were indicated by 3 & 4; only as per the case .Last digit indicates the no. of MS rings used as confinement in the specimens.

For example 25-8-0 represents specimens of M-25 grade concrete carrying 8 mm dia. column bars and carrying NO MS rings confinement. In similar way 25-10-3-3 indicates M-25 grade concrete specimens carrying 10mm dia. column bars and with 3 mm thick MS rings 3 in nos. as confinement.

IV. RESULTS AND DISCUSSIONS

The 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

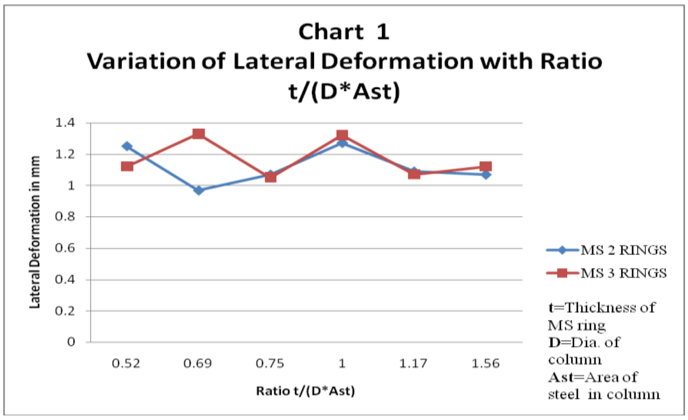
The average value of observations of each category has been specified in Table 1.

As mentioned in Table 1 below; for collapse loads corresponding lateral deformations were recorded-

Table 1. Lateral deformation (M 25 Conc. Grade)

S.No.	Sample Type	Lateral Deformation in mm	Ratio (LD^S/ LD^{UC})
1	25-8-0	1.24	1
2	25-8-3-2	1.09	0.88
3	25-8-3-3	1.07	0.86
4	25-8-4-2	1.07	0.86
5	25-8-4-3	1.12	0.9
6	25-10-0	1.18	1
7	25-10-3-2	1.07	0.91
8	25-10-3-3	1.05	0.89
9	25-10-4-2	1.21	1.02
10	25-10-4-3	1.32	1.12
11	25-12-0	1.32	1
12	25-12-3-2	1.25	0.95
13	25-12-3-3	1.12	0.85
14	25-12-4-2	0.97	0.74
15	25-12-4-3	1.33	1.01

LD^S =Lateral Deformation of specimen (confined),
LD^{UC}=Lateral Deformation of unconfined specimen



V. CONCLUSIONS

Based on experimental results & their analysis, the following conclusions are drawn-

1. The MS rings' confinement helps effectively in reducing lateral deformation along with the sizable increase in ultimate load. Thereby it helped in increasing axial load capacity of columns.
2. As lateral deformations were reduced alongwith increase in ultimate axial load ; it indicated increase in energy absorption capacity of specimen.This may lead to better performance of confined columns during lateral load incidences.
3. Generally, as spacing of MS rings (3 mm thickness) decreases; the lateral deformation also decreases.
4. The Ratio t/ (D*Ast) is of great importance in the study of the MS Rings confinement system.
5. As Ratio t/ (D*Ast) in columns is within 0.52 to 0.73, it is observed that there is appreciable effect of spacing of rings on lateral deformation.
6. As Ratio t/ (D*Ast) in columns crosses values above 0.73, it is observed that there is no appreciable effect spacing of rings on lateral deformation.

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