EXPERIMENTAL STUDY ON BEHAVIOUR OF EXTERNALLY CONFINED CIRCULAR COLUMNUSING M25 GRADE CONCRETE

S.Vallinayaki[1], I.Mohanpriya[1], S.Gouri[1], S.Kalaiselvi[2], Dr.K.Jagadeesan[3]

[1]UG STUDENT, [2]ASSISTANT PROFESSOR, [3] PROFESSOR

DEPARTMENT OF CIVIL ENGINEERING

SONA COLLEGE OF TECHNOLOGY, SALEM-636005

---***---

Abstract *This paper presents the study on the effectiveness of confined circular concrete column using M-Sand with and without external links under axial compression. M_{25} grade concrete mix design proportioning was carried out as per IS 10262:2009 Codal provisions. Three confined column specimens of M_{25} grade concrete, each of column height 500mm but having different diameters of confining PVC pipe,viz., 110mm, 140mm and 160mm, were cast and used in this investigation. The load carrying capacity of the column specimens were tested using universal testing machine. Load carrying capacity and energy absorption capacity were determined. The mode of failure was investigated.*

Keywords:Confinement, Manufactured sand, Load carrying capacity, Energy absorption capacity

1. INTRODUCTION

Instead of river sand we used manufactured sand as fine aggregate in the preparation of composite concrete. H.Toutanji and M.Saafi [1]reported a stress strain behavior of concrete columns confined with hybrid composite materials which considerably increases the ultimate compressive strength, ductility and energy absorption capacity of columns. P.K. Gupta, S.M. Sarda and M.S. Kumar [2] presented the effects of diameter and D/t ratio of steel tube, grade of concrete and volume of fly ash in concrete. A nonlinear finite element model was developed to validate experimental and computational results of load deformation. It was found that load carrying capacity decreased with the increase in %volume of fly ash up to 20% and increased at 25% of fly ash volume in concrete.Qing Quan Liang [3] proposed a new design formula to predict ultimate strength and behaviour of axially loaded circular CFST columns.Manojkumar V. Chitawadagi [4] evaluated the column strengths using existing design codes. V. Chitawadagi [5] reported a linear regression models to predict the ultimate axial load and the axial shortening at ultimate point.Pramod Kumar Gupta, Virendra Kumar Vermapresented a detailed investigation on reinforced concrete–filled unplasticized poly-vinyl chloride tubular specimens when it is exposed to sea water showed no change in strength and ductility.Y.Ouyang.A.K.H [6] presented the plastic behaviour of the steel tube and interaction at the concrete-steel tube interface to evaluate the confining stress field.C.X.Dong, A.K.H.K wan, J.C.M..Ho[8] proposed a formula to determine the minimum confining stiffness to avoid delamination, to predict yield strength and ultimate strength.

Experimental programme

Materials

Ordinary Portland cement having a initial setting time of 29 minutes was used in the casting of specimens. Manufactured sand having a specific gravity of 2.66 and fineness modulus of 2.92 was used. Coarse aggregate of maximum size 20 mm and specific gravity of 2.87 and fineness modulus of 7.35 was used. Potable water was used for the concrete preparation and for the curing of specimens. Mix ratio of 1:1.43:2.74 with a w/c ratio of 0.43 was adopted. Columns were confined with PVC tube with and without External confinement. The mix proportions and the compressive strength at 28days are given in Table 2.

Table 1Concrete mix proportions

Grade of mix	Water/cement ratio	cement kg/m³	Manufactured sand kg/m³	Coarse aggregate kg/m³	Water (lit)	Compressive strength at 28days (MPa)
M25	0.43	450	642	1231	192	43.75

Table 2 Details of test specimens

Description of specimen	D/t Ratio	D x t x L mm
T110M25S1	27.5	110 x4x500
T110M25S2	27.5	110 x 4 x500
T110M25S3	27.5	110 x 4 x500
T140M25S1	35	140 x 4 x 500
T140M25S2	35	140 x 4 x 500
T140M25S3	35	140 x 4 x 500
T160M25S1	40	160 x 4 x 500
T160M25S2	40	160 x 4 x 500
T160M25S3	40	160 X 4 x 500

(a) Labeling

The test specimens were cast and designated according to the diameter of column, PVC tube confinement with and without external links and spacing of external links. For example, the designation "T110M25S1" T110 stands for PVC tube of 110 mm external diameter, M25 stands for grade of concrete.

S1- stands for column specimen with PVC confinement.

S2- stands for PVC tube confined column specimen with provision of external links at top and bottom portion of column.

S3- stands for PVC tube confined column specimen with provision of socket at bottom portion of column.

The details of column specimens are presented in Table 2 and their images appear in Figure1.

Figure 1 Images of column specimens.

Testing of specimens

Nine specimens with the outer diameters of 110mm, 140mm and 160mm having a length of 500mm. The thickness of PVC tube is 4mm. Specimens are designated as T110M25S1. T110 stands for PVC tube of 110mm diameter, M_{25} stands for grade of concrete, S1 stands for PVCtube as external confinement, S2 stands for PVC tube as external confinement with external links provided at top and bottom of the column specimen. S3 stands for column with PVC tube as external confinement with the provision of bottomsocket. Columns were tested using universal testing machine.

Experimental results and discussion

Mode of failure

Column confined with PVC tube as external confinement exhibits shear mode of failure. In the case of S2specimen circular steel links are provided as external confinement along with PVC tube. External link for 110 mm diameter specimen (3 rings), 140 mm diameter specimens (4 rings), and 160 mm diameter specimens (4 rings) provided at the top and bottom of the specimen. Provision of external link reduces the axial compression. S2 specimen and S3 specimen shows better improvement in load carrying capacity, energy absorption capacity and ductility due to the provision of the external link and PVC tube confinement.

Figure 2 Typical failure mode of 110 mm diameter specimens

Figure 3 Typical Failure modes of 140 mm diameter specimens

Figure 4 Typical Failure modes of 160 mm diameter specimens

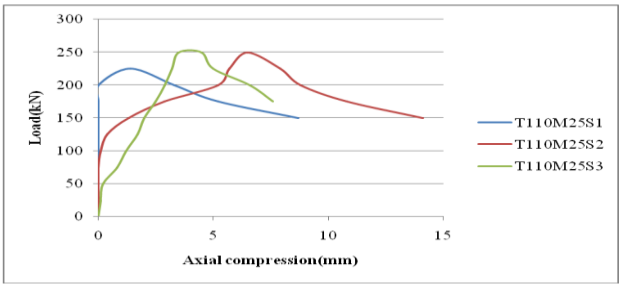

Figure5 Comparison of load compression curve for 110mm diameter specimen

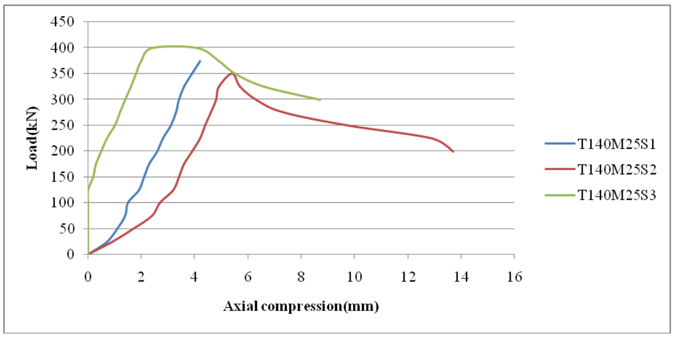

Figure6 Comparison of load compression curve for 140mm diameter specimen

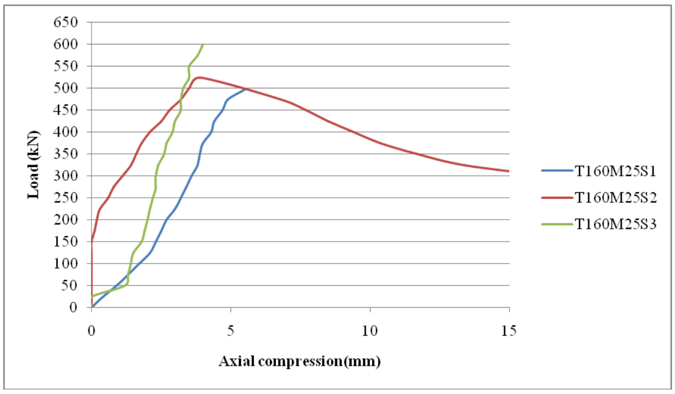

Figure 7 Comparison of load compression curve for 160mm diameter specimen

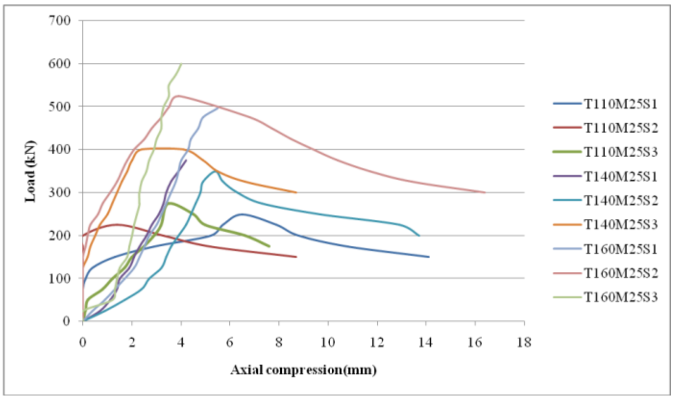

Figure 8 Comparison of load compression curve for 110mm, 140mm and 160mm diameter specimen

Energy absorption capacity

The energy absorption capacity is determined by calculating the area under load compression curve. The confinement effect can be assessed based on the energy absorption capacity and ductility of the specimens. Theenergy absorption capacity is shown in Table 3. From Table 3 it is clear that the energy absorption capacity increases by the provision of PVC tube composite system along with external link.

Table 3 Experimental results

S.NO	Description of specimen	Ultimate load (kN) (with external link)	Axial compression (mm)	Energy absorption capacity
1.	T110M25S1	243.3	9.9	618.4025
2.	T110M25S2	260.45	7.1	1862.23
3.	T110M25S3	271.45	9.4	2287.775
4.	T140M25S1	361.95	18.6	948.31
5.	T140M25S2	391.6	4.9	2841.25
6.	T140M25S3	416.45	10.9	4132.4125
7.	T160M25S1	496.8	6.3	1252.79
8.	T160M25S2	541.45	16.5	8167.385
9.	T160M25S3	616.25	15.9	8234.1875

Conclusions

Based on the test results the following conclusions are drawn.Provision of PVC tube in concrete column as external confinement shows better energy absorption capacity and load carrying capacity.In the case of S2 specimen provision of external link as confinement in concrete column increases load carrying capacity, energy absorption capacity.Load carrying capacity, energy absorption capacity of S2 specimen and S3 specimen increased considerably compared to S1 specimen.Column with PVC tube, external links, and socket arrangement as external confinement shows better ductility.Shear mode of failure was observed for S1, S2 and S3 specimens.

References

[1] H. Toutanji, M. Saafi (July 2001) stress-strain beahviour of concrete columns confined with hybrid composite materials, materials and structures(35):338-347.

[2] P. K. Gupta, S. M. Sarda, M.S. Kumar (February 2007) Experimental and computational study of concrete filled steel tubular columns under axial loads, Journal of constructional steel research 63: 182-193.

[3] Qing Quan Liang (December 2009) Nonlinear analysis of circular concrete-filled steel tubular short columns under axial loading, Journal of constructional steel research 65: 2186-2196.

[4] Manojkumar V. Chitawadagi (October 2010) Axial strength of circular concrete-filled steel tube columns-DOE approach, Journal of constructional steel research 66: 1248-1260.

[5] Manojkumar V. Chitawadagi (April 2010) Axial capacity of rectangular concrete-filled steel tube columns – DOE approach, Construction and Building Materials 24:(585-595)

[6] Pramod Kumar Gupta, Virendra Kumar Verma (December 2014) Study of concrete-filled unplasticized poly-vinyl chloride tubes in marine environment,SAGE Journals

[7] Y. Ouyang.A.K.H (2017) Finite element analysis of square concrete-filled steel tube (CFST) columns under axial compressive load, Engineering structures 156:(443-459)

[8] C.X.Dong, A. K. H. Kwan, J. C. M. .Ho (2017) Effects of external confinement on structural performance of concrete-filled steel tubes.

[9] BIS:10262:2009 Recommended guide lines for concrete mix design. Bureau of Indian Standards, New Delhi, India.