Scientific Journal of Impact Factor (SJIF) : 3.134

ISSN (Print) : 2348-6406
ISSN (Online): 2348-4470

International Journal of Advance Engineering and Research Development

Volume 1, Issue 11, November -2014

Cyclic Behaviour Of Double Skinned Concrete In-filled Beam-Column With Outer Cold Formed Square section and Inner PVC Circular Sections

Joshi P John[1],Dr. Joanna P S[2], Parvati T S[3], Eapen sakaria[4]

[1]PG Scholar Department of Civil Engineering, Saintgits college of Engineering, Kottayam Kerala, India, joshipjohnn@gmail.com
Professor, Department of Civil Engineering, Hindustan Institute of Technology and Science Chennai, Tamil Nadu, India
[3] P-hD Scholar, Department of Civil Engineering, Hindustan Institute of Technology and Science Chennai, Tamil Nadu, India
[4]Head, Department of Civil Engineering, Saintgits College of Engineering, Kottayam, Kerala, India

Abstract *—Study is done to compare the lateral load capacity, ductility and weight of double skinned light gauge in filled column with outer square and inner PVC section and concrete filled light gauge steel tubes. The test is done with the help of lateral load testing frame. The reversed lateral loads have to establish so that the frames experiences substantial inelastic deformation in tension and compression in the presence of axial compressive loads. Specimens are in filled with M30 grade concrete. Four specimens are tested, out of two are control specimen and rest two are testing specimens. Control specimens are those with concrete filled light gauge steel tubes and test specimens are double skinned light gauge concrete in filled column. Height of the column are 1000mm and of 100mm×100mm size. Based on the test results lateral load capacity of test specimen increased by 10.6% compare to control specimen, ductility increased by 13.77% compare to control specimen and weight decreased by 16.07% compare to control specimen. So the double skinned light gauge sections are more economical ad can be effectively use in seismic regions due its improved characteristics.*

Keywords*-Cold- formed column-beam, Double-skinned column-beam, In-filled concrete column-beam, Light-gauge double skinned column-beam.*

I. INTRODUCTION

Cold-formed steel (CFS) is the common term for products made by rolling or pressing thin gauges of sheet steel into goods. Cold-formed rectangular steel tubular columns have become popular in seismic regions, especially for high-rise structures. Tubes are very efficient compression members due to their larger radius of gyration and resistance to local stresses. Closed shapes also provide greater torsional strength and stiffness. In spite of having these advantages, tubes are susceptible to early cracking, which causes subsequent loss of ductility and strength. Preventing severe local buckling is the key to preventing early fractures. Review of past studies on concrete-filled columns provides the clue that concrete filling might be an effective way to delay or prevent early cracking caused by severe local buckling. Also the reduced weight of light gauge sections provide a reduction in the weight of each structural members and thereby reducing the overall weight of the structure which is highly adaptable in seismic regions.

II. EXPERIMENTAL INVESTIGATION

2.1 General

This experimental study deals with the behaviour of double skinned with outer light gauge steel section and inner PVC section in-filled with fly-ash concrete under variable reversed lateral loading and constant axial load and compare that with light gauge steel beam-column sections fully filled with concrete.

2.2 Experimental program

Two numbers of double skinned beam-column with outer light gauge steel section and inner PVC section in-filled with fly ash concrete and control specimens were tested in the reversed lateral load testing frame. Fly ash concrete with 40% cement was used in the investigation. The height of the column was 1000mm and of 100mm x 100mm size in all sections. Inner diameter of the PVC section tube is 50 mm The details of the specimens tested are given in Table 1. Columns were in-filled with M30 grade concrete. Same test procedure is conducted on control specimens also (concrete in-filled box section). The specimens were designed and detailed as per and IS801:1975.

2.3 Casting Of Specimens

The columns were cast with Light gauge steel sections conforming to IS801:1975 was used. The Specific gravity of the cement was used 3.08.River sand passing through 4.75mm IS sieve conforming to IS: 383 was used and having fineness modulus of 2.18 and Specific gravity of 2.71 was used as fine aggregate. The Coarse aggregate from Crushed granite stones of size 10mm & 20mm, conforming to IS: 383 were used. The fineness modulus and specific gravity of coarse aggregate used were 2.76 and 2.75 respectively.

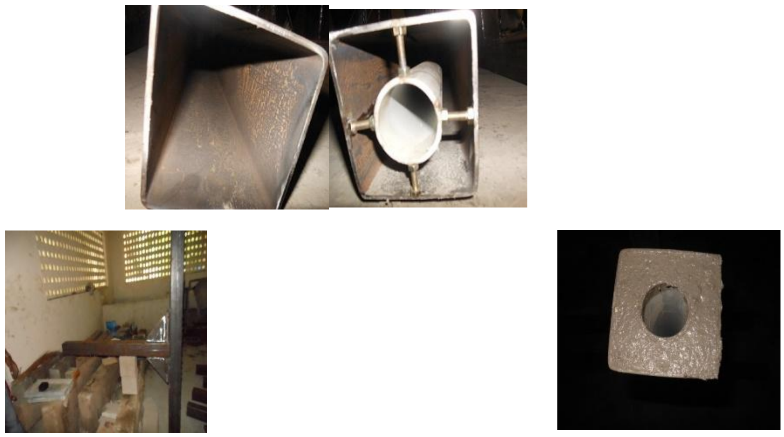


Figure 1. Casting of specimens

Table 1. Details Of The Beam-Columns Tested

Specimen	Beam sizes (mmxmm)	Inner tube diameter of column (mm)	Outertubeo f column (mmxmm)	Thickness of outer light gauge section (mm)
Control Specimen C1	100 x 100	-	100x100	3
Control Specimen C2	100 x 100	-	100x100	3
Test Specimen PVC1	100 x 100	50	100x100	3
Test Specimen PVC2	100 x 100	50	100x100	3

2.4 Test Set-Up

The test set-up consist of a reaction frame, a hydraulic actuator of capacity 200 kN laterally with a stroke length of ± 100 mm, loading frame with hydraulic jack of 160 KN to apply loads axially to test specimens using steel rollers.. A steel reaction frame was used to support the 200 kN actuator providing lateral load to the specimen. Instrumentation included linear variable differential transducers (LVDT) for lateral displacement measurement at the top of the column and one load cell attached to actuator was used for the measurement of reversed lateral loads. The vertical load was chosen to a design compression rate 40% of axial resistance found in the analysis. The experimental set-up is shown in Figure 2.

2.5 Loading

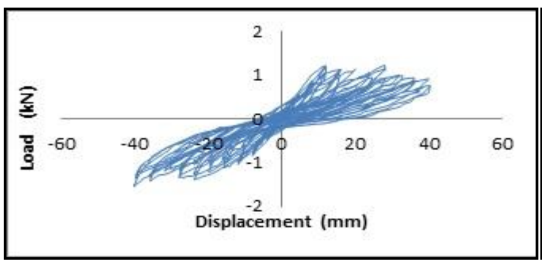
The specimen was mounted on the loading frame. A loading frame was used to apply a vertical constant axial load of 160KN through steel rollers placed with the support of steel plates in between the jack and column head and lateral loads were applied incrementally.

Figure 2. Test set-up

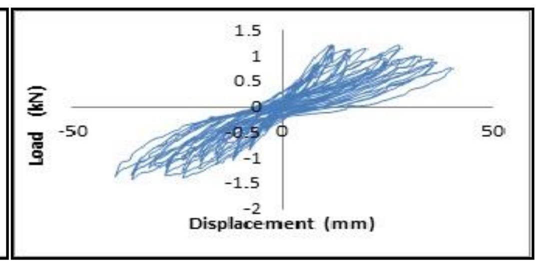
III. RESULTS AND DISCUSSIONS

3.1 Lateral Load Versus Lateral Displacement Curve

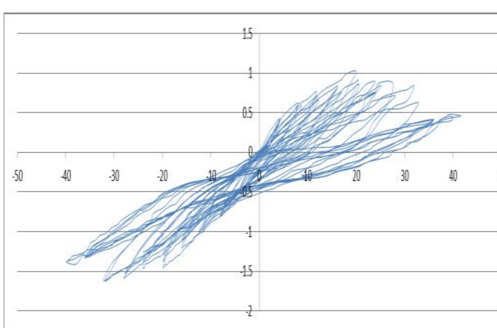
The control specimens without inner tubes C1 and C2 failed at an average lateral load of 14.6 kN with a lateral displacement of 37.85mm. The test specimens with inner tubes PVC1&PVC2 (in-filled with concrete and tested at 28days) and failed at an average load of 16.15kN with the corresponding displacement of 32.05mm.



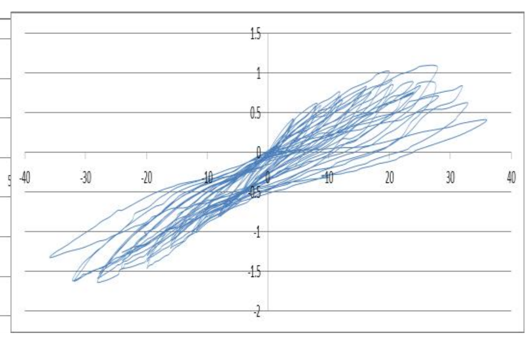
Specimen C1



Specimen C2



Specimen PVC1



Specimen PVC2

Figure 3. Load displacement curves for the test specimens (for specimens C1,C2,PVC1&PVC2 respectively)

From the hysteresis loops indicated, the maximum lateral load carried by the specimens series PVC1 and PVC2 (double skinned in-filled with concrete and tested at 28days) are significantly higher than that of the control specimens series C1 and C2. The average lateral load carrying capacity and the average maximum lateral displacement of the column of the specimens are compared with the control specimens and are shown in Figure 4. Table 2 shows the comparison on lateral load capacity and displacement among the specimens

Table 2. Comparison on lateral load capacity and displacement

Specimen	Load (kN)	Average Load(kN)	Lateral Displacement(mm)	Average Lateral Displacement (mm)
PVC1	16	16.15	31.9	32.05
PVC2	16.2		32.2	
C1	15	14.6	39.7	37.85
C2	14.2		36	

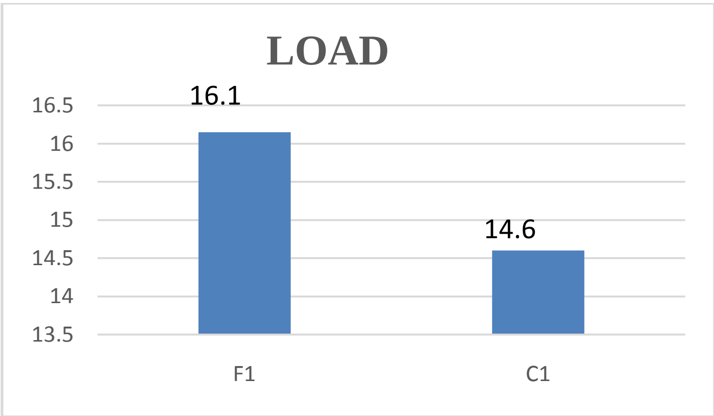


Figure 4. Comparison on lateral load capacity among the specimens

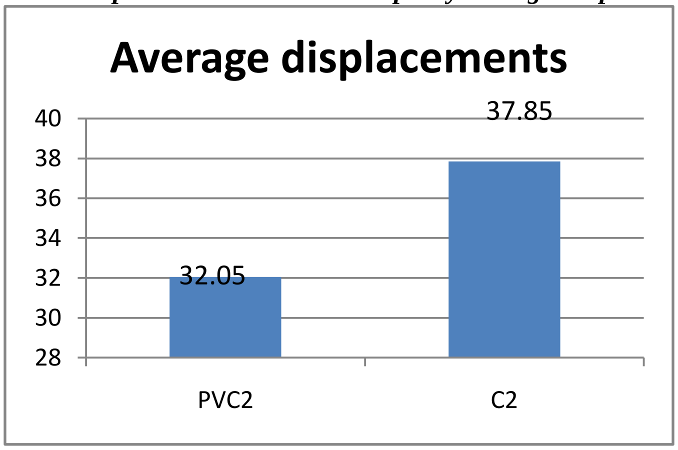


Figure 5.Comparison on maximum lateral displacement among the specimens

3.2 Ductility

Ductility is the property which allows the structure to undergo large deformation without losing its strength. It is the ratio of displacement at the failure to the displacement at yield point. The displacement at yield and failure of the specimens can be obtained from the peak lateral load versus lateral displacement curves of the corresponding specimens. The Table 3 shows the yield load and the failure load of the test specimens

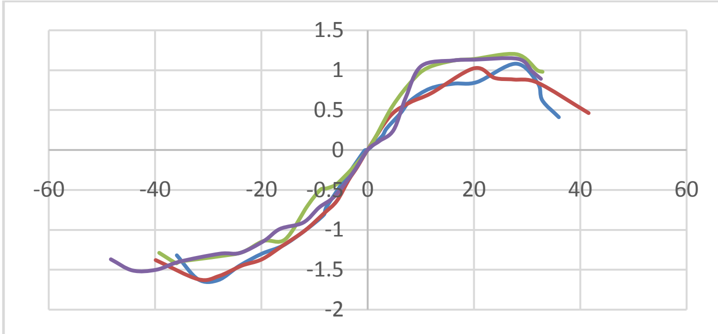


Figure 6. Comparison of peak lateral loads-lateral displacement of the specimens PVC1&PVC2 – Test Specimens C1 & C2- Control Specimens

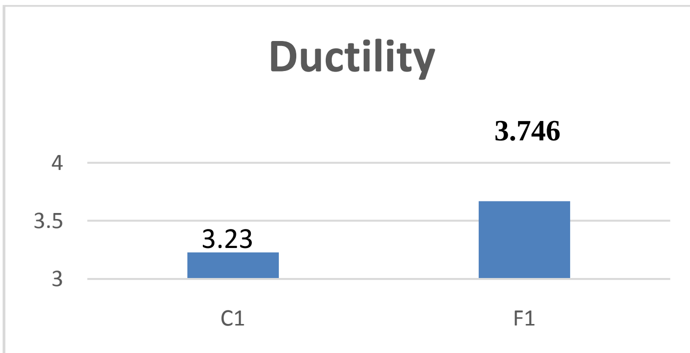


Figure 7. Comparison of ductility ratio with the specimens

It is observed that from Table 4, there is 13.77% increase in the average ductility ratio for the specimen series PVC1&PVC2. This shows that the specimens withinner tube have increased the ductility of the column in lateral loading. The specimen with double skinned infililled concrete and tested at 28days (PVC1&PVC2) has the highest ductility when compared to the controlled specimens.

Table 3. Ductility ratio of test specimens

Specimen Series	Yield Displacement(mm)	Ultimate Displacement (mm)	Ductility Ratio	Average Ductility Ratio	Percentage increase in ductility ratio,%
C1	12.1	39.7	3.28	3.23	--
C2	11.3	36	3.18		
PVC1	7.7	28.1	3.649	3.746	13.77
PVC2	8.3	31.9	3.843		

IV. CONCLUSIONS

Two experiments were conducted on double skinned light gauge sections and box sections with fly ash concrete respectively. The specimens were tested under constant axial load and varying lateral load and the following conclusions are drawn.

4.1 Lateral load Capacity of Specimens.

The lateral load carrying capacity of the specimens PVC1 and PVC2 with double skinned steel in filled concrete and tested at 28 days increases by 10.6% when compared with control specimens.

4.2 Ductility.

The Ductility of the specimens PVC1 and PVC2 with double skinned steel in filled concrete and tested at 28 days increases by 13.77% when compared with control specimens.

Experimental study on the behavior of double skinned light gauge steel sections with fly-ash concrete under reversed lateral loading and constant axial load were done. The test specimens were double skinned beam-column sections with outer light gauge and inner PVC section in filled with fly ash concrete. It is seen that ductility of specimen increased compare to control specimen.Hence the doubleskinned beam-column sections with outer light guage and inner PVC section could be effectively used in seismic regions.

V. REFERENCES

[1] Lin-Hai Han, Fei-Yu Liao, Zhong Tao(2011), Behavior and Calculations of Concrete-Filled Double Skin Steel Tubular (CFDST) Members
[2] N.Balasubramanian,R.B. Karthika and Dr.R.Thenmozhi (2011), Behavioural studies on hollow double skinned steel concrete composite columns.
[3] Min-Lang Lin and Keh- ChyuanTsa (2006), Mechanical behavior of double skinned composite steel tubular columns .
[4] T. Yu; J. G. Teng; and Y. L. Wong, April 1, (2010), Stress-Strain Behavior of Concrete in Hybrid FRP-Concrete-Steel Double-Skin Tubular Columns. This paper is part of the Journal of StructuralEngineering, Vol. 136, No. 4,
[5] J.G. TENG, Bing ZHANG ,Yu-Bo CAO, Tao YU (2012):Behaviour of Hybrid FRP-concrete-steel double-skin tubular Columns subjected to combined cyclic axial compression tests conducted by Sixth International Conference on FRP Composites in Civil Engineering (pp. 1-7). Rome, Italy:
[6] Togay Ozbakkaloglu1 and ButjeLoukFanggi (2013), Axial Compressive Behavior of FRP-Concrete-Steel Double-Skin Tubular Columns Made of Normal- and High-Strength Concrete.
[7] HanbinGe; and Tsutomu Usami(1996) Cyclic tests of concrete-filled steel Box columns.
[8] Kian Karimi, S.M.ASCE, Wael W. El- Dakhakhni, M.ASCE, and Michael J. Tai t(2011), Performance Enhancement of Steel Columns Using Concrete-Filled Composite Jackets .
[9] Brian Uy, Member, ASCE “Strength of concrete filled steel box columns incorporating local buckling” Journal of Structural Engineering, Vol. 126, No. 3, March, 2000.

