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Research Article

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Research significance: This Experimental program on composite columns is focused on the structural behaviours of circular Column with different slenderness ratio and hollow section ratios in order to obtain, Ductility of the member, load carrying capacity and flexural stiffness.

Required fresh properties of SCC include adequate flow ability, good passing and filling abilities and segregation resistance, which are achieved by properly proportioning the constituent materials and related admixtures. But only limited literature is available to evaluate the hardened behaviour of SCC members.

Here an attempt has been made to evaluate the properties of DSCFT and CFT columns in-filled with SCC under compression. The results should be of interest to engineers considering the use of such columns in various structural applications.

Practical use of DSCFT requires knowledge of the basic compressive behaviours of the concrete as well as knowledge of the interrelationship between stress and strain. The research discussed herein focuses on determining these basic behaviour's and defining the interrelationships.

Literature Review

Zhi-Wu et al. conducted an Experimental behaviour of circular concrete-filled steel tube stub columns. This paper presented on experimental study on behaviour of circular in-filled steel tube (CFT) stub columns with self-compacted concrete (NC) concentrically loaded in compression to failure. Seventeen specimens were tested to investigate the effects of concrete strength and different loading conditions on ultimate capacity and load—deformation behaviour of columns. Specimens with entire section loaded experience a significant increase in ultimate capacity, but their residual after failure is almost constant. Euro code 4 provides a good prediction of the ultimate capacities of the stub columns with SCC and NC when entire section was loaded [1].

Han et al. conducted an Experimental behaviour of thin walled hollow structural steel (HSS) columns filled with self-consolidating concrete. This experimental study is an attempt to study the possibility of using thin walled hollow square section (HSS) columns filled with SCC. 38 HSS columns filled with SCC to investigate the influence of concrete compaction methods on the member capacities of the composite columns are reported. The main parameters varied are column section type (circular and square), tube diameter-thickness ratio from 33-67, load eccentricity ratio from 0-0.3 mm. Comparisons are made with predicted column strength using existing codes. It was found that the features of the specimens with SCC compacted without any vibrators and compactors with hand were very similar [2].

Kuranos et al. conducted an experimental and theoretical program to evaluate the Behaviour of Hollow concrete Effect of stirrups on behaviour of Normal and High Strength Concrete Columns**.** Differences and similarities in behaviour of solid concrete and hollow composite members with different number of concrete core layers are discussed in this paper. Experimental investigations show that behaviour of hollow CFST elements is more complicated than that of solid ones because of its complex stress states. Multilayered elements had greater load bearing capacities with respect to single layered hollow CFST elements [3].

Experimental Program

General

For this experimental investigation a self-compacting concrete mix

Material Properties

Structural steel

F_Y=250 N/mm^2

Ea=200000 N/mm^2

Concrete

Concrete grade=M50

E_{cm}=5000 × (50)$^{0.5=}$27386.13 N/mm^2

Partial safety factors

ϑ_P=1.15

ϑ_C=1.50

Section Properties

Steel section

Aai=π/4 (75^2 – 69^2)=678.584 mm^2

Aao=π/4 (139^2 – 135^2)=860.79 mm^2

Aa=1539.38 mm^2

Iai=π/64 (754 – 694)=440.485 × 103 mm^4

Iao=π/64 (1394 – 1354)=2019966 mm^4

Ia=Iai+Iao=2460451.322 mm^4

Concrete

Ac=π/4 (135^2 - 75^2)=9896.01 mm^2

Ic=π/64 (135^4 – 75^4)=1.4751 × 10^7 mm^4

Design checks

Plastic resistance of the section

=(1539.38 * 250)/1.15+(1*9896.01*50)/1.5

$P_{P=}(A_P f_{y/}\vartheta_P)+\alpha_c (A_C (f_{ck/})_{cy}/\vartheta_C)+(A_s f_{st}/\vartheta_s)$=702.034 kN

Calculation of effective flexural stiffness of the section

$(EI)_{e=}E_{\alpha}I_{\alpha+}0.8\,E_{cd}I_c+E_sI_s$ (EC-4 Cl.6.4)

$I_{\alpha=}$2460451.322 mm^4

$I_{c=}$

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specimen the compressive strength is 59.779 N/mm^2. For the length of 310 mm specimen the compressive strength is 60.981 N/mm^2. For the length of 234 mm specimen the compressive strength is 86.459 N/mm^2. So with the decrease in length the compressive strength increases.

Variation of Load with deflection: Deflections of the specimens at the centre are shown with the applied load P. The Load versus corresponding axial deformation curves were drawn for M50 grade concrete columns are shown in Figures 3-7. These diagrams give a better picture of the behaviour of columns. The deflection of all the

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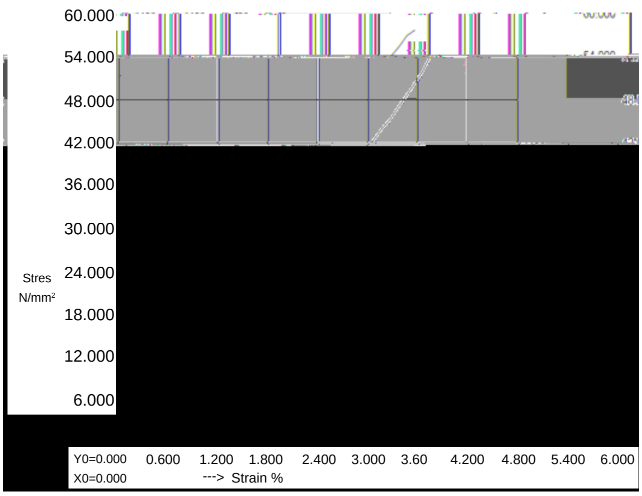

Figure 8: Stress vs. Strain-CFT 1.

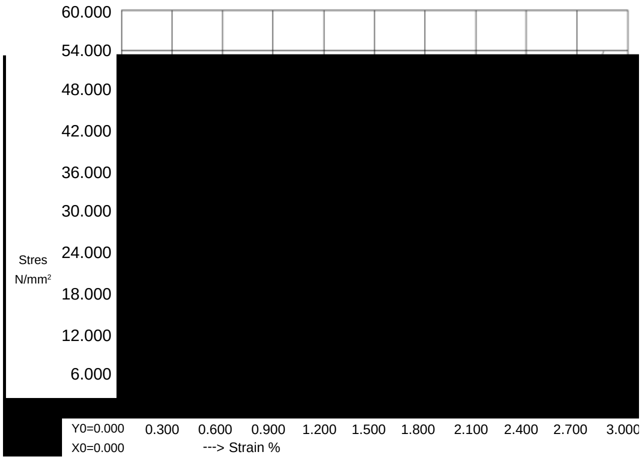

Figure 9: Stress vs. Strain-CFT 2.

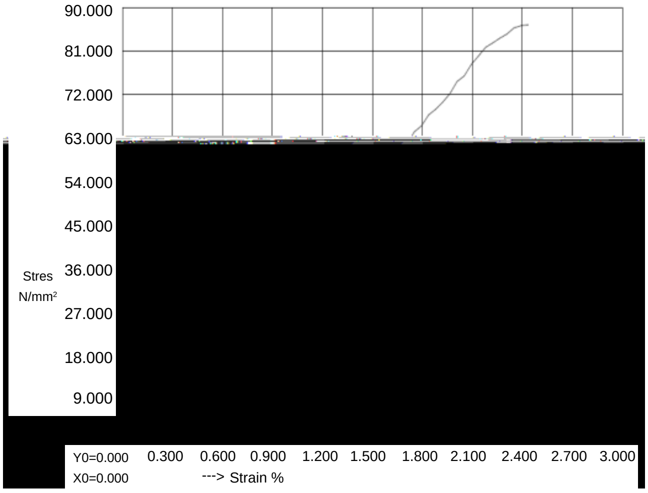

Figure 10: Stress vs. Strain-DSC 2.

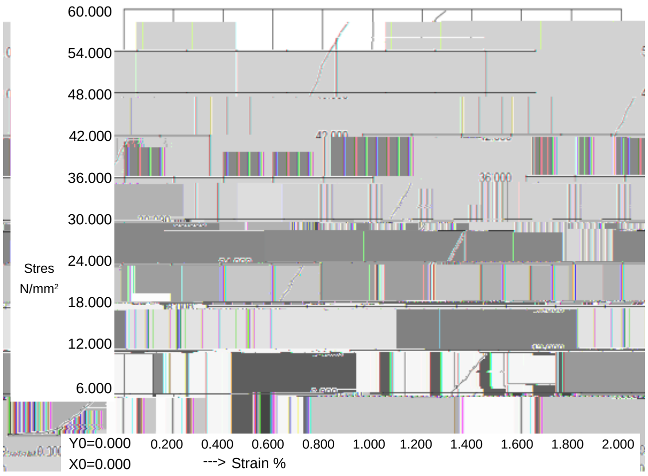

Figure 11: Stress vs. Strain-CFT 5.

Double skinned columns fail in the same pattern of overall buckling and local buckling of outer steel plate in compression flange in the vicinity of mid height leads the failure. It was found that because of the infill of concrete, the tested beam-columns behaved in a relatively ductile manner and testing proceeded in a smooth and controlled way. The enhanced structural behaviour of the composite specimens can be explained in terms of 'composite action' between the steel tubes and the filled SCC concrete. CFT columns carry almost similar load but the failure is sharp and brittle as in a RCC column. The ductility and strength index shows DSCFT are much better in ductility behaviour and Stress carrying capacity. Figures 17 and 18 show the variations in ductility and strength index respectively for different specimens of CFT and DSCFT.

The above Figure 19 shows the comparison of theoretical and experimental results of DSCFT and CFT. Figure 20 shows only the experimental ultimate load of DSCFT and CFT.

Analytical work has been carried out to compare the results with experimental results and theoretical calculations, thus showing a good

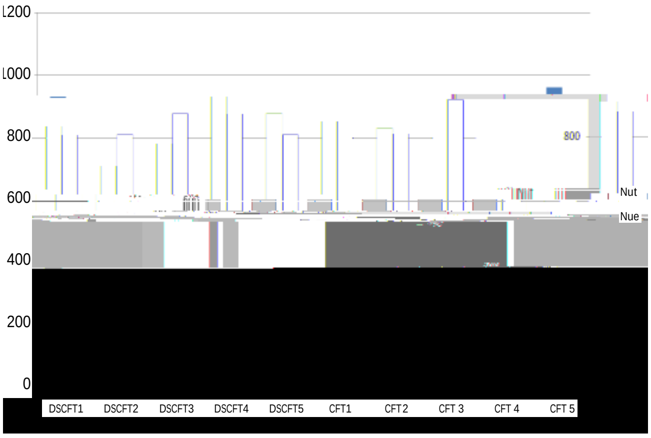

Figure 19: Comparison between DSCFT and CFT.

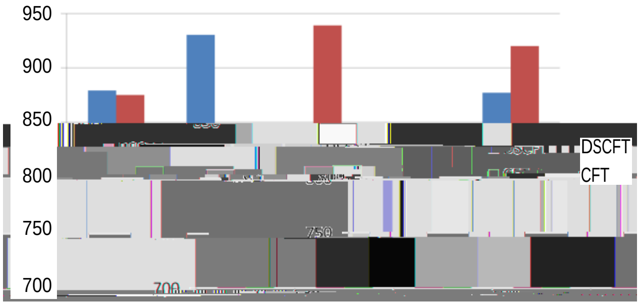

Figure 20: Experimental results of DSCFT and CFT.

of the model in order to avoid stress concentration problems. This provided a more even stress distribution.

The model of the hollow column is shown in Figures 21 and 22. The meshed column is shown in Figures 23 and 24. The column after applying load and boundary conditions are shown in Figure 25. The deformation of meshes of hollow column is shown in Figure 26 the deformation of contours of hollow column is shown in Figures 27 and 28. The maximum displacements compared with analytical results are shown in Figure 29.

The Mode of Failure of DSCFT is by folding of plates in the middle part of the total height of the column and by elephant foot failures at the bottom of the specimen. Figures 30 and 31 shows the failure pattern of the Double skinned composite columns, these shows that it is very ductile in nature.

Conclusions

1. The use of SCC reduced significantly the time of in-fill of the concrete between the steel tubes.
2. The cubes were attained strength by replacing 15% of coarse aggregate weight with silica fume. The strength is also excepting in column.
3. ductilemn.

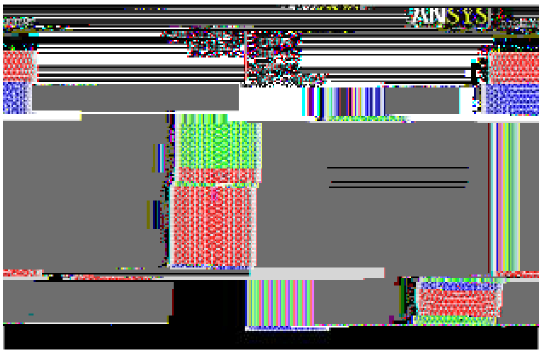

Figure 26: Deformation of meshes.

Figure 27: Deformation contours for CFT.

Figure 28: Deformation contours for DSCFT.

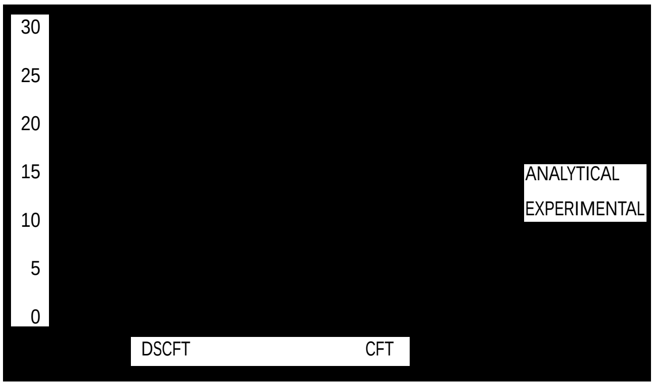

Figure 29: The maximum displacements compared.

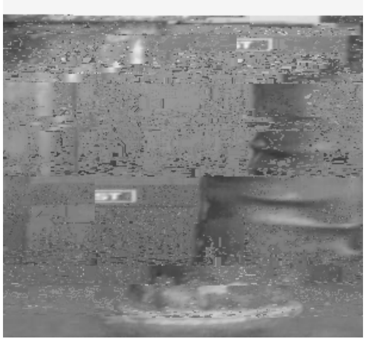

Figure 30: Failure pattern of DSCFT – Folding of Plates with analytical results (ANSYS).

Figure 31: Failure pattern of inner tube – Top view of DSCFT specimen.

4. Because of the in-fill of concrete and a hollow core a relatively ductile behaviour of the Columns are observed.

5. The load carrying capacity of the DSCFT is almost similar to the CFT columns but the overall weight of DSCFT is reduced when compared with the CFT columns.

6. It was observed from the tests, that the failure modes of the hollow composite columns depend on slenderness ratio. When the slenderness ratio is very less, the column fails due to yielding of steel and crushing of concrete under direct compression. When slenderness ratio is more, the column fails by elastic buckling.

7. For the increase of slenderness ratio by 3 the ultimate load decreases by 4%.

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