SHEAR RESPONSE OF DUAL STEEL COMBINED COMPOSITE COLUMNS IN NON PRISMATIC CONDITION

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Abstract - *Concrete-filled double-skin steel tube (CFDST) is a composite structure, in which concrete fills the gap between the inner and outer steel tubes. It was firstly guided as a new form of construction for deep water vessel to resist external pressure. Compared with the solid concrete-filled steel tube (CFST), CFDST is featured by its large bending stiffness, light weight, and good fire resistance. With the great prospect for engineering applications, CFDST is suitable to be used as the construction of bridge piers, power transmission towers, offshore platforms, and super high-rise buildings. As the CFDST members frequently used, researchers found that in some cases, for example during the earthquakes, the liquefaction and lateral spreading of soils caused by earthquakes may lead to extremely high shear force on drilled-shaft foundations. Moreover, with the occurrence of impact accidents or earthquake, the bottom columns of structures, such as the piers of bridge and columns of building, will be inevitably endure significant shear force, making them prone to suffer shear failure. This project attends to analyse the shear response of CFDST of various cross sections in primatic and non-prismatic conditions. A total of thirty-five specimens had tested to investigate and compare the shear response. The influence of shear span ratio, hollow ratio, type of cross section, dimensions of columns were studied. Numerical modelling of CFDST columns are doing in finite element modelling software ANSYS Workbench.*

***Key Words*: CFDST, shear span ratio, mechanical performance, material properties, sustainability.**

1. INTRODUCTION

Concrete-filled double-skin steel tube (CFDST) is a composite structure, in which concrete fills the gap between the internal and outer steel tubes. It was firstly guided as a new form of construction for deep water vessel to resist external pressure. Compared with the solid concrete-filled steel tube (CFST), CFDST is featured by its large bending stiffness, increase in section modulus, enhancement in stability, better damping characteristics, better cyclic performane, light weight, and good fire resistance. With the great prospect for engineering applications, CFDST is suitable to be used as the construction of bridge piers, power transmission towers, offshore platforms and super high-rise buildings. CFDST commonly is used and have different outer shapes e.g., circular-in-circular, circular-in-square, and square-in-square according to structural type and function. For instance, specimens with outer circular section are widely used in the construction of bridge piers or power transmission towers because of the strong confinement effect that outer circular steel provided while outer square section of specimens is commonly adopted in the high-rise buildings construction owing to its easy for beam-column joint connection.

2. PROPERTIES OF SECTIONS

Table -1: Dimensional Properties of Sections

Specimen	Outer Steel Tube (mm)	Inner Steel Tube (mm)	Thickness (mm)
SC	200X200	160	4
CS	225.73	141.76X141.76	4
SS	200X200	141.76X141.76	4
CC	225.73	160	4

ANSYS Workbench was used to develop the three-dimensional model and nonlinear simulations. A total of 24 models were developed in order to find the optimum shear span ratio for the shear capacity. Shear span ratios 0.4, 0.6, 0.8, 1.0 were selected for comparing the shear capacities. A tapered ratio of 1.5 is used in the models. The dimensional parameters of studies are shown in the Table 1.

3. ANALYZED SPECIMEN

The models of SC sections are formed in L, V, L IP, L OP, V IP and V OP conditions. Then the obtained models were analysed. The figures below shows the geometry and total deformations of sections to study the influence of shear span ratio on shear capacity of columns. Boundary conditions are fixed at both ends with reference of the base journal. The material properties are selected based on the literature reviews etc. The length of column is 900mm and the meshing of sections are 40mm which is selected after the mesh sensitivity analysis. The loading is provided by keeping the section horizontally and axial load is applied. Non linear static structural analysis was done using ANSYS software. The effect of stress and deformation on the various cross-sectional shaped columns are analysed.

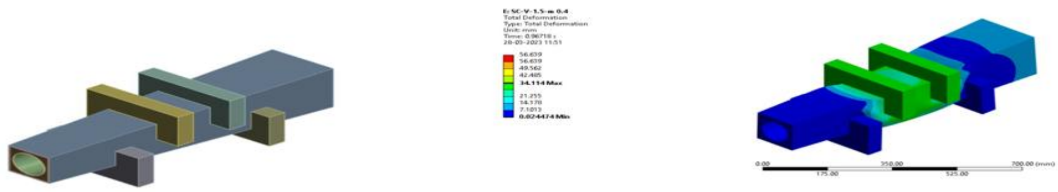

Fig -1: Geometry and Total Deformation of SC V m0.4

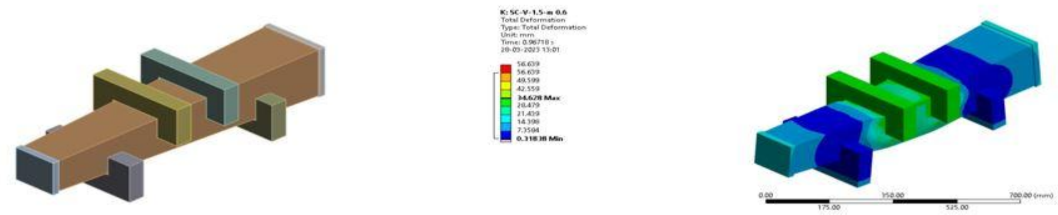

Fig -2: Geometry and Total Deformation of SC V m0.6

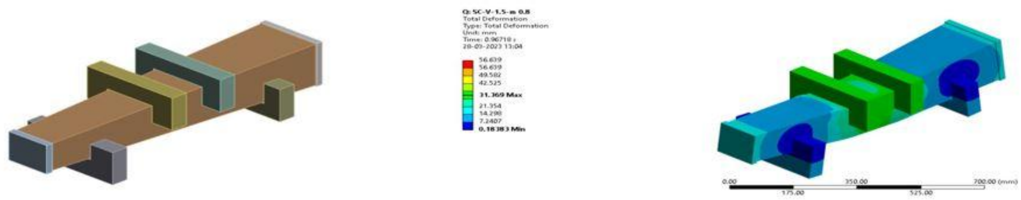

Fig -3: Geometry and Total Deformation of SC V m0.8

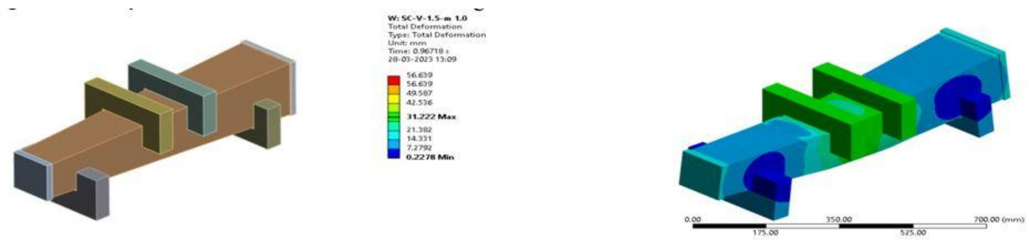

Fig -4: Geometry and Total Deformation of SC V m1.0

Table -2: Results Obtained for V Type Section

Section	Displacement in mm	Shear Load in kN	% Decrease in Load
SC V m0.4	9.64	800.01	
SC V m0.6	7.42	740.02	7.49
SC V m0.8	4.82	657.07	17.86
SC V m1.0	6.39	657.56	17.86

Table -3: Results Obtained for LType Section

Section	Displacement in mm	Shear Load in kN	% Decrease in Load
SC L m0.4	7.46	789.10	
SC L m0.6	6.96	748.42	5.16
SC L m0.8	12.11	644.51	18.32
SC L m1.0	17.49	607.88	22.97

Table -4: Results Obtained for L IP Type Section

Section	Displacement in mm	Shear Load in kN	% Decrease in Load
SC L m0.4 IP	10.24	753.97	
SC L m0.6 IP	7.55	743.30	1.42
SC L m0.8 IP	21.62	725.07	3.99
SC L m1.0 IP	17.50	601.69	20.20

Table -5: Results Obtained for L OP Type Section

Section	Displacement in mm	Shear Load in kN	% Decrease in Load
SC L m0.4 OP	7.57	929.34	
SC L m0.6 OP	9.63	789.10	15.09
SC L m0.8 OP	7.38	891.75	4.04
SC L m1.0 OP	16.34	607.88	34.59

Table -6: Results Obtained for V IP Type Section

Section	Displacement in mm	Shear Load in kN	% Decrease in Load
SC V m0.4 IP	11.263	758.40	
SC V m0.6 IP	10.66	748.42	1.32
SC V m0.8 IP	22.90	644.51	15.02
SC V m1.0 IP	22.14	504.07	33.54

Table -7: Results Obtained for V OP Type Section

Section	Displacement in mm	Shear Load in kN	% Decrease in Load
SC V m0.4 OP	11.11	954.36	
SC V m0.6 OP	9.58	926.12	2.96
SC V m0.8 OP	25.24	871.95	8.64
SC V m1.0 OP	27.16	640.47	32.89

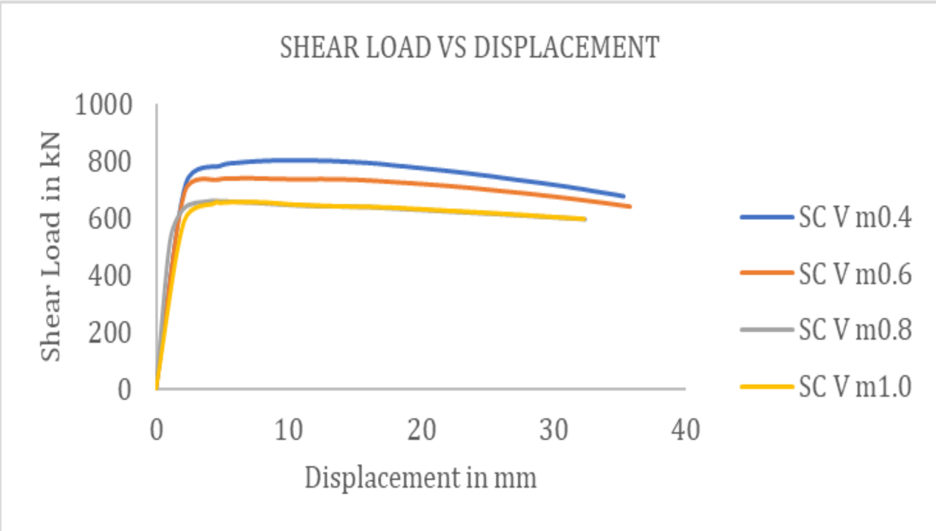

Fig -5: Shear Load VS Displacement Graph of V Type Sections

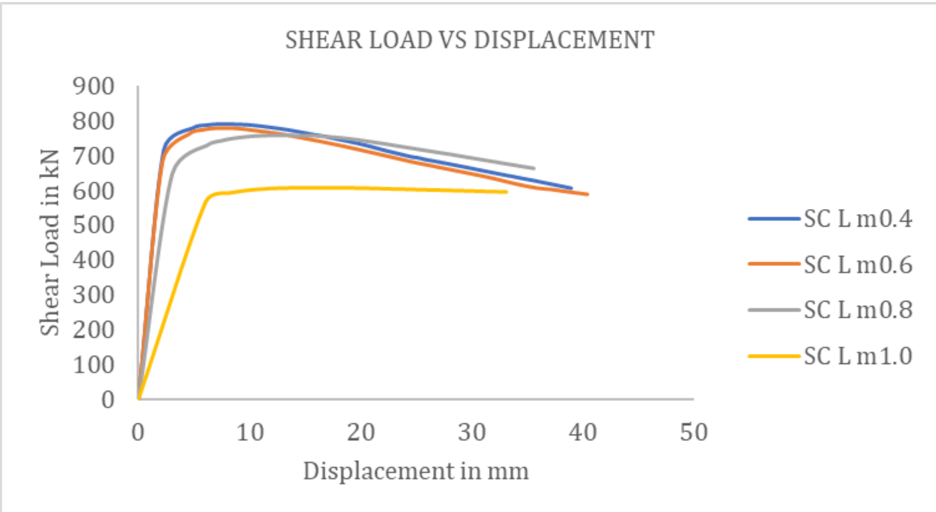

Fig -6: Shear Load VS Displacement Graph of L Type Sections

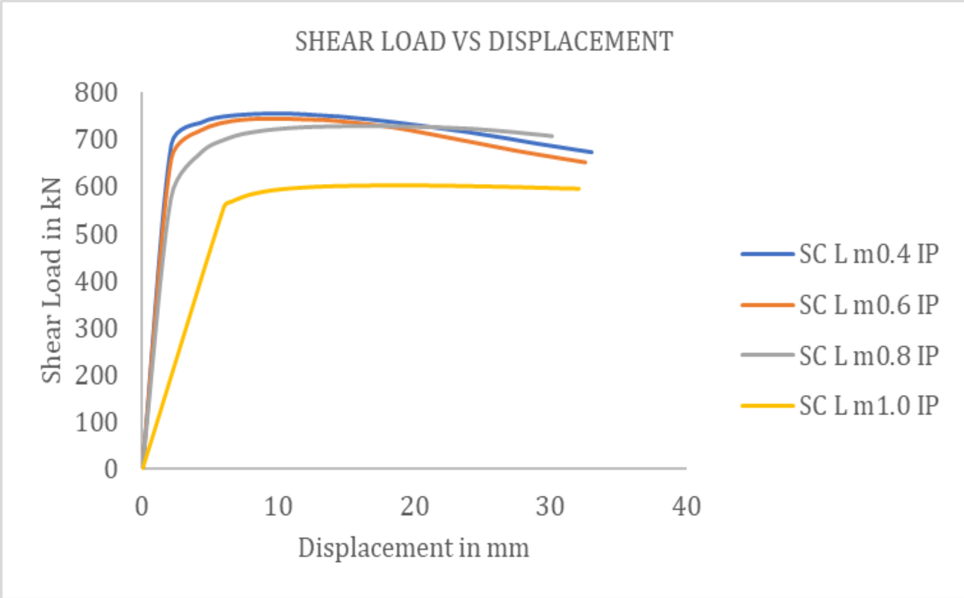

Fig -7: Shear Load VS Displacement Graph of L IP Type Sections

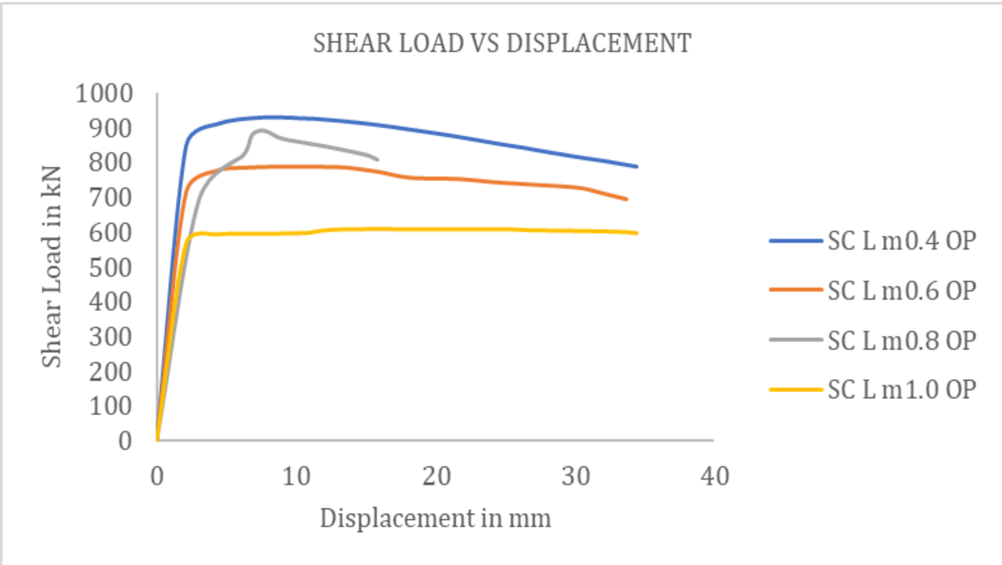

Fig -8: Shear Load VS Displacement Graph of L OP Type Sections

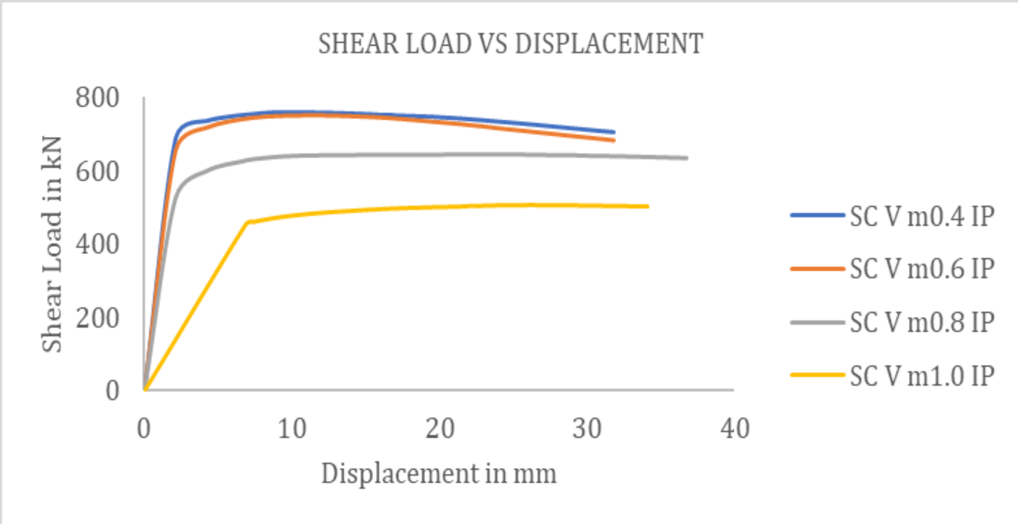

Fig -9: Shear Load VS Displacement Graph of V IP Type Sections

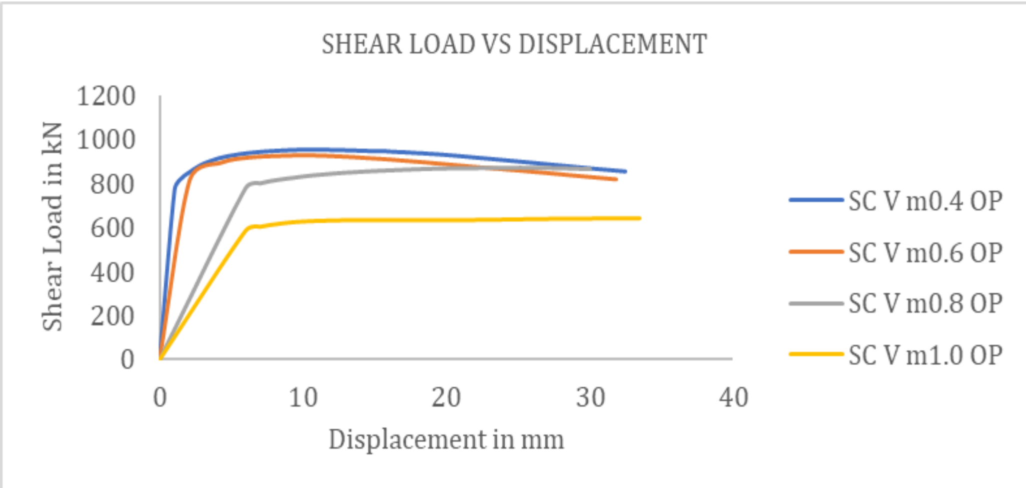

Fig -10: Shear Load VS Displacement Graph of V OP Type Sections

The graph given above shows the load vs displacement graph, after that different models with different shear span ratios are analysed.

4. CONCLUSIONS

An analytical investigation aimed to study the shear response of dual steel combined composite columns. The performance at different shear span ratios and the different shaped sections was evaluated in terms of shear capacity. The following are some of the important conclusions drawn from this study:

1. From the analysis at different shear span ratios of sections shaped subjected to shear loading, it is observed that sections with shear span ratio 0.4 have more shear capacity than sections with higher shear span ratios.
2. Shear span ratio significantly affects the load transfer mechanism, Specimen with lower shear span ratio exhibit stronger confinement effect and increses the shear capacity.
3. Circle in square and square in circle sections have more initial yield and maximum ultimate load than circle in circle and square in square sections.

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