Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 53(2) (2021) 117-120
DOI: 10.22060/ceej.2019.15430.5918

Investigation of circular concrete-filled double-skin steel tubular (CFDST) columns under Axial Compressive Load

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ABSTRACT: Two-layer composite columns are a family of single-layer composite columns consisting of two circular steel tubes, which are assembled in a center and are filled with concrete. In this type of column, the important effect of concrete is that it delays local buckling of the steel skin and that the concrete in its confined state can tolerate higher strains and tensions than the non-confined state. The advantages of two-layer composite columns, in comparison to single-layer columns, can be attributed to the lower weight of two-layer composite columns, more ductility, and greater axial force strengthening. The behavior of these columns under pure axial load is of interest. Therefore, the study of the behavior of two-layer composite columns under the influence of axial load is of particular importance due to the behavior close to the reality in these columns. In this paper, the capacity of double-skin steel columns filled with concrete has been investigated using ABAQUS finite element, under the influence of axial stress. in this paper, sections were compared with changing the thickness of the layers and the diameter of the inner core, and the existence and absence of concrete core. the results showed that the diameter of the tube increases with increasing the core diameter and the effective parameter in this issue is the ratio of thickness to diameter (D/t). In the discussion of the existence and absence of concrete in the core, the confinement effect has an important result and has increased the load strength capacity of the columns.

Review History:

Received: 12/11/2018
Revised: 2/4/2019
Accepted: 2/16/2019
Available Online: 2/20/2019

Keywords:

Concrete-filled double-skin steel tubular
CFDST
Axial load
Circular columns
Finite element method
ABAQUS

1. INTRODUCTION

The popularity of compound columns is increasing in many years. Depending on the composition of the two steel and concrete materials, compound columns are divided into several categories [1]. The most basic studies on compound columns by boron in 1908, after which many have conducted many studies and experiments and have achieved different theoretical results. The reinforcement of columns with steel sidewall using cards experimentally was first carried out in 1990 and experiments showed a significant increase in load-strength capacity and seismic activity, so the use of this technology is widely used, especially in seismic applications [2]. In recent years, a lot of papers have been published on the technology of compound columns filled with concrete. The results show that more experimental research is needed in the case of high-strength reinforced composite reinforced concrete (HSC)[3]. In 2016, Sulthana and jayachandara [4] conducted double - Skin research around the high-length CFDST column. In 2017 Ibanz and et al [5]. tested the composite columns of two layers under the non - central charge with different strengths in the core and the outer core [6]. In 2016, the same Geometric shape sections of the central core with different dimensions are checked into the inner circle, outer circle, and inner circle. In 2016. tested the composite columns of two layers under the central charge with different resistors in the nucleus and the outer core[7], Hasanein and et al, were investigated in 2017 [8] for the buckling and behavior of the two layers. The distinction of this paper is to compare the other articles on the subject of the two - walled columns with concrete, varying the area of the sections next to you, and that the effect of the core area is investigated by the effect of the existence and absence of the core.

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2. INTRODUCTION OF THE EXPERIMENTAL SPECIMENS

in this study, the effect of internal and external tubes on the concrete interaction with each of these side walls are investigated in ABAQUS explicit by using ABAQUS explicit elements software. In this study, three approaches to increasing the thickness of the outer steel, increasing the thickness of the internal steel, and finally filling the specimens for concrete steel and steel tubes were investigated. the first two approaches are studied by some researchers but in order to be able to compare the value of each of these solutions, the solution of all three approaches is needed. Along with these items, the core diameter variation is also investigated. It showed in Table 1.

Table 1. Specimens properties

ID	D_{ext} (mm)	t_{ext} (mm)	D_{int} (mm)	t_{int} (mm)	$f_{c,int}$ (MPa)	$f_{c,ext}$ (MPa)	L (mm)
1-C	220	3	110	6	30	30	3000
1-D	220	3	110	6	0	30	3000
2-C	220	6	110	3	30	30	3000
2-D	220	6	110	3	0	30	3000
3-C	220	3	132	6	30	30	3000
3-D	220	3	132	6	0	30	3000
4-C	220	6	132	3	30	30	3000
4-D	220	6	132	3	0	30	3000
3-C-1	220	3	132	5	30	30	3000
4-C-1	220	6	132	2.5	30	30	3000

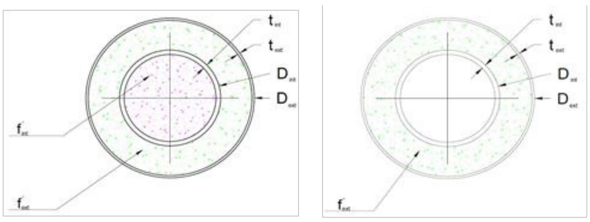

Fig 1. CFDST columns section Schematic

Table 2. Numerical comparison of results

Typ	ID	Dimension	$A_{ext}(cm^2)$	$A_{int}(cm^2)$	$\frac{D}{t}$	P_{max}(kN)	$\frac{P}{P_{max}}$	Ratio (%)
Typ 1	1-C	220×3-C30-110×6-C30	20.45	19.60	73.30	2686.47	0.957	2.150
	1-D	220×3-C30-110×6	20.45	19.60	73.30	2247.91	0.801	11.017
	2-C	220×6-C30-110×3-C30	40.33	10.08	36.60	2804.58	1	0
	2-D	220×6-C30-110×3	40.33	10.08	36.60	2366.56	0.843	8.470
Typ 2	3-C	220×3-C30-132×6-C30	20.45	23.75	73.30	2508.01	0.894	5.562
	3-D	220×3-C30-132×6	20.45	23.75	73.30	1988.32	0.709	17.030
	4-C	220×6-C30-132×3-C30	40.33	12.15	44.00	2705.45	0.964	1.800
	4-D	220×6-C30-132×3	40.33	12.15	44.00	2156.71	0.768	13.058
Typ 3	3-C-1	220×6-C30-132×5-C30	40.33	10.08	36.60	2343.28	0.835	8.961
	4-C-1	220×6-C30-132×2.5-C30	40.33	10.08	36.60	2681.26	0.953	2.248

3. INTRODUCTION OF SPECIMENS

In the present paper, a total of 10 double steel columns filled with CFDST concrete have been modeled by finite element software, to the capacity of the circular column and the effect of the concrete compressive strength and the width of the concrete compressive strength (D/t) in these columns under the axial force. By changing the thickness of the outer and inner tubes, the goal was to determine the effect and importance of each of the tubes. also, the specimens were divided into three sets, to be able to lower the larger inner wall with smaller inner wall columns, as well as two samples of larger cores with the equal area than larger core segments compared to the core effect on the larger cores. A schematic of the designed columns is shown in Fig. 1.

4. AXIAL LOAD CAPACITY

the load-displacement curve of the modeled columns. In the most ideal case of compound 2-C with an outer wall of 6mm and the internal sidewall 3mm with an axial force of 2804 KN strength the highest load capacity than other columns. by increasing the inner wall area as well as 10 %, the freight capacity was reduced by about 15 %. also to another result, in the first series of circular columns you have an average of about 10 % more loaded capacity than your columns. In the second series specimens, your columns bore about 20 % more strength capacity than your columns, as well as Type 2 columns were better than columns type 1. Table 2 shows the results numerically.

in this paper, we propose a general bow-buckling method based on short-term shear stress that is higher than the advantages of long columns in high deformability. In comparison results, the shape of transformation along Y for samples was the general type that was corroded for the first case of the specimen, in specimens 1-C and 1-D because of the depletion of the local concrete area and the ratio (D/t) and the relative mode (D/t) is contrary to other models. It is observed that, unlike normal columns in which the cargo capacity falls sharply after arriving at the maximum load and bearing large deformations in load balances, the columns are greatly reduced to load-strength capacity and well-strength large deformations in load - to - load balances. a maximum value of buckling is pre-

5. CONCLUSIONS

in the present study, the behavior of composite columns reinforced with concrete (CFDST) was investigated in axial loading. The ABAQUS explicit elements were used to perform nonlinear analysis and the accuracy of the proposed finite element modeling was observed by comparing the corresponding analytical and experimental results. The plastic-walled plastic deformation of solid cross-sectional samples is less observed than those with hollow cross-sectional samples. Also, the larger the hollow ratio (χ) the plastic deformation range of the smaller steel layer and, the maximum plastic deformations are larger. In the study of the effect of increasing the thickness of internal and external steel, the solution is to increase the strength of the columns and, as explained, the importance of the effect of the inner tube thickness is more important, and it is import-

presented. In comparison increasing the kernel with respect to (D/t), the loading capacity of the columns was increased, while in specimen 1-C with respect to (D / t), the loading capacity was reduced.

important to enclose the inner tube thickness as well as the confinement of the outer steel. It is best to design the thickness of the layers to be suitable to maintain the stated restrictions in the regulations so that the forces in the internal and external tubes are properly distributed to increase both axial loads and freight capacities.

the effects of the diameter changes in the sidewalls are also investigated, which results show that increasing the carrying capacity is not cost-effective for increasing the carrying capacity as well as increasing the thickness of specimens, but increasing the thickness of the specimen is decreased by increasing the thickness of ductility which is investigated in the paper (Chogoli et al , 2010)[9].

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HOW TO CITE THIS ARTICLE

A. Mokhtari, H. Saberi, V. Kolmizadeh, V. Saberi, Investigation of circular concrete-filled double-skin steel tubular (CFDST) columns under Axial Compressive Load, Amirkabir J. Civil Eng., 53(2) (2021) 117-120.

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