AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

EXPERIMENTAL STUDY FOR BEHAVIOR OF (WASTE CONCRETE FILLED STEEL TUBULER) COLUMNS SUBJECTED TO A STATIC AXIAL LOADS

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Received on 17 April 2017 *Accepted on 9 August 2017*

***Abstract**: In this study, composite columns have been tested under axial load. The steel tubes were filled with waste concrete to perform the composite action. The specimens divided into two groups; square and circular columns. The diameter of the circular hallow columns was 7.5 cm with 2mm thickness, while the dimension of the square hallow columns was (7.5 cm × 7.5 cm) with 2mm thickness. For each group a column without waste concrete filled steel tubular (W.C.F.S.T) was tested to act as a reference column. Load-deflection curves were constructed for all specimens. The results indicate that the waste concrete filled steel tube has more capacity due to the composite action. The pattern of failure in circular sections was different from the failure pattern of the square ones.*

Keywords :W.C.F.S.T columns; Load -deflection curves; waste concrete; axial load; pattern of failure .

INTRODUCTION AND LITERATURE REVIEW;

Steel materials have the advantage of high elasticity, while concrete material have the benefits of high compressive quality and solidness. Composite section joins steel and concrete, properties together and make new section that has the useful characteristics of both materials[4].Figure 1 explains waste concrete filled steel tubular (W.C.F.S.T) segments which comprises content of a steel tube filled with waste concrete. The applied load on composite sections (resisted) by both steel and waste concrete by composite action; the composite action depends on the *strength* of both the steel tube and concrete waste. In order to make the concrete waste more intact, cement mortar was added to each layer of the fill to act as a bonding material. The steel however, plays another role by acting as a confinement element and prevents the crushing of the filler materials.

Utilizing of composite sections as a part of structures like multistory structures (bridges piers, piles … and [so] far has been a promising systems because of their high (strength)limit, simple development, imperviousness to fire, and flexibility.

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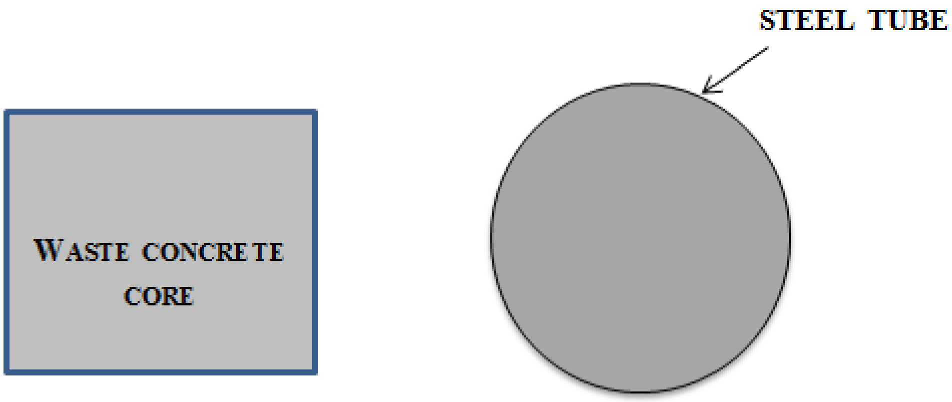
Vol. 10 , No. 3
ISSN: 1998-4456



1 Figure 1 . The waste concrete-filled steel tubular (W.C.F.S.T)

In 2009, Ghannam-[1] carried out study on the composite sections of rectangular cross area utilizing eight filled scale samples. In his study, he investigated the strength of lightweight total cement filled steel tube-shaped sections with typical weight total cement. All sections were tried up to the failure. In view of the exploratory results and outline count the light weight total cement utilized as a part of composite segments indicated satisfactory resistance in correlation with plan computation and the conduct of cement (C.F.S.T) sections with ordinary cement was like those obtained from light weight concrete. In 2011, Fei-Yu et al- [2] examined the behavior of composite sections in the presence of a gap between the filling materials and the steel tube. A twenty one examples were tried and partitioned into two gatherings: (fourteen short segments tested under only axial load, and seven bars subjected to flexure. The parameters studied in this research were the gap sort (circumferential or circular top), and hole proportion. In 2012, Hafes et al-[3] exhibited a hypothetical and investigational program for short compound sections subjected to stationary concentric and erratic burdens, the test program included trial of six square C.F.S.T segments ,one of the exploratory factors in the experiment is the applied load point. The investigational and hypothetical experiment reasoned that the concentric load enhanced a definitive ability to around 250 – 275% while the eccentric loading expanded a definitive ability to around 307 – 341%. the filling dilation action and the larger cross section area play major role in increasing the capacity limit. In 2012, Nie et al-[4] displayed a trial concentrate on the C.S.F.T sections conduct under torsion and pressure – torsion periodic loading. Eight (C.F.S.T) samples tried in the experiment. The standards researched in the experiment kind of cross section, strengthen proportion and applied loading level. as a conclusion, the torsional limit of C.F.S.T segments exposed to a Pressure – Torsion loading expanded in low compressive force. Be that as it may, the torsional limit of C.F.S.T segments diminished under the effect of great pressure loading. In 2013, Xiushu et al-[5] examined the rectangular C.F.S.T segments exposed to eccentric load .the experimental program contained seventeen rectangular C.F.S.T segments were tried under uniaxial and biaxial twisting burden. The standards concentrated on were ; pressure quality of solid, steel quality. In 2015, Alaa Hasson et al-[6] Studied a compound columns (square and circular) steel with hollow sections these filled with concrete. Specimens investigated under the action of concentric and eccentric axial loads for one instance, which those section tried horizontally likewise a beam to calculate the most bending resistant.

The objective of this research is to investigate the behavior of circular and square steel tube filled with concrete waste under axial load, and to know the amount of resistance that can be added by the concrete

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waste in the case of use as a composite with the steel sections of all kinds for the purpose of benefiting from these composite sections of the construction work.

1. EXPERIMENTAL WORK

six segments have been tested in this experiment ,divided into two groups ,one for (square) C.F.S.T columns and the other for circular C.F.S.T columns. The segments used in the experiment are shown in Figure 2.

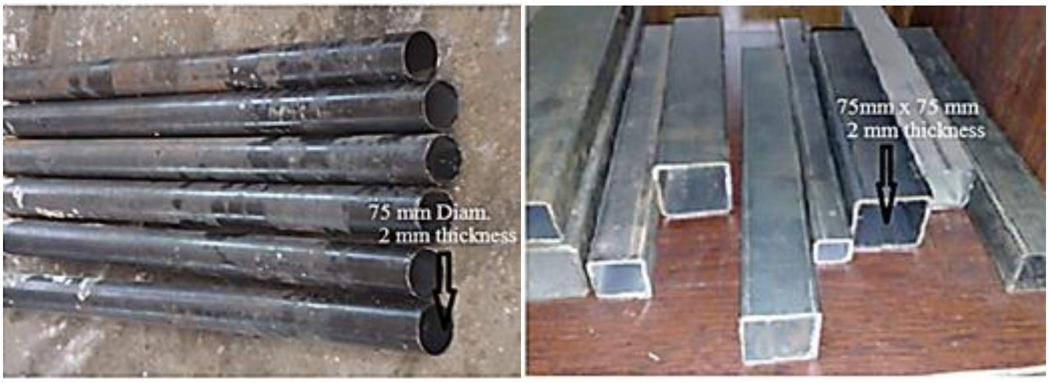

Figure 2 **.** *(Square and Circular) supports*

Each group moreover was divided into two subdivision groups of three segments according to waste filler. The first section of the first group is empty square section (no filler), the second section square is filled with waste of concrete remaining on the sieve measuring (19 mm) as a coarse waste of concrete, the third square is filled with waste of concrete transit sieve (4.75 mm) as a fine waste of concrete. The first of the second set circular section is empty, the second filled with remnants of concrete remaining on the sieve measuring 19 mm, and the third is filled with remnants of a circular concrete transit sieve (4.75 mm) . Bearing in mind that the fill section in the form of layers with good compaction.

The empty steel segments (square and circular) experienced as stated by (ASTM A6) to find their yield strength values. The sectional characteristics and yield strength of square and circular sections are concluded as shown in table (1).

Table 1.Segments characteristics of empty(steel columns)

Steel section	Dimensions (mm)	Yield strength (MPa)
Square section	75×75×2	352
Circular section	75×2	327

The segments were tested under axial load by using the testing machine shown in Figure 3. Each specimen was attached to a bearing plate from the bottom side to help applying the load uniformly to the section. The lateral deflection at the middle of each section was captured by using the dial gauges as explained in Figure 3.

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Figure 3. Testing machine.

Each specimen was placed in the loading deck with high accuracy to ensure the alignment of the column. The load then was applied monotonically and the reading of the load and corresponding dial gauges readings were recorded. The characteristics of tested C.F.S.T columns (square and circular) are concluded in Table (2) and Table (3) respectively.

Table2 . Characteristics of tested (square C.F.S.T) columns

Column	Dimensions (mm)	Yield strength f_y (MPa)
S1	75×75×2	352
S2	75×75×2	352
S3	75×75×2	352

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Table 3. Characteristics of tested (circular C.F.S.T) columns

Column	Dimensions (mm)	Yield strength (MPa)
C1	75×2	327
C2	75×2	327
C3	75×2	327

2. RESULTS

Based on investigational work explained in section 3. The results are summarized in Table 4 and Table 5.

Table 4. Patterns of failure and Loads for(square W.C.F.S.T)columns

Column	Waste Concrete type description	Load (KN)	Failure Pattern
S1	No filler	79	steel yielding at end span
S2	coarse waste of concrete	86	yielding near the support due to compression failure.
S3	fine waste of concrete	129	yielding near the support due to compression failure.

Table 5. Patterns of failure and Loads for(circular W.C.F.S.T)columns

Column	Waste Concrete type description	Load (kN)	Failure Pattern
C1	No filler	86	Buckling
C2	coarse waste of concrete	139	Buckling
C3	fine waste of concrete	151	Buckling

2.1. LOAD - DEFLECTION CURVES:

The load - deflection curves for square waste filled steel tube columns and circular waste concrete filled steel tube columns are explained in the figure 4 and figure 5 shown below.

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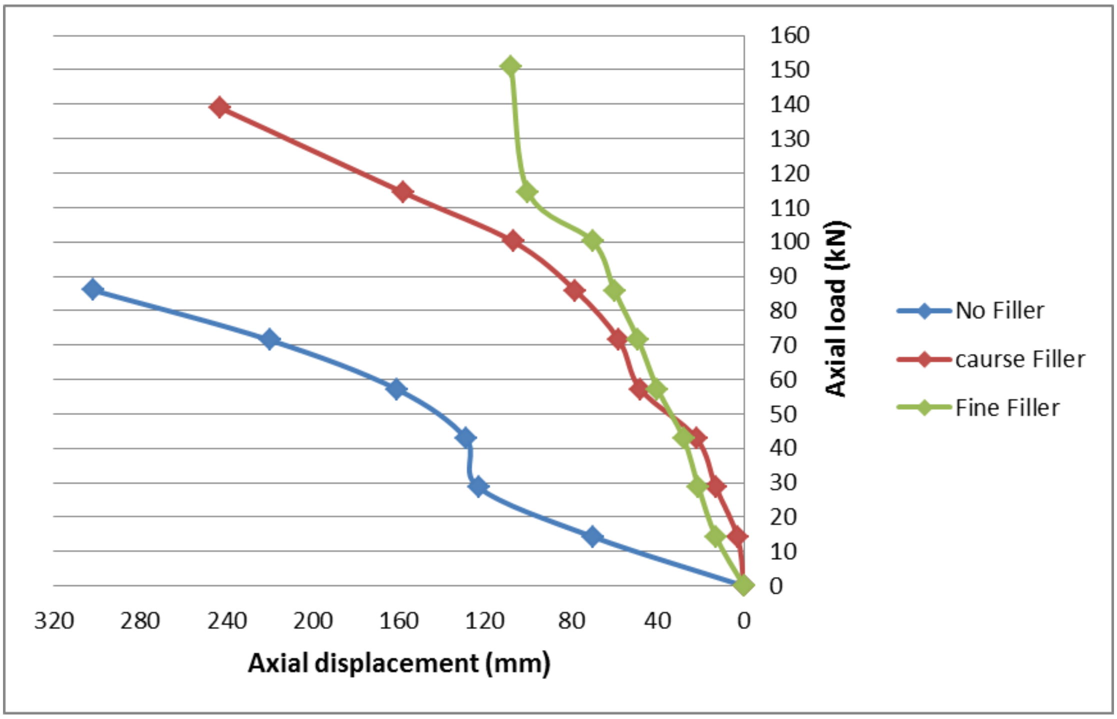

Figure 4. Load-displacement relationships of composite specimens of group(1) square W.C.F.S.T columns

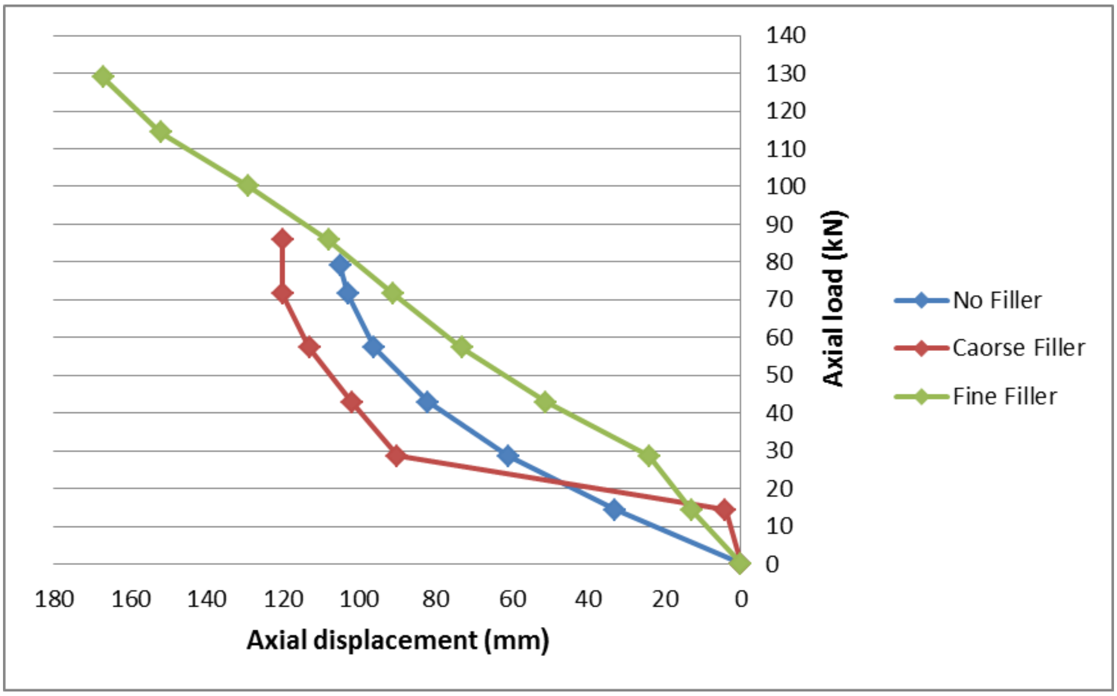

Figure 5 . Load-displacement relationships of composite specimens of group(2) circle W.C.F.S.T columns

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2.2. PATTERNS OF FAILURE

Figure 6 shows (square C.F.S.T) segments subjected to axial loading, the failure occurred because waste concrete crushing and steel yielding (at the loaded ends of the columns).The local yielding failure was observed for (S_1,S_2,S_3) segments due to the direct compression force from the loading deck.

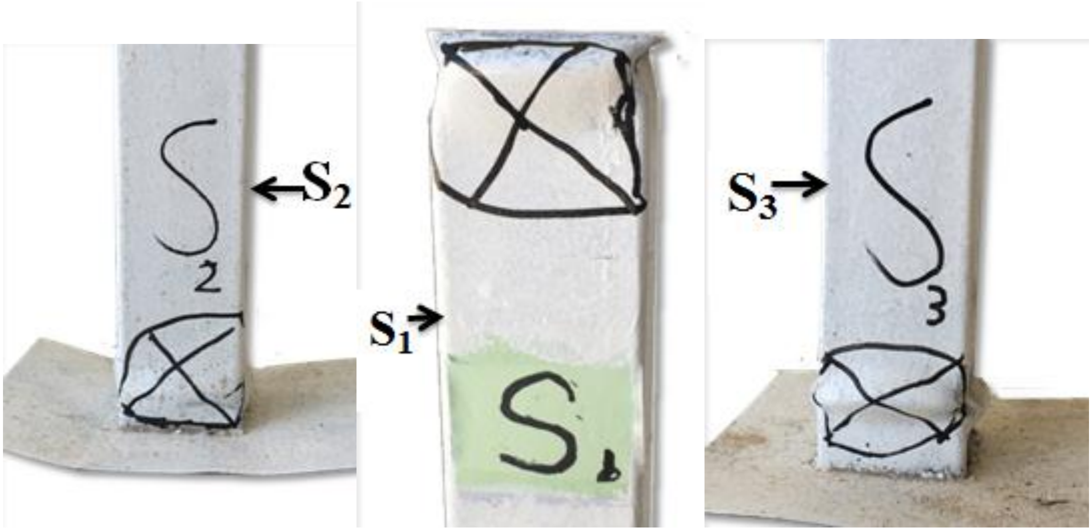

Figure 6. Patterns of failure for square W.C.F.S.T columns subjected to axial loading.

Figure 7. Patterns of failure for circular W.C.F.S.T columns subjected to axial loading.

Figure 7 shows (circular C.F.S.T) segments subjected to axial loading ,the failure was due to the axial buckling at nearly the middle of the columns.

CONCLUSION;

Three composite square waste filled steel tube columns and three circular waste concrete filled steel tube columns were investigated for their axial strength. from the obtained date, the following points can be concluded:

1. It is appeared from the results that the (W.C.F.S.T) segments generally have a limited increasing in axial load.
2. In axial loading case, the square W.C.F.S.T segments, the failure was due to steel yielding or waste concrete crushing while in circular W.C.F.S.T sections the failure occurred because of the buckling since the moment of inertia of the square segments (slightly) greater than the circular section. buckling accrued first in circular section while the square section failed by yielding the steel material.

3- The results proved that the waste concrete can be reused as filler in composite columns since give a reasonable strength has been obtained. On other word, this technique can be considered as sustainable method.

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