EXPERIMENTAL INVESTIGATION ON CONCRETE FILLED STEEL TUBE UNDER AXIAL COMPRESSION

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ABSTRACT

Now days in construction area availability of higher strength steel and high performance concrete have expanded the popularity of Concrete filled steel tube column. Concrete filled steel tube is component with good performance resulting from the confinement effect of steel with concrete. The concrete inside the mild steel tube prevents the local buckling of tube inside; hence increase the strength of the column .The objectives of these experimental investigations is test the behaviour of short concrete filled steel tube under axial compression to failure. A total 42 specimens are casted and tested out of which thirty six specimens are filling with concrete, three specimens are only concrete and three specimens are kept hallow. These 36 specimens are divided in to three classes according to their shapes as circular, rectangular and square. Due to which the effect of change in shape on the compression behaviour has become possible to study

Keywords: *Concrete filled steel tube, confined concrete, axial loading*

1. INTRODUCTION:

1.1 GENERAL

Concrete filled steel tubes (CFST) are mainly used in different structural columns like offshore structures, piles, bridge piers and column in seismic zone. The steel tubes are filled with high strength of concrete, and high in compressive strength of concrete with a plasticity of concrete is good, and the better bending ability of strong steel especially flexural capacity of concrete is weak. The concrete filled steel tubes (CFST) are divided in different cross section (square, rectangular, and circular) three types of cross sections were used in this experiment. An emerging composite structure of steel pipe and the load carrying capacity improving greatly, the two will be playing same role, an emerging composite structure of steel concrete, mainly based on a smaller force eccentric compression members and axial compression members and these will be widely used in the structural frame works like a high rise buildings and factories.

The concrete filled steel tubular columns have a excellence seismic performance to prevent the local buckling of occurrence an effectively due to the presence of concrete inside of the steel pipes, according to the some previous researches have been shown that the concrete filled steel tubular columns of bearing capacity is higher than the corresponding sum of pipes and columns.

Total 60 percent of steel can be saved by using concrete filled steel tube (CFST) type of test while compare to the structural steel system ,well distributed reinforcement to provide and permanent formwork of steel tubes were also used, located at efficient position.

1.2 LITERATURE REVIEW

Brief information of research work done by the researcher's about topic which will help us to decide about subject is given as below.

Georgios Giakoumelis Dennis Lam (2004) [3]

This author was presented the behaviour of the concrete filled steel tube under axial load, and also the various strength of the circular type of cross sectional tubes were presented, and the effect of the steel tube thickness, the concrete and steel tubes have a very strong bond between these two. To examine the confinement of concrete. To compare these strength of the columns with some other predicted values of design codes like a (Euro code 4, American standard codes and Australian standard codes). During the experiment all these 3 design codes to measure the predicted lower values.

In this test the steel tubes were used in some are greased and others are non greased in inside surface of the steel tubes. These design code values are shown that the different behaviour of load displacements. In this study to test the total 15 specimens, the testing of these specimens with different parameters like wall thickness and different concrete strength, and the material properties of this test was the diameter of the tubes were 114 mm, the wall thickness of the hallow circular section tubes were between 3.6 to 5mm, also the length of the all specimens were 300 mm long, to reduce the end effects, by column slenderness little effect for the specimens could be the stub columns.

Muhammad Naseem Baig, FAN Jiansheng NIE Jianguo (2006) [9]

This study was conducted on the concrete filled steel tube under axially loaded in compression to failure, and the short concrete tabular columns behavior, compare these experimental results with some other published results, and also compare with theoretical results. This study was conduct to test the total of 28 specimens were used in this test out of these 28 specimens sixteen specimens are filled with concrete and remaining 12 specimens were kept hallow, in this study was to test the different cross sectional tubes and load capacity is investigate. Coming to material properties of this study was used, preparing of steel pipes these pipes are made with mild steel and use of grade 36 (250mpa) steel was used to prepare pipes. The ratio of the columns length to diameter range between from 4 to 9, the thickness of steel pipes are varying from (1.98mm to 10mm), and also the diameter of pipe sizes are between (50 to 450 mm diameter) are available. Coming to this study main parameters were used in this test thickness ratio and tube shape. The internal bracing of concrete columns have a deformed bars are in #3 , by the compressive strength of 250 Mpa, this study was carried by the axial compression of steel tube by using of 200 mm long tubes. For the cross section of circular tubes only the pipe length is available in 6 m for each. It is testing of cast by use concrete cylinders; total 3 cylinders were used in this cast and test. The diameters of cylinders are between (150 to 300 mm) lengths.

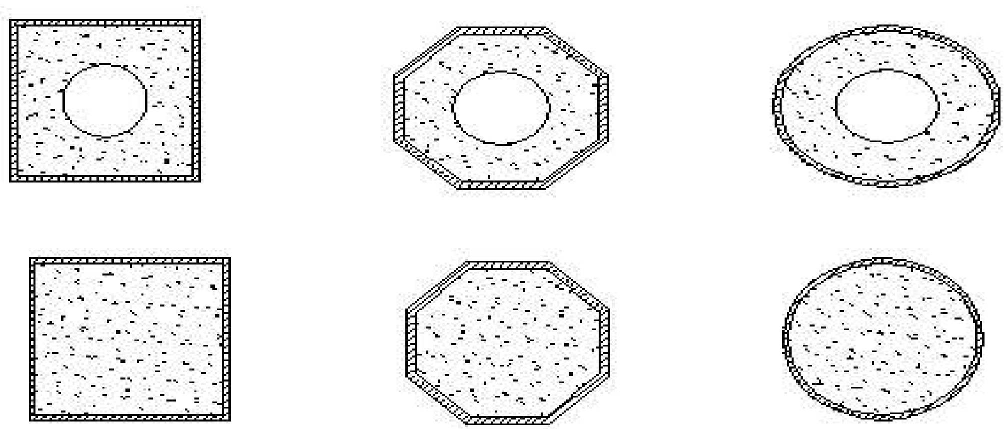

Fig. 1: Various types of CFST composite columns cross sections

2. MATERIAL AND METHODS

The experimental investigation of concrete filled steel tube (CFST) under axial compression test is conduct for the behavior of short CFST under axial compression to failure. A total of 42 specimens were tested and from these 42 specimens thirty six specimens are filling with concrete, three specimens are only concrete, and three specimens are kept hallow. And these total specimens are experimentally tested under axial compression and different cross-section of columns was tested to investigate load carrying capacity in particular and behavior

2.1MATERIAL PROPERTIES

2.1.1 GRADE OF CONCRETE

The concrete is used of M20, M30 and M40 grades. By using IS 10262:1982 the proportions of concrete. The concrete blocks of size 150mm x150mm x 150mm are prepared by obtained proportions. Three blocks are casted by each proportion and tests were carried out under compression testing machine. The average test results are tabulated in table 1

Table 1: 28 day's strength for M20, M30 and M40 grade of concrete block

Grade of concrete	Load in KN	Average strength in N/mm^2
A-M20	637.22	26.78
B-M30	789.60	34.15
C-M40	959.23	42.56

2.1.2 STEEL TUBE SPECIMEN DETAILS

The rectangular tube dimensions between 36.1mm to 76.2 and 300 mm long. The grade of mild steel pipes are 250 grades, the l/d ratio of specimens are 5.17 and 5.90. The d/t ratio is 18.5 to 58. The circular pipe sizes are D-50.8 and 300 mm long. And 1 mm to 3 mm thickness of tube wall. The total test specimens are prepared by using these dimensions.

Total three type of cross sectional (circular, square, and rectangular) tubes are used in this experiment. In those 3 tubes were prepared in different kind of pipes. The inside of specimens were attached in mild steel plates, some pipes are prepared with greased inside surface of pipe and some those are prepared by steel plates tagged inside surface of the pipes by using grease inside of pipes to reduce bond between concrete and steel tube. After preparing these specimens the test tubes were tested under axial compression testing machine.

The main Advantage of steel plates is use inside surface of pipes to achieve better bond between concrete and steel tube. The inside dimensions of steel tubes were also used in same dimensions of as plain concrete specimens. Experimental results compared with obtained of ultimate load carrying capacity. The experimental test results were compared with available theoretical design specifications (ACI, LRFD and EC4) code practice. These results were also tested with other published results.

2.2 EXPERIMENTAL TEST

The compression testing machine is used for testing of concrete filled steel tube specimens. The specimen of CFST is placed centrally on plates of compression testing machine and load is applied gradually.

2.3: TEST SPECIMENS

Fig. 2: Photograph of Specimens

Fig.3: CFST Specimen after casting.

Table 2: Details of marked CFST specimens

Sr. No.	Specimen marked	Tube Dimensions (mm)	Height(mm)	Thickness (mm)	d/t	l/d	Remarks
1	C	50.8	300	2	25.4	5.9	Circular pipe
2	C(G)	50.8	300	2	25.4	5.9	Circular pipe with grease inside

3	C(T)	50.8	300	2	25.4	5.9	Circular pipe with steel plate tagged inside
4	C(P)	50.8	300	2	25.4	5.9	Circular pipe with plate in 1/3 rd distance
5	S	50.8X50.8	300	3	18.5	5.40	Square pipe
6	S(G)	50.8X50.8	300	3	18.5	5.40	Square pipe with grease inside
7	S(T)	50.8X50.8	300	3	18.5	5.40	Square pipe with steel plate tagged inside
8	S(P)	50.8X50.8	300	3	18.5	5.40	Square pipe with plate in 1/3 rd distance
9	R	38.1X76.2	300	1	58	5.17	Rectangular pipe
10	R(G)	38.1X76.2	300	1	58	5.17	Rectangular pipe with grease inside
11	R(T)	38.1X76.2	300	1	58	5.17	Rectangular pipe with steel plate tagged inside
12	R(P)	38.1X76.2	300	1	58	5.17	Rectangular pipe with plate in 1/3 rd distance

3. RESULTS AND ANALYSIS

GENERAL -In this experimental investigation on concrete filled steel tube (CFST) under axial compression, the experimental test results to compare with other published test results, and also theoretical results to compare with other different code practices

According to ACI-318 and AS practices are to specify the formula code

$Nu = 0.85Ac\ fc + As\ fy$

According to EC4 code practices are to specify the formula

$Nu = Ac\ fc + As\ fy$

According to LRFD code practices are to specify the formula

$Nc = As \times fcr$

3.2 LOAD CARRYING CAPACITY OF VARIOUS CROSS SECTIONS

Table 4: CFST columns of test results in KN (A-grade concrete)

Type of cross-sections	Plain pipe	Pipe with grease	Pipe with steel plate inside	Pipe with steel plate at 1/3rd in distance	Hollow pipe	Solid concrete core
CIRCULAR	322	320	334	345	90	72
SQUARE	190	180	218	220	80	70
RECTANGULAR	190	160	200	207	60	66

Table 5: CFST columns of test results in KN (B-grade concrete)

Type of cross-sections-b	Plain pipe	Pipe with grease	Pipe with steel plate inside	Pipe with steel plate at 1/3rd in distance	Hollow pipe	Solid concrete core
CIRCULAR	340	320	350	360	88	106
SQUARE	216	210	230	250	80	80
RECTANGULAR	220	210	230	243	73	80

Table 6: CFST columns of test results in KN (C-grade concrete)

Type of cross-sections	Plain pipe	Pipe with grease	Pipe with steel plate inside	Pipe with steel plate at 1/3rd in distance	Hollow pipe	Solid concrete core
CIRCULAR	360	330	370	380	90	120
SQUARE	250	220	230	250	80	100
RECTANGULAR	220	190	220	250	70	110

3.2 COMPARATIVE GRAPHICAL PRESENTATION

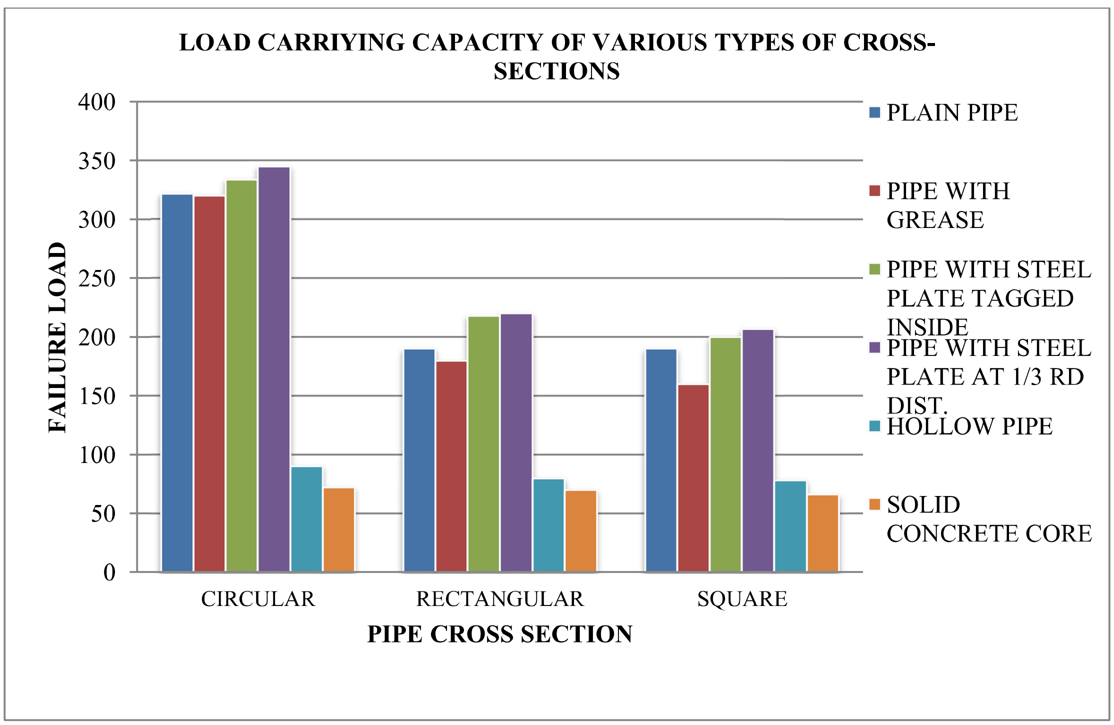

Fig. 4: Comparative graphical presentation for test results for different cross sections with M20 concrete

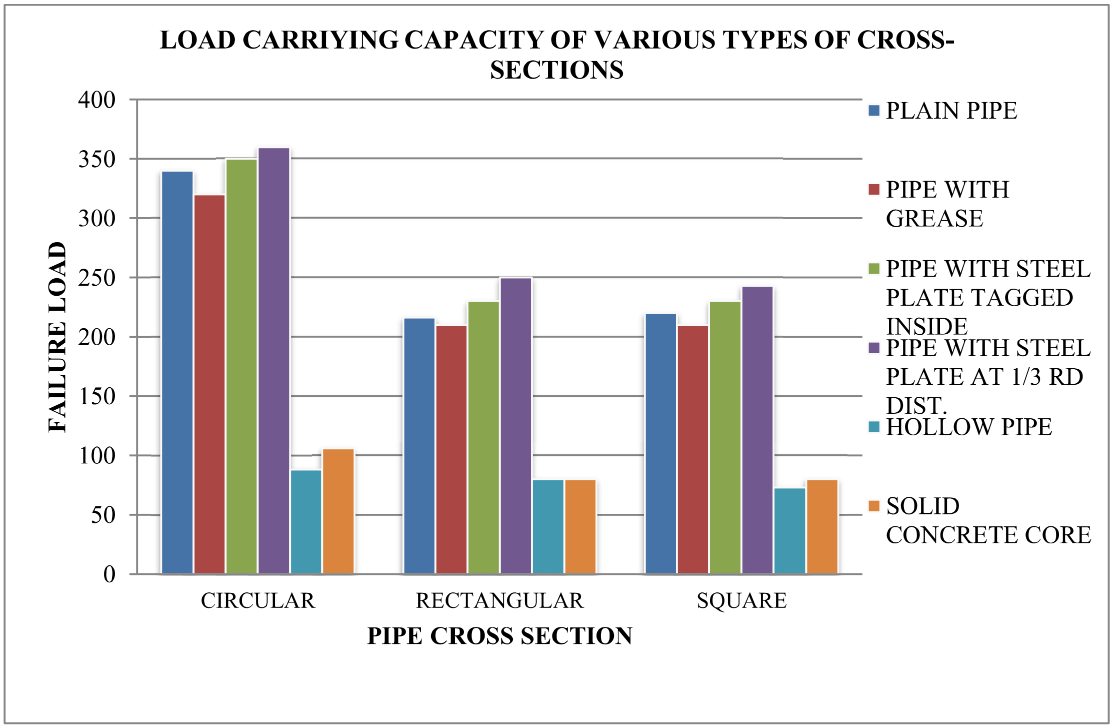

Fig. 5 : Comparative graphical presentation for test results for different cross sections with M30 concrete

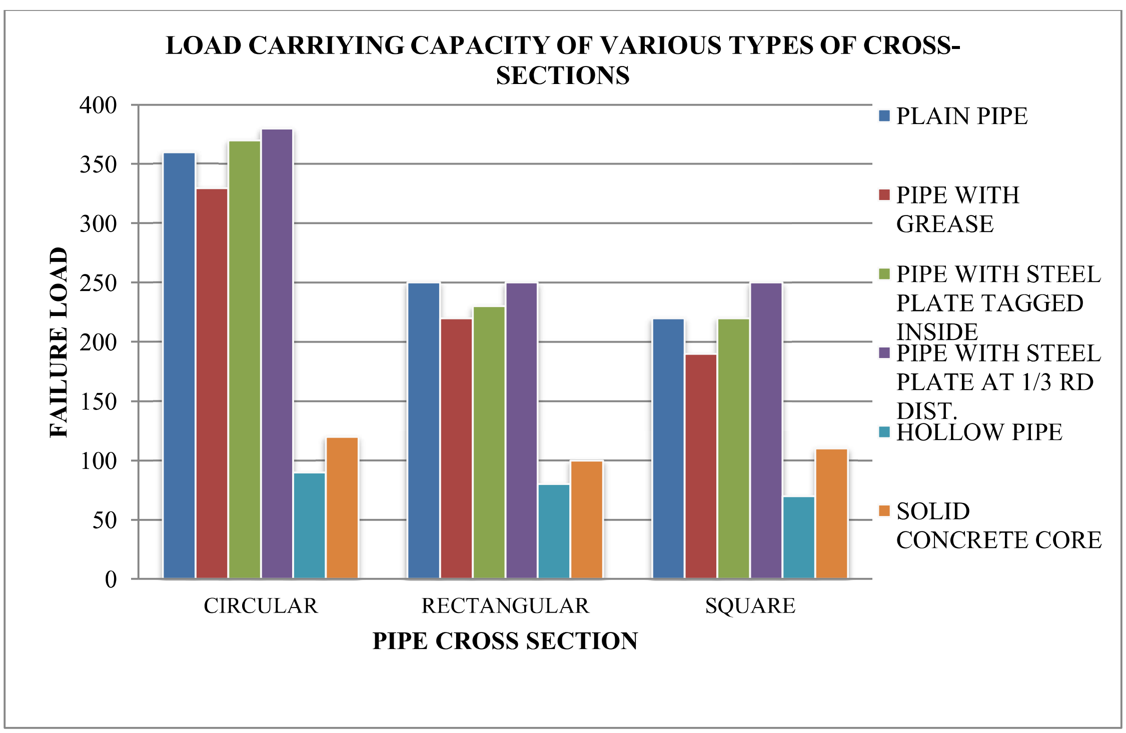

Fig. 6: Comparative graphical presentation for test results for different cross sections with M40 concrete

4. CONCLUSIONS

- To compare with square and rectangular columns, the circular columns have been increased more strength.
- Compressive strength was influenced by the few amount of bond strength, because concrete core and steel pipes have not relative slip possible between these two under axial compression.
- It was confirmed that the ductility of circular cross section was larger than the specimen of square and rectangular cross sections.
- The use high strength infill concrete is much more effective to get extra strength with same size CFST column

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