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# Experimental Investigation on Concrete Filled Steel Tube under Axial Compression

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**ABSTRACT:** In recent days, due to the expansion of cities it is required to construct the high storey buildings. Composite buildings prove to be promising for multi storey building. As a result, composite columns have recently undergone increased usage throughout the world, which has been influenced by the improvement of high strength concrete enabling these columns to be considerably economized. Columns are designed to resist the majority of axial force by concrete alone can be further economized by the use of thin walled steel tube. The project discusses about the behaviour of the composite column and various codal provisions. Experimental research carried out by comparative study between experimental results and analytical results for hollow steel tube (HST) and concrete filled steel tubes (CFST) under axial compression. To compare the experimental results of CFST with AISC-318 and Eurocode-4 the investigation is carried out on HST & CFST specimens of Circular Square and Rectangular cross section. The grade of concrete used for infill concrete is M20 and M30. The axial load is applied gradually on specimens. This project presents the details of study carried out and the conclusions arrived.

**Keywords:** HST, CFST, Eurocode-4, axial loading, etc

## I. INTRODUCTION

### 1.1 GENERAL

The composite structure of steel-concrete columns is not new to the construction industry. The columns have been used for over 100 years with the concrete material was initially used as insulation that was required to fulfill the fire-rating requirement. In the case of its early application, the contribution of composite action, which is in the structure, was not taken into consideration. The composite action exists when two different materials are joined together so strongly that, from a structural perspective, together, they are able to act as a single unit. Owing to the composite action, the composite member is stiffer and stronger than the sum of the individual members. However, these structural benefits were only established in the middle of the 20th century when the increment of stiffness and strength were observed in another type of composite structure namely encased composite beam. In 1948, British Standard has taken into account the increase of stiffness.

The concrete filled steel tubular columns have an excellent 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

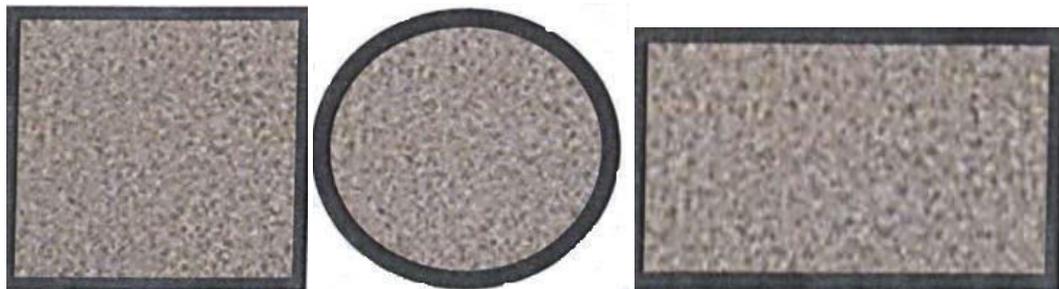
Brief information of research work done by the researcher's about topic which will help us to decide about subject is given as below.

**Zhong Tao [2016]** <sup>[5]</sup>: This paper deals with the bond behaviour between the steel tube and the concrete in CFST column. Number of push-out test on circular and square CFST columns were conducted and in this paper the parameters considered were cross-sectional dimension, to different steel tubes like carbon and stainless steel, concrete type like normal and expansive concrete, concrete age and interface types such as normal interface, interface with shear studs and interface with an internal ring. From this study the author had seen that the stainless steel CFST columns

have less bond strength when compared to carbon steel columns, and the bond strength decreases remarkably with increase in cross-sectional dimension

**Yu Chen [2016]<sup>[07]</sup>** This paper repeated push-out tests on concrete-filled stainless-steel tubes columns were made. The tubes with different values of height-to-diameter ratio, diameter-to-thickness ratio and concrete strengths were considered in the present study It been absorbed that the height-to-diameter ratio and the diameter-to-thickness ratio of the stainless-steel tube as well as the concrete strength have insignificant influence on the shear resistance of the bonding strength of the interface elements. It was also shown from the comparison that the current design rules of concrete-filled carbon steel tubes are inapplicable to the shear resistance of the bonding strength of concrete-filled stainless-steel tubes

**Ran Feng, Yu Chen [2018]<sup>[11]</sup>** In this paper total of 32 push-out tests were carried out on concrete filled stainless-steel square tubes with different values of height to width ratio, width to thickness ratio and concrete strength. The bond-slip behaviour of all specimens and the strain distribution on the exterior of stainless-steel tubes along the longitudinal height direction were carefully investigated. It been absorbed that shear failure loads of bonding slip and the interface friction resistance generally decreased with more loading cycles of the repeated push-out test employed in the same direction. In this paper the author had concluded that 70% of the bonding strength at the interface was taken by the friction force of the interface elements, while the remaining 30% of the bonding strength at the interface was sustained by the chemical adhesive force and the mechanical interlock force



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

## II. 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 48 specimens were tested and from these 48 specimens thirty six specimens are filling with concrete, six specimens are only concrete, and six specimens are kept hollow. 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 behaviour

### 2.1 MATERIAL PROPERTIES

#### 2.1.1 GRADE OF CONCRETE

The concrete is used of M20, M30 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 2.1

**Table 2.:** 28 day's strength for M20, M30 grade of concrete block

Grade of concrete	Load in KN	Average strength in N/mm <sup>2</sup>
M20	527.37	23.43
M30	723.9	32.17

### 2.1.2 STEEL TUBE SPECIMEN DETAILS

The rectangular tube dimensions between 40.0mm to 80.0 and 300 mm long. The grade of mild steel pipes are 250 grades, the l/d ratio of specimens are 5.0 and 7.5. The d/t ratio is 26.67 to 40. The circular pipe sizes are D-60.0 and 300 mm long. And 1.5 mm to 2.5mm 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 rod, some pipes are prepared with greased inside surface of pipe. After preparing these specimens the test tubes were tested under axial compression testing machine.

The main Advantage of steel rods 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 and EC4) code practice.

### 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 SET UP



Fig.2: Test Set up for column on UTM.



**Table 3: Details of marked CFST specimens (Type-A)**

Sr. No.	Specimen marked	Tube Dimensions (mm)	Height(mm)	Thickness (mm)	d/t	l/d	Remarks
1	A-C	60	300	1.5	40	5	Circular pipe
2	A-C(G)	60	300	1.5	40	5	Circular pipe with grease inside
3	A-C(T)	60	300	1.5	40	5	Circular pipe with steel rod tagged inside
4	A-S	50x50	300	1.5	33.33	6	Square pipe
5	A-S(G)	50x50	300	1.5	33.33	6	Square pipe with grease inside
6	A-S(T)	50 X 50	300	1.5	33.33	6	Square pipe with steel rod tagged inside
7	A-R	80.0X40.0	300	1.5	26.67	7.5	Rectangular pipe
8	A-R(G)	80.0X40.0	300	1.5	26.67	7.5	Rectangular pipe with grease inside
9	A-R(T)	80.0X40.0	300	1.5	26.67	7.5	Rectangular pipe with steel rod tagged inside



**Table 4: Details of marked CFST specimens (Type-B)**

Sl no.	Specimen marked	Tube dimensions (mm)	Height (mm)	Thickness t(mm)	d/t	l/d	Remarks
10	B-C	60	300	2.5	24	5	Circular pipe
11	B-C(G)	60	300	2.5	24	5	Circular pipe with grease inside
12	B-C(T)	60	300	2.5	24	5	Circular pipe with steel rod tagged inside
13	B-S	50.0X50.0	300	2.5	20	6	Square pipe
14	B-S(G)	50.0X50.0	300	2.5	20	6	Square pipe with grease inside
15	B-S(T)	50.0X50.0	300	2.5	20	6	Square pipe with steel rod tagged inside
16	B-R	80X40	300	2.5	16	7.5	Rectangular pipe
17	B-R(G)	80X40	300	2.5	16	7.5	Rectangular pipe with grease inside



18	B-R(T)	80X40	300	2.5	16	7.5	Rectangular pipe with steel rod tagged inside
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**Table 3.5 Hollow steel tube specimen**

Sr. No.	Specimen Marked	Tube Dimensions	Height	t(mm)	d/t	l/d	Remarks
1	C	60.0	300	2.5	24	5	Circular pipe
2	C	60.0	300	2.5	24	5	Circular pipe
3	S	50.0X 50.0	300	1.5	33.33	6	Square pipe
4	S	50.0X 50.0	300	2.5	20	6	Square pipe
5	R	80X40	300	1.5	58	7.5	Rectangular pipe
6	R	80X40	300	2.5	58	7.5	Rectangular pipe

**Table 3.6 Solid Concrete Specimen**

Sr. No.	Specimen Marked	Dimensions (mm)	Height (mm)	l/d	Remarks
1	C	60	300	4.9	Circular pipe
2	S	50.0X50.0	300	6.0	Square pipe
3	R	80x40.0	300	7.5	Rectangular pipe



**III. RESULTS AND ANALYSIS**

GENERAL -In this experimental investigation on concrete filled steel tube (CFST) under axial compression, the experimental test results to compare with theoretical results other different code practices According to ACI-318 and AS practices are to specify the formula code

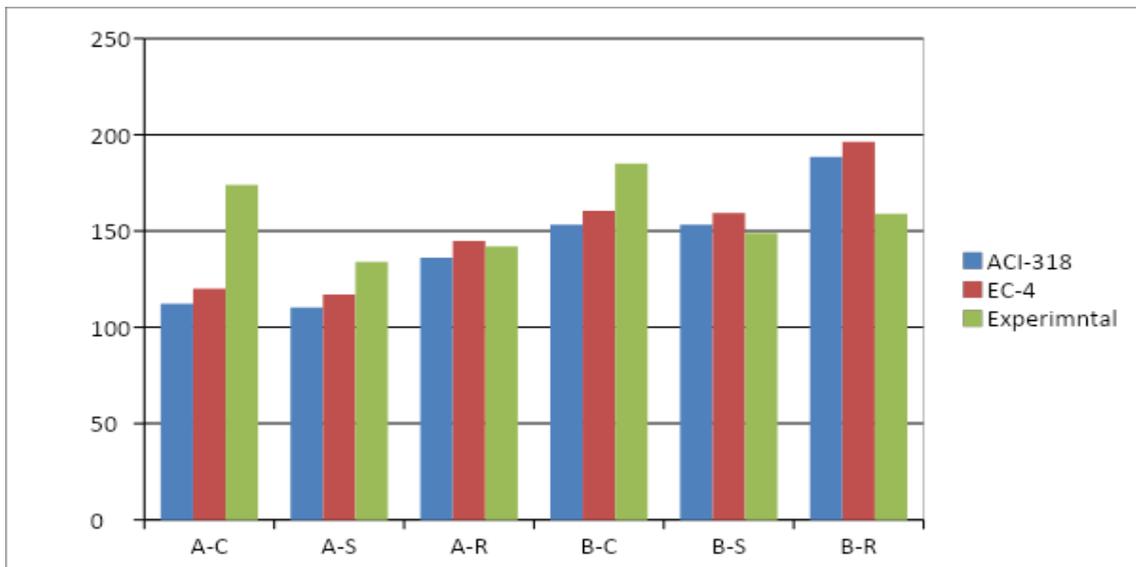
$$P_u = 0.85A_c f_c + A_s f_y$$

According to EC4 code practices are to specify the formula

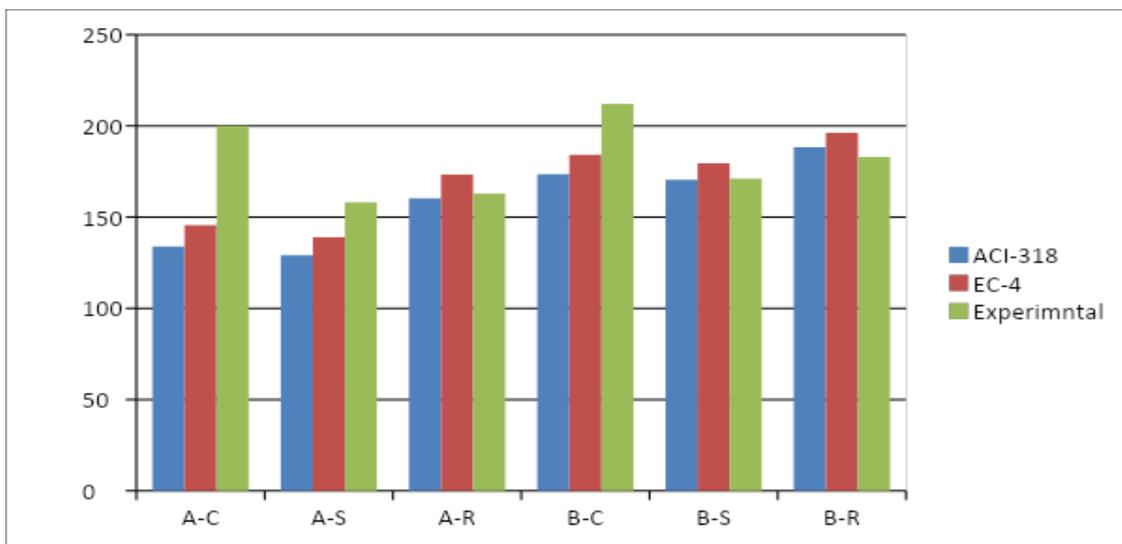
$$P_u = A_c f_c + A_s f_y$$

**3.1 Comparison of Results** In this comparison is made with results obtained by different code of practice and experimental results, also ratio of experimental load carrying capacity to analytical results are calculated for comparison on the basis of size and shape

**COMPARATIVE GRAPHICAL PRESENTATION**



**Fig 3: Comparative graphical presentation for test results and different code of practices with M20 concrete**



**Fig. 4: Comparative graphical presentation for test results and different code of practices with M30 concrete**

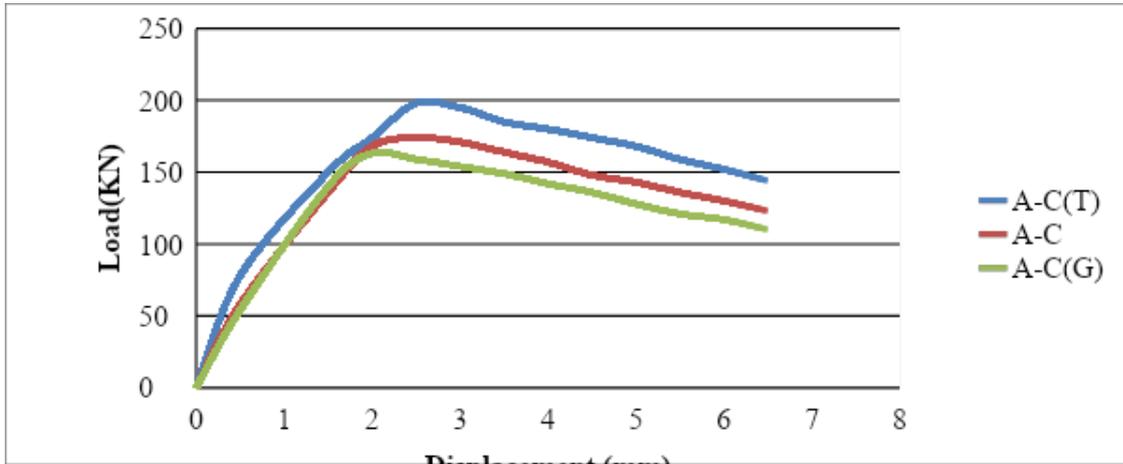


Fig. 5: Comparative Graphical presentation for test results of Load vs. Displacement with M20 concrete

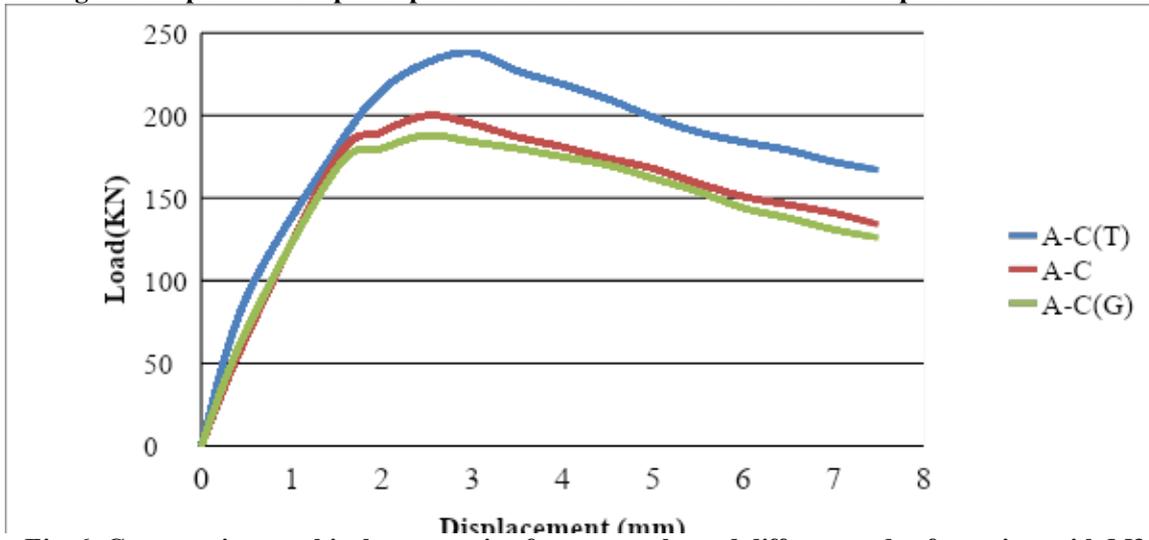


Fig. 6: Comparative graphical presentation for test results and different code of practices with M30 concrete

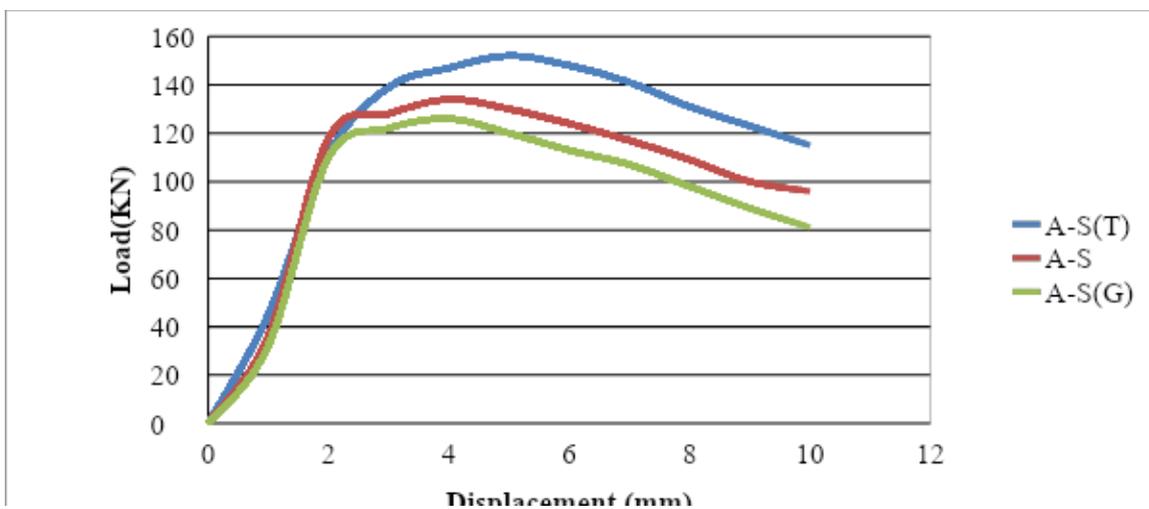


Fig. 7: Comparative Graphical presentation for test results of Load vs. Displacement with M20 concrete

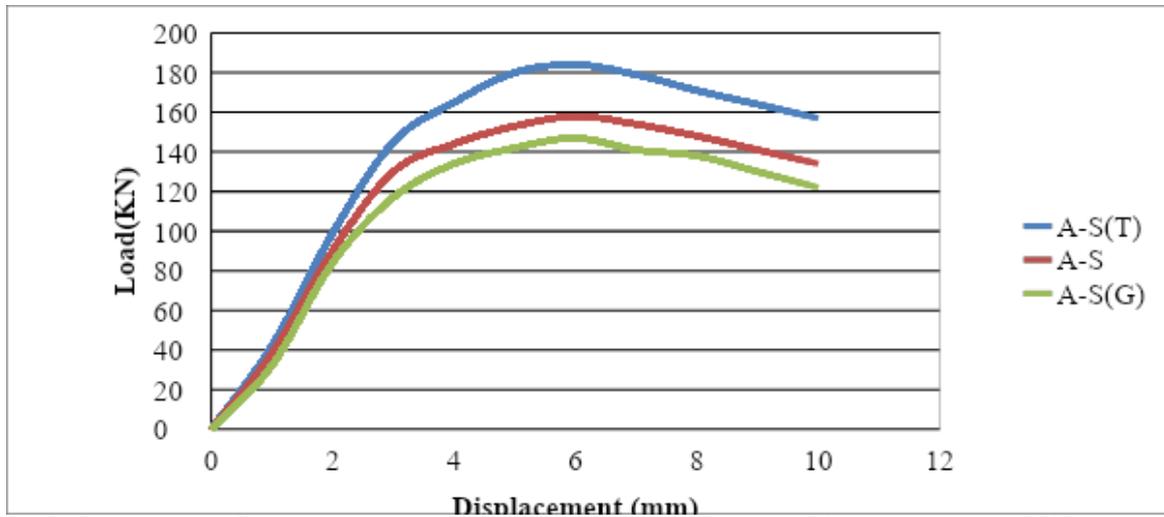


Fig. 8: Comparative Graphical presentation for test results of Load vs. Displacement with M30 concrete

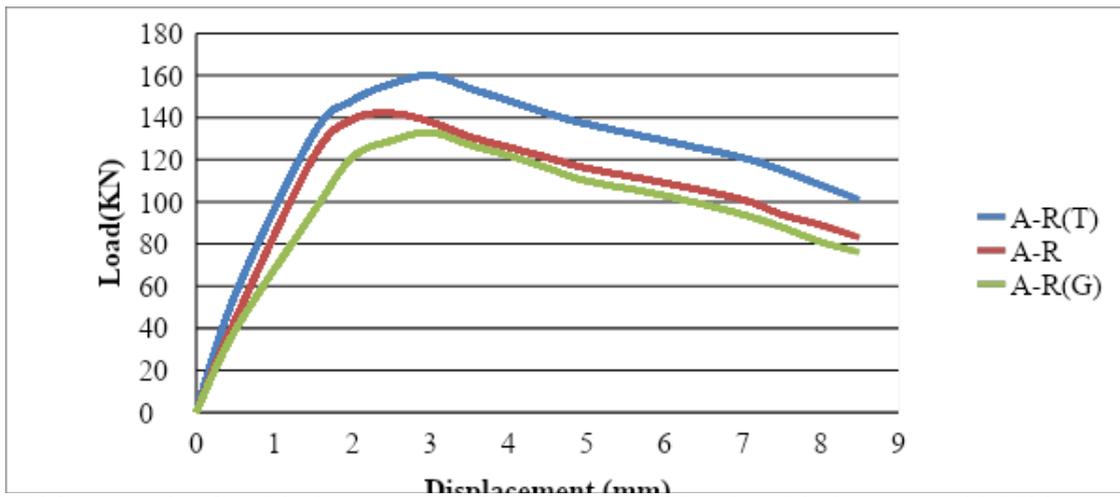


Fig. 10 Comparative Graphical presentation for test results of Load vs. Displacement with M20 concrete

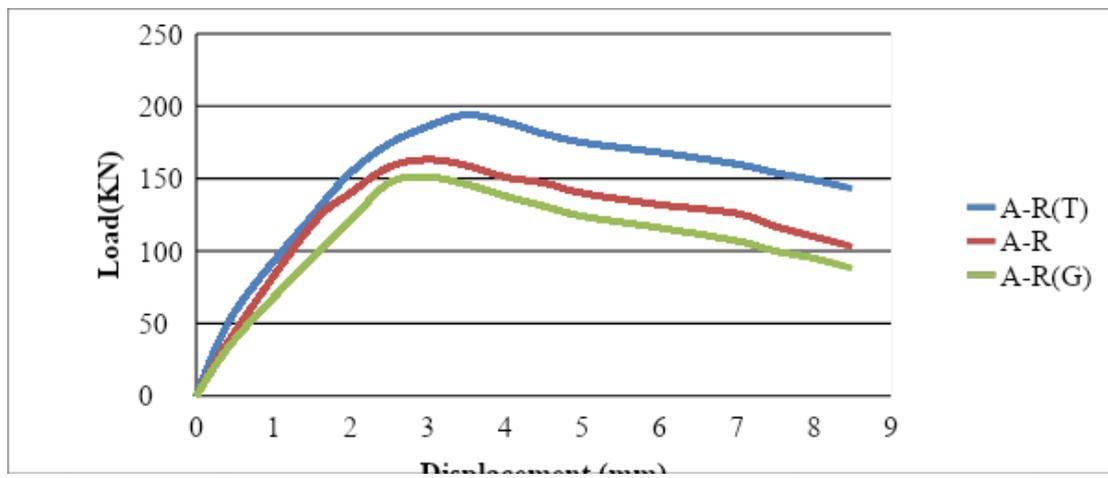


Fig. 11: Comparative Graphical presentation for test results of Load vs. Displacement with M20 concrete



#### IV. CONCLUSIONS

- The axial load carrying capacity of circular CFST columns was more than square and rectangular cross section
- As the grade of concrete infill increases strength is also increases. Therefore it is concluded that use high strength infill concrete is much more effective to get extra strength with same size CFST column
- As the grade of concrete infill increases strength is also increases. Thus the load verses displacement curve is shifted higher for higher grade of concrete.
- The theoretical axial load carrying capacity of Concrete Filled Steel Tubular columns evaluated in accordance with AISC-318 and Euro code 4 were found to be in best agreement

#### REFERENCES

- [1] C.S. Huang, Y.K. Yeh, G.Y. Liu, H.T. Hu, K.C. Tsai, Y.T. Weng, S.H. Wang and M.H. Wu “Axial load behavior of stiffened concrete-filled steel columns”, Journal of Structural Engineering, ASCE, September 2002.
- [2] Eurocode 4: Design of composite steel and concrete structures.
- [3] Georgios Giakoumelis and Dennis Lam “Axial capacity of circular concrete-filled tube columns”, Journal of Constructional Steel Research 60 (2004) 1049-1068.
- [4] Haider M. Abdul Hussein, Ahmed N. Mohammed In (2013), “Nonlinear finite element analysis of concrete filled steel tubes”. Journal of Babylon University/ Engineering Sciences/ N0.(2)/Vol.(21): 2013.
- [5] Zhong Tao, “Bond behaviour in concrete-filled steel tubes” publication Elsevier Journal of Constructional Steel Research, 12 January 2016
- [6] Kenji Sakino, Hiroyuki Nakahara, Shosuke Morino and Isao Nishiyama, “Behavior of Centrally Loaded Concrete-Filled Steel Tube Short Columns”. Journal of Structural Engineering, ASCE, February 2004
- [7] Yu Chen, “Bond-slip behaviour of concrete-filled stainless steel circular hollow section tubes” publication Elsevier Journal of Constructional Steel Research, 22 December
- [8] Martin D. O’ Shea, “Design of Circular Thin-Walled Concrete Filled Steel Tubes”, Journal of Structural Engineering”, ASCE, November 2000.
- [9] Muhammad Naseem Baig, FAN Jiansheng , NIE Jianguo “Strength of Concrete Filled Steel Tubular Columns”, Tsinghua Science and Technology, December 2006, 11(6): 657-666.
- [9], N. E. Shanmugam and B. Lakshmi, “State of the art report on steel–concrete composite columns,” Journal of Constructional Research, vol. 57, no. 10, pp. 1041–1080, 2001
- [10] Ran Feng, “Push-out tests of concrete-filled stainless steel SHS tubes” publication Elsevier Journal of Constructional Steel Research, 16 February 2018.
- [11] Lin Hai Han, Zhong Tao and Wei Liu in “Effects of Sustained Load on Concrete-Filled Hollow Structural Steel Columns”, Journal of Structural Engineering, ASCE, September 2004)



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