Validation of Ultimate Load Capacity using ANSYS on Hybrid Double Skin Composite Columns (HDSCs)

Mohammed Mukarrum Ali[1] Narayana B R[2] Dr. N S Kumar[3]
[1]PG Student [2]Assistant Professor [3]Professor Director R & D
[1,2,3]Department of Civil Engineering
[1,2,3]Ghousia College of Engineering, Ramanagaram

Abstract— This study implicates the structural physiognomies of the composite sections. An analytical and theoretical study relating to ultimate load behaviour of the circular double skin composite column fully filled with concrete is presented. The results have been analysed using ANSYS 17.2 software. Analytical results and theoretical results have been related and presented in this paper. Areas of supplementary exploration are presented in this paper. Composite sections are fetching progressively prevalent in construction. Coupling the strength of two diverse materials to form a composite section can be valuable in terms of both structural routine and price tag. A case in point of a far and wide used composite section in construction is composite column, this form of construction has turn out to be very widespread in modern years, where steel beam and concrete column act compositely to battle load. There has also been a current flow in acceptance of composite columns. Experimental compression tests on steel tubular columns filled with plain concrete & fibre reinforced concrete are carried out for two different grade of concrete (M20, M25). Lately, composite columns are finding a lot of tradition for seismic confrontation. In command to avert shear failure of RC column bring about in storey collapse of building, it is obligatory to make ductility of columns superior. Lately, most of building exploits this Concrete Filled Steel tubes (CFST) notion as chief for lateral load battling frames. The concrete cast-off for wrapping the structural steel section not only augments its strength & stiffness, but also shields it from fire reimbursements.

Key words: Concrete Filled Steel Tube, ANSYS, Finite Element Analysis, Contact Element, Composite Column

I. Introduction

Based on the experimental methodologies on a figure of erection methods for the columns in high rise structures, it is initiated that the concrete filled steel tube is a very constructible and reasonably priced elucidation for multi-storey building. A key issue is the capability to reduce the charges and the on-site interval of construction. From the interpretation point of the structural physiognomies, the most vital reason for the budget of this caring of column, is the confinement of the concrete by the tube, which further pep talk the ability of the concrete. This is not probable with any other composite column arrangement. On the other hand, a generous section of the axial load is taken on the high power concrete, which is the most inexpensive way to counterattack the compressive force. In count, the constructability of the unreinforced filled tube is its prime lead. The absenteeism of reinforcement has far-reaching aids in dipping carnage, treatment, and site labour, as well as critically make simpler fabrication and gathering of the columns. Moreover, the solidity of the steel tube will be upgraded against the indigenous do up. According to the compensations of this system, there is an evolving development all over the world on the road to the use of concrete filled hollow sections for the design of high rise structures. Concrete filled steel tubes have been expansively used in the modern structure mainly due to the mishmash of the advantage of Steel tube & Concrete core. However, many researchers cast uncertainty on the practice of plain concrete as in-fill material in steel tubes, due to tremendously terrible effects of 1995 Kobe shaking in Japan on steel & concrete composite structures. This provoked a revolution of seismic enterprise viewpoint from the earlier accent on structural strength to accent on structural ductility & energy interest. Accordingly, the in-fill material inside Steel tubes is essential to be of the worth as to upsurge the ductility, but not the strength of composite columns, many kind of infill materials were cast-off to expand ductility of composite columns. Among the various in-fill materials, fibre is gaining courtesy in the composite columns, due to high flexural strength, tensile strength, lower shrinkage, & healthier fire resistance.

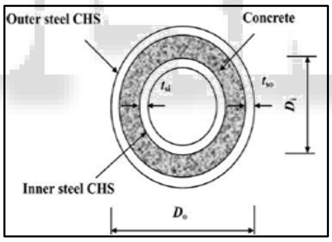

Fig. 1: Cross-sections of concrete-filled steel tube

A composite column is a structural adherent that uses a mixture of structural steel shapes, pipes or tubes with or without reinforcing steel bars and reinforced concrete to provide satisfactory load carrying capability to sustain either axial compressive loads alone or a blend of axial loads and bending moments.

A. Finite Element Modeling

Short circular double skin composite column filled with plain Cement Concrete has been modelled. For the contemporary study, the grade of concrete has diverse among 20 to 30MPa and yield strength of steel is set aside persistent 310MPa. The Poisson's ratio for steel is engaged as 0.3. The correct imitation of composite accomplishment between concrete and steel tube is the single utmost vital aspect guiding the behaviour of the CFT column. To model this interface, the normal interaction between the two materials is delivered by means of friction, with the inside surface of the stiffer steel tube helping as the unyielding surface and the external surface of the concrete core as the slave surface.

B. Modeling of the Specimen

All modeling has led using ANSYS 17.2 finite element software. The modeling of columns has done in stages i.e. hollow samples have modelled as 3D shell181 and concrete samples have modelled as element with alike geometry. Dealings rudiments are used for modeling interface amid Concrete and Steel. When two distinct surfaces trace each other such that they become conjointly tangent, they are supposed to be in interaction. The model is concluded only when interconnecting them appropriately. Both steel tube and concrete infill are interlocked of equivalent sizes to deliver contact between them very simply.

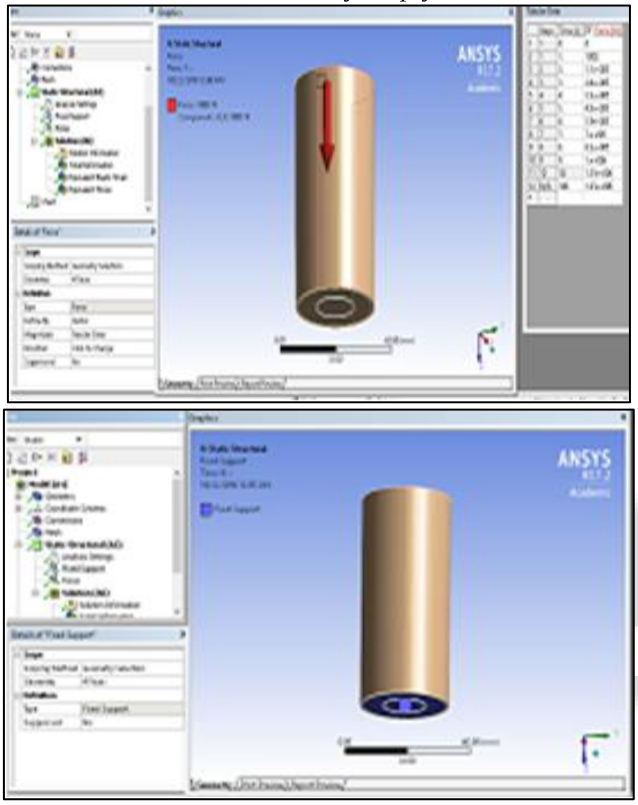

Fig. 2: Model after assigning load and support

II. STEEL

The steel columns cast-off were hot-rolled CHS sections. The tolerable D/t ratios of the steel hollow sections are less than the bounds quantified in EC-1994 and accordingly the untimely buckling let-down of CFT specimens is sidestepped.

Density	7850 kg/m^3
Poisson's ratio	0.3
Elastic Modulus	2.01 x 10^5 N/mm^2
Yield strength	310 N/mm^2

Table 1: Material Property of steel

III. CONCRETE

The concrete infill castoff for CFST is of M20 and M25 grades. The proportions attained by fusion design of concrete via IS 10262:1982.

Density	2500 kg/ m^3
Poisson's ratio	0.18
Elastic Modulus	25000 N/ mm^2
Compressive Strength	20 N/mm^2

Table 2: Material Property of Concrete

IV. ANALYSIS

A. Finite Element Method

For numerous engineering difficulties investigative explanations are not appropriate because of the complication of the material properties, the boundary settings and the structure itself. The basis of the finite element technique is the demonstration of a physique or a structure by an accumulation of sections called finite elements.

B. ANSYS

Ansys 17.2 is a commercial FEM platform having the aptitudes ranging from a simple, linear, static analysis to a complex, nonlinear, transient dynamic study. It is accessible in units. Each unit is valid to precise problem. For example, Ansys/Civil is related to civil structural analysis. The benefit of Ansys linked to extra good software's is, its accessibility as bundled software of pre, post and a Processor. The perfect imitation answer for universities is one that is flexible adequate to be of value to a diverse assembly of users with varying ranks of capability, from undergraduate students and teachers to postgraduate and faculty researchers. ANSYS offers a widespread choice of affordable technologies and amenities to support meet these diverse and growing desires. Universities, colleges and research institutes round the world turn to ANSYS for high-quality imitation solutions to guarantee that students obtain the best engineering learning likely.

V. RESULTS AND CONCLUSION

Result comparison with Euro code 4.

Sl. No.	Outer Tube Dia.(Do)	Outer Tube Thickness (to) (mm)	Inner Tube Dia. (Di) (mm)	Inner Tube Thickness (ti) (mm)	Do/to	Length (mm)	Ultimate Load as per EUROCODE4 (KN)	Ultimate Load as per ANSYS (KN)
1	42.4	2.6	21.3	2.0	16.3	84.8	242.8	235.0
2	42.4	2.6	21.3	2.0	16.3	169.6	212.1	203.1
3	42.4	2.6	21.3	2.0	16.3	254.4	185.0	176.1
4	76.1	3.2	33.7	2.6	23.8	152.2	421.0	407.6
5	76.1	3.2	33.7	2.6	23.8	304.4	378.8	362.9
6	76.1	3.2	33.7	2.6	23.8	456.6	341.2	324.8
7	114.3	3.6	60.3	2.9	31.8	228.6	664.5	643.3
8	114.3	3.6	60.3	2.9	31.8	457.2	609.8	584.2
9	114.3	3.6	60.3	2.9	31.8	685.8	563.1	536.1
10	165.1	4.5	88.9	3.2	36.7	330.2	1136.7	1100.3

11	165.1	4.5	88.9	3.2	36.7	660.4	1059.6	1015.1
12	165.1	4.5	88.9	3.2	36.7	990.6	991.6	944.0

Table 3: For fck 20 N/mm^2 & Fe 310 N/mm^2

Sl. no.	Outer Tube Dia. (Do)	Outer Tube Thickness (to) (mm)	Inner Tube Dia. (Di) (mm)	Inner Tube Thickness (ti) (mm)	Do/to	Length (mm)	Ultimate Load as per EUROCODE4 (KN)	Ultimate Load as per ANSYS (KN)
1	42.4	2.6	21.3	2.0	16.3	84.8	211.1	204.3
2	42.4	2.6	21.3	2.0	16.3	169.6	186.8	179.0
3	42.4	2.6	21.3	2.0	16.3	254.4	165.2	157.2
4	76.1	3.2	33.7	2.6	23.8	152.2	385.3	372.9
5	76.1	3.2	33.7	2.6	23.8	304.4	350.5	335.8
6	76.1	3.2	33.7	2.6	23.8	456.6	321.5	306.1
7	114.3	3.6	60.3	2.9	31.8	228.6	632.6	612.4
8	114.3	3.6	60.3	2.9	31.8	457.2	589.8	565.0
9	114.3	3.6	60.3	2.9	31.8	685.8	554.4	527.8
10	165.1	4.5	88.9	3.2	36.7	330.2	1112.9	1077.3
11	165.1	4.5	88.9	3.2	36.7	660.4	1052.6	1008.3
12	165.1	4.5	88.9	3.2	36.7	990.6	1001.9	953.8

Table 4: For fck 25 N/mm^2 & Fe 310 N/mm^2

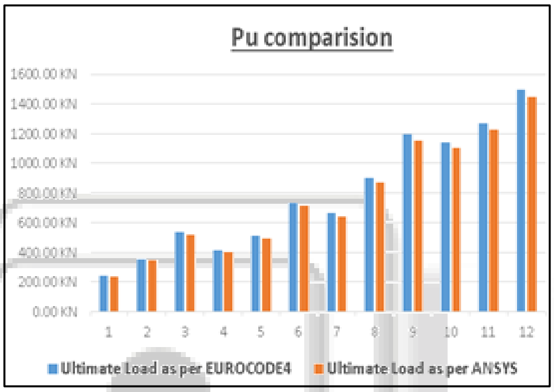

Fig. 3: Load variation for fck 20 N/mm^2 & Fe 310 N/mm^2

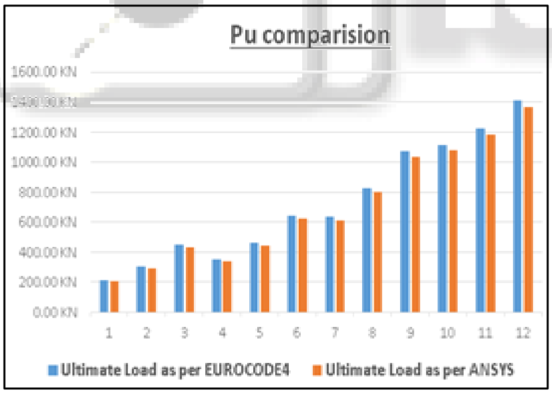

Fig. 4: Load variation for fck 25 N/mm^2 & Fe 310 N/mm^2

VI. Conclusions

In this work behaviour of HDSCs circular columns has been decoratively done by theoretical calculations conferring to EC 4 and FE study of particular examples has been carried out, we can draw the following common assumptions,

- The outcomes by ANSYS (17.2) display good agreement with the euro code 4 (1994) for composite columns.
- As grade of concrete is enhanced ability of CFST column is improved by 15 to 20%.
- Strength of circular HDSCs columns surges as grade of concrete improved.
- Cross-sectional area of the steel tube has the furthermost substantial outcome on both the ultimate axial load capacity and deformation of column.
- From the above outcome and chart it is clear that as the ratio of D/t surges strength declines.

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