International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Validation of Ultimate Load Capacity Using Nastran on Hybrid Double Skin

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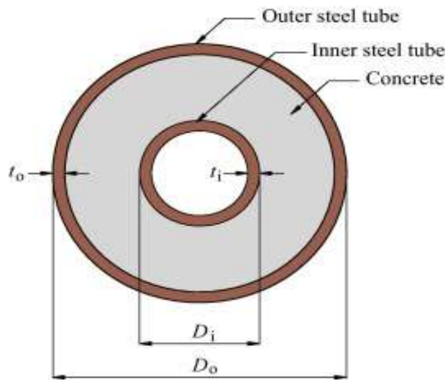
Abstract: ***Analytical investigation was carried out on Hybrid double skinned steel tubular columns consisting of an outer and an inner tube made of steel, with space in between filled with the different grades of light weight concrete as infill. Analysis was done for the ultimate load carrying capacity of tube subjected to axial loading, including the failure pattern up to the ultimate load. Firstly, the models of the required geometry has been created in Hypermesh software and later on the model is exported to NASTRAN software where the model is made to run and to get accurate analysis result. Finally the obtained results are made to view in Hyperview where we get the desired (pu) values. Comparison for analytical and experimental results is obtained as 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.***

Keywords: Hybrid double skinned steel tubular columns, light weight concrete, NASTRAN and Hypermesh software, Finite element analysis, composite column

1. Introduction

A composite column is a structural component so as to uses a mixture of structural steel forms, cylinder with or exclusive of reinforcing steel bars and durable concrete to supply adequate load carrying competence to maintain either axial compression loads only otherwise a mixture of axia loads and twisting moments. Some of the countries have their own codal provisions and design procedure. Most of researcher’s considered the geometric properties like length / diameter (L/D) ratio, thickness / diameter (t/d) ratio with some of boundary condition’s and type of loadings. Generally it has been found that Hybrid double skinned composite steel columns fails due to local bucking or yielding failure. It has found that Europeans codal provisions (Euro code) design method and also the ACI method which gives more reliable results nearer to experimental values.

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. In this project we are using NASTRAN which helps to get accurate results.



1.1 About light weight Concrete

In this project we are using self-compacting concrete infill of grade M30, M40 & M50 in Hybrid double skinned composite steel columns since to overcome problems while using conventional concrete such as:-

- Improves workability.
- Comparatively more durable.
- Relatively low thermal conductivity

LWC has quality proportionate with customary weight concrete, yet is typically 25% to 35% lighter. The fundamental elements of LWC are same as that of conventional cements yet the admixtures will be included which presents entrainment of air. Light weight totals are for the most part utilized as a part of seismic tremor safe structures.

1.2 Finite Element Modelling

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 30 to 50MPa 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.

1.3 Modelling of the Specimen:

All modelling has led using NASTRAN finite element software. The modelling of columns has done in stages i.e. hollow samples have modelled in Hypermesh software and concrete samples have modelled as element with alike geometry. Then analysis were made run in NASTRAN software. Dealings rudiments are used for modelling 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

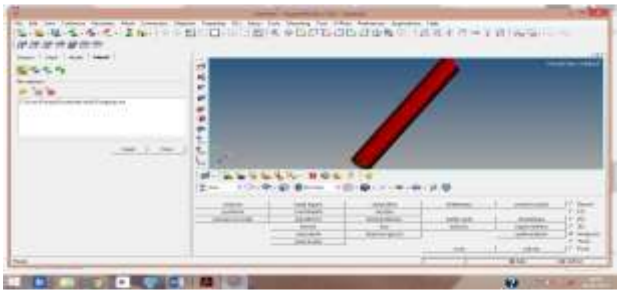


Figure 1: Model Created in Hypermesh

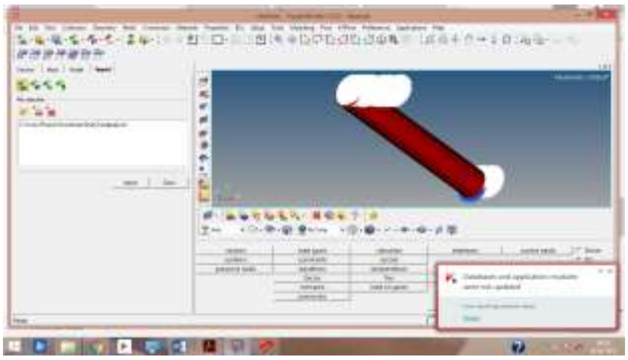


Figure 2: Model after Assigning Load and Support

2. Steel

The strengthen column used be hot-moved segments of diameters. The Steel is expected to have isotropic solidifying conduct, i.e., the yield surface changes consistently every which way with the goal that yield stresses increment or decline in all pressure headings when plastic stressing happens. Steel individuals have the benefits of high rigidity and malleability, while solid individuals might be beneficial in compressive quality and firmness.

Table 2.1: Material Property of Steel

Density	7750 kg/m^3
Poisson's ratio	0.3
Elastic modulus	2.0 x 10^5 N/mm^2
Yield strength	310 N/mm^2

The lengths of the steel tube used are 400 and 480 mm and 560 mm. The outer and inner diameter are 40 mm and 20 mm diameter respectively which remains same for all the 3 lengths

Table 2.2: Factors and Levels for Selected Steel Tubes

Factors	Levels		
	Level-1	Level-2	Level-3
Length (mm)-A	400-L1	480- L2	560 -L3
Thickness (mm)-B	1.6 -T1	2 -T2	2.6- T3

Table 2.3: Specification of Specimens

Diameter outer (mm)	L/D	D/T	Thickness mm	Length (mm)	Grade
40	10	25	1.6	400	M30
	12	20	2	480	M40
	14	15.4	2.6	560	M50

3. Concrete

In this study, the load carrying capacity of the hybrid double skin composite steel columns where inner void filled with **Light Weight Concrete (LWC)** and annulus is filled with rich mix mortar, subjected to concentrated loading. The solid infill utilized for concrete filled double skin tube is light weight concrete of M30 and M40 and M50 grades. The proportions gotten by combined design of concrete by using IS 10262-1982.

Table 3: Material property of Concrete

Density	1840 kg/m^3
Poisson's ratio	0.17
Elastic modulus	27300 N/mm^2
Compressive strength	30 N/mm^2

4. Analysis

4.1 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.

4.2 NASTRAN

NASTRAN is an industry-recognized, general purpose finite

Paper ID: ART20183819 DOI: 10.21275/ART20183819

element analysis (FEA) solver used for analyzing linear and nonlinear stress, dynamics, and heat transfer characteristics of structures and mechanical components. The solver works with Nastran-compatible pre- and post-processors and offers real-time results and changes in solution parameters while solving— helping users to identify and fix issues earlier in simulations. NASTRAN 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 NASTRAN for high-quality imitation solutions to guarantee that students obtain the best engineering learning likely.

5. Results and Discussions

In this case we study the analytical behavior of composite column tubes subjected to axial loading in NASTRAN software. Here analytical results were conducted to find the ultimate load bearing capability of tubes having varying thickness of 1.60mm, 2.0mm and 2.6mm, where different grade of light weight concrete used M30, M40 and M50 and lengths 400mm 480mm and 560 mm.

Table 5.1: Analytical Results for M30 GRADE

L (MM)	T_0 (MM)	L/D RATIO	P_U M30 (NASTRAN)(KN)	PuM30 (EXP)(KN)
400	1.6	10	185	181
400	2.0	10	234	229
400	2.6	10	281	279
480	1.6	12	170	167
480	2.0	12	211	209
480	2.6	12	260	254
560	1.6	14	144	143
560	2.0	14	195	191
560	2.6	14	223	221

Table 5.2: VI Analytical results M40 GRADE

L (MM)	T_0 (MM)	L/D Ratio	P_U M40 (NASTRAN) (KN)	PuM40 (EXP)(KN)
400	1.6	10	208	205
400	2.0	10	251	247
400	2.6	10	299	295
480	1.6	12	185	181
480	2.0	12	230	226
480	2.6	12	271	270
560	1.6	14	175	171
560	2.0	14	206	203
560	2.6	14	261	257

Table 5.3: Analytical Results For M50 Grade

L (MM)	T_0 (MM)	L/D Ratio	P_U M50 (NASTRAN) (KN)	PuM50 (EXP) (KN)
400	1.6	10	240	237
400	2.0	10	304	301
400	2.6	10	327	325
480	1.6	12	221	217
480	2.0	12	270	263
480	2.6	12	310	311
560	1.6	14	201	198
560	2.0	14	250	244
560	2.6	14	295	291

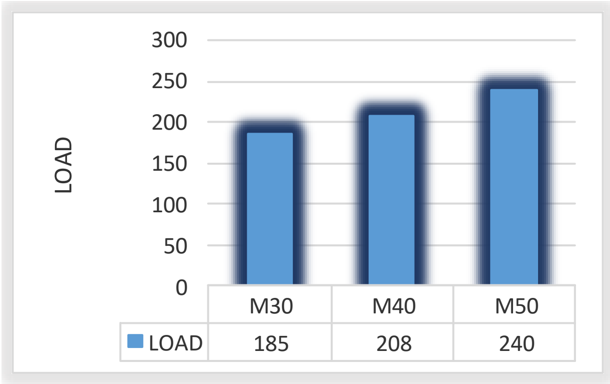


Figure 3: Load V/S Grades of LWC

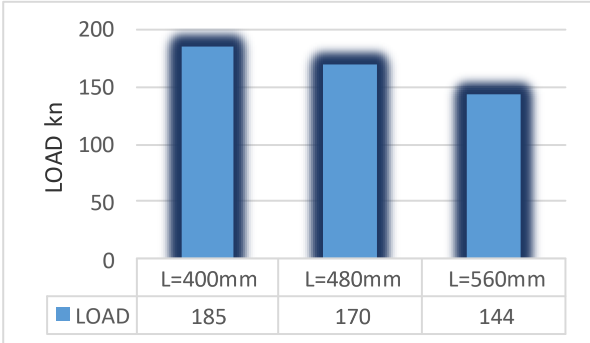


Figure 4: Load V/S Length

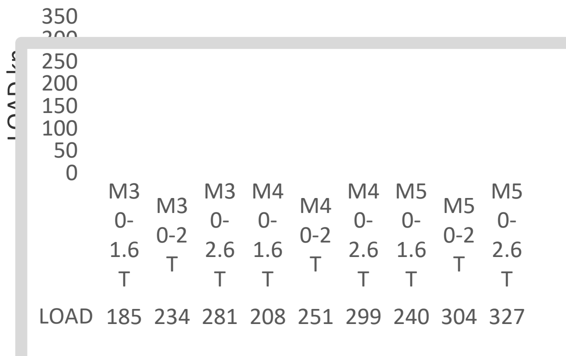


Figure 5: Load V/S Thickness

Figure 6: Load Vs L/D Ratio

After obtaining the analytical results from NASTRAN software, the main effects plot for ultimate axial load for steel tubes with different grades of LWC is entered in mini-tab as shown below.

Table 5.4: Analytical Values

Length	Thickness	Pu(M30)	Pu(M40)	Pu(m50)
400	1.6	185	208	240
400	2	234	251	304
400	2.6	281	299	327
480	1.6	170	185	221
480	2	211	230	270
480	2.6	260	271	310
560	1.6	144	175	201
560	2	195	206	250

560	2.6	223	261	295

6. Conclusion

1) As the column length increases load carrying capacity decreases for a particular grade of concrete has infill.
2) As the Grade of concrete increases, the ultimate axial capacity is found to increase by 10-15%.For length of the column keeping constant.
3) The ultimate axial load carrying capacity decreases as l/d ratio of the HDSCSCs increases.
4) The load carrying capacity increases with higher cross sectional area of the HDSCSCs
5) Maximum Load Carrying Capacity can obtained for Length-400 mm, Diameter-40.mm, Thickness2.6mm.
6) From Time Series plot we observe that Ultimate Axial load carrying capacity of column can be well predicted.
7) From this Research work parametric optimization and Factors like Thickness, length and Grade of concrete influencing the response can be well predicted
8) Nonlinear analysis obtained from NASTRAN varied by 2% to 9% when compared with experimental values

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