

Study on composite column cold-formed steel tube with steel fibre reinforced concrete

Submitted in partial fulfillment of the requirements for the award of
Master of Engineering Degree in Structural Engineering

by

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

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APRIL - 2021



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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
ANTONY RAJ T (39380002) who carried out the project entitled **“Study on
Composite column using cold-formed steel tube with steel fibre
reinforced concrete”** under my supervision from November 2020 to April 2021

Internal Guide
(Mr.J.VANJINATHAN)

Head of the Department

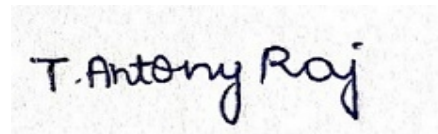
Submitted for Viva voce Examination held on

Internal Examiner

External Examiner

DECLARATION

I ANTONY RAJ T hereby declare that the Project Report entitled “**Study on Composite column using cold-formed steel tube with steel fibre reinforced concrete**” done by me under the guidance of **Mr.J.VANJINATHAN** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfillment of the requirements for the award of Masters of Engineering degree in Structural Engineering.

A handwritten signature in black ink that reads "T. Antony Raj". The signature is written in a cursive style with a horizontal line under the first name.

DATE:

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. DEVYANI GANGOPADHYAY., B.Arch., M.T.P., Ph.D.**, Dean, School of Building and Environment and **Dr. S. Packialakshmi, M.E., Ph.D.** and **Dr. R. PADMAPRIYA, M.E., Ph.D.** Head of the Department, Dept. of Civil for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Mr.J.VANJINATHAN.,M.E** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Civil who were helpful in many ways for the completion of the project.

ABSTRACT

The Cold-formed steel tube(CFST) of rectangular cross-section is used in column with fibre reinforced concrete(FRC). The column consists of the hollow cross-section of the cold-formed steel tube and infilled with the steel fibre reinforced concrete. To overcome buckling in the long columns and cold-formed steel tube has reduced the self-weight of the column and very economical in nature. The steel fibre reinforced concrete is used for the increase in the strength of the column to take more loads from upcoming floors. The column of cross-section 150mm*150mm and height of 480mm is tested experimentally and designed by using ANSYS software. The experimental results show more compressive strength than the conventional column in strength values. Finally both are compared analytically and experimentally to discuss and further to do research in cold-formed steel tubes plays a vital role in it. The column is tested for the Axial compression strength by the hydraulic testing machine. strength capacity and experimental results are analyzed from the finite element analysis. The buckling values of the column are analyzed by experimental values from the axial compression test.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

Both steel and concrete take merits of steel filled with concrete column. It consists of rectangular-shaped cold-formed steel tubes filled with fibre reinforced concrete. It is used in the apartments and multistory structures and also used for small buildings(Beams&columns).

In building construction usage of concrete-filled steel tube has increased due to simple construction and higher structure performance.

The hollow tubes were designed to withstand the load of the floor up to three to four-storey height. Once the upper floors are completed, the concrete was pumped into tubes from the bottom and continues at floor level.

Cold-formed steel(CFS)is the common term for steel products shaped by cold-working processes at room temperature through bending, rolling.

The buckling problem in the thin-walled steel tubes is reduced through the in-filled concrete cold-formed steel tube. The materials separation in the cross-section plays a vital role in the structural performance. The cold-formed steel tube lies in the outer surface which always takes the tension and bending stresses in it. The cold-formed steel and fibre reinforced concrete provide a higher modulus of elasticity and good values for moment of inertia under axial compression loads.

1.2 ADVANTAGES OF CFST COLUMN SYSTEM

CFST column system has added advantage over the conventional reinforced concrete system. The major advantages are given below

- Creep and dry shrinkage of the concrete are much smaller than ordinary reinforced concrete.
- Fast and easy erection and Installation and it gives High Strength and stiffness to the structure.
- They are Lightness in weight and Non-Shrinking and non-creeping at ambient temperature
- Uniform quality is provided for decks and the panels
- Non Combustibility to which no Formwork needed.

1.3 CROSS-SECTIONAL PROPERTIES

- The Concrete filled steel tubular(CFST) cross-section has a steel ratio has high than conventional column.
- The fibre reinforced concrete is in-filled in the steel tube and provides efficient cross-sectional properties.

1.4 CONSTRUCTION EFFICIENCY

Formwork and reinforcing bars are eliminated, and concrete casting is done by the pump-up method, which saves manpower and constructional cost and time.

- Construction site always remains clean and tidy.

1.5 FIRE RESISTANCE

Concrete provides excellent fire resistance properties and performance, the number of fireproof materials can be reduced.

1.6 COST PERFORMANCE

It provides better cost performance, by replacing the steel structure with the CFST structure.

1.7 ECOLOGY

- Environmental problems can be reduced by avoiding the form-work, and good quality concrete as recycled aggregates.
- In a Cold-formed steel tube(CFST)system weak point is the compactness of concrete around the connection(beam-column).
- Generally in construction practice it cast high-quality concrete and contains low water content and excellent workability using superplasticizers.

1.8 MERITS OF COLD-FORMED STEEL TUBE IN RESIDENTIAL BUILDINGS

- **Frame-tube system**

To resist the lateral load's reinforced concrete elevators can be used. For office buildings the frame-shear structure system also used. The set of symmetrical positions of plan in the shear wall.

- **Large span of columns**

The span of two rooms comes under a single column. The size of the foundation can be reduced by a reduction in the size of columns.

To take loads the cold-formed columns of large span plays a vital role to take loads.

- **Span of the frame is large**

The span is around 7m-8m of frame column. It also helps to control the construction cost.

- **Story Structure System**

The story structure system list some important points,

- a. The dimension of a cold-formed steel tube(CFST)is nearly the outline dimension of a steel column.
- b. The weight of the CFST column is very less compared to the steel column.
- c. The fire-resistant behaviours of CFST columns and seismic, corrosion properties are better than steel column.
- d. Steel composite column system.

1.9 COLD-FORMED STEEL DISADVANTAGES

The main disadvantages of the cold-formed steel

- Corrosion and Rust Problems and also Manufacturing process tedious compared to hot rolled section.
- The price of a single unit is high.
- The cold-formed steel tubes are very difficult to connect between them and requires skilled labour.
- The cold-formed steel tubes are assembled very properly and correctly utilizing good precision work.
- The cold-formed steel section residual stress affects the buckling resistance of the steel.
- The cold-formed steel has a very low fire resistance capacity.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Much research has been carried out on the Cold-formed steel tube(CFST) section for determining the behaviour of the column using certain parameters such as Grade of concrete, cross-section, Diameter to thickness(D/t) ratio and length to width(L/D)ratio.

2.2 REVIEW OF LITERATURE

Zhihua Chen, Guoping Zhang(2016) investigated the cold-formed rectangular steel columns with large walls. The design method and the mechanical performance of the cold-formed steel columns are studied. It also has a high bearing capacity under the axial compression tests, results in local plate failures. The test results and the numerical results are conducted and compared with each other. Cold-formed steel is generally used for large engineering construction across the globe, and high strength utilization of the steel in it and also gives good mechanical values and properties.

Jia-lin Ma(2021)conducted a study on cold-formed steel tubular column and also the mid-height deflection, by which the compression capacities accessed using the American standards. Finite element modelling methodology on cold-formed high strength steel tubular column is presented.

R. Saravanakumar(2020)investigated cold-formed steel, the behaviour and buckling capacities of cold-formed steel as compression members. The buckling failures calculated by theoretical and experimental by AISI, Euro standards. The support conditions assumed to be fixed type. the type of analysis helps in reduction in reduction of production and materials and leads to sustainable development.

Farid Abed et al(2013), investigated the behaviour of Cold-formed steel tubes(CFST) column filled with different concrete grades and changing D/t ratio. It also explains higher ratio was noted in experimental and analytical results. The results are analyzed by ABAQUS software and good values between both experimental and analytical results.

K.Kalingarani(2017) investigated the cold-formed steel tubes(CFST) compressive behaviour by using the various codes. It is carried out by changing the diameter to thickness and length ratios. using the codal method values the increase in D/t by keeping diameter(D) constant. The decrease in the slenderness value due to increase in length ratios.

B.R Niranjan, Eramma H(2016) investigated the triangular and rectangular fluted reinforced circular cold-formed steel tube(CFST) compression strength by changing the length to width(L/D). The experimental results of the compressive strength is generally higher than the analytical results. The codes equation is not sufficient to calculate the compressive strength of cold-formed steel tube.

M.F.Hassanein, O.F.Kharrob(2014), investigated the double skin concrete-filled steel tube of circular short columns with changing diameter to thickness(D/t) ratio. The software used is ABAQUS Software creating the finite element analysis. The new equation is arrived at for determining the strength of the Cold-formed double skin tube(CFDST) column.

X.H.Dia(2014) conducted a study on the elliptical slender Cold-formed steel tube(CFST)section compressive section. The ABAQUS software is used for developing the finite element analysis for its accuracy. The elliptical section of the cold-formed section is analyzed and done by experimental procedures in the compression test by axial compression test values to find the values of deformation and buckling in the cold-formed steel tube(CFST)

Burak evirgen(2015) conducted the Cold-formed steel tube(CFST) compressive strength of different cross-sectional shapes like circular, rectangular and many other shapes. The ratio of Breadth to thickness(B/t). The obtained results are compared with the software values of Ansys software. The ductility of the rectangular CFST section is more hexagonal, rectangular cold-formed steel tube(CFST). The cold-formed steel tube has various properties by which the thickness and the various ratios in it.

CHAPTER 3

MATERIALS & METHODOLOGY

3.1 MATERIALS

3.1.1 *Cement*

The Cement has various characteristics and properties depends on chemical compositions. The fineness of grinding and the oxide composites cement exhibits various properties and kinds. The different use of raw materials and additives results in the availability of various types of cement. The Cement grade 43 of ordinary Portland

3.1.2 *Aggregates*

It acts as an important part of the concrete. The effect of the shrinkage and economical values is considered. Aggregates are chemically inert materials and some of the materials are chemically active in state and also certain aggregates which exhibit chemical bond at the interface of the aggregates.

3.1.3 *Coarse Aggregates*

Crushed granite stones of sizes 10mm&20mm are used as coarse aggregates.

3.1.4 *Fine Aggregates*

Fine Aggregates should satisfy the condition of specification of IS:383-1970 and experimental work and values.

3.1.5 *Water*

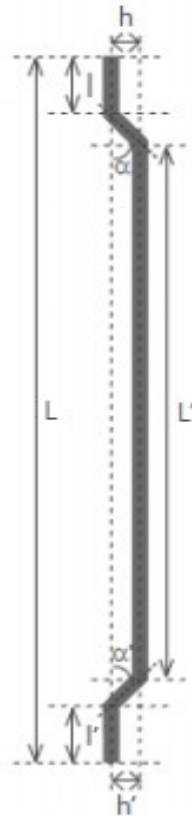
Clean and potable water is used for mixing the concrete and curing purposes.

3.1.6 *Steel Fibers*

The steel fibres are produced by chopping off the wire and cutting of the thin flat sheet. Various types of steel fibres are generally available which are Indented round, Machined round, Hook end round in it and according to the code of IS:280-1976 with the various aspect ratios of 30-200. The steel fibre of the Hook end is used.

Table 3.1 Steel Fibre properties

PROPERTIES	VALUES OF STEEL FIBER
Wire diameter(d)	0.75mm(± 0.03 mm)
Fiber length(L)	60mm
Length of hook(l and l')	2-3 Hook length
Depth of hook(h and h')	2.80mm
Angle of bending(α and α')	50°
(L/d)	90
Wire tensile strength	1300 N/mm ²



Hooked End Fibre of length 60mm and diameter 0.75mm.

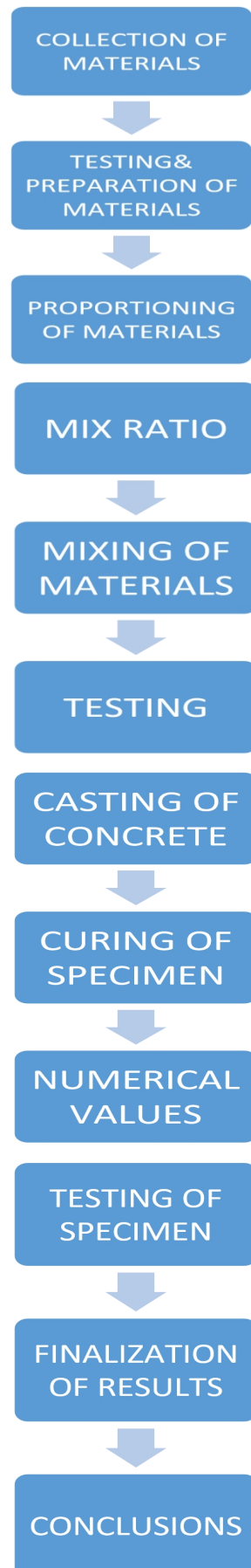
Fig 3.1 Hooked end steel fibre

3.2 OBJECTIVES

The main objective of the study is behaviour of the confined concrete with the steel fiber. The fiber used in the concrete increases the strength of the concrete.

- The Objective of the study is cold-formed section with steel fiber. The strength of concrete is increased by the addition of steel fibre.
- Effect of fibre on workability.
- To use fibre reinforced concrete (FRC) in Cold form steel of composite columns.
- To determine the strength of column by compression test.
- To reduce the chances of buckling failure in columns by Fibre reinforced concrete.
- To compare the failure mode, load deflection curve and strength capacity.
- The model can be analyzed by using ANSYS software.

3.3 METHODOLOGY



3.4 SCOPE

- By IS method, calculate the mix ratio of control concrete.
- To perform the specific gravity test, sieve analysis and slump test under Indian Standard methods.
- To conduct compressive strength.
- To increase the strength of column using cold form steel.
- By decreasing the self weight of column by fibre reinforced concrete.
- Static behaviour of cold form steel column.

3.5 CONCRETE MIX DESIGN

3.5.1 *Mixing Procedure*

Uniform and proper mixing of the concrete should be done for the proper test results of the specimen. For Ordinary concrete, the Coarse aggregate is weighed and put in the mixer of completely dry in nature. Further Cement is weighed and spread on the surface of the sand and uniform mixing is checked. Dry mixing is done and water is added with dry mix, mixing is done for five minutes until the uniformity appears, then the concrete is poured in moulds.

For steel fibre Reinforced concrete(SFRC), a similar practice is followed without adding water to cement, sand & coarse aggregates. Further, the fibre is fully mixed with cement, sand, and coarse aggregates, and addition of 3.5% fibre over the volume of ordinary concrete.

3.5.2 *Mix Proportion*

- Grade of concrete =M 25
- Cement type =Ordinary Portland Cement 43 grade
- Aggregate size =20mm
- Min Cement content =300kg/cu.m
- Max Water/Cement ratio =0.5
- Type of aggregate =Crushed Angular.

3.5.3 Test Data

1. 43 grade cement Portland
2. Cement Specific gravity =2.7
3. Coarse aggregates Specific gravity =2.5
4. Fine aggregates Specific gravity =2.5
5. Zone for confirming Sand -III

From Sieve Analysis of 100g of sand:-

Table No: 3.2 Fineness Modulus and Gradation

Size	Retained weight	Retained %weight	Retained Cumulative% weight	% of Passing
10	0.00	0.00	0.00	100
4.75	0.00	0.00	0.00	100
2.36	110.5	11.05	11.05	88.95
1.18	129.3	12.93	23.98	76.02
0.6	149.4	14.94	38.92	61.08
0.3	411.2	41.12	80.04	19.96
0.15	199.96	19.96	100	0.00

Fineness Modulus = Cumulative%weight Retained/100 =253.99/100=2.53

When the Fineness Modulus value is matched with fineness Modulus for fine aggregates it's fine sand. The IS:383 for gradation of fine aggregates is matched with Percentage Passing, which comes under ZONE III.

Mean strength for Mix proportion(F_{ck}) = $f_{ck} + 1.65 \times S = 25 + 1.72 \times 2 = 31.6 \text{ N/mm}^2$

Cement Content = $197 / 0.5 = 394 \text{ Kg/m}^3$

From IS 456 minimum cement content for moderate exposure condition is $300 \text{ Kg/m}^3 < 394 \text{ Kg/m}^3$.

hence ok

CHAPTER 4

EXPERIMENTAL INVESTIGATION

The Experimental investigation is done on the test specimens to study the strength characteristic of cold-formed steel tube(CFST) in various combinations. The experiment is conducted on Cold-formed steel tube test specimens(CFST) to find the workability and strength values such as Cube compressive strength, column compression test, cylinder split tensile strength, prism flexural strength. The specimen is tested according to Indian standards. Based on the test results of the compressive strength and others, the optimum percentage is achieved. After 14&21 days of the curing process, the specimen is tested for various tests and 21 days curing specimen tested for column compression test.

4.1 PREPARATION AND TESTING OF SPECIMEN

The Slump test for the concrete is done for determining the workability of the fresh concrete. Also, it is used for determining the consistency of the concrete in the freshly made concrete. Consistency is always closely related to workability, which indicates the degree of wetness and which affects the consistency. Generally proper water content in concrete makes good workability condition.

Concrete is prepared as per the mix design. The freshly prepared concrete is filled in a clean slump cone for the test of four layers. each layer is tampered with up to 25 times before another layer, excessive concrete is removed after the final layer has tampered. The slump cone is removed immediately after the process in the vertical direction. The difference between the height of the slump mould and the highest point of the subsidized concrete cone. finally the slump value is determined.



Fig 4.1 Preparation and Testing of Specimen

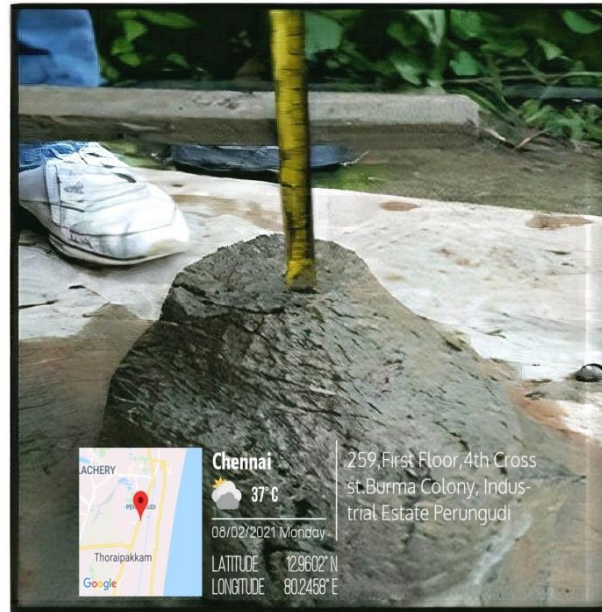


Fig 4.2 Slump test



Fig 4.3 Casting of specimen

4.2 CUBE COMPRESSION STRENGTH TEST

- The cube compression strength test is done on the cube of the 150mm*150mm*150mm. All specimens are completely drained for the moisture condition and tested. Three specimens are tested at the days of 14&21 days using a compression testing machine. The Load is applied until it fails and the ultimate load is noted.
- The cube compression test is mainly done for the values for desired strength of the concrete mix in it. It also helps in determining the correct mix proportions and concrete mix ratio.
- It also helps in calculating the addition of the strength of the concrete cubes samples which are tested at different days.



Fig 4.4 Cube Compression strength test



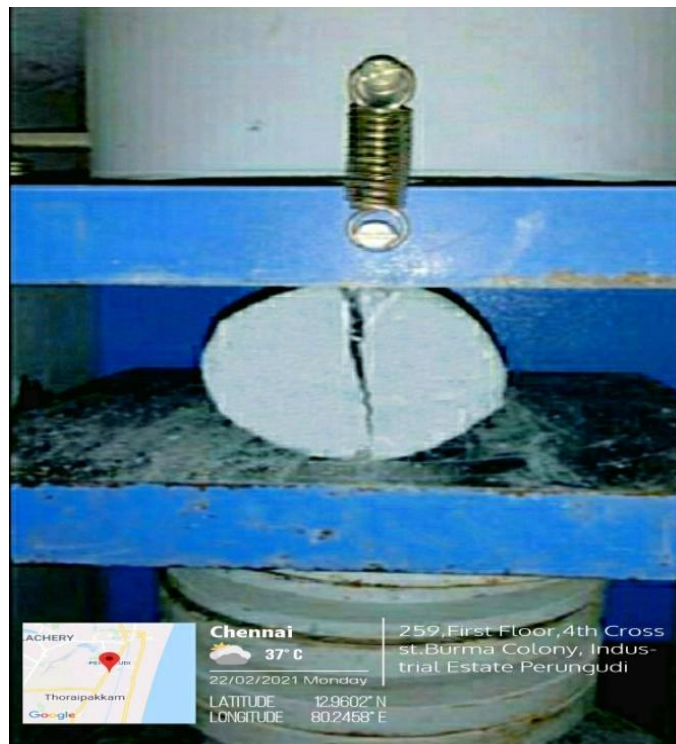
4.3 SPLIT TENSILE STRENGTH TEST

The test is carried out to determine the tensile strength of the cylindrical specimen, conducted at the age of 21 days for the concrete cylinder of size 150mm diameter and 300mm length by using the universal testing machine.

Finally, the split tensile strength is calculated by using the formulae
 $f = 2P / \pi dl$



Fig 4.5 Cylinder split tensile strength test



4.4 FLEXURAL STRENGTH TEST

The lateral load resistance can be determined, the specimen is tested for flexure. The size of the specimen(100mm*100mm*500mm)placed in a horizontal position and tested by third point loading. The initial failure location of all prism is noted. It is used to calculate the stress at the failure.

It also determines the tensile strength of the concrete using various ways. It always tests unreinforced concrete structures in it and gives the values and withstanding the failures in bending.



Fig 4.6 Flexural Strength Test

4.5 COLUMN COMPRESSION STRENGTH TEST

In the Experimental investigation, the axial load is applied on the cold-formed steel tube(CFST) and the surface should be plane. All specimens are tested for compression and simply supported at both ends.

The Cold-formed steel tube is filled with steel fibre reinforced polymer under axial compression of load-carrying capacity.

The test specimen of all the columns are tested and the size of the specimen is 150mm*150mm and thickness of about 6mm, all other cold-formed steel columns are tested.

The specimen is placed centrally in the compression testing machine. The conventional and fibre mixed columns are tested and noted and further compared with the analytical results.

CHAPTER 5

NUMERICAL INVESTIGATION

5.1 GENERAL

The ANSYS workbench Software is used for finite element analysis and addition with CAD system Design model. The software environment is used for performing structural, thermal and electromagnetic analysis. The geometry creation and optimization, existing geometry and also used for setting up for finite element model.

ANSYS is general-purpose software and also interact with the various disciplines of structural, vibration, fluid dynamics, heat transfer for the engineers. It also imports CAD files and data, to build the geometry with the various “pre-processing”. The finite element model is required for computation is generated. After applying loads in it and carrying out the analysis, results obtained as numerical and graphical. It also carried out advanced engineering, safely and variety of algorithms, non-linear materials models are obtained.

It integrates simulation technologies and parametric values of CAD systems with unique automation and performance. The power of ANSYS workbench to solve algorithms with many years of experience and to improve the product in the virtual environment.

5.2 ANSYS MODEL DESCRIPTION

The study of the 3D finite element model is designed and developed a steel-encased Column in the compression load test. The normal conventional column and further fibre mixed column.

5.3 ANSYS MODELLING PROCEDURE

The analysis mainly focuses on

1. Engineering data
2. Geometry optimization
3. Attaching section properties
4. Finite element model
5. Solving
6. Results

5.3.1 Engineering Data

Material properties like concrete, grade of steel and other specifications.

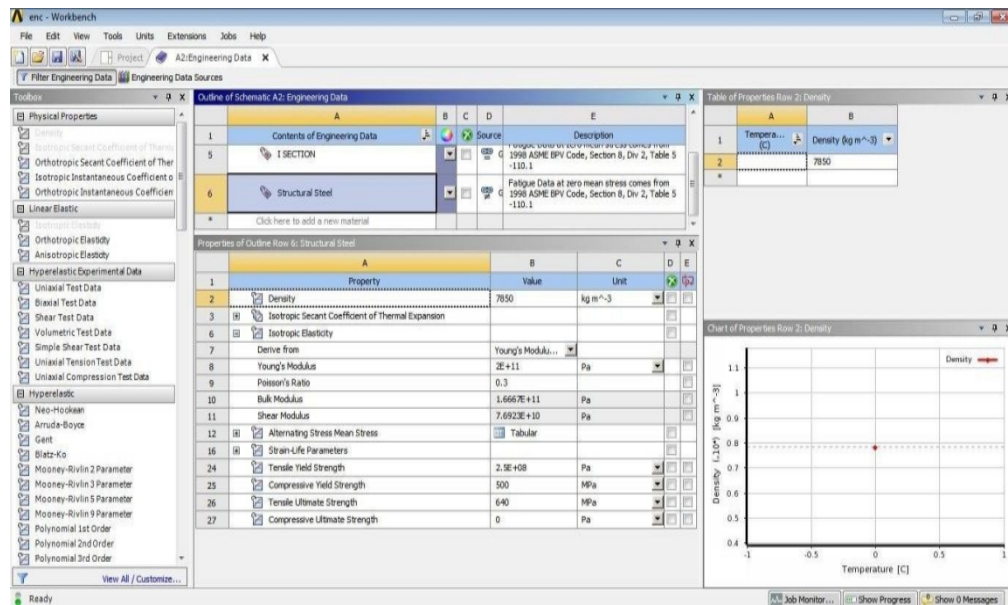


Fig 5.1 Engineering Data

5.3.2 Geometry Optimization

In this study, column model of cross section 150mm*150mm*480mm.

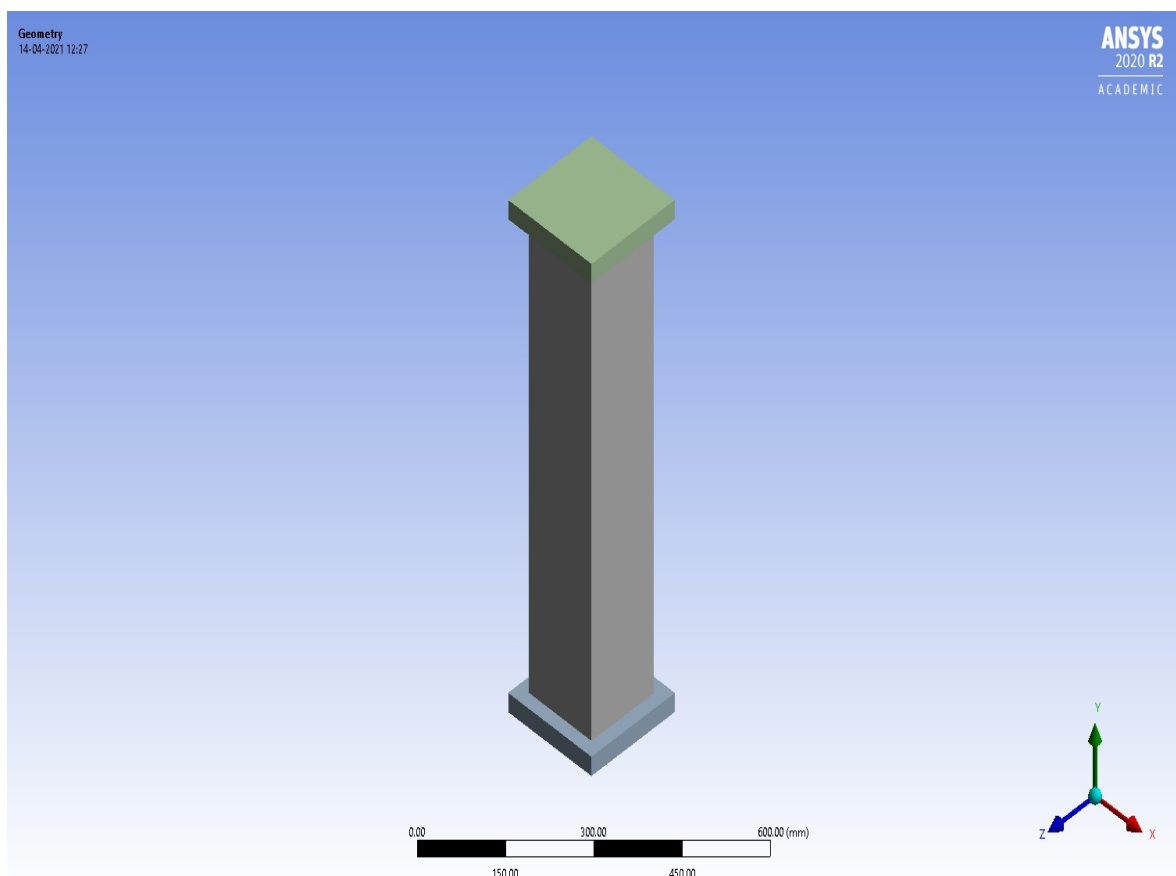


Fig 5.2 Geometry Optimization

5.3.3 Assigning the Section Properties

The region of the part and assign the section to the particular region, to the toolset and create the homogeneous set to the particular region and assign the section to set the values. The section properties include various assigning values and section of steel and concrete

5.4 CROSS-SECTIONAL OF COLD-FORMED STEEL TUBE

The cold-formed steel tube of thickness 6mm and cross section of 150mm x150mm having length of 480mm.

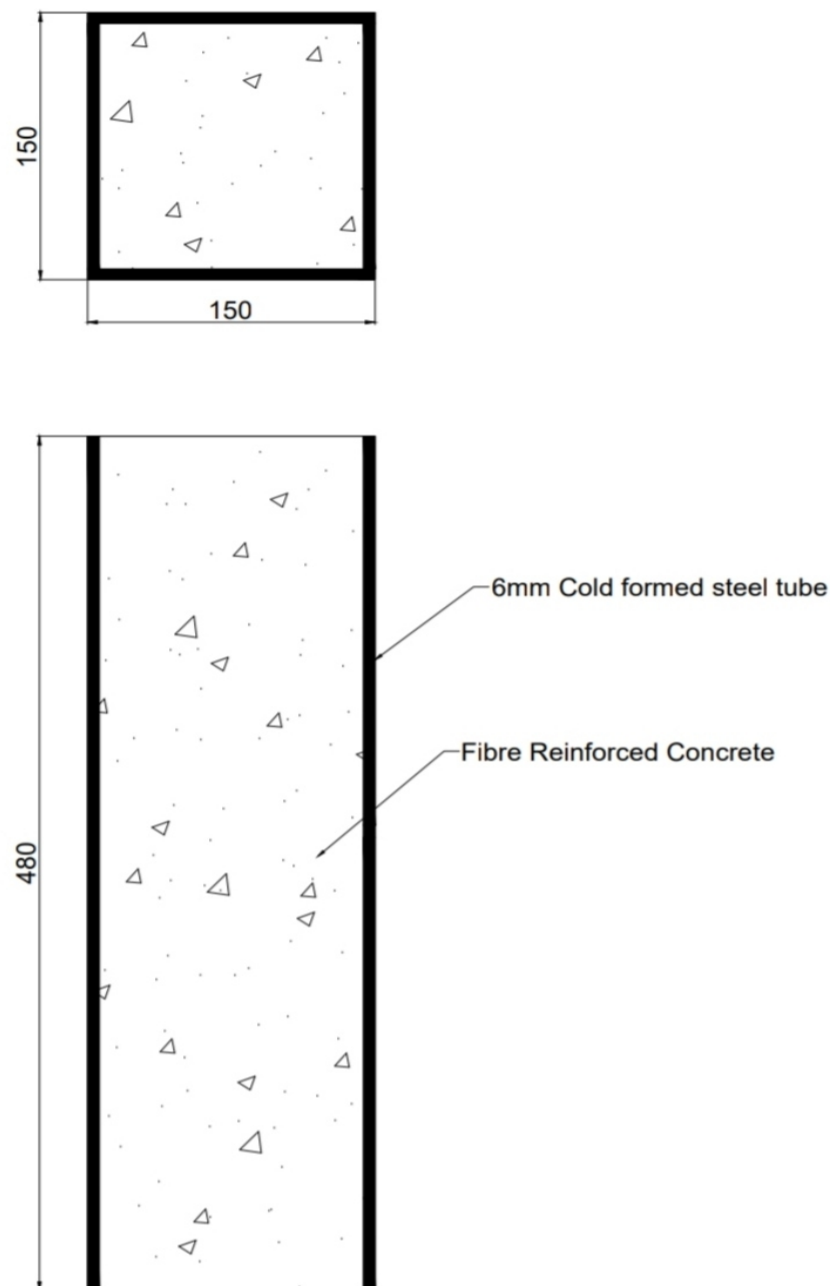


Fig 5.3 Cross-sectional of cold-formed steel tube

5.5 FINITE ELEMENT MODEL

After the geometry design, the modelling is to be done and assign material properties. The mesh is generated by using the finite element analysis and obtained correctly.

Table.No:5.1 Setting up the finite element model

Materials	Density(Kg/m ³)	Modulus of elasticity(Mpa)	Poisson Ratio
Concrete	2400	28	0.2
Steel	7850	2E5	0.3
SFRC	2500	32	0.28

5.6 MESH GENERATION

The Mesh generation is done to convert larger size particles into several nodes. Discretization is the process of generating the nodes. The load applies in each node and the load will be distributed throughout the structures.

The cold-formed steel tube column mesh generation for the cross-sectional properties and values of the analytical model is performed and studied for the values of the deformation and the axial compression value.

Discretization is the meshing process by which the continuous body into finite element analysis. The accuracy depends upon the number of elements.

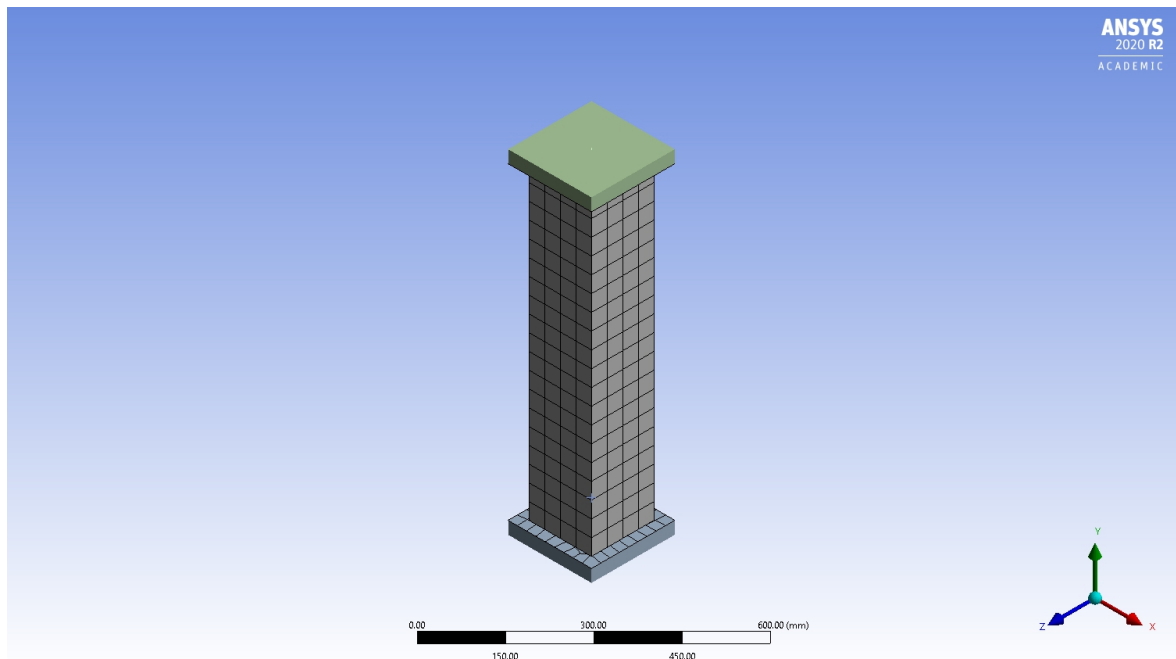


Fig 5.4 Mesh Generation

5.7 LOADING PATTERN

The cold-formed steel encased the fibre concrete applied the point load and also to investigate the failure modes and the improvement in the strength values.

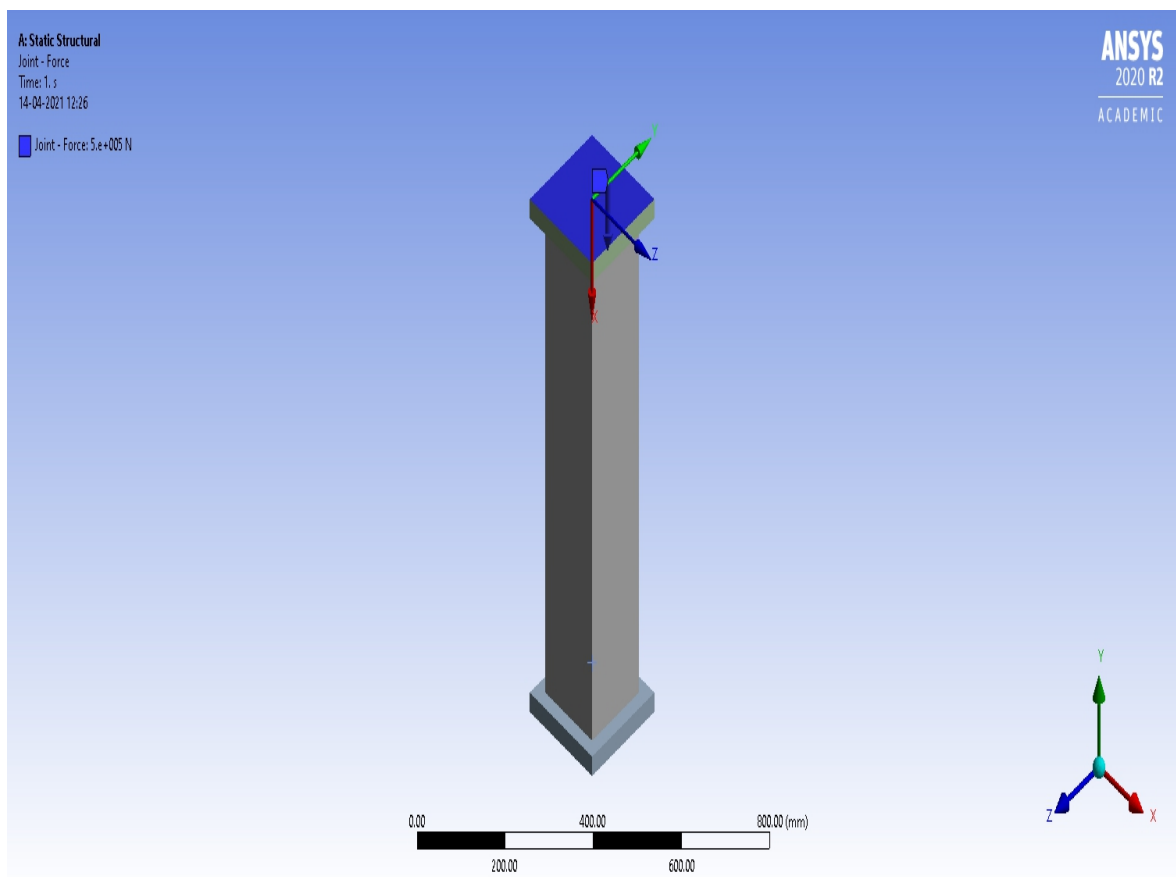


Fig 5.5 Loading Pattern

CHAPTER 6

RESULT AND DISCUSSION

The results and discussion gives the test results of compressive strength, tensile strength, flexural strength and column compressive strength using fiber over conventional column by which the steel tube are encased and two different curing periods.

6.1 CUBE COMPRESSIVE STRENGTH

The Structural design is based upon the compressive design. The strength development in the steel fibre reinforced concrete at 14&21 days.

The Compressive strength with different curing period of steel fiber over normal concrete, results shows that increase in compressive strength.

Table.No:6.1 Cube Compressive Strength Results

%Fiber	14 days(N/mm2)	21 days(N/mm2)
0%	25.44	31.80
3.50%	28.46	34.08

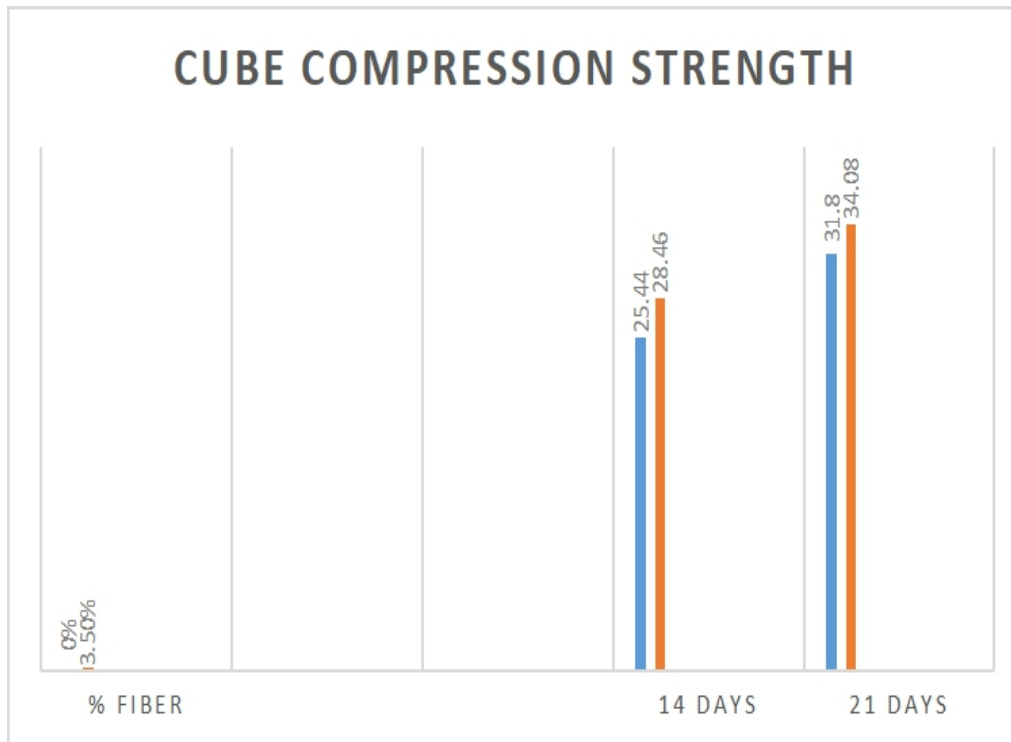


Fig 6.1.1 Cube Compression Test

6.2 SPLIT TENSILE STRENGTH

The Split tensile strength increases with steel fiber at the days of 14&21 days and also helpful in the reduction in the porosity of the cement matrix and well mixed of the cement grains throughout the mix and also increases the bond strength.

Table.No 6.2 Split Tensile Strength Results

%Fiber	14 days(N/mm2)	21 days(N/mm2)
0%	3.36	4.21
3.50%	5.93	6.39

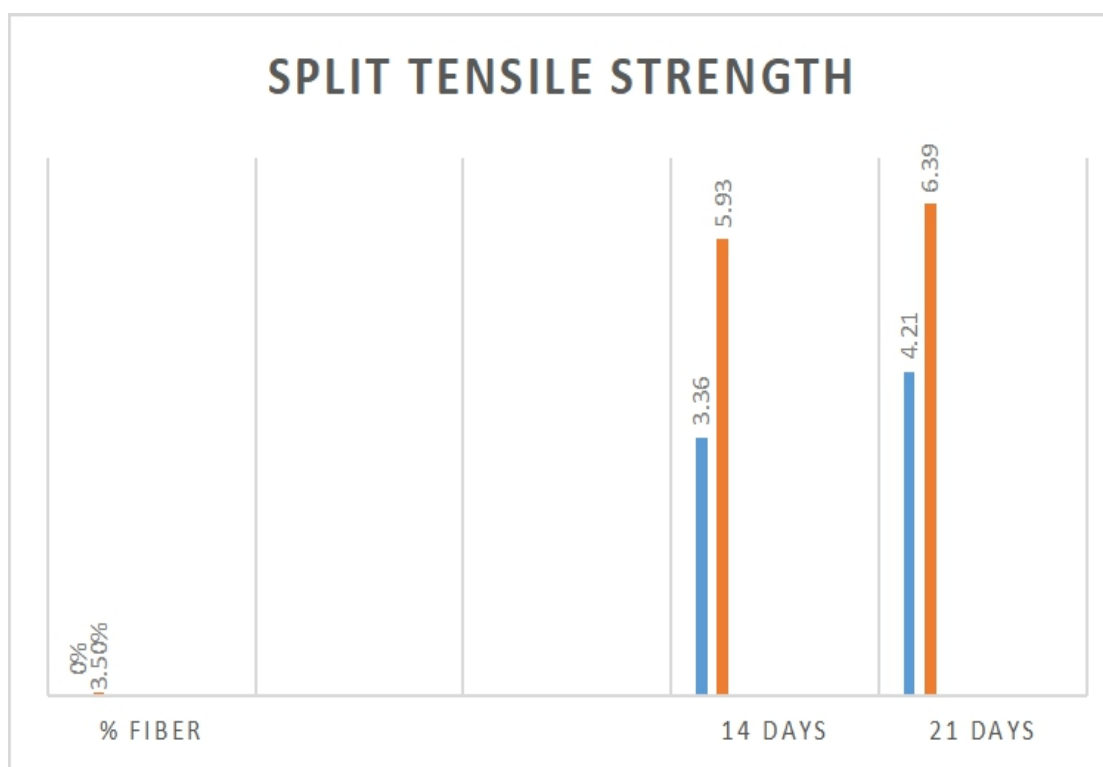


Fig 6.1.2 Split Tensile Strength

6.3 FLEXURAL STRENGTH

In flexural strength, the steel fibers play a vital role for the compression and tension strength and percentage increase is around 33.14% in it. It mainly depends upon the aspect ratio of the fibers, higher ratio gives higher strength.

The flexural strength is otherwise known as modulus of rupture or bend strength is the value of the material's property, stress in the material yields in the flexural strength.

Table.No 6.3 Flexural Strength Results

%Fiber	14 days(N/mm2)	21 days(N/mm2)
0%	6.00	7.12
3.50%	9.46	10.48

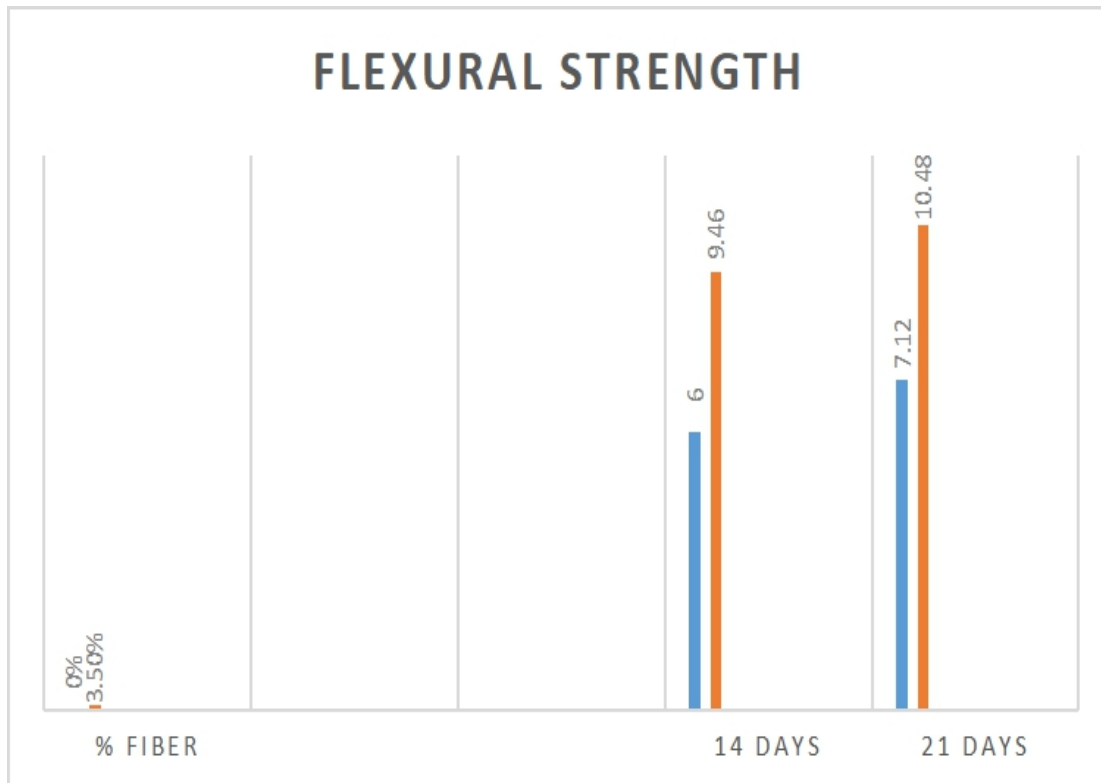


Fig 6.1.3 Flexural Strength

6.4 COLD-FORMED COLUMN STRENGTH

- A total of four concrete infilled Cold-formed steel tube(CFST)is casted and tested to study the load deformation behaviour and failure modes.
- The specimen with the steel fibre carries load more than the conventional specimen and lowest load carrying capacity is the conventional specimen due to its cross sectional area.
- The cold-formed steel column undergoes the axial compression test for the findings of the deformation and the buckling failure in the columns.
- The cold-formed rectangular steel tube of grade YST 310 and its properties such as minimum tensile strength and minimum yield strength(MPa) are noted.

Table 6.4 Cold-formed steel tube mechanical properties

GRADE	Min Tensile strength	Min Yield Strength	Min elongation
YST310	450	310	10

The axial compression test is carried out for the cold-formed rectangular steel tube and further in-filled with the fiber reinforced concrete. The cold-formed steel tube of this cross section weighed around 22.30kg/m.

The results of the axial compression test are noted

Table 6.5 Axial compression test Results

S.NO	LOAD	FRC COLUMN-1	FRC COLUMN-2	FRC COLUMN-3	FRC COLUMN-4
		Deformation	Deformation	Deformation	Deformation
1	300	4.23	4.5	4.62	4.56
2	350	4.96	4.92	5.23	4.98
3	400	5.50	5.82	5.64	5.24
4	450	5.68	6.02	5.93	5.68
5	500	6	6.12	6.23	6.38

Further the values of the stub columns by buckling failure is,

Table 6.6 Material Properties

Specimen	Proof stress $\sigma(0.2\%)$	Ultimate stress $\sigma(u)$	Local Buckling stress $\sigma(l)$	Failure
150mm*150mm	498	498	451	Local Buckling

The material properties obtained from the stub columns test of rectangular section of cold-formed steel tube.

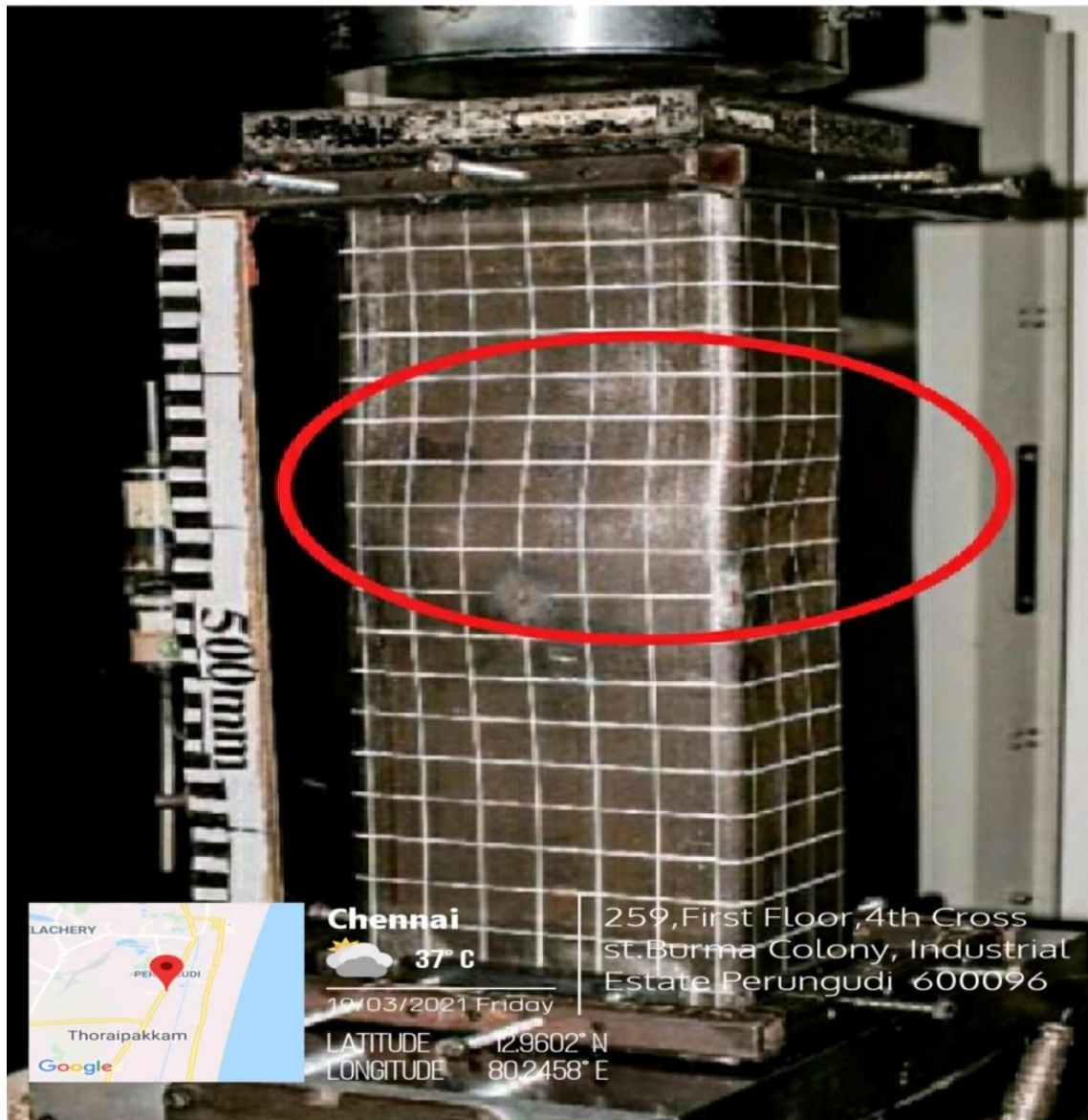


Fig 6.2 Axial compression test

- The rectangular cold-formed steel columns are tested for Axial compression load is tested and results are analyzed.
- The axial load is applied is applied eccentrically to one axes or both axes rather applying load in the center of the column.
- The axial compression load is occurs when the stress level is less than the ultimate stress of the column.
- Due to the applied axial compression load on the specimen,the column will cause deformation and bending of the column due to its instability.

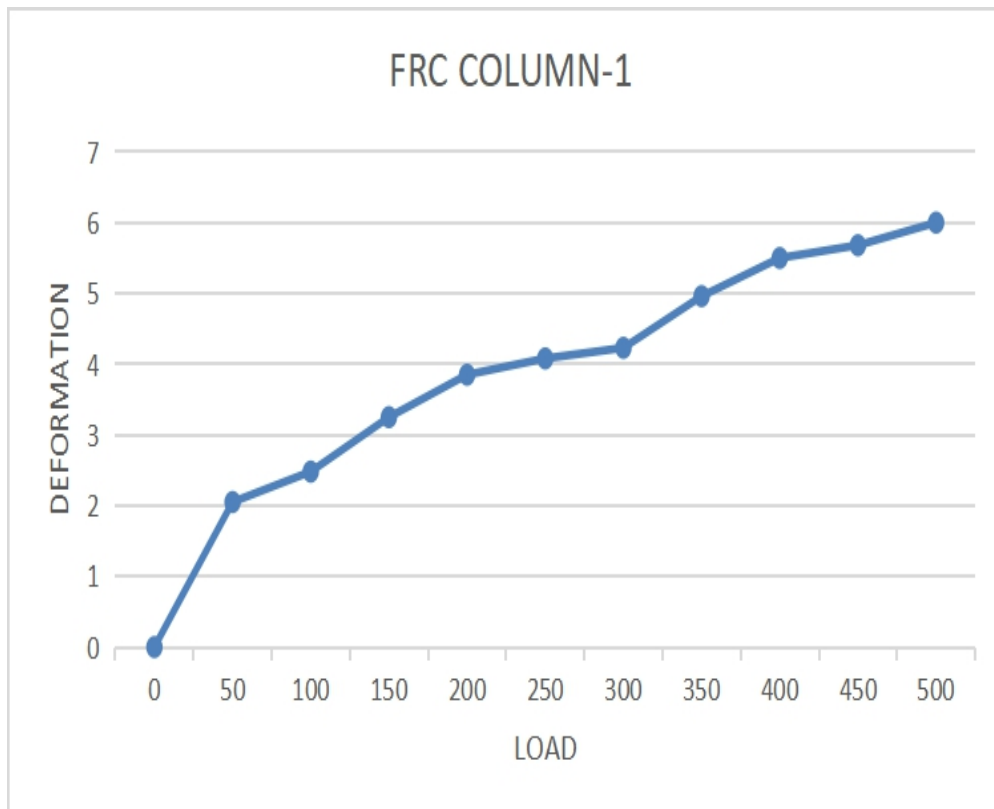


Fig 6.3.1 FRC column -1(EXP)

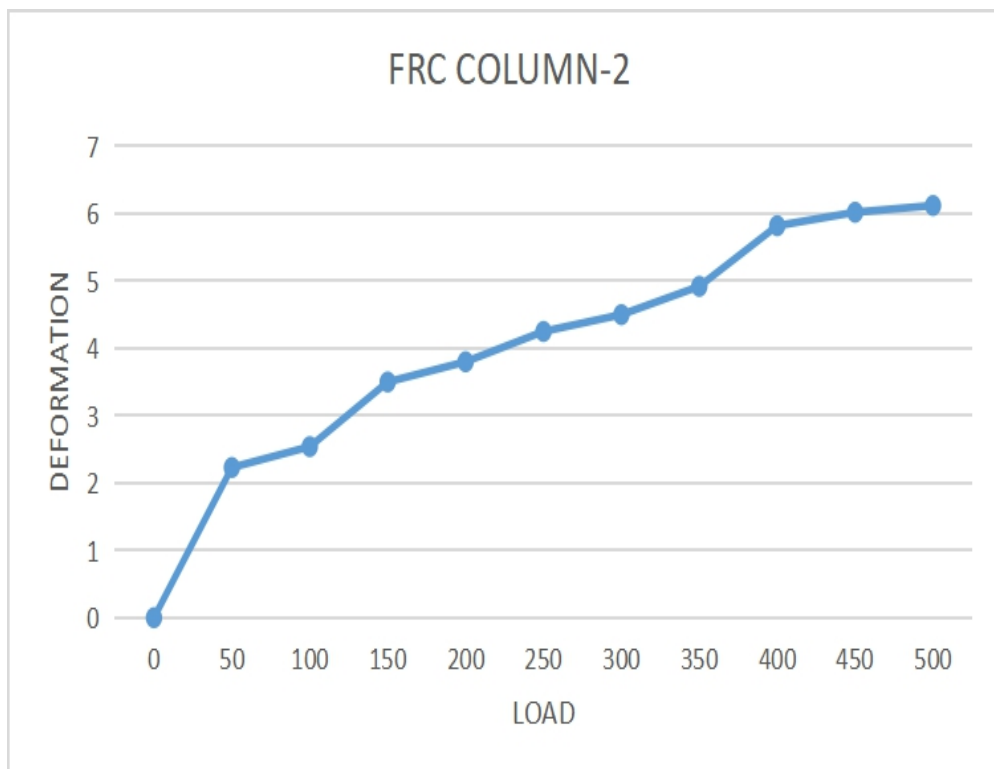


Fig 6.3.2 FRC column -2(EXP)

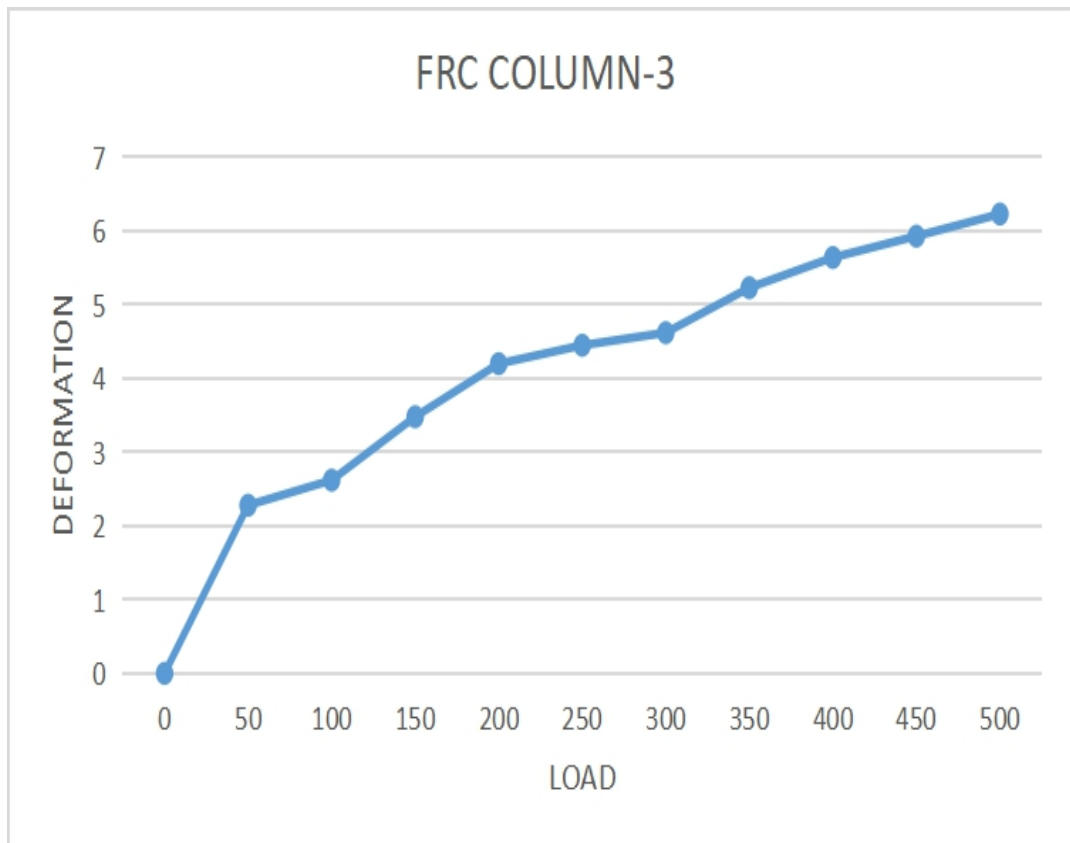


Fig 6.3.3 FRC column -3(EXP)

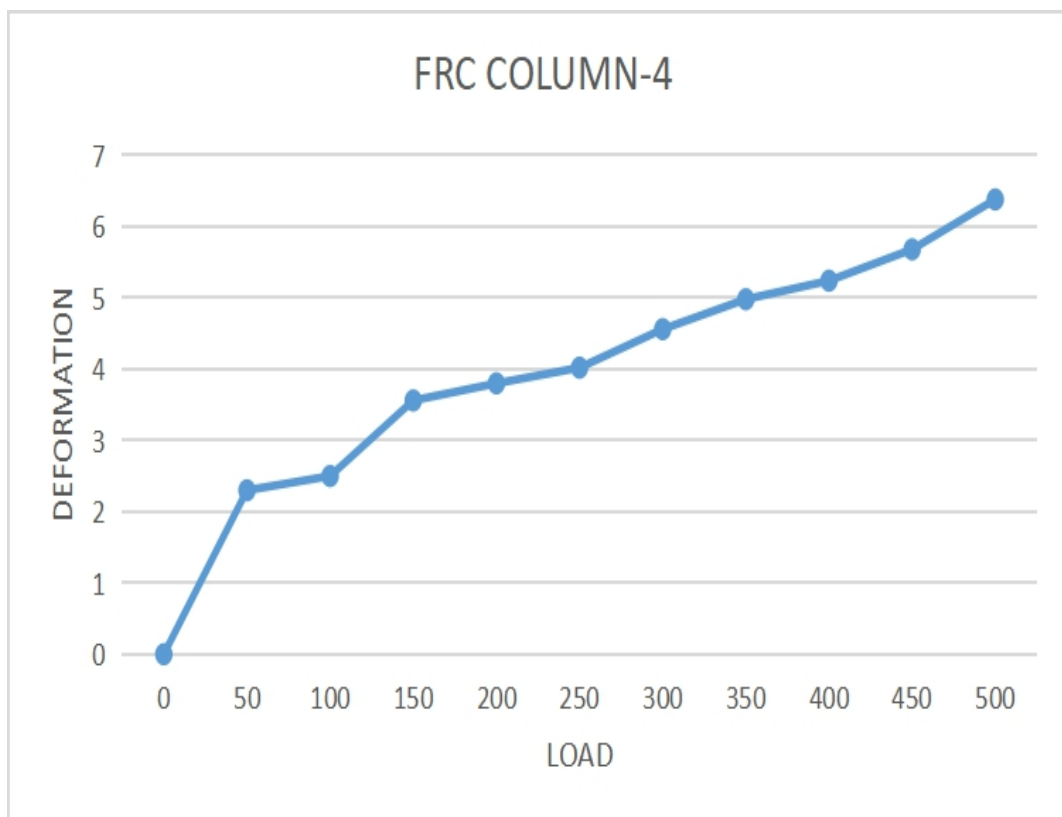


Fig 6.3.4 FRC column -4(EXP)

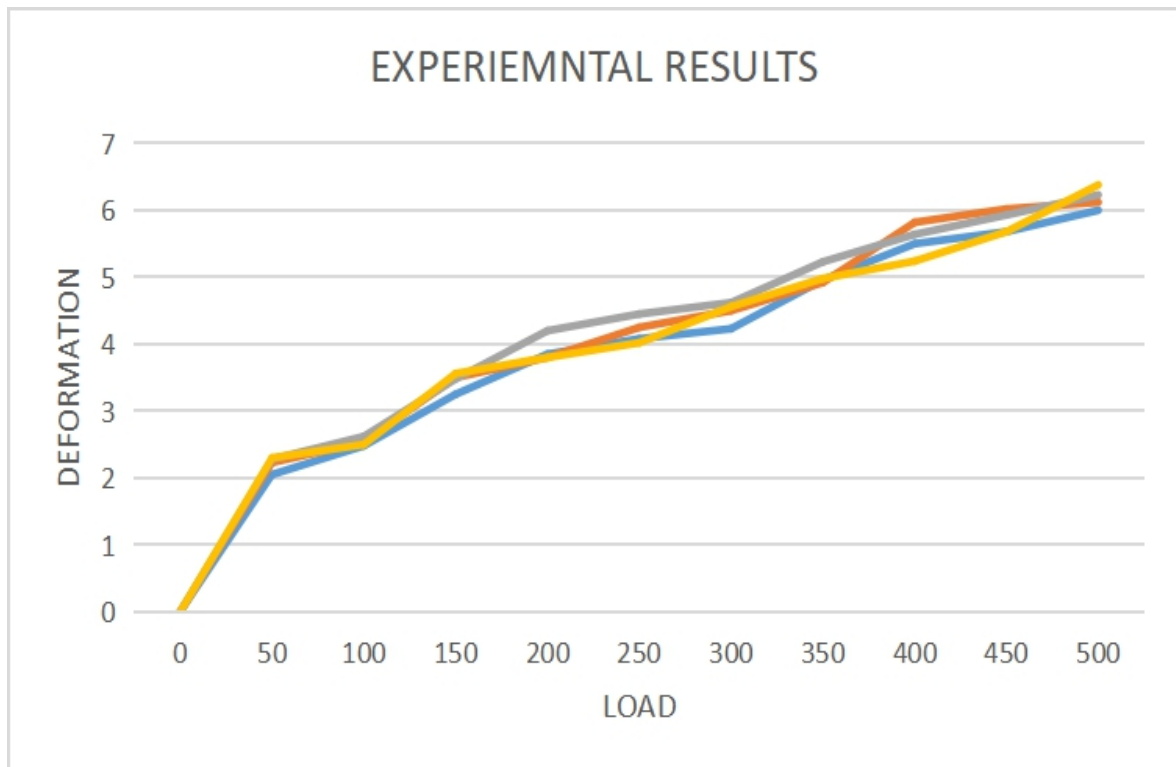


Fig 6.3.5 Comparison of All columns

6.5 NUMERICAL RESULTS

The numerical results and analysis is done for the all the columns, stress contour for the both conventional and steel fibre concrete.

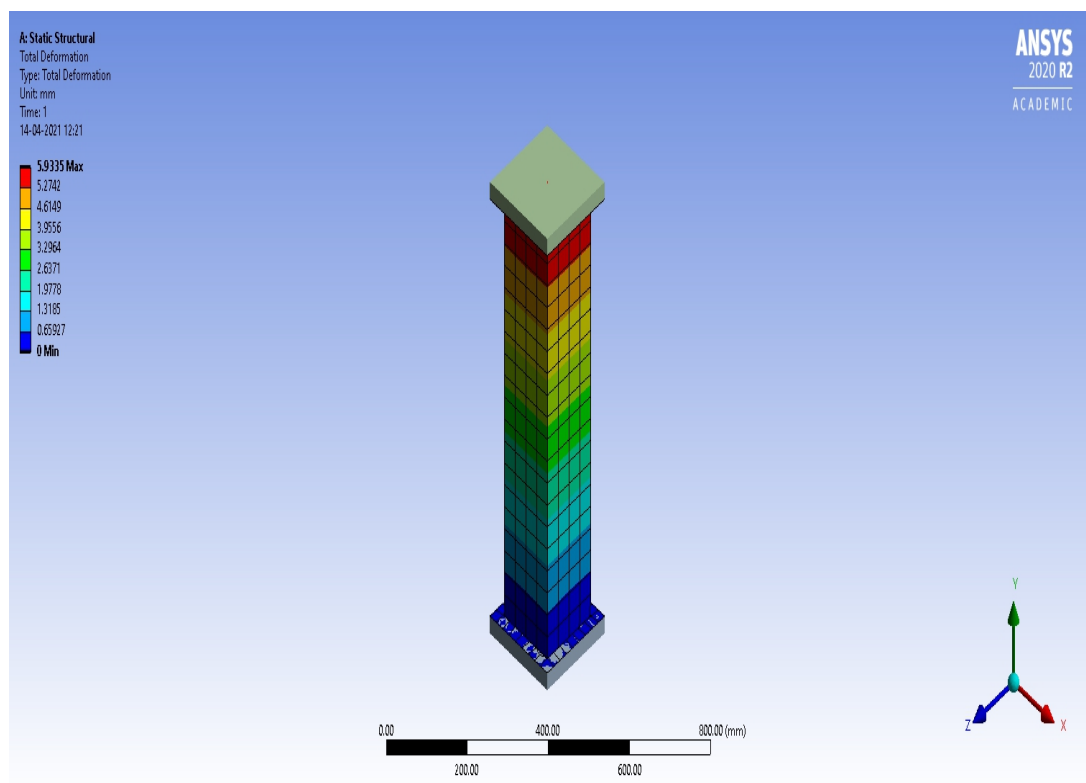


Fig 6.4.1 FRC column-1

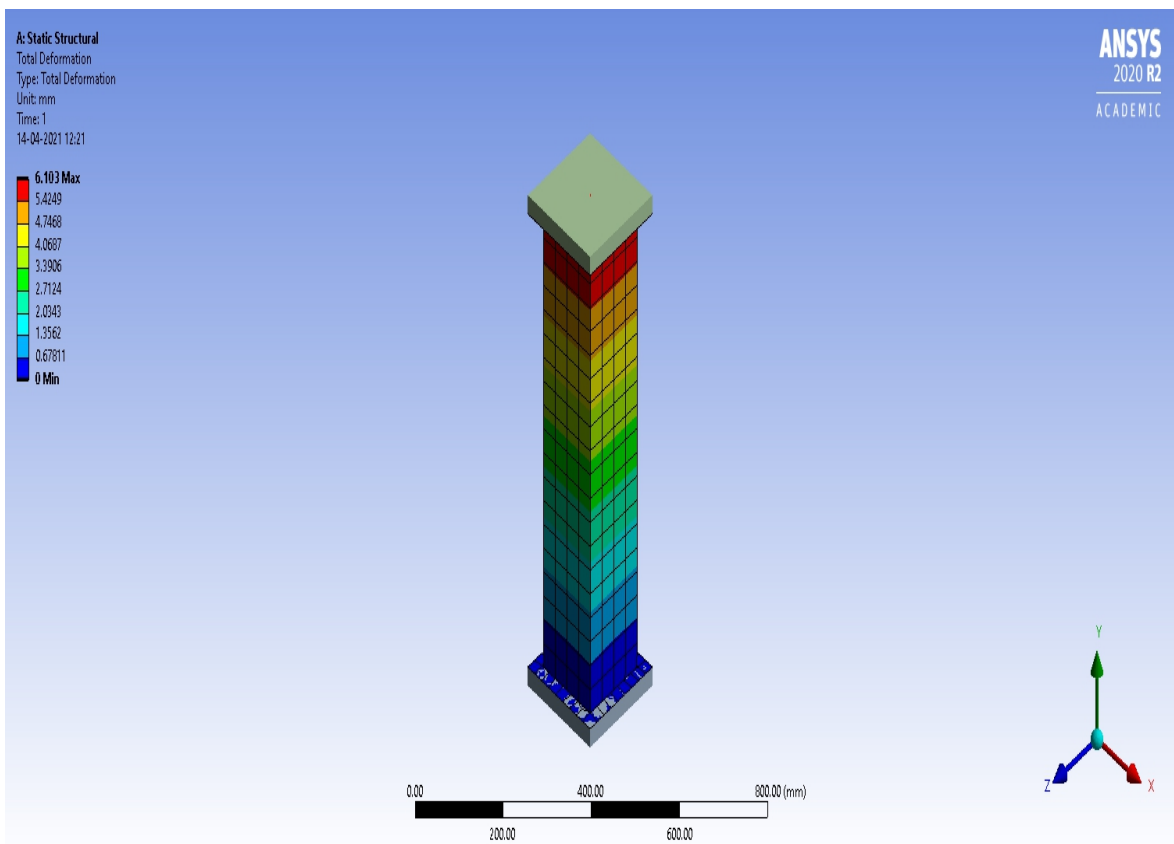
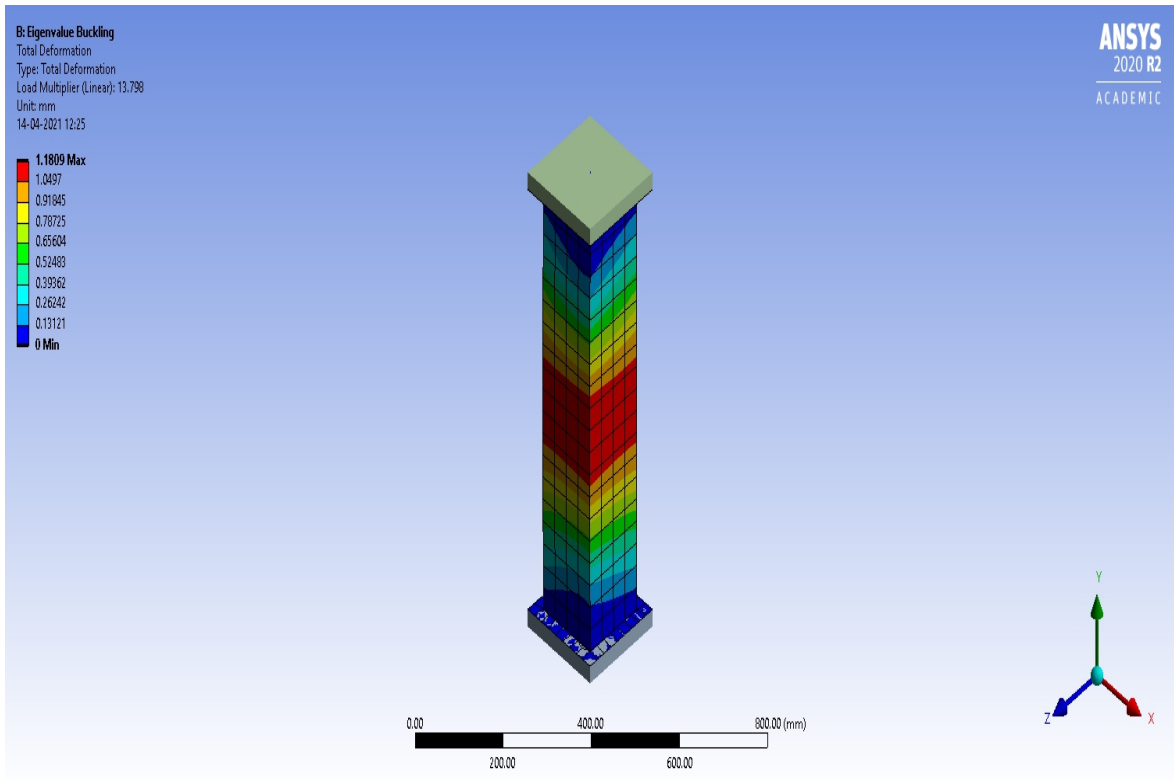


Fig 6.4.2 FRC Column-2

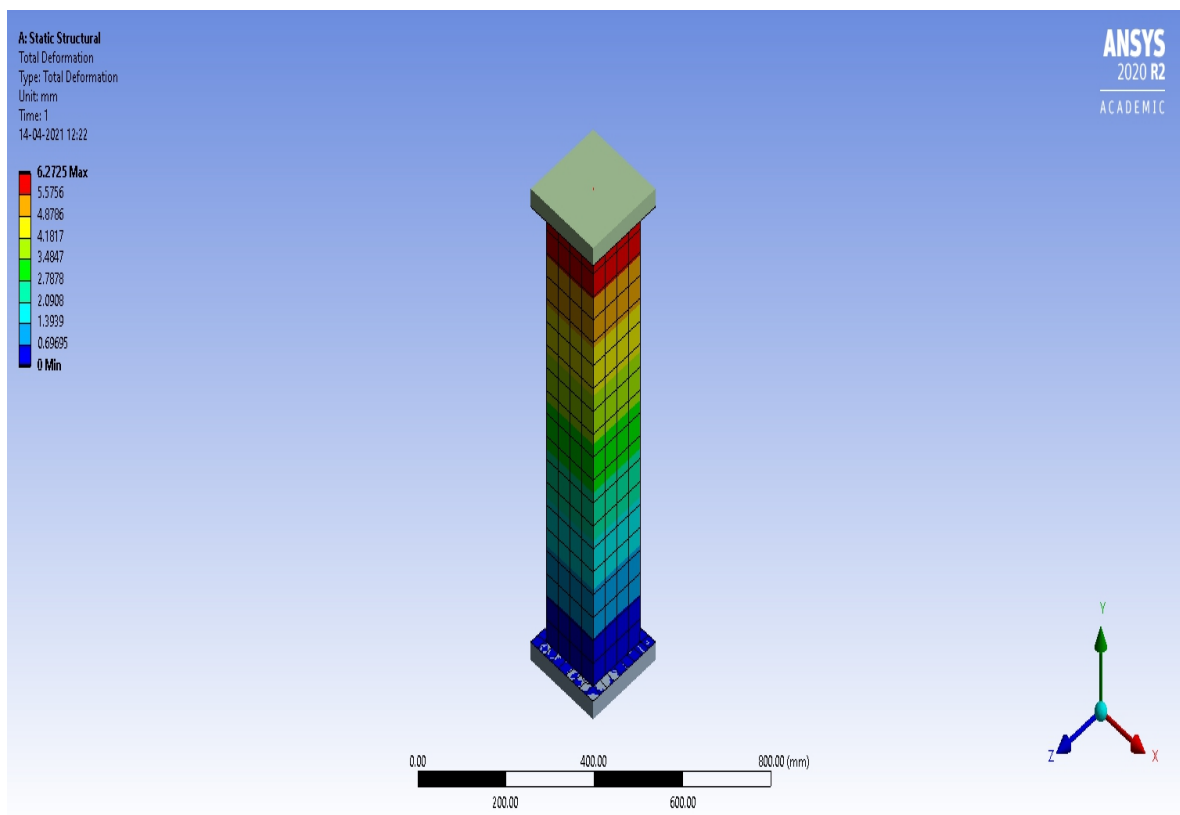
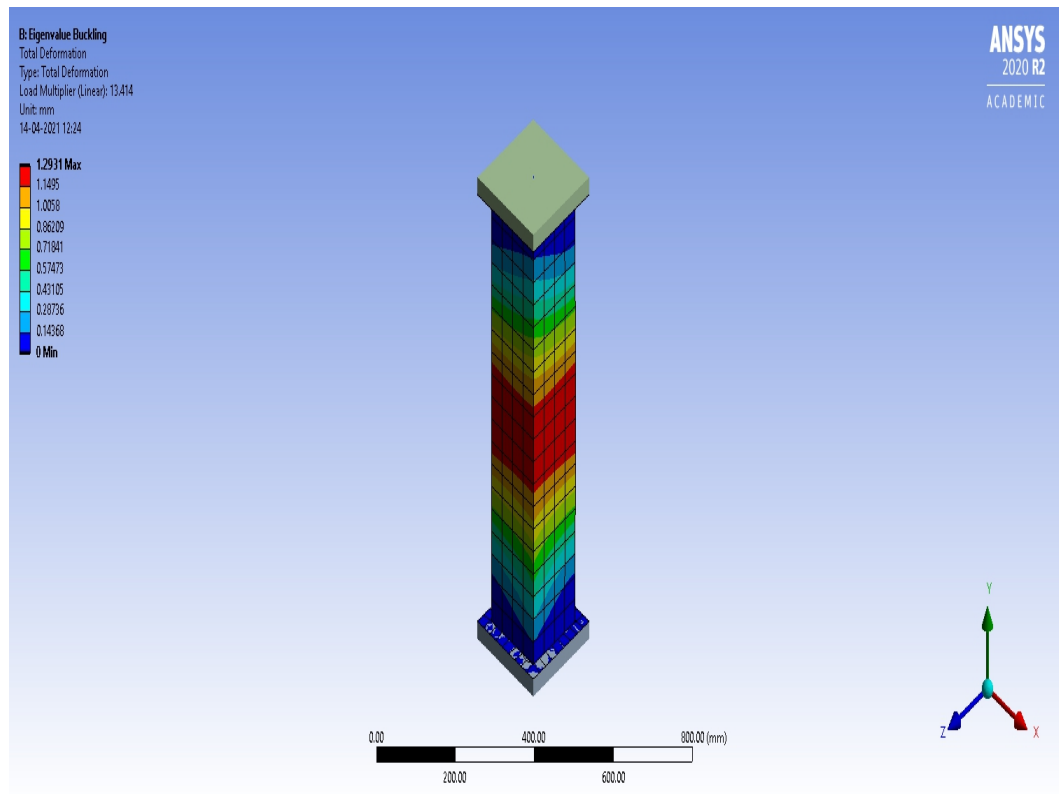


Fig 6.4.3 FRC Column-3

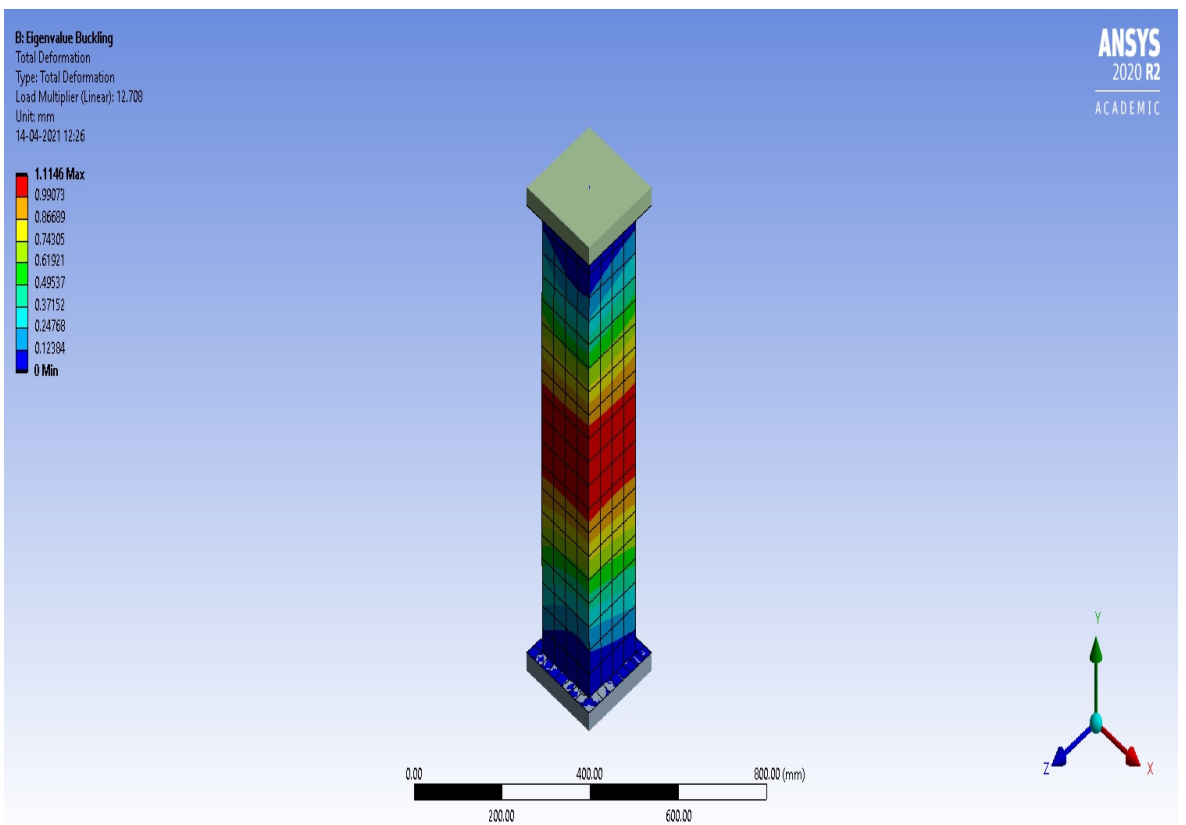
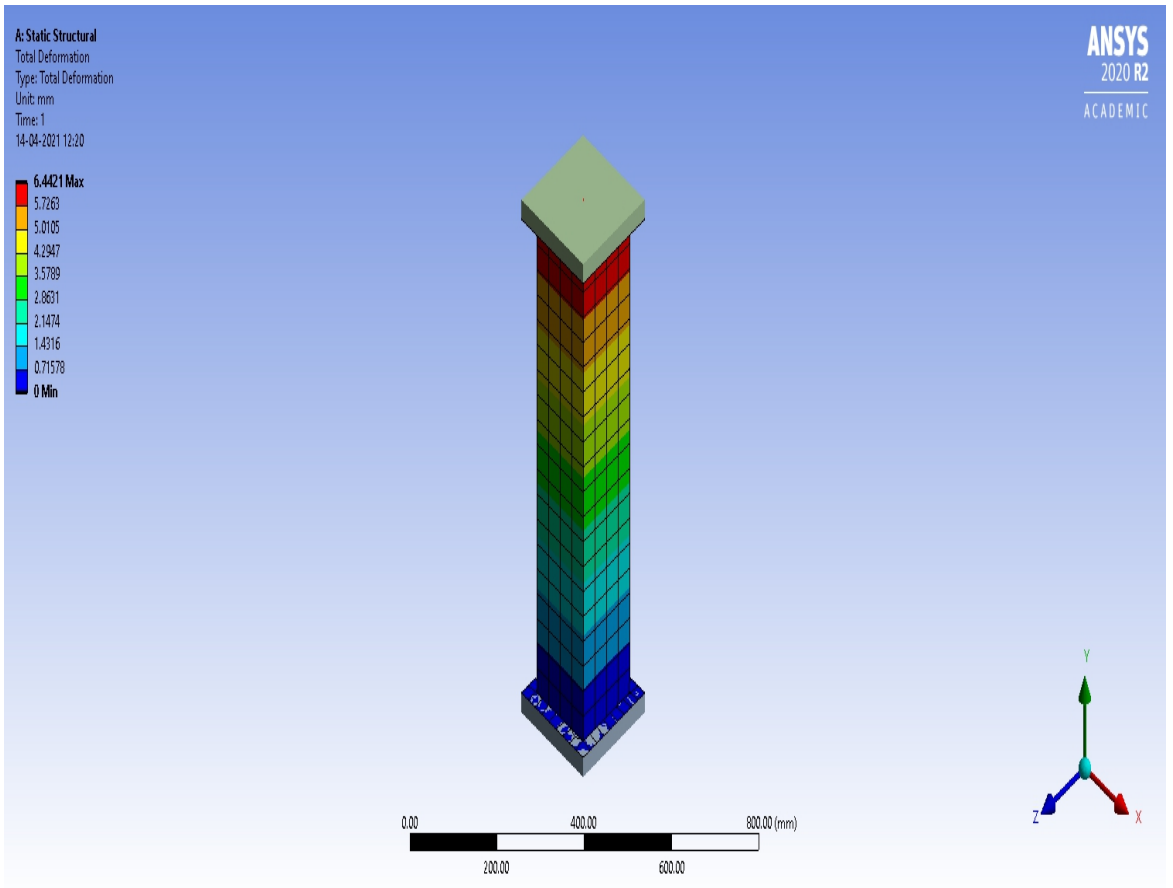


Fig 6.4.4 FRC Column-4

6.6 ANSYS Results

Table.No:6.7 ANSYS Results

S.NO	LOAD	FRC COLUMN-1	FRC COLUMN-2	FRC COLUMN-3	FRC COLUMN-4
		Deformation	Deformation	Deformation	Deformation
1	300	4.82	4.94	4.98	5.02
2	350	5.26	5.32	5.45	5.24
3	400	5.64	5.84	5.92	5.94
4	450	5.92	6.12	6.24	6.28
5	500	6.25	6.24	6.38	6.40

From the ANSYS Model,the fiber reinforced column(F3)have higher load carrying capacity than any other columns.

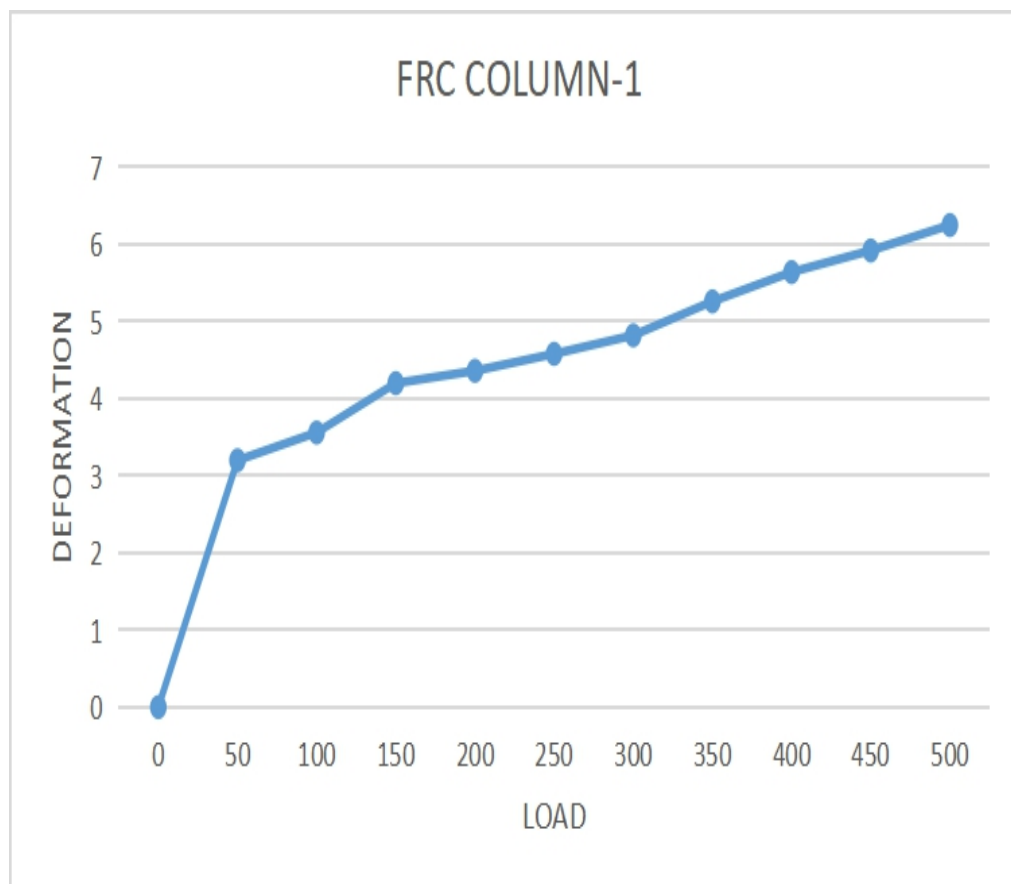


Fig 6.5.1 FRC Column-1

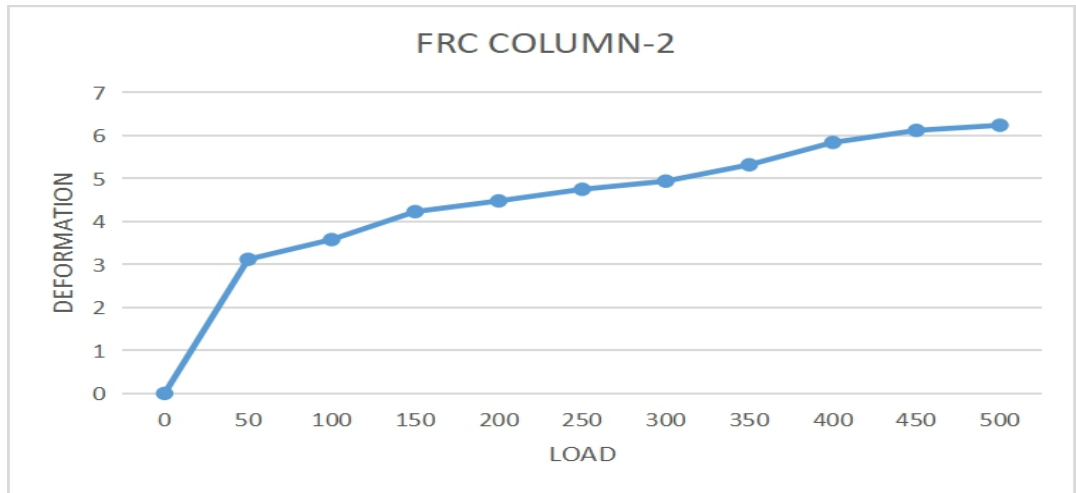


Fig 6.5.2 FRC Column-2

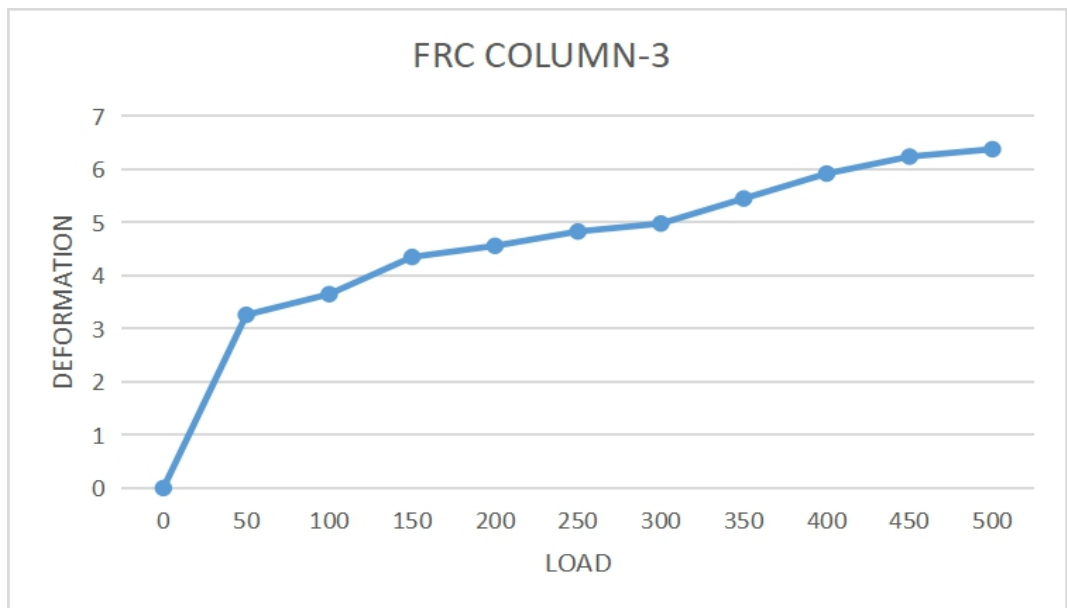


Fig 6.5.3 FRC Column-3

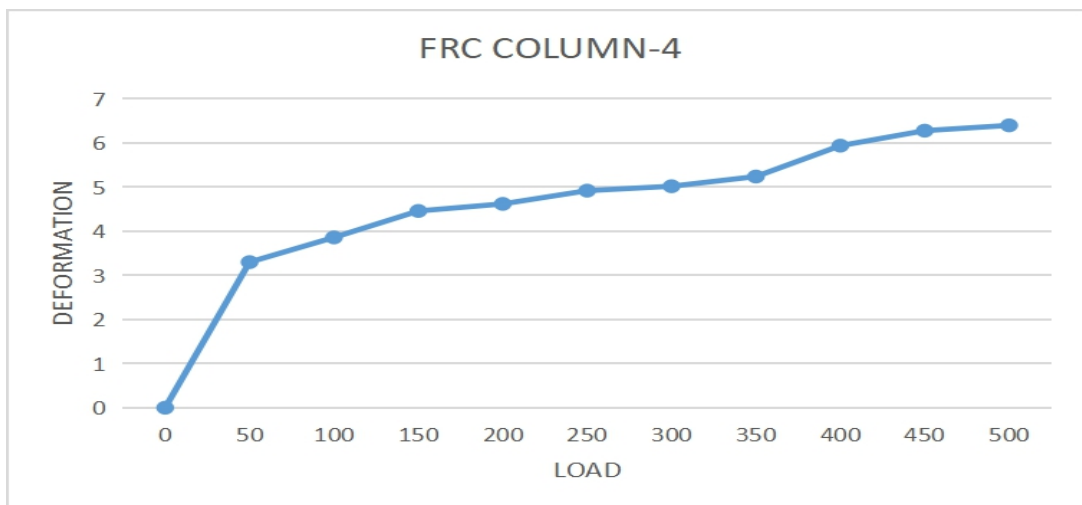


Fig 6.5.4 FRC Column-4

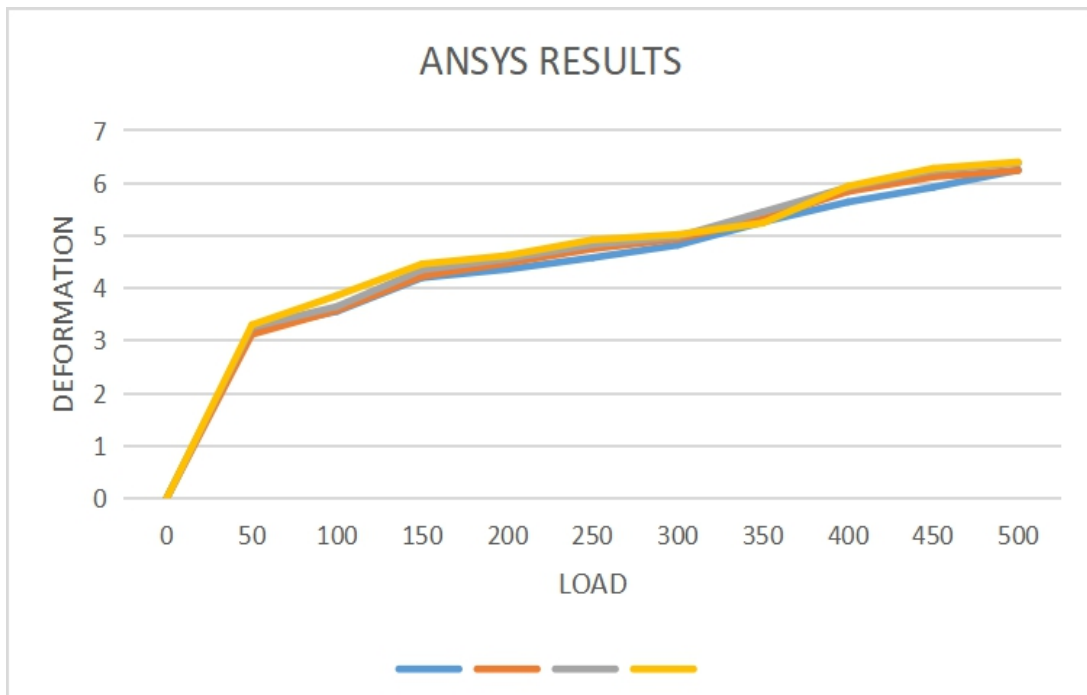


Fig 6.5.5 All column comparison

Comparison of Experimental& Analytical Results:-

The comparison of Experimental and analytical results obtained from the Ansys results of various column sections. The Ansys finite element analysis compared with experimental values and the various Axial shortening values against the Axial loads.

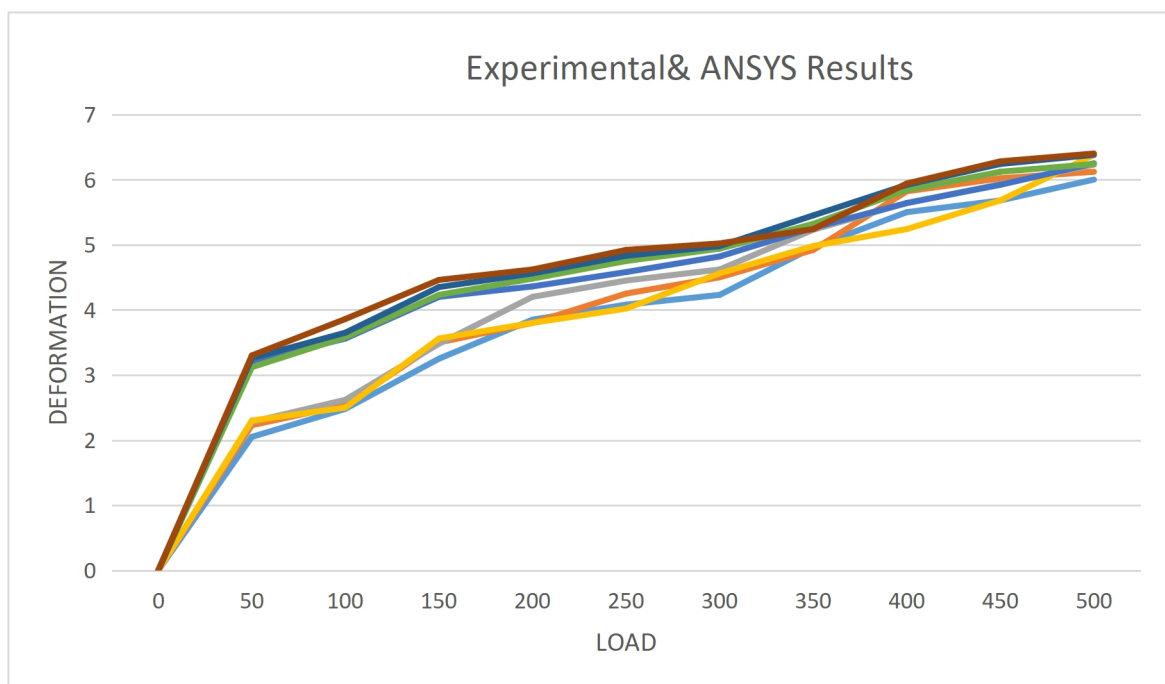


Fig 6.6 Comparison of experimental & Ansys

CHAPTER 6

CONCLUSION

This paper did research on the cold-formed steel tube thoroughly its behaviour and design of cold-formed steel tube(CFST). Many research has been done related to the cold-formed steel of rectangular section and also in the design areas. It also provides excellent seismic behaviour.

- The addition of the steel fibre increases the compressive strength by 24.15% and further addition of fibres quantities start decreasing. Rectangular cross-section is stronger than any other cross-section.
- The confinement effect increases due to this cross-section and also reduces due to stress concentration at the corners.
- Unlike Reinforced columns(RC), strain hardening does not occur in cold-formed steel tube column under axial loading.
- The tube of the cold-formed steel undergoes the confining effect and it can be investigated.
- Generally the use of high quantities of fibre in concrete leads to poor workability and segregation, lower self-weight.
- The cold-formed steel tube considerably reduces the local buckling, stiffness and further, the non-linear analysis is carried out.
- Based on the results of the split tensile strength, the load-carrying capacity is increased to 28.02% compared with the conventional specimen.
- Based on the results of the flexural strength, the load-carrying capacity is increased to 30.15% compared with the conventional specimen.
- The composite column can be used in industrial structures and low-rise buildings.

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