ANALYSIS AND DESIGN OF INFILLED TUBULAR COLUMNS IN CRITICAL COLUMNS CARRYING HEAVY LOADS IN COMMERCIAL BUILDING

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***Abstract :** The structural behavior of concrete - filled steel tube (CFST) columns and concrete columns in commercial building has been investigated by adopting the limit state method and designed. The effect of concrete compressive strength, thickness of steel tube, was considered in the analysis. The commercial building is design and analyzed after that the maximum axial load carrying column is replaced by the concrete - filled steel tube (CFST) columns by selecting the various sections by trial and error method, the analysis and design will be carried by using the Etabs 2016 software. Due to heavy axial load the foundation will be designed and analyzed using software safe 2016 for the both conventional column as well as concrete - filled steel tube (CFST).*

Keywords : **Stub column, Limit state method, Mat Foundation, Composite column, Concrete-filled steel tube column**

I. INTRODUCTION

Concrete filled tubular columns (CFT) consist of steel tubesand concrete. Steel pipes are used as longitudinal and transverse reinforcement, and concrete delays the local buckling of the steel pipes. Ordinary buildings usually have a higher axial force, which requires a larger column size to design these buildings, but the use of in filled columns can reduce the axial force, which is economical. Due to the advantages of these two materials for their complex functions, CFT columns have excellent seismic structures, such as high strength, high ductility, and high energy absorption. As a result, CFT columns are welcomed by supporting high-rise buildings, bridges, marine structures, and large marine structures, towers and heavy objects.

1.1 Types of Composite Columns

1.1.1Concrete encased structural steel shapes: It is generally believed that concrete encasement is the only protective measure against fire and corrosion of steel. The strength obtained from steel and interacting concrete is used for construction purposes. Steel formwork covered with concrete can be regarded as concrete reinforcement. The term "composite column" used in the architecture may refer to a "complex" sequence of columns. The steel ridge of the composite column provides increased buckling and strength.

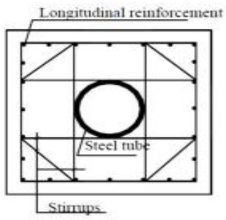


Fig 1: Encased composite column

1.1.2 Concrete Filled tubular Steel sections: Confined concrete fillers can increase the ability to resist axial loads, but have little effect on bending strength. For this reason, these are unlikely to be a good choice for framing resistance. Filling the tube with concrete will increase the ultimate strength of the component without significantly increasing the cost.

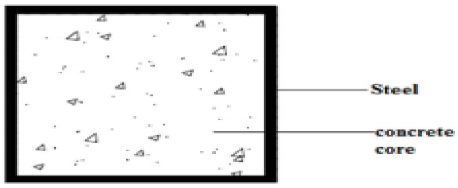


Fig 2: concrete filled steel columns

1.2 Advantages of Using Concrete Filled Tubular Columns.

1. The usage of concrete filled adjusted sections gives colossal saving in cost by extending the floor an area by a reduction in the vital cross-fragment size. This is huge in the arrangement of tall structures in urban networks where the cost of letting spaces is extremely high.

2. Concrete filled barrel shaped fragments can give a mind boggling monotonic and seismic block in two even manners.

3. Using items inlets of composite concrete filled adjusted area encompassing each fundamental method of a low-to medium-rising structure gives seismic abundance while abusing the two-way restricting capacities of concrete filled barrel shaped portions.

4. As an ordinary composite fundamental structure, on account of the composite effects, the upsides of the two materials can be utilized and their injuries can be kept up a key good ways from, as such forming an inexorably target system.

5. The steel chambers can be used as the formwork for tossing concrete and the shoring system being developed, in this manner concrete filled round and hollow segment structures have a lot of best constructability over strong structures.

1.3 Limit State Method

1.3.1 General

In the methodology for arrangement subject to restrict state thought, the structure will be proposed to with stand safely all stores in danger to catch up on it for an awe-inspiring span; its hall similarly satisfy the usefulness necessities, for instance, control youngster redirection and breaking. Quite far for the security and convenience essentials before frustration happens is known as a 'limit state'. The purpose of design is to achieve sufficient probabilities that the structure won't become unfit for the usage for which it is normal, that is destined to be, that it won't show up at a Limit state.

1.3.2 Limit State Collapse

The limit state of breakdown of the structure or some part of the structure could based from explosion of in any event one essential portion stay from fastening in view of adaptable or plastic instability (tallying the effects of impact where fitting) or upsetting. The security from turning, shear, bend and centre burden set each section won't be not actually the appropriate motivation at that zone made by the conceivable most inconvenient mix of weights on the structure using the best possible fragmented prosperity factors.

1.3.3 Limit States of Serviceability

Parting of concrete should not ominously impact the appearance or toughness of the structure; the agreeable farthest reaches of breaking would vacillate with such a structure and condition. Where assurance is required to compel the arranged split width to a particular worth. The helpful objective of registering break width is simply to offer bearing to the maker in making legitimate helper strategies and in keeping up a vital good ways from net missteps in structure, which may realize obsession and preposterous width of flexural split. The surface width of the breaks should not, when everything is said in done, outperform 0.3 mm in people where parting isn't ruinous and doesn't have any certified horrible effects upon the protection of strengthening steel nor upon the robustness of the structures.

2. OBJECTIVES AND METHODOLOGY

2.1 Objectives of the Study

The present work aims at the study of following objectives:

1. How the static evaluation of the building with composite in-filled tubular column should be carried out.

2. To evaluate the axial force (P) of building with reinforced concrete column and with composite in-filled tubular column.

3. The analysis of a high raised commercial building having Ground+15 Storey is analysed with replacing the column having high axial load.

4. To Model asymmetric commercial building plan in Etabs v.16 Software.

5. Analysis of the foundation by adopting different types of foundation in safe software.

6. Design the reinforced column as well as composite in-filled tubular column and compare the quantities such as concrete and steel.

7. To compare the performance of the structures that commerical building with reinforced concrete column with the commercial building with composite in filled tubular column.

8. To check the location in the building will give the maximum axial force bending moment and shear force.

2.2 Methodology

The step by step procedure followed to achieve the above objectives is;

1. An extensive literature review is carried out, and identified the problem of work which parameter to consider to analysis.

2. To establish the above objectives for the project work.

3. G+15 storey structure is choosen for the present investigation.
4. ETABS software is chosen for modelling and analysis of the selected structure.
5. In the modelling of the commercial building with reinforced concrete column and composite in-filled tubular column.
6. By considering static analysis fund out the maximum axial load carrying column in the reinforced column.
7. After the notifying the maximum axial load carrying column will be replaced by the composite in-filled tubular column.
8. Design the suitable footing in both such as reinforced column and the composite in-filled column the case which is suitable by using the software safev16.
9. As well as design the columns and detailing will also done by using auto cad for the both the cases that is reinforced column and the composite in-filled column.
10. Then calculate the quantity of reinforcement and concrete used in both the cases.
11. Concluded with the which building have more rate of reinforcement and concrete that is used for the in the construction
12. State that which is economical and which building gives more durable.

3. MODELLING AND ANALYSIS

Analysis and modelling of the high raised building is done with E-tabs 2016 software and dynamic analysis is carried out.

3.1 ETABS 2016 [Extended Three Dimensional Analyses of Building Systems]

ETABS is a software package developed by Computers and Structures, Inc. (CSI), California, USA and they are leaders in software's related structural and earthquake engineering. ETABS developed 40 years ago and many updates are done to achieve the accurate results. The recent ETABS is 3D object based modelling and visualization tool for fast linear and non linear analysis with good design capabilities for variety of materials. The software includes most of the structural design standards like American Standard Codes, Indian Standard Codes and many others.

3.2 SAFE 2016

SAFE is a conclusive composed device for arranging reinforced and post-tensioned strong floor and foundation structures. Disregarding the way that its name is unaltered, this absolutely new SAFE is overhauled and improved in each edge. This point rapidly depicts a bit of the new features in the program and aides you to manuals and specific assistance to help you with starting using the program.

3.3 Methods of Analysis

Analysis of the structural model is carried out to assess the static induced forces under different loading conditions from which parameters like Axial force(P) Bending moment (M) and Shear force (SF) can be obtained.

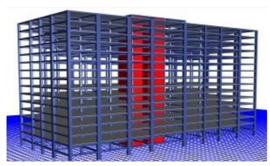
3.4 ETABS Modelling

E-tabs v2016 is used for the modelling of the high rise structure. G+15 storied reinforced cement concrete building is considered for the analysis. To understand the behaviour of structure, obtain the maximum axial load carrying column in the building that is replaced by the composite column analysis the structure compare with reinforced column

Table 1: Geometrical Property of validation model

Sl. No.	Description	Value(m)
1.	Typical story height	3.0
2.	Bottom story height	1.5
3.	No of storey	17 no's
4.	Dimensions of building	46.60 x 21.20

Table 2 High Raised Building Models

Sl.No	Description	Remarks
1.		Commercial building with reinforced concrete column
2.		Commercial building with composite in-filled tubular column

4. RESULTS AND DISCUSSIONS

Discussions are made based on following parameters

1. Axial force (P) of the commercial building with RC column.
2. Detailing of the reinforced concrete column and mat foundation.
3. Quantity and rate analysis of concrete and steel for the commercial building with RC column.
4. Detailing of the foundation of the commercial building with the reinforced concrete column.
5. Axial force (P)of the commercial building with CIFT column
6. Detailing of the composite in-filled tubular column
7. Detailing of the foundation of the commercial building with the composite in-filled tubular column.
8. Quantity and rate analysis of concrete and steel for the commercial building with CIFT colum

4.1 Axial Force (P) Of The Commercial Building With RC Column

If a load is applied to the structure along the length or perpendicular to the cross section of the member, then it is called as the axial load or the force acting through the centroid or geometric axis of a structure.

4.2 Design of Mat Foundations

By considering the axial load of commercial building after analysis the foundation should be designed we come across that is all column footing will overlaps in area of footing so we designed as mat or raft footing with using the software safe 2016.The mat footing reinforcement detailing will be as per is code of details

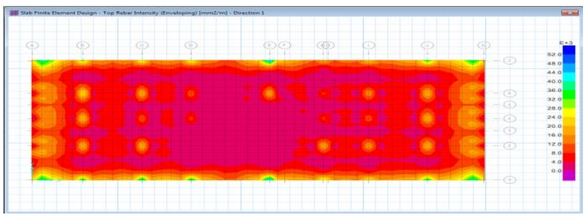


Fig 3: Top bar Reinforcement Intensity in X-Direction

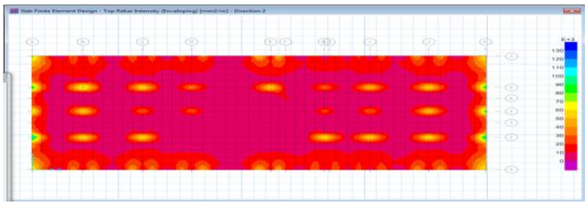


Fig 4: Top bar Reinforcement Intensity in Y-Direction

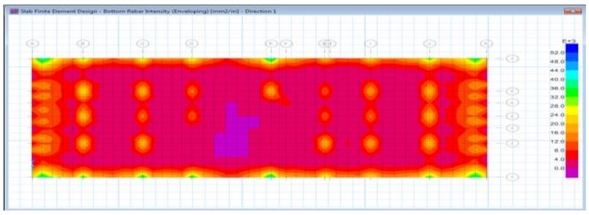


Fig 5: Bottom bar Reinforcement Intensity in X-Direction

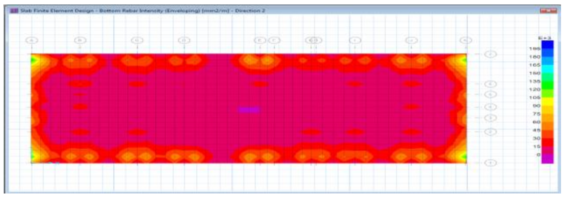


Fig 6: Bottom bar Reinforcement Intensity in Y-Direction

4.3 Axial force (P) of the commercial building with CIFT column

Axial forces

If a load is applied to the structure along the length or perpendicular to the cross section of the member, then it is called as the axial load or the force acting through the centroid or geometric axis of a structure.

4.4 Design of Mat Foundations

By considering the axial load of commercial building after analysis the foundation should be designed we come across that is all column footing will overlaps in area of footing so we designed as mat or raft footing with using the software safe 2016.The mat footing reinforcement detailing will be as per is code of details .

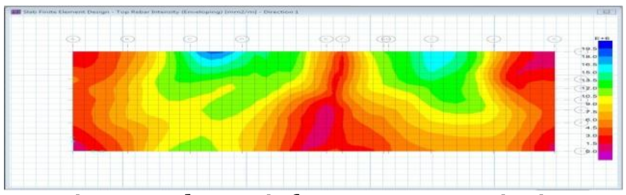


Fig 7: Top bar Reinforcement Intensity in X-Direction

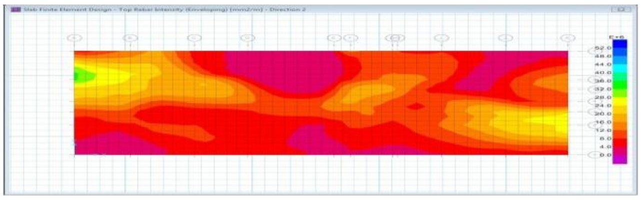


Fig 8: Top bar Reinforcement Intensity in Y-Direction

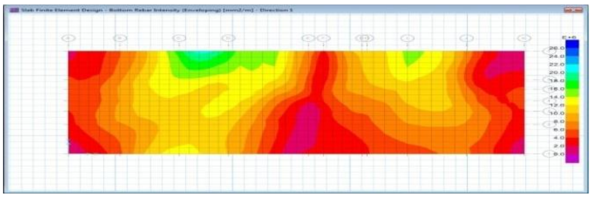


Fig 9: Bottom bar Reinforcement Intensity in X-Direction

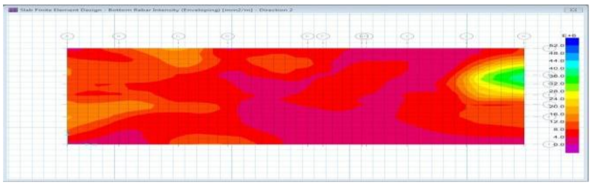


Fig 10: Bottom bar Reinforcement Intensity in Y-Direction

5. CONCLUSIONS

In the thesis two models are considered, one is commercial building with reinforced concrete column and the same commercial building with composite in-filled tubular column. The reinforced column and composite in-filled tubular column are designed and detailed as per BIS codes. Hence from the obtained results the following conclusions are made.

1. Considering the effect of axial force on structure, It has been observed that, building with reinforced concrete column will be stronger in carrying axial load as sectional area of column is higher compared to composite in-filled tubular column of smaller section.

2. The load carrying capacity will be more by 13.08% in the case of composite in-filled tubular column to the normal reinforced concrete column.s

3. In commercial building with the reinforced column that carries heavy axial load replaced by a composite in-filled tubular column to reduce the axial load on the foundation.

4. Concrete quantities required for the foundation and column for the commercial building with reinforced column is about 10% more than quantities required for the commercial building with composite in-filled tubular column.

5. Steel quantities required for the foundation and column for commercial building with reinforced column is about 36.09% lesser than the commercial building with composite in-filled tubular column.

6. As compare to the size to depth ratio in the column in commercial building with reinforced column is more compare to composite in-filled tubular column.

7. Rate analysis also done for the foundation and columns the quantities are more required in reinforced column than composite in-filled tubular column.

8. Load carrying capacity is more in the composite in filled tubular column because of steel and concrete will have high resistance column.

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