Comparative Study on Seismic Analysis Of Multistory Building With CSFT Columns And RCC Columns

JAYKRISHNA CHOUDHARY[1]DEEPTI HAZARI[2]

PG Scholar, Dept. Of Civil Engineering, Bhilai Institute of Technology, Durg, India
Assistant Professor, Dept. of Civil Engineering, Bhilai Institute of Technology, Durg, India
Email ID:jaykrishnachoudhary.jk@gmail.com

ABSTRACT

RCC and steel frames have been the most common frame systems for long times whereas composite frame system has also emerged as popular system for high rise buildings for few decades. Multi-story composite frames are generally composed of structural steel members made composite with concrete. Concrete-filled steel tubular (CFST) members have been widely used in buildings and bridges to utilize the benefits of both concrete and steel materials. In CFST members, steel provides confinement to the concrete to increase the strength and ductility, whereas concrete delays the local buckling of the steel tube to increase the load-carrying capacity Their usage as columns in high-rise and multi-story buildings, as beams in low-rise industrial buildings and as arch bridges, has become extensive in many countries in last four decades with abundant examples. But, their usage in India is a new concept. Hence, in this present study G+10 multi-storied building composed of RCC columns and CFST columns are analyzed by using ETABS software. In this study comparison has been made to study the variation in storey drift, storey shear, time period and the displacement of the building with RCC and composite columns.

Keywords: *Seismic analysis, Base shear, story drift, Etabs.*

1.0 INTRODUCTION-

The fundamental idea behind a Concrete Filled Steel Tube (CFST) is that when a steel tube is used as a casing outside of a concrete filling, both steel and concrete work together to modify the properties of the steel tube. Modern structures use concrete-filled-steel-tube (CFST) columns more frequently because of the advantageous composite action between steel tube and core concrete. Previous research has demonstrated that external confinement, such as jackets, tie bars, steel rings, or spirals, can enhance this composite activity even more. High strength concrete is used in the CFST because it combines the benefits of high strength steel and concrete strength. It has both static and earthquake-resistant qualities. The exceptional ductility and energy absorption capacity of CFST render it an ideal choice for constructing earthquake-resistant edifices. Their suitability as structural columns is attributable to their ability to withstand high shear stresses, wind and seismic forces. The application of high strength materials can have a significantly positive impact on the properties of columns and the economy of tall buildings. When high strength concrete is employed in CFST columns, it results in superior damping and increased stiffness. The utilization of high strength steel for steel tubes results in the usage of smaller sections to carry the same load, thereby enhancing the economy, which is a crucial consideration in projects. The pivotal aspect of a Concrete Filled Steel Tube (CFST) column is the interaction between the steel casing and infill concrete, wherein the concrete prevents and delays local buckling in the steel, while the steel surrounding the concrete prevents spalling and provides confinement to the concrete, thereby increasing its compressive strength. CFSTs are predominantly employed in seismic designs, roofs of storage tanks, piers in bridges, and various other structures

Types of composite columns:

a) Concrete encased steel (CES)
b) CFST (Concrete filled steel tube)
c) combination of CES and CFST
d) Hollow CFST sections
e) Double skin sections

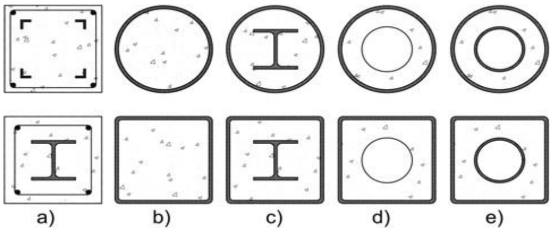


Fig-1.1Types of composite columns:

1.1 RESEARCH OBJECTIVES:

1. The objective is to model the buildings using ETABs Software
2. There are four models considered in this project work which are as follows:
    - RCC building- Structure with conventional RCC frame
    - Composite structure 1- Structure with CFST column and RCC beam
    - Composite structure 2- Structure with CFST column and Steel beam
    - Composite structure 3- Structure with RCC column and Steel beam
3. To analyze the buildings in seismic zone II using Response spectrum method.
4. To compare the behaviors of the buildings on the basis of different parameters such as story displacement, story drift, story shear, base shear.
5. Wind load is also considered for analysis of buildings.

2. METHODOLOGY:

In this present study G+10 multi-storied building composed of RCC columns and CFST columns are analyzed by using ETABS software. In this study comparison has been made to study the variation in storey drift, storey shear, time period and the displacement of the building with RCC and composite columns. IS code 456-2000: plain and reinforced concrete, IS code 875-1987(part-2): Live load and is code 1893-2016: criteria for earthquake resistant design of structures are taken in to consideration.

Table-1 Building Configuration of the project:

Type of structure	Multi-storey bay frame structure
No.of structure	G+10
Floor height	3m each floor
Grade of Concrete	M30
Grade of steel	Fe345
Grade of steel rebar	Fe550
Slab thickness	180mm

Table-2 Column and beam size in different models:

Model	Column	Beam
RCC Structure	RCC column 700mm*450mm	RCC Beam 300*450mm
Composite structure 1	CFST column 300mm diameter	RCC Beam 300*450mm
Composite structure 2	CFST column 300mm diameter	ISMB 250
Composite structure 3	RCC column 700mm*450mm	ISMB 250

Table-3 Seismic data :

Type of soil	Medium soil type
Seismic zone	Zone II
Imposed load	3kN/m²
Response Reduction factor	5
Importance factor	1.2
Damping	5%

Table 4 Loads acting on the Structure:

Types of load	Acting on structure	Acting on terrace
SIDL	2 kN/m3	3kN/m3
Live	3 kN/m3	1.5 kN/m3
Wall load	12.5 kN/m3	5 kN/m3

3. BUILDING MODELS:

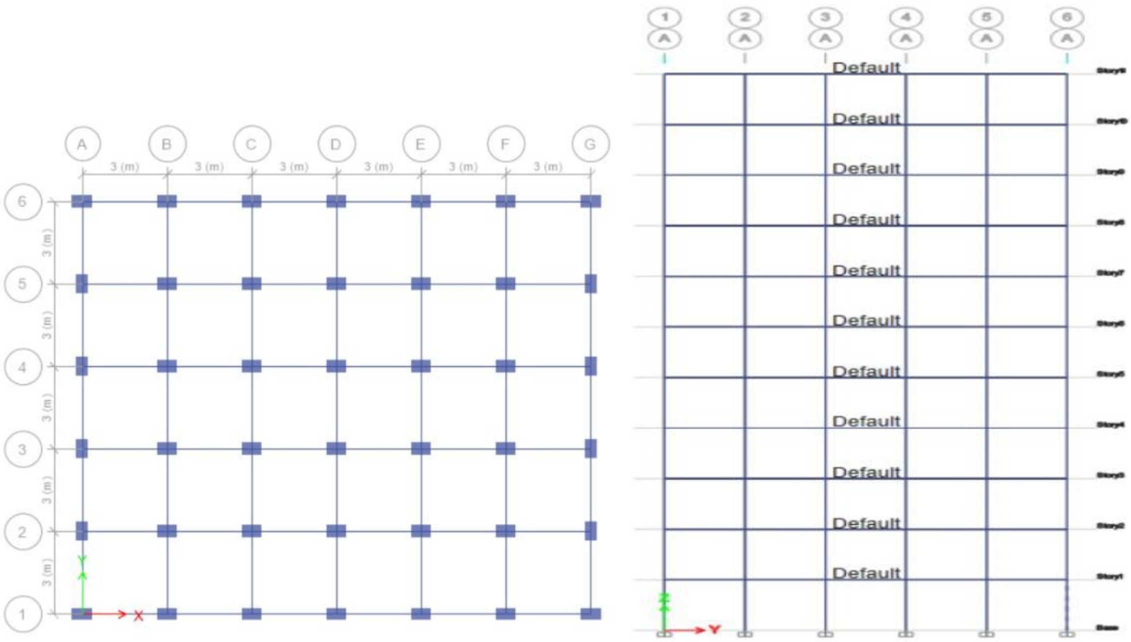


Fig 3.1-Plan & Elevation

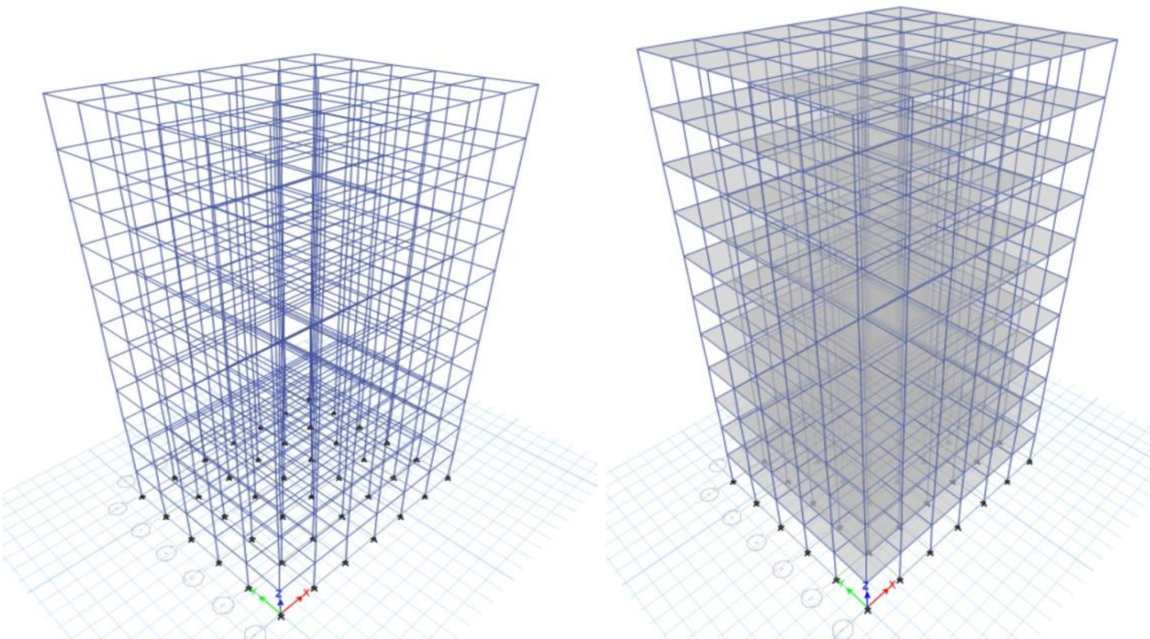


Fig-3.2 3D View of model

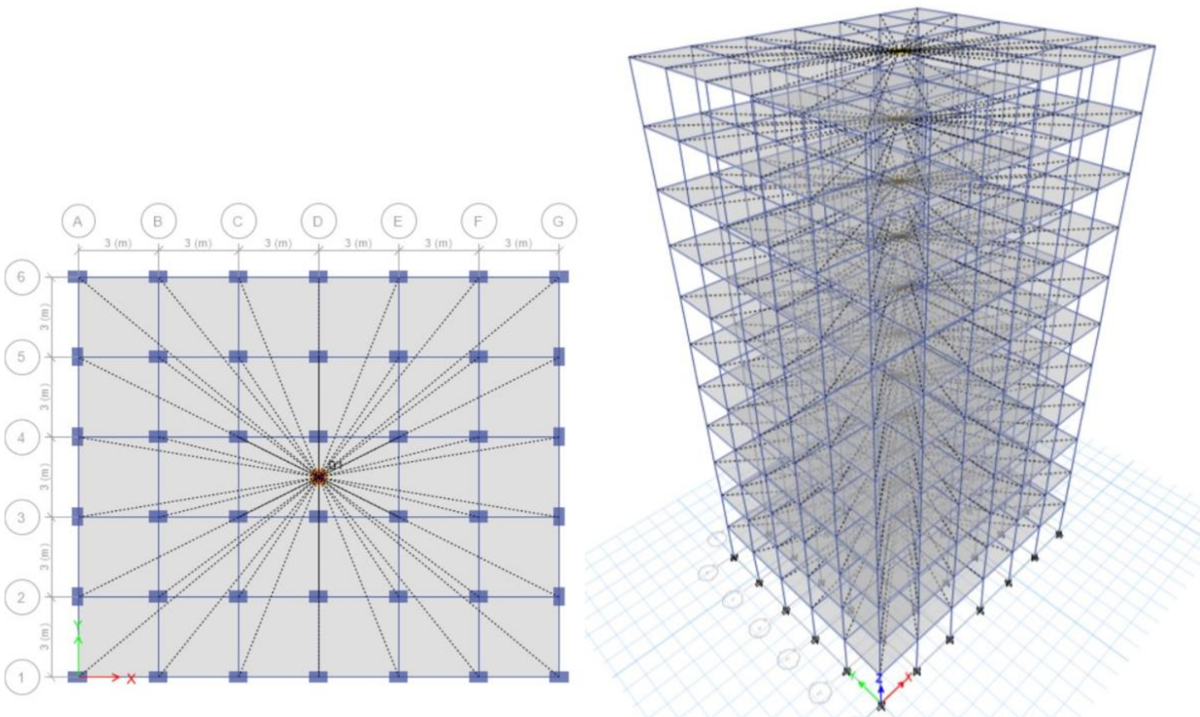


Fig 3.3 Diaphragms

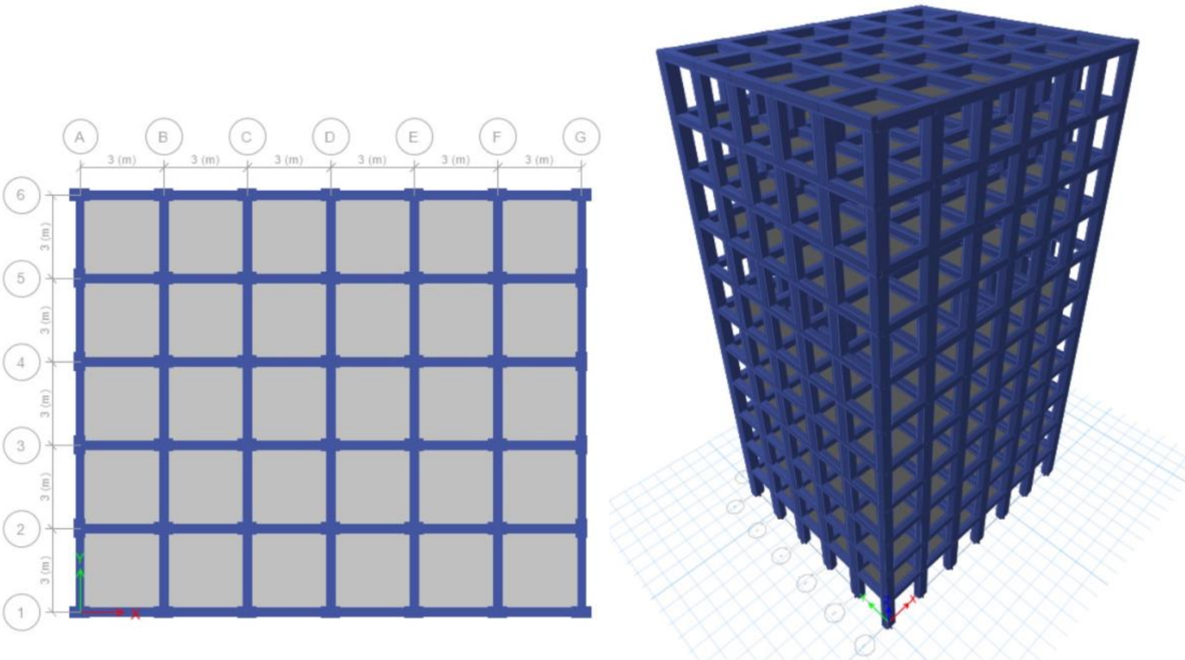


Fig-3.4 Extrauded View

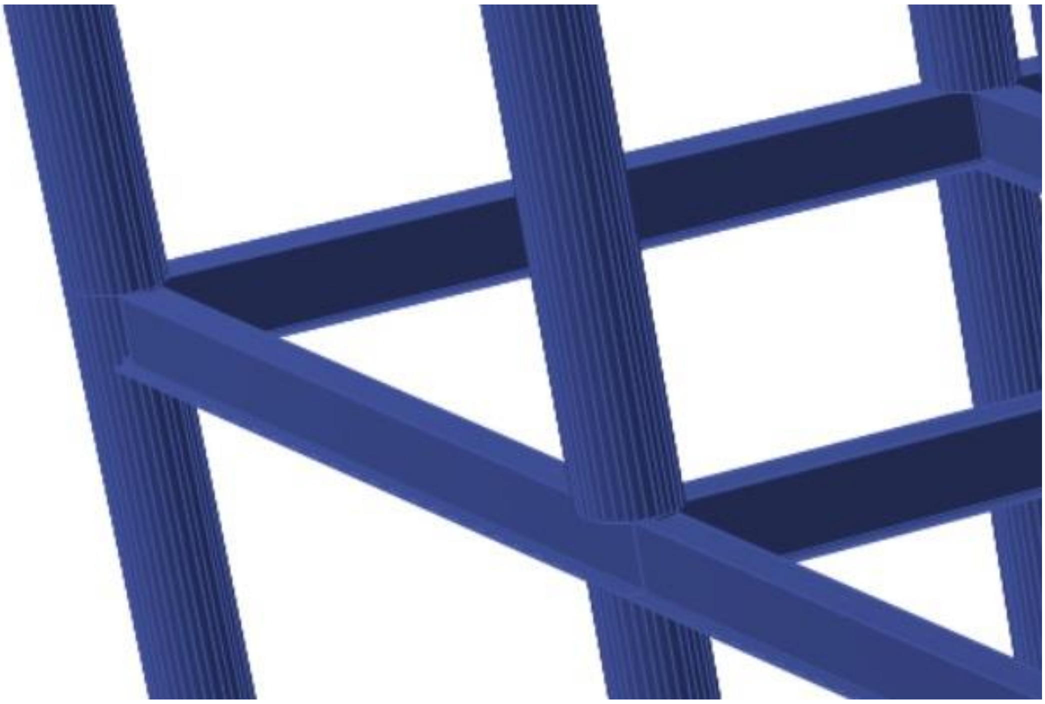
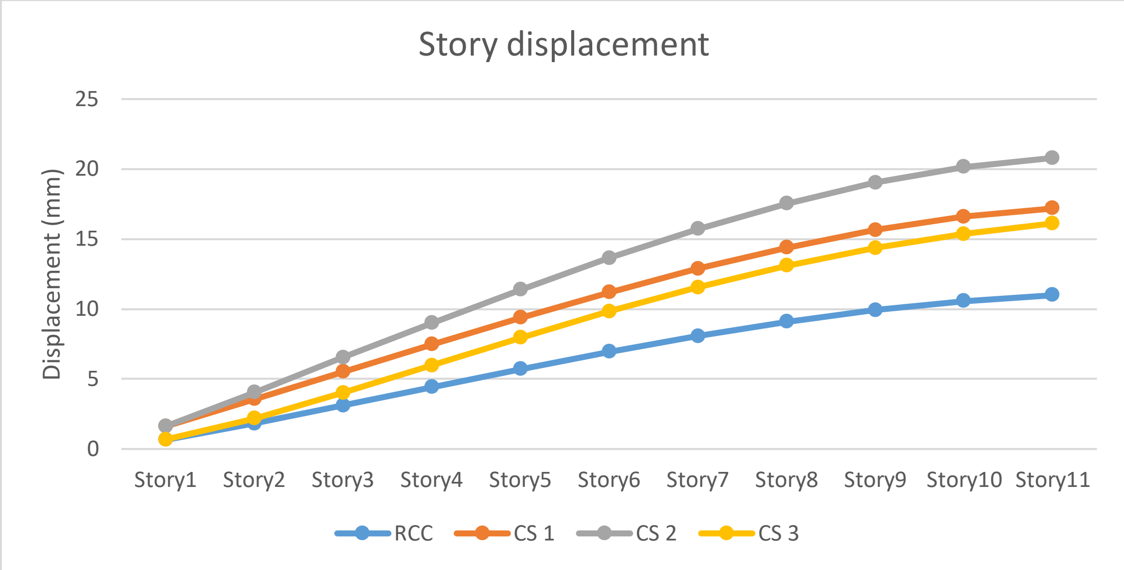


Fig 3.5 Joint of CFST column & steel beam

4. RESULTS AND DISCUSSION:

4.1 Story Displacement:

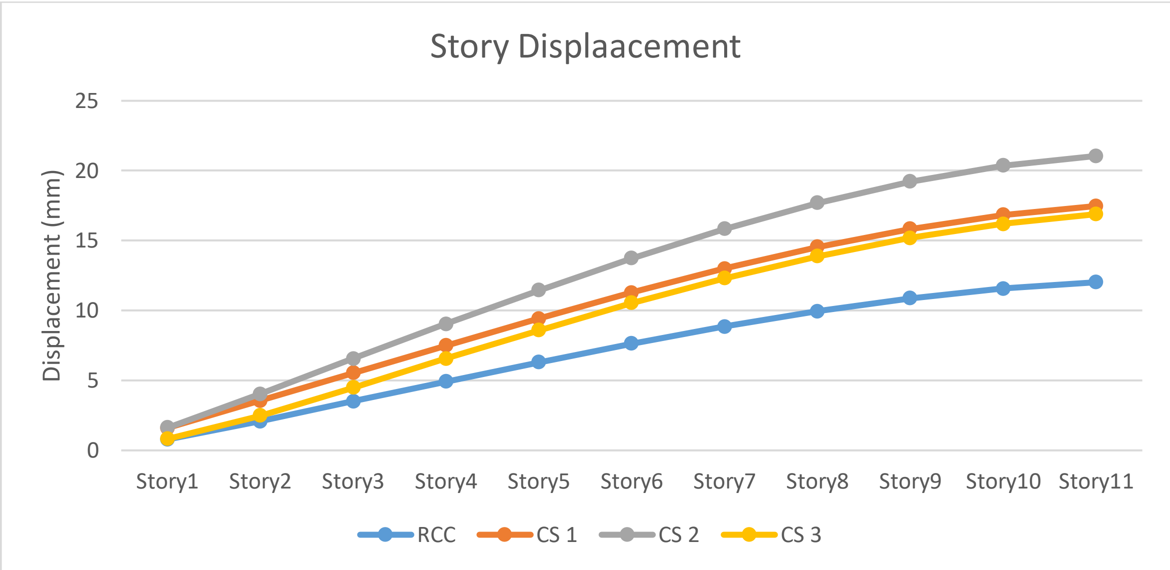
4.1.1 Story Displacement in Zone II in X Direction:



Graph 1. Story Displacement in Zone II in X Direction

G+10 composite structures 2 show maximum displacement as compared to all other buildings. Buildings with RCC frame show minimum story displacement. Building with CFST column and steel beam shows maximum displacement.

4.1.2 Story Displacement in Zone II in Y Direction:

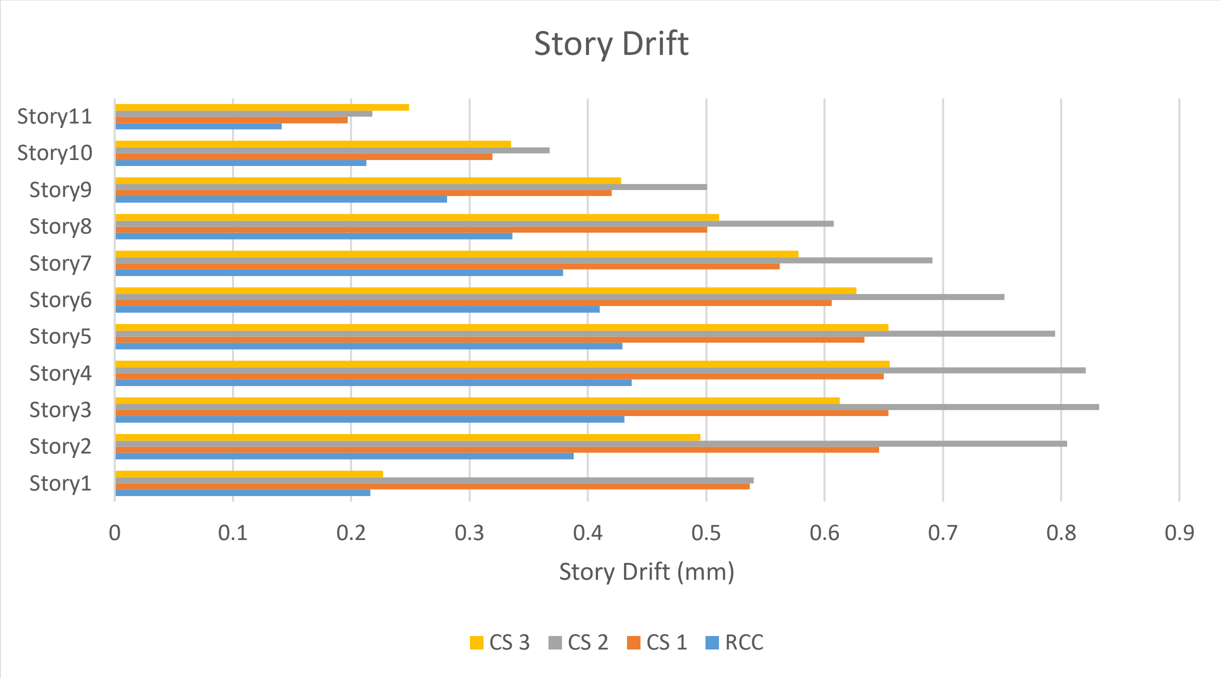


Graph 2. Story Displacement in Zone II in Y Direction

In zone II in Y direction Composite structure 2 (CFST column & steel beam) show higher displacement as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Displacement increases as story height increases.

4.2 Story Drift:

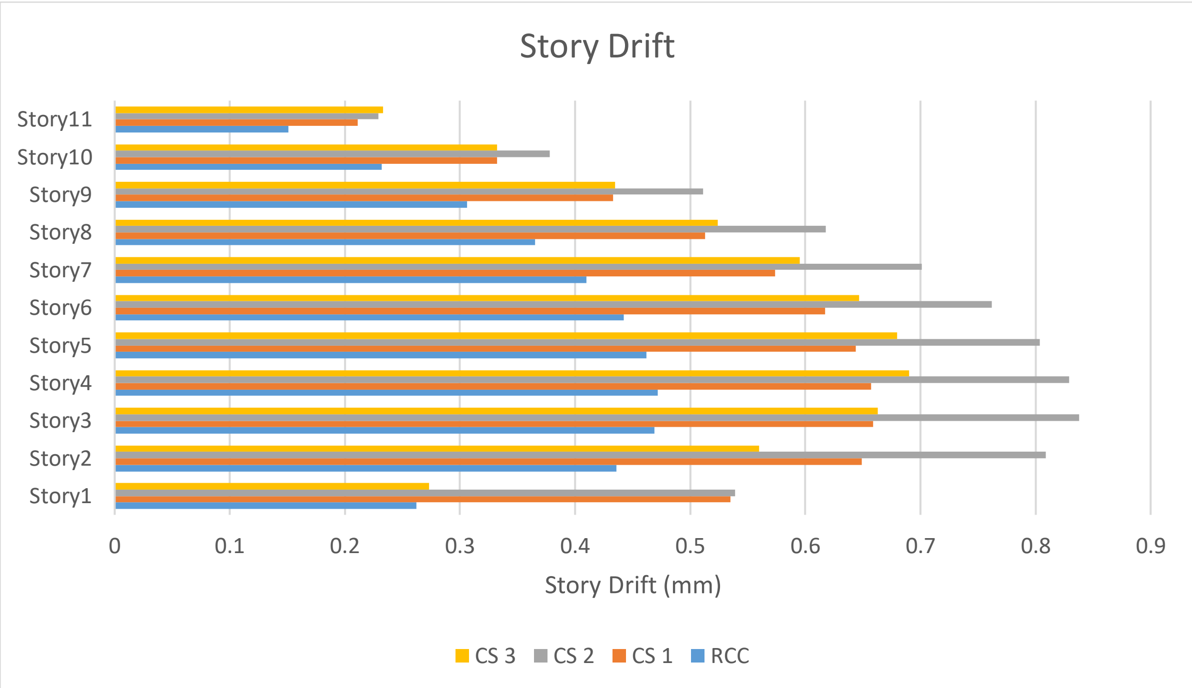
4.2.1 Story Drift in Zone II in X Direction:



Graph 3. Story Drift in Zone II in X Direction

In zone II in X direction buildings with CFST column & steel beam show higher story drift as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Where RCC building shows least story drift.

4.2.2 Story Drift in Zone II in Y Direction:

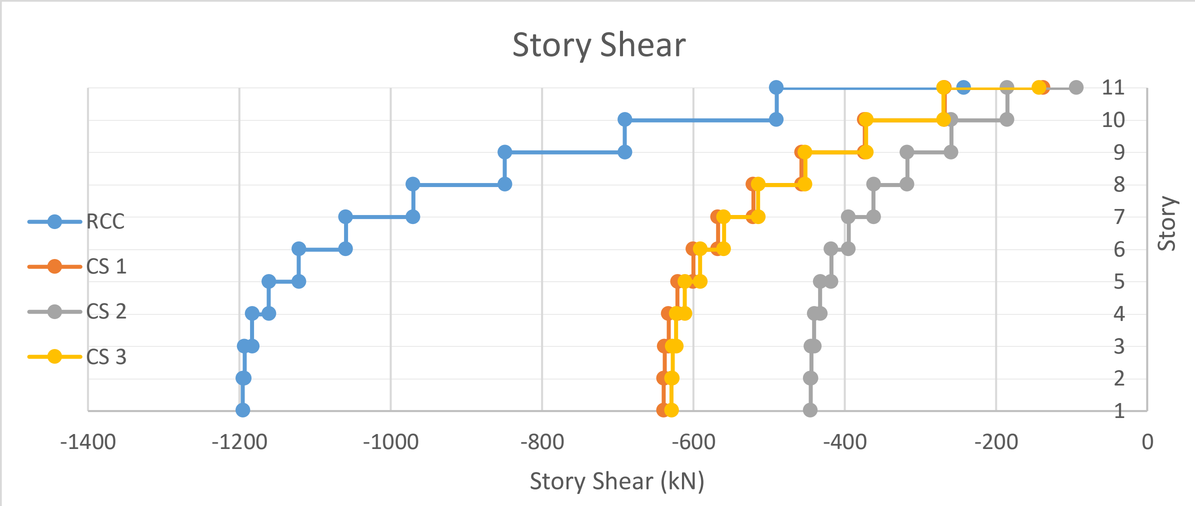


Graph 4. Story Drift in Zone II in Y Direction

In zone V in Y direction CS 2 building (CFST column & steel beam) show higher story drift as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Where RCC building shows least story drift.

4.3 Story Shear:

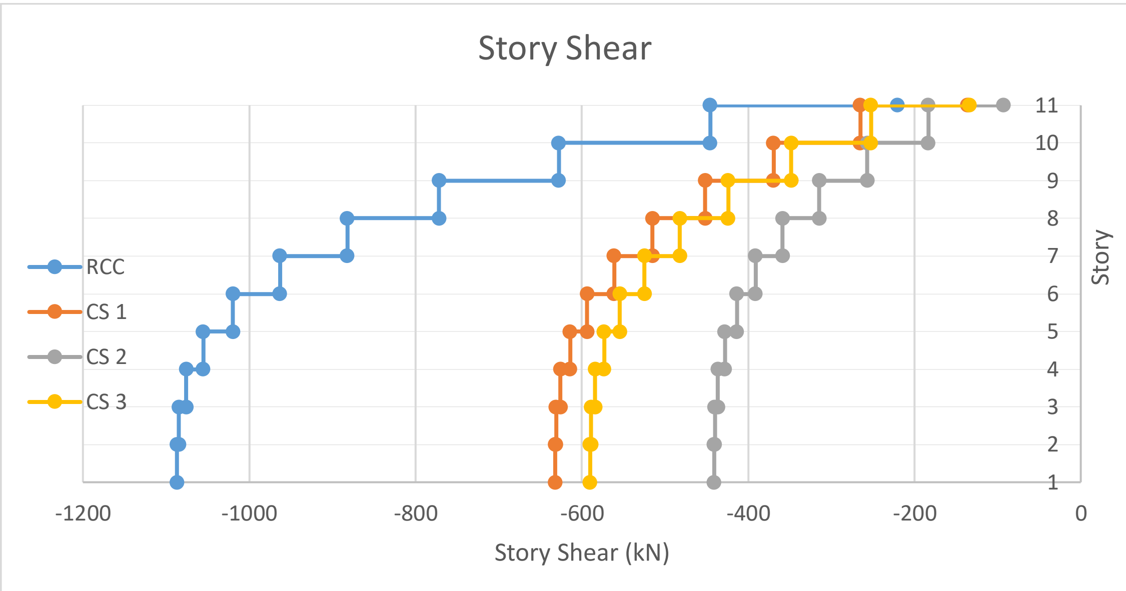
4.3.1 Story Shear in Zone II in X Direction:



Graph 5. Story shear in Zone II in X Direction

It is the lateral load acting on each story of the structure due to wind or earthquake effect. By using the diaphragm, it transfers the lateral load acting on the top story to the bottom story of the structure. Hence with the height of the structure the story shear at the base increases. Increase in story shear results in an increase in the load acting on the structure. In the case of CFST Structure, the Story shear has been decreased .

4.3.2 Story Drift in Zone II in Y Direction:

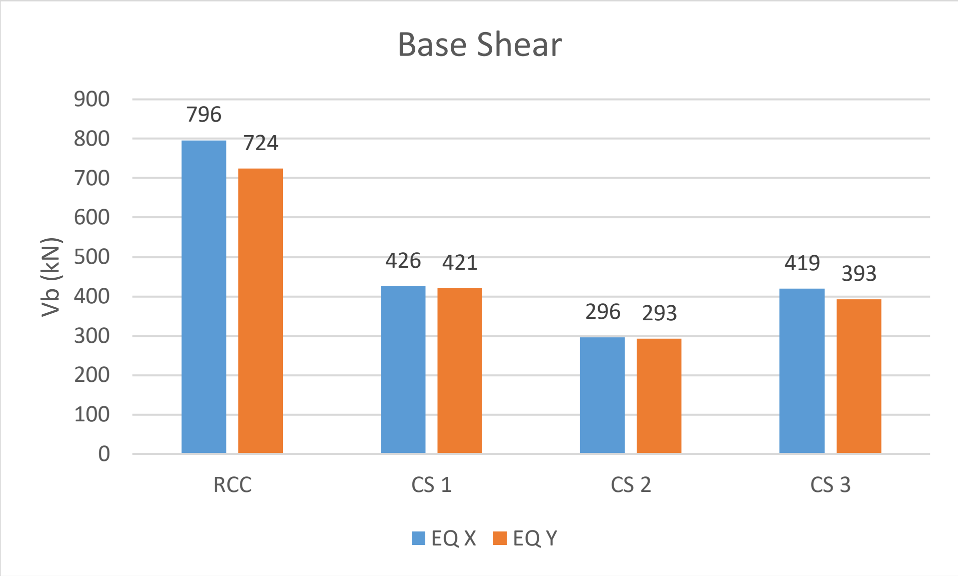


Graph 6. Story shear in Zone II in Y Direction

It is the lateral load acting on each story of the structure due to wind or earthquake effect. By using the diaphragm, it transfers the lateral load acting on the top story to the bottom story of the structure.

Hence with the height of the structure the story shear at the base increases. Increase in story shear results in an increase in the load acting on the structure. In the case of CFST Structure, the Story shear has been decreased .

4.4 Base Shear:



Graph 7. Comparison graph of Base shear between RCC,CS 1,CS 2 & CS 3 in Zone II

From above comparison RCC structure shows higher value of Base shear as compared to composite structures .

5.0 CONCLUSION:

1. The primary goal of this study was to compare the behaviors of the buildings on the basis of different parameters such as story displacement, story drift, story shear, base shear.

2.Base shear of RCC structure is 2.69 times higher than the base shear of composite structure 2 building in zone V.

3. Story displacement in composite structure 2 shows higher values of displacement than RCC structure in both X and Y direction. composite structure 2 in X direction in zone II is 1.90 times more as compared to RCC structure.

4. In zone II in Y direction buildings with CFST column & steel beam show higher displacement as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Displacement increases as story height increases.

5. In zone II in X direction buildings with CFST column & steel beam show higher story drift as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Where RCC building shows least story drift. Story drift in composite structure 2 in X direction is 1.90 times more as compared to RCC structure.

6. In zone II in Y direction buildings with CFST column & steel beam show higher story drift as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Where RCC building shows least story drift. In Y direction higher story(8-9) shows maximum drift whereas in x direction lower story(3-5) shows maximum drift.

7. In zone II in X direction RCC buildings show higher story shear as compared to all other buildings and composite structure 1 & composite structure 3 shows approximate same values. Where CFST column & steel beam(CS 2) shows least maximum story shear. Maximums story shear in RCC structure in X direction is 2.69 times more as compared to Composite structure 2.

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