Comparative Study of Seismic Parameters of Multi Storey Building Provided With RCC And Concrete Filled Steel Tubular Columns

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Abstract: *In Present scenario, world is facing enormous growth in population and shortage of land. Hence, it has become obligatory to go for high rise building construction. Failure of high rise RCC buildings mainly occurs due to earthquake forces. To overcome such problems, use of concrete filled steel tubular (CFST) column in buildings becomes the better option. Concrete filled steel tubular (CFST) column sections are the columns in which concrete is filled in to the steel tube. CFST column is a composite section which utilizes the advantage of both steel and concrete. This advantageous interactive behavior between steel tube and concrete increases the strength of CFST section. In the present paper, seismic behavior of G+19 storey high rise building situated in zone IV has been analyzed through response spectrum analysis method using ETAB-2017 software. Building with CFST columns performs better against seismic forces.*

Keyword: *Concrete Filled Steel Tubular Column, Seismic Behavior, Response Spectrum Method, ETAB-2017*

1. Introduction

Steel and Concrete are the two materials which are widely used in the construction of building structures. CFST column is a composite section formed by filling concrete into a hollow steel tube and it resists the applied load through the composite action of concrete and steel, use of concrete filled steel tubular (CFST) columns in construction are currently increasing due to their excellent static and earthquake resistant properties, such as high strength, high ductility, large energy absorption capacity, stiffness, fire performance along with easy construction ability etc. The main focus of the study is to evaluate the performance of building with CFST columns under seismic

nd gravity loading. In this study, the finite element (FE) technique is used to investigate the seismic response of CFST column framed structure (fig.1.1)

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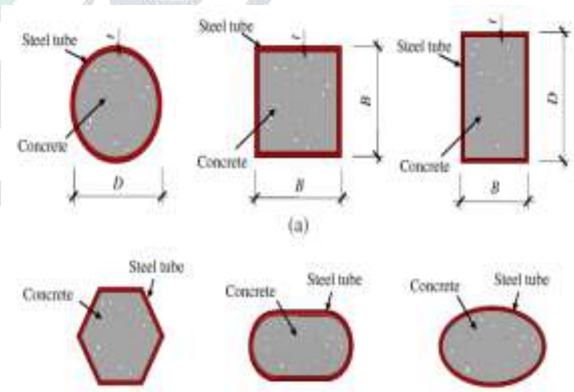

Fig.1.1 Types of CFST

2. Objectives of Work

- To study the seismic behaviour of RCC and CFST column in multi storey buildings.
- To evaluate the performance of different models and compare with the following

seismic parameters i.e Time period, stiffness, storey drift, storey displacement.

3. Building Description

Description of Residential building with G+19 storey located in Zone IV are given below:

3.1. Geometrical Properties:

S.NO	Structural Part	Dimension
1.	Length in X-direction	25 m
2.	Length in Y- direction	20 m
3.	No. of bay in X-direction	5 No@5 m
4.	No. of bay in Y-direction	5 No@4 m
5.	Floor to floor height	3 m
6.	Total height of building	60 m
7.	Slab thickness	150 mm
8.	Rectangular column size(Inner)	450x350mm
9.	Column size (periphery)	300x300
10.	Beam size	350x250mm

3.2. Material Properties:

S. No	Material	Grade
1.	Concrete (column)	M30
2.	Concrete(slab)	M25
3.	Concrete (beam)	M25
4.	Rebar	Fe500
5.	Steel tube	Fe250
6.	Thickness of steel tube	15mm

3.3. Seismic Data (IS Code 1893: 2016 Part-1)

1.	Zone	IV
2.	Zone Factor	0.24 (clause 6.4.2)
3.	Damping ratio	5% (clause 7.2.4)
4.	Importance factor	1.2 (clause 7.2.3)
5.	Types of soil	Type(II) (clause6.4.2.1)
6.	Response reduction factor	5 (SMRF) (clause7.2.6)

3.4. Loading:

- Dead load-self calculated
- Live load 3 KN/m^2 as per IS 875 Part II
- Earthquake load as per IS 1893:2016 Part-I

4. Problem Description

- Model 1-Multistorey building with RCC column in medium soil
- Model 2-Multistorey building with rectangular CFST column in medium soil

4.1 Plan Of Building For Different Models (Shown in figure 4.1 & figure 4.2)

Fig.4.1.1 Building with RCC columns

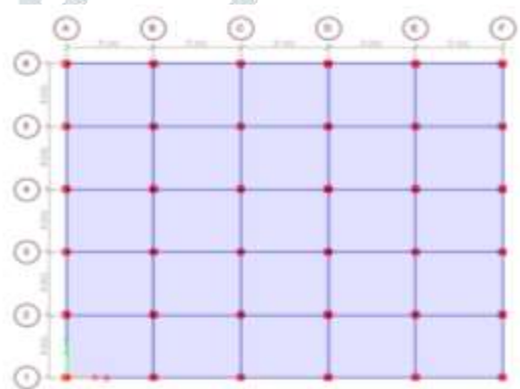

Fig.4.2 Building with CFST columns.

5. Analysis and Results

Results obtained after the analysis of G+19 storied RCC building considering CFST and RCC column by response spectrum method are represented in the form of graphics and tables.

5.1 Natural Time Period-

Time period 'T' of a structure is the time taken by it to undergo one complete cycle of oscillation.

$$T=2\pi\sqrt{\frac{m}{k}}$$

The time period for both models is shown in **table 5.1** and the time period variation with different modes is shown in **fig.5.1**

Table 5.1 Natural Time Period

Mode	RCC	CFST
1	6.083	4.971
2	5.847	4.676
3	4.945	4.203
4	2.008	1.631

5	1.925	1.533
6	1.636	1.379
7	1.173	0.945
8	1.115	0.885
9	0.966	0.802
10	0.824	0.652
11	0.784	0.613
12	0.678	0.551

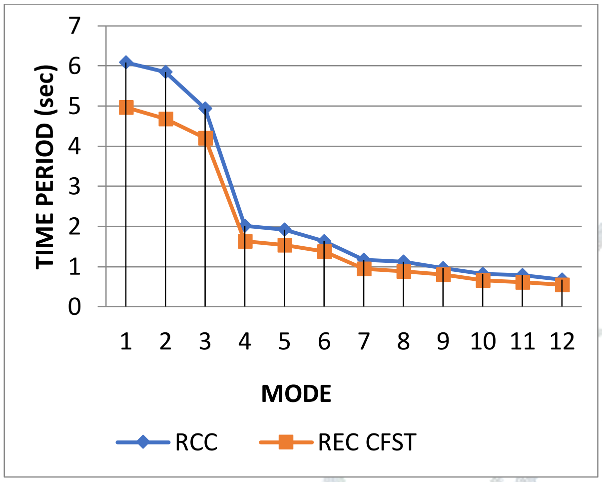

Figure 5.1 Variation of Natural Time Period

Natural time period is mainly proportional to the square root of stiffness. Maximum time period is observed in RCC building and minimum value is observed in CFST column building

5.3. Storey Displacement

According to IS Code, allowable displacement is calculated as H/250,where 'H' is total height of storey above the ground level. The variation of storey lateral displacement for CFST and RCC column buildings are shown below in **table 5.2 and fig. 5.2**

Table 5.3 Storey displacement

Storey	As per IS CODE (mm)	RCC (mm)	CFST (mm)
1	12	10.152	5.407
2	24	26.28	15.574
3	36	43.351	27.094
4	48	60.631	39
5	60	77.962	50.993
6	72	95.262	62.957
7	84	112.451	74.822
8	96	129.44	86.521
9	108	146.129	97.987
10	120	162.406	109.142
11	132	178.149	119.903
12	144	193.223	130.179
13	156	207.484	139.869
14	168	220.776	148.866
15	180	232.932	157.055
16	192	243.774	164.313
17	204	253.116	170.514
18	216	260.762	175.534
19	228	266.525	179.285
20	240	270.371	181.835

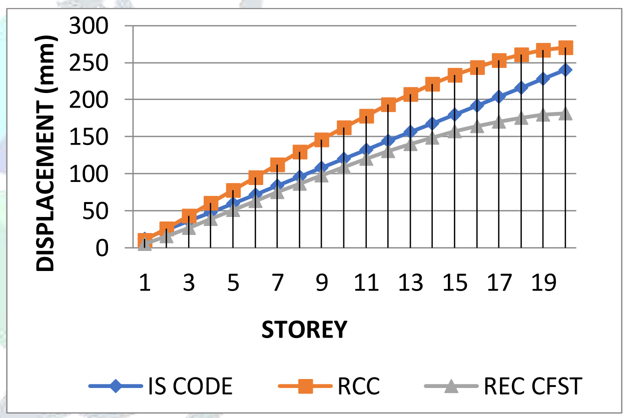

Fig 5.3 Storey displacement V/S Storey

Above figure shows that lateral displacement are minimum in building with CFST column as compared to ordinary RCC column building which indicates the stiffness of building with CFST column is more.

5.4. Storey Drift

As per IS 1893:2016 (I) the storey drift in both X and Y direction not be more than 0.004h, where 'h' is the storey height. The calculated storey drift is given in **table 5.4** and variation of storey drift shown in **fig. 5.4.**

Table 5.4 Storey drift

Storey	As per IS CODE(mm)	RCC(mm)	CFST(mm)
1	12	10.152	5.407
2	12	16.128	10.168

3	12	17.071	11.52
4	12	17.28	11.905
5	12	17.33	11.993
6	12	17.3	11.965
7	12	17.189	11.865
8	12	16.989	11.699
9	12	16.689	11.465
10	12	16.277	11.155
11	12	15.743	10.761
12	12	15.074	10.276
13	12	14.261	9.69
14	12	13.292	8.997
15	12	12.156	8.189
16	12	10.842	7.258
17	12	9.342	6.2
18	12	7.646	5.02
19	12	5.762	3.751
20	12	3.846	2.55

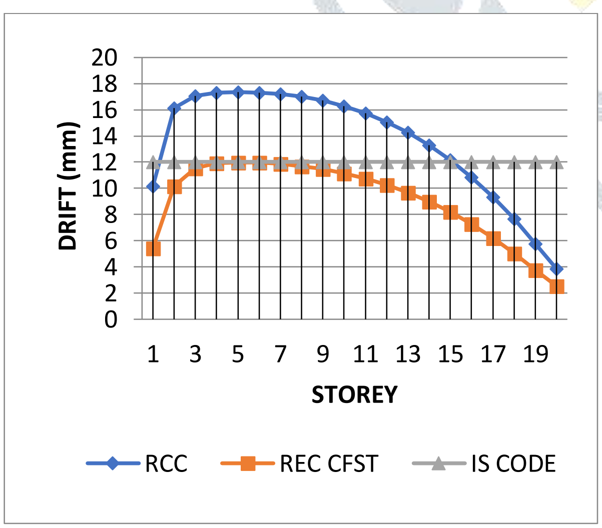

Figure5.4 Variation of storey drift

Above shows that the storey drift are minimum in building which is provided with CFST columns as compared to ordinary RCC building.

E. Storey Stiffness

Stiffness refers to the rigidity of a structural element.

Table5.5 Storey Stiffness

Storey	RCC(KN/m)	CFST(KN/m)
1	270900.157	493786.071
2	170664.306	262825.111
3	161049.568	231808.162
4	158564.221	223633.541
5	157167.259	220743.406
6	156006.803	219287.85
7	154949.755	218266.102
8	153956.003	217393.122
9	152997.557	216575.563
10	152044.905	215769.67
11	151063.138	214941.075
12	150007.995	214050.926
13	148819.546	213047.161
14	147410.947	211852.547
15	145646.923	210340.699
16	143298.272	208276.229
17	139934.397	205141.333
18	134590.593	199477.75
19	124544.615	186207.75
20	96606.708	141814.874

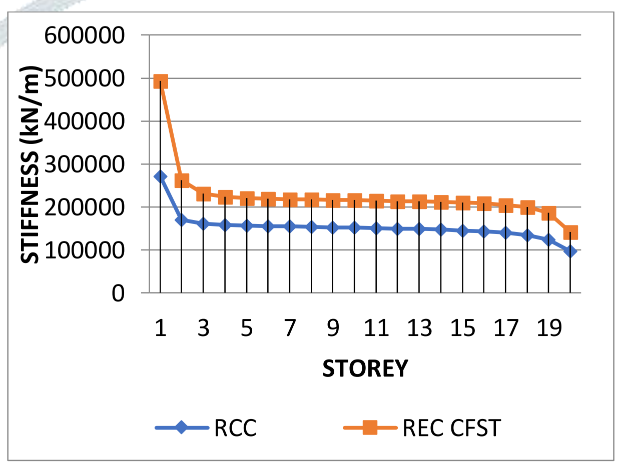

Figure 5.5 Variation of storey stiffness

From above **table5.5** and corresponding **fig.5.5**, we can conclude that model 2 i.e CFST column building is more stiffer than RCC column building.

6. Conclusions

Following conclusions are drawn from analysis of G+19 storied building considering RCC and CFST columns.

1- The natural time period value of the building with CFST columns reduces by 18-20% compared to building with RCC column. Which indicates that model-1 building provided with RCC column is more flexible.

2- The Storey Displacement value of the building with CFST columns reduces by 33-35% compared to building with RCC columns. This indicates that the building becomes stiffer when provided with CFST columns.

3- The Storey Drift value of the building with CFST columns reduces by 40-50 % compared to building with RCC columns and value of storey drift for building with RCC column is exceeding the permissible limits.

4- The Storey Stiffness value of the building with CFST columns increases by 32 % compared to building with RCC columns. Hence, building with CFST columns is less prone to damages.

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