International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 02 | Feb 2020 www.irjet.net p-ISSN: 2395-0072

Comparison of Seismic Behavior of Multi-storey Structure with Composite Column and RCC Column

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Abstract - *In this paper we study about the RCC building in which the first model is normal RCC building, second model is composite with the tube section only in column (CFT column) and third model is composite with I section with rebar in the column. The main purpose of using three model to check which one model is more stable at the given time history data. The analysis is done with the help of the Etabs software by using the IS Code 1893 part 1 2016. The parameter on which we analyze the structure is base shear, storey drift, storey displacement, storey stiffness, overturning moment. We take the value of the zone factor 0.24 which represent in the zone four. Time history data is taken from 2009 Andaman Islands earthquake data in which maximum magnitude is about 7.8 at the epicenter. In the all model we assume the frame is RC building with ordinary moment resisting frame.*

Key Words: Etabs, Time History, RCC building, Composite Section, I section, CFT Column.

1. INTRODUCTION

Now a day we are generally constructing the RCC building with and without the shear wall to decrease the effect of the earthquake in the structure. But in the paper we are making the composite structure member in the column to see the effect of the RCC building. In this paper there are three models in this paper in which first model is conventional RCC building, and in the model second we provide the tube section of the mild steel which increases the strength of the column where the tube section is placed in the column. In the last model we provide the I section at the middle of the column and also provide the reinforcement of the 16mm diameter with clear cover 40mm, the main purpose of the providing the rebar in the column to make the connection with beam. The parameter of the RCC building is taken from IS code 1893 part-1 2016 for the seismic analysis.

1.1 Composite Structure

Composite structure is defined the structure in which that structure are made up of the two material such as concrete, steel, aluminum, copper etc. The main purpose of the using the composite structure to study the effect of the using the single material and when that material are added with other material then what will be effect at that structure. In the Figure-1. it showed the example of the composite of the column in the structure.

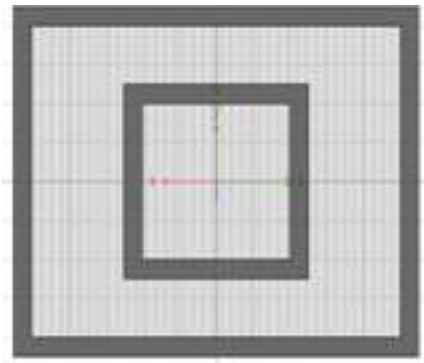

Fig -1: Composite Section in Structure.

2. METHODOLOGY

Dynamic analysis done in all models by using the "Time History Data" and data of the earthquake for time history analysis is taken from Region Andaman and magnitude was 7.8. The focus of that earthquake was about 3Km from ground surface and this type of the earthquake is known as the shallow earthquake because the depth of the focus of the earthquake is less than 75Km. The duration of record of the earthquake was about 184.720 Sec. and maximum acceleration was -6.550 cm/sec^2 of that earthquake.

2.1 Modeling of Structure

All models are prepared in the Etabs software which is developed by CSI company and version of the software was 17 and analysis of the models done with the help of the IS code 1893 part-1 2016. All parameter of the building Such as the material parameter, Section parameter, load parameter, and seismic parameter which are given below:

2.1.1 Material Parameter

The parameter of the material which is used in the building is given below in table-1:-

Table -1: Material Parameter

S.No	Material Name	Grade
1	Concrete	M40 for beam & Column
2	Concrete	M30 for Slab
3	Mild Steel (Fe250)	I section & Tube Section

2.1.2 Geometry and Seismic Parameter of the building

In this parameter we take the following parameter for the RCC building which is shown in the following table-2:-

Table -2: Geometry and Seismic Parameter of building

S.No	Building Parameter	Dimension
1	Beam	350mm X 450mm, M40
2	Column	450mm X 550mm, M40
3	Slab	150mm, M30
4	Bottom storey height	3m
5	Height of every floor	3m
6	Total height of building	45m
7	Area of the building	24mX24m
8	Span of beam	4m
9	Importance Factor (I)	1.2
10	Response Reduction Factor (R)	3
11	Zone Factor (z)	0.24
12	Type of the Soil	2nd
13	Eccentric ratio	0.05
14	Magnitude	7.8
15	Time history data	Andaman , 10/08/2009 19:55:35 UTC

2.1.3 Load Parameter

In the following table-3, the load value is given which act on the structure such as dead load, live load and wall load on the beam:

Table -3: Load Parameter

S.No	Load parameter	Value
1	Dead load	6.9 KN/m
2	Live load on Beam	2.5 KN/m
3	Live load	4KN/m^2

2.1.4 Composite Material Parameter

In the following table which is given below, its shows the dimension of the composite material which is used in models, such as representing the dimension of the I section and dimension of the tube section which is used in the column to check the stability of all model and which one represent is play better role in all these three models.

Table -4: Composite Material Parameter

S.No	Composite Section	Dimension
1	I section	B_f = 125mm, t_w = 6.9mm, t_f =6.9mm , D= 250mm
2	Tube Section	B_f = 250mm, D= 250mm, , $t_w = t_f$ = 25mm
3	Bar	16mm, 10 with I section Steel

2.1.5 Plan and 3D view of RCC building (Model-01)

The figure of the Model-01 is given below which represent Plan, Elevation and 3D view of the model-1:

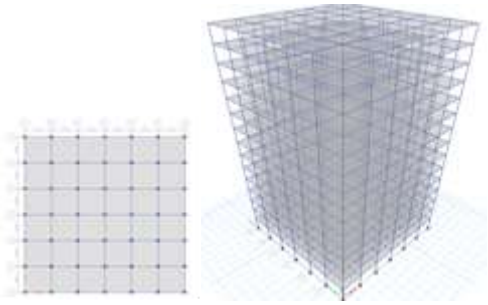

Fig -1: Plan and 3D View of Model-01

2.1.6 Plan and 3D view of CFT Column building (Model-02)

The cross section of the CFT column in the building (Model-02) is given below in figure and plan, elevation and 3D view same as RCC building.

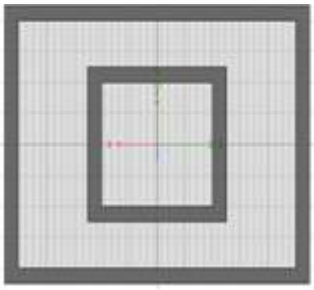

Fig -2: Cross Section of CFT column of Model-02

2.1.7 Plan and 3D view of building (Model-03)

The cross section of the column in the building (Model-03) is given below in figure and plan, elevation and 3D view same as RCC building.

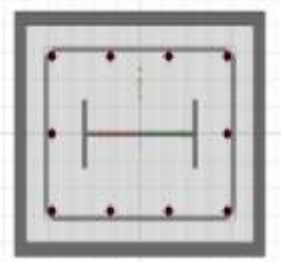

Fig -3: Cross Section of Column of Model-03

3. ANALYSIS

All models are analyzed with the help of the Etabs software by using Dynamic Analysis by defining time History data. We

had taken the following parameter for comparing all models with each other:

i. Base Shear.

ii. Storey Drift.

iii. Storey Displacement.

iv. Storey Overturning Moment.

v. Natural Time Period and Frequency.

3.1 Base Shear

The base shear is defined as maximum lateral force act on the each floor due to vibrating the ground surface on which the structure stabilized.

The graph of the base shear of all models is given below due to earthquake in X direction. The value of the base shear is same due to earthquake in Y direction because the building is symmetric.

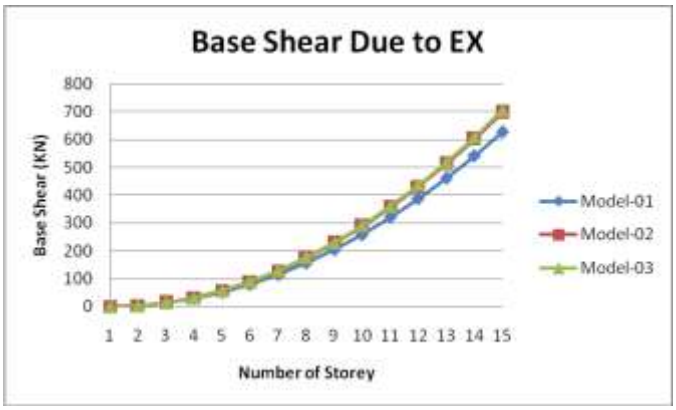

Chart -1: Base Shear Due to EX

From the graph we found that value of the base shear is low in the RCC model as compared to all model so during the earthquake, the lateral force acts minimum in RCC building as compared to composite column section.

3.2 Storey Drift

Storey drift is defined from clause 4.21 from IS code 1893 part-1 2016; it is relative displacement between the floor above or below storey under the consideration. The graph of the storey drift of all models is given below due to earthquake in X and Y direction (X and Y direction represent the horizontal directions) the value of the storey drift is given at that load combination where the value of the storey drift is maximum.

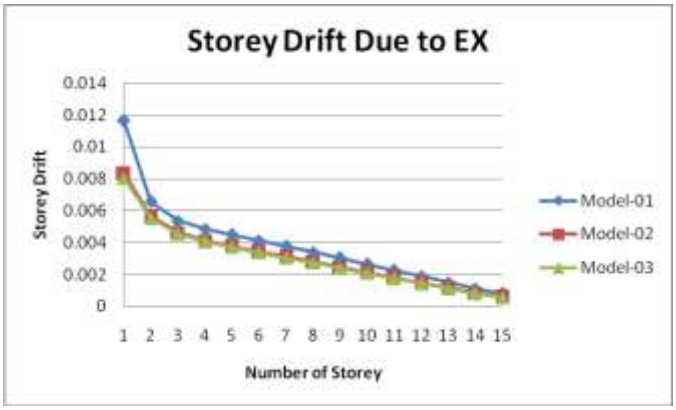

Chart -2: Storey Drift Due to EX

From above graph, we found that value of the storey drift is maximum in the RCC model as compared to all composite section models. According to IS code 1893 part-1 2016, the value of the storey drift should not be exceed than 0.004 height of storey (floor), by using this, all model is safe.

3.3 Storey Displacement

Storey displacement is defined as measurement of the displacement of the floor from the ground surface which is displaced due to effect of the earthquake. The graph of the storey displacement of all models is given below, which represent the maximum storey displacement.

Chart -3: Maximum Storey Displacement

From above graph, the value of the storey displacement is maximum in the RCC model as compared to composite section and value of the storey displacement is almost same in the Model-02 and model-03.

3.4 Storey Stiffness

The storey stiffness is defined as the ratio of the storey shear to storey drift.

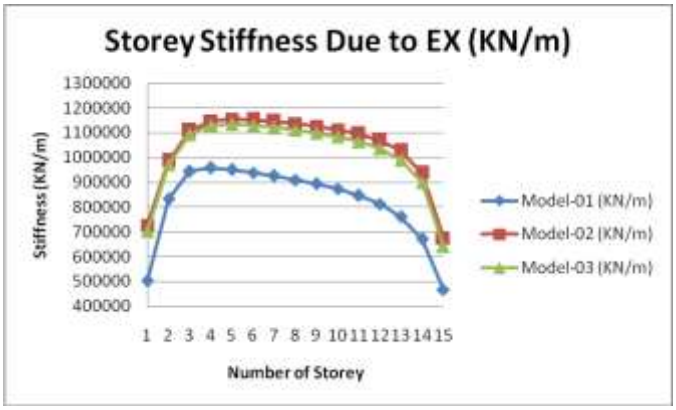

Chart -4: Storey Stiffness Due to EX

From the above graph, we found that the value of the storey stiffness is less in the RCC building as compared to the composite column section building.

3.5 Natural Time and Frequency

Clause 3.18 from is code 1893 part-2016, the natural time period it defined as time taken by the structure to complete one cycle of the oscillation in its natural mode (k) of oscillation. The graph of the natural time periods of all models is given below with table:

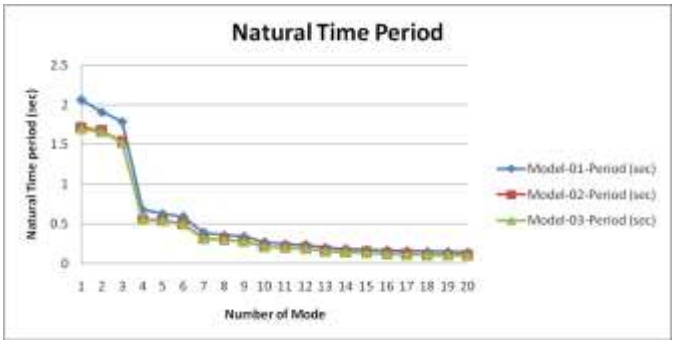

Chart -5: Natural Time Period

From above graph, the value of the natural time period is minimum in model-03 as compared to the model-01 and model-02. And there is maximum natural time period in the RCC building. The value of the natural time period should be from 0.05 to 2.0sec.

4. CONCLUSIONS

After analyzing the above parameter of the analysis of the all models in which first model is RCC building and second model is CFT column and third model is I section with rebar in the column. The following conclusion comes out after analysis:

i. The value of the base shear in the RCC building is less about 12.42% compared to the model-03 where in the column, I section provided with rebar. The value of the base shear in RCC is less than 11.21% as compared to the CFT column in the structure (Model-02).

ii. The value of the storey drift is found 40.10% more than as compared to the model-02 and model-03 which is obtained by applied the earthquake force in x direction. The value of the storey drift due EY is also same because the number and length of the bay in X direction is same in Y direction. The value of the storey drift is safe because it should not exceed than 0.004 height of storey according to the IS code 1893 part-1 2016.

iii. The value of the storey displacement is maximum in the RCC building and which is more than 40% as compared to the Model-02 and 42.25 % as compared to the model-03.

iv. The value of the natural time period in the RCC building (Model-01) is more as compared to the all other two models. The value of the natural time period in model-01 is 20% more as compared to model-02 and 21.23% more as compared to the model-03.

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