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RESEARCH ARTICLE OPEN ACCESS

Comparision of Composite and RCC Beam Girder Carrying Floating Column with RCC Frame Structure Using ETABS

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ABSTRACT
In this modern century the development of structures has increased rapidly leading to lesser unit areas and urging us to look for more ways to provide structure with all the amenities within the building leading to the high rise building with smaller areas. The floating columns are provided for the purpose of parking, lobby or assembly hall. When these floating columns are provided it becomes necessary to analyze their seismic behavior and design accordingly. In this current project study, the floating column multi storied structure of 10 storyed is analyzed in the seismic zone II according to IS 1893:2002. Three Models are considered in this, normal structure without floating column, RCC beam carrying the floating column structure, Composite beam carrying the floating column structure, these models are analyzed in ETABS software with adaptation of equivalent static method and response spectrum dynamic analysis and the results obtained are storey displacement, base shear storey drift and time period and compared with both method of analysis under different load combinations. The behavior of the RCC beam and composite beam carrying floating column is compared with long span normal structure. Their bending moment and shear force are tabulated and compared.

Keywords: Floating column, Composite Beam, RCC beam, Equivalent static method, Response spectrum method (ETABS).

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I. INTRODUCTION

In normal R.C.C framed structure, the columns are present in ground floor for parking purpose this column is an obstacle. To reduce these obstacles, the floating column concept is taken its existence. Basically, the column hangs in the storey above ground floor unlike in the normal structure where it starts from the ground that is from foundation. The floating column is acting as a concentrated load on a beam over which it rests. It provides good architectural view for that building and also increase the open space for parking purpose, assembly hall etc.

Normal structure can effectively withstand both loads in the horizontal and vertical direction. Steel-concrete composite structural systems have been most common method of construction since this type of construction utilises the property material of both used. Composite building construction uses properties of the two or more materials which helps in fast construction which saves time of construction, enormously cost-effective structural construction method having high durability, superior seismic performance and rapid erection.

1.1 Floating Column

A column is meant to be a vertical structural element rising from ground floor level which helps in transferring loads coming from above to the ground. Buildings with floating columns have an intercepted path in transferring loads to the ground. Generally floating columns are provided with transfer beam which transfers column load to the column below it. Columns are basically resting on the foundations in conventional building construction.

Floating columns are provided in high storied buildings for both residential and commercial purposes. The beam supporting floating column should be given design requirements carefully. floating columns transfer load through the grid network which includes the beam it rests upon. They are used in places where less obstruction is preferred like auditoriums etc. The load from column acts as point load on beam and column is considered to be pinned on analysing.

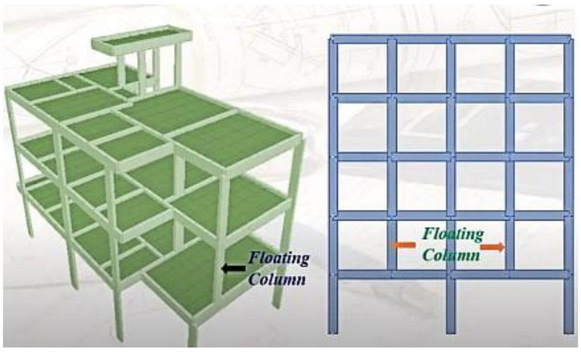

Figure 1.1 Floating column structure

1.2 Composite Beam

Composite materials are basically the combination of two or more materials so that the composite structural system can perform better with the inherent material properties. By their fundamental behaviour, these components give the essential attributes of strength, stiffness and stability to the overall system. Composite beams use two or more materials which will be concrete and steel generally. Conventional composite beam which uses steel and concrete are usually laid with steel angle section for beam and a deck concrete slab is placed upon it. This usually causes the slip between steel beam and concrete slab since there is no connection between them, when shear dia connectors are used in connecting steel beam to the concrete the slip is avoided and the steel beam and concrete behaves as a composite beam.

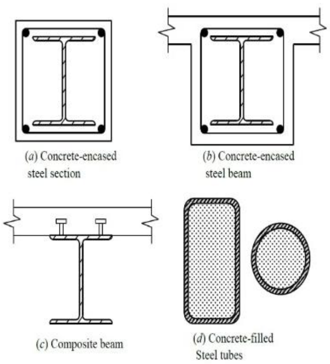

Figure 1.2 Types of composite section

II. LITERATURE REVIEW

Meghana B.S et al. (2016) studied the on the Effect of floating column for a composite multistoried building subjected to lateral load. In this paper they have considered composite (steel-concrete) structure with fluctuating column in various parts in their building plan, they considered various floor heights of storey with 3 storied, 10 storied and 15 storied building. Equivalent static method is used, and analysis is carried out using ETABS software. Parameters like displacement, storey displacement, storey drift, shear force and bending moment are obtained and then by comparing the values conclusions are drawn. The analysis is carried out in high prone seismic zone area and low prone seismic zone.

Parveen Hamza et al. (2020) studied "Seismic performance & structural stability analysis of floating column building". They analysed a G+9 storied building with external floating columns statically and dynamically for earthquake zones IV and V. A 10-storey building where floating column is provided at alternate floor levels such as in ground storey, second storey, fourth storey, sixth storey and eighth storey and without floating column is also considered. They concluded that Maximum storey drift and storey displacement is more in floating column carrying building compared to normal structure and the location of floating column has significant impact, and the chances of failure in floating column building is more.

Varghese Basil Alexander et al. (2019) studied on the Effect of Lateral Force on Different Types of Composite Building Frame Systems. They analysed three composite structure with composite deck, composite beam comprising of steel column, concrete encased square and circular column. In Model 1, Composite Deck Slab, Composite Beam, and Steel Column. In Model 2, Composite Deck Slab, Composite Beam, and Concrete Filled Steel Encased Circular Column and In Model 3, Composite Deck Slab, Composite Beam, and Concrete Encased Square Steel Column. They gave conclusion that there was a decrease in horizontal deformation of 27% and 6% in circular and square respectively. And the axial resistance ratio for the columns with different profile ranges between 0.92 and 0.95 also the cost is higher for the steel structure with square and circular encased column than the steel column.

M.C.Arun Prasad et al. (2016) studied on the investigation of RCC and composite multi-storey building. They analysed G+9 multi storey building using ETABS-2016 under Seismic Zone 3 and 4. Three different models were made. All the models are analysed using equivalent static method. The parameters such as Joint Displacement, Storey Drift, and Storey Shear are analysed. They concluded that Joint Displacement is on the higher side for the Steel-Concrete Composite Structure but within the Permissible limit. Storey Drift is lower for the RCC structure than the Steel-Concrete Storey shear is minimum for the steel-concrete composite structure because of its lower self-weight. Seismic zone 4 has higher of these values for joint Displacement, Storey Drifts and Storey Shear.

Rupali Goud (2017) studied "Study of Floating and Non-Floating Columns with and Without Earthquake". She studied building floating column and non-floating column with and without seismic load. Two building structure one with floating columns and other one without floating columns were analysed for the seismic loading. Height of the building was 16m. In model 1, 8 floating columns are provided. In model 2. same as model 1 floating columns are converted into non-floating columns. In model 3, 4 floating columns are provided. In model 4, same as model 3 but floating columns are converted into non-floating columns. She concluded that building with floating column experienced maximum displacement and storey shear and that floating column is uneconomical to that of normal building.

III. OBJECTIVES

1. Modelling of the floating column multi-storey building resting on RCC girder and Composite girder.
2. To analyze the building models in etabs using both static linear analysis and dynamic linear analysis that is response spectrum method
3. To study comparison of normal long span structure with floating composite column and RCC girder and to study the storey drift, base shear, storey displacement.

IV. METHODOLOGY

In this study, Equivalent static method and Response spectrum method is used to analyze the multi-storey building having a floating column structure carried by rcc beam and composite beam along with the normal structure. The whole analysis is carried out considering the seismic zone condition of Zone II.

4.1 Building Description

A 13.7m X 17.9m of G+10 multi storey building is considered for the study. Modeling & Analysis of the modeled structure is performed on the ETABS software. Three separate models are considered with RCC frame structure which are Model 1: Normal Structure with long span. Model 2: Structure with RCC beam carrying floating column. Model 3: Structure with composite beam carrying floating column

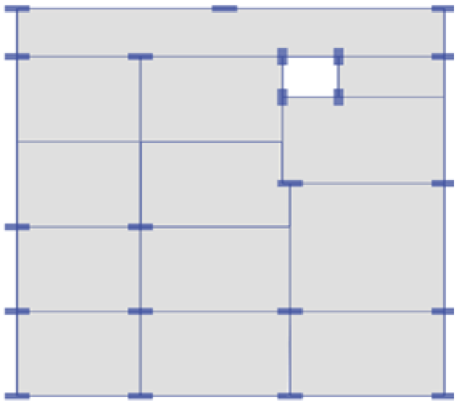

Figure 4.1 Plan of building

Material and structural properties considered for analysing and designing the building using ETABS is as shown below

Table 4.1 Structural member details

Thickness of slab	150mm
Column size	300 X 600mm
Beam size	300 X 750mm
Wall thickness	230mm
Composite Beam	300X600 mm ISMB 350

Table 4.2 Seismic properties

Seismic zone	II
Zone factor	0.1
Importance factor	1.2
Type of soil	Medium soil
Response reduction factor	3

4.2 ETABS Modelling

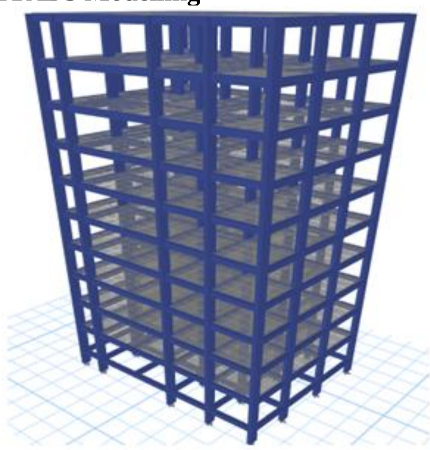

Figure 4.2 Model 1 without floating column 3D in ETABS

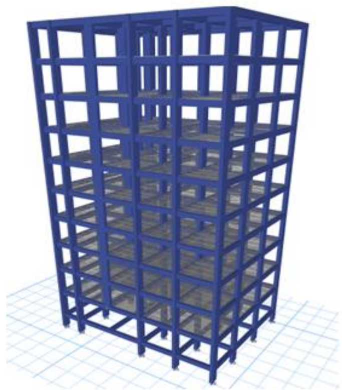

Figure 4.3 Model 2 with floating column 3D in ETABS

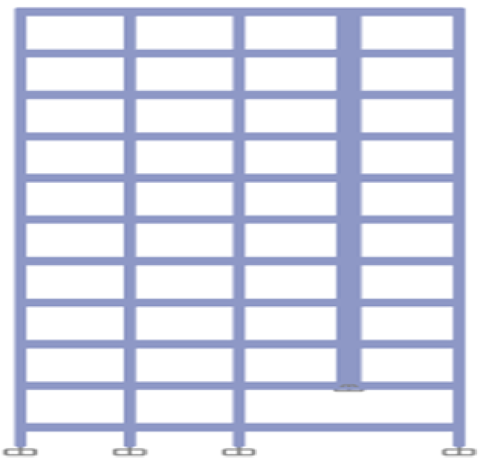

Figure 4.4 Model 2 Elevation in ETABS

M30 grade of concrete and Fe550 grade of steel is considered. Live load and floor finish of 4 and 1.2 KN/m^2 is applied.

V. RESULTS AND DISCUSSION

The results are presented for the building model considered, for different type of analysis namely equivalent static analysis and responses spectrum analysis. The results of base shear, lateral displacement, storey drift for building models are presented for load combination of 1.2(DL + LL ± EL) and compared for different analysis. An effort is made to study the comparison of normal structure, Floating Column structure with RCC Beam girder and Composite beam girder subjected to seismic activity forces.

5.1 Storey displacement and storey drift

The storey displacement and storey drift for each storey is calculated in both equivalent static analysis and response spectrum method and graph is plotted for each structure.

a. Story displacement is the total value of displacement of the storey under action of lateral forces acting on the building.

b. Story drift is the displacement of one floor level relative to another level above or below. According to IS 1893(Part 1): 2002 the storey drift in any storey due to minimum specified design lateral force, with partial load factor 1.0, shall not exceed 0.004 times of the storey height.

Table 5.1: Max. Displacement in both methods in X and Y direction

Maximum Displacement (mm)				
Model No	RSA		EQS	
	X	Y	X	Y
1	46.4	29.1	57.5	45.6
2	44.7	16.04	54.1	42.8
3	47.1	34.1	55.7	43.5

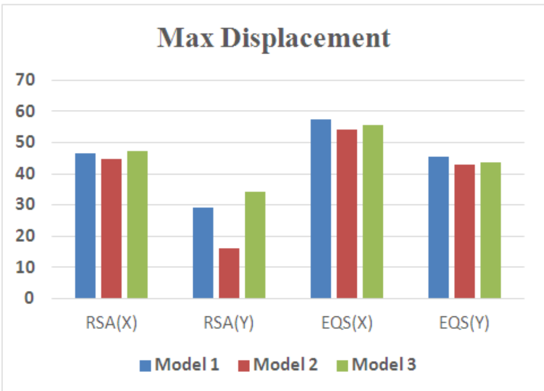

Figure 5.1: Shows Max. displacement in both analysis in X and Y direction

Table 5.2: Max. Drift in both methods in X and Y direction

Maximum Drift (mm)				
Model No	RSA		EQS	
	X	Y	X	Y
1	0.00133	0.0009	0.00165	0.00138
2	0.00161	0.0006	0.00194	0.00161
3	0.00162	0.0013	0.0019	0.00156

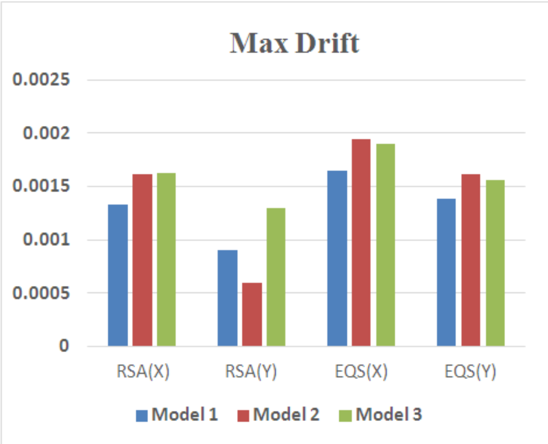

Figure 5.2: Shows Max. drift in both analysis in X and Y direction

For Max Storey Displacement- Considering the Response spectrum method, the maximum storey drift is more in Equivalent Static method. The displacement is max in model 1 in X direction, so the model 1 is flexible than another model.

For Max Storey Drift- Considering the Response spectrum method, the maximum storey drift is more in Equivalent Static method. The drift is max in model 2 in X direction, which is the floating column structure with RCC beam girder.

5.2 Base Shear and support reaction results

Table 5.3: Table 5.13 Base Shear along Scale Factor for Load combination 1.2(DL+LL±EL) of G+10.

	1.2 (DL + LL ± EL)					
Model	**EQX (KN)**	**RSX (KN)**	**SF**	**EQY (KN)**	**RSY (KN)**	**SF**
1	**420.77**	**375.24**	**1.12**	**67.00**	**55.38**	**1.21**
2	**555.96**	**477.86**	**1.16**	**484.14**	**412.00**	**1.18**
3	**695.81**	**591.44**	**1.18**	**630.14**	**535.68**	**1.18**

Table 5.4: Maximum support reactions of the columns.

Support Reactions of column	C1 (KN)	C2 (KN)	C3 (KN)	C4 (KN)
Model 1	2664.1	3022.07	3299.34	4406.08
Model 2	1685.06	2233.69	2359.3	3602.17
Model 3	1650.14	2200.21	2320.19	3569.47

5.2 Bending Moment and Shear force

Table 5.5: Comparison of Bending moment and shear force in models

Factor	Model 1 Normal Structure	Model 2 RCC Beam Girder Floating column	Model 3 Composite beam Girder Floating Column
Time Period	1.15sec	1.15sec	1.15sec
Bending Moment	208.557 KN-m	117.92 KN-m	103.82 KN-m
Shear Force	176.09 KN	94 KN	65.02 KN

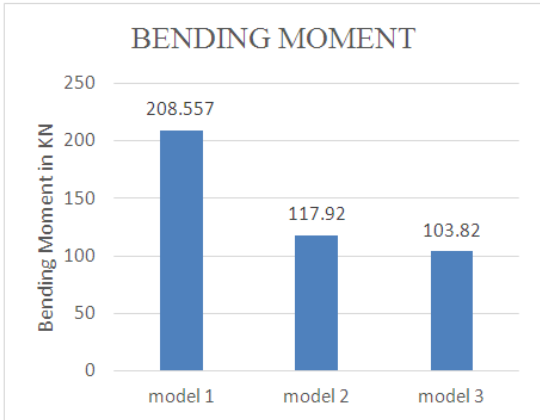

Figure 5.3: Comparison of Bending Moment

The Bending Moment in Model 1 that is in normal structure with long span beam is 208.557 KN-m which is more than that of Model 2 and Model 3 whose bending moment values of floating column carrying rcc beam girder and floating column carrying composite beam girder.

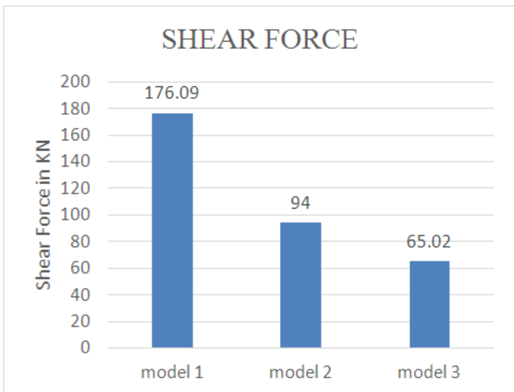

Figure 5.4: Comparison of Shear Force

The Shear Force in Model 1 that is in normal structure with long span beam is 176.09 KN which is more than that of Model 2 and Model 3 whose shear force values of floating column carrying rcc beam girder and floating column carrying composite beam girder.

VI. CONCLUSION

- When the lateral loads are applied in both X and Y direction, the storey displacement in the model 1 and model 2 that is floating column structure undergoes more storey displacement than that of the normal building. The storey displacement increases with the increase in the storey height.
- The storey drift values of each storey shows that the floating column structure experiences more storey drift than the normal structure.
- The floating column structure having composite beam shows slightly lesser drift values than the floating column structure with RCC beam. The storey drift values was found to be within the permissible limits as mentioned in IS 1893(Part 1): 2002 clause 7.11.1
- The structure with column carrying the long span beam shows maximum support reactions.
- The base shear values were found to be more in the floating column structure than that of the normal structure without floating column.
- Bending Moment of composite beam girder was found to be 6.38% lesser than that of RCC beam girder. The Bending Moment of long span beam of normal structure was 27.76% and 33.5% more than that of the floating column beam girder of both RCC and composite beam girder respectively.
- The shear force in composite beam girder was found to be 18.22% lesser than that of the RCC beam girder The Shear force was found to be more in normal structure with long span than that of floating column carrying structure. Shear force was found to be 30.4% and 40% less in RCC beam girder and composite beam girder than that of the normal long span beam structure respectively.

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