EFFECT OF FLOATING COLUMN POSITION ON MULTI STOREYED RCC STRUCTURE SUBJECTED TO DYNAMIC LOAD

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Abstract—In recent years, many multi-storey and commercial buildings are constructed with architectural complexities. The complexities are soft storeys or floating columns at various positions and storeys. The buildings with floating columns built in seismically active areas are very dangerous. The storey shear that are developed at different storey level in building due to earthquake force is to be transferred to the ground through the shortest path. But due to the presence of floating columns in the structure, there will be discontinuity in the load transfer path which results in the change in the behaviour of structure and change of the load transfer path. Present study focuses on the effect of the floating column position on multi storied RCC structures subjected to dynamic loads and the building models are analyzed using time history analysis with the assumption that the structure will be subjected to all the loads or full load in a single stretch when the whole structure is constructed completely. The dead load due to various structural components and finishes are imposed on the structure sequentially as the construction is done storey-wise. For better understanding the non-linear behaviour of material and the structural members, the construction sequence analysis is carried out. The analysis of the building models is done with the help of SAP2000 software. Many buildings are planned and constructed with architectural complexities. The complexities include various types of irregularities like floating columns at various level and locations.

Keywords—Floating column, Sap 2000, Equivalent and Time history analysis, Storey response

I. INTRODUCTION

A column is meant to be a vertical member ranging from basis stage and shifting the weight to the bottom. Floating column is moreover a vertical element that at its decrease level resting on beam that could be a horizontal member. Buildings with columns that suspend or flow on beam at an intermediate ground and do not cross all to the foundation, which have discontinuities within the load switch direction. The beams successively transfer the burden to special columns underneath it. Such columns anywhere the weight turned into notion of as a factor load.

There are plenty project in which floating columns are as of now embraced, particularly over the ground floor, with the goal that more space opened which is accessible on the ground floor. These open spaces might be required for get together lobby or parking. The column is a concentrated load on the shaft which supports it. The structures effectively made with these sorts of irregular members are imperilled in seismic areas. Numerous urban multi-storey structures in India today have open first story as an unavoidable component. This is fundamentally being embraced to suit parking or gathering lobbies in the primary story. While the aggregate seismic base shear as experienced by a working amid a earthquake is reliant on its characteristic period, the seismic force circulation is subject to the dispersion of stiffness and mass along the height.

Behaviour of a building amid earthquakes mainly depends fundamentally on general size, shape and geometry, notwithstanding how the seismic earthquake forces are conveyed to ground. Seismic forces
created at various floor levels in a building should be conveyed down along the height to the ground by most limited way; any deviation or else intermittence in this load move way brings about poor execution of building. Structures with vertical setbacks cause a sudden bounce in earthquake forces at the level of discontinuities. Structures that have less columns or walls in a specific story or with uncommonly tall story tend to harm or fall which is started in that story. Numerous structures with open ground story expected for stopping crumbled or extremely harmed in Gujarat amid the 2001 Bhuj earthquake. Structures with segments which hang or buoy on shafts at a middle of the road story and don't go the distance to foundation, have discontinuities in load exchange way.

II. RELATED WORK

Hardik Bhensdadia & Siddarth shah [2015][1]:- This studies an enterprise is finished to uncover the impacts of floating column and delicate story in numerous earthquake zones by way of seismic research. Hence because of this push over exam is embraced in mild of the reality that this research will yield execution degree of constructing for design restriction (removal) did up to failure, which allows assurance of fall load and ductility restriction of the structure. To accomplish this goal, 3 RC exposed body structures with G+4, G+9, G+15 stories in my view will be investigated and checked out the base force and elimination of RC uncovered body structure with G+4, G+9, G+15 stories in numerous zones of seismic earthquake like Jamnagar, Bhuj and Rajkot using SAP 2000 14 exam package deal.

D. Annapurna & Sriram Nadipelli [2015][2]:- Examined the research of G+5 story normal constructing and G+5 story floating column constructing for outside forces. Research become completed by using the utilization of E-Tabs programming with the aid of making use of proportionate static exam they additionally taken into consideration the kind of the two systems by way of making use of the forces of the beyond earthquake making use of the floor moves to structures, from that dislodging time records esteems are analyzed. The present paper manages the kind of term, displacement of shape, base shear, seismic weight of building from manual calculations and e-tabs. it become observed that floating column constructing is dangerous than a regular building.

Ashfi Rahman & Saritha singla (2015)[3]:- Considered a multi-story building with and without floating columns by response reaction range examination. Diverse instances of the building are contemplated by differing locations of floating column floor astute & inside the floor. Structural reaction of building models as for fundamental time period, Base shear, Spectral acceleration, Story drift and Story displacement is examined. The examination is completed utilizing programming STAAD Pro V8i. It was watched that in working with floating columns there is an expansion in fundamental time period in both X-direction and also Z-direction when contrasted with building without floating column, by presentation of floating columns in a building base shear and otherworldly increasing speed diminishes. In this way, it has this specialized and practical preferred standpoint over conventional construction.

T.Rajasekhar & Mr.P.V.Prasad [2014][4]:- Behavior of building outline with and without coasting section is examined under static load, free vibration and forced vibration condition. Outcomes are plotted for both frames with and without floating columns by looking at each other time history of floor displacement, base shear. Equivalent static examination is done on the whole venture numerical 3D demonstrate utilizing product STAAD Pro V8i and the correlation of these models are been exhibited. This will help us to locate the different scientific properties of the structure and we may likewise have an extremely methodical and temperate design for the structure. Tested the conduct of multi-tale building with and without floating column is taken into consideration below numerous seismic earthquake excitation. Perfect time records and elcentro earthquake statistics has been taken into consideration. The PGA of each the seismic earthquake has been scaled to 0.2g and time period
of excitation is kept equal. A restrained component display has been produced to consider the dynamic conduct of multi-story frame. Static and free vibration comes about were given utilizing present restricted issue codes are approved. The dynamic examination of frame is taken into consideration by means of moving the column measurement. It is inferred that with increment in ground floor column the best elimination is diminishing and base shear differs with the segment measurements.

A.P.mundada & S.G.Sawadakar [2014]5:- In this paper examine is improved the architectural drawing and the framing drawing of the building having floating column. For examination G+7 existing private building with and without floating column are taken for carry out whole extend work by utilizing STAAD ProV8i 3D 3 demonstrate are made identical static examination of these model are finished by utilizing STAAD Pro V8i .Different parameters, for example, axial load moment distribution, significance of line of activity of force and seismic variables are contemplated for models. This will enable them to locate the different investigative properties of the structure and furthermore to have an exceptionally orderly and economical design for the structure.

Prerna Nautiyal et.al, [2014]6:- In this paper study the effect of floating column under earthquake reaction for exceptional soil situations and as it is no arrangement or magnification calculate determined IS code, eventually guarantee of such elements for secure and least expensive design of a constructing having floating column. Linear dynamic analysis is stepped forward the state of affairs 2 dimensional multi story body with and without floating column. For that reason made the model G+4 and G+6 building having changing the situation of floating column after that response spectrum analysis is done for both building. dynamic reaction parameters, for example, base shear and moment for hard and medium soil condition are gotten for both building models.

Nikhil1 Bandwal et.al, (2014)7:- This observe implies at the exceptional varieties of irregularities like floating column at one-of-a-kind degrees and vicinity. Systems are basically analyzed for impact of earthquake. Earthquake load as indicated in is 1893 (element 1): 2002 are considered inside the analysis of building. A G+06 storied constructing with numerous architectural complexities, for example, inner floating columns ,external floating column, and aggregate of inner and outside floating columns is analyzed for exclusive earthquake zones. In fashionable research of seismic examination, vital load mixes are discovered. For these crucial load combos, case astute range in distinctive parameters like moments, forces and displacements on columns and beams at exceptional floor level are looked at and memorable co-connection between those characteristics are installation with graphs. On this constructing design & have a look at with help of staad-pro software.

III. OBJECTIVES
1. To study the behaviour of high rise RCC building of 30 storey subjected to dynamic.
2. Vertical stiffness irregularity in terms of providing floating columns is considered as per IS 1893 2002 for high Rise RCC building and its behaviour is studied.
3. To study the effect of floating columns at different locations on RCC building.
4. To study the responses like displacement, story drift, story shear, member forces in beams and columns, high seismic zone.
5. Equivalent Static and time history analysis is done to find out responses using SAP2000 Software.

IV. METHODOLOGY
1. Initially a 30 story rectangular RCC multi storied structure with and without floating column with different position, having overall dimension 40 m x 24 m in X and Y direction. Bay size is 4 m uniform along both the direction. Modelling and analysis is carried out using SAP 2000 ver.19.
2. Different types of columns and beams sections are considered for the modelling the RCC structure. And deck slab is modelled as floor element. At every 10 m height, column sections are reduced.

3. Different positions of floating column are considered for the analysis for different zones.

4. The effect of considering floating column locations condition has been studied for zones considered.

5. Equivalent static and dynamic time history analysis has been carried out.

V. STRUCTURAL MODELLING AND LOADING

The building is a G+30 story reinforced concrete building. The structure is 93 m tall, and is 40.0 m wide and 24.0 m length X & Y direction. The story height is 3 m. Proposed slab thickness is 175 mm for all typical floors. Area of building 960 m². Member Properties, dimensions of the Primary beams are 300 mm × 450 mm. The columns size are 300×450 mm and for 300×600 mm. The live load is 4 kN/m², floor finish is 1.5kN/m² and seismic load calculations can be done directly by SAP. The load combination is based on IS: 456 – 2000 and IS 1893 (Part 1): 2002. For modelling five sets of models are to be considered. the first set of model is rcc frame model Second set of model is the Regular building with floating column type 1 and the third set of model is Regular building with floating column type 2 and Regular building with floating column type 3 and Regular building with floating column type 4 and Regular building with floating column type 5. Figure shows the modelling of rcc frame. Regular building with floating column at different location.
VI. RESULTS AND DISCUSSIONS

Here key results are extracted using SAP 2000 Ver. 19 and presented in graph and table format along X and Y direction. Results like maximum base force, story displacement, inter story drifts, from equivalent static analysis have been presented and discussed. Modal analysis is done to find the frequency and time periods to understand the vibrational behaviour of the structure. Results from time history analysis i.e., peak displacement and peak accelerations are extracted and presented. All the above results and discussions are done for fixed based and soil structure interaction cases. Based on the results & discussions, conclusions are drawn and presented.

6.1 Storey Displacement:

"Figure 7. Variation of displacement for zone-3 and zone-5 for static analysis"
The Permissible Maximum displacement value is \( H/250 \) as per the IS 1893:2002. From Figure 8, story displacement is found to be highest in FC-4 i.e., 139.10 mm compared to all other structural systems. It is found that there is about 75.4% increase in story displacement compared to RCC and about 21.5% when compared to other FC types in FC-4 particularly along X direction. The Permissible Maximum displacement value is \( H/250 \) as per the IS 1893:2002. From Figure due to double height and floating column at mid height in FC-2, a significant increase in story displacements is found. Story vs. displacement response due to time history inputs, it is found that in floating column structures, there is an increase in displacement at lower floors of about 100% and variation of displacement has reduced with the height for FC-1, FC-2 and FC-3 structures. For FC-4 type an initial reduction in story displacements is observed, but with the increase in height a 46% increase in story displacements is found in comparison with the FC-2. RCC structure has undergone maximum displacement along Y direction due to time history inputs compared to floating column structures. FC-1 and FC-2 structure are responding in similar manner having displacements of 321 and 332.3 mm respectively, which are found to be 93% higher than that of FC-3 and FC-4. Hence direction of application of dynamic inputs has influence on the response characteristics of floating column structures.

6.2 Storey Drift:

“Figure 8. Variation of displacement for zone-5 for time history analysis along x & y direction”

“Figure 9. Variation of drift for zone-3 and zone-5 for static analysis along x direction”
Story drift responses for RCC and all types of floating columns. The variation of story drifts with respect to height is found to be similar for RCC, FC-1, FC – 2 and FC – 3 in the upper floors, where are in the lower floors a sharp increase in story drifts of about 137% in FC-1 and FC-2, 84% in FC-3 compared to regular RCC frame are observed along X direction. Story drifts are found to more in FC – 2 along Y direction. Also FC – 1 and FC – 2 story drifts are found to be very high due to floating column at the base. Story drifts are found to more in Y direction of about 66% compared to X direction. Due to the presence of floating at the base and intermediate level, a significant rise in the story drifts beyond the limit has been observed along Y direction for FC-1, FC-2. In remaining floating column acceptable change of 5% increase is found with respect to RCC. From the story drift results for Zone 5, it is evident, drifts are more in Z5 compared to Z3 along both X and Y direction and is found to almost double. Maximum drifts are found to be 25 mm and 48 mm along X and Y direction respectively. Maximum drift is found to be in FC-1 and FC-2 at the base of the structure at floating column location and found to be 71.1% higher than FC – 3. There is a significant sharp increase in the story drifts in Y dir. Compared to X direction and the story drifts are crossing the limit 12 mm (h/250).

6.3 Base Shear:

Figure shows the Maximum base shear in the Zone 3. Base force is found to maximum in case of RCC moment resisting frame. Due to floating column effect base force is found to be reduced and is found to be minimum in FC – 2 about 6% compared to RC moment resisting frame. Figure shows the
Maximum base shear in the Zone 5. Variation of base force is found to be similar as in Z3 but the corresponding values are found to be 120% higher in Z5.

6.4 PEAK DISPLACEMENT:

“Figure 12- Peak Displacement response – X & Y direction”

6.5 PEAK ACCELERATION:

“ Figure 13- Peak acceleration response – X & Y direction”

6.6 BASE FORCE:

“Figure 14- Variation of base force along – X & Y direction”
From the Table we can say that, FC – 2 type floating column structure exhibits maximum displacements (323.3 mm) compared to all other floating column structure along Y direction. From the Table we can say that, FC – 4 type floating column structure exhibits maximum displacements (176.2 mm) compared to all other floating column structure along X – direction. Peak acceleration is found to increase significantly. Base force is maximum in regular RCC building without floating column compared to that of RCC building with floating column.

VII. CONCLUSIONS

In the current work effort is made to study the effect of floating column positions on RCC multi-storied structures subjected to dynamic load and hence the following conclusions are made from modal, equivalent static and dynamic time history analysis.

Presence of floating columns in the structure has greater influence on the time period, displacements and story drifts. The position and type of floating column present in the RCC structure forms vertical irregular stiffness criteria hence drifts are found to be more that the limit specified in the code. Earthquake zone has a significant effect on response of the structure and it is suggested that, floating column buildings in high seismic zones to be avoided. Response of floating column structures depends on the type of the analysis adopted. And it is found that, responses are found to be more in time history analysis. Hence it can be concluded that, type of floating column, position of floating column, seismic zone, and type of analysis influences the response characteristics and it is suggested to used additional structural elements like bracings, dampers to floating column structure to limit the displacements and drifts within the limits.

REFERENCES