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EFFECT OF FLOATING COLUMNS ON THE SEISMIC PERFORMANCE OF AN RC FRAMED STRUCTURE IN DIFFERENT SEISMIC ZONES

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Abstract:
Many buildings are planned and constructed with architectural complications. The complications include various types of irregularities like introduction of floating columns at various floor levels and locations. Buildings are critically analysed for the effect of earthquake. Earthquake load as specified in IS 1893 (part 1) - 2016 are considered in the analysis of building.
In the present scenario, buildings with floating column is a typical feature in the modern multi-storey construction in urban India. Such features are highly undesirable in building built in seismically active areas. These floating columns are introduced to the buildings so that the structure serve for both commercial and residential purpose and the floating columns start from the floor levels where the building would serve as residential building.
A G+8 storied RC frame with and without floating columns has been considered. Building with floating columns are introduced at different storey levels is analysed for various earthquake zones. For this project effect of floating columns (i.e., G+8 storeys building) chosen considering different cases in each case the position of floating columns were changed in each floor and linear static analysis was done using STAAD Pro software.
This study highlights the importance of explicitly recognizing the presence of the floating column in the analysis of building. In overall study of seismic analysis, critical load combinations are found out. For these critical load combinations, case wise variation in various parameters like base shear, storey drift, lateral displacements, maximum bending moment at various floor level are compared and significant co-relationship between these values are established with graphs.

Keywords: Floating Columns, Framed Structure.

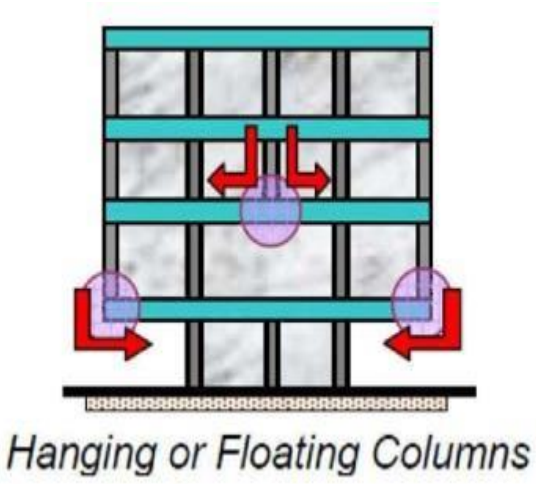
I. Introduction

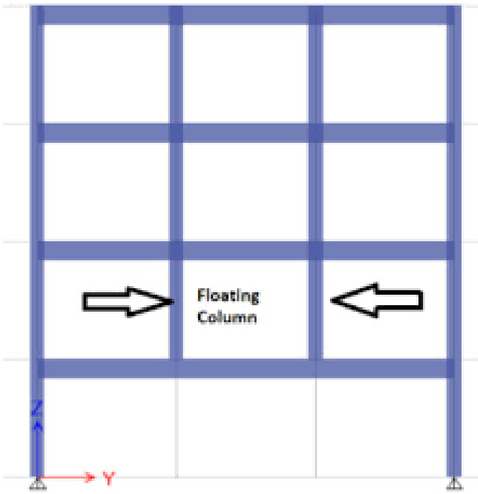
Buildings are symbol of modern city and as such are a crowning achievement of structural engineering, With the increasing pressure of population, commerce and trade, the cost of land in cities have raised which results in increases in the number of high rise buildings and also introduction of floating column in different positions. As per the Indian standard code the country is classified into different zones for which it specifies the seismic zone factor and it is very important to design the buildings for seismic force to prevent the losses occurs due to earthquake. Code of practice for earthquake engineering has been designed with the aim that human lives are protected, damage is limited and service structures remain operational.

The buildings can be broadly categorized as regular and irregular buildings. In the present day scenario, irregular buildings are given more preference due to a variety of reasons. The aesthetic considerations, space availability and user requirement are the most important reasons for preference of irregular buildings. An irregular building can be defined as a building that lacks symmetry and has discontinuity in geometry, mass or load resisting elements. The presence of structural irregularities has an adverse effect on the seismic response of the structure. The structural irregularities can be broadly categorized as horizontal and vertical irregularity, and different types of irregularities have different types of effects on the structure.

FLOATING COLUMNS

The floating column is a vertical member which rest on a beam but doesn't transfer the load directly to the foundation. The foundation column acts as a point load on the beam and this beam transfer the load to the column acts as a point load on the beam and this beam transfer the load to the columns below it. The column may start off on the first or second or any other intermediate floor while resting on a beam usually columns rest on the foundation to transfer load from slabs and beams. But the floating column rests on the beam





1.1 RC frame with floating columns

Load transfer in floating column and non-floating column

• The non-floating column structure load transfer is directly done by column. All loads coming on the structure move to column and column safely transfer it to foundation and then to soil. In case of floating column, the load is taken by the below beam. The column is arranged as a point load over the beam. The beam then transfers that load to column present below and then to foundation and soil.

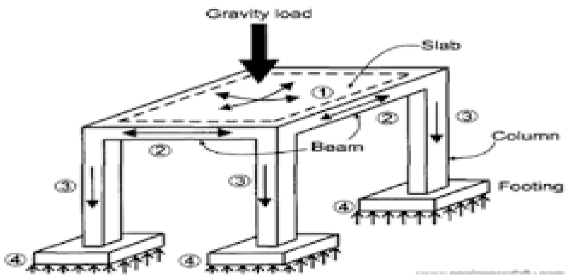


Figure 1.2 Load transfer in floating column

II. LITERATURE REVIEW

Mortezaei (2009) recorded data from recent earthquakes which provided evidence that ground motions in the near field of a rupturing fault differ from ordinary ground motions, as they can contain a large energy, or "directivity" pulse. This pulse can cause considerable damage during an earthquake, especially to structures with natural periods close to those of the pulse failures of modern engineered structures observed within the near-fault region in record earthquakes have revealed the vulnerability of existing RC buildings against pulse-type ground motions. This may be due to the fact that these modern structures had been designed primarily using the design spectra of available standards, which have been developed using stochastic processes with relatively long duration that characterizes more distant ground motions. Many recently designed and constructed buildings may therefore require strengthening in order to perform well when subjected to near-fault ground motions. Fibre reinforced polymers are considered to be a viable alternative, due to their relatively easy and quick installation, low life cycle costs and zero maintenance requirements

Mundada (2014) studied the architectural drawing and the framing drawing of the building Having floating columns. Existing residential building of G+ 7 has been selected for the project work. The load distribution on the floating columns and the various effects due to it is also been studied in the paper. For this Purpose, 3 cases are taken in case 1 no floating column is introduced, in case 2 floating column are introduced, in case 3 struts are provided below the floating column. Following are some of the conclusions which are drawn on the basis of this study.The probabilities of failure of without floating column are less as compared to with floating column and the probabilities of failure with floating column is more than floating column with inclined Compressive member i.e., struts. Due to the provisions of struts in the building with floating columns, the deflection is greatly reduced. This is because struts provide stability to the columns balancing the moments. Column shear values are increasing or decreasing significantly depending upon position and orientation of floating column.Provision of floating column is advantageous in increasing FSI of the building but is a risky factor and increases the vulnerability of the building

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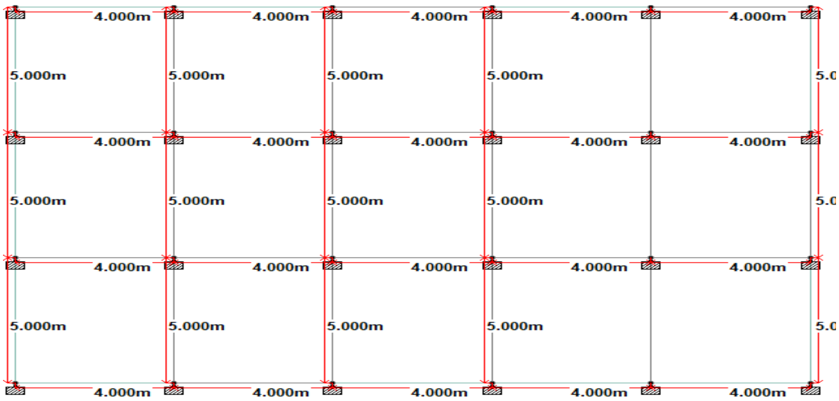
III. METHODOLOGY

STRUCTURE TYPE AND FORM:-

The building was idealized as a 3-dimensional, reinforced concrete moment resisting framed structure. This is considered as the fundamental structural system Since relative displacements (inter storey drifts) are proportional to the shear distribution and shear forces, and on the limitation of drift, this system is recommended for structures up to thirty- storeys. The modelled structure is just eight storeys tall and based on the recommendations on drift limitations, dual systems consisting of moment resisting frame either braced or with shear walls were not considered in this study.



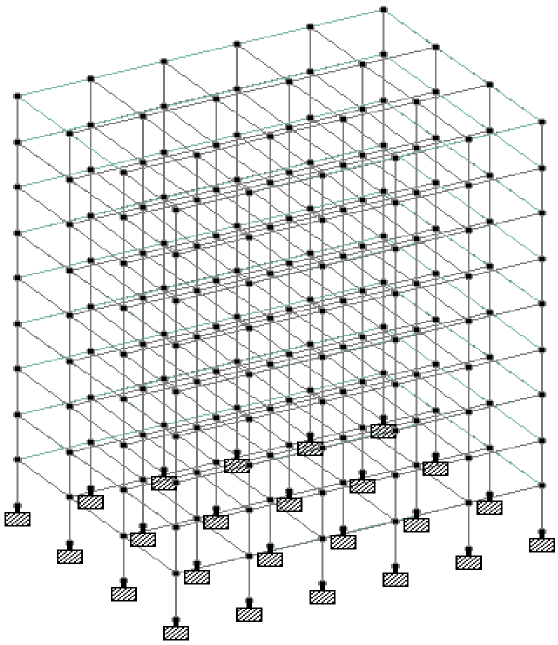


Figure 4.3.2 RC regular frame without floating column

DESIGN ACCELERATION COEFFICIENT

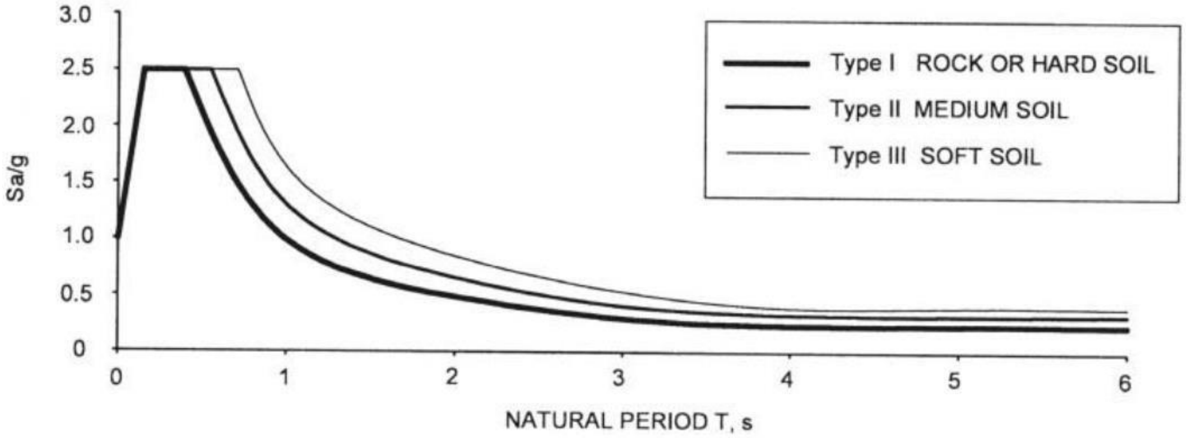


Figure 4.4.9 Design acceleration coefficient corresponding to 5% damping [IS 1893 (Part 1) - 2016]

EARTHQUAKE LOAD PARAMETERS

Table 4.6.1 seismic zone II parameters

Parameters	Values
Seismic zone factor, Z	0.10
Important factor, I	1
Response reduction factor, R	5
Percentage damping	5%

Soil type	Medium dense soil
Load case type	Linear static

IV.RESULTS AND DISCUSSIONS

In the present study, models of RC frame located in different zones have been prepared in STAAD Pro for the analysis. These models include regular frame and frames with floating columns in different seismic zones (i.e., zone II, zone III, zone IV, and zone V). Linear static analysis has been performed. Storey drift, base shear, lateral displacement, maximum bending moments are the parameters computed from the analysis are compared among the models

Calculation of displacement in zone-II

Table 5.1.1 Displacement in zone-II

Model	Displacement (mm)
Regular building	20.817
BWFC in 1st storey	21.272
BWFC in 2ndstorey	21.274
BWFC in 3rd storey	21.254
BWFC in 4th storey	21.212
BWFC in 5th storey	21.143
BWFC in 6th storey	21.046
BWFC in 7th storey	20.923
BWFC in 8th storey	20.825

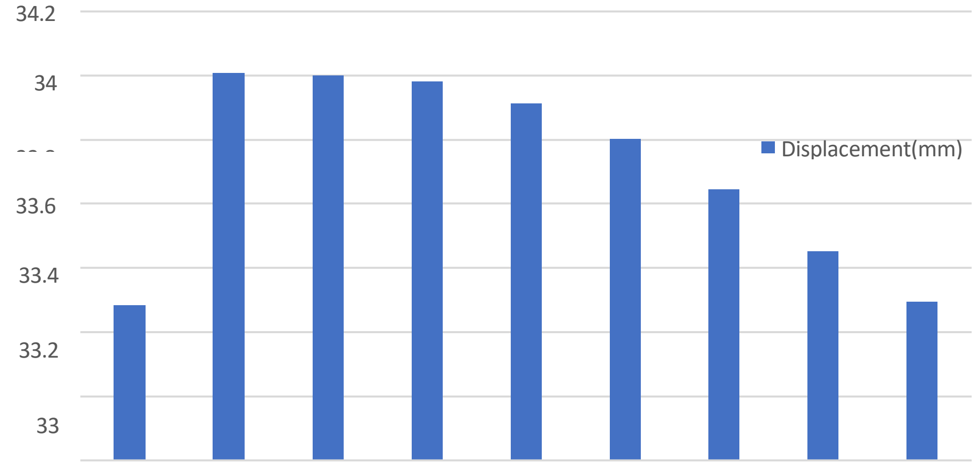


Figure 5.1.1 variation of displacement in zone II

Table 5.1.2 Displacement in zone III

Model	Displacement (mm)
BWFC in 1st storey	34.008
BWFC in 2ndstorey	34.001
BWFC in 3rd storey	33.98
BWFC in 4th storey	33.912
BWFC in 5th storey	33.802
BWFC in 6th storey	33.646
BWFC in 7th storey	33.451
BWFC in 8th storey	33.295

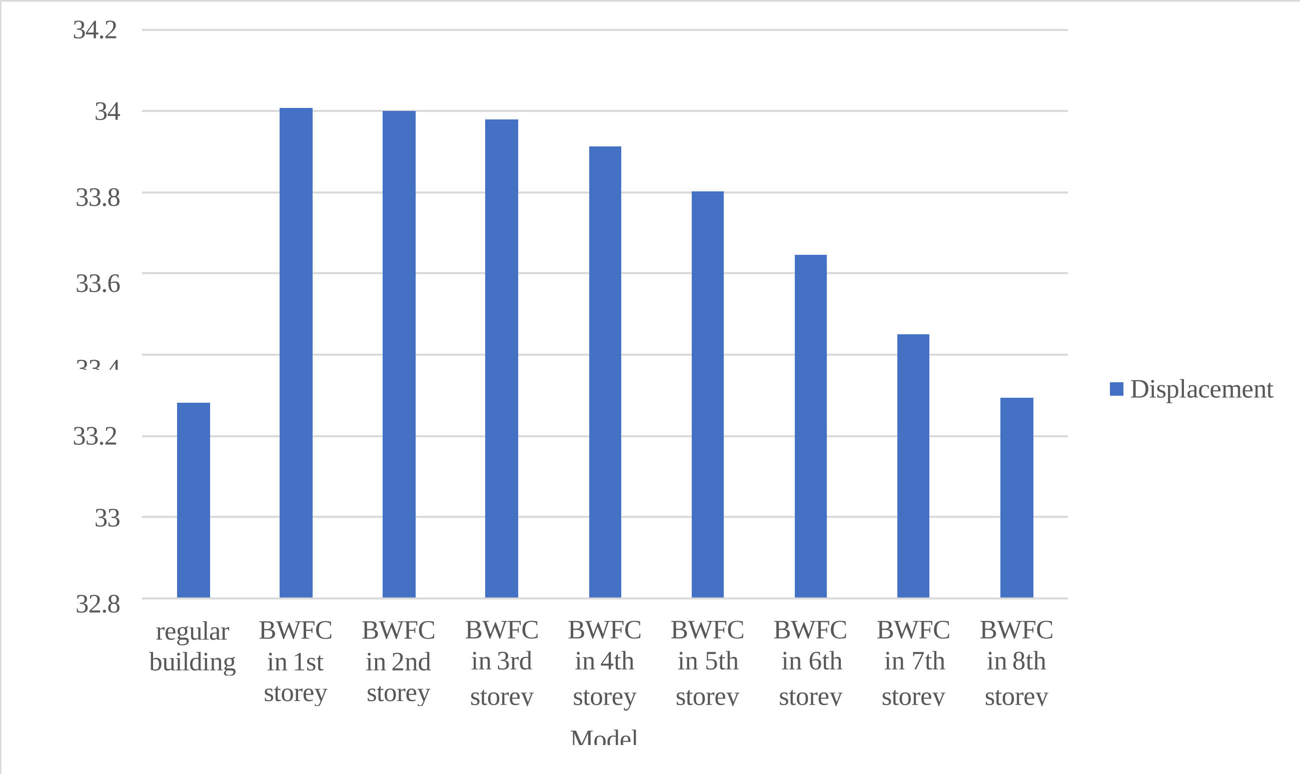


Figure 5.1.2 variation of displacement in zone III

Table 5.1.5 Maximum displacement in all seismic zones

Zone	**Regular building**	**BWFC in 1st storey**	**BWFC in 2nd storey**	**BWFC in 3rd storey**	**BWFC in 4th storey**	**BWFC in 5th storey**	**BWFC in 6th storey**	**BWFC in 7th storey**	**BWFC in 8th storey**
Zone-II	20.817	21.272	21.274	21.254	21.212	21.143	21.046	20.923	20.825
Zone- III	33.283	34.008	34.001	33.98	33.912	33.802	33.646	33.451	33.295
Zone- IV	49.904	50.989	50.994	50.947	50.845	50.68	50.447	50.155	49.921
Zone-V	74.835	76.461	76.469	76.398	76.245	75.998	75.649	75.211	74.861

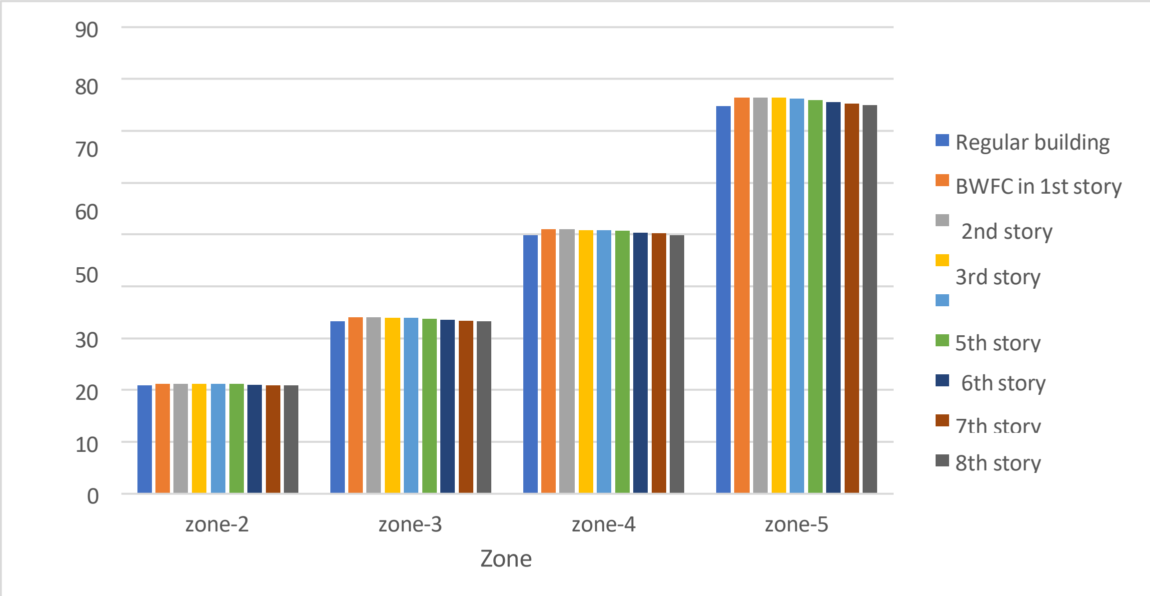


Figure 5.1.5 Variation of displacement in all seismic zones

Table 5.1.6 Displacements of regular building and building with floating column at 8th storey for all seismic zones.

Zone	Regular building	BWFC at 8th storey
Zone II	20.817mm	20.825mm
Zone III	33.283mm	33.295mm
Zone IV	49.904mm	49.921mm
Zone V	74.835mm	74.861mm

V.CONCLUSIONS

i. Base shear is increased by 3.6 times in seismic zone V than that calculated for seismic zone II for both regular building and building with floating column at 8th storey.
ii. In zone II the base shear value in building with floating column at 8th storey is decreased by 1 percent compared to regular building and similarly for zone III, zone IV and zone V.
iii. The maximum displacement at all storey levels when compared with building with floating column at 8th storey and regular building is increased by nearly 3.6 times in seismic zone V that calculated for seismic zone II.
iv. The frame in Zone V exhibited the highest displacement of 74.835 (greater than 54 mm). It exceeded the maximum permitted as structure considered with constant sectional properties from zone II to zone V. It is observed that building with floating column should be considered in zone V by increasing the sectional properties.
v. In all seismic zones, removal of columns at higher floor is better than that of ground floor as safety point of view because it seen that total displacement of structure is lower when columns from top floor was removed.

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