"STUDY of PLAZA BUILDING WITH and WITHOUT FLOATING COLUMNS SUBJECTED to SEISMIC LOADING"

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ABSTRACT - Floating columns are a typical feature adopted in the modern age multi-storey building construction These floating columns reduces the efficiency of the building to resist seismic forces up to large extent, that is why these are the extremely undesirable unit in the seismic prone areas.

In this paper, a multi storied Plaza building of storey (G+2+3) having different position of floating columns(4 columns of mid ordinate axis or 4 columns of diagonal axis) at different height of building(at the level above second floor) at two different zones (ZONE III and ZONE IV) has been considered for analysis. The plan area of building up to second floor is 30m×30m and above this floor area is reduced to 20m×20m.

Height up to second floor of the building is used for parking or commercial shops having floor height of 4m and above this it is used for residential and office purpose. Different combinations of office and residential floors are considered. Floating columns are provided at office floor.

Maximum nodal displacement and base shear are the main considerations in this study. It is found that in Floating column structures less Base Shear but higher Nodal Displacement occurs.

Index Terms - Base Shear, Floating Columns, Maximum Nodal Displacement, PLAZA Building, Seismic Analysis, , STAAD Pro, etc.

I. INTRODUCTION

Most of the urban dwellers in the world are facing challenge of commuting from one place to another, the problem is further aggregated during peak hours. When scours of commuters rush for their offices, often resulting in traffic jams and congestion. One radical solution being worked upon to tackle the problem of congestion is to design and build multipurpose composite buildings with offices and residential apartments in the same building. One of the solution being suggested could be the plaza building in which extensive use of floating columns or walls considering different requirement of various residential and commercial spaces can be used.

The structure which provides facility of commercial public recreation along with residential space is called Plaza building. These are the structure which fulfils the requirements of wide variety of users for various purposes.

A floating column is a vertical structural element which at its lower end instead resting on footing, rests on a beam or girder which is a horizontal member, due to architectural design or as per site situation. Now the beam or girder on which floating column is resting transfers additional load to the supporting columns.

These days Most of the multi-storied buildings in India having floating columns, which provides plenty of open spaces as an unavoidable feature. This is mainly being adopted to facilitate reception lobby or parking. These multi-storied buildings are more vulnerable to earthquake. The impact of earthquake mainly depends upon the mass of the building according to their height, stiffness distribution and natural period of seismic force. Behaviour of building during an earthquake depends primarily on its size, shape and its geometry and transfer of earthquake forces to the ground. The seismic stress developed at different floors in the building need to be carried to the ground by the shortest path. Any kind of deviation or discontinuity in

Figure: 1 SKYLINE PLAZA, Frankfurt, Germany

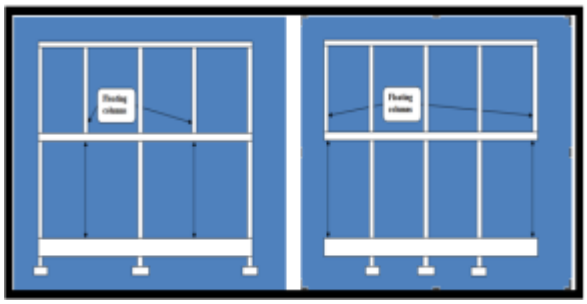


Figure: 2 Floating column

this load transfer mechanism results in poor efficiency of the building. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuity in the load transfer mechanism. In a building earthquake forces causes a sudden jump at the level of discontinuity due to these floating columns. Buildings having floating columns in a particular storey are more vulnerable for damage or collapse. Many buildings with an open ground storey or floating columns intended for parking or reception lobbies collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake[4], which is an eye opener for structural designers.

II. LITRETURE REVIEW

Ms. Waykule S.B. (2017) conducted static analysis for a multi-storey building with and without floating columns. Different cases of the building were studied by varying the location of floating columns floor wise. The structural response of the building models with respect to, Base shear, and Storey displacements are investigated. The author investigated the structural response of the building with respect to this. The analysis is carried out using software SAP 2000. It was observed that displacement of each storey of floating column building is more as compared to without floating column building. Snehal Ashok Bhayar (2017) has made a comparative study of behaviour of building with and without floating column for regular and irregular plan, subjected to seismic loading for equivalent static analysis by using ETABS Software. The areas of study were Base Shear, Lateral storey Displacement and Storey Drift in seismic zone IV. He found that the probability of failure of building with floating column is more. Y. Abhinay (2017) had done analysis of residential building with six Storey and 12 Storeys with column, Beams and Slabs. The buildings are analysed and designed with and without edge columns at base storey. The Buildings are analysed in two Earthquake zones according to IS 1893-2002 with medium soil. Static Load combinations and Response Spectrum Analysis is done to compare the results. Results are compared in the form of Storey displacements, Storey Shear, Storey Over turning Moments with and without columns at base storey in both Static and Dynamic Analysis. Also the Zone wise results are compared using tables and graph to find out the most optimized solution. A Evaluation package of ETABS 2013 has been utilized for analysing the above Building Structure.

III. METHODOLOGY

STAAD Pro software was used for seismic analysis of structure. Following steps were for analysis :

Step 1 Starting the STAAD PRO and Designing the Types of Structures and Unit.
Step 2 Modelling of Structure

The plaza building considered has ground floor + 2 commercial floors + 3 more floors(having different arrangement of office and residential floor as mentioned below)

Structure Detail of the Plaza Building

Plan area of model is (30x30)m^2 , having centre to centre spacing of columns 5m.

Cross sectional area of Column \is (0.5x0.5) m^2 and of Beam is (0.5x0.4)m^2

As the complete plaza building divided into two parts (Ground floor+2) used for commercial purpose and remaining for (residential+ commercial) as per the structure design condition. So here complete study is divided into two Zones (Zone3 and Zone4) and in zone it is further divided into building structure design.

Model 1: Have ground floor + 2 commercial floors +office + residential + residential floor,
Model 2: has ground floor + 2 commercial floors + residential +office + residential floor,
Model 3: has ground floor + 2 commercial floors + residential + residential +office floor.

In each model group of four floating columns are provided at office floor only. Further there are two types of possible arrangement of floating columns either at mid ordinate position or at diagonal position .

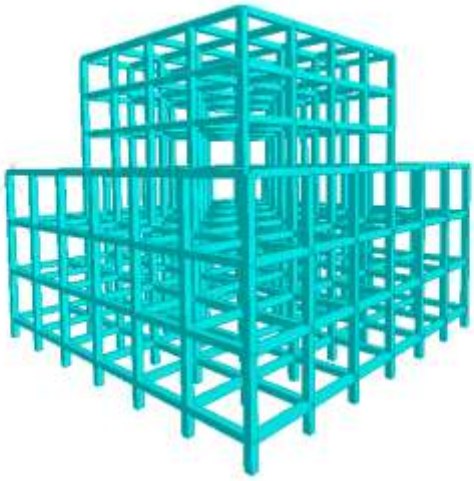


Figure: 3 Rendered Isometric View Of Framed Model

Figure: 4 , Rendered View Of Residential Floor Columns

Figure: 5, Rendered View Of Mid-Ordinate Arrangement Of Floating Columns Of Office Floor

Figure: 6, Rendered View Of Diagonal Orientation Of Floating Columns Office Floor

Step 3 Defining general parameters such as material and cross section shape and size of structural elements.

Step 4 Assigning supports for the Structure

Fixed support was assigned at the base of structure.

Step 5 Defining seismic load and other parameters related to seismic analysis

In the analysis of structure various types of loading conditions studied are mentioned below :

- Static Load :-
  - Dead load (IS 875 : part I)

    Dead loads are external loads acting vertically downward and arise due to self-load of the structure. It includes weight of beams, columns, slabs, floor finish, wall load etc.

    These are calculated by multiplying cross sectional area by the respective densities.

    Density of RCC considered is 25kN/m^3 and for brick wall it is 19.2kN/m^3
  - Live load (IS 875: part II & IV)

    The load which changes its position and magnitude and act vertically downward on the structure is called live load.
  - Load combinations :(IS 875 Part V)

Load Case Table	
Load case No	**Type**
1	Earthquake loading in X direction
2	Earthquake loading in Z direction
3	Dead load
4	Live load
5	Dead load+0.25 Live load

❖ Seismic load [IS :1893(2002)]

When ground motion is subjected to structure, structure responds in shaking fashion. The motion of structure in random in all possible direction and for analysis it is resolved in two directions horizontal(X) and vertical directions(Y).Due to this motion structure vibrate in all three directions.

The seismic force is evaluated as per IS:1893(2002).Analysis was done for seismic Zone III and Zone IV and Response Reduction factor of 3, Importance factor of 1, Damping of 5% and Medium Soil were considered.

Step 6 Structural analysis.

Step 7 Comparative analysis of results in terms of Base Shear and Maximum Nodal Displacement.

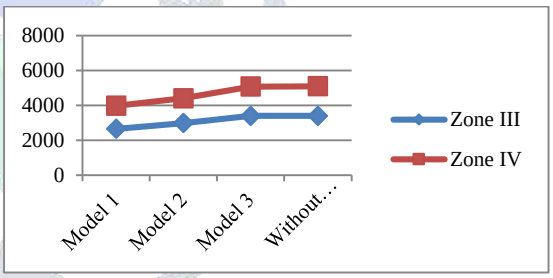
Step 8 Critical study of the results.

IV. RESULTS

Results of static seismic analysis of mentioned cases for zone III and zone IV are as follows:

- **Base Shear (in kN0 for mid ordinate orientation**

Type of structure	Zone III	Zone IV
Model 1	2650.18	3975.26
Model 2	2983.71	4410.43
Model 3	3395	5079.02
Without Floating Model	3400.62	5100.93



- **Base Shear (in kN) for Diagonal orientation**

Type of structure	Zone III	Zone IV
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Model 2	2983.71	4410.43
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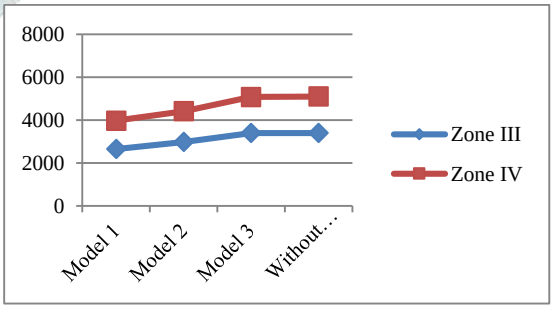
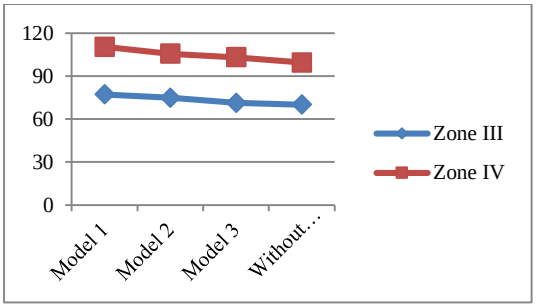


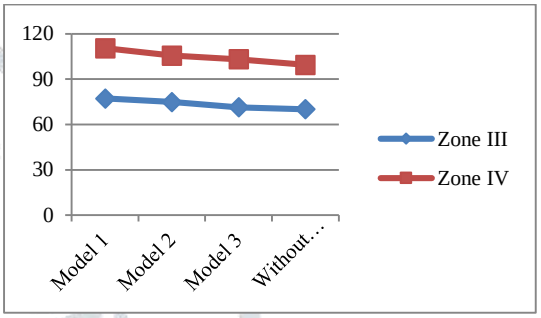
- **Nodal Displacement (in mm) for mid ordinate orientation**

Type of structure	Zone III	Zone IV
Model 1	77.9	111.13
Model 2	75.60	106.01
Model 3	72.16	103.76
Without Floating Model	70.10	99.46



- **Nodal Displacement (in mm)for Diagonal orientation**

Type of structure	Zone III	Zone IV
Model 1	77.24	110.5
Model 2	74.89	105.64
Model 3	71.34	103.2
Without Floating Model	70.10	99.46



V. CONCLUSIONS

On the basis of the study it can be concluded that

Base Shear for the structures having floating column is less than the structure without floating columns on the other hand Nodal Displacement for the structures having floating columns is more than the structure without floating columns. However, with the rise in the elevation of floating column base shear increases but Nodal Displacement decreases. But Base Shear and Nodal Displacement both are higher in zone IV then in zone III.

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