A STUDY ON EFFECT OF BRACING SYSTEM UNDER EARTHQUAKE EXCITATION USING RESPONSE SPECTRUM METHOD OF ANALYSIS - A REVIEW

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Abstract

Civil engineering structure with the floating column is becoming a usual feature for modern multi-story buildings in India. But this floating column 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 area, and the building with the bracing system has more lateral stability as compared to normal moment-resisting framed buildings the behavior floating column structure with the bracing system is studied. In this study G+10 regular column structure, G+10 floating column structure without bracing systems and G+10 floating column structure with bracing systems built in seismic zone 4 of India are considered for the analysis This study highlight the importance of bracing system for lateral stability in floating column structure. The comparison of result of maximum story displacement, maximum base reaction, and maximum story drift is done by Equivalent static method and Response spectrum method by using stad pro software considering the earthquake Indian code IS 1893:2002

Keywords— *Floating column, Bracing, Equivalent static method, Response spectrum, IS 1893:2002, STAAD PRO*

I. INTRODUCTION

Nowadays the vast majority of the multi-storied structures in India having a Floating column, which gives a lot of open spaces as an unavoidable component. This is mainly being adopted to facilitate anteroom or for parking of the vehicle.

Buildings oscillate during earthquake shaking. The oscillation causes inertia force to be induced in the building. The intensity and duration of oscillation, and the amount of inertia force induced in a building depend on features of buildings, called their dynamic characteristics, in addition to the characteristics of the earthquake shaking itself. The important dynamic characteristics of buildings are modes of oscillation and damping. A mode of oscillation of a building is defined by associated Natural Period and Deformed Shape in which it oscillates.

A vertical member whose slenderness ratio is more than 3 carrying compressive loads is called as a column. The main function of the column is to carry the load of the beam and transfer it to the foundation or footing of the structure. It is subjected to two equal and opposite compressive forces applied at its ends. They are the vertical members who support floors or girders in a building.

Regular column increases both stiffness and mass of buildings. Which provide lateral strength against earthquake loading.

Columns carry Axial Loads and therefore are designed for compression. Other loads from snow, wind or other horizontal forces can cause bending in the columns. Thus, the Columns are needed for Axial Loading and Bending.

The floating column is a vertical member which rest on a beam and doesn't have a foundation. The floating column act as a point load on the beam and this beam transfers the load to the columns below it. It belongs to a vertical member that is laid on a beam and it doesn't deliver the load directly to the foundation. The arrangement of a hanging column is in such a way that it simply floats or is being hung over a base (beam or slab) with no fixed support below with the foundation. This gives the vertical column the name floating or hanging column. There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available on the ground floor. These open spaces may be required for an assembly hall or parking purpose. The transfer girders have to be designed and detailed properly, especially in earthquake zones. The column is a concentrated load on the beam which supports it and, in that floor, and below floors, beams and columns should be in heavy in size and heavy material will be used to resist the concentrated load.

Floating column structure has low stiffness as compared to normal moment resisting framed structure due to this all other loading effects, e.g., wind loads, wave loads (excluding tsunami loads), blast loads, snow loads, imposed (live) loads and dead loads, earthquake excitation is
the most severe in floating column structure, because it imposes displacement under the
building, which is time varying. This, in turn, demands lateral deformation in the building between its base and upper elevations. Higher is the seismic zone, larger is the severity of this imposed relative deformation. Therefore, the main challenge is to meet the double demand – the building should be able to withstand this imposed deformation with damage under small intensity shaking, and with no collapse under high intensity shaking. The building needs to possess large inelastic deformation capacity and needs to have the strength in all its members to sustain the forces and moments induced in them.

The introduction of the floating column in the structure makes the building more susceptible to collapse, to avoid this phenomenon due to lateral loading various lateral load resisting system such as a shear wall, bracing, core and outrigger and tabular may introduce to avoid the failure of the structure due to the earthquake excitation.

Fig 1.1 :Structure showing Floating Columns

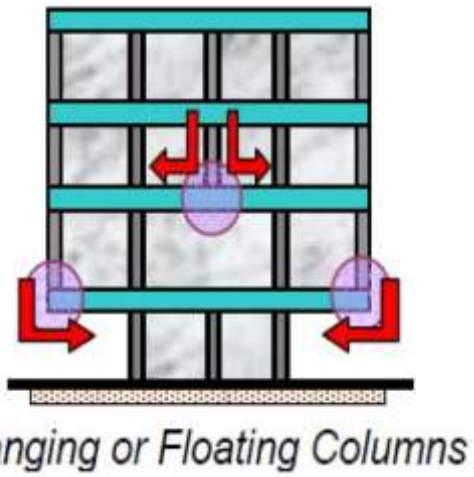

Fig. 1.2 : Structure showing Floating Columns

Advantages of Floating Column:-

- By using floating columns large functional space can be provided which can be utilized for storage and parking.
- In some situations (in case of less lateral load), floating columns may prove to be economical.
- The floating column is important for the flexible division of the rooms by using wooden or aluminum partition walls.

II. OVERVIEW OF WORK

In some bays of frame, diagonal members are provided within the story height and this pattern is repeated throughout the height of the building forming a vertical truss type structure. These vertical trusses increase the strength and stability of the buildings against lateral loads. A bracing system is a structural system which is

designed primarily to resist wind and seismic forces. By the addition of truss members such as diagonals or bracing elements between the floors the effectiveness of the structure to resist lateral loads can be achieved to a much greater extent. Braced frames are used for trussing to resist sideways forces on an R.C.C. structure. It is formed by inserting corner to corner (diagonal) structural members into rectangular zones of a structural frame. It helps to stabilize the frame against sideways forces from earthquakes and strong winds.

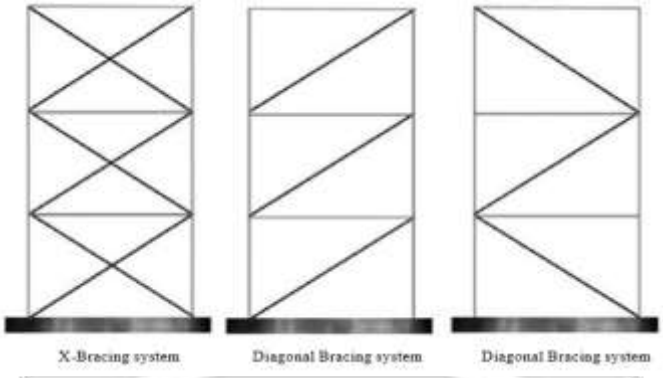

Fig 2.1: Various Bracing system

III. LITERATURE REVIEW

Literature based on the modelling of multi-storey building using floating column and transfer beam under seismic behaviour. From the detailed literature review, inference is studied.

Kapil Dev Mishra (2018), studied a multi-storied Plaza building of different heights (G+2+3, G+2+4, G+2+5) 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) are considered for analysis and STAAD PRO. Software is used for the analysis. The plan area of building up to the second floor is 30m×30m and above this floor area is reduced to 20m×20m. The comparisons were done on the basis of results from the software and are based on following parameters such as Maximum displacement at joint, Support reaction at the base, Maximum moment at the joint and Base shear.

Snehal Ashok Bhayar (2017) had done a comparative study of the behavior of building with and without floating column for the regular and irregular plan, subjected to seismic loading for equivalent static analysis by using ETABS Software. The areas of study were Base Shear, Lateral story Displacement and Storey Drift in seismic zone

Ms. Waykule S.B (2016) in their study of performance of floating column for seismic analysis of multi-storey concrete building performed the analysis and evaluation of building with and without floating column in highly seismic prone zone v. 4-models were produced by changing the place of floating column. Linear static and time history analysis were performed on all the four models and the results were compared with each other. From time history analysis, response of all the 4-models were plotted. In this paper, they concluded that, the floating column at dissimilar position results into dissimilarity in dynamic response and building with floating column has much more storey drift in comparison with conventional one.

K. K. Pathak et. al. (2016), studied and analyzed G+9 steel frames with a different type of bracing pattern and different combination of soft-story using software STAAD Pro. Effect of these different bracings on the soft story is studied for different parameters like column displacement, maximum deflection, story drift, maximum bending moment, maximum axial force and maximum shear force**.**

Akshay Sonawane et. al. (2016), focuses on the effect of bracing system on the story that is critical in the structure. They studied on bracing systems like cross bracing, diagonal bracing, inverted V bracing and V bracing systems and results on components like story drift and bending moment in columns and story displacement were calculated.

Nitin Bhojkar and Mahesh Bagade (2015), studied the seismic evaluation of high- rise structure by using steel bracing system. For the seismically inadequate reinforced concrete frames, the use of steel bracing systems is done for strengthening. In this study, different types of bracing systems are used and seismic analysis is done for seismic zone III as per IS1893:2002. Lateral displacement, story drift, axial force, and base shear are the main

parameters which are studied. It was seen that the structural stiffness was contributed by the X type of steel bracing and maximum inter-story drift of the frames also gets reduced. The bracing system gives best results in lateral stiffness, strength capacity as well as in displacement capacity. They conclude that a reduction in lateral displacement of the structure occurs up to 65% by the use of X type of bracing system. Story drift gets reduced in X type of bracing system. There was an increase in axial force for X bracing system up to 22%.

Niroomandi, Maheri & Mahini (2010) retrofitted an eight-storey frame strengthened previously with a steel bracing system with web- bonded CFRP. Comparing the seismic performance of the FRP retrofitted frame at joints with that of the steel X-braced retrofitting method, it was concluded that both retrofitting schemes have comparable abilities to increase the ductility reduction factor and the over-strength factor; the former comparing better on ductility and the latter on over-strength. The steel bracing of the RC frame can be advantageous if a substantial increase in the stiffness and the lateral load resisting capacity is required. Similarly, FRP retrofitting at joints can be used in conjunction with FRP retrofitting of beams and columns to attain the desired increases

IV. NEED FOR THE PROPOSED WORK

Floating column have following problems

Floating column are not suitable in the high seismic zone since the abrupt change in stiffness was observed. It required large size of girder beam to support floating column. Floating columns leads to stiffness irregularities in the building.The load from structural members shall be transferred to the foundation by the shortest possible path. The flow of load path increases by providing floating columns, resulting in poor performance of the structure. It results in more displacement, story drift than structure without floating column.

As we have studied following problem of floating column structures, to overcome these disadvantages several methods are used such as the introduction of the bracing system, shear wall, infill wall, etc. In this study to overcome the disadvantages of floating column structures bracing system are adopted and an attempt is made to know the importance of the bracing system in floating column structure.

V. OBJECTIVE OF THE WORK

The main objective of the study is to do a comparative analysis of R.C.C. framed structure with a floating column structure and floating column structure with the bracing system. The same work is done on STAAD PRO software.

Following are the objectives of this work-

1.To compare the regular structure & floating column structure (without bracing) and floating column structure with the bracing system.

2.To check the effect of changing the locations of floating columns on multi storey building .

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