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Seismic Analysis of a Multistorey Building with Floating Column: A Review

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Abstract: Nowadays in most of the commercial as well as residential buildings lower floors contain banquet halls, showrooms, conference rooms, large parking space etc. All these amenities require huge uninterrupted space unlike closely spaced columns on upper floors, hence the concept of floating column came into existence. This paper aims towards the review of studies carried out on Seismic Analysis of the building with Floating column by various authors in the past. The analysis is done on building models having different numbers of storey of RCC with simple and complex floor plan with floating columns. Finite element base software namely ETABS, Staad pro v8i are used for the analysis which can easily determine the parameter such as lateral forces, bending moment, shear force, axial force, storey shear, storey drift, base shear. Time history method or response spectrum method is used for the dynamic analysis for simple and complex building configuration.

Keywords: - Floating column, seismic analysis, finite element method, STAAD Pro, Multi-storey building

I. INTRODUCTION

Many urban multistorey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height. The behavior of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open round storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in load transfer path.[9]

The Provision of floating columns can be stated almost of the buildings in India are covering the maximum possible area on a plot within the available bylaws. Since balconies are not counted in floor space index (FSI), buildings have balconies overhanging in the upper stories beyond the column foot print areas at the ground storey, overhangs up to 1.2 m to 1.5 m in plan are usually provided on each side of the building. In such cases, floating columns are provided along the overhanging perimeter of the building. Most of the time, architect demands for the aesthetic view of the building, in such cases also many of the columns are terminated at certain floors and floating columns are introduced. [5]

But Provision of floating columns resting at the tip of taper overhanging beams increases the vulnerability of the lateral load resisting system due to vertical discontinuity. This type of construction does not create any problem under vertical loading conditions. But during an earthquake a clear load path is not available for transferring the lateral forces to the foundation. Lateral forces accumulated at the upper floor during the earthquake have to be transmitted by the projected cantilever beams. Overturning forces thus developed overwhelm the columns of the ground floor. Under this situation the columns begin to deform and buckle, resulting in total collapse. This is because of primary deficiency in the strength of ground floor columns, projecting cantilever beams and ductile detailing of beam column joint. [5]

In case of floating column, shear is induced to overturning forces to another resting element of the low level. This imposition of overturning forces overwhelms the columns of lower level through connecting elements. Therefore the most critical region of damage is the connecting element (link between discontinuous columns to lower level column) and lower level columns. Therefore,

the primary concern in load path irregularity is the strength of lower level columns and strength of the connecting beams that support the load of discontinuous frame. [5]

II. LITERATURE REVIEW

- A. Jayesh Rathi (2017) carried out the comparative study on normal multistoreyed building and building with floating columns. A ten storey building was considered for this study and various structural responses such as Storey Displacement, storey Drift, Storey Shear and Time period were evaluated and compared. For dynamic analysis response spectrum method was used and analysis was done using ETABS software. From this study he concluded that:
- 1) Storey displacement increases with introduction of floating column.
 - 2) Storey drift increases with increase in storey displacement since they are directly proportional to each other
 - 3) Storey forces are less in the building with floating column compared to normal building as number of columns are less
 - 4) Time period is more for the building with floating column compared to normal building.[1]
- B. Sukumar Behera (2012) studied the behavior of multistory building with and without floating column under different earthquake excitations. The PGA of both earthquake was kept 0.2g and duration of excitation was kept constant. The finite element model was prepared to study dynamic behavior of the building. The static and free vibrations results were validated using finite element code. From the study he concluded that with increase in ground floor column the maximum displacement, inter storey drift reduces. The base shear and overturning moment varies with change in dimensions of column.[2]
- C. Badgire Udhav (2015) carried out the analysis of multistory building with floating column. He selected G+10 structure for his analysis. Model was prepared using STAAD Pro software and analysis was done using equivalent static method. This study was done on a preliminary basis with three different cases namely Case1: Modeling & Analysis of G+10 RCC building with floating columns located outer periphery (4 Sides), Case2: Modeling & Analysis of G+10 RCC building with floating columns located outer periphery (2 Longer Sides) and Case3: Modeling & Analysis of G+10 RCC building with floating columns located outer periphery (2 Shorter Sides). From this study it was concluded that the difference in probabilities of failure with floating column (Case2) is more than that of floating column (Case3). In case 2 and 3 the values of column shear increases or decreases significantly depending upon position and orientation of column.[3]
- D. Sabari (2014) has done analysis of RCC framed structures having different stiffness and keeping the base of the building frame fixed. The author did time history analysis using FEM package SAP2000. By changing column size the author carried out dynamic analysis and concluded that with increase in column size, the maximum deflection and inter storey drift are reduced.[4]
- E. Mundada (2014) studied the architectural drawing framing drawing of the building having floating column. The author considered existing residential building of G+7 for the study of load distribution on the floating column and various effects due to it. In the study the author studies three cases i.e. Building without floating column, Building with floating column and building with floating column with strut. By this study the author concludes that the probabilities of failure of building without floating column are less as compared to that of building with floating column and the possibility of failure of structure with floating column is more than that of the structure with floating column with strut and the deflecting is much more in case of floating column than floating column with strut.[5]
- F. Srikant M K (2014) has performed the whole work consist of four models i.e., models, FC (floating column is provided in particular floor, location), FC+4(floating column is provided by rising height by 4m), FC+ HL (floating column is provided by applying heavy load), FC+4+HL (floating column is provided by rising the storey height by 4m). The design methodology employs the fully combined process that allow modelling, analyzing, designing. From this study the author observed that, the displacement of the building increases from lower zones to higher zones, because the magnitude of intensity will be more for higher zones, similarly for drift, because it is correlated with the displacement. Storey shear will be more for lower floors, then the higher floors due to the reduction in weight when we go from bottom to top floors. And with this if we reduce the stiffness of upper floors automatically there will be a reduction in weight on those floors so in the top floors the storey shear will be less compared to bottom stories.[6]
- G. Umesh Patil (2015) considered G+5 Structure for earthquake analysis. The author compared three models, one with normal structure, second with shear wall and third with masonry infill walls. All three methods, equivalent static, response spectrum and time history methods were used for analysis using ETABS software. The conclusion of this paper is that the structure with shear wall performs best among all three structures during earthquake. Time history analysis gives highest value of base shear for multi-storey building with shear walls. Response spectrum analysis gives least value of storey drift for multi-storey building

with shear walls, whereas equivalent static method of analysis gives lowest value of displacement for multi-storey building with masonry infill walls.[7]

III. CONCLUSION

The present study models is limited upto the structures with simple configuration for medium soil condition having parameters bending moment, shear force, storey drift, storey shear, axial forces.[8] It shows that parameters such as storey drift, storey displacement etc. increases with introduction of floating column. Hence, it should be avoided in earthquake prone regions if possible. Whereas in structures with complex configurations there is lot of work to be done. Future investigation should be concerted on the modes shapes which reflect the actual structural behaviour of the building.[8]

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