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Analysis of Multistory Buildings With Stub Column In Different Seismic Zones In India – A Review

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Abstract: *Construction of building requires proper planning and management. Buildings are subjected to various loads such as dead load, live load, wind load and seismic load. Seismic load has extreme adverse effect on building so it is necessary to perform seismic analysis. This paper explains about the response of building when it is subjected to seismic load, this response can be shown by story drift and base shear. Behavior of buildings with stub columns is analyzed and the results are compared with buildings without stub columns. Seismic analysis has been performed on (G+7) buildings located in seismic zones 2,3,4&5 using ETABS software. Analysis has been performed according to IS 1893:PartI (2002).The storey drift and design base shear are evaluated and compared. Pushover analysis was performed and the results were compared.*

Keywords: Stub column, Floating column.

I. Introduction

Designing a structure in such a way that reducing damage during an earthquake that makes the structure quite uneconomical, as the earthquake might or might not occur in its lifetime. In this paper a multistoried RCC framed structure with stub column at different seismic zones has been analyzed and designed using ETABS using pushover analysis method. The scope of this project is to analyze and design the buildings with and without stub columns in order to withstand the seismic forces. It is aimed to perform comparative study of behavior of buildings in different seismic zones in India with and without stub columns, to observe the lateral forces in the multistorey building and to study the different components in building under seismic load. The main objectives of this project is to model a multistoried structure with stub column, to analyze the structure under various seismic zones by pushover analysis method, to compare maximum displacement, maximum storey drift, maximum storey shear, maximum base shear vs monitored displacement of the structure with and without stub columns.

1.1 Types of Columns

Hanging (or) Floating columns, Stub Columns are various types of columns in structures.

- **Floating Column**: It is a column that is not directly connected with footing and constructed on a building more than one floors. Floating Columns start from One floor and go up to the height of the building that is up to the top floor of the building.
- **Stub Column**: Stub column is defined as a type of column that is directly connected with footing, constructed over a beam or slab to transfer the load on the primary beam as shown in Figure 1 and Figure 2. Stub column is a non- structural type of column and the height of the stub column is very less.Stub Column start and end between One floor.

Figure 1: Stub column

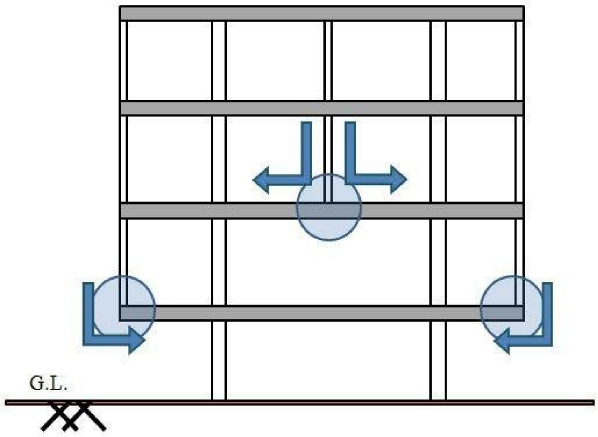

Figure 2: Floating column

II. Literature Survey

[1] Mohana, et. al (2015)

"Comparative Study of Flat Slab and Conventional Slab Structure Using ETABS for Different Earthquake Zones of India", analyzed a G+5 commercial multistoried building having flat slab and conventional slab for the parameters like base shear, storey drift, axial force, and displacement. The performance and behavior of both the structures in all seismic zones of India has been studied. The storey shear of flat slab is 5% more than conventional slab structure, the axial forces on flat slab building is nearly 6% more than conventional building, the difference in storey displacement of flat and conventional building are approximately 4mm in each floor. The work provides reasonable information about the suitability of flat slab for various seismic zones without compromising the performance over the conventional slab structures.

[2] Gouramma, et. al[2015]

"Seismic performance of different RC slab systems for tall building", investigated analytically different types of RC slab taken as an example and performed the various analytical approaches (linear and nonlinear analysis) on the building to identify the seismic demand and also performed pushover analysis to determine the performance levels. The analysis of seismic behavior of different type of RC slab systems is done by using ETABS software. The tall building is located in seismic zone-II, III, IV, V and soil type is II in accordance with IS 1893-2002(part-1). They concluded that pushover analysis is useful tool to performance based seismic engineering to study post yield behavior of structure It is more complex than traditional linear analysis.

[3] Lande, et.al (2015)

"Seismic Behavior of Flat Slab Systems", carried out a parametric investigation in order to identify the seismic response of systems a) flat slab building b) flat slab with parametric beams c) flat slab with shear walls d) flat slab with drop panel. e) Conventional building the aforementioned hypothetical systems were studied for two different storey heights located in zone v. and analyzed by using ETABS Nonlinear version 9.7.3. Linear dynamic analysis i.e. response spectrum analysis was performed on the system to get the seismic behavior. On the basis of the results following conclusions have been drawn:1. The storey displacement is found maximum for the flat slab building as compared to conventional RC building and flat slab with shear wall the maximum displacement of the flat slab building is due to the absence of lateral load resisting system.2. The maximum storey drift found for G+6 building having a flat slab (As compared to its maximum limit i.e. 0.04% of height)3. For all the cases considered drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey. Flat slab displacement is found 28%

more than of conventional building for G+ 6.And 49.49% for G+12 building. Therefore it is advisable for tall building to use the shear wall.

[4] Khan, et. al (2015)

"Comparative study of Seismic Performance of multistoried R.C.C buildings with Flat slab & Grid slab", performed dynamic analysis of three different high rise buildings having 12, 15 & 18 stories using response spectrum method for all four seismic zones of India, as categorized by the Indian code for earthquake resistant structures. The assessment of the seismic response is based on the maximum inter-story drift, roof displacement, Time period and the base shear. E-TAB v9.7.3 software is used for the analysis. It is observed that the seismic performance of grid slab buildings was better as to that of flat slab buildings.

Based on the results the following conclusions could be drawn: 1. The choice of the system for slab in the tall building is very important to resist the internal forces and stability 2.The base shear will increase drastically as the height increases. Base shear of flat slab building is more than that of the grid slab building. The difference between the two varies from 3-4(%).3.The lateral displacement (both Ux and Uy) is maximum at terrace level for all types of used for columns. Lateral displacement of Grid slab building is less than that of the flat slab building. The difference between the two is less if the building width is more as a result of this, additional moments are developed. Therefore, the columns of such buildings should be designed by considering additional moments can used by the drift. The difference between the two is less if the building width is more.

[5] Hassaballa, et. al (2014)

"Pushover Analysis of Existing 4 Storey RC Flat Slab Building", analyzed a four-story residential existing reinforced concrete building in the city of Khartoum-Sudan, subjected to seismic hazard Plastic hinge was used to represent the failure of beams and columns when the member yields. The pushover analysis was performed on thebuildingusingSAP2000software (Ver.14) and equivalent static method according to UBC 97. The pushover analysis is carried out in both positive and negative x and y directions Default hinge properties, available in some programs based on the FEMA -356 and Applied Technology Council (ATC-40) guidelines were used for each member. One case study has been chosen for this purpose. The evaluation has proved that the four-story residential building is not seismically safe. The main output of a pushover analysis was interns of response demand versus capacity. If the demand curve intersects the capacity envelope near the elastic range, then the structure has a good resistance. If the demand curve intersects the capacity curve with little reserve of strength and deformation capacity, then it can be concluded that the structure will behave poorly during the imposed seismic excitation and need to be retrofitted to avoid future major damage or collapse.

[6] Joshi, et. al (2013)

"Performance of Flat Slab Structure Using Pushover Analysis", performed push over analysis on flat slabs by using software SAP2000.Foranalysis they have considered a (G+7) frame having 5 bays. From the analysis they concluded the following points:1. The pushover analysis is a relatively simple way to explore the non linear behavior of buildings.2.Base shear of conventional RCC building is more than the flat slab building.3.The performance point of flat slab is more than the conventional structure due to its flexibility. 4. The behavior of properly detailed conventional building is adequate as intersection of the demand and capacity curves.5. The results obtained in terms of demand capacity gave an insight into real behavior of the structure.

[7] Sathawane, et. al (2012)

"Analysis And Design of Flat Slab and Grid Slab and Their Cost Comparison", aimed to determine the most economical slab between flat slab with drop, Flat slab without drop and grid slab. The total length of slab is 31.38 m and width is27.22 m. total area of slab is 854.16 sqm. It is designed by using M35 Grade concrete and Fe415steel. Analysis of the flat slab and grid slab has been done both manually by IS 456-2000 and by using software also. Flat slab and Grid slab has been analyzed by STAAD PRO. Rates have been taken according to N.M.C. C.S.R It is observed that the Flat slab with drop is more economical than Flats lab without drop and Grid slabs. Also they concluded the following points:1.Drops are important criteria in increasing the shear strength of the slab.2.Enhance resistance to punching failure at the junction of concrete slab and column.3.Byincorporatingheadsin slab, we increasing rigidity of slab.4.Thenegative moment's section shall designed to resist the larger of the two interior negative design moments for the span framing into common supports.

[8]Soni, et.al (2012).
"Non-Linear SAP2000", performed the push over analysis on flat slabs by using most common software SAP2000.According to this paper many existing flat slab buildings may not have been designed for seismic forces. But when compared to beam-column connections, flat slabs are becoming popular and gaining importance as they are economical. A typical flat slab with two stories is considered in the present study. It has not been detailed for earthquake loads but have been designed for wind loads. The height of each storey is 3m..The materials used are M 20 grade concrete and Fe 415 grade steel. The thickness of the slab is200 mm and no shear reinforcement is provided in the slabs. The columns are 250mm .It is important to study their response under as seismic conditions and to evaluate seismic retrofit schemes. Hence push over analysis has been gaining importance for the strengthening and evaluation of the existing structures. By conducting the pushover analysis on flat slabs, pushover curve and demand curve can be obtained. Then, based on the results we need to decide whether to perform rehabilitation or retrofitting depending upon the seismic zone of the existing structures.

[9] M. A. Ismaeil
"Pushover Analysis of Existing3 Stories RC Flat slab Building", focused on the study of seismic performance of the existing hospital buildings in the Sudan. Plastic hinge is used to represent the failure mode in the beams and columns when the member yields. The pushover analysis was performed on the building using SAP2000 software (Ver.14) and equivalent static method according to UBC 97.base shear versus tip displacement curve of the structure, called pushover curve, is an essential outcomes of pushover analysis. The pushover analysis is carried out in both X and Y directions. Default hinge properties, available in some programs based on the FEMA -356 [3] and Applied Technology Council (ATC-40) [4] guidelines are used for each member. One case study has been chosen for this purpose. The evaluation has proved that the three stories hospital building is seismically safe.

[10] Mr. S. Mahesh & Mr. Dr. B. Panduranga Rao et. al. (2014)
Studied a residential of G+11 multistory building for earthquake and wind load using ETABS and STAAS PRO V8i. Assuming that material property is linear static and dynamic analysis are performed. These analyses are carried out by considering different seismic zones and for each zone the behavior is assessed by taking three different types of soils namely Hard, Medium and Soft. Different response like story drift, displacements base shear are plotted for different zones and different types of soils.

[11] Pardeshisameer, Prof. N. G. Gore et. al. (2016)
Discussed a study on 3D analytical model of G+15 storied buildings were generated for symmetric and asymmetric building models and analyzed using structural analysis tool ETABS software. This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of this study to carry out Response spectrum analysis (RSA) of regular and irregular RC building frames and Time history Analysis (THA) of regular RC building frames and carry out the ductility-based design using IS13920 corresponding to response spectrum analysis.

[12] Dr. Raghvendra Singh, P et. al. (2014)
Discussed & compare the seismic behavior of regular building frame with vertically irregular building frame at different positions. For this purpose, four frames of multi-storey buildings are considered. For study the behavior the

response parameters selected are lateral displacement and storey drift. All the frames are assumed to be located in zone II, zone III, zone IV and zone V. For analysis STAAD Pro software is used. Observation shows that for all the frames considered, drift values follow a similar path along storey height with maximum value lying somewhere near the thirteenth to fifteenth storey.

[13] C.M. Ravi Kumar, et. al. (2012)
Discussed the performance evaluation of RC (Reinforced Concrete) Buildings with vertical irregularity. The study as a whole makes an effort to evaluate the effect of vertical irregularity on RC buildings, in terms of dynamic characteristics and identifies the influencing parameters which can regulate the effect on Base Shear, Time Period, Story Displacement & Story Drift. Also, the analysis has been carried out for various zones of India and soil conditions taken in to consideration.

[14] K. Rama Raju, et. al. (2013)
Studied the limit state method of analysis and design of a 3B+G+40-storey reinforced concrete high rise building under wind and seismic loads as per IS codes of practice is described. Safety of the structure is checked against allowable limits prescribed for base shear, roof displacements, inter-storey drifts, accelerations prescribed in codes of practice and other relevant references in literature on effects of earthquake and wind loads on buildings.

[15] E. Pavan Kumar, et. al. (2014)
Studied the seismic analysis of structure for static and dynamic analysis in ordinary moment resisting frame and special moment resisting frame. Equivalent static analysis and response spectrum analysis are the methods used in structural seismic analysis. We considered the residential building of G+15 storied structure for the seismic analysis and it is located in zone II. The total structure was analyzed by computer with using STAAD.PRO software.

III. Conclusion

1. The pushover analysis is a simple way to explore the non-linear behavior of building.
2. Pushover analysis can identify weak elements by predicting the failure mechanism and account for the redistribution of forces during progressive yielding. It may help engineers take action for rehabilitation work.
3. Pushover analysis is an approximation method based on static loading. It may not accurately represent dynamic phenomena.
4. The building that was analyzed according to UBC is satisfactory. The performance point location is at IO (Immediate Occupancy) level. It means the design satisfies pushover analysis according to ATC -40.
5. The performance point is obtained as per ATC
6. 40 capacity spectrum method. Performance points for flat slab are larger than in grid slab models.

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