

Comparative Analysis of (G+11) R.C.C. Frame Structure with Flat slab & Conventional Slab having different Cross-Sectional Shape of Columns

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Abstract – Earthquake resistant design of structures deals with such a design which reduces or minimizes the effect of earthquake in a building. A ground motion is something strong enough to collapse a building mainly in higher seismic zones here in this paper we are dealing with seismic zone 5 of India. This review paper deals with a brief study of comparative analyzation of R.C.C. Frame structure with different slab and different cross-sectional shapes of columns in seismic zone 5. The software used for this analyzation is ETABS 2016. The parameters through which we study and evaluate this Review paper are maximum and minimum displacement, maximum and minimum storey drift, maximum and minimum storey shear, maximum and minimum storey stiffness.

Key Words: Max. & Min Storey displacement, Storey Drift, Storey Stiffness, Rectangular column, Circular column, Square column, Conventional slab, Flat slab, R.C.C. frame building.

1. INTRODUCTION

A R.C.C. Frame structure is a combination of various parts such as Columns, Beams & Slabs, each one of them performing their own role in supporting the building. A Column is a vertical member and beam is a horizontal member of a building and slab acts as a platform. Here in this Review paper we are going to study about the R.C.C frame of structure having Flat slab and Conventional slab with different cross sectional shape of columns such as Rectangular, Circular, Square. In conventional slab R.C.C. Frame structure the load is transferred in such way that slab transfers its load to the beam and beam transfer it to the column and through column it transferred to the ground by footing. In case of flat slab R.C.C. Frame structure the slab directly transfer its load to the column because in flat slab there is no beam, that means slab is directly rested on columns. We are taking three shapes of column Circular, Rectangular & Square for study here each one of them will be used in separate models such as a building contain a specific shape only in a model. We are going to study through this paper that which combination of slab and column will give the best result.

2. LITERATURE REVIEW

Shital Arun Navghare, Prof. Amey Khedikar (Assistant Prof.) carried out analysis that the RCC Columns are the major component of building which carry and transfer the loads. Generally, regular (Rectangular, square or circular) shaped RCC columns are used for the construction. In order to improve the performance of traditional shaped reinforced concrete columns under the influence of Dynamic Forces (forces generated by a given ground motion), it will be replaced by the other various RCC column cross sections (L-shaped, +-shaped, T-shaped, Z-shaped) in model. The model will be executed in FEM software. The stress behavior of different cross sections of RCC columns in G+5 RCC framed structure will be analyzed by using FEM Software. The result will indicate the comparative analysis and study of regular shaped and other various shaped column cross sections. They concluded that, various methods of analysis such as pushover analysis, time history analysis and hinge formation has been studied including the finite element software for analyzing the considered G+5 RCC framed structure. The modeling and analysis of the structure is under process and result will be displayed very soon. Pushover analysis will be executed for displacement and base shear along x-direction and y-direction. **TECH CHRONICLE (ISSN NO: 2454-1958 Volume 2 : Issue 3 - May 2017)**

Vidhya Purushothaman, Archana Sukumaran carried out analysis that Due to large population and small per capita area need of tall buildings becomes more essential in the society. The limitations of the available land frequently restrict the freedom of an engineer to create a perfect structure. In such situations s the buildings will have to be designed in various shapes even with oblique corners so as to utilize the maximum benefits of available land. As earthquakes are one of the greatest damaging natural hazards to the building, the design and construction of tall structures which is capable of resisting the adverse effects of earth quake forces is the most important. Concrete-filled steel tubular columns have excellent earth-quake resistant properties such as high strength and ductility and large energy absorption capacity. The objective of this paper is to evaluate the comparison of composite columns with concrete filled steel tube and composite encased I section column. This paper mainly emphasizes on structural behavior of multi-storey building for different plan configurations like Rectangular, C, L and H shape with two different column property. It is also to compare and find which building with composite column is more effective against lateral

loads. Modeling of 15- storey buildings are analyzed using ETABS 2015. The results are tabulated, compared and final conclusions are framed. From the output of ETABS, various results are obtained. And these results are evaluated by preparing various graphs. (IJERT Vol. 6 Issue 06, June – 2017)

Harman, Dr. Hemant Sood studied about the effect of cross-sectional change of column (i.e. rectangular, square & circular shape) on unsymmetrical R.C.C. frame structure. G+3, G+7, G+11 storey buildings were designed for this study with different cross section of column and then it was analyzed by using the software Staad.pro for gravity loads as well as seismic forces with the codal provisions provided in IS-456:2000 and IS-1893:2002. The objective of this paper mainly focuses on finding out the optimum cross-section for the column involving minimum cost of the building under same loading conditions and other parameters. After optimizing the structure in software, results were recorded and have been presented in this paper. The results of the analysis show that square is the optimum shape of column for G+3, G+7, G+11 storey buildings as the total cost of the building involving the cost of concrete and steel is minimum as compared to other two cross-sections (i.e. rectangular and circular). They concluded that with variable storeys were analyzed using different cross-sections of column (i.e. rectangular, square and circular) through Staad.Pro and inferences have been made from the post-processing results including the total cost of concrete and steel. (IJERT VOL.6 Issue : 06, June- 2017)

Amit A. Sathawane, R.S. Deotale studied and determined that the FLAT slab system of construction is one in which the beam is used in the conventional methods of construction done away with the directly rests on column and the load from the slabs is directly transferred to the columns and then to the foundation. Drops or columns are generally provided with column heads or capitals. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The aim of the project is to determine the most economical slab between flat slab with drop, Flat slab without drop and grid slab. The proposed construction site is Nexus point apposite to Vidhan Bhavan and beside NMC office, Nagpur. The total length of slab is 31.38 m and width is 27.22 m. total area of slab is 854.16 sq. m. It is designed by using M35 Grade concrete and Fe415 steel. 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 Flat slab without drop and Grid slabs. They concluded that Drops are important criteria in increasing the shear strength of the slab, Enhance resistance to punching failure at the junction of concrete slab & column, By incorporating heads in slab, we are increasing rigidity of slab, Concrete required in Grid slab is more as compared to Flat slab with Drop and Flat slab without Drop, Steel required in Flat slab without Drop is more as compared to Flat slab with Drop and Grid slab. (IJERA Vol. 1, Issue 03)

K. G. Patwari, L. G. Kalurkar studied and analyzed that Tall buildings are being increasingly designed with structural system comprising of flat slab and shear wall core with or without perimeter beams. The behavior of this system under lateral loads is dependent on numerous parameters such as the height of the building, floor plate size, location of the shear wall core, flat slab spans and others. This paper studies the effect of RC flat slab with shear wall at different location for various heights of building. Shear wall with flat slab gives stability to structure as well as it improves lateral load resistance. The effectiveness of RC flat slab and shear wall building is studied with the help of three different models. Model one is a conventional building with regular slabs, beams & column framing. Model two is conventional building with various shear wall location and model three with flat slab and shear wall. Time history analysis is carried out for the structure using ETABS software. (IJER Volume No.5 Issue: 27-28 Feb. 2016)

Priyanka Vijaykumar Baheti, D.S.Wadje, G.R.Gandhe studied that The main objective of this paper is to study the behavior of flat slab structure under equivalent static analysis and compare the behavior with a shear wall panel and infill wall panel provided at center and corner of building. The analysis is carried out in E-tabs software. To achieve the objective flat slab peripheral beam provided at structure and infill wall panel and shear wall panel provided different heights such as G+4, G+8, G+12 are modeled and analyzed In this paper it is proposed to carry out static analysis to study the behavior of flat slab with peripheral beam structures till collapse and identify the weaknesses under seismic loading. The natural time period increases as the height of building (No.of stories) increases, irrespective of type of wall panel provided at different stories, flat slab structure. In comparison with the shear wall panel and infill wall panel provided to flat slab with peripheral beam of building, the time period, deflection, drift and base shear considered for analysis. For analysis seismic zone IV and medium soil condition are used. (IOSR-JMCE Volume 14, Issue 3 Ver. IV. {May - June. 2017})

Mohit Jain, Dr. Sudhir S. Bhadauria, Danish Khan studied and analyzed that comparative analysis of flat slab system and wide beam system in reinforced concrete buildings . The comparison is performed with reference to conventional moment resisting frame. A G+3 building model is selected and is modelled as conventional beam column system, flat slab system and wide beam system. These models are then analyzed for gravity loads and seismic loads. For seismic analysis, two different methods- linear static and linear dynamic are used. They conclude that two configurations of reinforced concrete building- flat slab system and

wide beam system are modelled and analyzed for their performance under gravity and earthquake loads. The RCC building model of G+3 i.e. 4 storey building is selected and above configurations are modelled in its. These models are then analyzed under gravity loads and seismic loads. For analysis under seismic loads, two different methods- linear static and linear dynamic response spectrum are used. Linear static analysis under gravity loads (dead load and live load) of building shows that the deformations are less in case of flat slab system compared to conventional and wide beam system. This is due to the reduced weight of the structure but same pattern is also observed in case of live loads. The wide beam system however shows same behavior to that of conventional building with less magnitude of deformation. From both seismic analyses- equivalent static analysis and response spectrum, it is observed that comparatively larger magnitude of lateral deformation has been observed in case of flat slab. This is due to decrease in lateral stiffness of flat slab system and wide beam system, The deformation is more pronounced in case of flat slab system. In this scenario, conventional beam is found better than other two configurations. (AJER Volume-5, Issue-10)

J. Selwyn Babu & N. Mahendran studied and analyzed that after the devastating Bhuj earthquake, the seismic design of structures is becoming more important. Earthquake induced motion is one of the sources of dynamic loads, that must be considered in the design of structures. The revised code IS 1893- 2002 (Part 1) has reclassified the zonal map of India into four zones, thus bringing more than 55% of the area under seismic zones. An attempt has been made in this paper to study the behavior of interior columns of multistoried building frames in various seismic zones. In normal practice, the interior columns of a symmetric building are designed only for axial loads using IS 456:2000 with a minimum eccentricity. But during earthquakes, higher moments are generated in these interior columns and there is no provision in IS 1893-2002 for the eccentricity to be adopted in the design of columns. Several multistoried building frames were analyzed using STAAD Pro and the eccentricities of loading in the interior columns were calculated. Based on the study, suitable equations were developed for each seismic zone to calculate the eccentricity of an interior column in symmetric buildings. This eccentricity can be adopted as the design criterion for the seismic design of interior columns. They concluded that it is observed from the e/D ratios that even in mild earthquake Zone (i.e. Zone 2), the minimum eccentricity given in IS 456 – 2000 is exceeded. The e/D ratio is found to decrease when the span is increased. In addition, the e/D ratio is found to increase from bottom storey towards the top storey. It is also found out that e/D ratio increases with the Zone Number. Equations have been developed for finding the minimum eccentricity of interior columns of multistoried building frames. This minimum eccentricity can be used as the design criterion for the seismic design of interior columns of multistoried building frames. (IJERT Vol. 2 Issue 4, April – 2013)

Disha Sahadevan ,Megha Vijayan studied about the behavior of G+9,G+14 Storied R.C. frame buildings subjected to earthquake located in seismic zone 3 with a different cross section of column of equivalent square, equivalent circular, and special shaped column (L, +, Z) by using ETAB Software and there result is such that the plan configuration of structures has significant impact on the seismic analysis of structures in terms of displacement, Storey drift, Storey shear. (IRJET Volume :04 Issue: 06 June-2017)

Sachin Rajendra Ingle studied the earthquake resistant design of structures requires that structures should sustain, safely, any ground motions of an intensity that might occur during their construction or in their normal use. However ground motions are unique in the effects they have on structural responses. In this study the seismic behavior of a frame building has been analyzed by using software called as Staad. Pro. The seismic performance evaluation of the building has been carried out by changing the sizes of the columns and also by replacing the rectangular columns with the circular columns. The buildings are designed for the gravity and seismic loadings as per IS 456:2000 and IS 1893: 2002. The analysis of the multi-storeyed building reflected that there is not much variation of base shear between the rectangular and circular building. Almost both the buildings have same base shear. This is due to the assumption of same dimensions for both buildings. Corner Edge Displacement is found to be more in the rectangular columns than the frames having circular columns. Thus, the rectangular column building will perform better with less roof displacement as compared to circular column building with same amount of loading. Storey drift is found to be more in the rectangular columns than the frames having circular columns. Thus, the behavior of rectangular column building is good as compared to circular column building. From the above points discussed we can conclude that rectangular shaped columns give good performance against earthquake as compared to circular column, hence rectangular shaped columns should be preferred as compared to circular shaped columns in areas prone to high risk of earthquake. (IJCESR Volume :04 Issue: 10, 2017)

Sumit Pahwa, Vivek Tiwari, Madhavi Prajapati studied and analyzed that a traditional common practice in construction is to support slab by beam and beam supported by column this may be called as beam slab load transfer construction technique. As due to this old traditional construction net height of room is reduced. Hence to improve aesthetical and structural aspect of multi storey, shopping mall ,offices, warehouses , public community hall etc. are constructed in such a way where slab are directly on columns. This types of slab directly supported on column termed as flat slab. The present objective of this work is to compare behavior of flat slab with old traditional two way slab. The parametric studies comprise of maximum lateral displacement, storey drift and axial forces generated in the column. For these case studies we have created models for two-way slabs and flat slab

without shear wall for each plan size of 16X24 m and 15X25 m, analyzed with Staad Pro. 2006 for seismic zones III, IV and V with varying height 21m, 27 m, 33 m and 39 m. This investigation also told us about seismic behavior of heavy slab without end restrained. They concluded that For all the cases considered drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey, Use of flat slabs with drop results in increase in drift values in shorter plans and decrease in larger plans, marginally in a range of 0.5mm to 3mm. Still all drift values are within permissible limits even without shear walls, In zone III and IV use of flat slabs with drop in place of beam slab arrangements, though, alters that maximum displacement values, however, these all are well within permissible limits, even without shear walls, Provision of part shear walls in zone V is not enough to keep maximum displacements within permissible limits, whether it is a beam slab framed structure or framed structure with flat slabs with drop. (IJLTET Vol. 4 Issue 2 July 2014)

Rasna P, Safvana P, Jisha P they studied and analyzed that in today's construction activity the use of flat slab is quite common which enhances the weight reduction, speed up construction, and economical. Similarly from the beginning conventional slab has got place in providing features like more stiffness, higher load carrying capacity, safe and economical also. For analysis material properties like grade of concrete steel, density, modulus of elasticity, must be defined initially and also various loads like dead load, live load, SDL. In this present work direct approach is adopted for manual design of flat slab and check for punching shear using software. Flat slabs are more vulnerable to punching shear because of absence of beam. Analysis of flat and conventional slab structures has been done using ETABS software. They concluded that the flat slab are generally adopted in commercial spaces since we need a larger grid spacing, aesthetic appearance and for facilitating the services. An RC Flat slab building with single storey was manually designed. Analysis of Flat slab and conventional slab were done using ETABS software. The punching shear value of Flat slab obtained from software analysis was compared with manual design, Punching shear value obtained from Direct Design Method was 0.538 MPa which was within the permissible limit. So the depth of slab is sufficient for punching around drop panel, Punching shear value of the middle strip of Flat slab obtained from software analysis is 0.63 MPa which is comparable with the manual design value The value of maximum displacement of Flat slab is less at middle strip portion and is equal to 3.3 mm. In comparison with conventional slab structure, displacement is greater than that of Flat slab. The value of shell stresses of Flat slab is lesser than that of conventional structure. Thus it can be concluded that Flat slab buildings are better option in construction. (IJSRSET Volume 3)

Pu Yang, Hongxing Liu and Zongming Huang studied that According to the current Chinese code and technical specification, some frame structures with rectangular columns and specially shaped columns are designed respectively based on the criterion of the same section area, moment of inertia, initial stiffness of the specially shaped frame structure. Using the program of fiber beam-column element based on flexibility method of finite element, nonlinear dynamic analysis is taken to analyze the two types of structures. The response of structures (such as story drift and torsion varying rules) is obtained under the fortification and rare grand motion. Still, the crack and yield rules of the main elements of the structures are compared by analyzing the stress and strain data of section fibers. So the change rules of the nonlinear seismic behavior of the two kinds of structures are obtained and some advices are provided for the seismic design of the specially shaped column structures and revising of the related specifications. (The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China)

T. Matsumoto, E. Okstad, K. Kawashima and S. A. Mahin executed experiment that Seismic performance of RC rectangular columns was clarified in comparison with interlocking spiral columns based on a shake table experiment as a part of NEES and E-Defense collaboration on bridge project. It is found from the experiment that the interlocking spiral columns and rectangular columns with cross ties performed satisfactorily under the design and ultimate level excitations. (The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China)

Kapil Verma studied that the earthquake resistant design of structures requires that structures should sustain, safely, any ground motions of an intensity that might occur during their construction or in their normal use. However ground motions are unique in the effects they have on structural responses. The most accurate analysis procedure for structures subjected to strong ground motions is the Push over analysis. Pushover analysis is based on the assumption that structures oscillate predominantly in the first mode or in the lower modes of vibration during a seismic event. This leads to a reduction of the multi-degree-of-freedom, MDOF system, to an equivalent single-degree-of-freedom, ESDOF system, with properties predicted by a nonlinear static analysis of the MDOF system. The ESDOF system is then subsequently subjected to a nonlinear time history analysis or to a response spectrum analysis with constant-ductility spectra, or damped spectra. The seismic demands calculated for the ESDOF system are transformed through modal relationships to the seismic demands of the MDOF system. In this study the seismic behaviour of a frame building has been analysed by using push over analysis. The seismic performance evaluation of the building has been carried out by changing the sizes of the columns and also by replacing the rectangular columns with the circular columns. Static type of pushover analysis is to be used in this research work where the loads consist of permanent gravity loads and incremental horizontal forces at each storey level. Capacity curves (base shear versus story total drift) obtained from static pushover analysis using commercially available software called Etabs (Etabs 2015) are used for the calculation of some seismic demand parameters. The dimensions of the buildings have been kept constant and only the column sizes have been changed.

Three different combinations of the rectangular column dimensions are taken and the non-linear response of each is evaluated by using the pushover analysis. The rectangular columns are then replaced with the circular columns of suitable dimension. The buildings are designed for the gravity and seismic loadings as per IS 456: 2000 and IS 1893: 2002. (**International Journal of Advance Research, Ideas and Innovations in Technology, Volume3, Issue3**)

3. CONCLUSION

From the Literature Review it has been concluded that Conventional slab is having somewhat good results as compare to the Flat slab the various parameters on which we are concluded are Max. and Min. Displacement, Max. and Min. Storey Drift, Max. and Min. Storey Shear, Max. and Min. Storey Stiffness. Where as in case of using shapes such as Circular, Rectangular, Square we are concluding that Rectangular one is having better results in comparison to the other shapes. So, by study I here concluded that the combination of slab and column which performed better is Conventional slab with Rectangular column.

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BIOGRAPHIES



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