REVIEW PAPER ON SEISMIC BEHAVIOR OF FLAT SLABS OVER CONVENTIONAL RC SLABS IN MULTISTORIED BUILDING

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Abstract –*Flat slab is an important part of modern construction field due to its huge advantages over conventional slab. Due to its asthetic appearance, shorter construction period, easier formwork, flexibility in the layout of room etc, the conventional slabs are being replaced by beamless slabs. The flat slabs have less stiffness and less shear strength with more flexibility feature than the conventional slabs. So, from structural engineer's point of view, flat slabs are not suitable for the high seismic zones unless it is adopted with shear wall, bracings or reetrofittings. The main objective of this paper is to review the earthquake behavior of flat slabs in different height variations, soil conditions, seismic zones etc. The different analysis has been carried out by using various methods by various authors Generally the analysis has been done by the equivalent static analysis method, response spectrum method, and time history method using different softwares like STADD PRO, ETABS &SAFE. The authors have been found focusing on the parameters like story shear, story drift, story displacement, natural time period etc.*

Key Words: **Flat slab, Drop panel, Response spectrum analysis, ETABS, Flat ground, Sloped ground, Story drift, Natural time period**

1. INTRODUCTION

Nowdays, the buildings are being constructed rapidly due to the population increment. The demand of high rise building is higher than the past decades. Along with the construction, the desires of the people have been upgraded with respect to asthetic appearance, short construction period, flexibility in the room layout, framework installation, reinforcement placement and so on. To meet the demands of people the technique of construction has been changed these days. Among different techniques, beamless slab (i.e flat slab) is one. Generally, the buildings are constructed with the conventional RC slabs which proves it to have high story strength and stiffness. But due to the several advantages of flat slabs the traditional construction of slabs are being slowly replaced by flat slabs.

The flat slab was introduced by C.A.P Turner in 1906 in U.S.A. The flat slabs directly rests on the columns and transfers the loads directly to it. It is built monolithically with the supporting columns and is reinforced in two or more directions. It can be designed and built either by conventional Rcc or post tensioning. Since it is a beamless slab, it results in plain ceiling thus providing the attractive appearance from architecture point of view. Generally the plane ceiling diffuses the light better and is taken as less vunerable in case of fire compared to the conventional RC slab. It avoids the beam column clogging and economical as the concrete is more logically used in this type of slab construction. Hence the cost is considerably low in the case of large spans and heavy load. It is a developing technique in the south asian countries where as the european countries have already stepped into it and many structures are being built day by day using flat slabs. These types of slabs are mostly used in theatres, auditorium, offices, ware houses, go downs, shopping malls, factories, mills, etc.

1.1 Components of flat slabs

Drop panel: It is the part of the slab around the column that is of greater thickness than the rest of the slab. It increases the shear strength of slab and negative moment capacity of slab. Likewise, it stiffens the slab and helps in reducing the deflection.

Column head: Whenever the diameter of the supporting column is increased below the portion of slab, this area of column with increased diameter is considered as column head. It is the local enlargement of the supporting column at the junction with the slab. It increases the rigidity and shear strength of slab. By reducing the clear effective span, it reduces the moment in the slab.

2. LITERATURE REVIEW

Navyashree k (2014) worked on the use of flat slab in multistory building situated in high seismic zones. The was carried out by considering six models of G+3,G+8 and G+12 of conventional Rc frame and flat slab building .The seismic behavior of these models were analyzed according to the increment of height under seismic forces in zone IV. It was seen that the column moment, the natural time period, lateral displacement and storey drift is more in flat slabs. The base shear of the flat plate model is less compared to conventional R.C.C building.

Muniraju k. s (2015) focused on the title comparative study of seismic analysis between conventional RC frame and flat slab with with drop. The three models G+3, G+7 and G+11 were considered for conventional RC frame and flat slab building. The Vulnerability of purely frame and flat slab models for earthquake load was analyzed in different soil conditions and seismic zones. The analysis was carried out with the equivalent static method and response spectrum method. By analysing with etabs software the conclusions were made like natural time period, design base shear and lateral displacement is more for flat slab model than conventional RC slab. The flat slab was concluded as the best option for horizontal plan irregularity.

Mohana H. S (2015) gave his effort on the G+5 model of commercial multistoried building having flat slab and conventional slab. The analysis was done by checking the parameters like base shear, story drift, axial force and displacement in all the seismic zones. After the completion of work, it was found that the storey shear of flat slab is 6% more compared to conventional slab structure and it is maximum at base and least at top storey. Similarly, design axial forces on flat slabs are higher than conventional structure and the difference of forces is nearly 5.5%.

Sayali A. Baitule (2016) carried her work on the performance evaluation of flat slab with storey height variation using pushover analysis. The three models of G+12 with different storey height variation at different storey were considered. The ground storey,7th storey and 13th (top storey) of 1st , 2nd and 3rd model was considered as 5.5m with 3m for remaining stories in zone IV. It was found that T_{eff} decreases as the large storey height floor shifted to higher level. So it is safer to provide large floor height at top storey the storey height increases with respect to storey drift also increases.

Navya Medasana (2017) worked and compared the earthquake behavior of 30 storey building with conventional beam slabs, flat slabs and alternate flat slabs as per IS 1893(2002).The parameters were focused on storey shear, modal mass, participation ratios, column forces etc. The time period of flat slab and alternate flat slab-beam slab structure was found to be almost same at 90% mass participation. Likewise, the beam slab building was to have more base shear than other considered models. The flat slab structure was found to have more response spectrum accelerations compared to other models.

Sandeep GS (2017) worked on the lateral displacement and storey drift of flat slab and conventional slab structures in different earthquake zones with type II medium soil and studied the performance of different height of buildings under seismic forces in these zones. It was found that 5 storey building with flat slab without drop panels, 10 storey and 15 storey buildings with flat slab with drop and without drop panel buildings are not appropriate for zone IV and V with respect to lateral displacement. Likewise, conventional slab building having flat slab with drop panel are not suitable for zone V with respect to lateral displacement. Further to minimize this risks, shear walls, bracings should be adopted. The conventional slab structure has more lateral stiffness than the flat slab with or without drop panel as well as the flat slab with drop has higher lateral stiffness compared to flat slab without drop panel.

Raghavendra M S et al (2017) worked on seismic behavior of high rise building on sloping ground and flat slab ground with flat slab for various soil and seismic zones. They compared the flat ground buildings and sloped ground building with flat slabs. The sloping angles considered for the dynamic analysis were 0^0, 20^0 and 30^0 which was performed by etabs software. It was observed that the time period of 30^0 sloped ground building is higher than 0^0 and 20^0.Likewise, for 20^0 and 30^0 sloped ground building, the displacement and storey drift was found to be less. The displacement was found to be maximum at top floor in III, IV and V zones whereas the max displacement can be found in zone V.

Kumar Vanshaj (2017) worked on seismic response of multistory flat slab building with and without shear wall. The objective was to investigate the behavior of flat slab multistory G+19 building without and with shear wall at core, corners and side centers of the perimeter boundary of the building in zone V by elastic time history method using etabs software. It was concluded that the performance of flat slab without shear wall was poor during earthquake excitation that of flat slab with shear wall. Shear wall was found to be very useful to decrease the storey drift index and recommended at side center in case of flat slab building.

Anusha. I. Koti (2018) made her effort on the post tensioned flat slab with drop considering seismic effect. The main objective of this work was to determine stresses, moment forces and to evaluate frequency and natural time period of the structure. The post tensioned slab with drop for equivalent frame analysis was a big concern and it was analyzed by using CSI SAFE 2016 software. It was found that the post tensioned with drop reduces the stress concentration in the column and slab junctions. Due to tensioning of flat plate slab, no effect was found on axial force at great extent but moment and shear on column increases. The moment calculated for RCC flat slab was found to be higher than the PT flat plate.

Imran B K et al (2019) analyzed the office building of G+5 with flat slab and conventional slab for Bangalore, India by using etabs software. They concluded that the flat slab is not economical at all. Due to slab thickness and size of drop panel, the quantity of concrete will be more and thus increases the construction cost to some extent.

3. CONCLUSIONS

The various research and studies shows the different merits of flat slabs .In some cases flat slabs are lacking due to its less stiffness and shear strength where as the conventional slabs steps ahead due to its less flexibility. The additional structure like shear wall, bracings and retrofiitings helps in reducing the story drift, base shear, lateral displacement to some extent. Likewise the components of flat slabs like drop panel and column heads also plays a vital role in minimizing the seismic risk to great extent. The construction of flat slab in high seismic zones is to be analysed carefully by checking the different seismic parameters like natural time period, story displacement, axial forces etc and location of shear wall is to be placed at the side center of the building to minimize the risk of damage occurred by earthquake and wind forces in the future.

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