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Seismic Analysis of High Rise Building Structure Considering Flat and Grid Slab : A Review

Paritosh Singh[1], Rajesh Joshi[2]
P.G. Scholar[1], Asst. Prof. & H.O.D.[2]
Department of Civil Engineering, R.G.P.M. Bhopal, Madhya Pradesh, India

ABSTRACT

Modern slab systems have shown great potentials in the field of conventional slab casting. Recent advances in the field of RCC Design are related to the use of Flat Slabs and Grid Floors. Flat slabs are versatile elements which are widely adopted in construction providing quick construction, minimum depth, and allowing flexible column grids. In flat slabs, the beams used in conventional slabs are taken away and the slab is made to rest directly over the columns. In case of higher loads, a drop panel or a column head may be provided to reduce the intensity of loads. They are particularly appropriate for areas where tops of partitions need to be sealed to the slab soffit for acoustic or fire reasons. On the other hand, grid floor systems consist of a large number of beams spaced at regular intervals in perpendicular directions, monolithic with slab. The rectangular or square void thus formed in the ceiling is advantageously utilized for works such as providing concealed architectural lighting. Grid floors are generally employed for architectural reasons in case of large rooms such as theatre halls, auditoriums, vestibules, and show rooms of shops where column free space is the main requirement. In this study we are review the past researches and publications describing efficiency of different type of slab over different structures. This paper will help in understanding the potential of different slab types and their utilization in structural analysis and designing.

Keywords: Flat Slabs, Grid Floors, Monolithic & SAP2000.Pro, Cost Analysis, Structure.

I. INTRODUCTION

There is an increasing demand for construction of high rise buildings due to urbanization and an ever increasing population. Earthquake is the one of the biggest enemy of such tall structures. These earthquake forces are haphazard in nature & are thus unpredictable. The designers need to acuminate engineering tools for analyzing structures under the action of these seismic forces. Thus a careful modeling of such loads needs to be done, so as to evaluate the behavior of tall structures with a clear perspective of the damage that is to be expected. To analyze the structures for different earthquake intensities and then perform checks for various criteria at each level has become an essential practice for the last couple of decades.

The constantly varying geology at different locations in our country clearly implies that the likelihood of major earthquakes taking place at various locations is different. Thus a seismic zoning map was required to identify these regions. Based on the levels of intensities sustained during past major earthquakes, the zone map divided India into 5 zones in 1970 which was later revised in 2002 to 4 zones i.e. Zones II, III, IV & V. The areas under seismic zone I of the

1970 version of the zone map were merged with the areas under zone II.

To provide a past work done related to slab flexibility in its entirety would be difficult to address here. Although there has been a lot of work modeled as fully rigid diaphragms in reinforced concrete structures ranging from analysis assumptions to design recommendations – no one provide in-depth understanding of the seismic response of reinforced concrete (RC) buildings contributions related to grid slab and flat slab diaphragm and past efforts most closely related to the needs of the present work. A brief review on diaphragm flexibility and code provision of previous studies is presented here. This literature review focuses on flexibility of grid and flat slab diaphragm in reinforced concrete structures and some code provisions will be addressed by area.

II. LITERATURE SURVEY

Mondala & Jain (1984) [15] Studied analytical method for resisting dynamic analysis by considering walls and slabs as beams and than determine the effect of slab stiffness, here different shapes of irregular geometry of buildings are taken and concluded that slab and wall stiffness can be included as a useful design tool for dynamic forces.

Kunnath & Panashahi (1991) [14] Studied the in-plane adaptability of slab-section frameworks has been seen to impact the seismic reaction of many sorts of strengthened RC structures. The suspicion of unbending floor slabs is frequently used to rearrange designing investigations without huge misfortune in the exactness of seismic reaction forecast for generally structures. In any case, for specific classes of structures, for example, long and limit structures (particularly with double propped parallel load opposing frameworks), and structures with level (T or L-formed) or vertical (difficulties or cross-dividers) balances, the impact of slab adaptability can't be dismissed. This paper displays a disentangled full scale demonstrating plan to consolidate the impact of inelastic floor adaptability in the seismic reaction examination of RC structures. The piece show incorporates impacts of both in-plane flexure and shear. The inelastic conduct of slabs is accentuated through an investigation of restricted rectangular structures with end dividers. The investigation demonstrates that the in-plane redirections of floor sections force a bigger request on quality and pliability of adaptable casings than anticipated esteems utilizing the presumption of unbending or flexible pieces. These requests may thusly prompt a disappointment of the gravity stack supporting framework.

Hawary (1994) [13] Explores the significance of including the impacts of the adaptability of the level slabs when utilizing the P-delta technique for examination, particularly while considering the heaps connected to middle of the road outlines on trusses that are not some portion of the sidelong power opposing framework. Examinations were led for auxiliary frameworks with a variable number of stories, number of coves and slab firmness and bolstered by inflexible jointed plane edges or vertical trusses.

Kappos & Bull (2002) [12] Has examined the relative accuracy of elastic frame models for unreinforced masonary buildings in 2dimensional and 3 dimensional structure considering pushover analysis for lateral load with and without Slab effect and analyzed for both equivalent frame and finite element frame. He found that the effect of slab is valid in 3-d model only since action is in the plane normal to the walls thus 2-d model have negligible effect.

Bari et. al. (2004) [10] has taken a finite element analysis method for slab to compare with other conventional method of analysis, also developed a computer program to analyze the finite element equations and considered rigid structure. He observed

that results using finite element mesh is deviating by approx 20% than analytical results. states that more refined slab mesh is required to have accurate results

Barron and Hueste (2004) [8] Examined under seismic stacking, floor and rooftop frameworks in fortified cement (RC) structures go about as slabs to exchange sidelong quake burdens to the vertical horizontal power opposing framework (LFRS). In current practice, even slabs are regularly thought to be unbending, along these lines ignoring the impact of their in-plane development in respect to the vertical LFRS. The target of this examination is to assess the effect on in plane slab twisting on the auxiliary reaction of regular RC rectangular structures utilizing an execution based approach. Three-story and five-story RC structures with end shear dividers and two perspective proportions (around 2:1 and 3:1) were created and outlined by current code strategies accepting unbending slab conduct. The execution based plan criteria laid out in the FEMA 273-NEHRP Guidelines for Seismic Rehabilitation of Buildings were utilized to survey the sufficiency of the four contextual analysis structures when slab adaptability was incorporated into the basic reaction

Gardiner et. al. (2008) [6] Researcher investigates the magnitude and trends of forces in concrete floor diaphragms, with an emphasis on transfer forces, under seismic loading. This examination thinks about the accompanying things: inertial powers which create from the speeding up of the floor mass; exchange powers which create from the connection of parallel power opposing components with various distortion designs, for example, divider and edge components; and variety of exchange powers because of various qualities and solidness of the basic components. The size and patterns of powers in the floor slabs have been resolved utilizing 2-dimensional inelastic time history examination.

Ozturk et. al (2008) [5] watched that the effects of piece composes on the direct of load passing on systems are inspected on multi-story reinforced strong structures under seismic weights as demonstrated by the principles and controls of the present Turkish Earthquake Code (TEC) specifically, detail for structures to be worked in a disaster districts. Segment openings in floor structures may cause abnormalities in the level plane as showed by the shudder code. Examination of the case in which the piece openings are surrounded close to the vertical load passing on parts is in like manner included. He gathered that The unbendable slab indicate is usable when in doubt for helper plot. Every so often, it may be imperative to use the versatile segment illustrating

Sathawane & Deotale (2012) [9] 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 sqm. 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

More et. al. (2013) [3] Observed that when slab stiffness are taken as rigid. M25 grade of concrete was

used. Axial deformation was considered for vertical members. Torsional impact was considered according to May be 1893:2002.Seismic investigation was performed utilizing Response Spectra strategy according to IS1893:2002.Moment opposing conventional edge was consider for every one of these structures in seismic zone III. Also, they watched restricted harm shows up in the event of Set-back building. Additionally investigation of monetary cost for inclining soil and different measures are should be examined. Removal of best story is most extraordinary for Step back building. On slanting soil Setback-Step back building is favored.

Chourasia et. al. (2015) [2] Studied the effect of bracings at different position of the structure and compared it with rigid diaphragm structure under dynamic loading, using analysis tool SAP2000and concluded that rigid diaphragm is comparatively more effective in reducing lateral forces also making the structure cost effective in terms of reinforcement steel.

Pradeep et. al (2016) [1] contemplated the strategy to neutralize parallel powers following up on a building outline by acquainting inflexible slab with the structure additionally take a gander at the three conditions of rigid slab, semi firm slab and with no area, to make sense of which one is more beneficial and derived that use of unyielding slab is more effective than other condition in regards to column and section controls and dislodging.

Kaulkhere & Shete (2017) [16] Flat slabs are now a days becoming more popular and they are economical as compared to beam-column connections. RC frame buildings are commonly used for the construction. The use of flat slab building provides many advantages over RC frame building in terms of architectural tractability, use of the space, easier formwork under earthquake loads. In the present work flat slab building of G+8 storey building models are considered. The design of flat slab building with direct design method and also we have discussed the results obtained by performing Non-linear pushover analysis on flat slab building of various shapes and different types also by using software ETAB2015. To improve performance of building,it is necessary to analysis the seismic behaviour of building, provision of flat slab with drop and without drop on the performance of these two types of buildings. As per IS 456:2000 codes provisions present work gives the information on the parameters max strip moments, base shear, max storey displacement and storey drift.

Bhaduria & Chuggani (2017) [11] Structural Engineering is a branch of Civil Engineering where the study is done to know how the structure behave when building is constructed at real environment and to identify the various forces like axial force and shear force, bending moment and displacement etc. acting on the structure. When the analysis come to complex structure or multistory structure the manual calculation will be difficult to perform and hence there is various software available to perform these calculations, this software are STAAD Pro V8i, ANSYS, ETAB, SAP-2000 etc. In this study, slab system design and analysis for G+10 building for seismic zone III and having medium soil condition by using STAAD Pro V8i and these slab system analyzed for different plan area or grid size/ spacing of the column. The analysis and design of slab system is done as per IS 456-2000 and IS 1983-2002. Design of the slab system is done for different spacing/ grid size of column to find out which grid size of the column or plan area which slab is economical.

Patel &Padamwar (2017) [4] Modern slab systems have showed potentials for improvement in the conventional techniques of slab casting. Recent advances in the field of RCC Design are linked to the use of Flat Slabs and Grid Floors. Flat Slabs are highly versatile elements widely used in construction, providing minimum depth, fast construction and

allowing flexible column grids. In flat slabs, the beams used in conventional slabs are done away and the slab is made to rest directly over the columns. In case of higher loads, a drop panel or a column head is provided to reduce the intensity of loads. Flat slabs are particularly appropriate for areas where tops of partitions need to be sealed to the slab soffit for acoustic or fire reasons. Grid floor systems consist of beams spaced at regular intervals in perpendicular directions, monolithic with slab. The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. 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. This work focuses on studying the behavior of conventional slab, flat slab and grid slab separately. A comparative study was done to identify the best slab system.

Harish et. al. (2017) [7] Grid floor/Ribbed floor slab consists of beams spaced at regular intervals in perpendicular directions which are monolithic with slab. These slabs are generally used for architectural purpose for large spans such as public assembly halls, auditoriums; show rooms were the slab has to cover a large column free space is required. Since gird slab offers more stiffness the rectangular voided pattern is used in present study. In the present study G+4 building is considered, analyzed and designed for both gravity, seismic and wind loading conditions as per IS codes. The structure is analyzed using ETABS software and design has been done manually. Analysis with respect to seismic activity majorly involves Equivalent method and Response spectrum method.

Srinu & Kumar (2018) [17] An endeavour has been made to evaluate the two way rectangular orthotropic slab with interior Enclose opening with one short boundary intermittent slab using yield line theory. Keeping in view the basic principles of yield line theory, all possible yield line patterns are considered for the given configurations of the slab subjected to uniformly distributed load (udl). A computer program has been developed to solve the virtual work equations derived in this paper. Relevant tables and charts for given data and the governing admissible failure patterns of the slab for different sizes of openings are presented using the affine theorem. In this paper, the authors also present the transformation of orthotropic slab into an equivalent isotropic slab using the affine theorem. The analysis is carried out with aspect ratio of opening quite different to that the slab.

III.CONCLUSION

- It is clear that the use of flat slab and Grid slab has shown better performances as compared to the conventional two-way slabs.
- However a detailed study is required based on the structural performance of the two slab systems.
- In the past, researchers have done studied the shear behavior of grid and flat slabs extensively.
- But a model study of both these slabs for a particular site, in comparison with a conventional slab, will provide us with the exact figures.
- The present study suggests designing three frames each with conventional, grid and flat slab systems and comparing the structural performances of each

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