International Journal of Civil Engineering Applications Research (IJCEAR)
ISSN : 2249-653X
Vol. 3, No. 1, (2022), pp. 15-19

Seismic Analysis of building Structures with different Slab arrangements by using ETABS Software

Chandan Kumar Chandravanshi[a], Ramanuj Jaldhari[b]
[a]M.Tech Scholar, Department of Civil Engineering, KITE, Jaipur
[b]Assistant Professor, Department of Civil Engineering, KITE, Jaipur
E-mail Id: chandanchandravanshi123@gmail.com[a], rd01586@gmail.com[b]

Article Received: 07 October 2022; Revised: 18 November 2022; Accepted: 16 December 2022

Abstract

As the advancement in the world is occurring use of software in every field has become prominent and with the help of software we are able to give results as fast as possible. Now a days using various software in the field of civil engineering, in which one of the software is ETABS which is used to design and analysis of building structures. Analysis is process to observation of behavior of structures under different load combinations. Design is the process of finding appropriate specification of structures. Recently it has been observed that many concrete structures have collapsed or damaged due to earthquakes. In this paper, presents a seismic analysis of building structures with different slab arrangements i.e. conventional slab, flat slab with drop panel and flat slab without drop panel. The effect of seismic forces on building having eleven stories (G+10), and twenty-one stories (G+20) with different slab arrangements are analyzed by ETABS software 2016 version. Analysis and design of building structures have done as per IS 456:2000, grade of concrete is M30 and grade of steel Fe-500 are adopted. It determines the critical design loading for multistory buildings situated at Patna subjected to earthquake zone IV. In the present study the response of multistory buildings are analyzed with earthquake loads based on IS 1893:2016. There are several concerns play important role to behavior of structures which are storey drift, storey displacement and storey shear. After comparison with these results concerns, we decide better arrangement of the building structures.

Keywords*: Conventional slab, Flat slab, Drop panel, Storey response, multi-storey building, Seismic zone IV.*

1. INTRODUCTION

Metropolitan regions have produced vertical construction in the form of low-rise, medium-rise, and high-rise building constructions. Modern buildings of this type typically use frame constructions with different slab arrangements, such as flat slabs with drops, flat slabs without drops, conventional slabs, flat slabs with peripheral beams, grid slab systems, etc. The impact of lateral load always increases along with the peak of the demand building. Vertical masses or loads do not compare to lateral masses or loads in terms of impact strength. These lateral masses, also known as lateral loads, are typically wind and seismic loads. The tendency of lateral forces or lateral loads is to tilt the building body in the direction of the applied lateral force. If production is not given the proper measurement and the proper intended parameters are not followed by way of means of the proper perceptions, structures in numerous seismically inclined places or sloping areas are always at risk of collapsing. Reading the results of an earthquake or seismic mass is crucial because of all those studies. Sometimes an exceptional earthquake with exceptional magnitudes and intensities occurs at an exceptional location. It is crucial to consider a number of seismic factors, such as storey shear, storey drift, and storey displacement. The seismic response of a building's structure must therefore be analyzed by seismic assessment, a building's layout that does not consider seismic evaluation should not be chosen, especially in earthquake-prone areas. Due to the high pace of population increment or growth, buildings are now being constructed quickly. Due to metropolitan areas taking up less space than in previous decades, there is a greater demand for high rise buildings. Along with building, people's preferences have evolved in terms of aesthetic value, speedy construction, flexibility in room layout, installation of structural elements, placement of reinforcement, and other factors. People's preferences and likes about construction methods have evolved recently in accordance with the situation's needs and expectations. The flat slab method is one of the various beamless slab construction methods that is most frequently adopted. The conventional RC slab, which has high story strength and stiffness compared to any beamless slab, is typically used to create structures. However, because to the numerous benefits of flat slabs, the conventional construction of slabs is gradually being replaced by flat slabs day by day. There has been a noticeable increase in the number of tall buildings structures relative to less storey building structures for both residential and commercial purposes because of the increased demand for land everywhere in urban areas. The modern trend is towards the taller building structures for this reason. Building structures is not a reasonable solution given the population growth rate and the absence of horizontal expansion. Therefore, building multi-story complexes on the available land at any cost is the only way to meet the expanding demand. A new generation of tall structures that are flexible, low in damping, thin and light in weight, and more durable has emerged as a result of the development of high strength concrete, higher grade steel, new construction processes, and enhanced computational technique. In general, building high rises has proven essential for urban development. As a response to the expanding population and increased demand for housing for the growing population, the demand for multi-story buildings has expanded dramatically. There is little doubt that when a structure's height rises, the forces acting on it, such as lateral forces like seismic forces, will rise as well. A tall structure's column loading may be of a larger order than that of a low rise building due to the accumulation of gravity loading across a large number of storeys. The accumulation of a tall building's load into considerably greater structural pressures makes it different from a low rise building's burden. It is imperative to design the structure preferably for lateral forces such as wind and seismic forces, moments, story drift, and total horizontal deflection at the topmost storey level since the height of the tall building structures affects the stiffness and stability of the structure. In general, unexpected dangerous events like earthquakes and cyclones cannot be forecast in advance. Planning and developing building structures in metropolitan areas with great attention is the only way to make it through this disaster. Because of how high a structure is, lateral forces caused by seismic activity have a significant impact on the structural design. High rise building structure has to resist to overturning moment and lateral deflection i.e. storey displacement, storey drift caused by lateral forces like earthquake and wind forces in addition to the gravity loads acting on the building structures. The main objectives of the study are, the structural performance of both flat slab and conventional slab structure are subjected to various loads and conditions, behavior of both flat slab and conventional slab structures for the parameters like lateral displacement, story drift and storey shears by using ETABS software, and the important goal of this study is the analyze, and layout of a constructing with one of a kind slab preparations like as Conventional slab, Flat slab with drop panel and Flat slab without drop panel.

2. METHODOLOGY AND BUILDING DESCRIPTION

In this research paper, there are many techniques used in the design and analysis of building structures for seismic analysis. The results of seismic analysis are provided separately for each method. The first method is Static seismic analysis: linear static seismic analysis (Equivalent static method), and Non-Linear static seismic analysis (push over analysis). The second method is Dynamic seismic analysis: Linear dynamic seismic analysis (Response spectrum method), and Non- Linear dynamic seismic analysis (Time history method). A structure of G+20 i.e. twenty one storey and G+10 i.e. eleven storey reinforced concrete residential building is analyzed by linear equivalent static method. In this research the building is considered with various slab arrangement i.e. (flat slab system, flat slab with drop panel system, conventional slab system). The building's length is 56 meters and its width is 56 meters. 63.5 m is the building height for twenty one storey i.e. G+20 and 33.5 m is the building height for eleven storey i.e. G+10 storey building All supports are considered as fixed condition. Column size is 800 X800 mm. Analysis of G+20 and G+10 building in zone IV for earthquake forces are carried out.3D model are prepared for G+20 and G+10 building is in ETABS.

3. MODELING

The lateral load analysis is done using the E-TABS software, which is also used to create 3D models. The lateral loads that must be applied to the buildings in the form earthquake loads are based on Indian specifications. Every seismic zone has a study conducted in accordance with IS 456:2000 (Dead load, Live load), and IS 1893:2002. (Earthquake load). The model data of structures are given below:

Common Structure Model Data	
No. of grid lines in X- direction	8
No. of grid lines in X- direction	8
Spacing of grid lines in X- direction	8 m
Spacing of grid lines in X- direction	8 m
Bottom storey height	3.5 m
Typical storey height	3 m
Grade of concrete	M30
Grade of steel (longitudinal bar)	Fe-500
Load Intensities on Slab	
Dead load on slab	3 KN/M^2
Live load on slab	5 KN/M^2
Seismic zone Intensities	
Seismic zone	IV
Seismic Zone Factor (Z)	0.24
Response Reduction Factor (R)	3
Importance Factor (I)	1.2

Conventional slab	
Common Structure Model Data	
Thickness of slab	150 mm
Grade of steel (confinement bar)	Fe-250
G+20 storey	
Beam Size	450 mm x 900 mm
Column Size	800 mm x 800 mm
G+10 storey	
Beam Size	400 mm x 750 mm
Column Size	600 mm x 600 mm
Flat slab with or without drop	
Common Structure Model Data	
Thickness of slab	200 mm
Grade of steel (confinement bar)	Fe-415
G+20 storey	
Column Size	800 mm x 800 mm
G+10 storey	
Column Size	600 mm x 600 mm
Flat slab with drop	
Size of drop	2 m

The plan of conventional slab and flat slab without drop and flat slab with drop as shown in Fig. 1.

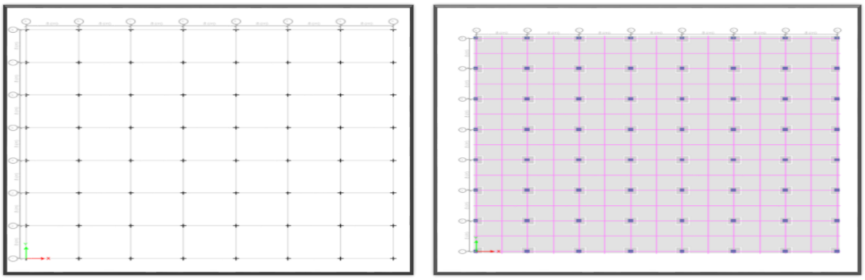


Fig.1: Plan view of slab

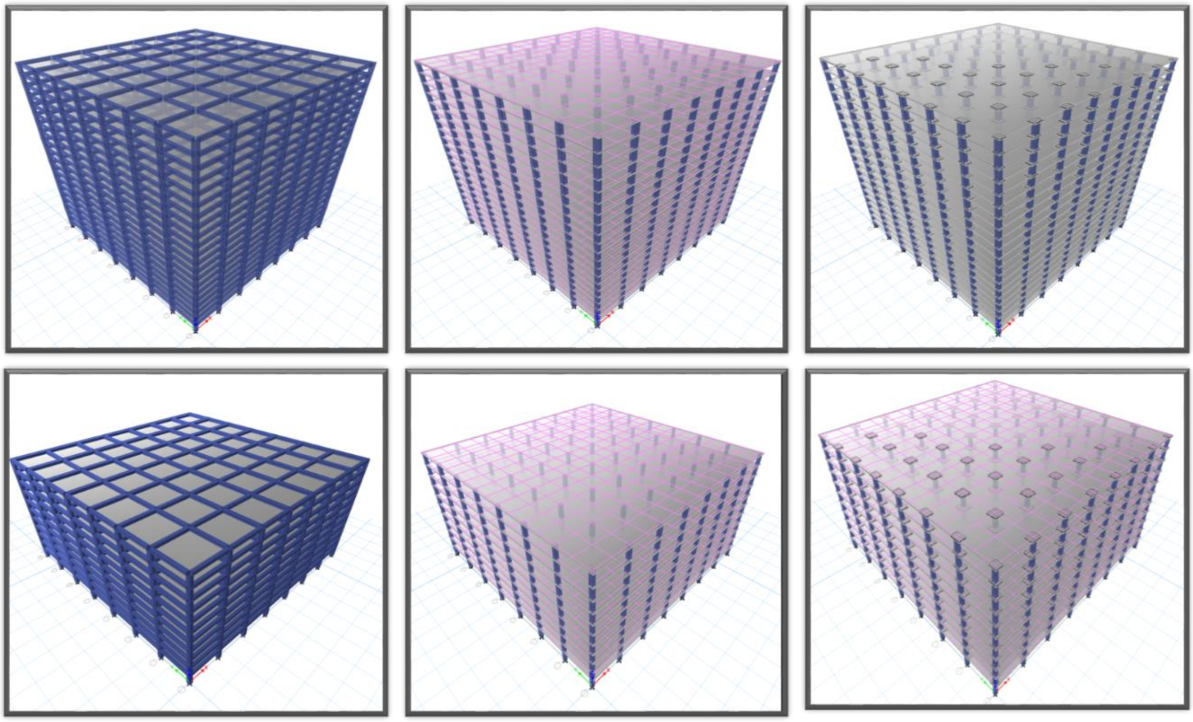
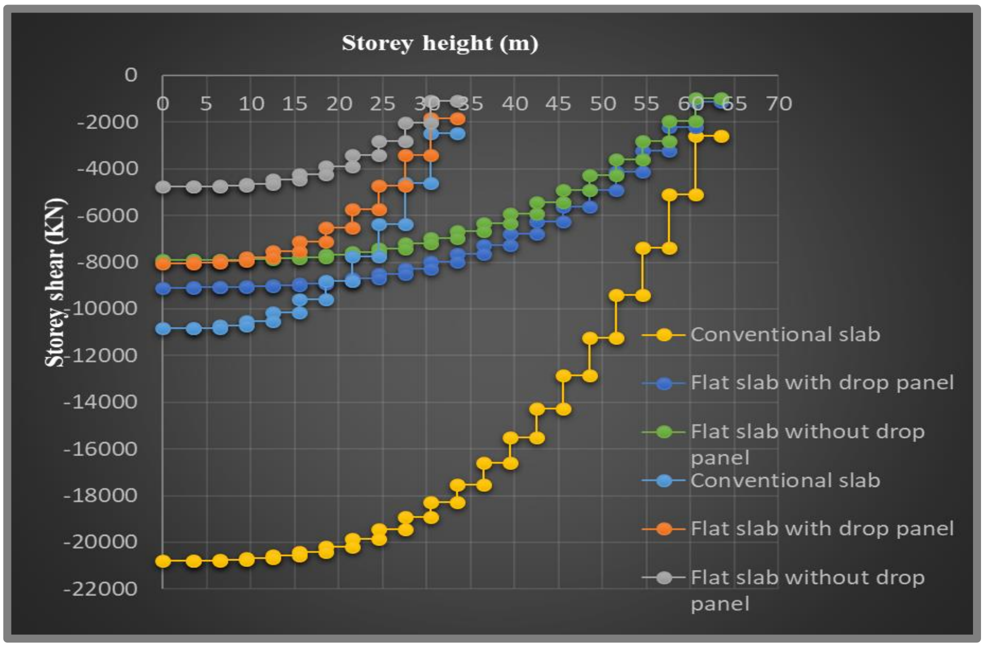


Fig. 2: 3D Rendered view of G+20 conventional slab, G+20 flat slab without drop, G+20 flat slab with drop, G+ 10 conventional slab, G+10 flat slab without drop, and G+10 flat slab with drop

4. RESULTS

The lateral forces acting on the structure such as earthquake forces produce a sway movement of the building as a result the structure produces lateral displacement of the building.



The maximum forces that could act on the building when subjected to the lateral forces are the storey shears. The effect of the lateral forces on the building are compared according to the storey displacements, storey drifts and storey shears. The effect is studied based on the comparison of lateral displacements and storey drifts in terms of the forces and a graphical representation is made to explain the impact of these forces.

5. CONCLUSION

On the basis of above study in which G+10 and G+20 multistorey buildings have been taken in to consideration for different slab arrangements i.e. Conventional slab, Flat slab with drop panel and Flat slab without drop panel. The parameters which are taken for comparing the models are storey displacements, storey drifts and storey shears. From the modeling and analysis of these building, following conclusions are drawn out.

- Storey displacement is maximum for Flat slab without drop panel and minimum for conventional slab structures. Storey displacements increases with increase in storey height for all cases.
- Building having Flat slab without drop panel structure shows highest value of storey displacement among all three cases for G+10 storey, which is almost 2.4 to 2.5 times of the lowest storey displacement shown by building having Conventional slab.
- Building having Flat slab without drop panel structure shows highest value of storey displacement among all three cases for G+20 storey also, which is almost 5.4 times of the lowest storey displacement shown by building having Conventional slab.
- For G+10 storey, the storey drift is highest for Flat slab without drop panel at fourth storey and lowest for Flat slab with drop panel at third storey, which is almost 1.6 to 1.7 times of the lowest drift shown by Flat slab with drop panel.
- For G+20 storey, the storey drift is highest for Flat slab without drop panel at eighth storey and lowest for Conventional slab, which is almost 5.8 times of the lowest drift shown by Conventional slab.
- Storey shear is maximum for Conventional slab and minimum for Flat slab without drop panel. The value of storey shear is decreases with increase in storey height.

- Building having Conventional slab structure shows highest value of storey shear among all three cases for G+10 storey, which is almost 2.2 to 2.3 times of the lowest storey shear shown by building having Flat slab without drop panel.
- Building having Conventional slab structure shows highest value of storey shear among all three cases for G+20 storey, which is almost 2.6 to 2.7 times of the lowest storey shear shown by building having Flat slab without drop panel.

6. FUTURE SCOPE

There are few investigations to be performed for the study and are explained as below:

1. The focus of the current study is mainly on how seismic forces affect flat slab structures without any lateral force-resisting infill components. We must analyze structures with infill elements that either resist the lateral displacement of the structure or do not resist the movement in order to gain in-depth knowledge about structural behavior.
2. To prevent irreparable damage to the lives of animals and humans as well as other economic and strategic losses, damage types and critical damage points must be studied.
3. While flat slabs are an efficient solution for multi-story buildings without beams, but they are not frequently used in Indian construction.
4. Predicting the behavior of flat slabs and conventional slabs under seismic loads using Static Linear Seismic Analysis Method.
5. Comparison of a flat slab having a drop panel with flat slab without drop panel can be done for different seismic zones.
6. It would give people enough knowledge and assurance to choose flat slabs for future construction in India. As a result, the study can be considered before designing a building.