Seismic Response of Multistorey Flat Slab Building with Shear Wall using ETABS

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***Abstract*— The floor system of a common type of concrete building is a flat concrete slab (without supports).This system is really easy to construct and efficient in that regard. It stipulates the optimum height of the building for a specified number of stories. Currently, the flat slab method is frequently utilised in construction. It allows for greater architectural flexibility space, low building height, easier formwork, and a quicker construction period, construction time. Furthermore, Flat slab building structures much more adaptable than conventional concrete as there are no beams present. They are more susceptible to harm earthquakes. The purpose of this research is to examine the behaviour of a G+9 flat slab structure with shear wall. The normal lateral behaviour of a flat slab construction is analysed using dynamic analysis utilising the ETABS software by response spectrum method. The effectiveness and functionality of Indian standard code in seismic zone III has been observed.**

Keywords—Flat slab, Shear wall, ETABs, Linear Time history Analysis

I. Introduction

An earthquake (also known as a quake, tremor, or temblor) is the severe shaking of the Earth's surface, which can destroy huge structures and kill thousands of people. Earthquakes have been recognised as one of the most devastating natural disasters for centuries. Malls, theatres, and other constructions that require broad beam-free zones are constructed with flat slabs. Flat slab construction requires shear walls when earthquake resilience is considered. IS 1893 Part1:2002 permits the construction of flat slab structures to resist both vertical and lateral stresses in areas of low seismicity (Zone II). In zones III, IV, and V, however, the code prohibits the construction of flat slabs without a lateral load resisting system or lateral force resisting system. In this research, modelling and analysis of the seismic response of a ten-story (G+9) flat slab multi-story building with a shear wall were conducted. Shear walls are installed at the building's corners and in the middle, and then the model's efficiency and serviceability under Indian standard circumstances in seismic zone 'V' are evaluated.

A. Flat Slab

Flat slabs are preferred by architects and clients due to their aesthetic and financial benefits. Although this type of reinforced concrete construction has a number of advantages over framed structures, it also has a number of problems due to the brittle punching failure at the slab column junction and the considerable horizontal deformation. Many researchers argue that flat slabs used in higher seismic zones should be built to resist solely gravity loads, while lateral loads should be transferred by a system resistant to lateral force. The column itself or a column capital and drop panel can support a flat slab. Due to the lack of frame action, which causes excessive lateral deformation, the performance of flat slab buildings under seismic loading is inferior to that of framed structures. The most vulnerable component of a flat slab construction is the slab column joint. The behaviour of flat slab column connections has been the subject of extensive research. The mode of failure is dependent on the type and quantity of loading. Punching shear strength of slab column connection is essential and is heavily dependent on gravity shear ratio. A punching failure of a flat slab may come from the transfer of shearing force and an imbalanced moment between the slab and column.

B.Shear Walls

Shear walls are one of the most prevalent lateral load-resisting systems seen in high-rise buildings. Shear walls have great in-plane stiffness and strength, allowing them to resist huge horizontal loads and support gravity loads simultaneously.

Buildings utilise R.C. shear walls to resist lateral forces caused by wind and earthquakes. Typically, they are installed between column lines, in stairwells, liftwells, and shafts housing other utilities. Shear walls provide lateral load resistance by transmitting wind and seismic loads to the base. In addition, they offer lateral rigidity to the system and support gravity loads. They are widely employed to prevent the collapse of tall buildings. International Research Journal of Engineering and Technology (IRJET) Shear wall may become inevitable from an economic and control of lateral deflection standpoint. When shear walls are strategically placed in a building, they can form an effective system for resisting lateral forces. Numerous construction rules mandate the installation of these barriers to make homes safer and more sturdy.

The column-slab system of a flat slab building is designed to resist both gravity loads and earthquake-induced lateral inertialoads. Due to the low lateral stiffness and lateral load resistance of the column-slab system, the columns are incapable of accommodating the additional secondary moments generated by the large lateral drift of the flat slab building.

Consequently, there are significant problems with the usage offlat-slab buildings in seismic zones IV and V.

Attempts were made to compensate for this lack of capacity in flat slab structures by lowering overall lateral deformation and so improving their overall lateral resistance by adding structural walls as a supplemental lateral load resisting system(LLRS).

Fig 1. *Flat slab with drop panel and column head*

II. METHODOLOGY

Analytical research of the models dealized linear timehistory approach was carried out to analyse the seismic

dealize of flat slab building with shear wall. ETAB software was used to conduct the analysis. Only the maximum values are used in the response spectrum method for calculating other parameters such as displacement and member forces.

A. Modeling

The fundamental goal of structural analysis of building structures is to determine the distribution of internal forces and moments across the entire structure or a portion of it, as well as to identify essential design conditions in all sections. The geometry is frequently dealized by

imagining the structure to be composed of linear and plane two-dimensional parts. The ETABS application is used to do nonlinear dynamic time history analysis in order to acquire the modal properties.

- **Properties**

The properties of various materials used are shown in the table.

TABLE I. MATERIAL PROPERTIES

Name	Type	**E** MPa	ν	**Unit Weight** kN/m³	Design Strengths
A416Gr270	Tendon	196500.6	0	76.9729	Fy=1689.91 MPa, Fu=1861.58 MPa
A615Gr60	Rebar	199947.98	0.3	76.9729	Fy=413.69 MPa, Fu=620.53 MPa
HYSD500	Rebar	200000	0	76.9729	Fy=500 MPa, Fu=545 MPa
M30	Concrete	27386.13	0.2	24.9926	Fc=30 MPa
Mild250	Rebar	200000	0	76.9729	Fy=250 MPa, Fu=410 MPa

The shear wall is modeled with a thin shelled element usingM30 grade concrete at a depth of 250mm.

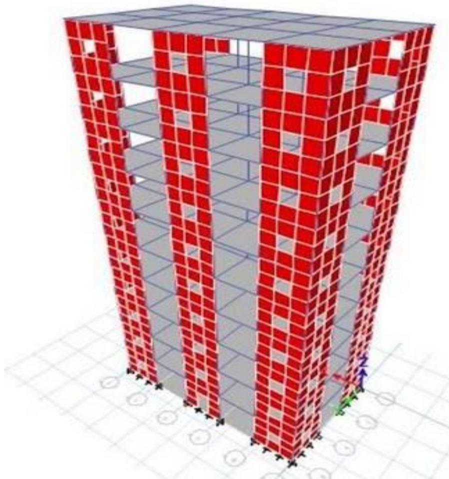


Fig 2. *3D View of model*

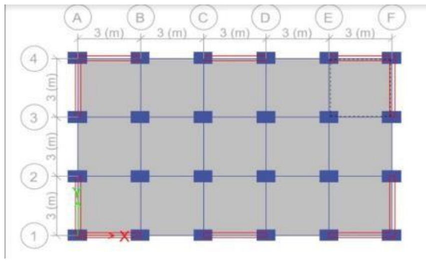


Fig3. *Plan view of the model*

B. Analysis

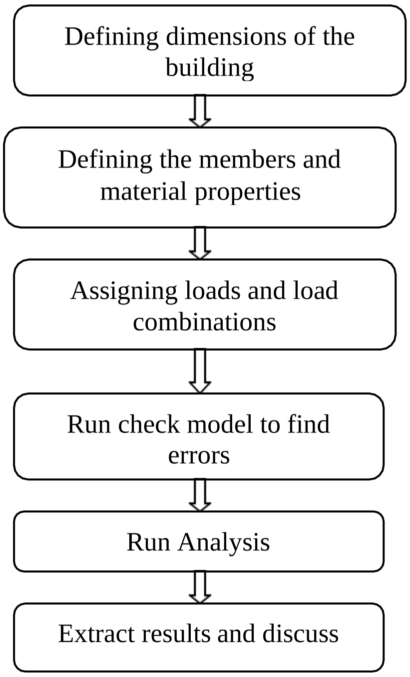
- Response spectrum method

Response spectrum analysis is a method to estimate the structural response to short, nondeterministic, transient dynamic events. Examples of such events are earthquakes and shocks. Since the exact time history of the load is not known, it is difficult to perform a time-dependent analysis. Due to the short length of the event, it cannot be considered as an ergodic ("stationary") process, so a random response approach is not applicable either.The response spectrum method is based on a special type of mode superposition.

The idea is to provide an input that gives a limit to how much an eigenmode having a certain natural frequency and damping can be excited by an event of this type.

The analysis of flat slab structure has been done by using ETABS 2016 software package. Before analysis all the required elements of the structure needs to be defined earlier like material properties, loads, load combinations, size of members, response spectrum function etc. once the analysis has been done we can extract the results like displacement,storey shear, storey drift , drift ratio, storey stiffness for comparing the performance of all models. The

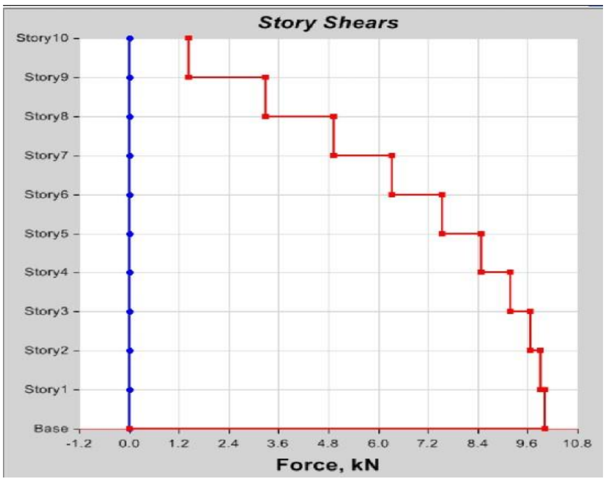
flow chart shows the steps involved in the analysis of ETABS.



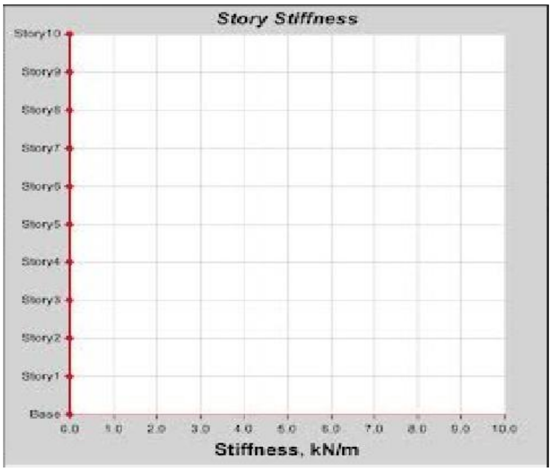
III. RESULTS

This section defines about detail discussions of software results of flat slab building model with shear wall with respect to storey shear, storey stiffness, storey displacement, storey drift etc

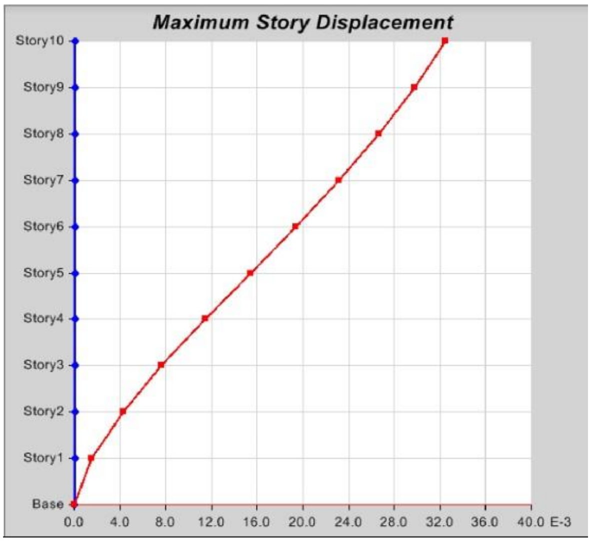
A. Storey Shear



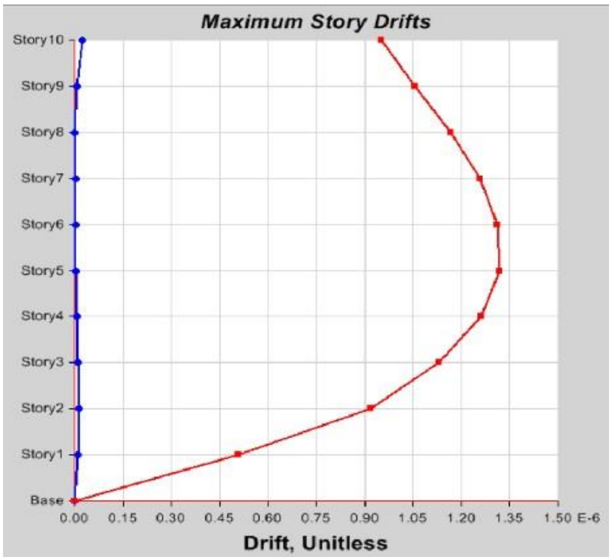
B. Storey Stiffness



C. Storey Displacement

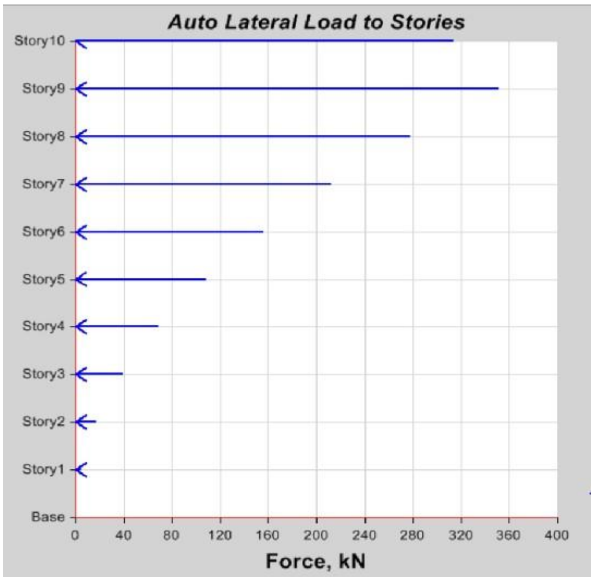


D. Storey Drift



E. Storey Overturning Moment

F. Auto Lateral Loads



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IV. CONCLUSION

This study examines multi-story flat slab construction. G+9 building with shear wall at corners and middle of the building. Based on analysis following findings have been drawn for the structural framework of a flat slab.

- To increase the performance of the flat-slab structure under horizontal loads, particularly when speaking about seismically prone areas modifications of such system can be done by adding structural elements such as RC shear wall.
- From the results obtained from the analysis a multistory flat slab building with shear wall at corners and middle is safer and recommended than the one having shear wall at core or centre.

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REFERENCES

[1] Analysis and design of flat slab: Professor, Department of Applied Mechanics, Walchand College of Engineering, Sangli, Maharashtra, India
[2] Dr. Uttamashagupta et.al, "Seismic behavior of buildings having flat slabs with drops". International Journal of Emerging Technology andAdvanced Engineering website:
[3] www.ijetae.com (ISSN 2250-2459, volume 2, issue 10, October 2012).
[4] Ms. Navyashree K and Sahana T.S "Use of flat slabs in multi-story commercial building situated in high seismic zone". IJRET: International Journal of Research in Engineering and Technology2014.
[5] Mrs.Sumitpahwa et.a1, "Comparative study of flat slab with old traditional two way slab". International Journal of Latest Trends in Engineering and Technology (IJLTET)2014.
[6] Pushover Analysis of Existing 4 Storey RC Flat Slab Building A. E. Hassaballa , M. A.Department of Civil Engineering, Jazan University, Jazan, KSA$_a$
[7] Performance of Flat Slab Structure Using Pushover Analysis Dhananjay D.Structural Engineering Department, Govt. College of Engineering Aurangabad,
[7] Seismic Behaviour of Flat Slab Systems Pradip S.Landel, Aniket B. Raut Associate Professor Government College of Engineering, Amravati Maharashtra, India
[8] IS:456-2000-code of practice for plain andreinforced concrete