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Study of a Flat Slab Building with a Shear Wall at Periphery and X-Bracing

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Abstract: Flat slab construction practice faces great risk during severe earthquake shaking. In the study two different types of flat slab buildings are taken into account; flat slab with shear wall at X-Bracing and flat slab with at periphery. This lateral force resisting mechanism strengthens structural stiffness of these flat slab structures. It is observed that the lateral force resisting capacity of flat slab structure increases significantly with the use of shear wall.
Keywords: Shear wall, X-Bracing, pushover, at periphery, ETABS software, seismic response.

I. INTRODUCTION

Seismic activity is one of nature's most damaging phenomena, and their occurrence is often unforeseeable. The Traditional RC Frame structures are extensively utilised for construction in today's world. Flat slab construction has significant benefits over traditional RC Frame construction in terms of architectural freedom, space use, ease of form work, and construction speed. Earthquake are mostly caused by tectonic and volcano activity so, it is our responsibility to fulfil the provision of earthquake resistant design IS1893 and IS13920 should be completely adhered. Here in this paper two different types of flat slab buildings are taken into account.

The behaviour of flat slab building with 2 models were analyzed, and a non linear static pushover analysis technique is used in the study.

II. LITEATURE REVIEW

Klemencic et al. conducted a several tests on post-tensioned wall connections with slab, and the findings revealed that the joints fail at internal storey drift 5%.

Weidlinger and Ettouney studied the tectonic lateral disturbance of high rise building of flat slab in the New York City.

Vinod Goud (2015):- The structural behaviour of shear wall – flat slab interaction is studied; among the important objectives some are resistance to various forces of action as well as the advantage of shear walls on the performance of these buildings structures under seismic forces.

Robertson et al research concluded brittle punching failure caused by shear stresses and asymmetrical forces transferred between slabs and columns Inconsistent moments also cause large shear stresses in the slab when subjected to a flat slab with a drop and a shear wall at different locations during earthquake has been investigated intensively.

III. PUSHOVER ANALYSIS

Pushover analysis is used to identify the nonlinear behaviour of structures under dynamic loading, such as max storey displacement, storey shear, overturning moment, storey drift, and max storey drift.

That's a sort of non-linear static and dynamic analysis in which the structure's strength is evaluated beyond its limit of proportionality.

Due to their effective span/depth ratios and the savings generated by constraining storey heights, concrete flat slab systems are a common kind of reinforced concrete structures, primarily in medium-sized industries. These slabs are prone towards gradual failure than slab-beam-column complexes because the pressure formerly absorbed by the removed columns cannot be shifted in the absence of beams.

It is consequently critical to evaluate the resistance to progressive collapse of RC flat slab constructions. As a result, it was advised that in seismically prone areas, flat-slab construction should only be implemented as the vertical structural members system in structures braced by framework or shear walls responsible for the structure's transverse capacity. To withstand gravity loads, slab–column interfaces must absorb the lateral elastic deformation of the primary lateral load-resisting structural parts resulting punching failure.

IV. OBJECTIVE

To compare the results of displacement, base shear and storey drift parameters as specified in IS-1893:2016 for various flat slab also to maximize the performance of various flat slab building models in relation to various types of force resisting systems further to investigate the nonlinear behaviour of flat slab buildings subjected to seismic stresses.

V. STRUCTURAL CONFIGURATION AND DESIGN

SNo.	Parameters	Dimension
1	Building Type	Commercial Building
2	Type Of Frame	Flat Slab System
3	Plan Dimension	25x15 (X*Y)
4	No. Of Stories	G+9
5	Bottom Storey Height	3m
6	Floor To Floor Height	3m
7	Total Height Of Building	48m
8	Slab Thickness For Flat Slab	150mm
9	Thickness Of The Drop	200mm
10	Width of drop	2m
11	Shear wall Thickness	200mm
12	Column size	400x400mm
13	Grade of concrete (slab)	M20
14	Grade of concrete(column)	M25
15	Rebar	Fe-415

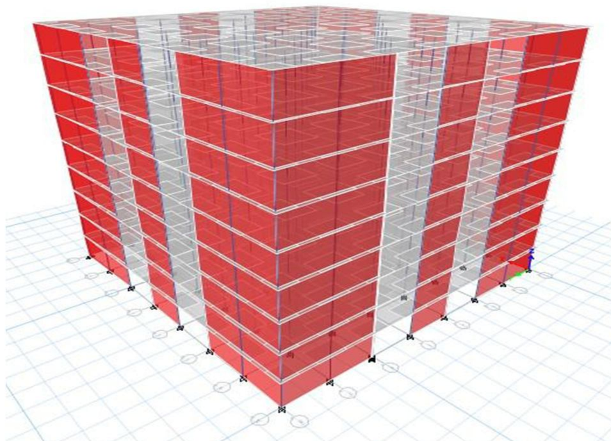
MATERIAL PROPERTIES (I.S.456:2000)

SNo.	Material	Grade (N/mm^2)
1	Grade of concrete(column)	M-25
2	Grade of concrete (slab)	M-20
3	Rebar	Fe-415

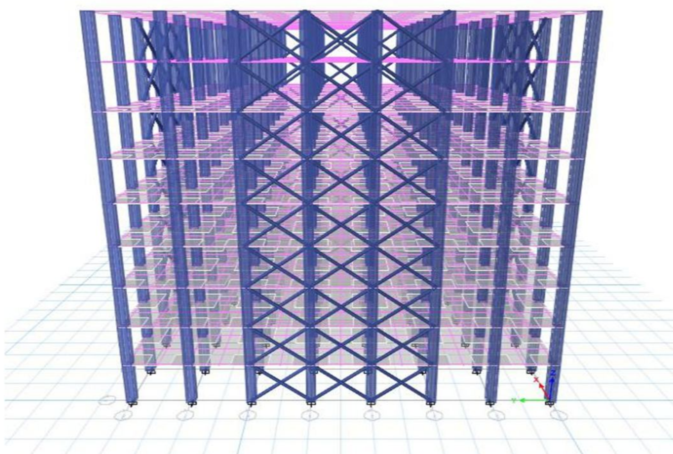
SEISMIC PROPERTIES (I.S.1893:2016)

1	Zone	V
2	Damping ratio	5%
3	Importance factor (I)	1
4	Type of soil	Type II (medium soil)
5	Response reduction factor ®	5

A. Model 1-Flat Slab With At Periphery

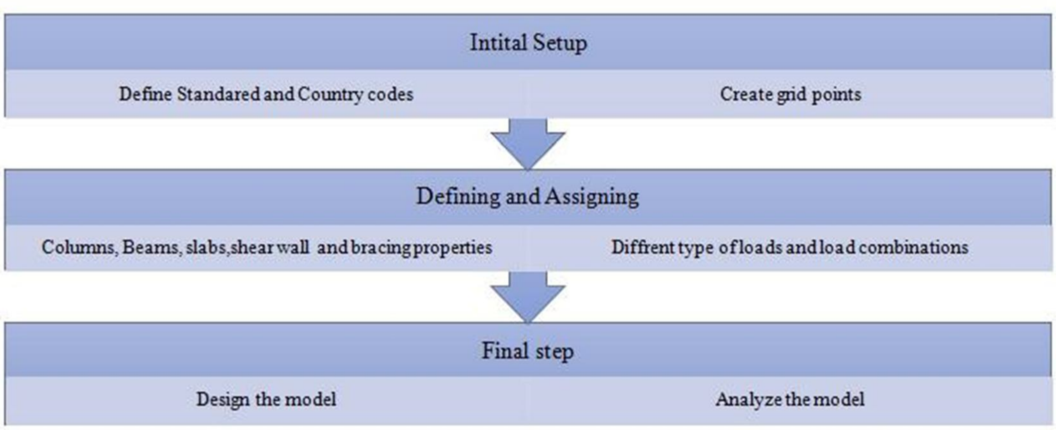


B. Model 2-Flat Slab With Shear Wall At X-Bracing



VI. METHODOLOGY

In this paper we model a G+9 BUILDING with plan layout of 25x15m. After this we assign material properties, section properties and load condition using code IS 1893 (Part1) in ETABSv16 software. Then we perform pushover analysis to analyse non-linear behaviour in both the models and compare more efficient and sustainable building of the two.



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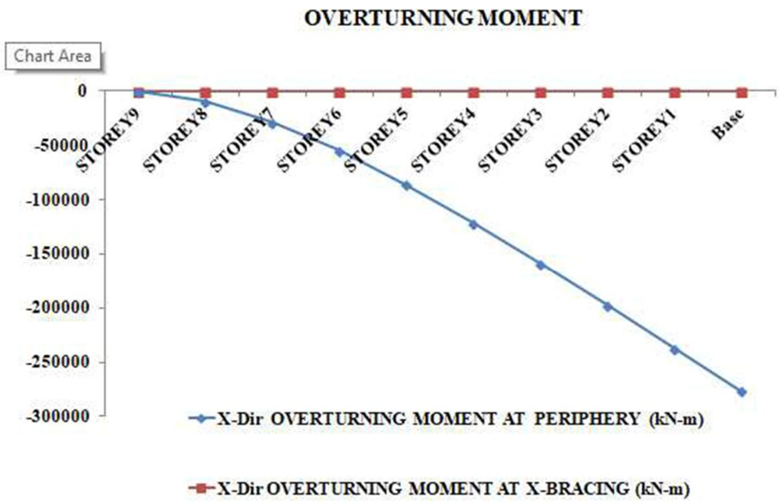
VII. RESULT AND DISCUSSION

The comparative investigation was caarried out under certain condition

VIII. OVERTURNING MOMENT

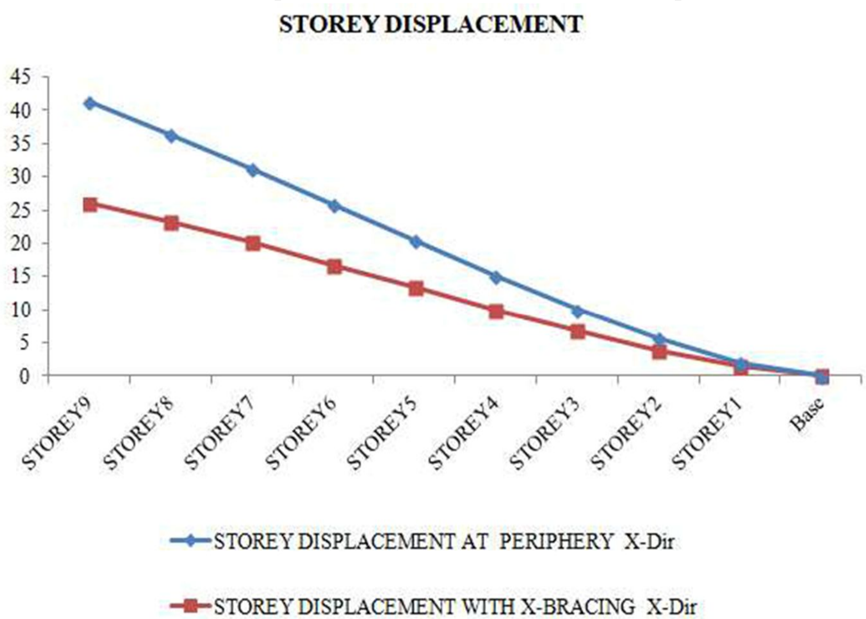
The table demonstrates the overturning moment in horizontal as well as in vertical plane is on the structure as a whole resulting from the dynamic earthquake forces. The overtturning moment with negative value depicts the counter balancing the seismic disturbance resulting in more stability at shear wall at periphery as compared to sheear wall X-Bracing, thus model 1 is much stable as compared to model 2.



The overturning moment for building with At periphery is less as compared to buiilding with shear wall at X-Bracing. According to IS 456:20000, Cl. 20.1, structure stability in the event of resisting moment must be larger than 6/5 times the maximumm moment due to the normal dead load and grreater than 7/5 times the typical applied loads.

IX. MAX STOREY DISPLACEMMENT

As shown below the table when sheear wall placed at X-Bracing and at periphery are compared to the storey displacement as parameter. IS 1893:2016 defines the permissible value of storey displacement as 0.004 of storey height (H).The sheear wall acting as a resisting system limits the excessive lateral displacement at different location commparison between the two are as follows



According to the following charts, the storey displacement and drift will be less at the bottom and higher at the top. The average storey displacement of flat slab as per IS 456:2000, Cl. 20.5, shall not exceed H/500 for lateral sway at top, where H is the building's entire height. According to IS 1893(Part -I) Cl. 7. 11.1, the minimum storey drift shall not be greater than 0.004 times the storey height.

The building with shear wall at X-Bracing has storey drift is 0.000526 m whereas in building with at periphery storey is 1.14E-07 m both are in max permissible limit is 0.192 m. Hence our building is safe, in y as a well as in x direction, drift values are under permissible limit according to IS 1893.

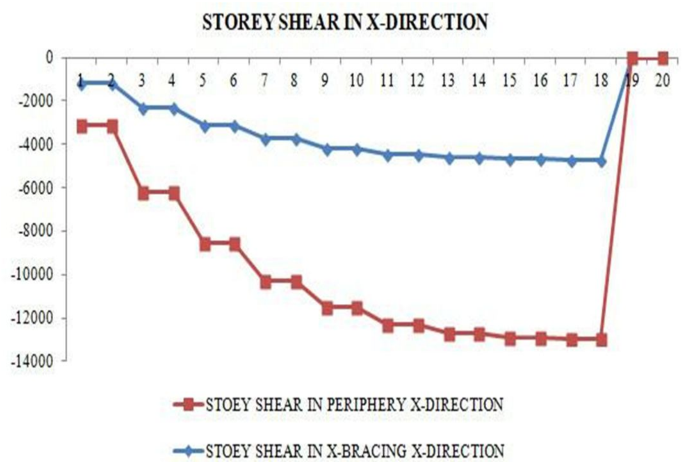
X. STIFFNESS

The relative storey drift ratio is the most vital displacement-related characteristic that must be regulated to reduce the damage to structures subjected to earthquake-induced ground accelerations. The demand for tale drifts changes with temporal variation of ground motion. The stiffness and storey drift relation is inversely proportional to each other, the stiffer the structure is lesser will be the drift in respective direction either X-direction or Y-direction.

The shear at periphery can be used where economy is considered, to decreases the flexibility of concrete the frame with X-bracing is recommended with the use of shear walls results in an increase in wall stiffness. As the Stiffness grows, the level drift lowers significantly.

The stiffness of model with shear wall at X-Bracing shows lower stability as compared to model with at periphery. Thus At periphery provides more stability to building under lateral loads.

XI. STOREY SHEAR



The storey shear in x direction of X-Bracing is 42% more than shear wall at core .Thus; the building is much stable under lateral seismic loading with respect to shear wall at periphery.

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XII. CONCLUSION

The lateral force acting per storey is significantly higher in case of shear wall at X-Bracing and for at periphery the lateral force decreases from top storey to base.

Shear wall at X-Bracing offers better resistance to lateral forces and results in increasing the serviceability and stability of the structure.

Flat slab building with X-bracing offers greater flexibility than building with shear wall at X-Bracing. In order to decrease deformation demands during major earthquakes, stronger structural systems such as shear walls with steel bracing can be used as replacement.

The value of displacement obtained under action of lateral forces for shear wall at X-Bracing is better when compared to shear wall at periphery**.**

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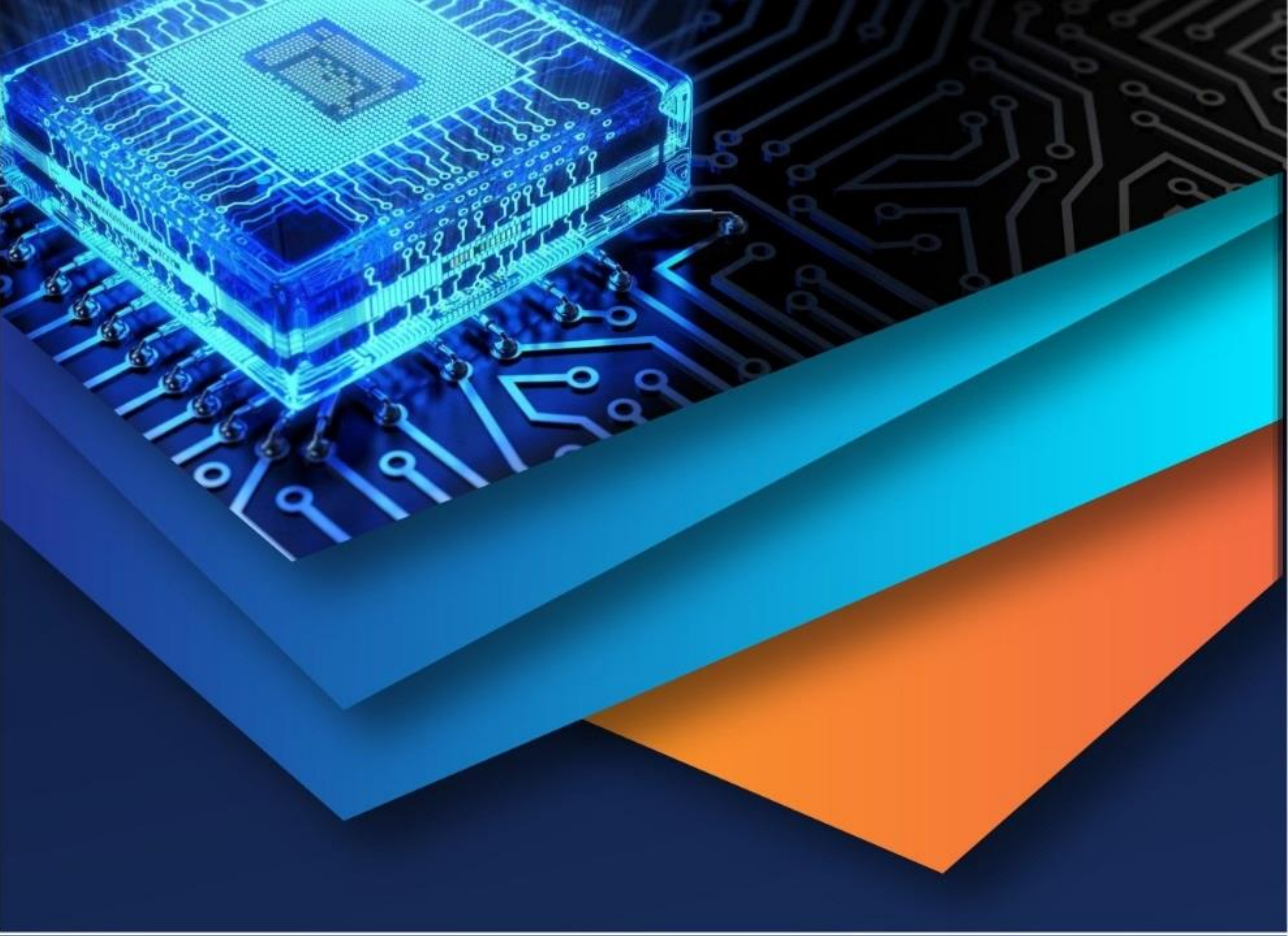

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