Analysis of an Unsymmetrical Mid Rise Building Frame Considering Different Slab Types under Seismic Loading

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Abstract- *As advance structure analysis is performed now a days using analysis tool which provide easy and quick analysis comparing to conventional method, since analysis of structure consist of analysis of individual member with distributing load in each member, thus In this research work we will analyze the effect of slab membrane in structure analysis and its role in distribution of load. For this study we are considering a mid rise unsymmetrical structure with and without the effect of slab membrane also with the effect of flat & Grid slab to counteract there effect on structure stability, forces and cost. For analysis purpose staad.pro tool is considered under seismic load (Zone IV) with soft soil condition.*

In this study it is observed that slab stiffness is much efficient in comparison to simple frame without slab system in reducing moment, storey displacement, peak displacement and cost effectiveness.

Keywords- Structure analysis, slab membrane, stability, moment, forces.

I. INTRODUCTION

Reinforced concrete slabs are broadly utilized as a part of the concrete developments. In basic examination, the torsional solidness of slab is disregarded. At the point when this firmness is considered, the correct hypothesis of bending of flexible plates demonstrates that the contorting minute alleviate around 25 percent. The essential capacity of floor and rooftop frameworks is to help gravity stacks, for example, sections and dividers. Besides, they assume a focal part in the circulation of wind and seismic powers to the vertical components of the sidelong load opposing framework. The impact of the slab boards isn't considered in reinforced concrete basic investigation since architects disregard their commitment in parallel load opposition. For the most part, the development completed is reinforced concrete with slabs giving the useable floor territory. As they frame a vast piece of basic framework, in this way creators ought to get advantage from their extensive in plane firmness. So in this investigation the reaction of two basically same structures, with and without thought of solidness of slabs were assessed and looked at based on changed auxiliary parameters. Reinforced concrete slabs are generally utilized as a part of the concrete developments. In auxiliary investigation, the torsional firmness of slab is overlooked in like manner.

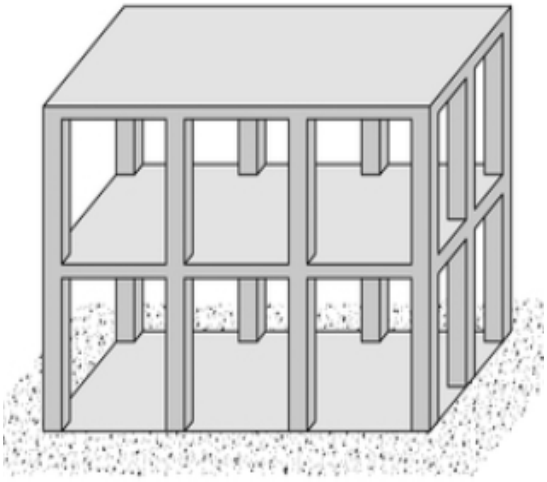

Fig 1: slab structure

Seismic Analysis:

It has been seen in past seismic tremors that the structures on inclines serve more overlay. Shivers make substantial damage to structures, for case, loss of people in the building and if the intensity of tremor is high it prompts breakdown of the structure.The structures in these zones are made on inclining grounds. A tremendous piece of the unforgiving ranges in India go under the seismic zone II, III and IV zones in such case working in context of slanting grounds are exceedingly slight against seismic tremor. This is a possible result of the way that the bits in the ground floor differentiate in their statures as showed up by the tendency of the ground. Segments toward one side are short and on flip side are long, by righteousness of which they are exceedingly

delicate. Seismic forces acts more separate in inclining zones due to the assistant inconsistency

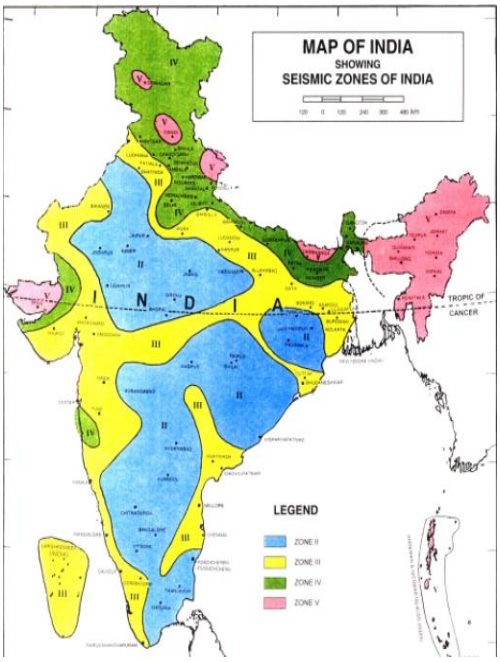

Fig 2: seismic distribution of India

Soil Type:

Soil-Structure Interaction is an attempting multidisciplinary subject which covers several areas of Civil Designing. In each functional sense each progression is associated with the ground and the collaboration between the old inconsistency and the establishment medium may affect basically both the superstructure and the establishment soil. The Soil-Structure Collaboration issue has changed into an essential piece of Basic Engineering with the technique of huge upgrades on delicate soils, for example, atomic power plants, concrete and earth dams. Structures, stages, passages and underground structures may in addition require specific idea to be given to the issues of Soil-Structure Interaction. Seeing how the earth reacts to fruitful seismic tremors could be vital to plans and coordinators outlining future structures to withstand the level of quickening estimated in this shudder. The data will in like way offer seismologists some assistance with developing new models to associate the impacts with these sensational and to an exceptional degree convincing occasions.

Sudhir Singh Bhaduria et. al. (2017) Here the author analyzed slab system design for G+10 building for seismic zone III, having medium soil condition using STADD.Pro V8I for different plain area or grid size of the column. The analysis and design of the slab system was done as per IS 456-2000 along with IS 1983-2002.The author concluded that flat slab was considered extremely economical because maximum displacement, maximum force and maximum bending moment in the three directions x,y and z was found minimum in comparison to grid slab system. Ultimately decreasing the quantity of steel and concrete requirement.

Raghav Gupta (2018) here the author focused on comparison in between behavior of flat slab with waffle or grid slab used in high rise buildings in various geometry. The authors parametric study comprised of maximum nodal displacement, maximum share force, storey drift maximum beam moment and axial forces generated in the beam and column. According to the analytical study of Rectangular, Pentagonal and Octagonal geometry models with different floors using Waffle Slab and Flat Slab it was subjected that the seismic hazard of important and high-rise structures has to be carefully evaluated before the construction. The results generated from the stadd.pro application stated that waffle slabs in rectangular geometry sustain more load in comparison of other models, in basic geometry, the deflection increases as height of structure increases stating maximum deflection occurs in case of octagonal geometry. While considering finances flat slab fits the pocket size easily but waffle slabs with rectangular geometry roved better results to resist loads.

UlfatSaboreeet. al. (2018) here the author carried out a comparative analysis and design of flat , grid and their different combinations of slabs on various parameters such as , for seismic behavior, summation of total moment, dead loads, base shear, storey drift, displacement against height of the structure and design specifications. The author study was done using the application STADD.Pro carried out static analysis of six different models G(10), F(10),G+F(5+5), F+G(5+5), G+F(3+7) and F+G(3+7), separately in Zone 4 and their results were compared to find out the right and appropriate type of slab with respect to different failures and design specification. The analytical results summarized that the best combination for smallest value of storey drift was G+F (5+5) besides total height of flat slabs is smaller than total height of grid slabs.

KavitaGolghateet. al. (2018) here the author motive was construction of houses for lower income group population who needs houses build on low cost. In order to achieve the required purpose, the for most target was to reduce the use of concrete from the structure as concrete being the most expansive material used in the building, therefore a economical and lighter slab with dimension 1000 X 1000 X 150mm was modeled along with recycled plastic cavity in shape of sphere, egg and elliptical was placed in middle of cross section of slab and cavity was fixed at joint of the reinforcement. A pressure of 15000 Pa was applied on front

face and the rest sides faces were fixed to analyze the condition of the edges. This analysis was done using ANSYS WORKBENCH 14.0. The author analysis concluded that maximum tenure, the cavity slab acts far well than solid slab and from economical point of view, sphere cavity saved 6% concrete, egg cavity 4% concrete and elliptical cavity saved 15% concrete.

Omar et. al. (2018) Here the author demonstrated the behavior of voided slabs which was simulated numerically and experiments were done on slab specimens with various void shapes, numbers geometry and reinforcement state. The experimental results verified that full load distribution was attended up to the ultimate flexural capacity of the system based on field test of hollow core concrete slabs.

II. OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

- To determine the effect of slab stiffness on structural performance in terms of forces, moment, displacement and support reactions.
- To determine the effect of slab stiffness in resisting lateral forces.
- To determine the cost effectiveness of structure using grid slab and Flat slab.
- To check stability of a structure considering different type of slab.

Table 1: Geometrical Discription

S.No.	Description	Values
1	Number of storey	6
2	Number of bays	4
3	Storey height	3.0 m
4	G.F. height	3.0 m
5	Bay width	4.0 m
6	Size of beam	250 x 400 mm
7	Size of column	500 x 450 mm
8	Thickness of R.C.C. slab	125 mm

Table 2: Material

S.No.	Material property	Values
1	Grade of concrete	M-25
2	Young's modulus of concrete, E_c	2.17×10^4 N/mm^2
3	Poisson ratio,	0.17

Table 3: Seismic Parameters

S.No.	Parameter	Value	Remarks
1	Zone Intensity	0.24	Table 2 (1893-part-1 2002)
2	Damping ratio	5%	Table-3 (1893-part-1 2002)
3	Importance factor	1.5	School building Table 6 (1893-part-1 2002)
4	Response Reduction Factor	5	Ductile detailing (S.M.R.F.) Table-7 1893-part-1 2002
5	Soil site factor	Soft	Adopt

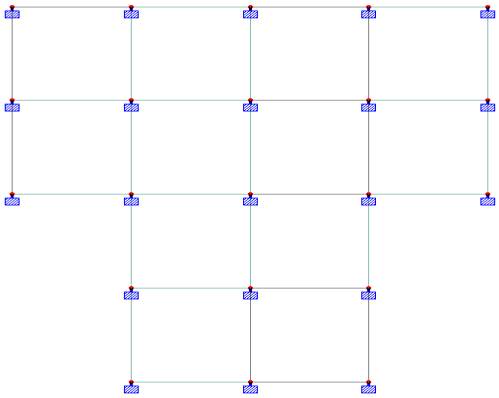

Fig 3: Plan of Structure

III. ANALYSIS RESULT

Max. Bending Moment kN-m:

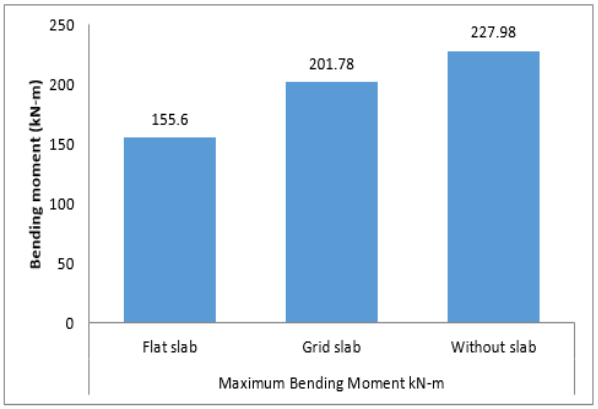

Fig 4: Max. Bending Moment

As shown in graph above it can be clearly observed that while considering slab stiffness bending moment is decreasing which translates in a more economical structure as area of steel requirement decreases, In case of grid slab and flat slab due to geometry and distribution of load flat slab is comparatively more stable.

Max. Shear Force kN:

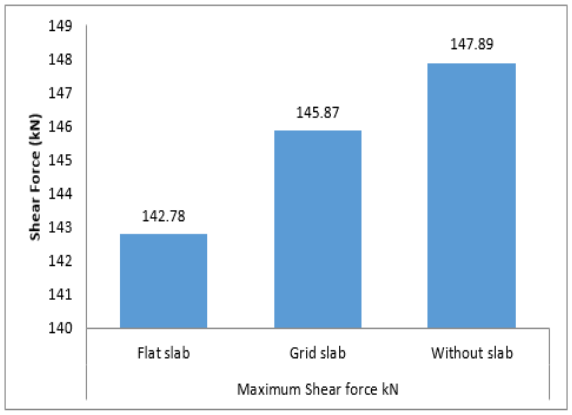

Fig 5: Max. Shear Force

Shear forcecan be defined as the unbalance forces acting at the ends of the beam, here results prove that due to slab stiffness there is a decreament in shear force by 4.8 % but in case of flat slab due to direct transfer of load from slab to column with slab unbalance forces decreases.

Max. Axial Force kN:

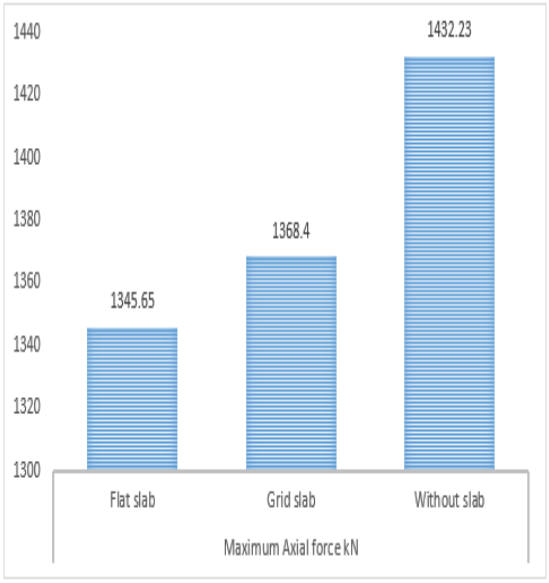

Fig 6: Max. Axial Force kN

If the load on a structure is applied through the center of gravity of its cross section, it is called an axial load. Axial force is the compression or tension force of the member. Here results shows that there is a decrement of 16% in axial force due to slab stiffness.

Max. Storey Displacement mm:

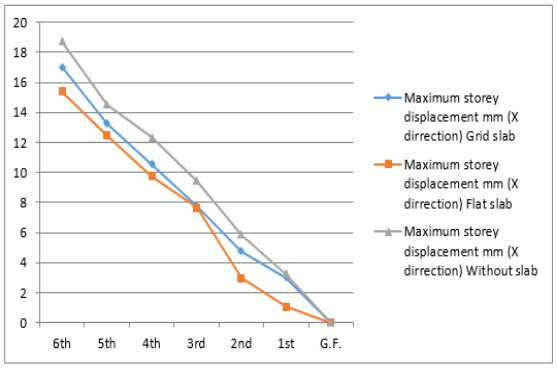

Fig 7: Storey Displacement (mm) in X direction

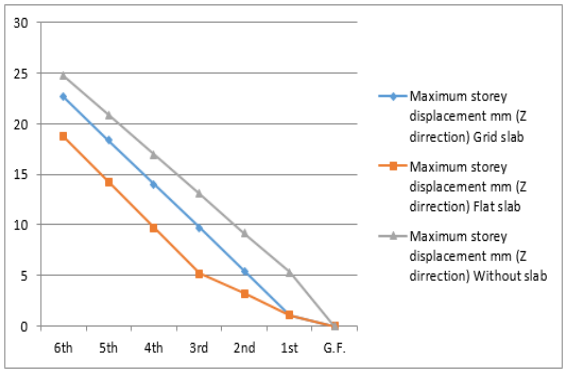

Fig 8: Storey Displacement (mm) in Z direction

Cost Analysis:

Rebar Cost:

S. No.	Frame type	Reinforcement kg	Rate of Reinforcement (Kg) as per S.O.R.	Cost of Reinforcement in INR (Rupees)	Remark
1	Without slab	9354.23	160 / Kg	15,22,676.80	14.73% lesser steel is required when stiffness of slab is considered
2	Grid slab	8161.672	160 / Kg	12,79,867.52	
3	Flat slab	8298.98	160/ Kg	1327836.8	

Concrete Cost:

S. N0.	Frame type	Concrete cu.m	Rate of concrete (m^3) as per S.O.R.	Cost of concrete in INR (Rupees)	Remark
1	Without slab	98.76	4500	1,85,200	Since Bending is comparatively more in bare frame case heavy sections are required which results in more concrete consumption.
2	Grid slab	92.6	4500	1.85,200	
3	Flat slab	91.76	4500	412920	

IV. CONCLUSION

From the present study it was examined that slab stiffness is much efficient in comparison to simple frame without slab system in reducing moment, storey displacement, peak displacement.

Effect of slab stiffness on shear force and bending moment for seismic loadbuilding frame without slab shows more node displacement, beam and column forces as compared to building frame with slab stiffness.

It has been observed from the analysis of various building that the rigid diaphragm is more effective in economical designing.

It is concluded that the building with rigid diaphragms will be structurally economic resulting into a great deal of saving in reinforcement steel.

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