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A STUDY ON SEISMIC ANALYSIS OF MULTI-STOREY FLAT SLAB AND CONVENTIONAL STRUCTURES WITH AND WITHOUT SHEAR WALLS USING ETABS

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Abstract - *The main objective of this project is to analyze & study the comparative seismic performance of conventional & flat slab structures with and without shear wall using Etabs. In earthquake zone the displacement and drift of the structures will be more so to have more stiffness to the structure shear wall is to be provided therefore this project is compared between conventional slab & flat slab (with drops) building with and without shear wall. The report includes detailed analysis of a multi storey G+9 Commercial building using software ETABs. All the structures were subjected to various kinds of loads such as dead load, live load, earthquake load. This study is mainly based on Response spectrum analysis which is linear dynamic analysis to know the seismic performance of the structures. Analysis were done as per IS:1893-2002, and all the RCC members were designed as per IS: 456-2000. Load Calculations were calculated as per IS: 875 Codes. The results provide best information on storey drifts, displacements, stiffness and storey shears and show its performance on different conditions of the structure*

***Key Words*: Conventional slab, Flat slab, Shear wall, Response spectrum analysis, Storey displacement, Storey drift, Storey shear, Storey stiffness.**

1. INTRODUCTION

This project provides information on a study of seismic analysis of multistorey (G+9) Conventional slab & Flat slab (with drops) structures with and without shear wall by response spectrum method under different conditions of structures. Generally Conventional slab system consist of beams connected at regular intervals in perpendicular directions they are also called Beam-Slab mechanism, because in this load transfer will follow Yield line theory i.e., load transfer from slabs to beams to columns to foundation. Flat slab is a RC slab directly supported by columns without beams. In this, load transfer will follow Finite element method in which the load transfers from part by part or node to node. Load mechanism carries from slab to column to foundation by FEM. Shear walls are the structural members used to resist the seismic load. The shape and plan of the shear wall influences the behavior of structures such as strength, stiffness , therefore to reduce to the seismic loads on the structure the provision of shear walls is required. This project is checked for Zone III & compared for all models to know, how it behaves whether it passes all checks, if not what behavior it takes place and to study the comparative results like storey displacement, storey drift, storey shear, storey stiffness of buildings when subjected to seismic loads under different conditions by Response spectrum method. Based on these comparative results we are going to study the performance of flat Slab & Conventional slab mechanism with shear wall and without shear wall.

2. LITERATURE REVIEW

Dhananjay D et.al., (2013) [1], Entitled that performance of flat slab structures. Nowadays, for earthquake resistant design, the Performance Based Seismic Engineering is used. Since flat slabs are more economical they are gaining more attention. A study ha to be made how the flat slab behave under seismic loads the present flat slab building, may not be designed for seismic loads. The main aim of researcher was on implementing push over performance on flat slabs the software used was Etabs. For analysis, (G+7) building having five bays is adopted. The result shows that the performance of flat slab is compared to regular building.

Aniket B. Raut et.al., (2015) [2], Entitled that seismic behavior of flat slabs. Flat slab method is adopted in many buildings to make the building economical and to reach the architecture demands. There are many advantages of flat slab compared to conventional beam column building, however the flat slab structural effectiveness is effected by poor performance in earthquake loading. But flab slabs are used in earthquake prone areas in many parts of the word. Proper measures has to be taken design has to be made carefully, because in various areas flat slab construction is the major reason for failure and damage to buildings therefore analysis should be done carefully in flat slab construction.

K Jaya Prakash et.al., (2016) [3], Entitled that analysis and design of flat slab using Etabs. Flat slab can be explained as the slab which directly rests on the supports without like walls and columns beams, like walls and columns, from the above effect, more shear force and bending moment are developed near the columns. In conventional construction method beams are used, but in flat slab construction beams are eliminated. The flat slabs, rests on columns, loads are transferred to the foundation through columns. The term drop is used to indicate increase in thickness to support the heavy load, columns are provided with enlarged head called Capitals.

K. Parbat et.al.,(2017) [5], Entitled that analysis and design of RCC and flat slabs. The Implementation of Post-tensioning is increasing more rapidly due to its wider advantages, from using Post-tensioning method the structure cost can be made economical and safer designs can be made, while using this method in flat slabs, precautions should be taken for deflection and shear, the flat slab design can be made by using load balancing and equivalent frame method. A case study was considered to apply the design procedure, an office building was chosen (G+4), and design of building with four cases and different floor systems was adopted. The required materials like steel, concrete were calculated and are shown in tabular form, the total cost per square meter was found and the comparison was made.

2.1 LITERATURE SUMMARY

From the above literature survey a brief review was made on comparison of flat slab structure and conventional method of construction and comparative analysis of flat slabs and conventional reinforced concrete slabs with and without shear slabs and we can conclude that this method is related to evaluation of the dynamic response of the structure which may be unsymmetrical or includes discontinued area and irregularity in their behaviour.

3. METHODOLOGY

To examine the seismic behavior of conventional and flat slab structures with and without shear wall, comparative study has been carried out between the models using response spectrum method. The analysis has been performed using Etabs version 17.0.1. In response spectrum method, for the calculation of different parameters like displacement, drift shear, stiffness only maximum values are considered.

3.1 Description of Building with load parameters

Table -1: Data for Conventional Building

Sl. No	Parameter	Remarks
1	Structure type	Commercial
2	Total number of floors	G + 9
3	Area of plan	30.48x29.26 m
4	Floor to floor height	3 m
5	Column size	600x600 mm
6	Beam size	450x600 mm
7	Slab thickness	200 mm
8	Thickness of wall	230 mm
9	Thickness of shear wall	200 mm
10	Concrete grade	M45
11	Steel grade	Fe550
12	Self-weight of reinforced concrete	25 kN/m³
13	Self-weight of bricks	18 kN/m³
14	Self-weight of masonry wall	18.75 kN/m³
16	Self-weight of cement plaster	20.40 kN/m³
15	Self weight of ceiling plaster	0.25 kN/m³
17	Masonry wall load	11.47 kN/m
18	Live load on all floors	3 kN/m²
19	Live load on roof	1.5 kN/m²
20	Floor finish on floors	1 kN/m²
21	Floor finish on roof	0.4 kN/m²
22	Mass source	25% of live load
23	Damping ratio	0.05
24	Soil type	II (MEDIUM)
25	Seismic zone factor III	Z = 0.16
26	Importance factor	1.5
27	Response reduction factor	3 (OMRF)

Table -2: Data for Flat slab Building

Sl. No	Parameter	Remarks
1	Structure type	Commercial
2	Total number of floors	G + 9
3	Area of plan	30.48x29.26 m
4	Floor to floor height	3 m
5	Column size	600x600 mm
6	Peripheral Beam size	450x600 mm
7	Slab thickness	200 mm
8	Drop thickness	250 mm
9	Area of drop	2.4 x 2.4 m
10	Thickness of wall	230 mm
11	Thickness of shear wall	200 mm
12	Concrete grade	M45
13	Steel grade	Fe550
14	Self-weight of reinforced concrete	25 kN/m³
15	Self-weight of bricks	18 kN/m³
16	Self-weight of masonry wall	18.75 kN/m³
17	Self-weight of cement plaster	20.40 kN/m³
18	Self weight of ceiling plaster	0.25 kN/m³
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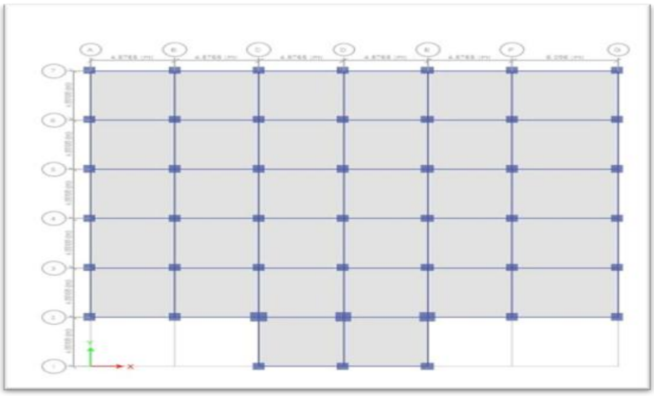
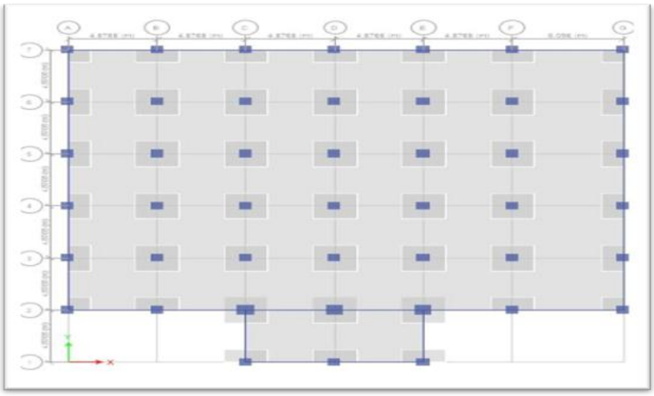
27	Seismic zone factor III	Z = 0.16
28	Importance factor	1.5
29	Response reduction factor	3 (OMRF)

Table -3: Model Details

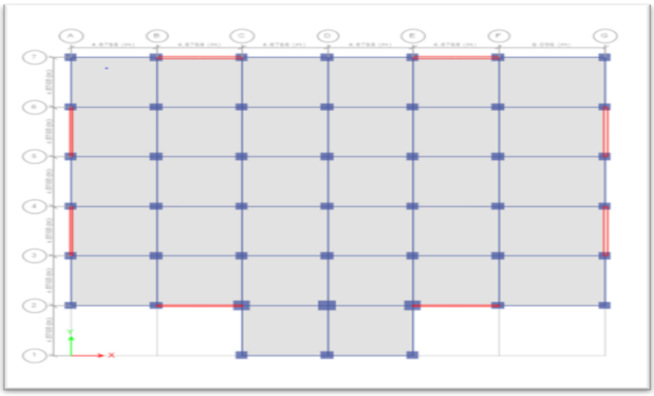
Sl No.	Model No.	Description	Positioning of Shear wall
1	S1(Regular)	Conventional building	-
2	S2	Flat slab building	-
3	S3	Conventional building	Middle
4	S4	Flat slab building	Middle
5	S5	Conventional building	Corner
6	S6	Flat slab building	Corner



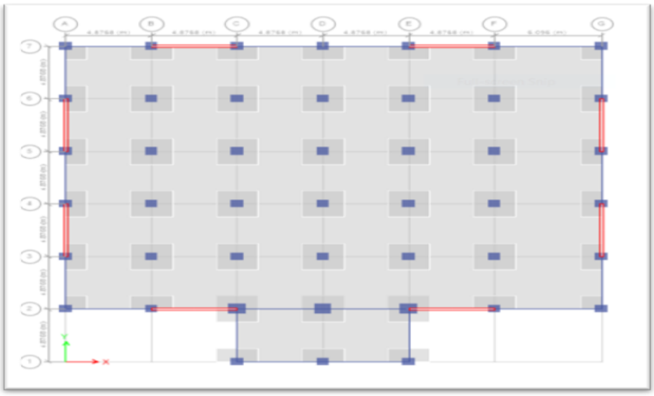
Model -S1: Conventional Structure



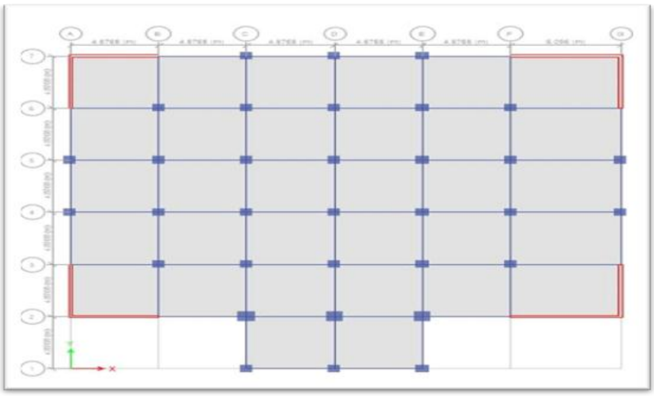
Model -S2: Flat slab Structure



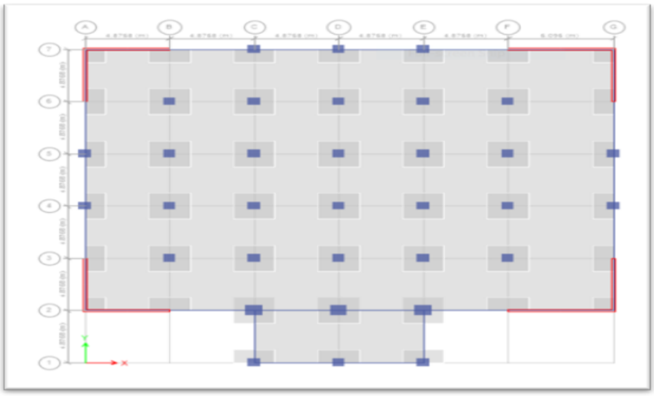
Model -S3: Conventional Structure with shear wall middle



Model -S4: Flat slab Structure with shear wall middle



Model -S5: Conventional Structure with shear wall at corner



Model -S6: Flat slab Structure with shear wall at corner

4. RESULTS AND DISCUSSION ON COMPARISION OF MAXIMIM VALUES

4.1 Storey Displacement

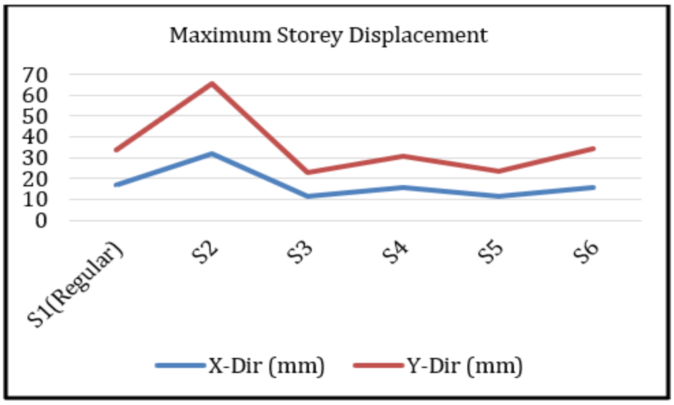


Chart -1: Storey Displacement

From chart -1 it can be concluded that, Model S3 i.e., conventional building having shear wall middle shows least valve of displacement in both X and Y directions than the other models.

4.2 Storey Drift

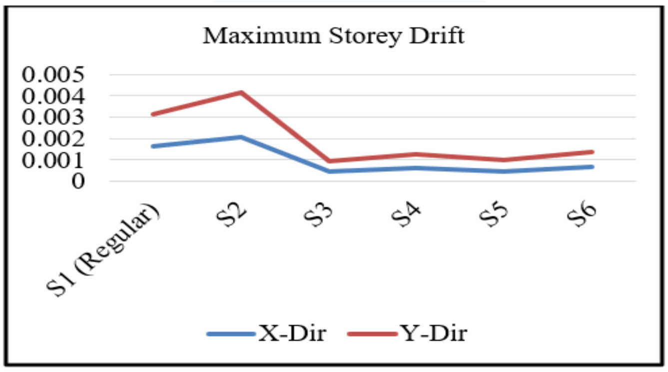


Chart -2: Storey Drift

From chart -2 it can be concluded that, maximum storey drift ratio obtained from all models are within the maximum limits as specified by Cl. 7.11.1 of IS 1893-Part 1 (2002). Further model S3 having shear wall middle shows least value of storey drift ratio in both X and Y directions than other models.

4.3 Storey Shear

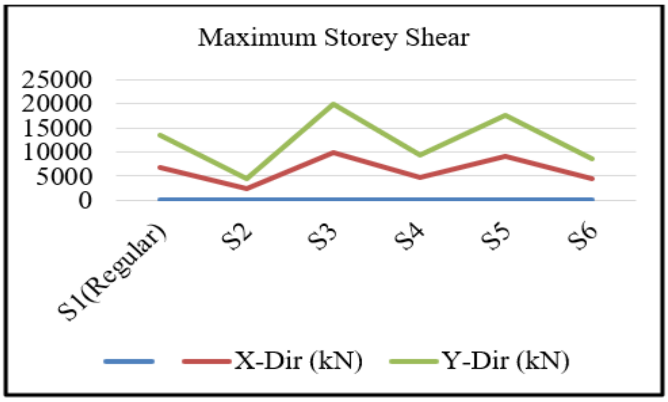


Chart -3: Storey Shear

From chart -3 it can be inferred that maximum storey shear value is achieved in model S3 having shear wall middle, than the other considerations and model S2 is having minimum shear than the other considerations.

4.4 Storey Stiffness

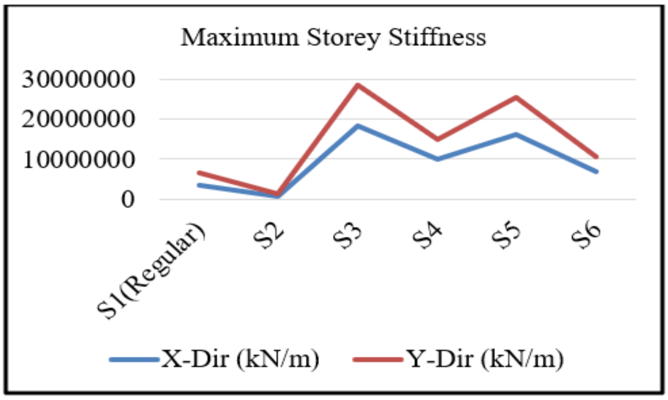


Chart -4: Storey Stiffness

From chart -4 it is inferred that maximum stiffness is observed in model S3 having shear wall middle, than the other considerations and the model S2 is having minimum stiffness than the other considerations.

5. CONCLUSIONS

This research represents the study on seismic analysis of multistorey (G+9) flat slab and conventional structures with and without shear wall, on the basis of analysis following conclusions have been drawn:

1. Considering the displacement, the model S3 i.e, conventional building with shear wall middle perform better when compared with all other models, also the model S5 performs better, only a few mm of difference i.e, 0.127(1.1%) mm is there between the models S3 and S5. However for conclusion model S3 performs better when compared with all other models.

2. Considering the drift analysis the conventional building with shear wall middle perform better when compared with all other model, also the model S5 performs better, but only a few difference is there i.e, model S5 is having the drift ratio 1.29% more compared to S3. However for conclusion model S3 performs better when compared with all other models..

3. Considering the shear analysis the model S2 has a lower force than the all other models and model S3 has the maximum force compared to all other models, the model S2 has a reduction of forces up to 76.40% and similarly S1,S4,S5,S6 has a reduction of forces up to 32.46%, 53.06%, 5.01%, 54.97% respectively compared to S3.

4. Considering the stiffness the model S2 has a lower stiffness than the all other models and model S3 has the maximum stiffness compared to all other models, the model S2 has a reduction of stiffness up to 95.99% and similarly S1,S4,S5,S6 has a reduction in stiffness up to 81.78%, 46.12%, 13%, 62.21% respectively compared to model S3.

5. From the above Results so obtained from all graphs is clear that the model S3 performs better than all other models as it has additional structural member such as shear wall in middle.

6. Finally, the model S3 proves to be most economical and effective to earthquake activities in earthquake prone area, as shear wall gives better resistance against earthquake forces and offers a stable structure.

Concluding remarks : For the considered plans, number of stories and dimensions of RC structural components, both conventional and flat slab models with and with out shear wall safely resist the earthquake w.r.t storey drift ratio as the maximum value is within permissible limits as specified by IS 1893 – Part 1 (2002).Conventional building with shear wall middle shows higher value of storey shear, storey stiffness as compared to other RC models. Conventional models with shear walls are preferred I high seismic zones as they show high structural performance in resisting displacement, drift.

6. FUTURE SCOPE

From the above researches a broad conclusion can be taken on flat slabs and their behaviors, further studies can be carried out on the fallowing aspects.

1. Flat slab with grid mesh model with various shapes analysis can be made using finite element software.
2. In the present study flat slab with periphery beams is considered for structure, further study may also be undertaken by flat slab without periphery beam structure.
3. In this research fixed base is considered for the structure, in future study can be made using soil structure interaction.
4. Through response spectrum method structure analysis can be made and time history analysis can be carried out.
5. The structure can be analysed by different software.

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