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"Seismic Analysis of Multi-Storey RCC Structure with Flat, Grid and Conventional Slab"

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Abstract - The primary goal of this work is to analyze and design a RCC Frame building with various slab such as conventional slab, flat slab with drop panels, grid/waffle slab. A commercial building is one that uses at least 50% of its floor space for commercial purposes. Response spectrum dynamic analysis is adopted for the analysis using ETABS software. The building with different slab cases as per re-entrant corner is analyzed to identify the displacement response in order to avoid vulnerability.
Keywords: Grid Slab, Flat Slab, Conventional Slab, Seismic Analysis

1. Introduction

We can witness massive construction activities taking place everywhere in our modern industrial period; as a result, there will be a shortage of land space, prompting the construction of tall skyscrapers to address this issue. Several features are updated to make work faster and more cost-effective, such as the introduction of flat slab construction, which eliminates dead weight, hides beams, and increases floor surface.

Conventional Slab

A slab is a two-dimensional flat planar structural element with a thin thickness in comparison to its other two dimensions. A typical slab is supported by beams and columns, with the load being passed to them. The following are the characteristics of a standard slab:

- **One Way Slab -** When a slab is supported by beams or parallel walls on two opposite sides the slab is known as one way slab. As per IS codes, in one way slab the ratio of the longer span is equal to the shorter span is equal or greater than 2.
- **Two Way Slab-** The slab which is supported by beams are walls on all four sides is known as two way slab the loads are carried out along both shorter and longer directions. as per IS codes the ratio of longer span to shorter span is always less than 2.

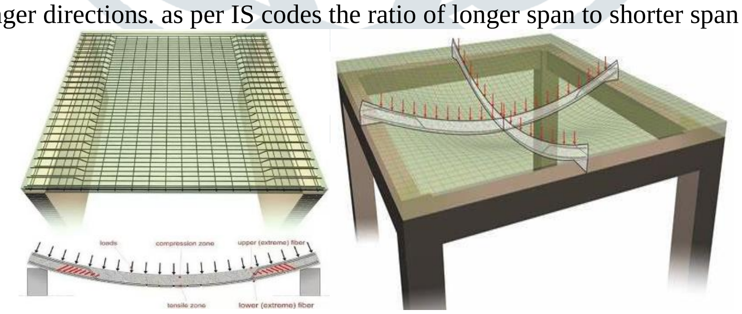


Fig. 1 One -way and Two-way slab

Flat Slab

Flat slabs are commonly utilized to add greater headroom to floors and to improve the aesthetic of interiors. Capital/head, drop panel, columns strip, and middle strips are the major components of a flat slab. They are commonly used for architectural purposes in big rooms such as auditoriums, vestibules, theatre halls, and retail showrooms, where column-free space is often the most important need.

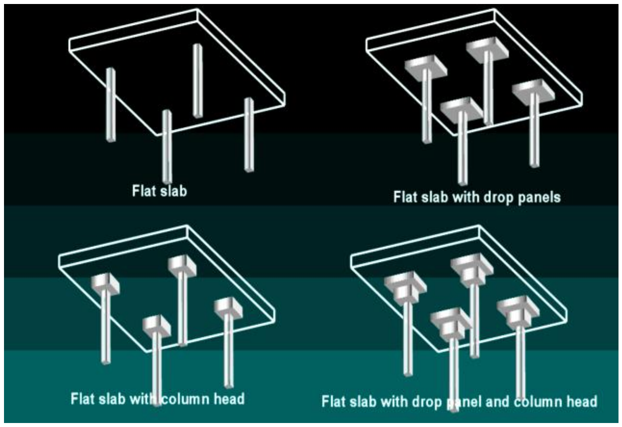


Fig. 2 Types of Flat Slab

Grid Slab

Waffle slabs with hidden beams and waffle slabs with solid parts around columns are the two main varieties of grid slabs or waffle slabs. The first waffle slab type, with beams, behaves similarly to a solid slab (slab with beams between columns), and the analysis procedure is also similar.

Criteria of Re-Entrant Corner Irregularity - ***"A building is said to have a re-entrant corner in anyy plan direction, when its structural configuration in plan has a projection of size greater than 15 percent of its overall plan dimension."*** In building with reentrant corners, three-dimensional dynamic method shall be adopted.

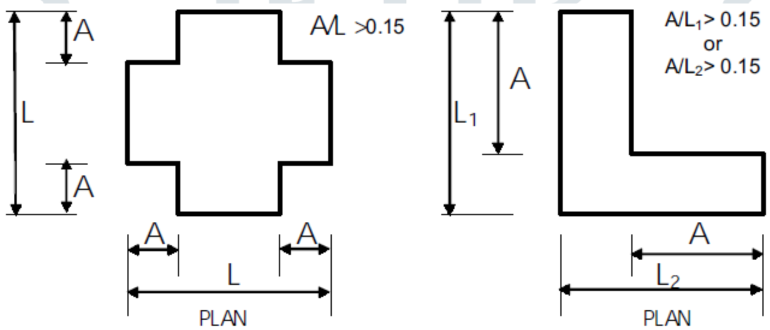


Fig. 3 Re-Entrant Corners Plan Irregularity Specification In IS 1893: 2016

2. Literature Survey

Divya D. Gawand (2021), In the present work the comparison of Conventional building and Flat slab in different zones, using ETABS software. Therefore, the characteristics of a seismic behavior of Flat slab and Conventional RC frame building measures for guiding the concept and design of these structures and for improving the performance of buildings during seismic loading.

CH. Lokesh Nishanth et al (2020), The principle purpose of this work is to analyse and design a commercial building with different slab arrangements, i.e., Conventional slab, Flat slab with drop panels, Grid/ Waffle slab, and building with load bearing wall. A commercial building is one in which at least 50 percent of its floor space is used for commercial activities. The effect of seismic and wind forces on buildings with different slab arrangements have been analysed by utilizing ETABS software.

P. Sharmini, X. Steni (2020), In this report investigation on the seismic behavior of flat slab and grid floor are carried out using the Etabs. The aim of the project is to determine the most economical slab in the seismic zone between flat slab with drop and grid slab.

Dr Ramakrishna Hegde et. al (2018), In this project work an attempt is made to study and compare the procedure and performances of the Conventional RC frame slab, Flat Slab and Grid slab. These are studied and analyzed, under earthquake zone II. The modes are is done using E-Tabs 2015 IS Code 456-2000. G+14 storey buildings are taken and designed and analysis is done for both Gravity (D.L and L.L) and lateral (earth quake and wind) loads.

Ms. Priyanka Chandanshive (2017) aims to determine the seismic analysis between the flat slab and grid slab. The proposed construction site is Sri Nirmal madhav apartment 4 manis nagar behind shardha square, Nagpur. The total length of slab is 45m and width is 30 m. total area of slab is 1350 sqm. It is designed by using Fe415 steel and M30 Grade concrete and Fe415 steel. Analysis of the grid slab and flat slab has been done both manually as well as software by IS 456-2000 and software also. Flat slab and Grid slab has been analyzed by ETABs software. Rates have been taken according to N.M.C. C.S.R.

3. Methodology

In this study, the dynamic analysis has been done on the different buildings in which conventional slab, flat slab and grid slab are involved with different ratio of re-entrant comers is been analyzed carried by Seismic Zone-V using ETABS software. Loads considered are taken in accordance with the IS-875 (Part1 & Part2), IS-1893:2002/2016 & load combinations are according to IS-875(Part5).

3.1 Structural Details

The following below is the Case Study to be analyzed and designed in this thesis-

Table 1 Description of Case Trials considered for the study

Description	Case ID
Building with Conventional Slab	RCS
Building with Flat Slab	RFS
Building with Grid slab	RGS
Cross shape Building with A/L ratio 0.15 having conventional slab	A15CS
Cross shape Building with A/L ratio 0.15 having flat slab	A15FS
Cross shape Building with A/L ratio 0.15 having Grid slab	A15GS

Table 2 Structural Specification for the study

PARTICULARS	STRUCTURAL PROPERTIES
Total Built-Up Area	**40 X 40 m**
Number of Stories	**G+5**
Floor to floor Height	**3.5 meter**
Size of Columns	**400X 400 mm**
Beam Size	**230 X 400 mm**
Conventional Slab thickness	**150 mm**
Grid Slab thickness	**150 mm**
Flat Slab thickness	**150 mm**
Dead load	**IS 875 Part-1**
Live load	**IS 875 Part-2**
Roof live load	**IS 875 Part-2**
Earthquake load	**IS 1893:2016**

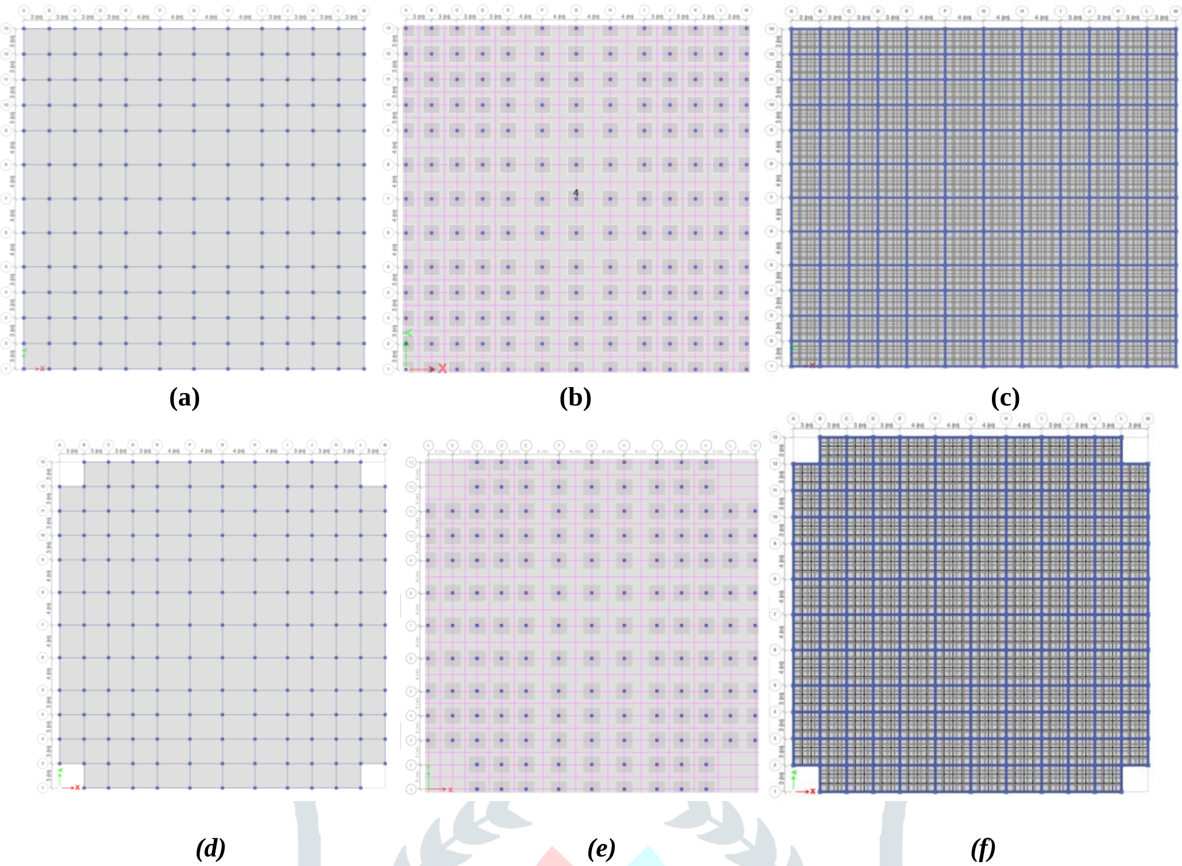


Fig. 3 Plan View of all Studied Cases (a) RCS (b) RFS (c) RGS (d) A15CS (e) A15FS (f) A15GS

3.3 Material Specifications Considered for Design & Analysis of Cases

These building frames models are made up of two basic materials i.e., concrete and reinforced steel. The table given below shows the properties of materials considered for design and analysis of all RCC frame buildings.

Table 3 Material Properties used in all Frames

Particular	Details
Grade of Concrete	M30
Grade of Main Steel	Fe500
Grade of Secondary Steel	Fe500
Beam & column cover	25 mm & 40 mm
Density of Reinforced Concrete	25 KN/m^3
Density of Brick walls, Plaster	18 KN/m^3
Young's modulus of steel	$2 X 10^5 N/mm^2$

4. Loading Specification & Calculations Common for All Frames Used in Software –

The loads which is to be studied in the project is discussed under following clauses below in which their calculation detail is also been discussed such as Primary load, Seismic Load & their load combination etc.

4.1 Primary Loads Applied for Analysis -

In Software, the loads are taken in the form of load cases i.e. primary load cases and the load combination of primary load cases also which are used same for all frame buildings. Firstly, here are the primary load cases which have been used in ETABS software analysis are given below in table 3.4 with their load type & numbers-

Table 4 Primary Load Cases

Load Case Number	Load Type	Name
1	Dead Load	DL
2	Live Load	LL
3	Seismic Dynamic Load	DQX
4	Seismic Dynamic Load	DQY

4.2 Load Calculations Used for All Frame Cases

The calculated load acting on the structures of dead load, floor live load, roof live load is given below-

4.2.1 Dead Load (D.L) –

In this analysis, dead load includes dead load of the slab, dead load of beam & column, dead load of external walls and dead of internal walls. DEAD LOAD is designated as D.L in ETABS.

Self-Weight of Slab/Plate = (unit weight of concrete X thickness of slab)
= 25 X 0.15
= 3.75 KN/m^2

Self-Weight of Column (0.45x0.45) =
= (unit weight of concrete X size of column)
= (25 X 0.45X 0.45)
= 5.0625 KN/m (per meter height)

Self-Weight of Beam in all floors =
= (unit weight of concrete X depth of beam X width of beam)
= 25 X 0.40 X 0.23
= 2.3 KN/m

4.2.2 Live Load (L.L) –

In this research, live load includes live load for all the floors as it is considered from the commercial building category given in IS 875 Part -1 and live load for roof is also considered from same above code. LIVE LOAD is designated as L.L. and ROOF LIVE LOAD is designated as R.L.L in ETABS. Here we consider-

Live load for all the floors = 4 KN/m^2

Live load for roof (at Terrace) = 1.5 KN/m^2

4.2.3 Earthquake or Seismic Load (EQX & EQZ) -

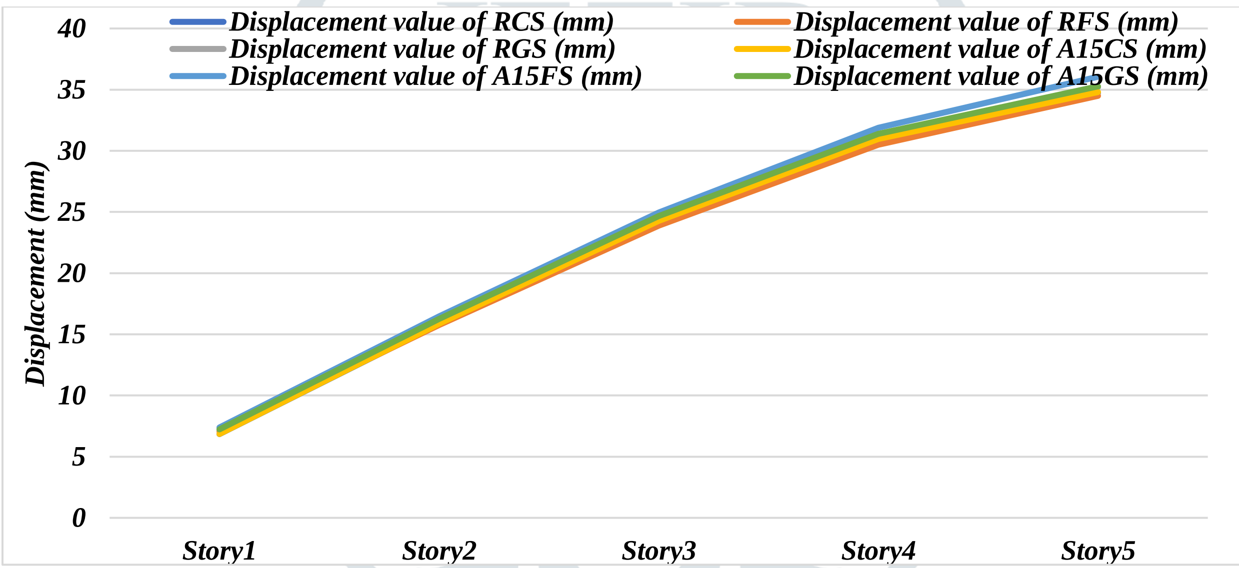
Earthquake load or seismic load calculation involves the full dead load plus the percentage of live or imposed load as per IS 1893:2016 considerations and importantly for calculating earthquake or seismic load. Also, as per IS 1893 Seismic weight of each floor is its full dead load plus approximate amount of live or imposed load. In this study, the approximate amount of live or imposed load considered is 50% of the total live load as per IS 1893 (Table 8) and all the rest calculation is done with the help of ETABS Software. SEISMIC OR EARTHQUAKE LOAD is designated as DQX & DQY where "DQ" stands for Dynamic Earthquake load whereas X & Y represents their respective lateral direction.

5. Result & Discussions

Table 5 Dispalcement report for all the cases

Story	Story5	Story4	Story3	Story2	Story1
Displacement value of RCS (mm)	34.742	30.904	24.237	15.848	6.847
Displacement value of RFS (mm)	34.495	30.506	23.894	15.77	7.075
Displacement value of RGS (mm)	35.207	31.318	24.614	16.236	7.222
Displacement value of A15CS (mm)	34.802	30.956	24.277	15.872	6.854

Displacement value of A30CS (mm)	35.013	31.131	24.404	15.944	6.874
Displacement value of A45CS (mm)	35.468	31.504	24.672	16.093	6.915
Displacement value of A15FS (mm)	36.057	31.883	24.97	16.476	7.387
Displacement value of A30FS (mm)	37.133	32.554	25.498	16.82	7.534
Displacement value of A45GS (mm)	43.387	38.3	29.932	19.658	8.683
Displacement value of A15GS (mm)	35.269	31.374	24.658	16.263	7.23
Displacement value of A30GS (mm)	35.475	31.543	24.78	16.332	7.249
Displacement value of A45GS (mm)	35.915	31.903	25.038	16.476	7.288



Graph 1 Dispalcement report for all the cases

The detail of displacement for all the analyzed model is been given above. It is been seen that the **RCS and RFS** Case are showing least displacement and the **A45CS** case is showing maximum value of 43 mm.

6. Conclusions

- The displacement of A45GS shows maximum value along both the lateral direction which is approximately 10 % more than RCS and RFS case model.
- The RFS case can be said most suitable case in replace of conventional RCC slab.

References

1. CH. Lokesh Nishanth "***Analysis and design of commercial building with different slab arrangements using ETABS",*** Materials Today: Proceedings, 33 (2020), 700–704, DOI: 10.1016/j.matpr.2020.05.823
2. Divya D. Gawand et. al. , ***"Comparative Study Of Flat Slab And Conventional Slab Using Etabs Software For Different Earthquake Zones In India"*** International Research Journal of Engineering and Technology, e-ISSN: 2395-0056 Volume: 08 Issue: 02, Feb 2021
3. Ms. Priyanka Chandanshive et. al., "***Comparative Analysis and Design of Flat Slab & Grid Slab in Multistoreyed Building Under Seismic Condition"***, IOSR-2017, Pages 29-32.
4. P. Sharmini, X. Steni, ***"Comparative Study On Seismic Behaviour of Flat Slab and Grid Slab Using ETABS",*** International Journal of Research in Engineering, Science and Management ,Volume-3, Issue-4, April-2020, ISSN (Online): 2581-5792.
5. Dr Ramakrishna Hegde et. al., ***"Comparative Study On Seismic Analysis Of Conventional Slab, Flat Slab And Grid Slab System For A R.C Framed Structures"*** International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 05 Issue: 09 | Sep 2018.