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Comparative Study Of Conventional Slab And Grid Slab Using Etabs In Earthquake Zoning In India

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Abstract—

The rapid growth of the urban population and the consequent pressure on limited space has considerably influenced multi-storied building construction. With increase in demand for space, construction of multi-storied buildings is becoming a necessary part of our living style. These multi-storied buildings can be constructed using various structural systems. Two main groups according to the arrangement of slabs, beams or girders, and columns are Framed Structure and flat slab structure. Framed structures are the structure having the combination of beams, columns and slabs to resist the lateral and gravity load. These structures are usually used to overcome the large moments developing due to the applied loading. Grid slab consists of beams spaced at regular intervals in perpendicular directions which are monolithic with slab. These slabs are generally used for architectural purpose for large spans such as public assembly halls, auditoriums; show rooms were the slab has to cover a large column free space is required. Since gird slab offers more stiffness the rectangular voided pattern is used in present. In this project, we are going to compare the structural behaviour of both grid slab and conventional slab in multi-storied building. This multi-storied building structure will be analysed not only considering the vertical loads (dead load & live load), it also includes lateral load (earthquake load). Earth quake loads will be considered for all different zones in India. Structural modelling & analysis will be done using ETABS software.

Keywords— Grid slab, Conventional slab, Lateral load, ETABS software

I. INTRODUCTION

Slab is a flat two dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or two directions. Reinforced concrete slabs are used in floors and roofs of buildings. Conventional slabs are supported on monolithic concrete beams and columns as framed structure system (or) it can be directly supported by walls. The grid slabs are only supported by beams when used in the areas where less number of columns provided.

Grid slab systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is required. Often the main requirement, the rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of the beams running in perpendicular directions are generally kept the same.The grid Slab depths typically vary from 75 to 125 mm and rib widths from 125 to 200 mm. grid spacing of 600 to 1500 mm can be used. The overall depth of the floor typically varies from 300 to 600 mm with overall spans of up to 15 m if reinforced, longer if post-tensioned. The use of grids to the soffit of the slab reduces the quantity of concrete and reinforcement and also the weight of the floor. The saving of materials will be offset by the complication in formwork and placing of reinforcement. However, formwork complication is minimised by use of standard, modular, reusable formwork, usually made from polypropylene or fibreglass and with tapered sides to allow stripping. For grids at 1200-mm centres (to suit standard forms) the economical reinforced concrete floor span ‘L’ is approximately D x 15 for a single span and D x 22 for a multi-span, where D is the overall floor depth. The one-way ribs are typically designed as T-beams, often spanning in the long direction. A solid drop panel is required at the columns and load bearing walls for shear and moment resistance.

II. SCOPE OF THE PROJECT

- Grid slabs are effective systems for multi storied buildings with less number of columns but these slabs are mostly not employed in Indian conditions.
- Predicting the behaviour of grid slabs and conventional slabs under seismic loads using Equivalent Static Method and Response spectrum method.
- It will provide sufficient information and confidence to go for grid slabs in future construction in India.

III. OBJECTIVE OF THE PROJECT

- To study the structural performance of grid slab and conventional slab structure subjected to various loads and conditions.
- To the study the behaviour of both structures for the parameters likes lateral displacement, story drift.
- Comparison of grid slab and conventional slab in RCC building for the above said parameters.

IV. SOFTWARE USED

The modelling, computer aided analysis of the models under study is done using Three Dimensional Analysis of Buildings and Structures software ETABS.

MODELS CONSIDERED

G+18 storey RCC buildings are taken for this project. The building has plan dimensions of (30 m x 18 m). The size of slab panel is 6m x 6m and the storey height is 3.6m in the entire floor including the ground Floor. M30 grade concrete and Fe415 structural steel is used. In seismic weight calculations, 25 % of the floor live loads are considered. G+18 storey RCC buildings with conventional slab and grid slab are analysed. The buildings adopted consist of reinforced concrete and brick masonry elements. The frames are assumed to be firmly fixed at the bottom and the soil– structure interaction is neglected.

V. DESIGN DATA OF BUILDING

Design data of conventional slab and grid slab are listed in Table 1.1.

Table 5.1 Design Data

DESCRIPTION	CONVENTIONAL SLAB	GRID SLAB
No. of Stories	G+18	G+18
Plan area of the building	30 m x 18 m	30 m x 18 m
Typical storey height	3.6 m	3.6 m
Total height of building	64.8 m	64.8 m
Slab panel size	6 m x 6 m	6 m x 6 m
Slab thickness	200 mm	100 mm
Beam size taken	0.3 m x 0.75 m	0.3 m x 0.75 m
Column size taken	0.6 m x 0.6 m	0.6 m x 0.6 m
Soil type	Medium	Medium
Earthquake zones	II, III, IV & V	II, III, IV & V
Importance factor, I	1.5	1.5
Response reduction factor	5	5
Grade of concrete	M30	M30
Grade of steel	Fe415	Fe415
Support conditions	Fixed	Fixed
Grid spacing	-	1.5m c/c

VI. LOAD CONSIDERATIONS

3-D model is prepared with the above specifications for the Static and Dynamic analysis of the building in ETABS. The dead, live and earthquake load considerations that are taken into account are explained in detail.

Dead and Live loads

The basic loading parameters for dead and live loads, considered for the design are based on IS 875 (part 1):1987 and IS 875(part2):1987. The loadings are as shown in Table 1.2

Table 6.1 Dead Load and Live Load

Loads	Conventional slab	Grid slab
Live load	3.0 kN/m^2	3.0 kN/m^2
Floor finish	1.0 kN/m^2	1.0 kN/m^2
Wall load	13.2 kN/m	13.2 kN/m

LOAD COMBINATIONS

1.5(DL+LL)
1.2(DL + LL ± EQX)
1.2(DL + LL ± EQY)
1.5(DL ± EQX)
1.5(DL ± EQY)
0.9DL ± 1.5 EQX
0.9DL ± 1.5 EQY
1.2(DL + LL ± RSX)
1.2(DL + LL ± RSY)
1.5(DL ± RSX)
1.5(DL ± RSY)
0.9DL ± 1.5 RSX
0.9DL ± 1.5 RSY

Where EQX & EQY and RSX & RSY are lateral force obtained from static analyses and Response spectrum analyses in X and Y direction respectively.

VII. CONVENTIONAL SLAB

In a G+18 RC building, 200 mm thickness of conventional slab is provided in all stories. The height of each storey is 3.6m including the base storey. The width of the wall is 6 m in all directions and it's provided from the base to the top storey of building. Rigid diaphragm is assigned for all floors.

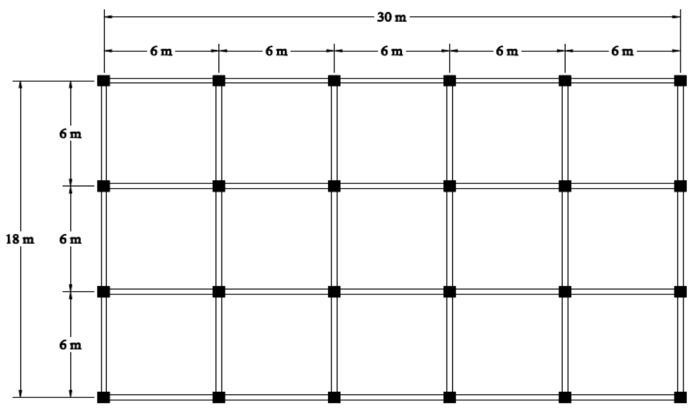

Fig. 7.1 Plan Layout of conventional slab

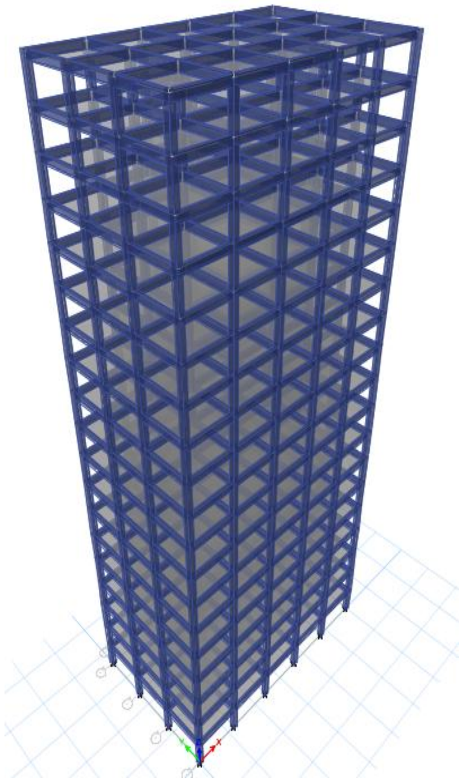

Fig. 7.2 3D view of conventional slab

GRID SLAB

In a G+18 RC building, 100 mm thickness of grid slab is provided in all stories. The centre to centre spacing between the grids is given as 1.5m. The height of each storey is 3.6m including the base storey. The width of the wall is 6 m in all directions and it's provided from the base to the top storey of building. Rigid diaphragm is assigned for all floors.

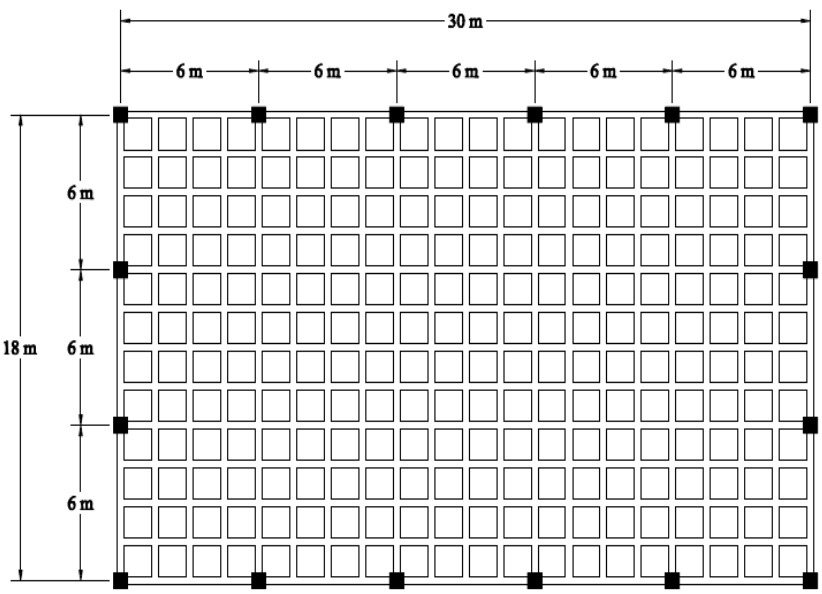

Fig.7.3 Plan Layout of Grid slab

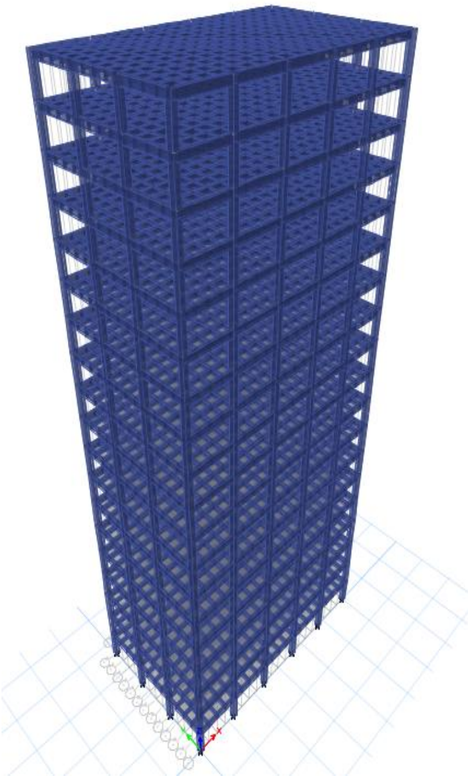

Fig. 7.4 3D view of Grid slab

VIII. RESULT AND ANALYSIS

The analysis is run and the necessary data such as maximum storey drift and displacement of the structure are taken into account for comparison and the maximum storey displacement variations, all zone values in the buildings are also compared. From the seismic analysis, the results obtained in X and Y directions are illustrated. The result are found for two methods such as,

- Seismic co-efficient method
- Response spectrum method

MAXIMUM STOREY DISPLACEMENT

- Maximum storey displacement is the maximum lateral displacement of a structure under seismic loads. It is observed that the results obtained for conventional slab and grid slab model using linear static analysis is higher than the results obtained in linear dynamic analysis. Maximum storey displacement will usually occur at the top storey of building and the lateral displacement of building under seismic load using the equivalent Static and the response spectrum analyses is shown below.

STOREY DRIFT

- Storey drift is the displacement of one level relative to other level above or below. It was checked whether the structure satisfies maximum permissible relative lateral drift criterion as per IS: 1893-2002 (Part-I) which is 0.004H for both conventional slab and grid slab. The storey drift of all models using equivalent static method and response spectrum method is shown in below.

Table 8.1 Displacement for Conventional & Grid slab for Zone II

(X -Direction): (Seismic co-efficient method)

Storey	Conventional slab	Grid slab
(No)	(mm)	(mm)
19	29.322	35.495
18	28.768	34.89
17	27.999	34.023
16	27.021	32.892
15	25.857	31.526
14	24.531	29.953
13	23.066	28.201
12	21.482	26.295
11	19.8	24.261
10	18.038	22.123
9	16.215	19.9
8	14.347	17.615
7	12.448	15.283
6	10.532	12.924
5	8.611	10.55
4	6.698	8.176
3	4.801	5.816
2	2.936	3.497
1	1.166	1.332

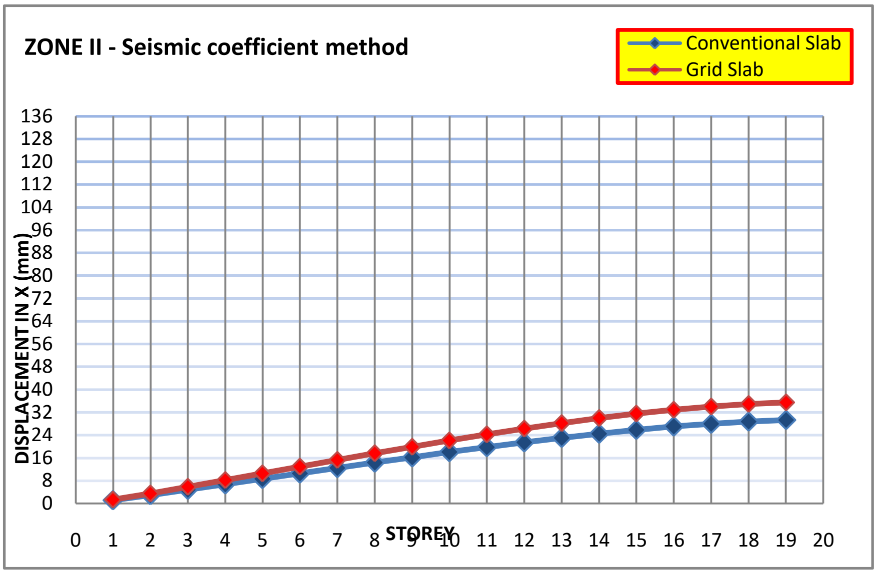

Fig.8.1 Graph storey vs displacement

Table 8.2 Displacement for Conventional & Grid slab for Zone II

(Y -Direction): (Seismic co-efficient method)

Storey	Conventional slab	Grid slab
(No)	(mm)	(mm)
19	32.4	48.836
18	31.604	47.842
17	30.594	46.512
16	29.377	44.843
15	27.979	42.867
14	26.422	40.62
13	24.732	38.14
12	22.93	35.463
11	21.037	32.621
10	19.075	29.647
9	17.063	26.57
8	15.018	23.419
7	12.958	20.219
6	10.898	16.993
5	8.853	13.763
4	6.834	10.551
3	4.856	7.383
2	2.937	4.317
1	1.146	1.564

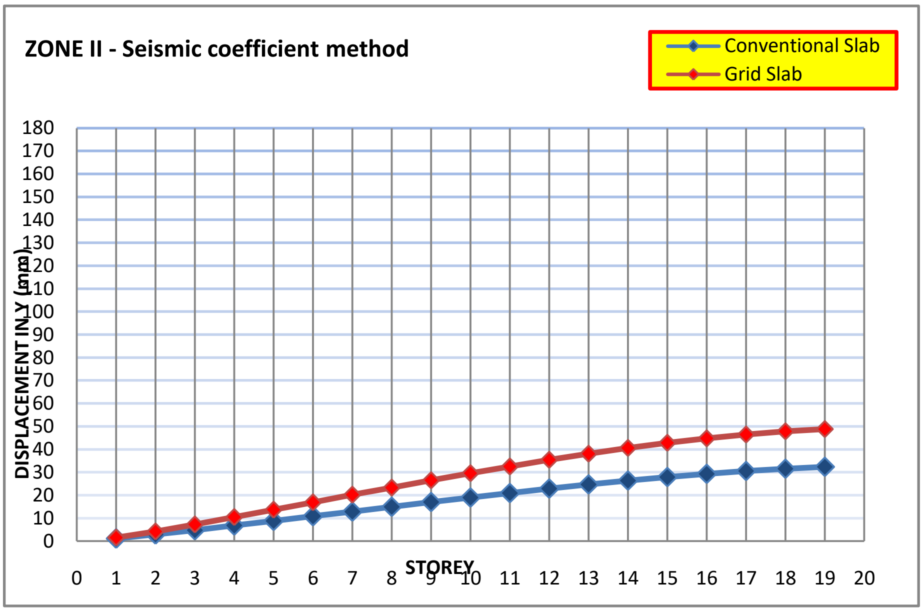

Fig. 8.2 Graph storey vs displacement

Table 8.3 Displacement for Conventional & Grid slab for Zone III (X -Direction): (Seismic co-efficient method)

Storey	Conventional slab	Grid slab
(No)	(mm)	(mm)
19	46.915	56.792
18	46.028	55.824
17	44.799	54.437
16	43.234	52.628
15	41.372	50.442
14	39.25	47.925
13	36.905	45.121
12	34.371	42.072
11	31.68	38.818
10	28.861	35.396
9	25.944	31.841
8	22.955	28.183
7	19.916	24.454
6	16.851	20.678
5	13.778	16.88
4	10.716	13.082
3	7.681	9.306
2	4.698	5.595
1	1.866	2.131

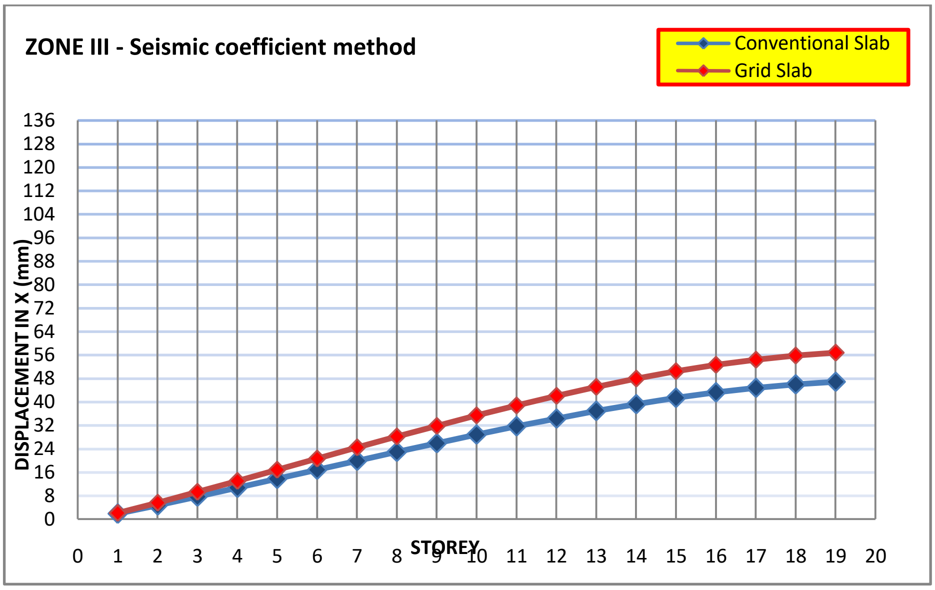

Fig .8.3 Graph storey vs displacement

Table 8.4 Displacement for Conventional & Grid slab for Zone III (Y -Direction): (Seismic co-efficient method)

Storey	Conventional slab	Grid slab
(No)	(mm)	(mm)
19	51.84	78.138
18	50.566	76.548
17	48.95	74.418
16	47.004	71.749
15	44.766	68.587
14	42.276	64.993
13	39.571	61.025
12	36.687	56.74
11	33.66	52.193
10	30.521	47.435
9	27.301	42.512
8	24.029	37.47
7	20.733	32.35
6	17.437	27.188
5	14.164	22.021
4	10.935	16.882
3	7.77	11.813
2	4.699	6.907
1	1.834	2.502

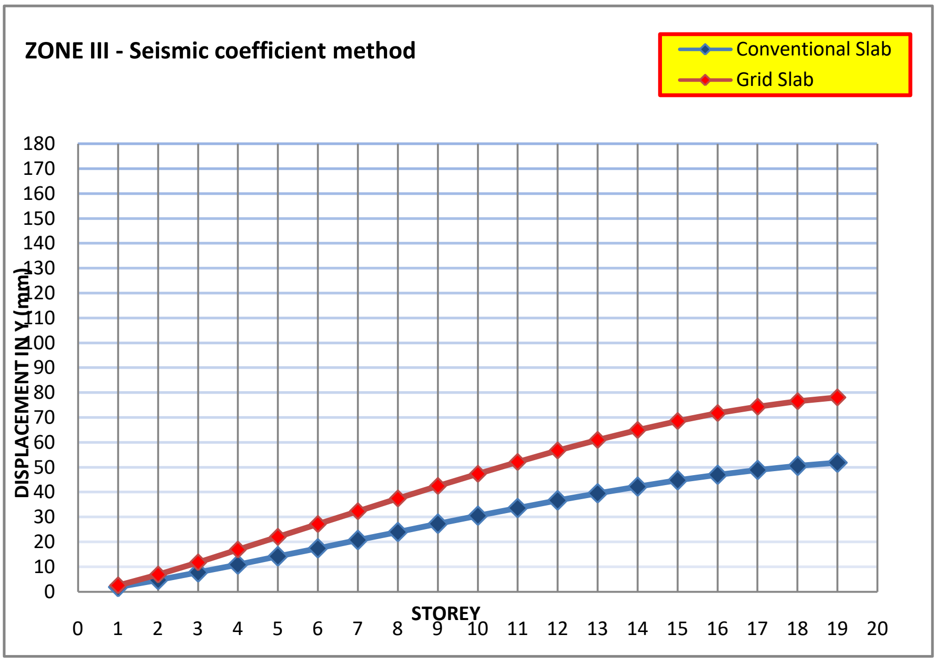

Fig. 8.4 graph storey vs displacement

X. CONCLUSION

Present study is carried out to study the comparison between grid slab and conventional slab under four different seismic zones for various parameters and from the above results it can be concluded that,

- The Lateral displacement of both conventional slab and grid slab are having minimum at plinth level and maximum at terrace level, as the number of stories increases lateral displacement also increases.
- When compared to conventional slab, grid slab having more displacement in all seismic zones
- The lateral displacement of both conventional slab and grid slab are found out for seismic co-efficient method and response spectrum method and when comparing the displacement value obtained from seismic co-efficient method are greater than response spectrum method.
- Storey drift is having minimum value at plinth, top stories and maximum at middle stories, thus extra stiffness of column requires at middle stories compared to other stories in both seismic co-efficient method and response spectrum method.

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