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DYNAMIC ANALYSIS OF FLAT SLAB AND GRID SLAB SYSTEM IN A MULTISTOREY BUILDING

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ABSTRACT

The development of multi-storeyed buildings has been greatly impacted by the fast increase in urban populations and the resulting strain on restricted space. The development of multi-story buildings is becoming an integral element of our way of life due to the rising need for space. A variety of structural techniques may be used in the construction of these multi-story structures. Framed structures and flat slab structures are the two primary categories based on the configuration of slabs, beams, girders, and columns. In order to withstand the effects of gravity and lateral loads, framed constructions use a mix of slabs, columns, and beams. When huge moments form as a result of applied stress, these structures are often used to counteract them. Many newly-built structures use flat slab construction, in which the slab rests directly on columns, to satisfy architectural and economic demands for lower floor-to-floor heights.

Keywords - Flat slab, Grid slab, Base shear, Shear force and Building drift.

I. INTRODUCTION

1.1 FLAT SLAB SYSTEM

Reinforced concrete slabs with or without dips, often supported by columns with or without flared heads, are known as flat slabs. The soffit of a flat slab could be solid or have recesses cut into it in two directions, creating a pattern of ribs. The filler bricks used to create the recess might be either permanent or removable. Beamless slabs are flat slabs of reinforced concrete that are supported directly by columns rather than beams. A panel is a section of the slab that is encircled on all four sides by the column's midline.

The flat slab is often thickened close to supporting columns to provide adequate strength in shear and to reduce the amount

ability to resist two-way shear and decreases the negative bending moment at the support.

1.2 GRID SLAB SYSTEM

Ground systems with a grid pattern that are monolithic and comprised of beams separated at regular intervals in perpendicular directions. As a general rule, architects will use them to create column-free spaces in big rooms like auditoriums, vestibules, theatre halls, and retail showrooms. In many cases, it is obligatory. For hidden architectural lighting, the ceiling void that forms in a rectangle or square shape is ideal. In most cases, the dimensions of the beams that run perpendicular to the ground remain constant. A diagonal beam grid would be better than a rectangular one.

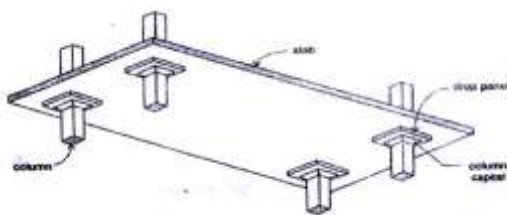


Figure-Flat slab system

of negative reinforcement in the Support regions. The term "drop" or "drop panel" describes the thicker area that protrudes below the slab. Some columns have their top sections enlarged where they connect to the floor slab or a drop panel. This is done to raise the critical section's perimeter, which increases the slab's

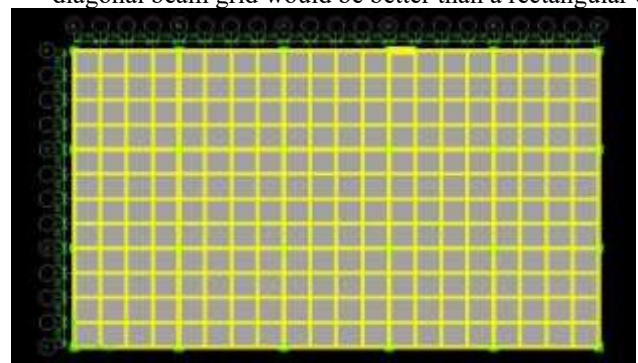


Figure-Grid slab system

II. METHODS OF ANALYSIS

2.1 ANALYSIS OF FLAT SLAB

The Indian Standard Codes provide the guidelines for design of flat slabs. These are basically empirical and are supported by the vast experimentation. But since the standard experimentation has been done on standard layouts and configuration of the slabs, these design procedures are limited in their scope and applicability. Nowadays, irregular layouts are becoming common, and it is this light that standard codal procedures seem inadequate. Methods of analysis of flat slabs-

1. Direct design method (DDM)
2. Equivalent Frame method (EFM)
3. Finite element method (FEM)

2.2 ANALYSIS OF GRID SLAB

For inclosing large area rooms such as theatre hall and auditoriums, where column free space is the main requirement, grid floors are used. Grids with diagonal members are called diagonal grids. Thickness of slab and edge beam of small grid can be analysed by the conventional method as in ribbed slab. Large grid floor which do not follow these restricted layouts are analysed by other methods. This method can be divided into three groups:

1. Method based on plate theory (Approximate Methods)
2. Stiffness matrix method using computer
3. Equating deflection method of each intersecting node by simultaneous equation.

Preliminary Data for 12-story Flat slab building

1	Length in X-direction	41 m
2	Length in Y-direction	24.6 m
3	Floor to floor height	3.6 m
4	No. of Stories	12
5	Total height of Building	43.2 m
6	Slab Thickness	250 mm
7	Drop thickness	450 mm
8	Size of the Column	1-3 story-950 mm x 950 mm 3-6 story- 850 mm x 850 mm 6-9 story-750 mmx750 mm 9-12 story-650 mmx650 mm
9	Grade of concrete	M25

10	Grade of Steel	Fe415	
11	Panel Dimensions	8.2mx8.2m	
12	Zone-II	Soil Type 1- Roc k or hard soil	
Soil Type 2- Medium soil			
Soil Type 3 -Soft soil			
13	Loading	Terrace	Floors
14	Dead load (FF)	1 KN/m ²	1 KN/m ²
15	Live load	1.5 KN/m ²	3KN/m ²
16	Wall load	12 KN/m	12KN/m

Preliminary Data for 12-story Grid slab building

1	Length in X-direction	41 m	
2	Length in Y-direction	24.6 m	
3	Floor to floor height	3.6 m	
4	No. of Stories	12	
5	Total height of Building	43.2 m	
6	Slab Thickness	115 mm	
7	Edge Beam	230mmx 865 mm	
8	Size of the Column	1-3 story-950 mm x 950 mm	
		3-6 story- 850 mm x 850 mm	
		6-9 story-750 mmx750 mm	
		9-12 story-650 mmx650 mm	
9	Grade of concrete	M25	
10	Grade of Steel	Fe415	
11	Panel Dimensions	8.2mx8.2m	
12	Grid spacing	2.05m c/c	
13	Zone-II	Soil Type 1- Roc k or hard soil	
		Soil Type 2- Medium soil	
		Soil Type 3 -Soft soil	
14	Loading	Terrace	Floors
15	Dead load (FF)	1 KN/m ²	1 KN/m ²
16	Live load	1.5 KN/m ²	3KN/m ²
17	Wall load	12 KN/m	12KN/m

III. LOAD COMBINATIONS

In the limit state design of reinforced and prestressed Concrete structures, the following load combinations shall be accounted-

- 1.5 DL + 1.5 LL
- 1.5 DL+1.5 EQX
- 1.5 DL-1.5 EQX
- 1.5 DL+1.5 EQY
- 1.5 DL-1.5 EQY
- 1.2 DL + 1.2 LL+1.2EQX
- 1.2 DL + 1.2 LL-1.2EQX
- 1.2 DL + 1.2 LL+1.2EQY
- 1.2 DL + 1.2 LL-1.2EQY
- 1.5 DL + 1.5 RSPX
- 1.5 DL-1.5 RSPX
- 1.5 DL-1.5 RSPY
- 1.5 DL+1.5 RSPY
- 1.2 DL + 1.2 LL+1.2RSPX
- 1.2 DL + 1.2 LL-1.2RSPX
- 1.2 DL + 1.2 LL+1.2RSPY
- 1.2 DL + 1.2 LL-1.2RSPY

IV. DYNAMIC ANALYSIS

1. According to the existing code, 90% of the structure's mass has to be included in the response calculation for each principal direction in order to conduct the response spectrum analysis. Consequently, this criterion must be satisfied by the number of modes that are to be examined.
2. With the inclusion of 15 modes, over 90% of flat slab and grid slab construction is accomplished. Hence, fifteen modes are taken into account for every constructed structure.
3. The study is conducted using the response spectrum approach. The response reduction factor is three and the importance factor is one.
4. The analysis is carried out using Eigen Vectors. An analysis is conducted on the case of a rigid diaphragm.
5. The building's layout, mass, and stiffness are regular, thus the centres of mass and rigidity coincide. At (20.5m, 12.3m) you'll find the centre of mass and the centre of stiffness.

V. RESULTS AND DISCUSSION-

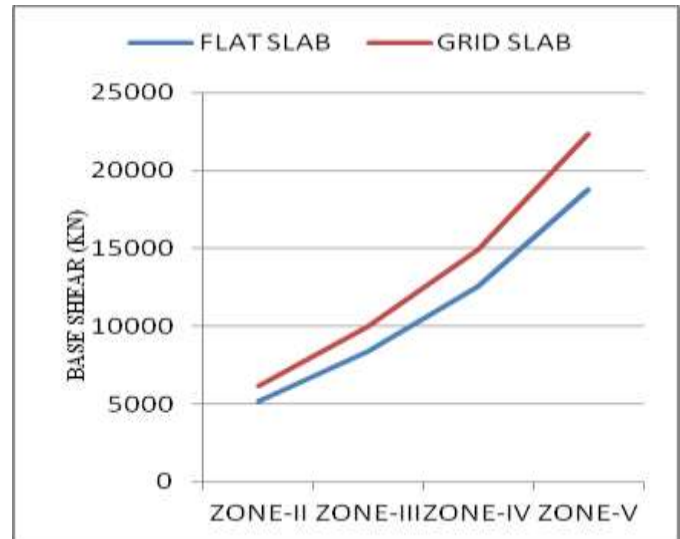
1.1 COMPARISON OF SEISMIC BASE SHEAR

It is the total design lateral force at the base of a structure. The total design lateral force or design seismic base shear (VB) along any principal direction shall be determined by the following expression:

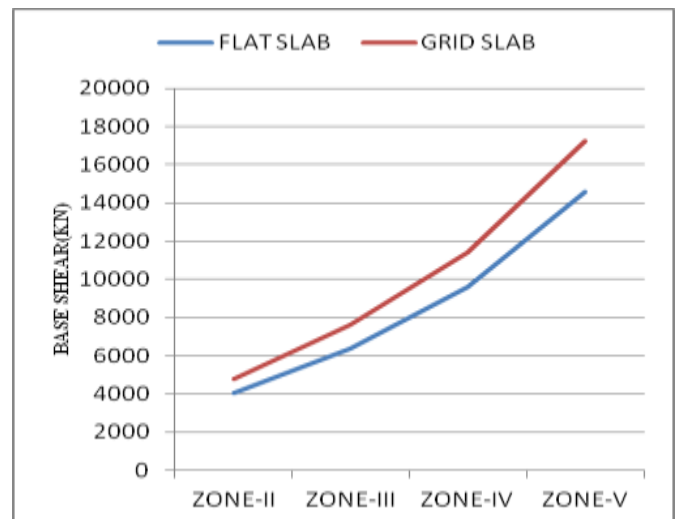
$$V_B = A_h \times W$$

Where-

A_h = Design horizontal acceleration spectrum



Graph 1 Seismic base shear in x-direction for soil type 2



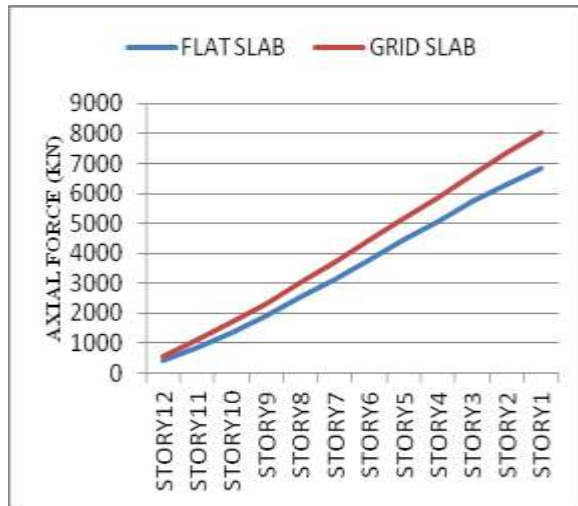
Graph 2 Seismic base shear in Y-direction for soil type 2

1.2 COMPARISON AXIAL FORCE

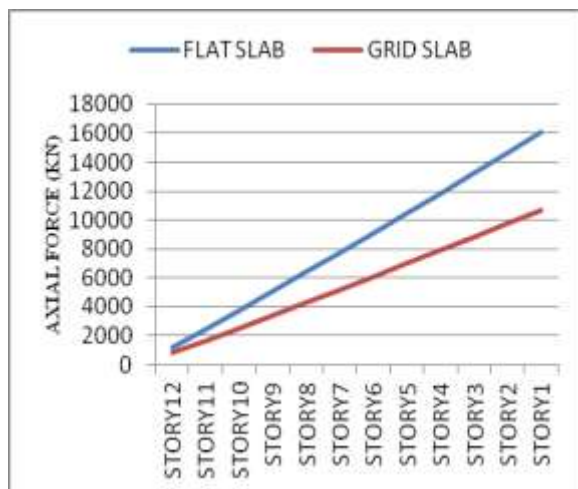
Axial force experienced by each storey of Flat slab and Grid slab is compared for two (End and intermediate columns) columns of each story. Building in zone II and type of strata is medium soil i.e. (soil type 2)



W= Seismic weight of the building



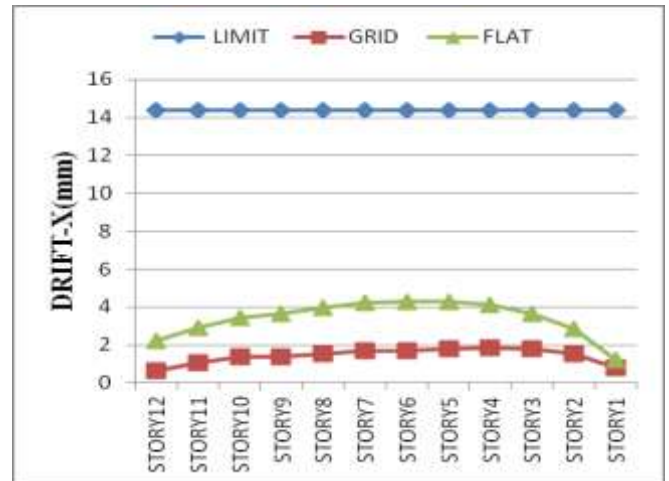
Graph 3 Axial force in end columns



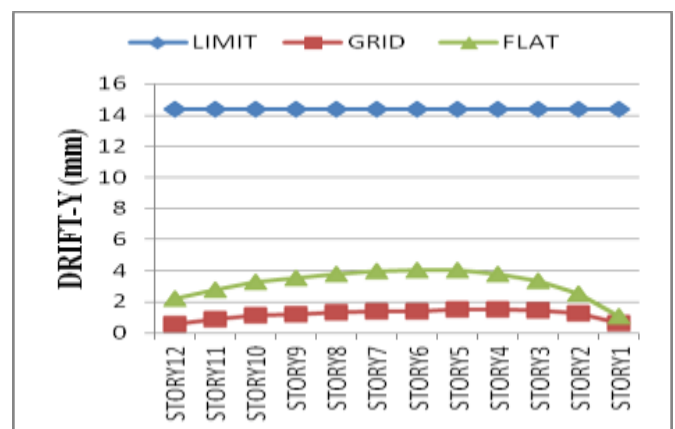
Graph 4 Axial force in intermediate columns

1.3 COMPARISON OF BUILDING DRIFT

Storey drift is defined as difference between lateral displacements of one floor relative to the other floor. Total building drift is the absolute displacement of any point relative to the base. As per IS. 1893-2002 CL.7.11.1; the storey drift in any storey due to the minimum specified design lateral force with partial load factor 1.00 shall not exceed 0.004 times the storey height. In this case storey height is 3600 mm. therefore limited storey drift is calculated as = storey drift / 3600 = 0.004
Therefore, storey drift = 14.4 mm



Graph 5 Comparison of building drift-X, zone II soil-2



Graph 6 Comparison of building drift-Y, zone II soil-2

VI. CONCLUSION

1. The base shear in a grid slab structure is greater in the X- and Y-axes than in a flat slab construction.
2. at contrast to grid slab buildings, flat slab buildings experience less axial stress at their end columns.
3. In a grid slab construction, the axial force in the intermediate columns is less than in a flat slab building.
4. The third story's column experiences the highest shear force possible.
5. Drift in flatslab and grid slab buildings is within the limit in both the X and Y-directions for zone-II and soil type-II construction.
6. Grid slab buildings have reduced building drift in the X and Y axes per story compared to flat slab buildings.

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