International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

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

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ABSTRACT
The rapid growth of the urban population and the consequent pressure on limited space has considerably influenced multi-storeyed building construction. With increase in demand for space, construction of multi-storeyed buildings is becoming a necessary part of our living style. These multi-storeyed 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.
The flat slab buildings in which slab is directly rested on columns, have been adopted in many buildings constructed recently due to the advantage of reduced floor to floor heights to meet the economical and architectural demands.
Keywords - Flat slab, Grid slab, Base shear, Shear force and Building drift.

I. INTRODUCTION

1.1 FLAT SLAB SYSTEM

The term flat slab means a reinforced concrete slab with or without drops, supported generally without beams, by columns with or without flared heads, A flat slab may be solid slab or may have recesses formed on the soffit so that a soffit comprises a series of ribs in two. directions. The recess may be formed of permanent or removable filler blocks. A reinforced concrete flat slab, also called as beamless slab, is a slab supported directly by columns without beams. A part of the slab bounded on each of the four sides by centerline of column is called panel. The flat slab is often thickened closed to supporting columns to provide adequate strength in shear and to reduce the amount

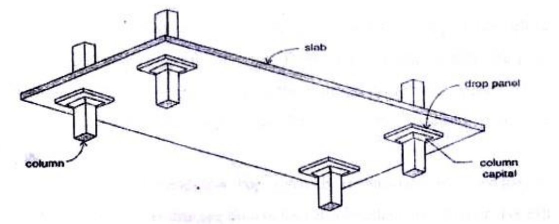

Figure-Flat slab system

of negative reinforcement in the Support regions. The thickened portion i.e. the projection below the slab is called drop or drop panel. In some cases, the section of column at top, as it meets the floor slab or a drop panel, is enlarged so as to increase primarily the perimeter of the critical section, for shear and hence, increasing the capacity of the slab for resisting two-way shear and to reduce negative bending moment at the support.

1.2 GRID SLAB SYSTEM

Grid floor 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. Instead of rectangular beam grid, a diagonal.

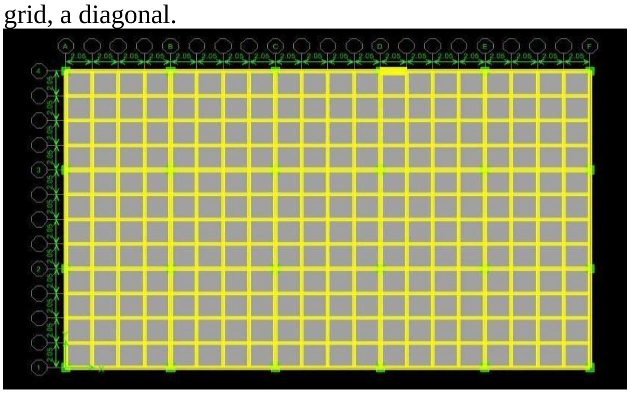

Figure-Grid slab system

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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

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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. For the response spectrum analysis the current code states that “at least 90 percent of the participating mass of the structure must be included in the calculation of response of each principle direction. Therefore number of modes to be evaluated must satisfy this requirement.
2. By considering 15 modes participation of flatslab and grid slab building is achieved more than 90 % Therefore for all buildings 15 modes are considered.
3. Response spectrum method is used for the analysis. Importance factor and response reduction factor are considered as 1 and 3 respectively.
4. Eigen Vector analyses are used for analysis. Rigid diaphragm action is considered for analysis
5. Centre of mass & centre of rigidity coincides, due to regularity in the plan, mass and stiffness of the building. Centre of mass & centre of rigidity lies at (20.5m, 12.3m)

V. RESULTS AND DISCUSSON-

5.1 COMPARISION OF SEISMIC BASE SHEAR

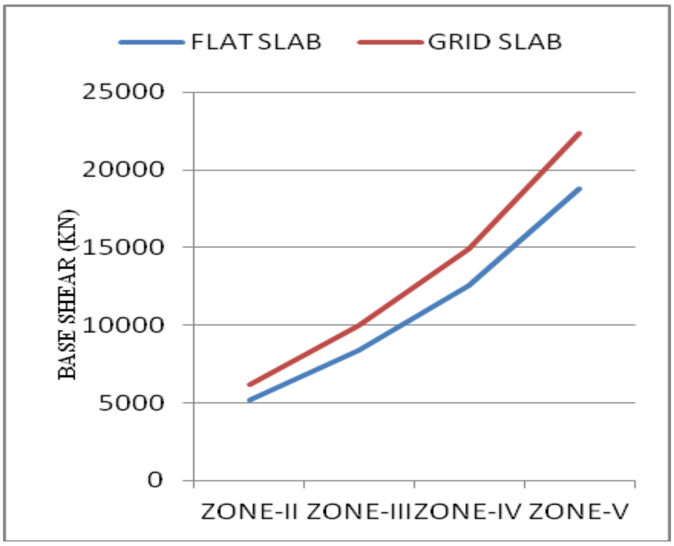
It is the total design lateral force at the base of a structure. The total design lateral force or design seismic base shear (VB) along any principal direction shall be determined by the following expression:

$$V_B=A_h \times W$$

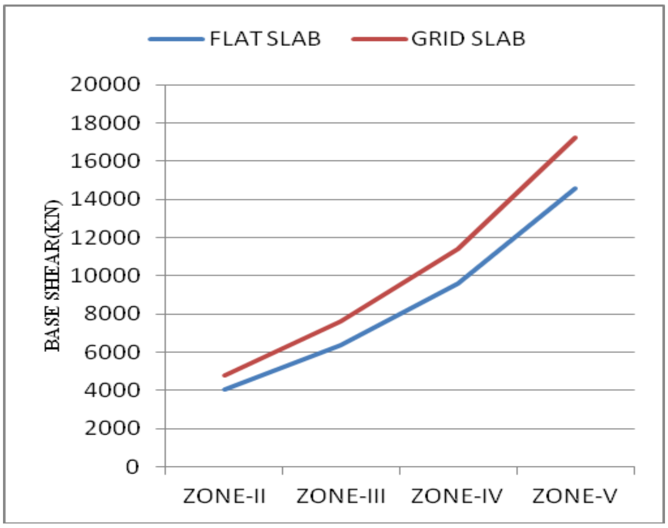
Where-

A_h =Design horizontal acceleration spectrum

W= Seismic weight of the building



Graph 1 Seismic base shear in x-direction for soiltype2



Graph 2 Seismic base shear in Y-direction for soiltype-2

5.2 COMPARISION 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)

Index in Cosmos
May 2024, Volume 14, ISSUE 2
UGC Approved Journal

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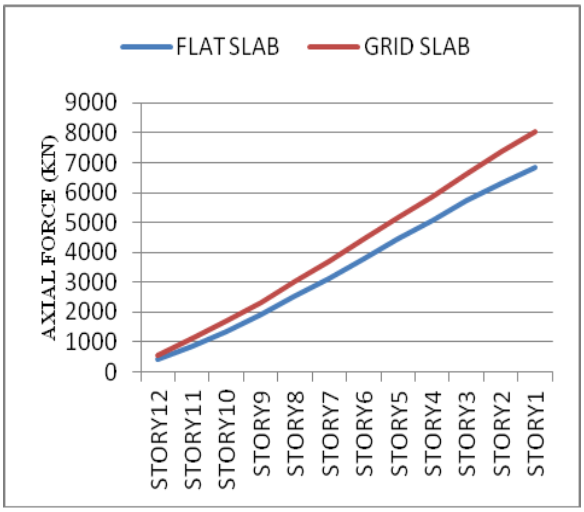
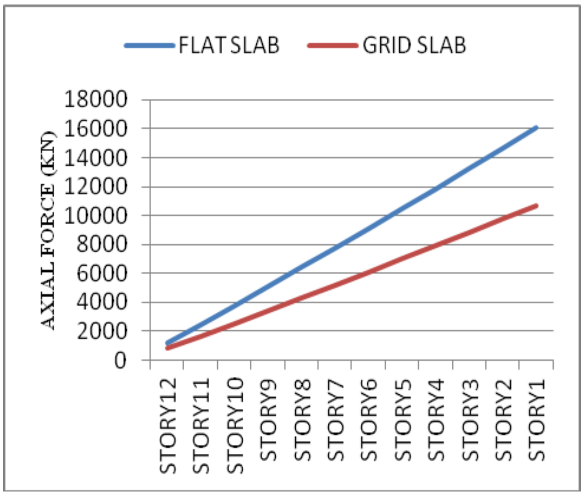


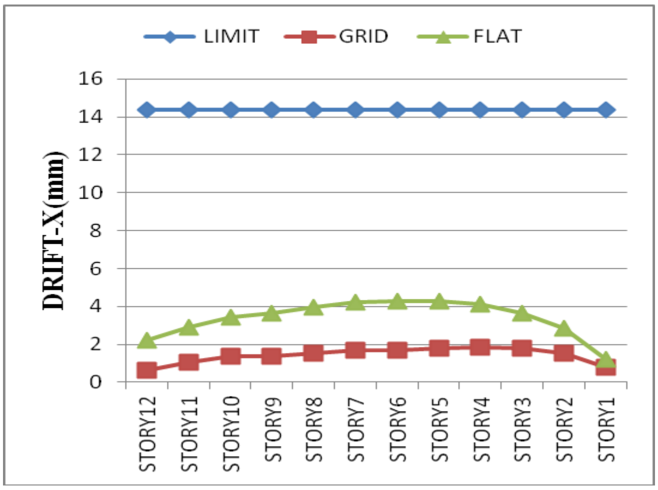
Graph 3 Axial force in end columns



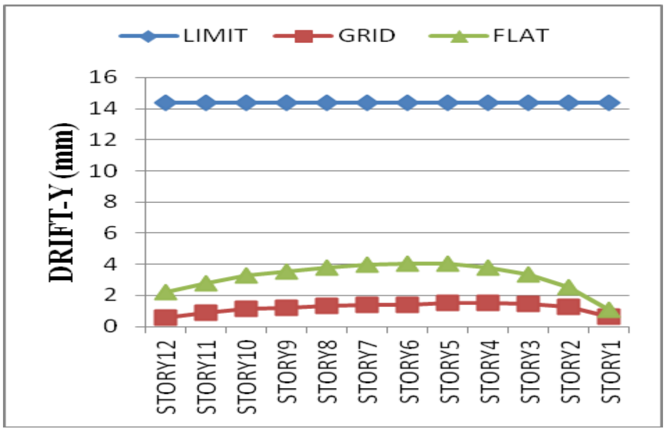
Graph 4 Axial force in intermediate columns

5.3 COMPARISION 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. Base shear of flat slab building is less than the base shear in grid slab building in both X and Y-directions.
2. Axial force in end columns of flat slab building is less as compared to grid slab building.
3. Axial force in intermediate columns of flat slab building is more as compared to grid slab building.
4. Maximum shear force is ocurs in column of story-3
5. For zone-II and soil type-II building drift in flatslab building and grid slab building is within limit in both X and Y-directions.
6. Building drift in grid slab building is less as compared to flat slab building in each story in both X and Y-directions.

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