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A Study on the Behavior of Grid Slab Subjected to Seismic Loading

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Abstract - *A grid is a planar structural system composed of continuous members that either intersect or cross each other. Grid slab is a very popular structural configuration deployed for the construction of hotel porticos, airport terminal buildings, large banquet hall, convention centres and car parks. A load set on a cable or a beam is channelled to the support along the cable line or the beam axis, an arch, a frame, and continuous beam produce the same type of one–directional load dispersal type. A G+9 Storey Grid slab structure is considered for this study and the models are analysed with seismic zone IV, this models are modelled in ETABS 2016 Software, and the analysis is carried out using a response spectrum method. The comparison is made on the two models for base shear, storey drift, storey displacement and storey stiffness. It was concluded that the Box effect of modular type scheme, it is increasing overall stiffness of the building thus, reducing the sway problem in the structure and As spacing of grid beams decreases higher will be load carrying capacity of the building.*

Key Words: **Grid Slab1, Earthquake forces2, Seismic zone IV3, Response spectrum analysis4**

1. INTRODUCTION

A grid is a planar structural system composed of continuous members that either intersect or cross each other. Grids are used to cover large column free areas and have been constructed in number of areas in India n abroad. Is subjected to loads applied normally to its plane, the structure is referred as Grid. It is composed of continuous member that either intersect or cross each other. Interconnected grid systems are being commonly used or supporting building floors, bridge decks and overhead water tanks slabs. Grids in addition to their aesthetically pleasing appearance provide a number of advantages over the other types of roofing systems.

Grid slab (waffle slab) is a very popular structural configuration deployed for the construction of hotel porticos, airport terminal buildings, large banquet hall, convention centres and car parks. Void space formed in the underside of waffle slabs are utilized for architectural lighting. This type of slab has more structural stability without using a lot of additional material. This makes a waffle slab perfect for large flat areas like foundations or floors. Waffle foundations are resistant to cracking and sagging and can hold a much greater amount of weight than traditional concrete slabs. In almost all constructions slab system includes openings for multi purposes like stairs, air conditioning ducts and elevators. And also the opening with smaller dimensions is needed to accommodate heating, plumbing, and ventilating risers, floor and roof drains, and access hatches. The behaviour of waffle slabs are modified by the presence of these openings. Introducing openings will reduce the strength of waffle slabs.

1.1 Types of Grids

- Orthogonal grid
- Diagonal grid
- Three way grid
- Hexagonal grid
- Skew grid (It is comparatively strong as the stress distribution is uniform)

2. Objectives

- A G+9 Storey Grid slab structure is considered for the study purpose and the models are analysed with seismic zone IV and the results are compared.
- The building models with grid slabs are modelled and analysed using ETABS Software.
- To compare the responses of grid slab models with seismic zones IV for base shear, storey drift, storey displacement and storey stiffness.
- To know the behaviour of the grid slab structure.
- To know the performance of the structure under seismic conditions.

3. Methodology

The step by step procedure followed to achieve the above objectives are;

1. An extensive literature review is carried out to establish the above objectives for the project work.
2. G+9 storey structure is chosen for the present investigation.
3. ETABS software is chosen for modelling and analysis of the selected structure.
4. To understand the behaviour of structure, model-1 is considered with varying seismic zone at Zone IV.

3.1 Modelling

Table-1: Grid slab building with seismic Zone IV

Number of storeys	G+9
C/C distance between columns in X-direction	6m
C/C distance between columns in Y-direction	6m
Foundation level to ground *level*	3m
Floor to floor height	3m
Live load on all floors	3kN/m^2
Live load on Roof	1.5kN/m^2
Floor Finish	1.5kN/m^2
Materials	M25 and Fe415
Size of column	500x500mm
Seismic zone IV	0.24
Soil Type	II

Table-2: Grid Slab Properties

Type of steel	Fe_{415}
Grade of concrete	M_{25}
Overall depth	400mm
Slab thickness	100mm
Stem width at top	125mm
Stem width at bottom	125mm
Spacing of ribs along X-direction	1000mm
Spacing of ribs along y-direction	1000mm

Fig-1: Plan of Model

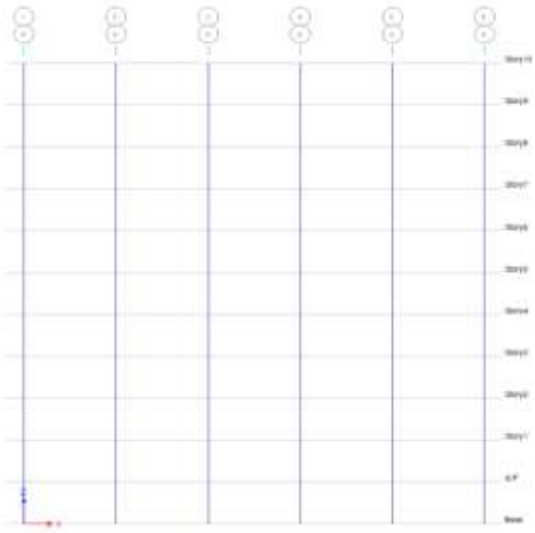

Fig-2: 2D Elevation

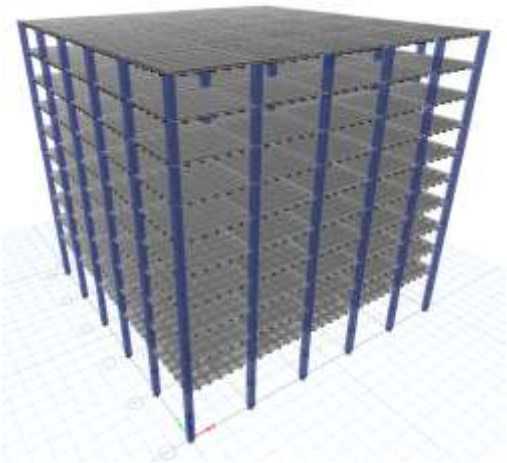

Fig-3: 3D View of Model

4. Analysis Results

This chapter deals with results and discussion of multi storey building with grid slab subjected to seismic forces in Zone IV.

- Model - Structure subjected to seismic forces in Zone IV

Results are obtained for the following parameters:

- Storey displacement
- Storey drift
- Storey acceleration
- Storey forces
- Storey stiffness
- Base shear
- Time Period
- Frequency

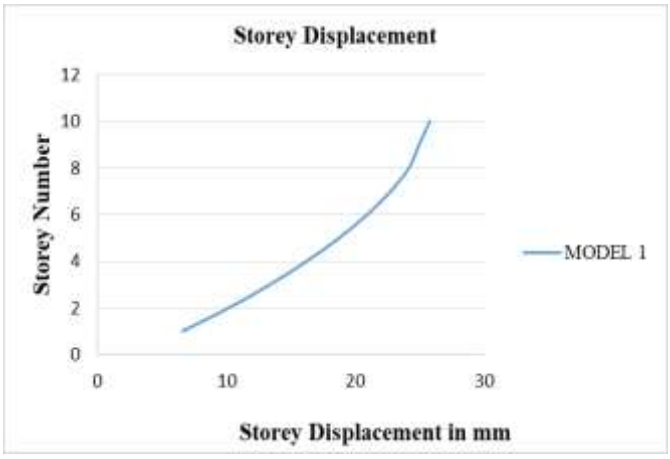

Chart-1: Storey Displacement

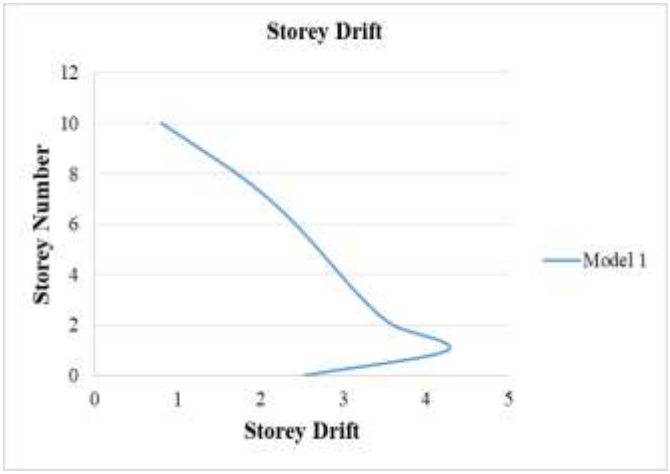

Chart-2: Storey Drift

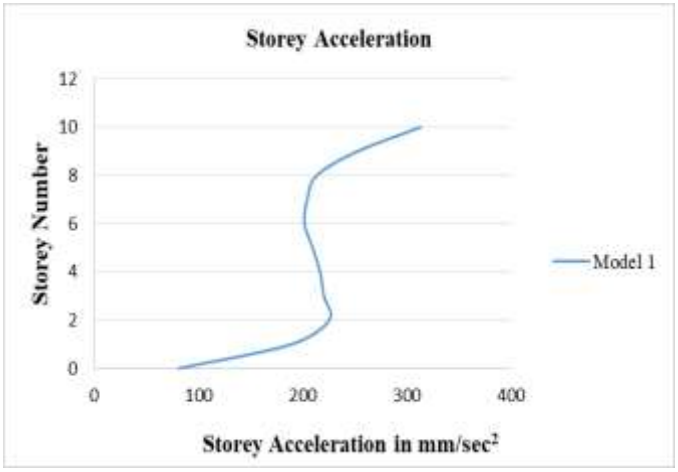

Chart-3: Storey Acceleration

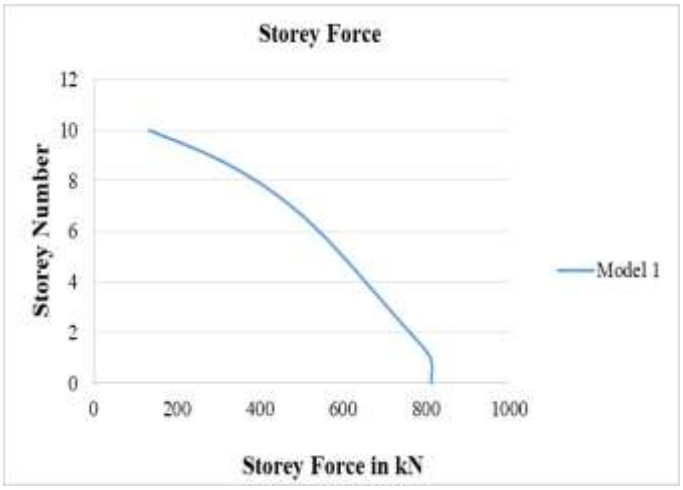

Chart-4: Storey Force

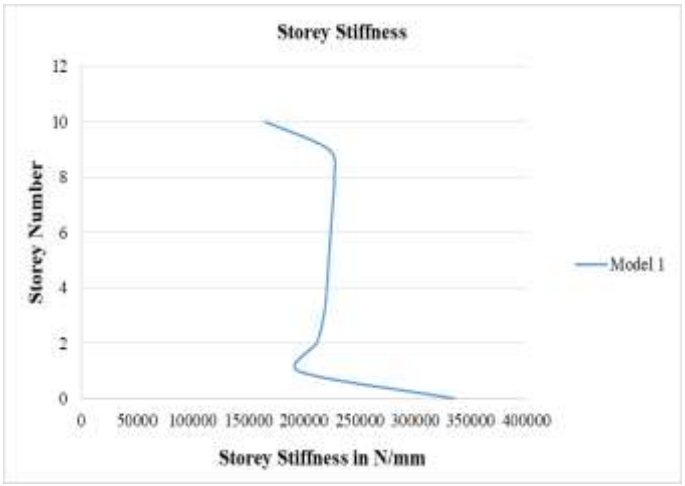

Chart-5: Storey Stiffness

Chart-6: Base Shear

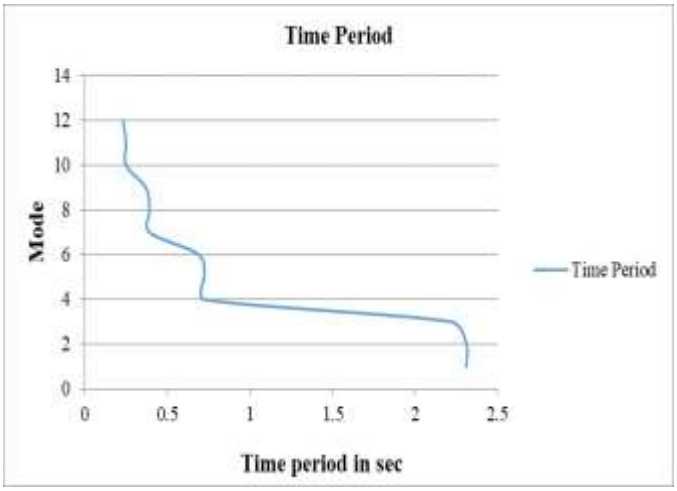

Chart-7: Time Period

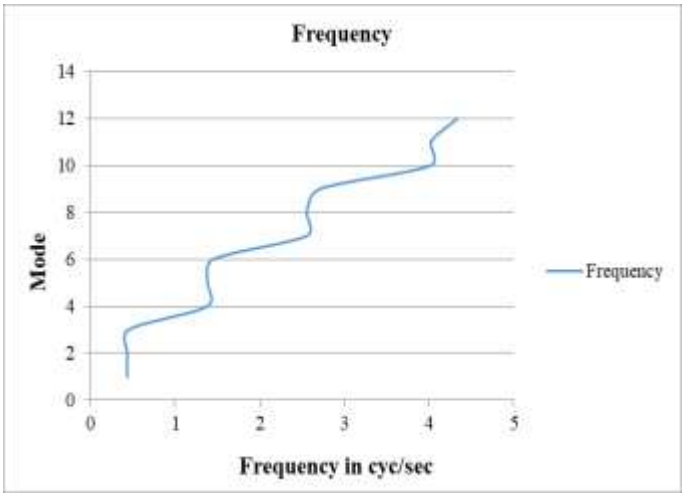

Chart-8: Frequency

5. CONCLUSIONS

The behaviour of multi-storey building with grid slab with varying seismic intensity is studied in the present paper. By comparing various parameters such as displacements, storey drifts, storey acceleration, storey force and base shear. Hence from the obtained results the following conclusions are made,

1. The storey displacement for grid slab with zone IV seismic intensity has a lesser displacement values.

2. It is clear that as the seismic intensity increases the response of the building varies accordingly.

3. Because of the Box effect of modular type scheme, it is increasing overall stiffness of the building thus, reducing the sway problem in the structure.

4. As building is symmetric in plan the behaviour in both directions is similar. Further, the comparison between regular and modular type indicates the overall feasibility of the scheme without affecting its stability in gravity as well as lateral loads.

5. As spacing of grid beams decreases higher will be load carrying capacity of the building.

6. By providing smaller spacing between the grid beams performance of the building can be enhanced.

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