Comparative Study of Flat Slab and Conventional Slab using Software Aid

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Abstract

Configuration of building is very much important for good seismic performance of the building. The important aspects affecting seismic configuration of a building are overall geometry, structural system and load part. Those parameters are behaving different way in flat slab structure and conventional slab structure. Research on the design of structure has started not only India but in other developed countries also. The building still damages due to some or other reasons due to earthquake. In spite of all the weakness in the structure either code imperfection or error in analysis and design, the structure configuration system has played a vital role in Calamity. In general normal frame construction utilize column, slab and beam .however it may be possible undertake construction without providing beams, in such a case the frame system would consist a slab and column without beam. In our study it has been planned to analyses a building having flat slab and conventional slab under the effect of various loading conditions. The focus of our project is to compare the behavior of building having flat slab and having conventional slab using software aid.

Keyword- Building, flat-slab, seismic, storey height, parametric beams, weight reduction

I. INTRODUCTION

The current work is focused on the Comparative Study of flat slab and conventional slab. The configuration involves the conventional frame structures which acting on different loading circumstances. The conventional R.C. and flat slab having different conditions in framework so, they are performing different way on different loading circumstances. Components of flat slab and conventional R.C. slab are dissimilar so the performance was studied in terms of , lateral displacement, time period, base shear, story drift, base shear, in linear analysis by means of code-IS 1893 (part-1):2002. The complete modelling, analysis, and design were put into execution by the mean of SAP 2000 software.

Advantages of flat-slab reinforced concrete structures are widely known but there are also known the disadvantages concerning their earthquake resistance. It is Remarkable that both Greek codes, Reinforced Concrete Code and Seismic Code do not forbid the use of such structural systems however both Codes provide specific compliance criteria in order such structures to be acceptable.

The advantages of these systems are:

- 1) The ease of the construction of formwork.
- 2) The ease of placement of flexural reinforcement.
- 3) The ease of casting concrete.
- 4) The free space for water, air pipes, etc. Between slab and a possible furred ceiling.
- 5) The free placing of walls in ground plan.
- 6) The use of cost effective pressurising methods for long spans in order to reduce slab thickness and deflections as also the time needed to remove the formwork.
- 7) The reduction of building height in multi-storey structures by saving one storey height.

A. Material Properties and Loads

This work has been analysed using SAP 2000 software. For the analysis the material properties like grade of concrete, steel, density, modulus of elasticity must be define initially. And also the various loads like dead, live, SDL, wind, seismic needs to be define earlier. Concrete grade: M20 Steel Reinforcement bars: HYSD bars Fe415

Steel Reinforcement bars: HYSD bars Fe415 Modulus of elasticity E: $2 \times 10^{5} \text{ N/mm}^2$ Live loads: 5 kN/m^2 SDL: 3.5 kN/m^2

B. Structural Modelling

Structural modelling has been done in SAP-2000. Structural model has been prepared by using the following data as input

C. Model Description

Building Details		
	Flat Slab	Conventional Slab
Column Size	500 mm X 500 mm	500 mm X 500 mm
Beam Size	230 mm X 180 mm(Hidden beam)	230 mm X 600 mm
Slab Size	180 mm thick	150 mm thick
No. of Bays	5 No.	5 No.
C/c Span length	3.50 mt	3.50 mt

Table 1: Building Configuration

D. Description for Loading

The loading on the buildings is considered as per following calculations

- 1) Dead Loads
- a) Wall load of 230mm thickness on all beams =20x3x0.23 = 13.8KN/m ≈ 14 KN/m
- b) Wall load of 230mm thickness on all beams =20x1x0.23 = 4.60KN/m ≈ 5 KN/m
- c) Dead load of Floor finish on slab = 1 KN/m^2
- d) Self-weight of building is automatically considered by the SAP 2000 software.
- 2) Live Loads
- 3) Live load of on slab = 4 KN/m^2
- 4) Earthquake Forces Data

Earthquake load for the building has been calculated as per IS-1893-2002:

- a) Response Reduction Factor (R) = 5
- b) Importance Factor (I) = 1.5
- c) Damping Ratio (DM) = 0.05
- d) Earthquake zone and soil type has been changed as per requirement.
- 5) Loading Combinations

The different loading combinations for the analysis of the building have been taken automatically by SAP-2000.

E. Draw Model

After defining all properties now draw the frame section & area section & assign the restrained conditions. 3D view of Structural is shown in Fig.



Fig. 1: View of Structural model of Flat Slab in SAP 2000



Fig. 2: View of Structural model of Conventional Slab in SAP 2000

F. Design of Flat Slab (Direct Design Method)

For the analysis and design of flat slab different methods are available like finite element, equivalent frame, and direct design methods. In this present work direct approach is adopted for manual design of flat slab and to check for punching shear against software. Flat slabs are more vulnerable to punching shear because of the absence of beam. In direct design method following criteria must be satisfied for design of flat slab. • The panel must be square or rectangle • Ratio of longer span by shorter span not more than 2 • Live load should not be more than 3 times design dead load. In the present work only manual design of flat slab taken and punching shear values of software is compared with manual calculated punching shear.

II. RESULTS AND DISCUSSIONS

The study of results has been divided in following points:

- Comparison of Natural time period of Flat slab building and Conventional R.C. framed building of 13 floors for various mode shapes.
- Comparison of Shear forces, Bending moments, Axial forces in columns at ground level due to all load combination forces for Flat slab building and Conventional R.C. framed building of 13 floors.
- Comparison Base shear force, maximum top storey displacement (Sway) and Shear forces, Bending moments, Axial forces in columns at ground level due to earthquake force for Flat slab building and Conventional R.C. framed building of 13 floors for different earthquake zone in medium soil condition.
- Comparison Base shear force and maximum top storey displacement (Sway) for Flat slab building and Conventional R.C. framed building of 13 floors for different soil condition in earthquake zone 5.
- Comparison of Natural time period, Base shear force, maximum top storey displacement (Sway) and Shear forces, Bending moments, Axial forces in columns at ground level due to all load combination and due to earthquake force for different numbers of floors of Flat slab building and Conventional R.C. framed building up to 13 floors in earthquake zone 5 and medium soil condition.

A. Natural Time Period

Graph of comparison of Natural time period of Flat slab building and Conventional R.C. framed building of 13 floors for various mode shapes.



Fig. 3: Graph Sowing Natural Time Period for various Mode Shapes for Flat slab and Conventional RC slab structure

B. Comparison Graphs for 13 Story Flat Slab And Conventional RC Slab Structure

Graphs of comparison of Shear forces, bending moments, Axial forces in columns at ground level due to all load combination forces for Flat slab building and Conventional R.C. framed building of 13 floors







Fig. 5: Comparison of Axial force due to load combination for Flat slab and Conventional RC slab structure

C. Comparison Graphs for 13 Story Flat Slab And Conventional RC Slab Structure For Different Earthquake Zones

Graphs of comparison Base shear force, maximum top storey displacement (Sway) and Shear forces, Bending moments, Axial forces in columns at ground level due to earthquake force for Flat slab building and Conventional R.C. framed building of 13 floors for different earthquake zone in medium soil condition.



Fig. 6: Comparison of Base shear for Different Earthquake Zone for Flat slab and Conventional RC slab structure



Fig. 7: Comparison of Floor Sway for different Earthquake Zone for Flat slab and Conventional RC slab structure

D. Comparison Graphs for 13 Story Flat Slab And Conventional RC Slab Structure For Different Soil Type

Comparison Base shear force and maximum top storey displacement (Sway) for Flat slab building and Conventional R.C. framed building of 13 floors for different soil condition in earthquake zone 5.



Fig. 8: Comparison of Base shear for different Soil Type for Flat slab and Conventional RC slab structure



Fig. 9: Comparison of Floor Sway for different Soil Type for Flat slab and Conventional RC slab structure

E. Comparison Graphs for Different Number of Floors of Flat Slab and Conventional RC Slab Structure

Graphs of comparison of Natural time period, Base shear force, maximum top storey displacement (Sway) and Shear forces, Bending moments, Axial forces in columns at ground level due to all load combination and due to earthquake force for different numbers of floors of Flat slab building and Conventional R.C. framed building up to 13 floors.



Fig. 10: Graph Sowing Natural Time Period for change in numbers of floor of Flat slab and Conventional RC slab structure



Fig. 11: Graph Sowing Base Shear for change in numbers of floor of Flat slab and Conventional RC slab Structure



Fig. 12: Graph Sowing Column axial force due to load combinations for change in numbers of floor of Flat slab and Conventional RC slab structure



Fig. 13: Graph Sowing Column axial forces due to Earthquake load for change in number of floor of Flat slab and Conventional RC Slab structure



Fig. 14: Graph Sowing Sway for change in numbers of floor of Flat slab and Conventional RC slab structure



Fig. 15: Graph Sowing Column Moment due to Earthquake load change in numbers of floor of Flat slab and Conventional RC Slab

III. CONCLUSION

Based on Static Analysis and Dynamic Analysis of Flat slab building and Conventional R.C. framed buildings, the following conclusions are drawn:

- In comparison of the conventional R.C. building to flat slab building, the time period is more for conventional building than flat slab building because of monolithic construction.
- The time period will be maximum at mode 1, 2 and 3. After mode 3, time period will reduce drastically.
- The natural time period is increases as the numbers of floors increases.
- Base shear of conventional R.C. framed building is more than the flat slab building.
- Base shear in flat slab is increases constantly up to 3 floors and then it increases very slowly. And in conventional R.C. framed it increases up to 6 floors and then it decreases slowly.
- Story drift (Sway) in buildings with flat slab construction is significantly more as compared to conventional R.C.C building. As a result of this, additional moments are developed. Therefore, the columns of such buildings should be designed by considering additional moment caused by the drift.
- Sway at terrace level is maximum for both types of building.
- Sway increases as the numbers of floors increases.
- Axial force on column due to all load combination is approximately same in both building but shear force and bending moment is comparatively more in conventional slab building.
- The column behaviour changes as height of the building increases.
- The columns have been designed for the combination of dead load and earthquake load for all cases and the load combination 1.5[DL±EX] is the most critical.
- The column moments are more in conventional R.C. building compared to flat slab building.
- As increasing earthquake zone, all forces acting on both structures are increases constantly.
- Building in soft soil is more critical than building situated in medium and hard soil.

IV. FUTURE SCOPE OF WORK

- The structure can be compared with post tensioned slab designed methods.
- The structure behaviour different Seismic zones and its Behaviour of Buildings having Flat Slabs with Drops.
- The structure can be analysed with effect of Shear Wall.
- The same study may be carry out by using steel structure.

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