Comparative Study of Flat Slab and Conventional Slab Structure Using ETABS

Mr.B.R.Navale[1] *PG Student Civil Engineering, AVCOE, Sangamner*

DR. M.R. Wakchaure[2] *Civil Engineering, AVCOE, Sangamner*

Abstract

In today's construction activity the use of flat slab is quite common which enhances the weight reduction, speed up construction, and economical. Similarly from the beginning conventional slab has got place in providing features like more stiffness, higher load carrying capacity, safe and economical also. As the advancement era began practice of flat slab becomes quite common. In the present dissertation work a G+9 commercial multistoried building having flat slab and conventional slab has been analyzed for the parameters like base shear, story drift, axial force, and displacement. The performance and behavior of both the structures in all seismic zones of India has been studied. In the present work the storey shear of flat slab, the axial forces on flats slab building, the difference in storey displacement of flat and conventional building are approximately calculated by using ETABS software. The present work provides reasonable information about the suitability of flat slab for various seismic zones without compromising the performance over the conventional slab structures.

The main objective of the present work is to compare the behaviour of multi storey buildings having conventional RC frame, flat slab without drop and to study the effect of height of building on the performance on these types of buildings under seismic forces. Linear dynamic response spectrum analysis and nonlinear dynamic time history analysis is performed on the structure to get the seismic behaviour.

Key Words: *flat slab, drop, conventional slab, storey shear, storey displacement, axial forces.*

I) INTRODUCTION

Flat slab is system of construction is one in which slab is directly rest on the column. The slab directly rests on the column and load from the slab is directly transferred to the columns and then to the foundation. To support heavy loads, the thickness of slab near the support is increased and these are called drops and columns are generally provided with enlarged heads called column heads or capitals.

These increasing thickness of flat slab in the region supporting columns provide adequate strength in shear and to increase the amount 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. Flat slab structure is preferred over conventional structure in construction due to their advantages in reducing storey height and construction period as compared with conventional structure leading to reduction of construction costs.

Because of absence of deep beam flat slab building structures are more significantly flexible than conventional concrete structures, thus becoming more vulnerable to seismic loading. Thus the seismic analysis of these structures is necessary to know the vulnerability of these structures to seismic loading.

The main aim of this project is to study the performance of flat slab and Conventional slab structures for various loads in all seismic zones factors

Methods of Analysis

The analysis can be performed on the basis of external action, the behavior of structure or structural materials, and the type of structural model selected. Based on the type of external action and behavior of structure, the analysis can be further classified as given below-

- Equivalent static analysis:
- Nonlinear Static Analysis
- Response Spectrum Method
- Time History Method

II) EXPERIMENTAL METHODOLOGY

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 have same conditions in framework so, they are performing same way on same 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 ETABS. To know the performance of the structure it should be subjected to all type loadings, all seismic zones factors, various soil categories then only we can extract best choice or suitability parameter for the structures.

In the present dissertation work a G+9 commercial multistoried building having flat slab and conventional slab has been analyzed. The performance and behavior of both the structures in all seismic zones of India has been studied.

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 innovative and revolutionary new ETABS is the ultimate integrated software package for the structural analysis and design of buildings. Incorporating 40 years of continuous research and development, this latest ETABS offers unmatched 3D object based modelling and visualization tools, blazingly fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and easily decipher and understand analysis and design results.

III) EXPERIMENTAL PROCEDURE

A) The following flow chart shows the steps involved in the analysis by ETABS

1. Defining dimensions of the plan
2. Defining the members and material properties
3. Assigning loads and load combinations
4. Run check model to find errors
5. Run Analysis
6. Extract Results and Discussions

B) Material Properties and Loads:

This work has been analyzed using ETABS 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.

Grade of concrete: M20
Grade of steel: Fe 500
Modulus of elasticity E: 2x105N/mm2
Live loads: 5kN/m2
SDL: 3.5kN/m2

C) Model Description

Number of stories	G + 9
Height of each storey	3.7 m
Total height of building	40.7 m
Number of bay's along X	4
Number of bays along Y	4

D) Structural Elements Details

Columns	700 x 700
Beams	600 x 750, 500 x 750
Flat slab	200 mm
Flat drop	450 mm
Conventional slab	175 mm

E) Earthquake and Wind Load Data

The structures are more vulnerable to lateral loads, as the height of building increases the structures becomes flexible and prone to damage. Hence lateral loads are mainly derived from seismic and wind loads for which structure needs to be analyzed:

Seismic Zone	III
Zone Factor Z	0.16
Importance Factor I	1
Response Reduction Factor	3
Damping Ratio	0.05
Type of Soil	Medium
Basic Wind Speed Vb	33 m/sec
Design Wind Pressure Pz	1.6 KN/m2

F) Load Calculation:

Self weight: 0.65x1x25 = 16.25kN/m2

Live load: 5kN/m2

SDL: 3.5kN/m2

Total load = 24.75kN/m2

Ultimate load = 1.5x24.75= 37.125kN/m2

Design load on the slab= 37.125x10x8 = 2970kN

G) Load Combinations

The structure is analyzed considering proper ratios of the applied dead loads, live loads and seismic loads. The Load combinations are given in IS 1893 (part-1):2002 which has been presented in Table 3 [6].As the seismic loads are assigned in both X and Y direction so E.LX and E.LY should be considered.

S.No	Loads	Factors
1	Dead load	1.5
	Live load	1.5
2	Dead load	1.2
	Live load	1.2
	Seismic Load (X Direction)	±1.2
3	Dead load	1.2
	Live load	1.2
	Seismic Load (Y Direction)	±1.2
4	Dead Load 1.5	1.5
	Seismic Load (X Direction)	±1.5
5	Dead Load	1.5
	Seismic Load (Y Direction)	±1.5
6	Dead Load	0.9
	Seismic Load (X Direction)	±1.5
7	Dead Load	0.9
	Seismic Load (Y Direction)	±1.5

H) Design Technique and Philosophy

Design was conducted according to IS 456-2000 and the SP 24 Manual 13th edition. The LSM approach was used as a design criterion. All load combinations were entered into the model, and the combined load effects were compared to the reduced nominal strengths of the members. In addition to analyzing members under typical load effects, for seismic design, a drift criterion accounting for plastic deformation was enforced as indicated by IS 1893-2000. The structure was designed for serviceability: Deflections of beams under service live load are limited to L/240 and story drifts under 50-year wind events (un-factored wind load) are limited to L/400. A computer model was constructed in ETABS to conduct three-dimensional frame analysis of the structure. The model included only the main beams and the columns; the floor beams and decking were designed by hand. Lateral loads were applied to diaphragms at each floor; diaphragms were assumed rigid as justified by a diaphragm flexibility study.

IV) CONCLUSION

From the analysis of the commercial building, the following conclusions can be drawn:

1. Flat plate/slab construction is a developing technology in India flat slabs has many advantages over conventional slabs and hence it can be a very good option for modern constructions demanding structural stability and state of art aesthetic aspects and prospects.
2. From the output files obtained from Etabs it is observed that if proper supervision is locally made available the construction of flat slabs will prove more economical than conventional slabs.
3. Flat plate/slab can be designed and built either by conventional reinforced concrete or posttensioning. However, due to issues mentioned above with post- tensioning construction in India and its higher cost, conventional reinforced concrete design should be the preferred choice for spans up to 10 meters.
4. Design of conventional reinforced concrete. Flat plate/slab in India, utilizing Indian codes, has many shortcomings, which have to be addressed and revised soon.

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