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Assessment of Different Aspects of R.C. Flat-Slab Building and Its Serviceability

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Abstract: *Flat-Slab building is very popular from the aesthetic and architectural point of view. From functional aspect a flat-slab building is more efficient than a R.C. frame building. So, construction of Flat-Slab building is increasing also in high seismic zone.. In this paper the response of Flat-Slab building and a normal symmetric R.C. frame building of same dimension have been studied for varying seismic intensities and serviceability. Static, Response Spectrum, have been performed to assess the performance of buildings. The costs of construction for these two buildings have also been compared. An extensive study of serviceability has also discussed in the paper. The paper also comments on the cost of the flat slab building and conventional building and there serviceability. Papers also conclude that which building is more serviceable during earthquake.*

Keywords: *Flat slab building, Plastic hinge, , Performance of flat slab and typical R.C. building.*

1. Introduction

Common practice of design and construction is to support the slab by beam and beams by column. This may be called as beam-column construction. The beam reduces the available net clear ceiling height. The aesthetically this type of construction is poor but performance of those buildings are quite good. In recent practice slabs are directly put on the column for aesthetic and architectural point of view. The load transmission path changes due to deletion of beams. But the safety of those building is to be checked. But from the past history it can be understood that the flat is very vulnerable in earthquake point of view. Figure 1.1 shows the flat slab failure in an earthquake.

(a)

(b)

Fig. 1.1: Flat slab failure in earthquake at Tropicana casino parking

Keeping the failure in mind in this dissertation the performance of the flat slab building over a similar conventional building is estimated. Frequency analysis, response spectrum analysis, has performed to ensure the stability of flat slab building. In this paper the feasibility of flat slab in high seismic zone is checked. The cost effectiveness of flat slab over a conventional building is also estimated. The comparison of the response parameters of flat slab and conventional building by using IS:1893-1984 and euro code method is also included in the scope of the paper. The comparison of deflection of flat slab building and conventional building is also presented here.

2. Building data

A multistory frame structure with Flat Slab is to be analyzed. It is G+3 building and the height of the floor is 2.7m. The building is situated on group type C according to Euro code EN 1998-1:2004. The building frame with flat slab is analysis using Finite Element Method. The stability of the frame with flat slab is checked for its stability.

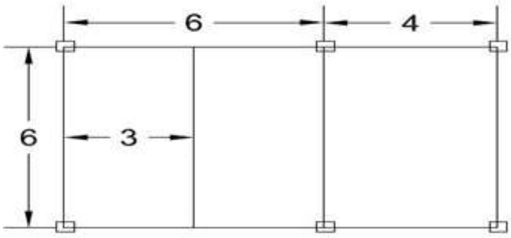

Fig. 3.1: Floor plan of flat slab building

Fig. 3.2: Elevation of flat slab building

The building is considered as an ordinary moment resisting frame (OMRF).

For comparing the performance of the flat slab building with some improvement seven different model of same building has been analyzed. The basic features of those buildings are given in Table-3.1.

TABLE 3.1: The dimensions of the components

Model no.	Slab thickness (mm)	Beam (mm)
Model-1 (Conventional)	150	300 x 400
Model-2 (Flat Slab)	150	No
Model-3 (Thick flat slab)	240	No

The flat slab as well as conventional building models has shown in Fig 3.2.

(a) Flat slab building (b) Conventional building

Fig. 3.2: Two building models

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2.1. Comparison of cost

The cost of the construction of the two building is tabulated in Table-3.2

TABLE 3.2: Comparisons of cost

Parameters		Rate	Conventional building		Flat Slab		Thick Flat Slab	
			Quantity	Cost	Quantity	Cost	Quantity	Cost
Column	Concrete	4927	7.8 m^3	38312	7.8 m^3	38312	7.8 m^3	38312
	Steel	42	612 kg	25722	612 kg	25722	612 kg	25722
Beam	Concrete	4927	15.8 m^3	78044				
	Steel	42	623 kg	26198				
Slab	Concrete	4927	21 m^3	103467	27m^3	133029	43.2m^3	212846
	Steel	42	590	24809	590	24809	885	37170
Total cost (INR)				296552		221872		314050

The cost of construction for flat slab building is more than that of conventional building although the size of column is same. But the main difference is induced due to the more slab thickness. If drop panel or column head is also included then the cost of flat slab construction will increase.

But the cost related to the installation of electrical and mechanical appliances will reduce significantly.

3. Results and Discussion

3.1. Static Analysis Results and Discussion

In static analysis, only self weight of the building considered. Maximum shear stress on the slab of the top floor is shown in Fig-4.1

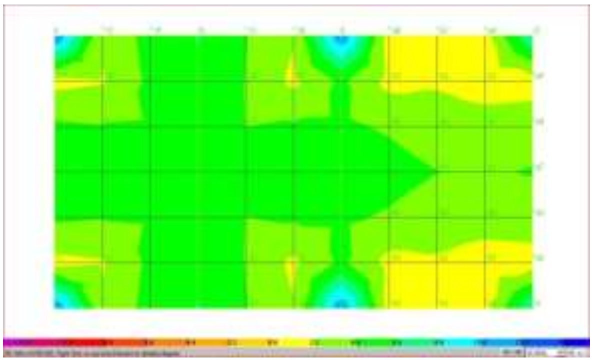

Fig. 4.1: Maximum shear stress (max 13.7 MPa)

The maximum shear stress in the slab is 13.7MPa is observed at junction of the beam and column.

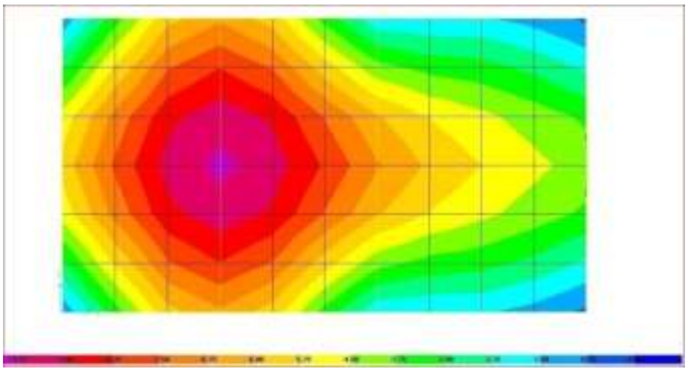

Fig. 4.2: Maximum vertical deflection

The maximum vertical deflection on the slab at top story is 9.75mm and the deformations of the deflection are shown in Fig-4.2.

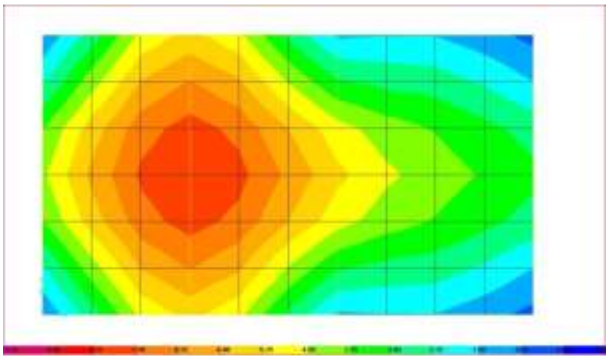

Fig. 4.3: second story max deflection

The maximum deflection on the slab at second story is 8.55mm and in variation of deflection is shown in Fig-4.3. The variation of punching shear is plotted in Fig 4.4.

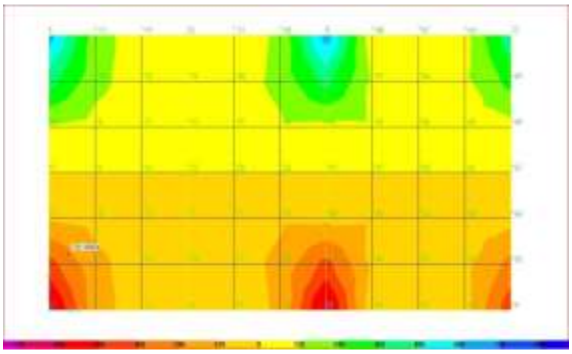

Fig. 4.4: Punching shear of flat slab

Maximum punching shear stress value in the slab is 0.6 MPa at the junction of the column and the maximum permissible value is 3MPa as per IS: 456-2002. If 0.5% longitudinal reinforcement is provided in the slab then the shear capacity of the concrete will be 0.5MPa. So shear reinforcement has to provide at the slab column junction. Maximum shear diagram of beam and column shown in Fig- 4.5

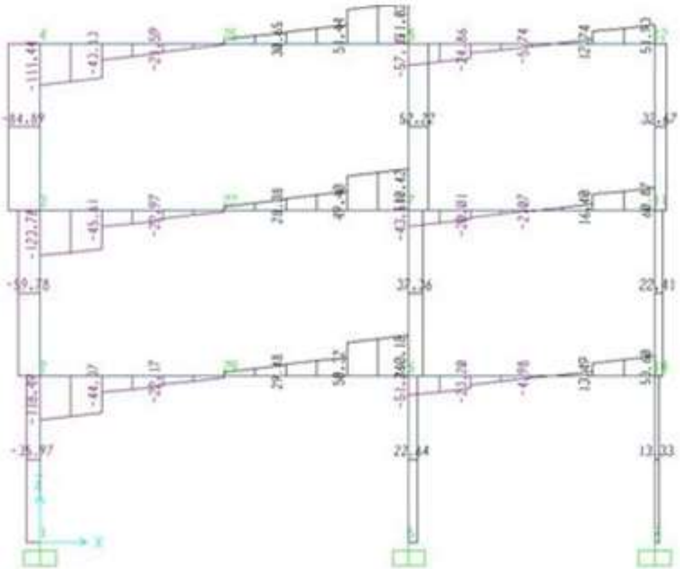

Fig. 4.5: Shear of beam and column (Max 123.78 KN)

The IS: 456-2000 procedure of beam design has followed. Longitudinal reinforcement of the beam is 0.5%. Assuming the bar diameter of the transverse reinforcement is 8 mm then the spacing is 150 mm. The building frame is designed for static loads using various codes. The maximum reinforcement of top and bottom is tabulated in Table-4.1.

4. Conclusion

Different aspect of flat slab building over a conventional building has been assessed for seismic safety. From architectural and mechanical and electrical aspect the flat slab building is more convenient the conventional building.

The same three story flat slab building has been considered as a numerical example. Static analysis has been perform on the building to obtain the reinforcement of the structure by using different building codes for example IS 456, ACI 318, NZ code, EURO code. It can be concluded from the result that Indian code IS 456 suggest maximum amount of reinforcement. Result of shear force, spacing of shear reinforcement and the moment of the beam are compared An similar conventional building has also been analyzed and compared with the flat slab building. Flat slab building is more flexible as compare to conventional building due to more thickness slab. But the comparative stiffness of flat slab building is more than conventional building.

Response spectra analysis is also performed to determine the response of the flat slab and conventional buildings. Indian and Euro codes have been employed to compute the response of the two buildings. Although the flat slab building is more flexible, still show large base shear due to thicker floor slab.

5. References

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