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COMPARATIVE STUDY OF ANALYSIS ON SLABS

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Abstract: There is a rapid evolving of new methods and innovation in recent trends for Structural Elements in Civil Engineering Techniques. One of the proven and most using is Flat Slabs, due to its most advantages in the field and cost of the construction industry. Even though a lot of research work is going on to improve its methodology like susceptible to seismic conditions. Flat slab analysis is executed by finite element method, direct design method and Equivalent load method. The analysis and design are done by using software named SAFE (slab Analysis by Finite element method) and SAP 2000 is used in this Study.

This Study involves dynamic analysis and comparison between three types of slabs like (i) Complete flat slabs (ii) slab with drop panels (iii) slab with beams. A comparative study had been made on Modal Analysis, Bending, Shear Stress and Ductile detailing by using these three types of slabs.

***Keywords*:** Flat slabs, seismic, finite element method, SAP 2000, SAFE.

I. Introduction:

Flat slab is a reinforced concrete slab supported directly on concrete columns or drop panels. Flat slab have no beams. They are supported on columns. Loads are transferred to columns directly. In this type of construction a plain ceiling is obtained and giving an attractive appearance from architectural point of view. The plain ceiling diffuses more light better and is considered less vulnerable in the case of fire than the usual beam slab construction. The flat slab is easier to construct and requires less formwork. The thickness of Flat slab is minimum 8″ or 0.2m.

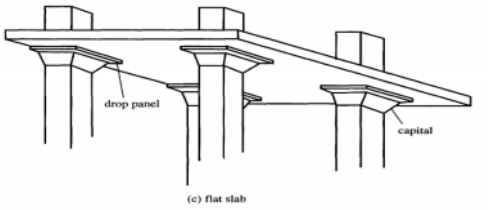

Fig: 1 Flat Slabs

Components of flat slabs:

A. Drop panel:

It is the local thickening of the slab in the of the supporting column. Drop panels or simply drops are provided mainly for the purpose of reducing shear stress around the column supports. The steel requirements for the negative moments at the column supports are reduced. The drops should be rectangular in plan, and have length in each direction not less than one third of the panel length in that direction. The measured length of exterior panels is perpendicular to the discontinuous edge from the centerline of column and they should be one half of the corresponding width of the drop for the interior panel.

Specification: If the drop is at least one third of the smallest span of surrounding panel, then it is effective.

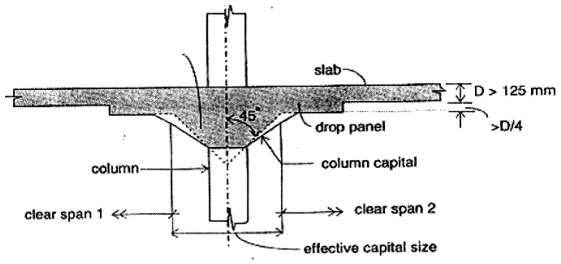

Fig: 2Flat Slab With Both Drop Panel And Column Head

B. Column capital:

The column head or caps provided at the top side of a column are intended primarily to increase the capacity of resisting punching shear in the slab. The flaring of the column at the top is generally done such that the plane geometry in the column head is similar to that of the column. The useful portion of the column capital and that portion which lies within the largest part of typical pyramid or right circularcone, which has a vertex angle with 90° and can be included within the outlines of the column and the column head.

II. Literature Review

ThimmayapallyDileep Kumar[1], A.Mownika Vardhan[2]

ThimmayapallyDileep Kumar studied that the purely flat slab is considered to be more flexible for horizontal loads than the conventional RC frame structure which contributes to the increase of its vulnerability to seismic effects.

JayeshJayantilal Patel[1], Nirajkumar Dubey[2]

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Niraj Kumar Dubey studied the different methods and compared the superiority of the methods. He concluded that the design of flat slab by direct design method has some restrictions. The equivalent frame method is not suitable for simple calculations, so software which is based on finite element analysis is adopted.

S.S.Patil1, Rupali Sigi2

S.S Patil studied the analysis and design by the equivalent frame method with staggered column and without staggered column as prescribed in different codes. He concluded that positive mid span moment is increasing and negative moment is decreasing when we analyze the slab with the equivalent frame method. The negative moment obtained at the sections should be taken care and shall be designed to resist the larger of the two interior negative design moments for the span on common supports.

Gururaja B1 R Sridhar2

Gururaja B studied the analysis of finding the potential of local and global failure of a flat slab building with respect to punching shear distribution. He concluded that the presence of shear wall will eliminate the risk of punching shear failure.

III. Methodology

Methods To Analyse A Slab

Flat slabs are generally supported on columns. The methods used for analysis may be carried out

a) Finite Element Method

b) Simplified Method or Direct Design Method

c) Equivalent Frame Method

Finite ElementMethod:

It is generally used in the analysis of the numerical solution. It can be applied to many other fields. They are generally used by simple, classic or standard method. The main advantage of finite element method is that it can be adapted to a wide range of complex problems; it returns results with suitable accuracy for engineers and others also.

The finite element dicretization of this formulation and the effective solution of resulting finite element equations.These steps are basic and same where ever problem is considered and together with the help of computer present day of natural approach to engineering analysis

IV. Case Study

In this project a model has been firstly analyzed in **SAP2000** and design checked with earthquake load and modal analysis. After the design check the single slab element material and section properties are taken in SAFE software to analyze a single slab with three modals i.e., flat plates, conventional slab and slab with drop panels. The slab dimensions, grade, rebar and surface loading are similar in each case. The comparative study is between its three slabs i.e displacements, bending stress, shear stress, ductile detailing

and modal analysis. The analysis is done separately for each slab model and comparative results are taken.

The 3D analysis of buildings with flat plates, conventional slab and slab with drop panels are done using a standard software, **SAP** 2000 and SAFE software.

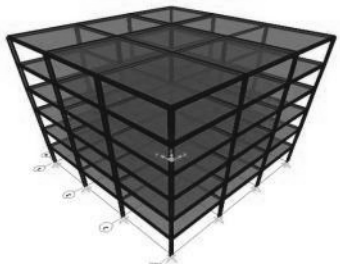

Fig: 3Building Model in SAP 2000.

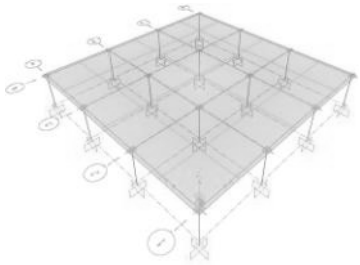

Fig: 4Building Model in SAFE

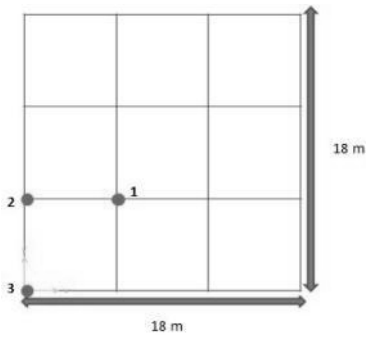

Fig: 5Building Model in SAFE

Table-1Material and section properties

Material and Section properties	
Slab dimensions	150 mm thick
Grade	M 30
Rebar	Fe 415
Beam size	300mm x 450 mm

Column size	350 x 350 mm
Drop size	2000 x 2000 mm
Surface loading	3 kn/m^2

V.Modeling And Analysis

A. Analysis Of Flat Plates

We want to represent the displacements, shear stress and bending stress values within in a table and compare the results which are taken at different locations of slab columns and panels at the center, corner and edge which are shown in plan view of the table - 2. Here in the case of flat plates the maximum negative displacement is at the corner with 3.273 mm and minimum at Center 2.134mm. The maximum bending stress is at corner 15.7 KN and minimum at Center 9.991 KN. The maximum shear stress is at center 32.75 KN/m and maximum negative shear at edge 42.24 KN/m. The edge bending stress is 10.114 KN which is slightly more than stress at corner. By this corner bending stress is more than edge bending stress.

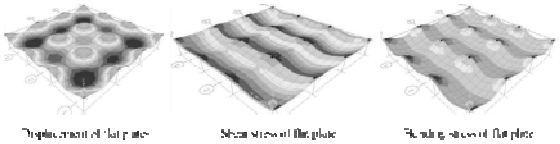

Fig: 6Flat Plate Displacements, Shear And Bending Stress

Table-2Comparison of Flat Plate Displacements, Shear And Bending Stress.

Column/Panel	Displacements	Shear stress	Bending stress
Centre	-2.134 mm	32.75 Kn/m	9.991 Kn
Corner	-3.273 mm	-37.3 Kn/m	15.37 Kn
Edge	-2.636 mm	-42.24 Kn/m	10.114 Kn

B. Model Analysis For Building With Slab Panel

We have done modal analysis for building with slab panel; we have obtained 12 mode shapes of first mode shape time period of 0.11315 sec and frequency of 8.837 Hz and the last mode shape time period is 0.06376 sec and frequency of 16.68 Hz. As the model number increases the time period decreases and frequency increases. The modal analysis is mainly depends the cross section and material properties. The dimensions of the cross section are 18m X 18m with slab thickness 0.15 m and material property is M30 and Fe415.

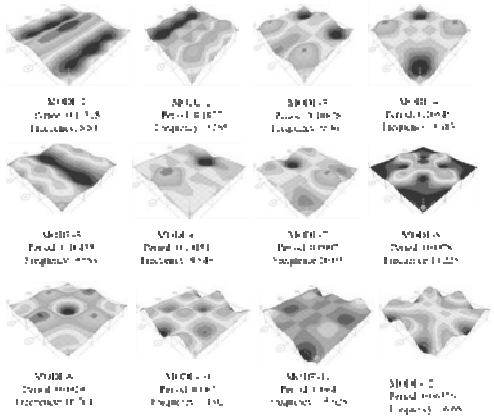

Fig: 7 Mode shapes of flat plate

C. Analysis Of Slab WithBeams

We want to represent the displacements, shear stress and bending stress values within in a table and compare the results which are taken at different locations of slab columns and panels at center, corner and edge which are shown in plan view of table – 3. Here, in case of slab with beams the maximum negative displacement is at the corner with 1.885 mm and minimum at Center 1.404 mm. The maximum bending stress is at corner 13.175 KN and minimum at center 7.700 KN. The edge bending stress is 8.769KN. The maximum shear stress is at the center 15.6 KN/m. The maximum negative shear is at the edge with 14.57 KN/m. The bending stress is more at corner less at the edges and decreases to the center of the slab.

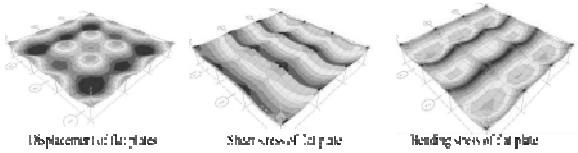

Fig: 8Slab With Beam Displacements, Shear And Bending Stress

Table - 3Comparisons of Slab With Beam Displacements, Shear And Bending Stress.

Column/Panel	Displacements	Shear stress	Bending stress
1. Center	-0.927 mm	15.6 Kn/m	7.700 Kn
2. Corner	-1.885 mm	-13.6 Kn/m	13.175 Kn
3. Edge	-1.404 mm	-14.57 Kn/m	8.796 n

D. Model Analysis For Slab With Beam

We have done modal analysis for building with slab panel; we have obtained 12 mode shapes of first mode shape time period of 0.09206 sec and frequency of 10.862 Hz the last mode shape time period is 0.052 sec and

frequency of 19.2 Hz. As the mode number increases the time period decreases and frequency increases. The modal analysis is mainly depends the cross section and material properties. The dimensions of the cross section are 18m X 18m with slab thickness 0.15 m and material property is M 30 and Fe 415.

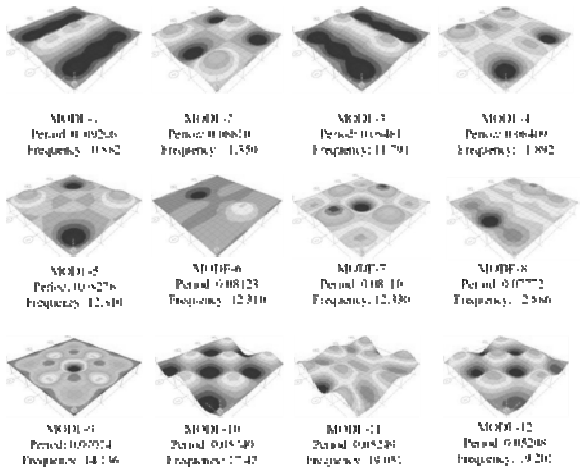

Fig: 8Mode shapes of Slab With Beam

Analysis Of Slab With DropPanels

We want to represent the displacements, shear stress and bending stress values within in a table and compare the results which are taken at different locations of slab columns and panels at center, corner and edge which are shown in plan view of table 3.

Fig: 9Slab With Drop Panel Displacements, Shear And Bending Stress

Table - 4Comparison of Slab With Drop Panel Displacements, Shear And Bending Stress

Column/Panel	Displacements	Shear stress	Bending stress
1. Centre	-1.553 mm	15.6 KN/m	8.045 KN
2. Corner	-2.670 mm	13.6 KN/m	13.567 KN
3. Edge	-2.058 mm	-14.57 KN/m	9.685 KN

Here in the case of slab with Drop panels the maximum negative displacement is at the corner with 2.670 mm and minimum at center 1.553 mm. The maximum bending stress is at corner 13.567 KN and minimum at center 8.045 KN . The edge bending stress is 9.68 KN. The maximum shear stress is at center 15.6 KN/m. The maximum negative shear is 14.57 KN/m.

E. Model Analysis Slab With Drop Panel

We have done modal analysis for building with slab panel; we have obtained 12 mode shapes of first mode shape time period of 0.1079 sec and frequency of 9.266 Hz and the last mode shape time period is 0.05958 sec and frequency of 16.78 Hz. As the mode number increases the time period decreases and frequency increases. The modal analysis is mainly depends the cross section and material properties. The dimensions of the cross section are 18m X 18m with slab thickness 0.15 m and material property is M 30 and Fe 415.

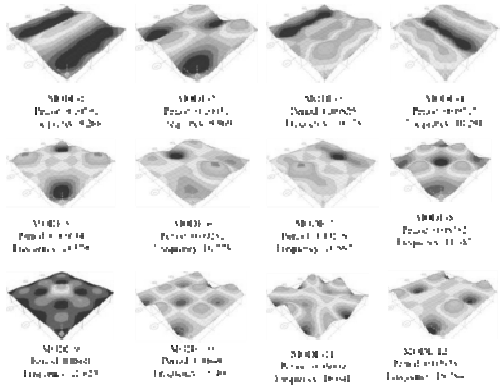

Fig: 10Mode shapes of Slab With Drop pannel

Table 5 Comparasion mode shapes of three slabs

MODE SHAPES	FLAT PLATES		SLAB WITH BEAMS		SLAB WITH DROP PANELS	
	TIME PERIOD (Sec)	FREQUENCY (Hz)	TIME PERIOD (Sec)	FREQUENCY (Hz)	TIME PERIOD (Sec)	FREQUENCY (Hz)
1	0.113	8.830	0. 092	10.86	0.107	9.26
2	0.107	9.28	0. 088	11.35	0.100	9.96
3	0.106	9.36	0. 084	11.79	0. 098	10.18
4	0.105	9.48	0. 084	11.89	0. 097	10.29

The 12 model shapes of three different slabs are shown in the table…. The maximum time period occurred in the case of flat plates with 0.113 sec and frequency of 8.837 Hz. Compare to flat plates and slab with drop panels, the slab with beam has less time period of 0.092 sec and frequency of 10.86 Hz. In all cases as the mode number increases the time period decreases and frequency increases . The maximum frequency occurred in the case of slab with beams and minimum frequency occurred in the case of flat plates.

VI. Conclusion

a) On observing three slabs, maximum displacements occurred in flat plate compared with a slab with beams and slab with drop panel with 2.636 at one edge discontinuous panel.

b) There is a maximum shear stress of 32.27 KN/m in case of flat plates at the centre column and also maximum negative shear is 42.24 KN/m at edge column. In all three cases, edge column undergoes maximum negative shear. The maximum bending stress is more in case of flat plate with 15.370 KN at two adjacent edges discontinuous panels.

c) The reinforcement provided is more in slabs with beam of Ast 2035.74 mm^2 than with flat plate having Ast 1017.87 mm^2 and slab with drop panel having Ast 1583.36 mm^2. The maximum time period occurred in the case of flat plates with 0.113 sec and frequency of 8.837 Hz. compare to flat plates and slab with drop panels, the slab with beam has less time period of 0.092 sec and frequency of 10.86 Hz. So the maximum frequency occurred in the case of slab with beams and minimum frequency occurred in the case of flat plates.

d) In Conventional slabs the distribution of shear stresses varies. The bending stress is increased by 40% in flat plates & 20 % in slabs with drop planes than conventional slabs.

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