Analysis and Design of Flat Slab

Gaurav Ravindra Chavan
PG Student, Department of Applied Mechanics
Walchand College of Engineering, Sangli, Maharashtra, India

Dr. S. N. Tande
Professor, Department of Applied Mechanics,
Walchand College of Engineering, Sangli, Maharashtra, India

Abstract- A floor system plays an important role in overall cost and service of the building. Nowadays flat slabs are used in most of the building because of its advantages. There are two methods of analysis of RC flat slab viz. Direct Design Method and Equivalent Frame Method. The objective of this paper is to present analysis and design of RC flat slab using two different methods and compare the superiority of the two methods over one another by various aspects. Also Finite element analysis & Equivalent frame analysis is carried out by using software SAFE.

Keywords- RC Flat Slab, Direct Design Method (DDM), Equivalent Frame Method (EFM), SAFE

I. INTRODUCTION

A slab is a flat two dimensional planar structural element having thickness is small as compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges. The floor system of a structure can take many forms such as in situ solid slab, ribbed slab or pre-cast units. Slabs may be supported on monolithic concrete beam, steel beams, walls or directly over the columns. Concrete slab behave primarily as flexural members and the design is similar to that of beams. [1]

Flat plate/slabs are economical since they have no beams and hence can reduce the floor height by 10-15%. Hence flat plate /slab construction has been in practice in west for a long time. However the technology has seen large scale use only in last decade and is one of the rapidly developing technologies in Indian building industry today. [2] Material advances in concrete quality available for construction, improvement in quality of construction; easier design and numerical techniques has contributed to the rapid growth technology in India.

II. METHODOLOGY

For this IS 456-2000 permits use of any one of the following two methods:
(a) The Direct Design Method
(b) The Equivalent Frame Method
Both Direct Design Method and Equivalent Frame methods are approximate methods so values of bending moment and shear force differ significantly. So with the advent of sophisticated finite element analysis programs which are relatively easy to use and have significant economy can be used as an alternative for above two methods.

2.1 Direct Design Method:

DDM is very simplest and approximate method for analysis of flat slab. In this method total moment (M0) is calculated and then it distributed to total Negative Moment and total Positive moment All the Negative & Positive moments are distributed in the column strips & Middle strips respectively.

2.2 Equivalent Frame Method:

In this method moments at each joint is calculated by Moment Distribution Method using the Fixed End Moment on each span. Using those moments calculate negative moments at both left & right support i.e. (Mu-)& the maximum positive moments in the middle of span i.e. (Mu+).

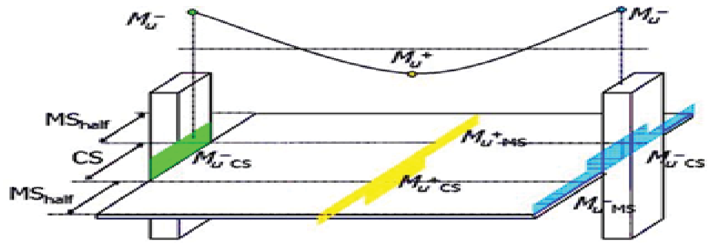

Fig.2.1 Distribution moment to the column strip and middle strip

III. PROBLEM FORMULATION

Analysis of flat slab of size 5 m X 5 m and 7m X 7m providing drop and column head. Size of columns is 500mm X 500 mm and live load on the panel is 4 kN/m2. Take floor finishing load as 1 kN/m2. UseM20 concrete and Fe 415 steel. Slab is modelled using SAFE software. By using

1) Direct Design Method
2) Equivalent Frame Method

Table 3.1 Description of modelled 5m X 5m Slab

Floor height	3 m
Size of columns	500mm X 500 mm
Depth of slab	170 mm
Depth of drop	220 mm
Size of Drop	2.5mm X 2.5mm
Grade of Concrete	M20
Grade of Steel	Fe 415

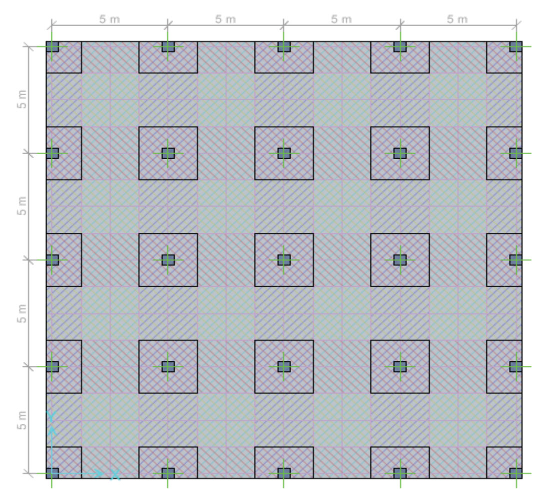

Fig.2.1Plan view of 5m x 5m model

Table 3.2 Description of modelled 7m X 7m Slab

Floor height	3.5m
Size of columns	500mm X 500 mm
Depth of slab	230 mm
Depth of drop	290 mm
Size of Drop	3.5mm X3.5mm
Grade of Concrete	M20
Grade of Steel	Fe 415

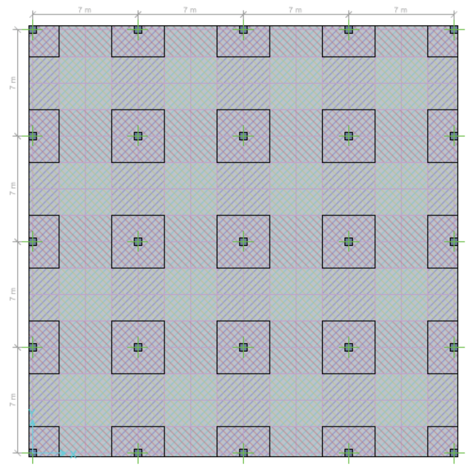

Fig 3.2Plan view of 7m x 7m model

IV. RESULTS AND DISSCUSION

Table 4.1 Results of modelled 5m X 5m Slab For Exterior Panel

Moments	Strip	DDM	EFM	FEM Using SAFE
Positive Moment (Span)	C.S	12.8	18.36	15.03
	M.S	8.53	12.24	12.26
Negative Moment (Interior Support)	C.S	27.6	21.65	18.20
	M.S	9.2	7.216	6.14
Negative Moment (Exterior Support)	C.S	31.71	26.46	27.35
	M.S	0	0	0

Table 4.2 Results of modelled 5m X 5m Slab For Interior Panel

Moments	Strip	DDM	EFM	FEM Using SAFE
Positive Moment (Span)	C.S	11.66	17.04	11.24
	M.S	7.8	11.36	8.09
Negative Moment at Support	C.S	27.1	20.38	37.4
	M.S	9.02	6.79	8.0

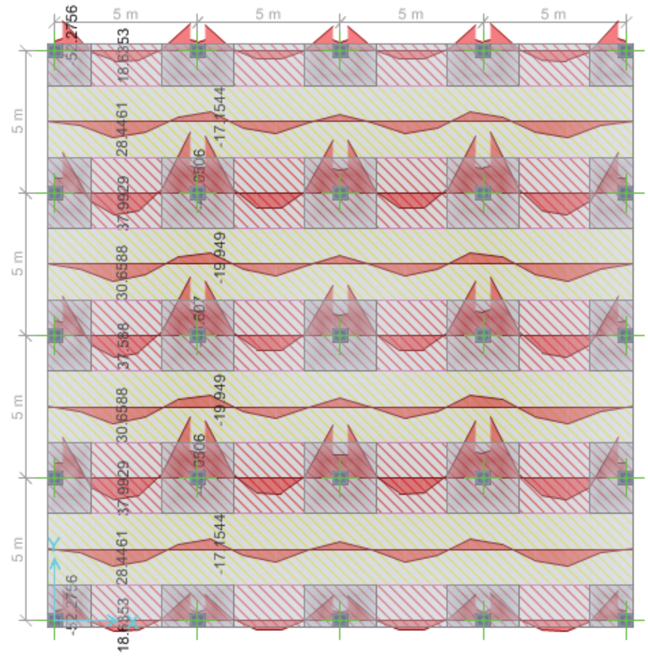

Fig 4.1BMD of 5m x 5m model from SAFE

Table 4.3 Results of modelled 7m X 7m Slab For Exterior Panel

Moments	Strip	DDM	EFM	FEM Using SAFE
Positive Moment (Span)	C.S	31.07	45.6	57.84
	M.S	20.75	30.4	44.08
Negative Moment (Interior Support)	C.S	61.9	50.78	97.08
	M.S	21.1	17	31.29
Negative Moment (Exterior Support)	C.S	59.45	37.5	42.89
	M.S	0	0	0

Moments	Strip	DDM	EFM	FEM Using SAFE
Positive Moment (Span)	C.S	26.1	39.18	36.57
	M.S	17.2	26.12	25.45
Negative Moment at Support	C.S	59.9	46.71	91.42
	M.S	19.75	15.57	31.29

Table 4.4 Results of modelled 7m X 7m Slab For Interior Panel

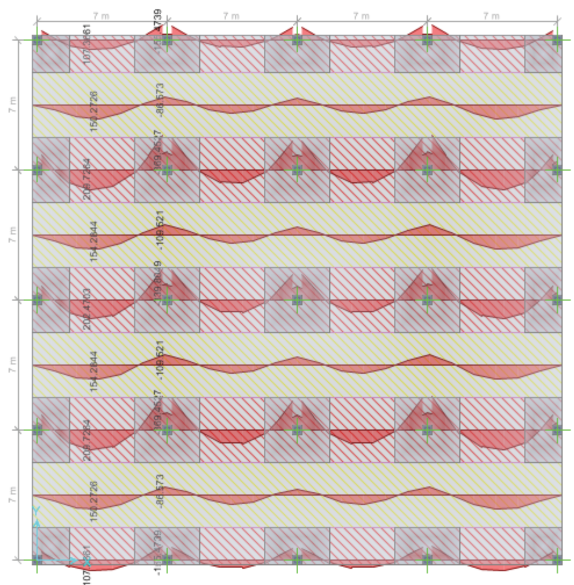

Fig 4.2BMD of 7m x 7m model from SAFE

V. COMPARISON

As compare to DDM the positive mid-span moment is increasing and negative moment is decreasing when slab is analysed with Equivalent Frame Method. The positive mid-span moment is increasing and negative moment is decreasing when slab is analysed with Equivalent Frame Method. The negative moment section shall be designed to resist the larger of the two interior negative design moments for the span framing into common supports

VI. CONCLUSION

Based on above results and discussions the following conclusions are drawn,

1. The design of flat slab by Direct Design Method has some restrictions that (a) It should have minimum three spans in each directions and (b) It should not have staggered column orientation. Hence Equivalent Frame Method is adopted.
2. Both Direct design method and Equivalent frame method are approximate methods but results obtained from Equivalent frame method are more accurate.
3. The equivalent frame method is not satisfactory for hand calculations. Therefore, use of computers software which based on Finite Element Analysis is adopted.

REFERENCES

[1] Patil&Sigi "Flat Slab Construction in India,"International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10, April 2014.
[2] Patil&Sigi "Analysis And Design Of Flat Slabs Using Various Codes,"International Journal of Research in Engineering and Technology (IJRET) Volume 3, Issue 4, April 2014.
[3] Bahoria and Parbat "Analysis and Design of RCC and Post-tensioned Flat Slabs Considering Seismic Effect," IACSIT International Journal of Engineering and Technology, Vol. 5, No. 1, February 2013.
[4] Franklin S. O. (2010). "On yield line estimates of the punching strength of full panel unbonded post-tensioned flat slabs at internal columns", ARPN Journal of Engineering and Applied Sciences, Vol. 5, No. 12, 65-70.
[5] Patil&Sigi "Flat Slab Construction in India,"International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10, April 2014.
[6] Bharathi&Chandrashekar "Review & Design of Flat Plate/Slab Construction in India"
[7] Amit A, Shavane, R S Deotale "Analysis and Design of Flat Slab and Grid slab and their Cost Comparison" International Journal of Engineering Research and Applications, ISSN: 2248-9628, vol.1, Issue 3, pp.837-848.
[8] Patil&Sigi "Analysis And Design Of Flat Slabs Using Various Codes,"International Journal of Research in Engineering and Technology (IJRET) Volume 3, Issue 4, April 2014.

[9] Patil and Shinde “Comparative Study of Flat Plate Structure With RCC Beam Column Structure” International Journal of Engineering Research Volume 3,Issue 3 2015.
[10] “Fundamentals of Reinforced Concrete”,(2005) by Sinha.
[11] P.C. Varghese “Advanced Reinforced Concrete Design”, New Delhi, EEE (2002).
[12] Bureau of Indian Standards, New Delhi, “IS 456:2000, Plain and Reinforced Concrete - Code of Practice”, Fourth Revision, July (2000).
[13] Pimanmas A., Warnitchai P. and Pongpornsup S. (2004). “Seismic performance of 3/5 scaled post tensioned interior flat slab column connections”, Asia conference on earthquake engineering, Manila.
[14] Prawatwong U., TandianC.H. andWarnitchai P. (2008). “Seismic performance of post–tensioned interiorslab-column connections with and without drop panel”, The 14th World Conference on Earthquake Engineering, Beijing, China.