International Journal of Technical Innovation In Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-Issn:2455-2585
"Recent Trends in Structural Engineering" (RTSE-2018)
Volume 4, Special Issue 01, Sept.-2018

COMPARATIVE ANALYSIS AND DESIGN OF FLAT SLAB USING VARIOUS CODES: Review

Akash Galani[1], Maulik Kakadiya[2], Palak Trivedi[3]

[1]*Post Graduation Student, Department of Civil Engineering, CGPIT, UTU, Bardoli,*
[2]*Assistant Professor, Department of Civil Engineering, CGPIT, UTU, Bardoli,*
[3]*Assistant Professor, Department of Civil Engineering, CGPIT, UTU,*

Abstract: ***"Flat Slab" is better understood as the slab without beams directly resting the slab on the column and load from the slab is directly transferred to the columns. Large bending moment &shear forces are developed close to the column. These stresses brings about the cracks in concrete & may produce the failure of slab, thus there is a need to provide a larger area at the top of column called as column head/ capital. Absence of beam gives a plain ceiling, thus giving better architectural appearance. Plain ceiling diffuses light better, easier to construct and requires cheaper form work. As per local conditions and availability of materials different countries have adopted different methods for design of flat slabs and given their guidelines in their respective codes. The aim of this paper is to analyse the flat slab in India followed by a review of design methods for flat slab structure designs based on IS: 456-2000 and ACI-318-2008 design codes, with ETABS Programming for the easy application for the design of flat slab.Bothcodeshave specified the fixed coefficients for lateral and transversedistribution of moments as per direct design method andequivalent frame method. The paper aimed to check whether those moments remain the same when we analyse the flat slab usingETABS software.***

Keyword; Flat slab, IS 456-2000, ACI-318-2008, ETABS SOFTWARE.

I. INTRODUCTION

The term flat slab means a reinforced concrete slab with or without drops, supported generally without beams, by columns with or without flared column heads. A flat slab may be solid slab or may have recesses formed on the soffit so that the soffit comprises a series of ribs in two directions. The recesses may be formed by removable or permanent filler blocks. Behaviour of flat slab and flat plates are identical to those of two way slab. Bands of slab in both directions along column lines are considered to act as beams. Such bands of slabs are referred as column strips which pass through the columns and middle strips, occur in the middle of two adjacent columns. The deflections are minimum at supports and maximum at mid spans. The deflected flat slab at the centre of panel shall have saucer shape. Where δx and δy is the deflection at midspan in X and Y direction and lx and ly is the span length in X and Y direction.

II. LITERATURE REVIEW

A. Gaurav Ravindra Chavan, "Analysis and design of flat slab", International Journal of Latest trends in Engineering and technology(IJLTET).

A floor system plays an important role in overall cost and services to 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 both the methods over one another by various aspects. Also finite element analysis and equivalent frame analysis is carried out using SAFE.

Table 1- Result for modelled 5mx5m slab with 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

B. Er. Sachin Nahre1 Prof. Sourabh Dashore2 (M.TechScholar 2. Professor :1,2Department of Civil Engineering), (Analysis and Design of Flat Slabs using Various Codes'; IJSRD - International Journal for Scientific Research & Development| Vol. 5, Issue 12, 2018 | ISSN (online): 2321-0613

Abstract— "Flat Slab" is better understood as the slab without beams directly resting the slab on the column and load from the slab is directly transferred to the columns. To support heavy loads the thickness of slab near the support with the column is increased and these are called drops and that large bending moment &shear forces are developed close to the column. These stresses brings about the cracks in concrete & may produce the failure of slab, thus there is a need to provide a larger area at the top of column called as column head/ capital. Absence of beam gives a plain ceiling, thus giving better architectural appearance and also less vulnerability in case of fire than in usual cases where beams are used. Plain ceiling diffuses light better, easier to construct and requires cheaper form work. As per local conditions and availability of materials different countries have adopted different methods for design of flat slabs and given their guidelines in their respective codes. The aim of this project is to try and illustrate the methods used for flat slab design using ACI -318, Eurocode2 and IS: 456 design codes. For carrying out this project an interior panel of a flat slab with dimensions 6.6 m x 5.6 m and super imposed load 7.75 KN / m2 was designed using the codes given above. A flat slab consists of a reinforced concrete slab that is directly supported by concrete columns without the use of intermediate beams. C.A.P. Turner constructed flat slabs in U.S.A. in 1906 mainly using intuitive and conceptual ideas, which was start of this type of construction. Many slabs were load-tested between 1910- 20 in U.S.A. It was only in 1914 that Nicholas proposed a method of analysis offlat slabs based on simple statics. This method is used even today for the design of flat slabs and flat plates and is known as the direct design method. Structural engineers commonly use the equivalent frame method with equivalent beams such as the one proposed by Jacob S. Grossman in practical engineering for the analysis of flat plate structures. Floor systems consisting of flat slabs are very popular in countries where cast-in place construction is predominant form of construction because of many advantages in terms of architectural flexibility, use of space, easier formwork, and shorter construction time. Flat slabs are being used mainly in office buildings due to reduced formwork cost, fast excavation, and easy installation.

Key words: Flat Slabs, Various Codes

TABLE 2: - Comparison between codes.

CODE	IS-456	ACI-318	Euro code
Shape of test specimen for concrete strength (mm)	Cube 150x150x150	Cylinder 152.4x304.8	Cylinder 152.4x304.8
Grade of concrete(N/mm²)	20	20	20
Grade of steel (N/mm²)	415	413.7	500
Negative moment(KN-m)	188.5	208.89	192.6
Positive moments(KN -m)	90	113.22	135.5
Area of reinforcement(mm²)	4209	2829	2415.5
Thickness of slab for Serviceability criteria(mm)	170	150	315
Punching shear	Safe	Safe	Safe

C. S.S.Patil1, Rupali Sigi2 1Head of Department, Civil Engineering Department, Walchand Institute of Technology, Maharashtra, India 2Student, Civil Engineering Department, Walchand Institute of Technology, Maharashtra, India, 'International Journal of Engineering Research and Technology(IJERT), Department of Civil Engineering, Government Engineering College, Kannur., "ANALYSIS AND DESIGN OF FLAT SLABS USING VARIOUS CODES."

"Flat Slab" is better understood as the slab without beams resting directly on supports (like columns & or walls).By virtue of that large Bending Moment & Shear Forces are developed close to the columns. These stresses brings about the cracks in concrete & may provoke the failure of slab, thus there is a need to provide a larger area at the top of column recognized as column head/ capital. The analysis of flat slab is executed by Direct Design Method (DDM) & Equivalent Frame Method (EFM) as directed by different standard, however the Finite element analysis & Equivalent frame analysis is carried out by using software SAFE (Slab Analysis by Finite element method and Equivalent frame method). The analysis & design is performed by Equivalent Frame Method with staggered column & without staggered column as prescribed in the different codes like IS 456-2000, ACI 318-08, BS 8110-1997, EC2 Part1 2004 are compared. In this process moments are distributed as column strip moments & middle strip moments. The methodology for analysis & design of slab is thoroughly explained in the paper. Equivalent frame analysis is also carried out for distribution of

column strip moments & middle strip moments by using software SAFE. Excel worksheets for analysis and design of flat slab using equivalent frame method for all standard codes are also prepared. Keywords: Flat Slab, IS 456-2000, ACI 318-08, BS 8110-1997, EC2 Part I 2004 etc…

Table 3:- IS 456-2000[2] Distribution of moments across panels for Exterior Slab

Sr. No.	Distributed moment	Column strip moment%	Middle strip moment%
A	Negative BM	100	0
B	Negative BM	75	25
C	Positive BM	60	40

Table 4:- IS 456-2000[2] Distribution of moments across panels for Interior Slab

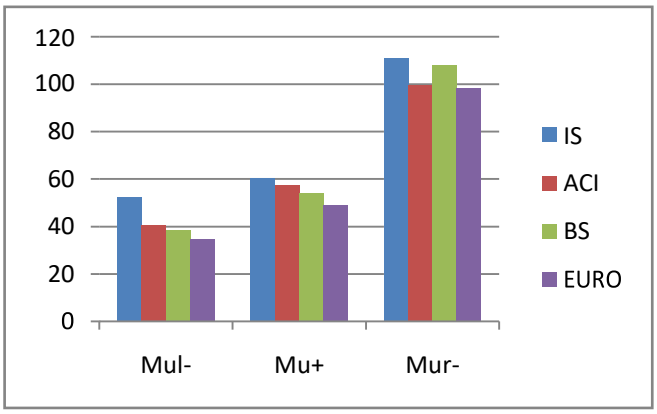
Sr. No.	Distributed moment	Column strip moment %	Middle strip moment %
A	Negative BM	75	25
B	Negative BM	75	25
C	Positive BM	60	40

Table 5:-ACI 318[3] Distribution of moments across panels for Slab

	Ext. edge Un- restrained	Slab with Beams Between all Supports	Slab without beams Between interiorSupports		Ext. edge Fully Restrained
			Without edge Beam	With edge beam	
Interior Negative Moment	0.75	0.7	0.7	0.7	0.65
Positive Moment	0.63	0.57	0.52	0.5	0.35
Exterior Negative Moment	0	0.16	0.26	0.3	0.65

Table 6:- The distribution of moments calculated is shown in the table

DISTRIBUTION OF MOMENTS RESULT				
	Exterior Slab			
FRAME		Mul-	Mu+	Mur-
F	IS	A11	B11	C11
	ACI	A21	B21	C21
	BS	A31	B31	C31
	EURO	A41	B41	C41



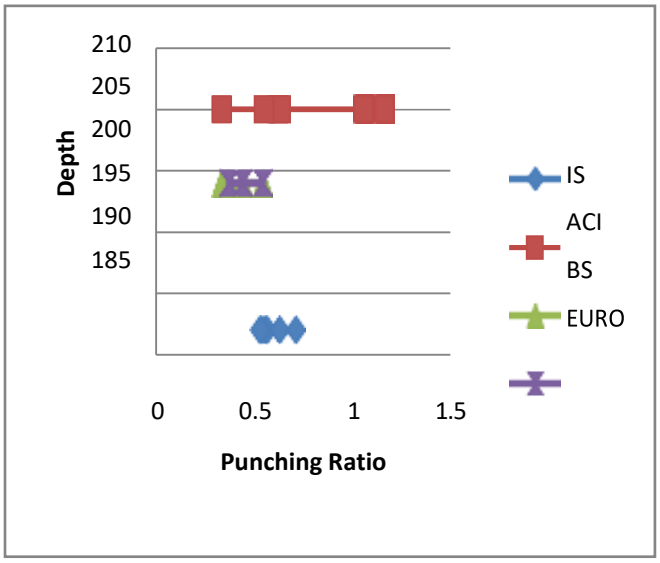
Graph 1:-Graph compared to the table can be created like

Table7:- Distribution of moment results for interior slab

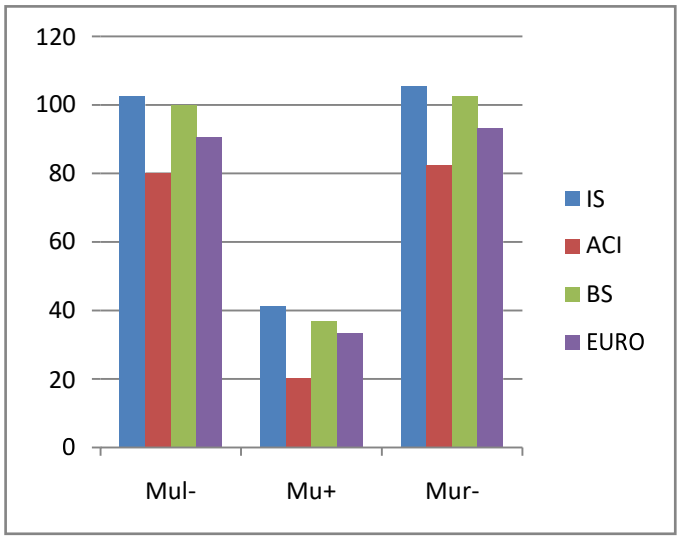
DISTRIBUTION OF MOMENTS RESULT				
	Interior Slab			
FRAME		Mul-	Mu+	Mur-
F	IS	A12	B12	C12
	ACI	A22	B22	C22
	BS	A32	B32	C32
	EURO	A42	B42	C42

Table 8:- Punching shear results for different codes.

PUNCHING SHEAR RESULTS			
column		punching ratio	Depth
F	IS	a1	b1
	ACI	a2	b2
	BS	a3	b3
	EURO	a4	b4



Graph 2:- The graph of punching ratio to depth created shows



Graph 3 :- compares the Mu for different codes from the table.

III. CONCLUSIONS

From the study of above research papers it can be concluded that,

- The positive mid-span moment is increasing and negative moment is decreasing when we analyse the slab with Equivalent Frame Method.
- In the Exterior support, the total design moments (Mo) are distributed as 100% in column strip and 0% in middle strip in both the case IS 456-2000 and ACI 318-08 & the total design moments (Mo) are distributed as 75% in column strip and 25% in middle strip in both the case BS 8110-1197 and EC2Part1-2004.
- The negative moment's section shall be designed to resist the larger of the two interior negative design moments for the span framing into common supports.
- In flat slab (with & without staggered column) in both cases the punching shear criteria is satisfy except Interior columns as per ACI 318-08 as compared to other code.
- Since Direct design method has some restrictions such as – it should have minimum three spans in direction and also it should have staggered column orientation, Equivalent Frame method is adopted.
- Equivalent Frame method is more accurate than directdesign method.
- Indian standard actually uses 46% of total concrete characteristic strength. While in International practice is to take 85% of total strength achieved by test and then apply factor of safety which is same as Indian standard so in actual they use 57% of total strength.
- By comparing with different codes we concluded that ACI 318, & euro codes are most effective in designing of flat slabs.
- Drops are important criteria in increasing the shear strength of the slab.
- In the interior span, the total design moments (Mo) are same for IS, ACI, EURO CODES.
- Pre fabricated sections to be integrated into the design for ease of construction.

IV. REFERENCES

[1] Indian Standards, New Delhi, "IS 456:2000,Plain and Reinforced Concrete - Code of Practice", Fourth Revision, July (2000).

[2] American Concrete Institute, "ACI 318-08, Building Code Requirements for Structural Concrete and Commentary", January (2008).

[3] European Standard, "Euro code 2:Part1-2004, Design of concrete structures - Part 1-1: General 2rules and rules for buildings", December (2004).

[4] M.Anitha, B.Q.Rahman and JJ.Vijay, "Analysis and Design of Flat Slabs Using Various Codes", International Institute of Information Technology, Hyderabad, April (2007).

[5] P.C. Varghese "Advanced Reinforced Concrete Design", prentice hall of India limited, New Delhi, EEE (2002).

[6] I.C.Syal&A.K.Goel "Reinforced Concrete Structures, S.Chand& Company of India limited, New Delhi.

[9]. European Standard, "Euro code 2:Part1-2004, Design of concrete structures - Part 1-1: General 2rules and rules for buildings", December (2004).

[10]. M.Anitha, B.Q.Rahman and JJ.Vijay, "Analysis and Design of Flat Slabs Using Various Codes", International Institute of Information Technology, Hyderabad, April (2007).