Analysis and Design of Flat slab Building with and without drop

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Abstract: - Flat slab is the slab without beams resting directly on supports (like columns & walls). A floor system plays an important role in overall cost and service of the building. Nowadays flay slabs are used in most of the buildings because of its advantages. 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 is executed by direct design method as directed by IS 456:2000 for concrete design. This paper gives the design by direct design method and analysis of flat slab building with drop panel and without drop panel by using software ETAB2015.

Keywords: - flat slab design by direct design method (with & without drop), punching shear and Max strip moments.

I.INTRODUCTION

Common practice of design and construction is to support the slab by beams and beams by column. This may be called as beam-column construction. The beam reduces the available net clear ceiling height. Aesthetically this type of construction is not convenient but, performance of these buildings are quite good. In recent practice slab are directly put on the column for aesthetic and architectural point of view. Flat slab are preferential by both architects and clients because of their aesthetic and economic advantages. Though this form of reinforced concrete construction gives several advantages over framed structure, they also have some disadvantages because of brittle punching failure and large deformation. In general normal frame construction utilizes columns, slabs and beams it may be possible to undertake construction without providing beams, this frame system consist of slab and column without beams or a reinforced concrete structure slab supported directly by columns without the use of beams. This type of slabs are called as flat slabs. The flat slab is having with various shapes (rectangular/square). RC slabs with long spans extended over several bays and only supported by columns, without beams known as flat slab. The design of flat slabs is typically governed by the punching shear strength at failure. Flat slab system is very simple to construct and is efficient in that it requires the minimum building height for a given number of stories. This is more acceptable concept to many designers. It is adopted in some office buildings. The flat slabs are plates that are stiffened near the column supports by means of 'drop panels' and/or 'column capitals'.

In cast-in-situ reinforced concrete construction the floor system consists of one of the following:-

1)Wall supported slab system

2)Beam supported slab system

3)Two way ribbed (waffle) slab system

4)Flat slab system

II. FLAT SLAB

Different component parts of flat slab:-

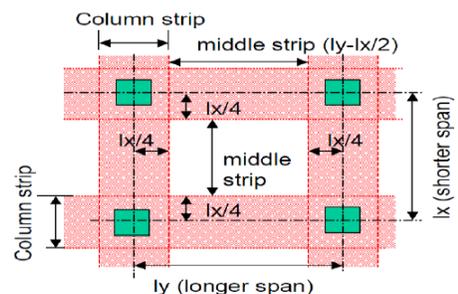Main components of flat slab are [a] Panel [b] Drop [c] Column head [d] Column strip [e] Middle strip.

Fig.1 Components of flat slab

Column Strip: - In flat slab some portion of the slab along the column lines called strip, is considered to act as flexible wide beams. The strip of slab acting as beam along the centre line joining the columns is called the column strip. It having a width of 0.25L2 but not greater than 0.25L1 on each side of centre line. L1 and L2 are the spans in longitudinal and transverse directions.

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Middle strip: - The middle portion of slab between column strips is called middle strip. The portion of the slab between the middle strips may be considered as a slab suspended across flexible column strip.

Drop Panels: - Simply drops are provided mainly for the purpose of reducing shear stress around the column supports. They also helps in reducing the steel requirements for the negative moments at the column supports. The code recommends that drops should be rectangular in plan, and have length in each direction not less than one third of the panel length in that direction. For exterior panels, the length measured perpendicular to the discontinuous edge from the column centreline should be taken as one half of the corresponding width of drop for the interior panel.

Types of Flat Slab:-

Flat slabs can be classified as per the slab column junction. There are four types of flat slabs commonly used in buildings. They are as follows

A)Slab without drop and without column head.

B)Slab with drop and without column head.

C)Slab without drop and with column head.
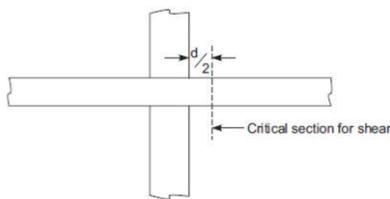
D)Slab with drop and with column head.
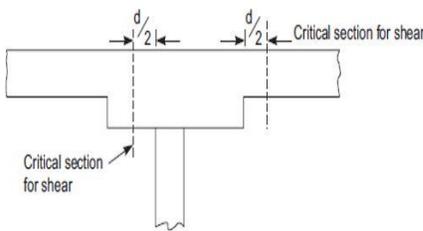

Fig: 2 Slab without drop and column head

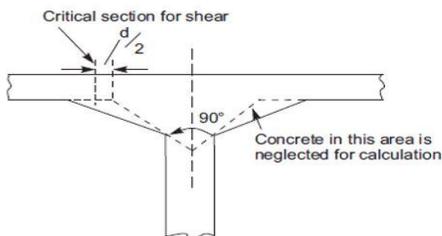**Fig: 3 Slab with drop and without column head**

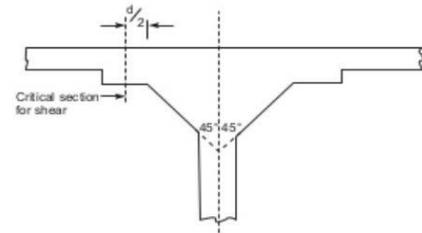**Fig: 4 Slab without drop and with column head**

Fig: 5 Slab with drop and column head

III. METHODS OF ANALYSIS OF FLAT SLAB

A flat slab is a highly indeterminate structures and its exact analysis is difficult. An approximate analysis can be made by considering an interior panel of slab. For this IS 456-2000 permits use of any of the following methods:-

(a)The 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.

(b)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+)
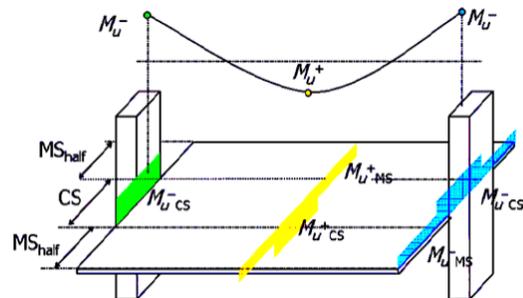

Fig: 6 Distribution Moments to the Column Strip and Middle Strip

IV. SOFTWARE MODELLING ANALYSIS AND RESULTS

Modelling: -

Design Parameters: -Grade of concrete = 20 N/mm2, Grade of steel = 500 N/mm2, Density of concrete = 25 KN/m2, Modulus of elasticity of concrete = $5000\sqrt{Fck}$, Floor to floor height = 4 m, Wall thickness = 150 mm, Shear wall thickness

= 150 mm, Live load = 3 KN/m2, Floor finish load = 1 KN/m2, Beam sizes = 230 mm x 450 mm.

Flat slab with drop:- Column sizes = 800 mm x 800 mm, Slab thickness = 300 mm,

Drop thickness = 400 mm, Drop panel sizes = 4 m x 4 m, Dead load = 7.5 KN/m2.

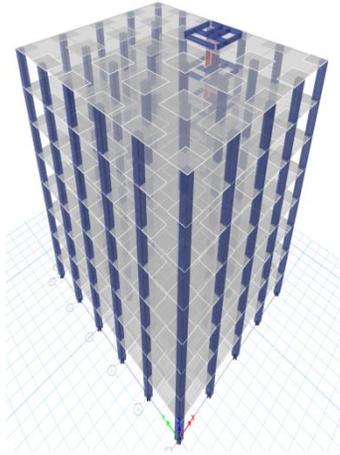**Flat slab without drop:-**Column sizes = 1000 mm x 1000 mm, Slab thickness = 400 mm, Dead load = 10 KN/m2.
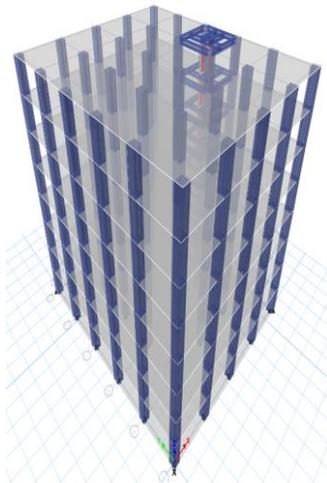

Fig 7. 3-D plan with drop

Fig 8. 3-D plan without drop

Static analysis: -

Punching shear & Strip Moments Results: -

MODEL 1: - The following results come from software analysis

The maximum punching shear = 1.02 N/mm2, Maximum strip moments:-

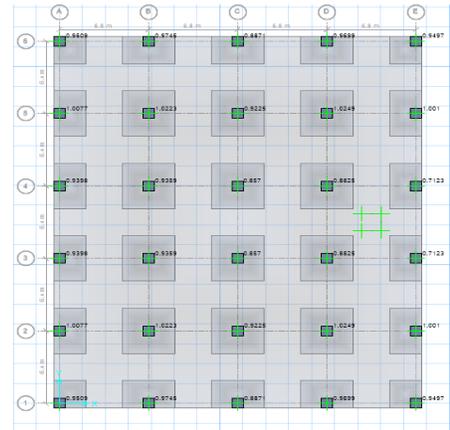| Max Moments	Column strip	Middle strip
Negative Moment	250.12 KN-m.	91.73 KN-m.
Positive Moment	121.43 KN-m.	75.25 KN-m.

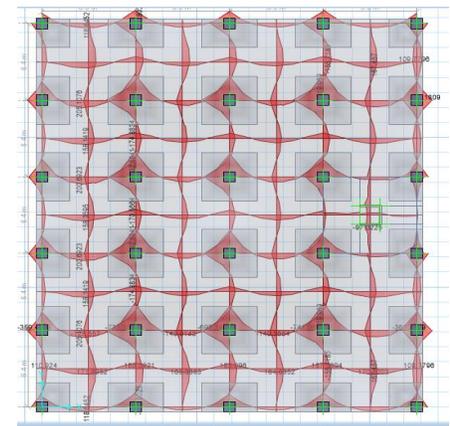**Fig 8 Punching Shear diagram results by software**

Fig 9 Strip Moments results by software

MODEL 2: -The following results coming from software analysis

The maximum punching shear = 0.869 N/mm2, Maximum strip moments:-

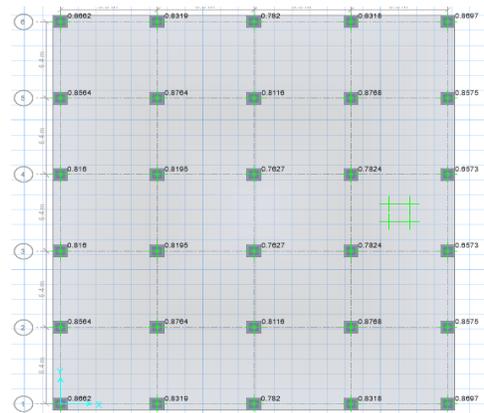| Max Moments	Column strip	Middle strip
Negative Moment	291.12 KN-m.	105.77 KN-m.
Positive Moment	132.25 KN-m.	92.01 KN-m.

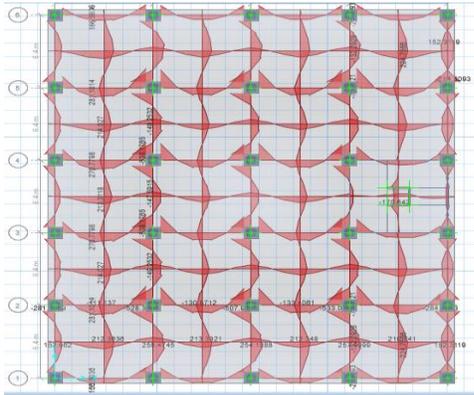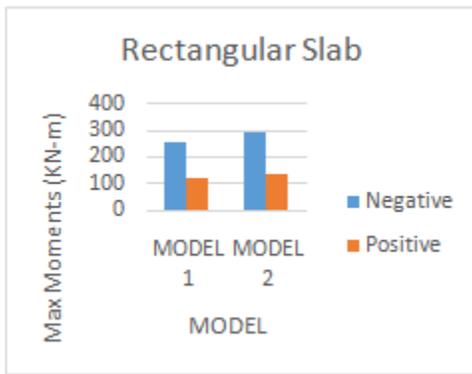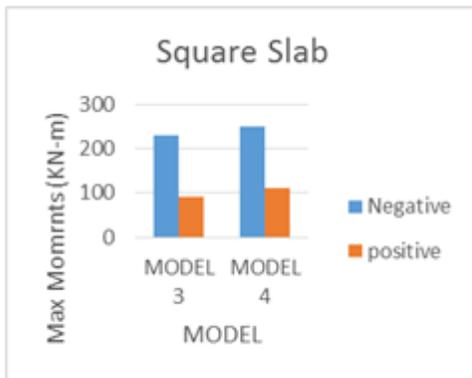**Fig 11 Punching Shear diagram results by software**

Fig12 Strip Moments results by software

V. RESULTS

Graph 1. Max strip moments for Rectangular slab

Graph 2. Max strip moments for Square slab

VI. CONCLUSION

- The direct design method is accurate method in practical for design purposes.
- In flat slab building in both cases (manual design & software analysis) the results are satisfied for Punching Shear and Strip Moments criteria for all models.
- The maximum strip moments for flat slab without drop is more as compared to that of with drop.

- The software results and manual design has not much variations in values so we can also use software results for design of flat slab building.

FUTURE SCOPE FOR TOPIC

1. The project future works can be done with the analysis and design of flat slab with grid mesh model with different shapes of flat slab and analyse with Finite Element software.
2. The structure can be compared with post tensioned slab designed methods.

REFERENCES

➢ Agrawal. P. and Shrikhande. M (2007), "Earthquake Resistant Design of Structure", prentice Hall of India Private Limited, New Delhi, India.

➢ Bhavikatti S. S, " Advance R.C.C Design", New Age International (p) Limited, Publishers, New Delhi, India.

➢ MohdRizwanBhina, Arnab Banergy, D.K. Paul, Assessment of R.C. Flat slab building (International Conference on Architecture and Civil Engineering (ICAACE'14) Dubai, December 25-26, 2014, pp 87-91)2)

➢ Pradip S. Lande, Aniket B. Raut (Journal of Civil Engineering and Environment Technology Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 2, Number 10, April-June, 2015 pp. 7-10) 4 critical.

➢ Kim and Lee (Effective analysis of flat slab structure subjected to lateral loads, Engineering Structure, page no. 251-263.2005)

➢ M.A. Ismaeil (2014), pushover analysis of 4 storey building (IJSBAR-International journal of sciences: Basic and applied Research volume 16)

➢ Mr. Gururaj B. Katti, Dr Basavraj S. Balapgol (International Journal of Engineering Research & Technology) IJERT ISSN: 2278-0181 Vol. 3 Issue 7, July-2014).

➢ S.S.Patil, RupaliSigi, Analysis and design of flat slabs Using Various Codes, International Journal of Reasearch in Engineering and Technology eISSN:2319-1163 | pISSN : 2321-7308.

- IS: 456:2000, "Indian Standard Code for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.

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