IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

EFFECTIVE SPAN AND ECONOMIC BEHAVIOR OF FLAT SLAB

Mohamed Shafeek K.V[1], [2]P Gokuldeepan, Dr. Sunilaa George[3]

[1]PG Scholar, Department of civil engineering, EASA College of engineering and technology, coimbatore,

[2] Assistant Professor, Department of civil engineering, EASA College of engineering and technology, coimbatore,

[3]Professor, Department of civil engineering, EASA College of engineering and technology, coimbatore

Abstract: A slab that rests directly on the columns without the provision of beams is called a flat slab. Unlike conventional slabs, the load applied on the flat slab is transferred directly to the column which is a relatively small area. Construction of a flat slab has its own advantages like good architectural appearances, easier formwork, shorter construction time, reduced building height and better illumination. But in the flat slab system, it is not possible to have larger spans and the thickness of the slab is more when compared to conventional reinforced concrete two-way slab system. The effective span of the column defines the load distribution in the flat slab system. Hence the flat slab design is direct connected with column spacing or Effective length of span. Punching shear failure is one of the failure that occurs in a flat slab. When the load is applied on the slab, large shear forces and bending moments occur near the columns and it leads to failure of the slab by punching around the column. Punching shear failure is a brittle failure.

Index Terms **– Flat slab, Effective span, Economic behavior, FEM**

1. INTRODUCTION

A flat slab is a two-way reinforced concrete slab that usually does not have beams and girders, and the loads are transferred directly to the supporting concrete columns. The flat plate is a two-way reinforced concrete framing system utilizing a slab of uniform thickness, the simplest of structural shapes. The flat slab is a two-way reinforced structural system that includes either drop panels or column capitals at columns to resist heavier loads and thus permit longer spans. When the load is applied on the slab, large shear forces and bending moments occur near the columns and it leads to failure of the slab by punching around the column. Punching shear failure is a brittle failure. It is caused by shear diagonal cracks that develop through the full slab thickness and forms a frustum pyramid around the column. In other words, the column and slab completely get separated on failure. The load is then transferred to adjacent columns which leads to overloading them and eventually causes a progressive collapse of the whole structure. There are numerous strategies which can be implemented to prevent the punching shear failure in a flat slab. Some of them are increasing the thickness of the slab, providing drop panels and column heads, reducing the application of loads and providing shear reinforcement. But these methods must be adopted during the design of flat slab. The first four options just add to the cost of construction and thus not recommended. So, we provide shear reinforcement to avoid the punching shear failure.

2. LITERATURE REVIEW

Amit A. Sathawane , R.S. Deotale The flat slab system of construction is one in which the beam is used in the conventional methods of construction done away with the directly rests on column and the load from the slabs is directly transferred to the columns and then to the foundation. Drops or columns are generally provided with column heads or capitals. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The aim of the project is to determine the most economical slab between flat slab with drop, Flat slab without drop and grid slab. The proposed construction site is Nexus point apposite to Vidhan Bhavan and beside NMC office, Nagpur. The total length of slab is 31.38 m and width is 27.22 m. total area of slab is 854.16 sqm. It is designed by using M35 Grade concrete and Fe415 steel. Analysis of the flat slab and grid slab has been done both manually by IS 456-2000 and by using software also. Flat slab and Grid slab has been analyzed by STAAD PRO. Rates have been taken according to N.M.C. C.S.R It is observed that the FLAT slab with drop is more economical than Flat slab without drop and Grid slabs.

Kaulkhere R.V , Prof G. N. Shete Analyzed and design of flat slab building with and without drop. 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 bring 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.

Jasmin Jenger (2016) Modeling and design of rigid connections between columns and flat slabs.When it comes to the statical calculation and the design of the connection between reinforced concrete flat slabs and columns, the usual practice is to assume a hinged connection. However, in many cases this assumption does not reflect the actual behavior of the connection and a rigid design should be targeted in order to transfer the moments from the slab into the column. This project aims to develop adequate strut-and-tie models in order to find practical solutions on how to transfer the moments from flat slabs into their supporting columns or in other words how to design a rigid slab-column connection. Special emphasis is devoted to solutions for the use of precast columns because the arrangement of the reinforcement is often limited. Reinforced concrete flat slabs supported by columns are currently one of the most common structural elements for multi-story buildings like apartments, offices and institutional buildings. At the same time, the connection between slab and column is an area that is subjected to a complex loading state and therefore needs to be designed properly.

Harshal Deshpande , Radhika Joshi , Prashant Bangar Design considerations for reinforced concrete flat slab floor system Flat slabs are highly versatile elements widely used in construction, providing minimum depth, fast construction and allowing flexible column grids. Common practice of design and construction is to support the slabs by beams and support the beams by columns. Here 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. The purpose of this paper is to present the use of flat plate/slab construction in India followed by a review of design methods for flat plate/slab structure designs based on Indian Standard 456:2000[1] and American Concrete Institute ACI-318[2]codes.

N. Girish , N. Lingeshwaran (2018) A comparative study of flat slabs using different shear reinforcement parameters. Punching shear failure is a brittle failure and it is one of the most important types of failure to be considered while designing a rein-forced concrete flat slab. This paper aims to study the performance of reinforced concrete flat slabs equipped with different punching shear reinforcement parameters. Three flat slab specimens were cast where two specimens contain punching shear reinforcement in the form of shear stirrups and structural shearbands. The test specimens have length and width of 1000mm and thickness of 185mm for the slabs. The slabs are connected to a column at the center with length and breadth of 300mm and a depth of 700mm. The test specimens were supported by steel plates with length and breadth of

150mm and a thickness of 25mm at the four corners of the slab. The test specimens are loaded on the column face at the top. The deflection, strain and crack pattern were observed and recorded.

Andrey Istomin, Maksim Kudryavtsev Strength of cast-in-place slabs for rectangular cross-section columns punching flat slabs in contemporary buildings are most commonly supported by rectangular cross-section columns. Research of slabs supported by rectangular cross-section columns for punching is rathernarrow. The purpose of this work was the experimental research of slabs punching by rectangular cross-section columns and adjustment of theirdesign method. Reinforced concrete slabs 6 cm in thickness without transverse reinforcement were used as testing specimens. During tests loadon the slab was transferred using stamps. Side ratios for stamps variedfrom 1 to 5 in experiments. Strength and strain properties of concrete were determined before slabs testing for punching. Ultimate loads, that resulted in slab punching, were acquired from test results. Formulae for punching load are suggested for rectangular cross-section columns punching based on obtained results.

Hadi N. G. Al-Maliki , Ali Al-Balhawi , Asma M. Ali (2021) Punching shear resistance of reinforced concrete flat slabs strengthened by cfrp and gfrp: a review of literature Flat reinforced concrete (RC) slabs or plates are still widely used in buildings and are most popular in single or multiple story floor construction systems. This is due to the ease and speed of implementation as well as the continuous smoothness that is provided in relation to the locations of members. Flat slab systems have an inadequate shear strength in both directions. Thus, they are subjected to a shear failure at their intersections with columns, which results in the collapse of a larger part of the structure. Shear failure occurs due to many reasons including changing the functions of the facility, the technical errors in the design and implementation procedures, an increase in the load, deterioration of materials, and poor quality. The carbon fiber reinforced polymer (CFRP) sheets/strips and glass fiber reinforced concrete polymer (GFRP) are used as a composite section formulated when there is a structural deficiency. Strengthening by using CFRP and GFRP provide an improvement in the punching shear resistance in both directions as well as flexural strength, ductility, and hardness.

3. RESEARCH METHODOLOGY

- Framing objectives
- Data collection and analysis
- Numerical method
- Software method
- Comparison of result
- Trial and error method
- Analysis and result

4. NEED OF THE STUDY

Design of various flat slab conditions
The various methods for flat design are adopted
Effective length/span of flat slab supports conditions are analyzed
Economic approach of flat slab design is adopted
Comparing conventional R.C.C slab and flat slab in the basis of Economical approach
This study can be executed on numerical methods or by structural software like Etabs/ Staad

5. OBJECTIVES

To find behavior of flat slab on various load condition with respect to the Effective length of the span.
To find the improvements in performance of flat slab on changing the structural dimension but not the span and loading.
To investigate the performance of flat slab in various condition and economic behavior of the slab
To assess the best adoptable span to get economical cross section of the flat slab.

6. RESULTS AND DISCUSSION

Result Analysis of various span and characteristics in Manual Method

Effective span (Meter)	5M x 5M	6M x 6M	7M x 7M	8M x 8M	9M x 9M
Column size (mm)	500x500	500x500	500x500	500x500	500x500
Depth of slab (mm)	180	220	250	270	300
Depth of slab with drop (mm)	230	270	300	320	350
Area of steel reinforcement (mm^2)					
Column strip, –ve BM	1310.88	2420.33	3776.33	3330.20	7841.14
Column strip, +ve BM	544.70	1285.22	1555.16	1365.04	3202.31
Middle strip, –ve BM	542.22	983	1484.75	1282.17	2946.42
Middle strip, +ve BM	465.07	842.58	1277.57	1098.60	2524.27
Volume of slab per section (m^3)	0.18	0.23	0.25	0.32	0.35
Unit rate (₹/m^3)	22500	22500	22500	22500	22500
Cost of the concrete (₹)	4050	5175	5625	7200	7875
Economic aspect	ok	ok	ok	ok	Break even

Result analysis of various span and characteristics in ETABS

Effective span (Meter)	units	5M x 5M	6M x 6M	7M x 7M	8M x 8M	9M x 9M
Column size (mm)	mm	500x500	500x500	500x500	500x500	500x500
Depth of slab (mm)	mm	180	220	250	270	300
Depth of slab with drop (mm)	mm	230	270	300	320	350
Slab area	m2	243.36	438.12	558.72	605.16	853.92
Concrete volume	M3	43.805	100.994	144.288	193.651	260.784
Average thickness	mm	180	231	258	320	305
Rebar weight	kg	1189	4774	9015	16853	23779
Rebar per area	Kg/m2	4.863	10.896	16.135	21.548	27.847
Rebar ratio	Kg/m^3	271.4257	47.2687	62.4796	75.851	91.1836
Rate of rebar(₹73/kg)	₹/kg	354.99	795.40	1177.85	1573.00	2032.83
Rate of concrete(₹22500/$m^{3)}$	₹/m^3	22500	22500	22500	22500	22500
Total cost	₹/m^3	22845.99	23295.40	23677.85	24073	24532

7. CONCLUSION

The Flat slab with drop is analyzed of both manual and using software. And the results were analyzed with Economic behavior of the structures. According to the support condition the flat slab act as economical in some extant and then leads to uneconomical aspect reaching after some extent. In conclusion, Flat slabs are Economical when the span ranging from 5m to 9m.

The lower span like below 3m. It is desirable to undergo for conventional R.C.C slab. However the span above 9m is not Economical due to higher punching shear will be heavier structure in demands. The four side supported slab can increase the stiffness of the slabs and enhance concrete ductility and integrity of domain of slab-column connections. Flat Slab with drop construction is developing construction in India and can be implemented for Apartment buildings even in the seismic prone areas for better stability and life span of the building. Compare to conventional concrete, flat slab has a very good storey drifts and its lies within the permissible limit and hence the design and construction will be safe. Maximum displacement is seen at higher stories and to improvise the strength and stability of the building we can increase the supporting drop panel thickness or the overall slab thickness can be increased. The equivalent static method analyzed can get more accurate results in Etabs when compare to manual calculations as it is a big procedure to carry out. Flat Slab with drops is used avoiding the beams in this apartment building system by this we can conclude that its economical way of construction and only the initial cost will be high. The results obtained above shows that the ductility of building and stiffness of building is withing the codal provision by comparing with manual to software output.

8. REFERENCES

[1] Amit A. Sathawane, R.S. Deotale . *"Analysis And Design Of Flat Slab And Grid Slab And Their Cost Comparison" ISSN: 2248-9622 www.ijera.com Vol. 1, Issue 3*

[2] Kaulkhere R.V, Prof G.N. Shete. " *Analysis and Design of Flat slab Building with and without drop" Volume-7,Issue-5, (May-17) ISSN (O) :- 2349-3585*

[3] Jasmin Jenger (2016). *"modeling and design of rigid connections between columnsand flat slabs"* University of Applied Sciences, Germany.

[4] Harshal Deshpande , Radhika Joshi , Prashant Bangar. *Design Considerations for Reinforced Concrete Flat Slab Floor System Volume 5, Issue 12, December-2014 59 ISSN 2229-5518*

[5] N. Girish , N. Lingeshwaran *(2018).* *"A Comparative Study of Flat Slabs Using Different Shear Reinforcement Parameters" 7 (2.20) 321-325*

[6] Hadi N. G. Al-Malikia , Ali Al-Balhawi b , Asma M. Alic (2021). *"Punching Shear Resistance of Reinforced Concrete Flat Slabs Strengthened by CFRP and GFRP" Journal 39 (08) (2021) 1281-1290*

[7] Andrey Istomin, and Maksim Kudryavtsev (2021*).* *Strength of cast-in-place slabs for rectangular cross-section columns punching E3S Web of Conferences 263, 02035*