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Construction of Flat Slabs

Kolapuri Akshita, P.Ashwin², Koramati Siddardha³

Assistant Professor, Department of Civil Engineering, MRITS College, Maisammaguda, Dulapally, Secunderabad,
Dist. Medchal, India^{1,2,3}

ABSTRACT: Flat slab called beamless slab is a slab supported directly by columns without beams. A part of slab bounded on each of the four sides by centre line of column is called a panel. Panel may be divided into column strip and middle strip. The flat slab is often thickened closed to supporting columns to provide adequate strength in shear and to reduce the amount of negative reinforcement in the support regions. The thickened portion ie the projection below the slab is called drop or drop panel. In some cases , the section of column at top as it meets the floor slab or drop panel, is enlarged so as to increase primarily the perimeter of the critical section, for shear and increasing the capacity of slab for resisting two-way shear and to reduce –ve BM at the support. Such enlarged or flared portion is called capital. Slabs of constant thickness which donot have drop panels or column capitals are refered to as flat plates. Flat slab systems are popular for use in office and residential buildings, hospitals, schools and hotels. They are quick and easy to formwork and build. Absence of beams allows lower storey heights and as a result cost saving in vertical cladding, partition walls, mechanical systems, plumbing and a large number of other items of construction especially for medium and high rise buildings. They provide flexibility for partition location and allow passing and fixing services easily.

SAP is expanded as Structural Analysis Program. SAP 2000 represents the most sophisticated and user-friendly release of the SAP series of computer programs. This is the first version of SAP completely integrated within Microsoft Windows. It features a powerful graphical user interface unmatched in terms of ease-of-use and productivity. SAP 2000 is object based, meaning that the models are created using members that represent the physical reality. A beam with multiple members framing into it is created as a single object, just as it exists in the real world and the meshing needed to ensure that connectivity exists with the other members is handled internally by the program.

KEYWORDS: DECISION SUPPORTING SYSTEM, CONGESTION, TRAFFIC, ESTIMATION

I.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 column tends to punch through the SLAB in flat slabs, which can be treated by three methods: using a drop panel and a column capital in FLAT SLAB.

A FLAT SLAB consists of a reinforced concrete slab that is directly supported by concrete columns without the use of immediate beam. C.A.P. Turner constructed flat slab 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 of flat slab based on simple statics. This method is used even today for the design of flat slabs and flat plates and it is known as direct design method. Structural engineers commonly use the equivalent frame method with equivalent beams such as the one proposed by Jacob s. Grossman in partial 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 frame work, and shorter constructing time. Flat slabs are being used mainly in office buildings due to reduced frame work cost, fast excavation, and easy installation.

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II. LITERATURE REVIEW

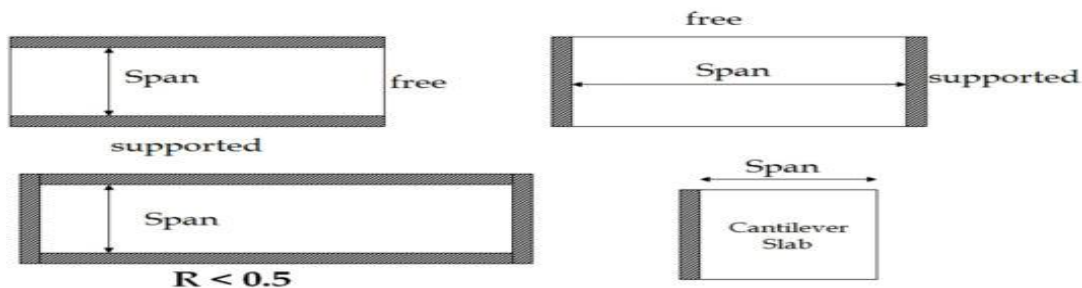
To resist the punching shear which is predominant at the contact of slab and column support, the drop dimension should not be less than one-third of panel length in that direction

certain amount of negative moment is transferred from the slab to the column at the support. To resist this negative moment the area at the support needs to be increased. This is facilitated by providing column capital/heads flat slab with drop panel and column head. The term flat slab means a reinforced concrete 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 soft fit comprises a series of ribs in two directions. Column strip means a design strip having a width of $0.25L$, but not greater than $0.25L$, on each side of the column center line, where L is the span in the direction moments are being determined, measured center to center of supports. L is the span transverse to L , measured center to center of supports. Middle strip means a design strip bounded on each of its opposite span. Panel means that part of a slab bounded on each of its four sides by the center line of a column or center lines of adjacent panels. Panel means that part of a slab bounded on each of its four sides by the center line of a column or center lines of adjacent

2.1 One way slab

“The slab which resists the entire/major part of applied load by bending only in one direction”

- If slab is supported on all four sides and $R = (\text{Shorter side} / \text{Longer side}) < 0.5$ it behaves as one-way slab.
- Slabs having supports on less than four sides can be designed as one-way.
- Two edge supported slab is always one-way.
- Cantilever slab is always one-way.
- Main steel is only provided parallel to span
- One-way slab is designed as singly reinforced rectangular section.
- $h(\text{min})$ for the slab is different compared with the beams.



Figure(3.1)

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End Conditions	Steel Grades		
	300	420	fy
Simply Supported	L/25	L/20	$\frac{L}{20} \left(0.4 + \frac{f_y}{690} \right)$
One end continuous	L/30	L/24	$\frac{L}{24} \left(0.4 + \frac{f_y}{690} \right)$
Both ends continuous	L/35	L/28	$\frac{L}{28} \left(0.4 + \frac{f_y}{690} \right)$
Cantilever	L/12	L/10	$\frac{L}{10} \left(0.4 + \frac{f_y}{690} \right)$

L=effective span

Lesser of the following:

$$L = L_n + h/2 + h/2 = L_n + h$$

h=depth of slab and

L=c/c distance between supports

2.2 Two way slab

When the ratio of long span to short span is less than 2, then the slab is known as slab spanning in two directions or two-way slab.

Two Way Slab Design by Direct Design Method:

Before the start of two way slab design, slab depth should be determined in addition to specify column strips and middle strips.

Column and middle strips

There are continuous variations of moments across slab panel therefore to help placement of steel, design moments are averaged over column strips and middle strips.

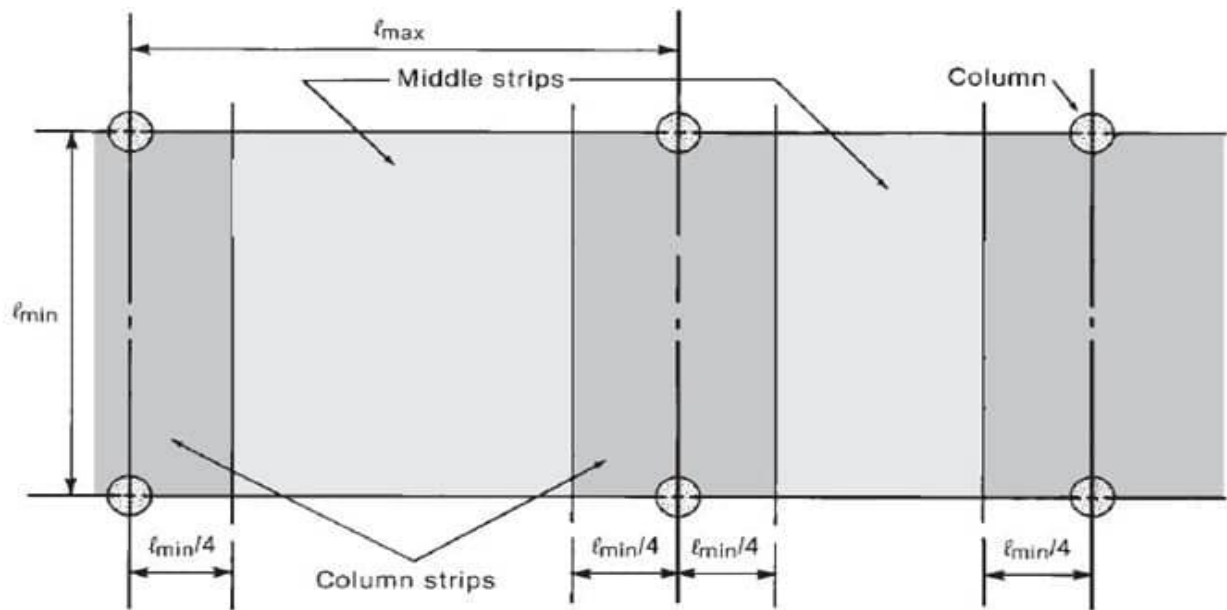
The column strips are located over columns and have a width on each side of the column centerline equal to smaller panel dimension divided by four and middle strips is located between two column strips. Figure-1 and Figure-2 illustrate middle strip and column strip for long and short directions of panel.

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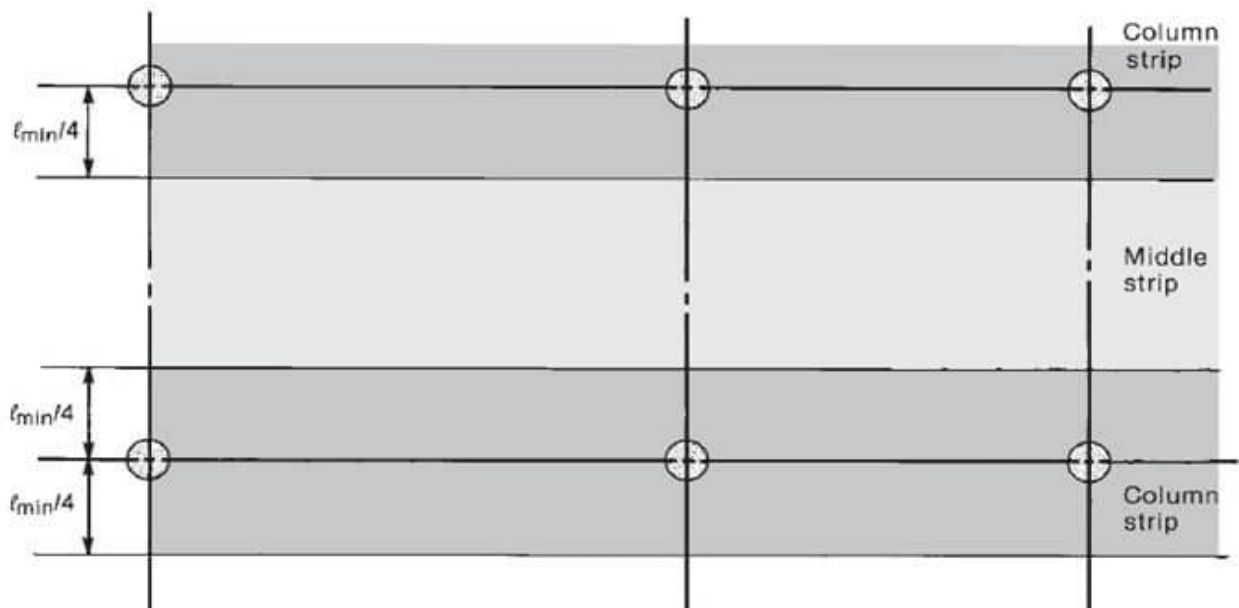
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Column and Middle Strip in Short Direction of the Panel



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Total static moment for a span (M_o)

Clear span (l_n) which is extended from face to face of walls or columns, in the direction of moments is used to compute total static moment in a panel. Factored moment in a span is calculated as per the following equation:

$$M_o = \frac{w_u l_2 l_n^2}{8} \rightarrow \text{Equation-1}$$

w_u : Ultimate load per unit area of the slab

l_n : Clear span in (M_o) direction measured face to face of walls, columns, brackets, or capitals, and should be equal or larger than $0.65l_1$

l_1 : span length in the direction of (M_o)

l_2 : span length perpendicular to l_1

1. CONSTRUCTION PROCEDURE

A flat slab is a one-way or two-way system with thickenings in the slab at the columns and load bearing walls called 'drop panels'. Drop panels act as T-beams over the supports. They increase the shear capacity and the stiffness of the floor system under vertical loads, thus increasing the economical span range.



flat slab construction with drop panel and column head

Figure(4.1)

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This form of construction has become less popular in recent years because of the limit on economical spans of about 9.5 m for reinforced concrete slabs and about 12 m for pre-stressed slabs. Reinforced flat slabs may need to be sensibly pre-cambered (not overdone) to control deflection.

The plan dimensions of the drop panels are a minimum of 1/3 of the span in the direction under consideration, usually rounded to the nearest 100 mm. The overall depth of the drop panel is typically taken as 1.75 to 2 times the depth of the slab, again rounded to suit timber sizes or the nearest 25 mm.

III. LOADS AND CALCULATIONS

3.3 Different IS-conditions

IS: 875 (Part 1) - 1987 for Dead Loads, Indian Standard Code Of Practice For Design Loads (Other Than Earthquake) For Buildings and Structures, All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions door finishes, false ceilings, false doors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. The unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 KN/m and 24 KN/m respectively.

IS: 875 (Part 2) - 1987 for Imposed Loads Indian Standard Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures, This standard gives wind forces and their effects (static and dynamic) that should be taken into account when designing buildings, structures and components thereof. Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either upwards or downwards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term 'wind' denotes almost exclusively the horizontal wind, vertical winds are always identified as such.

IS: 875 (Part 5) - 1987 for Load Combinations, Indian Standard Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures, The various loads should be combined in accordance with the stipulations in the relevant design codes. In the absence of such recommendations, the following loading combinations, whichever combination produces the most unfavorable effect in the building, foundation or structural member concerned may be adopted (as a general guidance). It should also be recognized in load combinations that the simultaneous occurrence of maximum values of wind, earthquake, imposed and snow loads is not likely.

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Load cornier rations		Remarks
1.5(DL+LL)		
1.5(DL±EQ _x)	1.5(DL±WL _x)	DL - Dead load of the structure
1.5(DL±EQ _z)	1.5(DL±WL _z)	
0.9(DL±1.5EQ _x)	0.9(DL±1.5WL _x)	EO _x - Earthquake load along X direction
0.9(DL±1.5EQ _z)	0.9(DL±1.5WL _z)	EO _z - Earthquake load along Z direction
1.2(DL+LL±EQ _x)	1.2(DL+LL±WL _x)	WL _x - Wind load along X direction
1.2(DL+LL±EQ _z)	1.2(DL+LL±WL _z)	WL _z - wind load along Z direction

IS 456 - 2000, Indian standard code of practice for plain and reinforced concrete (fourth revision), Bureau of Indian Standards. This standard deals with the general structural use of plain and reinforced concrete. For the purpose of this standard, plain concrete structures are those where reinforcement, if provided is ignored for the determination of strength of structures

IS400-2007, Indian standard general construction in steel-code of practice(third edition). This standard gives only general guidance as regards the various loads to be considered in design. For the actual loads and load combinations to be used, reference may be made to IS875 for dead, live, snow, and wind loads and to IS 1893 (part 1) for earthquake loads. For seismic design, recommendations pertaining to steel frames only are covered in this standard.

3.4 DIFFERENT SP-4 CHARTS

SP: 16 - 1980, Design Aids for Reinforced Concrete to IS: 456-1978 (third revision), Bureau of Indian Standard. This is the explanatory handbook which covers the basis/source of each clause. The objective of these design aids is to reduce design time in the use of certain clauses in the Code for the design of beams, slabs and columns in general building structures. The charts and tables included in the design aids were used in calculation of footings and slabs.

Hand Book of Concrete Reinforcement and Detailing, Bureau of Indian Standards. This Handbook provides information on properties of reinforcing steel & detailing requirements, including storage, fabrication, assembly, welding and placing of reinforcement in accordance with IS: 456-1978. As a result of the introduction of limit state method of design for reinforced concrete structures and the concept of development length, detailing has become extremely important as many of the design requirements are to be met through detailing. This Handbook will be useful to concrete design engineers, field engineers and students of civil engineering.

3.5 REINFORCED CONCRETE - LIMIT STATE DESIGN

In the limit state design method, non deterministic parameters are determined based on observations taken over a period of time. The object of design based on the limit state concept is to achieve an acceptable probability that a structure will not become unserviceable in its life time

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for the use for which it is intended, that is, it will not reach a limit state. A structure with appropriate degrees of reliability should be able to withstand safely all loads that are liable to act on it throughout its life and it should also satisfy the serviceability requirements, such as limitations on deflections and cracking. It should also be able to maintain the required structural integrity during and after accidents such as fires, explosions and local failure. Due to its realistic approach, limit state method is used in design of structures.

IV.CONCLUSION

Flat plate/slab construction is a developing technology in India. Flat plate/slab can be designed and built either by conventional rcc or post-tensioning. However, due to issues mentioned above with pt construction in India and its higher cost, conventional rcc should be the preferred choice for spans up to 10 meters. Design of conventional rcc flat plate/slab in India utilizing Indian codes. codes.Has many shortcomings, which have to addressed and revised soon. Until the Indian engineers will continue to use indian codes in combination with other standards like the aci, bs or euro code to design and analyze flat/plate slab. evolving. Today it is still possible to reconstruct the history of Decision Support Systems (DSS) from retrospective accounts from key participants as well as from published and unpublished materials

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