# Analysis And Design of Flat Slabs Using Different Codes

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***Abstract-*** *Flat slabs system of construction is one in which the beams used in the conventional methods of constructions are done away with. The slab directly rests on the column and load from the slab is directly transferred to the columns and then to the foundation. To support heavy loads the thickness of slab near the support with the column is increased and these are called drops, or columns are generally provided with enlarged heads called column heads or capitals.*

***Keywords***- Flat slabs, Beams, Conventional construction, Load transfer,Slab thickness,Column heads

## I. INTRODUCTION

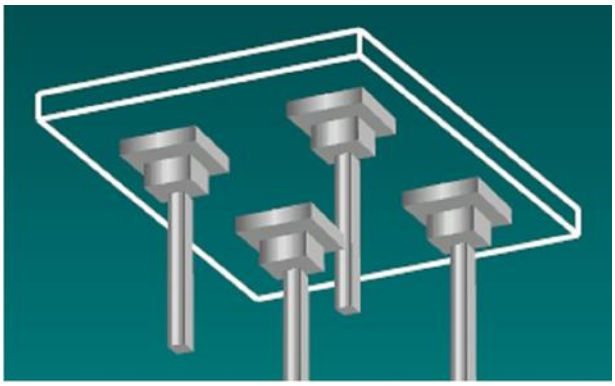
**Basic definition of flat slab**: In general, normal frame construction utilizes columns, slabs & Beams. However, it may be possible to undertake construction without providing beams, in such a case the frame system would consist of slab and column without beams. These types of Slabs are called flat slab, since their behavior resembles the bending of flat plates.

**Components of flat slabs:**

**Drops:** 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.

**Column heads:**

Certain amount of negative moment is transferred from the slab to the column at he supports. 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 & column head**

**Use of Flat slab**

1. Flat slabs or plain ceiling surface provide better diffusion of light
2. it's economic friendly because it reduces formwork
3. It can use where headroom Larger or storey height shorter & pleasing appearance.
4. Flat slabs are generally used in

**Advantages of flat slab**

1. The flat slab system offers flexibility in room layout, and the Partition wall can be constructed as per need. It also provides a variety of room layouts to the owner and avoids the false ceiling requirement.
2. Since a flat slab offers more straightforward reinforcement detailing, it is In more effortless to place.
3. Such slabs need less formwork. Use extensive table formwork to provide Faster construction.
4. Since flat slabs don't need beams, floor height can be minimized, reducing the building height. Also, reduce the load on the foundation. It can save approx 10% of the vertical member.
5. Due to the use of extensive table formwork, it requires less time to construct it.
6. A flat slab allows the use of a prefabricated mesh of standard size, requiring less installation and better-quality control.

7. Since the beams are absent in the flat slab, it is easier to install sprinklers and Pipes for other use.
8. They provide a better appearance and offer better diffusion of light.
9. They provide better fire resistance than a conventional floor system. 10. It offers faster construction provides economy in the overall cost of the building.

**Disadvantages of Flat Slab**

Having many benefits of the flat slab also has some disadvantages, which are as follows.

- It has span limitations. It doesn't offer a large span.
- They are not suitable for masonry partition of brittle nature.
- It uses drop panels that may interfere with oversized mechanical ducting.
- They have middle strip deflection, which may be critical.
- They have more thickness as compared to typical RCC Slabs.

**Design of flat slabs by IS: 456**

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 (see Fig. 12). A flat slab may be solid slab or may have recesses formed on the soffit so that the sof fit comprises a series of ribs in two directions. The recesses may be formed by removable or permanent filler blocks.

Components of flat slab design:

**a) Column strip:**

Column strip means a design strip having a width of 0.25 I, but not greater than 0.25 1, on each side of the column center-line, where I, is the span in the direction moments are being determined, measured center to center of supports and 1, is the -span transverse to 1, measured center to center of supports.

**b) Middle strip:**

Middle strip means a design strip bounded on each of its opposite sides by the column strip.

**c) Panel:**

Panel means that part of a slab bounded d on-each of its four sides by the center -line of a Column or center-lines of adjacent-spans.

## II. LITERATURE REVIEW

Mostly among all available literature and experimental work is based on the analytical parts of flat slab floors. Seismic response of flat slab building has been a subject of discussion since many decades. A lot of research work has taken place in this field addressing all relevant issues pertaining to the modelling, analysis and construction of flat slab structures.

**Park et al:** (2008) found that Equivalent Frame method is not appropriate in accurately predicting the response of two-way slab systems under lateral loads. Currently design code, ACI 318-05[2.1] permit the EFM for the analysis of two-way slab system under gravity loads and lateral loads such as seismic loads.

**Subramanian**: (2005) found that to increase the punching shear strength of flat slab, the shear reinforcement is found to provide economical solution. They not only enhance the shear capacity but also result in flexural failure of the slab and thus increasing the ductility of flat slab, which is very important in earthquake prone zone.

**Meghally and Ghali**: (2005) have proposed the value of the unbalanced moment to be used in punching shear design.

**Kim and Lee:** (2005) proposed an improved analytical method that can consider the stiffness degradation effects in the slab depending on the lateral drifts using super element for the efficient and accurate analysis of flat slab structure. The major observations and findings could be summarized as follows.

Structural analysis of the flat slab structure having irregular plan or slab with openings can be performed and stress distribution of floor slab can be easily represented by finite element method if the stiffness degradation could be considered properly

**Corley and Jirsa** (1970) first developed “Equivalent Frame Method (EFM)” for design of all types of slab system in 1970. This method had no limitation like direct design method. They compared the moment calculated by EFM with those measured in test slab and the moment shown the satisfactory agreement. They provided the list of constants for calculating stiffness, fixed end moments and carry over factor for beam element.

**Dovich and Wight** (2005) developed an effective slab width model to describe the lateral behavior of the reinforced

concrete flat slab frame with in a two-dimensional non-linear frame analysis.

**Hwang and Moehle** (1993) carried out an experimental study on nine panel model having a slab supported without beams, drop panels, slab shear reinforcement. A part of the slab was designed for gravity and wind load in accordance with ACI 318-83.

**Vikunj k.Tilva, Prof. B.A.Vyas** (2011) in their paper presented that to aim a comparison between flat slab panel with drop and without drop in four storey lateral load resisting model. A four-storey structure is subjected to gravity load + lateral load using ETABS software and each storey was exported to SAFE software for analyzing punching effect due to lateral loads. On the beginning of permissible punching shear criterion on accordance with IS 456, economical thickness of flat slab with drop and without drop are preferred the results showed that since economic point of view slab with drop provision is preferable. Also punching shear stress is a

**Dr. Uttamasha Gupta, Shruti Ratnaparkhe, Padma Gome** (2012) in their paper presented work to compare the behavior of multi-storey buildings having flat slabs with drops with that of having two-way slabs with beams and to analyze the cause of part shear walls on the performance of these two types of models under seismic forces. Present work provides a good source of information on the parameter's lateral displacement, seismic base shear, storey shear and storey drift. Despite the cases taken drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey. Use of flat slabs with shear wall in increase in drift values in similar plans as compared to conventional slabs with shear wall. Still all drift values are within permissible limits even without shear walls. In zone V use of flat slabs with shear wall in comparision to conventional slab arrangements alters the maximum lateral displacement values, however, these all are well within permissible limits, even without shear walls. Similarly, storey shear for flat slabs with shear wall as compared to conventional slab system with shear wall has been increased to a great extent.

## III. METHODOLOGY

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+)

## IV. EXPERIMENTAL RESULTS

| ODE | IS-456 | ACI-318 | Euro code |
|---|---|---|---|
| Shape of test specimen for concrete strength (mm) | Cube 150x150 x150 | Cylinder 152.4x304.8 | Cylinder 152.4x304.8 |
| Grade of concrete(N/mm²) | 20 | 20 | 20 |
| Grade of steel (N/mm²) | 415 | 413 | 500 |
| Negative moment(KN-m) | 186 | 210 | 195 |
| Positive moments(KN-m) | 88 | 111 | 133 |
| Area of reinforcement(m m²) | 4206 | 2827 | 2413 |
| Thickness of slab for Serviceability criteria(mm) | 165 | 145 | 310 |
| Punching shear | Safe | Safe | Safe |

## V. CONCLUSIONS

- By comparing with different codes, we concluded that ACI 318 & euro codes are most effective in designing of flat slabs.
- As per Indian code we are using cube strength but in international standards cylindered are used which gives higher strength than cube.
- Drops are important criteria in increasing the shear strength of the slab.
- Enhance resistance to punching failure at the junct ion of concrete slab & column.
- By incorporating heads in slab, we are increasing rigidity of slab.
- In the interior span, the total design moments (Mo) are same for IS, ACI.
- 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.

- According to Indian standard (IS 456) for RCC code has recommended characteristic strength of concrete as 20, 25, and 30 and above 30 for high strength concrete. For design purpose strength of concrete is taken as 2/3 of actual strength this is to compensate the difference between cube strength and actual strength of concrete in structure. After that we apply factor of safety of 1.5. So, in practice Indian standard actually us es 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.
- Pre-fabricated sections to be integrated into the design for ease of construction.

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