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Reinforced Concrete Flat Slab: Code Compliance, Analysis, and Design

Ayush[1], Miss Nitu[2]

[1]M.Tech, Structural Engineering & Construction, Department of Civil Engineering, Matu Ram Institute of Engineering and Management, Rohtak, Haryana, India
[2]Assistant Professor, Department of Civil Engineering, Matu Ram Institute of Engineering and Management, Rohtak, Haryana, India

ABSTRACT

A floor system that consists of a single, horizontal concrete slab rather than any kind of beams is one of the most common types of concrete structure. This system is relatively easy to construct, and it is effective in the sense that it calls for the bare minimum of building height in order to accommodate a specific number of storeys. Unfortunately, earthquake experience has shown that this form of construction is susceptible to failure, in which the thin concrete slab fractures around the supporting columns and drops downward, potentially leading to the complete progressive collapse of a building as one floor collapses down onto the floors below it. When not designed and detailed properly, this type of construction can fail because the thin concrete slab fractures around the supporting columns. Analysis and design of flat slabs are currently active fields of study, and there is still no broad consensus on the optimal design technique, despite the fact that flat slabs have been used in building for more than a century at this point. The current iteration of the Indian Standard Codes of Practice only provide an outline of design techniques for slabs that have uniform geometry and arrangement. But in recent times, as a result of a lack of space, restrictions on height, and other circumstances, deviations from normal geometry and regular arrangement have become rather widespread. There is a significant amount of uncertainty regarding the behavior and response of flat slabs during earthquakes. By use of dynamic analysis, the lateral behavior of a typical flat slab structure that is planned in accordance with I.S. 456-2000 is examined. The deficiencies of these structures are examined by contrasting their behavior with that of traditional beam and column framing. This is done in order to illustrate the shortcomings. The grid slab technology will be used for this particular endeavor. The flat plate system is also investigated so that we may understand the influence that drop panels have on the behavior of flat slabs when they are subjected to lateral stresses. The zone factor and soil conditions, which are equally key factors that determine the behavior of the structure, are treated here as well. This is accomplished through the usage of the ETABS software. The relationship between the number of stories, zone, and soil condition is formed over the course of this investigation.

Keywords: Flat Slab, Code Compliance, concrete building

INTRODUCTION

Flat floors made of reinforced concrete (RC) contribute to artistically beautiful buildings and bridges in addition to simplifying and speeding up site operations. RC floors may be found in both commercial and residential construction. They make it possible to divide space in a way that is both simple and flexible, and they bring the overall height of tall structures down. The term "panel" refers to the portion of the slab that is bordered on each of its four sides by the center line of the column. In order to provide sufficient shear strength and to limit the amount of negative reinforcement required in the support zones, the flat slab is often thickened in the areas near to the columns that offer support. The term "drop" or "drop panel" refers to the local thickness of the slab in the area of the column. A column head is a local expansion of the column at the junction with the slab. Its purpose is to enhance the capacity of the slab for resisting two-way shear action and to lower the amount of negative bending forces at the support. C. A. P. Turner began his investigation of the flat in 1906, during which time he relied mostly on impromptu and basic concepts. This marked the beginning of this kind of building.

They conducted experiments in the United States between the years 1910 and 1920 to determine the maximum load that could be carried by slabs. They also presented a straightforward static technique of analysis for flat slabs. This approach, which is also known as the direct design method, is often used in the design of flat slabs or flat plates and is quite well known. The comparable frame approach with equivalent beams is often used in the field of practice by structural engineers, as Deshpande's investigation revealed.

A flat slab is a kind of two-way reinforced concrete slab that does not typically have any beams or girders, and the loads are instead passed straight to the concrete columns that are supporting the slab. They are exposed to loads in both the vertical and lateral directions simultaneously. The design is determined more by the lateral loads brought on by the wind and earthquake than by the vertical stresses. It's possible that structures that were intended to support vertical loads won't have the strength to withstand lateral stresses. The lateral loads are the most important ones because, in contrast to the vertical load, which may be expected to rise linearly with height, the lateral loads are rather variable and increase very quickly with height. This makes the lateral loads the most important ones. The overturning moment at the base of the structure is rather significant and fluctuates in a manner that is proportional to the square of the building's height when subjected to a uniform wind and earthquake load. As a result of the fact that the lateral loads are much greater in the top storey compared to the bottom level, the structure has a tendency to operate as a cantilever. The frame has a tendency to wobble as a result of these lateral stresses. In many of the regions that are prone to earthquakes, there have been several cases of the collapse of structures that were not constructed to withstand the stresses of an earthquake. The study of the influence of lateral loads is given a lot of importance as a result of all these reactions. Columns, slabs, and beams are the standard components used in typical frame building.

However, it is conceivable to carry out construction without supplying any beams; in this scenario, the frame system would be made up of the slab and the column instead of the beams. The bending of these different kinds of slabs is analogous to that of flat plates, which is why they are referred to as flat slabs. It is not sufficient to use a pure rigid frame system or to produce the frame action required by the interaction of slabs, beams, and columns. The frame by itself cannot offer the necessary degree of lateral rigidity for structures with a height more than 15 to 20 storeys (50 to 60 meters). This is as a result of the shear taking part of the deflection component. A significant amount of the building's deflection may be attributed to the bending of the columns and the slab. There are two methods to fulfill these needs: the first is to raise the size of the members above and above the strength requirements, and the second is to modify the shape of the structure into one that is more rigid and stable in order to restrict deformation. The first strategy has its own set of limitations, but the second strategy is more refined; it boosts the structure's stiffness and stability while simultaneously limiting the amount of deformation that is required. The structure is developed for a critical force situation among the various load combinations in earthquake engineering. In the current investigation, the reaction of multi-storey commercial reinforced concrete was investigated. It has been completed with the frame and the r c flat slab to the lateral and vertical stresses.

The gravity load (both dead and live load) that is applied on the horizontal floor system is resisted by this system, and this resistance is transmitted to the vertical frame systems. During this procedure, the floor system is predominantly subjected to flexure and transverse shear. On the other hand, the vertical frame parts are often subjected to axial compression, which is frequently paired with flexure and shear. Additionally, the floor acts as a horizontal diaphragm, linking and stiffening the numerous vertical frame sections. This function is performed by the floor. Because of their high flexural stiffness in plane, the floor diaphragms respond rigidly when subjected to the action of lateral loads, which allows them to efficiently distribute the lateral load to the different vertical frame components and shear walls. Floor systems typically consist of one of the following components when cast in situ reinforced concrete is used for the construction of a building.

BAR CUTOFFS AND ANCHORAGES

In the case of slabs that do not have any supporting beams, the ACI Code permits the bars to be chopped off in the manner shown in the following image (ACI Code). When neighboring spans are not of equal length, the extension of the negative-moment bars beyond the face of the support is calculated based on the length of the adjacent span that is the greater distance. Positive moment reinforcement perpendicular to a discontinuous edge is required to continue to the edge of the slab and have embedment, either straight or hooked, of at least 150 millimeters in spandrel beams, columns, or walls according to the ACI Code. The ACI Code mandates that any piece of negative-moment steel that is perpendicular to an edge must be developed in tension by being either bent, hooked, or otherwise secured in spandrel beams, columns, or walls along the edge. Even if there isn't an edge beam, this steel should still be hooked to function as torsional reinforcement, and it should continue out from the edge of the slab to the minimum cover thickness.

The Navy makes use of a significant number of explosive storage magazines with flat slab roofs, such as the Navy Type IIB magazine; nevertheless, these magazines are separated by distances that are relatively vast and nonstandard. These distances are mandated by NAVSEA OP-5. Because box-type flat slab roof magazines are so well liked by operations workers, a significant number of the new magazines that are being designed will have this layout. These new magazines will be built to resist the increased blast loads that are associated with the shorter conventional magazine separation lengths in order to minimize the amount of land that is needed. NAVFAC P-397, which is the latest version of the Navy's blast-resistant design handbook, does not, however, provide a design technique for flat slabs. As a consequence of this, the purpose of this paper was to create and record the techniques for building flat slab structures to withstand dynamic blast loads. The work that is presented in this report was made possible by funding from the Department of Defense Explosives Safety Board. This study is a component of the explosives safety program that is run by the Naval Civil Engineering Laboratory to support ordnance logistics for the Fleet.

DESCRIPTION OF FLAT SLAB

Flat, practical surfaces are provided by slabs in structures that are made of reinforced concrete. A reinforced concrete slab is a wide, flat plate that is typically laid horizontally and has top and bottom surfaces that are parallel or nearly parallel to one another. A flat slab structure is one that, by definition, consists of a slab that is created monolithically with columns and that is supported directly by these columns without the assistance of beams and girders. The flat slab system that was investigated for this paper features outer walls that are continuous and monolithic.

As soon as the ratio, 0, of the long span, L, to the short span, S, of the deflected surface becomes one of double curvature. After that, the weight of the roof is transferred in both forward and backward directions to the panel's four supporting columns. The column has a tendency to punch upward through the slab, and it is necessary to avoid the inclined cracking that results from the punching shear. As a result, it is typical to increase the top of the column in the form of an inverted frustum, which is referred to as the column's "capital." It is possible to gain more shear (inclined cracking) resistance by thickening the slab in the region of the column. This section of the slab that has been thickened is referred to as the "drop panel" or just the panel. Although the columns and column capitals may have either a round or square cross section, it is recommended that square column capitals be used since circular column capitals are less likely to concentrate shear stress. However, the circular capital is occasionally transformed to an equivalent square capital using the following etuality when it is necessary to do calculations using the circular capital.

The reinforced concrete flat slab is one of the floor systems that is most often used for building practice in many earthquake-prone locations of the globe.

Flat slab construction has a number of significant benefits over the more traditional slab-beam-column building method, which is perhaps why it is so widely used in the majority of Middle Eastern and Mediterranean nations. The structural efficiency of the flat slab system is, on the other hand, sometimes hampered by the system's occasionally poor performance under seismic loading as a result of the inherent inadequate lateral resistance. This unwanted behavior is mostly brought on by the flat slab system's lack of deep beams and/or shear walls, which in most cases results in significant lateral deformations. As a result, it is becoming more essential to pay even more attention to the investigation of this structurally attractive system, which is, nonetheless, contentious in terms of the seismic effectiveness, dependability, and vulnerability it has. In modern building practice, flat slab systems are often used for relatively modest residential loads and for spans ranging from 4.5 meters to 6 meters in length. Flat slabs with drop panels or column capitals are often employed in situations with severe loads, such as those seen in industrial or office building applications. The construction method of a flat slab offers more architectural freedom, an increased amount of open space, a reduction in building height, simpler formwork, and, as a result, a shorter amount of time spent constructing.

OBJECT

1. The Study Code Compliance, Analysis, And Design
2. The Study the Lateral Behavior of a Typical Flat Slab Building

CONCLUSION

Using ETABS to design a structure with a flat slab and a grid slab for a long-span construction reveals that ETAB delivers the best result for reinforcing data. During the course of my investigation, I discovered that this is the primary reason. In the event that ETABS failed members can be examined easily after the design stage, ETABS provides the reinforcement details with drawings in the form of unique tables. In the design section, "Check failed members" will directly choose those members. The Design Engineer will then be able to modify the section of those members by taking them and putting them in "view selected objects only." The section is then altered to those members in order to make them acceptable for the loading that has been specified. Because the completion of a design in ETABS requires numerous stages, including the assignment of each design parameter, the findings obtained were obtained by making use of this program.

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