A numerical study of flat slab for punching shear using static structural analysis

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Abstract: In this paper FEA model of flat slab column connection is model using ANSYS 16.0 . Punching shear failure is one of the major problem encountered in the design of reinforced concrete flat plates..The obtained results indicate that, the proposed depth and drop panel has a positive effect in the punching shear capacity and the strain energy of interior slab–column connection of both high strength concrete and normal. The finite element software ANSYS.16 can be used successfully to simulate the punching shear behaviour of reinforced concrete flat plates.

***Index Terms* - ANSYS.16, Drop Panel, Flat Slab, Punching Shear.**

I. INTRODUCTION

1.1 General

The Punching shear is a critical design factor of reinforced concrete flat plates since it is associated with brittle failure. Many alternative reinforcement systems had been introduced in literature; e.g., shear studs, bent bars, in order to enhance the punching shear and the strain energy of slab–column connection. The punching shear strength and deformation capacity are strongly influenced by the type and characteristics of the shear reinforcing system. Flat slab is an ideal structural form for architects and contractors. Its flush soffit makes the formwork construction, wiring and ducting work easy. Without using beams, flat slab provides more headroom or lower storey height. It can thus allow for more storeys than other types of slab systems within the same building height. But flat slab has inherent weaknesses. The connections between the floor slab and column in a flat slab structure are generally the most critical part as far as the strength is concerned because it is a region where large moments and shear forces are concentrated.

1.2 Drop Panels

The 'drop panel' is formed by the local thickening of the slab in the neighborhood of the supporting column. Drop panels or simply drops are provided mainly for the purpose of reducing shear stress around the column supports. They help in reducing the steel requirements for the negative moments coming 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 centerline should be taken as one half of the corresponding width of drop for the interior panel.

1.3 Column heads:

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 is to be increased .this is facilitated by providing column capital/heads

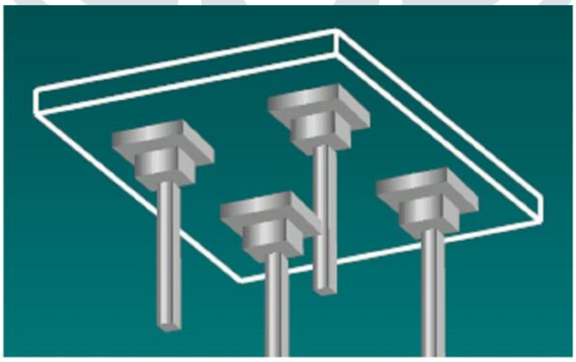

Fig.1: Flat slab with drop panel & column head

I. CODE PROVISION

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 centre-line, where I, is the span in the direction moments are being determined, measured centre to centre of supports and 1, is the -span transverse to 1, measured centre to centre 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 on-each of its four sides by the centre -line of a Column or centre-lines of adjacent-spans.

d. Division into column and middle strip along Depth of flat slab:

The thickness of the flat slab up to spans of 10 m shall be generally controlled by considerations of span (L) to effective depth (d) ratios given as below: Cantilever 7; simply supported 20; Continuous 26 depth d/2. It is observed that the deformation of slab is considerably reduced. For future work scope research work can be done in shape such as circular, hexagonal, pentagon with various depths.

II. Literature Review

1. Hyun-Su Kim1, Dong-Guen Lee2: An improved analytical method that can consider the stiffness degradation effect in the slabs depending on the lateral drifts using super elements was proposed in this study for the efficient and accurate analysis of flat plate structures. The stiffness degradation in the flat plate system could be taken into consideration by the equivalent frame method for flat plate structures with regular plan. Structural analysis of a flat plate structure having irregular plan or slabs with openings can be performed and stress distribution of floor slabs can be easily represented using the finite element method if the stiffness degradation in the slab could be considered properly. In the analysis of a flat plate structure subjected to gravity loads, direct design method or equivalent frame method is generally used for the rectangular slabs while commercial software such as SAFE [5] and MIDAS/SDS [6] is used for the slab with irregular plan.

2. Boskey Vishal Bahoria and Dhananjay K. Parbat: The plan of the office building (G+4) is considered. This building is designed by considering four cases with different floor systems. And total cost of the building per square meter is found and comparison of all the four cases with respect to cost is done. The thickness of reinforced concrete flat slab is 12.5% greater and its cost is 27% greater than the post-tensioned flat slab.

3. Carla M. Ghannoum: The design of flat plate structures is generally governed by serviceability limits on deflection or by ultimate strength of the slab-column connections. Failure of the connection, usually referred to as punching failure, is of special concern to engineers because of its catastrophic consequences. The incrase in the punching shear strength, due to the concentration of the top reinforcing bars in the "immediate column region". Increasing the concrete compressive strength of slabs.

4. Simon BROWN1, Walter DILGER2: It is proposed to base the punching shear design on the probable unbalanced moment capacity of the connection, promoting a flexural failure mode over a shear failure mode. In this way a ductile failure mechanism is assured for the connection. This paper has presented a simplified method for determining the peak unbalanced moment capacity of a slab column connection based on flexural limitations. This value can conservatively be used as the unbalanced moment for punching shear design to ensure that a brittle shear type failure is avoided.

5. U. Prawatwong, C.H. Tandian and P. Warnitchai This paper presents an experimental study on the seismic performance of scale posttensioned (PT) interior slab-column connection models, one without drop panel and another one with drop panel. Both models were tested under a constant gravity load. A conventional displacement-controlled cyclic loading routine with monotonically increasing drift levels until failure was adopted to investigate the seismic performance. The model without drop panel abruptly failed by punching shear shortly after attaining its maximum lateral strength at 2.0% drift, while the improved model experienced a saturation of

6. Omar M. Ben-Sasi An experimental investigation was carried out on a total of six specimens representing flat slab-column connections at interior columns. The parameters studied were moment to shear ratio, Column aspect ratio, column side length to slab depth ratio, and presence of openings in the slab region next to the column stub. The punching strength of an interior slab-column connection increases as the column aspect ratio c1/c 2 increases whereas it decreases as the ratio of moment to shear force increases. The shear stress resistance at the slab-column connection decreases as c/d ratio increases. With increase in demand for space, construction of multi-storeyed buildings is becoming a necessary part of our living style. The dearth of space is forcing us to raise the height of buildings as much as possible to accommodate maximum number of people, and also in harmony with the architectural necessities. These multi-storeyed buildings can be constructed using various structural systems. Also with increase in height the need of resisting lateral loads like wind and earthquake also comes in picture. Two main groups according to the arrangement of slabs, beams or girders, and columns are (1) F r Study of dynamic behaviour of flat slab using time history analysis in ansys

III. FEA Model in ANSYS:

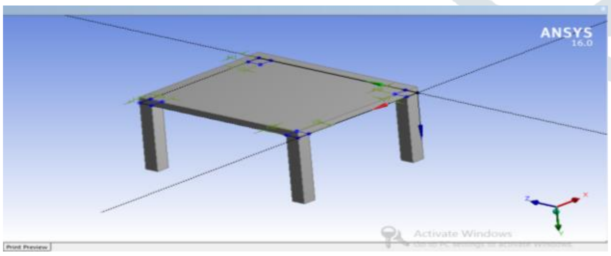

Fig.3.1: Model of flat slab

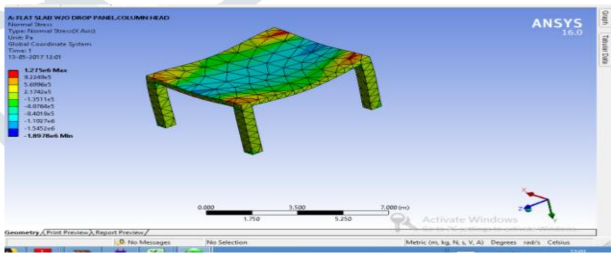

Fig.3.2: Mode shape-I

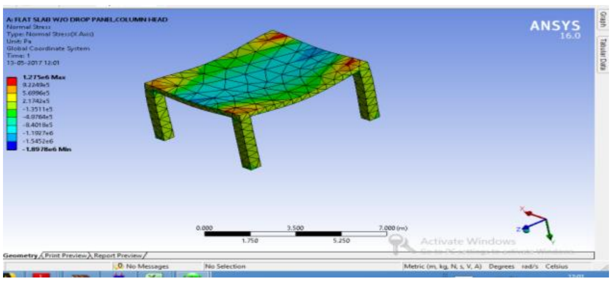

Fig.3.3: Mode shape-II

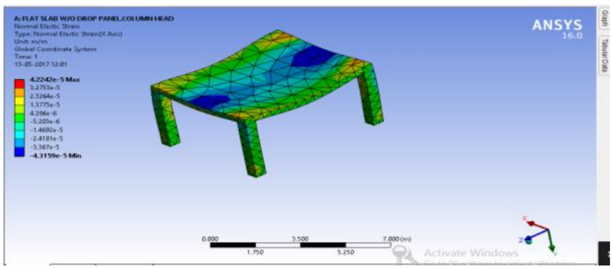

Fig. 3.4: Mode shape-III

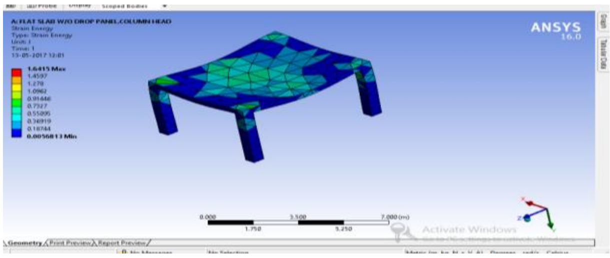

Fig.no.3.5- Mode shape-IV

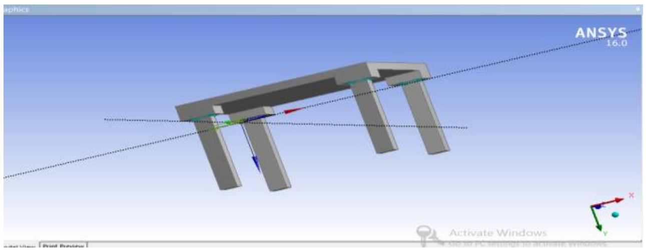

Fig.no.3.6- Mode shape-V

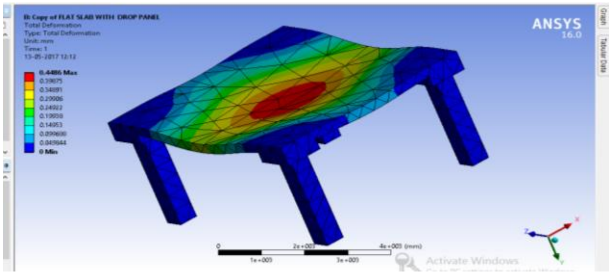

Fig. no.3.7- Mode shape-VI

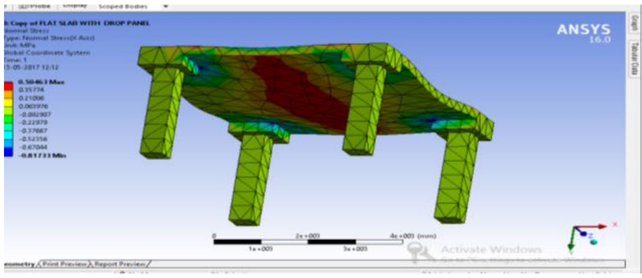

Fig. no.3.8 Mode shape-VII

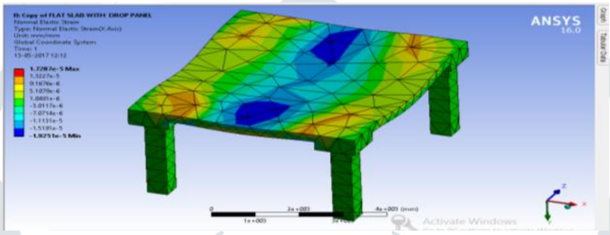

Fig. no. 3.9-Mode shape-I

IV. CONCLUSION

In this paper finite element modeling of Flat slab with and without drop panel is done. a drop panel is inserted at critical depth d/2. It has been observed that the deformation of slab is considerably reduced. For future work scope research work can be done in shape such as circular, hexagonal, pentagon with various depths.The above study indicates the validation with IS-456.

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