Experimental Investigation for Studying the Shear Behaviour of Flat Slabs Using Shear Reinforcement

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***Abstract* - Flat slabs in recent times are generally used for the construction of large industrial structures ,high rise buildings because of its so many advantages. Flat slabs are beam less slabs. They reduce the overall height of the structure and also carry the concentrated loads. They require less framework. Reinforcement detailing of flat slabs is simple and easy to place. Flat slabs may undergo failure due to punching shear and high deflection and to overcome this failure we provide additional shear reinforcement to columns. In This Paper a review is presented to study the shear behaviour of flat slabs.**

***Index Terms* - Flat slabs, Shear Reinforcement, Column Reinforcement, shear behaviour.**

1.INTRODUCTION

The use of flat slabs in buildings and especially in parking garages has been growing as it is an economic and efficient solution. Flat slabs are easy to build and have, through their smaller depth; an economical and architectural advantage compared to slabs on girders. Punching shear reinforcement improves the strength and the rotation capacity of flat slab column connections significantly. It is an efficient method to enhance the rotation capacity of the flat slab column connection, which is rather brittle without transverse reinforcement. Additionally, compared to slabs without transverse reinforcement, the strength of the connection increases due to the provided shear reinforcement within the critical section. However, in presence of shear reinforcement, other failure modes can occur

There are two main failure modes of flat slabs:

i. Flexural Failure mode
ii. Punching Failure mode

A flexural failure corresponds to the moment when tension reinforcement reaches the yielding limit. In order to find the flexural punching value of a flat slab column connection the plasticity-based yield line theory has to be used. The theory uses the same behaviour stages as presented earlier. Plastification occurs following incrementally the envelope of maximum bending moments.

A more complex approach which divides in three main failure types, considering an intermediate punching failure would be:

i. $V_{test} / V_{u, flex} >$ 1.15– flexural failure (F),
ii. 0.95 < $V_{test} / V_{u, flex}$ < 1.15- flexural punching failure (FP),

2.LITERATURE REVIEW

Pradip S. Lande, Aniket B. Raut

Because of its reduced floor height, flat slabs are adopted. However, the flat-slab construction is hindered by its worse behaviour under earthquake loading. Flat slabs are mostly preferred in severe earthquake regions of the world. Unfortunately, behaviour of flat slab during earthquake has proved that this form of construction results in severe damage, when not designed and detailed properly. This paper carried out the parametric investigation in order to identify the seismic response of flat slab. Building is analysed using ETABS. Linear dynamic analysis i.e., response spectrum analysis is performed on the system to get the seismic behaviour.

Mohana H.S, Kavan M.R

The use of flat slab in today’s construction activity is quite common which results in weight reduction, speed up construction and economical. Advancement in newtechnology makes flat slab quite common. This paper studied the G+5 commercial multi storied building having flat slab and conventional slab has been analysed. Parameters like base shear, storey drift, axial force, and displacement are verified

Renuka Ramteke

Advantages of flat slabs over traditional structures because of the less design space, less construction time and economical aspects. Than traditional RC frame system, flat-slab structural system is more flexible in the absence of deep beams and shear walls, for lateral loads. The critical part of flat slab design is the slab-column connection, i.e., the shear force in the slab at the connection, which should retain its bearing capacity even at maximal displacements.

Recent experimental research has been performed at Imperial College London in the United Kingdom by Volume *et al.* 2010 [20] in which the arrangement of the punching shear reinforcement was investigated. More recent work has been performed in Brazil regarding punching shear reinforcement in combination with prestressing (Carvalho *et al*. 2011) [18] and the performance of punching shear reinforcement that does not embrace the flexural reinforcement (Trautwein *et al.* 2011) [19].

3.OBJECTIVES

1. The main purpose of the project is to find which of the two shear reinforcement types provides higher deformation capacity or ductility.
2. To correlate the theoretical strength with the experimental strength.
3. To find the mode of failure in slab.
4. To analyze the development of cracks at different loads and deflections.

4.EXPERIMENTAL PROGRAM

Four panels of size 1m ×1m each are to be casted for the present study. One of the slab panels is treated as modal panel (control slab,[S00]) with no shear reinforcement, & the slab [S01] with shear reinforcement.

Square shaped flat slabs had the dimensions of 1000 mm ×1000 mm. The nominal height of the slabs was 40mm and the average effective depth 32mm. square column of Ø100 mm and a height of 50 mm was used. Slabs were reinforced with mesh reinforcement with Ø3@45mm c/c bars for tension. Column had 8bars of Ø3.

One of the configurations of shear reinforcement contained stirrup cages of 5 rows of Ø3 bars @ 20 mm spacing.

fig 4.1 Arrangement of reinforcement in slab

5.EVALUATION OF PROPERTIES OF USED MATERIALS

Aggregates

(a) Gravel: Well graded crushed gravel of nominal size 10 mm and having specific gravity and water absorption capacity of 2.70and0.71% respectively are used for casting all specimens.

(b)Sand: The fine aggregate used in this research was natural river sand locally available from river "Jhelum" in. The specific gravity was determined by Pycnometer test. Its value was found to be 2.67.

The result of sieve analysis carried out on fine aggregates is shown in table and according to IS 3831970 grading of fine aggregate conforms to zone III having fineness modulus 2.38 i.e., fine sand.

ii) Cement

Khyber Cement OPC complied of grade 43 was used. Its specific gravity on testing is 3.15.

iii) Steel Reinforcement

Mild steel bars of Ø3 mm are used for all slab panels. The yield strength f_y of the bars is equal to 250N/mm^2.

iv) Water

Clean water was used in all mixes, to give water cement ratio w/c 0.46.

CONCRETE MIX DESIGN

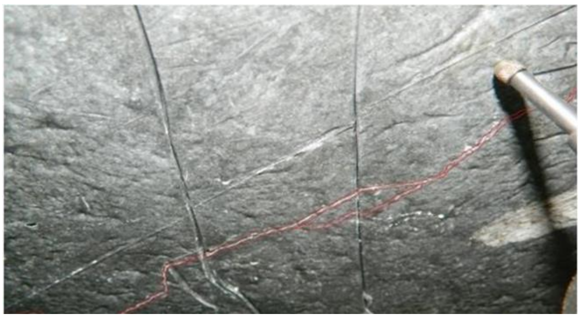
During the casting of slabs, cubes as suggested by IS 456:2000, were also casted to know the exact strength of concrete. The cubes were tested in a UTM and the results were recorded after 28 days. The average strength of the concrete cubes was 23.1 N/mm^2 and 24.2N/mm^2

RESULTS OF SLAB S00(CONTROL PANEL) AND DISCUSSION

The experimental results are shown in Table 5.2.1. The load at first crack, failure load and their corresponding deflections are given below the table.

Test results for slab S00[control slab].

Load (kN)	Deflection in mm			
	Centre Location	Location A	Location B	Location C
4.98	0.69	0.65	0.46	0.64
9.98	1.97	1.10	0.91	1.05
13.28	1.85	1.60	1.30	1.53
18.26	2.30	2.14	1.77	2.05



cracks for slab S00

6.CONCLUSION

From the experimental work and its results, the following conclusions can be drawn:

1. In comparison to slab without shear reinforcement, the punching strength as well as the deformation capacity of other slabs with shear reinforcement increased significantly. The improvement in performance of the slab is influenced by the type of the shear reinforcement system.
2. The ultimate load carrying capacity of slabs with double headed stud rails is 8% more than the control slab.
3. The deformation capacity of the slabs with double headed stud rails is better than the slabs with stirrup reinforcement.
4. The ultimate load carrying capacity is maximum for the slabs with stirrup reinforcement.
5. The slab without shear reinforcement fails due to punching but the slabs with shear reinforcement showed flexural punching behaviour.

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