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Experimental & Analytical Investigation On Shear Behaviour & Strengthening Of Flat Slabs [Using Shear Reinforcement &Etabs For Analysis]

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ABSTRACT
The slab without beams resting directly on supports is what is meant by the term "Flat Slab" (like columns & or walls). Large Bending Moment & Shear Forces are therefore created in close vicinity to the columns. With a flat slab building approach, the beams used in more traditional construction methods are eliminated. The slab is fully supported by the column, and the weight of the slab is transferred directly to the columns before being delivered to the foundation. The thickness of the slab close to the column's support is raised to handle enormous loads; these are known as drops. In addition, columns are often equipped with expanded heads known as column heads or caps. Lack of a beam results in a simple ceiling, which improves the aesthetic of the architecture and makes it less vulnerable to fire than in typical situations when beams are employed. Better at diffusing light, simpler to build, and requiring less form work is the plain ceiling. Many nations have chosen various ways for designing flat slabs and have provided their rules in their own regulations depending on local conditions and material availability. The design and analysis are carried out utilising the Equivalent Frame Method with unequal column & without staggered column as specified in different standards such as IS 456-2000, ACI 318-08 and are compared using software named ETABS. Moments are dispersed in this method as middle strip moments and column strip moments. Using the rules, an internal panel of a flat slab with dimensions of 6.6 x 5.6 m and the load is increasing from 7.75 KN to 33.20 KN for various locations was developed for this project.
One of the most significant forms of failure to consider while building a reinforced concrete flat slab is punching shear failure, a brittle failure. The overall objective of this research is to investigate the efficiency of reinforced concrete for flat slabs with varying punching shear strengthening settings. Three flat slab samples were cast, two of which had punched shear reinforcement in the form of structural shear bands and shear stirrups. The examination specimens measure 1000 mm in length, 1000 mm wide, and 185 mm thick for the slabs. The slabs are joined to a central column that is 300 mm long, 300 mm wide, and 700 mm deep. To support the test specimens, steel plates 150 mm long, 150 mm broad, and 25 mm thick were installed across the slab's four corners. The top of the column face is loaded with the test specimens. We noticed and noted the deflection, strain, and crack pattern.
Keywords:*Flat Slabs, flexure shear, Drop, ETABS software, Punching shear, Shearbands, Shear reinforcement; Shear stirrups.*

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I. INTRODUCTION

General:

A flat slab is a two-way reinforced concrete slab without beams or girders that transfers loads directly from the slab to the concrete columns it supports. Both lateral and vertical loads are applied to them. The design is dictated more by lateral stresses from earthquake and wind than by vertical loads. It's possible that structures built to withstand vertical loads won't be able to withstand lateral stresses. The main loads are the lateral ones because, unlike vertical loads, which are thought to rise linearly with height, lateral loads are very variable and rise quickly. The overturning moment at the base is quite significant and changes in proportion to the square of the building's height under uniform wind and earthquake loads. The top-level experiences significantly greater lateral stresses than the bottom storey, which causes the building to exhibit cantilever behaviour. These lateral stresses cause the frame to wobble. Buildings that were not built to withstand earthquake loads have failed on numerous occasions in several seismically active regions. The analysis of the impact of lateral loads is crucial considering all these reactions.

In general, columns, slabs, and beams are used in typical frame building. Yet it could be conceivable to start building without providing beams; in this instance, the frame system would consist of a slab and a column without beams. As the behaviour of these slabs resembles the bending of flat plates, they are known as flat slabs. It is insufficient to use a pure rigid frame system or frame action that results from the interplay of slabs, beams, and columns. For structures taller than 15 to 20 storeys (50 to 60 metres), the frame by itself is unable to provide the necessary lateral stiffness. It is as a result of the deflection's shear taking component. The severe deflection of the structure is caused by the bending of the slab and columns. These conditions can be met in two different ways. Initially, members should be made larger than necessary to meet strength requirements, and then the shape of the structure should be altered to make it more stable and stiffer in order to limit deformation. The first strategy has its own limitations, but the second is more elegant, increasing the structure's stiffness and stability while constricting the amount of deformation needed. While designing a structure for an earthquake, the critical force condition for the load combination is taken into consideration. The reaction of multi-story commercial reinforced concrete was examined in this study. Frame and RC flat slab have been constructed to accommodate lateral and vertical stresses.

One of the most frequent forms of failure in a flat slab is punching shear failure. Large shear forces and bending moments are produced at the columns when the load is given to the slab, which causes the slab to collapse by punching around the column. Brittle failure is punching shear failure. Shear diagonal fractures that grow across the whole slab thickness are to blame, and they create a frustum pyramid around the column. In other words, in the event of failure, the column and slab entirely separate. The stress is subsequently distributed to nearby columns, overloading them and finally leading to a gradual collapse of the entire building. There are several methods that may be used to avoid a flat slab's punched shear failure.

Some of these include adding drop panels and column heads, thickening the slab, lowering the application of stresses, and adding shear reinforcement. Nonetheless, same techniques must be used when designing flat slabs. The first four solutions are not advised since they just increase building costs. To prevent the punching shear failure, we thus offer shear reinforcement. The improvement of the flat slab's strength and ductility is ensured by the addition of punching shear reinforcement. In addition to shear stirrups, structural shear studs, structural shear bands, matrix shear reinforcement, and UFO punching preventers, we can also offer punching shear reinforcement[1]. In this study, the behaviour of a flat shear-reinforced concrete slab is investigated when shear stirrups and structural shear bands are utilised.

As flat slab construction is a practical and affordable option for buildings, particularly parking garages, it has grown in popularity. Since they are shallower than slabs on girders, flat slabs are simpler to build and have superior architectural and cost advantages. By adding punching shear reinforcement, flat slab column connections' strength and ability to rotate are considerably increased. The flat slab column connection is rather brittle without transverse bracing; hence it is a good technique to boost rotational stability. Moreover, the supplied shear reinforcement inside the crucial zone strengthens the connection more than slabs without transverse reinforcement. However, when there is shear reinforcement, other failure mechanisms are also conceivable.

Under uniform wind and earthquake loads, the overturning moment at the base is quite significant and changes in proportion to the square of the building's height. The structure exhibits cantilever behaviour because the top story is subjected to much more lateral pressures than the bottom storey. The frame sways as a result of these lateral stresses. In many seismically active places, structures that weren't constructed to resist earthquake loads have crumbled on multiple occasions. Given all of these reactions, it is imperative to analyse the effects of lateral loads.

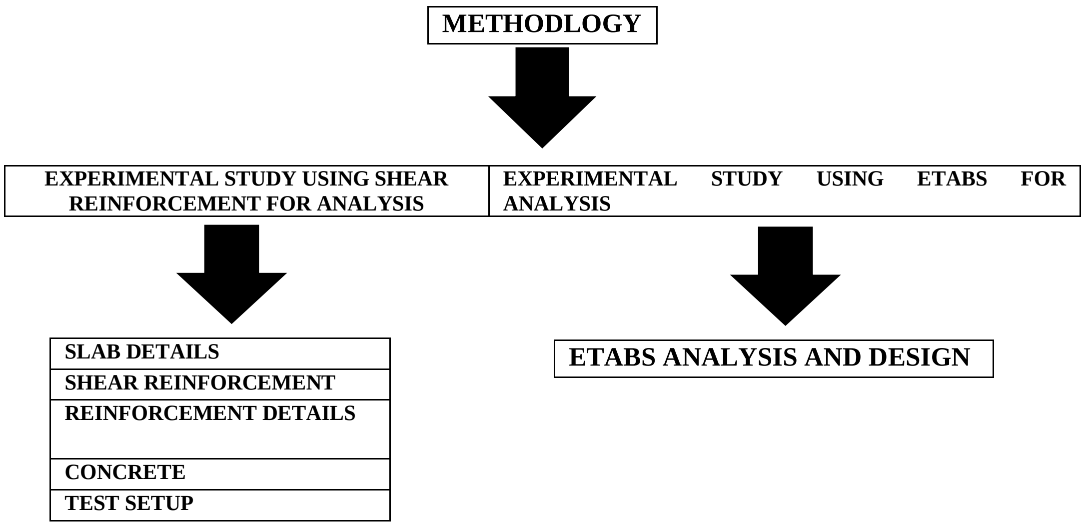
II. OBJECTIVE OF STUDY

This project involves designing and estimating flat reinforced concrete slabs with spans ranging from 6.0 metres to 12.0 metres. And concrete processes using prestressing. Regardless of the economics, prestressed concrete construction becomes too laborious for smaller spans associated with typical building projects. So that the calculated bending moment will be comparable to that which develops in cases of commercial buildings, the intensity of the anticipated loading is kept high enough. In order to stay fashionable, post-tensioning is preferred while building broad span slabs. Floor framing is typically the largest component of all structural costs. Similar to this, the horizontal components of a structure typically have the highest formwork costs. Therefore, choosing the structural system that has the lowest overall cost while still meeting load requirements is the first consideration when building for economy. Construction of multifamily buildings at a reasonable cost requires posttensioning. Additionally, post-tensioned buildings can be made to deflect and break less even when fully loaded. Lower building weight is achieved by using thinner floors, which also results in a reduction in other structural components. Additionally, labour and time savings are related.

In the present study, a 6m x 300mm interior panel supported by 300mm x 300mm columns was taken into consideration, and the panel's analysis was carried out manually using the direct design approach. In order to build the flat slab in accordance with the Indian code, IS 456: 2000[2], a live load of 5kN/m2 was measured, and the moments obtained using this way of analysis were employed. Three reinforced concrete slabs in all were cast and put to the test using the loading frame. This research's major objective was to examine the behaviour and performance of reinforced concrete flat slabs both with and without shear reinforcement. The three slab specimens' cross-sectional details and reinforcement are listed below.

The following are the research's primary goals:

- To investigate the effectiveness of flat slab and conventional slab structures under varied loads and circumstances.
- To research the behaviour of both structures regarding factors including axial forces, storey shear, and storey displacement drift ratio.
- Comparisons between conventional versus flat buildings for the factors mentioned.
- The analysis's primary goal is to examine the many forces operating on a building. The following section discusses the outcomes of conventional reinforced concrete structures for various heights, including slab, beam and column, and flat slab reinforced concrete structures.
- The modelling and analysis of conventional reinforced concrete structures and flat slab reinforced concrete for various heights under various combinations of dynamic loads. Buildings constructed using flat slab reinforced concrete are compared to traditional reinforced concrete structures since they are both located in seismic zone IV.
- To investigate the susceptibility of pure frame and pure flat-slab models under various variables, including base shear, time, lateral displacement, and storey drift.



III. EXPERIMENTAL STUDY USING SHEAR REINFORCEMENT FOR ANALYSIS

Slab Details*:*

The three slabs were assigned the FS (Flat Slab) codes 1 through 3. The control specimen, designated as FS1, lacked shear reinforcement. Punching shear reinforcement was given to FS2 and FS3 in the form of structural shearbands and shear stirrups, respectively. Table 1 lists the crosssectional information for the three slab specimens.

Table 1: Dimensions of flat slab.

Specimen		Slab			Column	
	Length (mm)	Width(mm)	Dept h (mm)	Length (mm)	Width(mm)	Height(mm)
FS1						
FS2	1000	1000	185	300	300	700
FS3						

Shear Reinforcement:

Only two of the three slab specimens had punched shear reinforcement in the form of structural shearbands and shear stirrups. Shear stirrups were used as punching shear reinforcement for slab FS2. One of the most popular kinds of shear reinforcement is the shear stirrup. It can be offered with one, two, three, or more closed or hollow shaft legs. In this investigation, the top and bottom reinforcement of the slab-column junction were connected using single-legged stirrups. To link the top and bottom horizontal reinforcement, 8mm diameter Fe500 grade steel bars are bent into the necessary lengths and put around the column at a 45mm distance from the column face. Structural shearbands were offered as shear reinforcement for slab FS3. High ductility and high strength steel strips with a width of 30mm and a thickness of 0.5mm[3] were used to create the shearbands. The strip's tensile strength was determined to be 1200N/mm^2. Furthermore, 8mm-diameter holes were bored into the steel strips. These holes have shown to enhance the anchoring properties over short distances. These strips were bent into vertical legs and fastened to the top mat of the column's reinforcement 45 mm from the column face.

Reinforcement Details:

All three slab examples have the same longitudinal reinforcement. Even so, extra shear strengthening was offered for the slabs FS2 and FS3. Tables 2 and 3 respectively indicate the reinforcing details for the slab and column. The reinforcing features of slab FS1, which lacks shear reinforcement, are shown in Figure 1. The reinforcing details for slab FS2 are shown in Figure 2, which includes stirrups with open legs for shear reinforcement. The reinforcing features of slab FS3 are shown in Figure 3. This slab contains structural shearbands for shear reinforcement.

Table 2: Detailing of reinforcement in the slab

	Longitudinal Reinforcement		Shear Reinforcement		
Specimen	No & Dia A_{st}(mm^2)	p_t (%)	No & Dimensions	Ast (mm2)	p_t (%)
FS1	8No-10mm(Top) 8No-12mm (Bottom) 1533.1	0.82	-	-	-
FS2	8No-10mm(Top) 8No-12mm (Bottom) 1533.1	0.82	12No-8mm Dia	603.19	0.32
FS3	8No-10mm(Top) 8No-12mm (Bottom) 1533.1	0.82	4No-30mm wide, 0.5mm thick	60	0.16

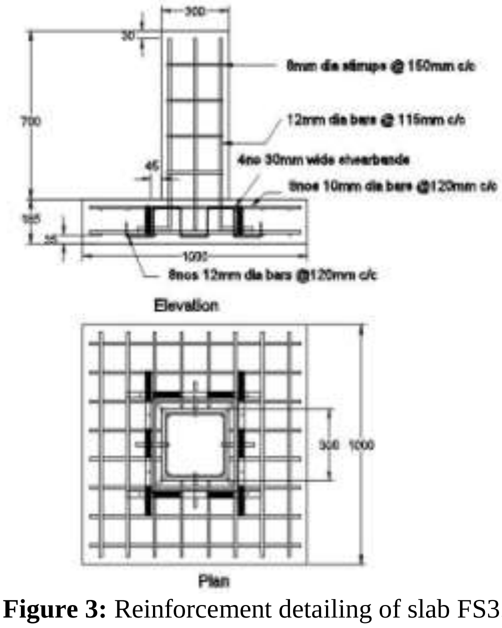


Figure 3: Reinforcement detailing of slab FS3.

Concrete:

According to IS 10262: 2009[4], concrete was used to create the three slab specimens. Utilized was ready-mixed M35 concrete with a 1:2:3.5 mix pattern. The concrete mix also included 1% SP430 additive to improve workability. Vibratory equipment was used to compress the concrete before casting, and the three slabs required a 28-day curing period. The same sample was used to cast three 150mmx150mmx150mm concrete cubes, and the cubes were tested on the same day as the slab specimens. Table 4 displays the concrete mix design's obtained compressive strength.

Table 4: Compressive strength of concrete.

Specimen	**FS1**	**FS2**	**FS3**
Load(kN)	860	900	880
Load(kN)	920	860	910
Load(kN)	900	910	930
Compressive Strength(N/mm^2)	38.95	38.81	39.53

Test Setup:

In the structural laboratory of the K.L Education Foundation, the three slab specimens were tested using a loading frame with a 200-ton capacity. In actual reality, the load is often shifted from the slab to the column. Thus, the slab must be on top above the column in order to test the specimens. Nonetheless, the specimens are inverted and examined for stability and safety concerns. The four corners of the three slab specimens are supported by steel plates that are 150 mm in length, breadth, and thickness, and at the top, a hydraulic jack applies the weight to the column face. A compression loading cell was used to measure the load placed on the flat slab test specimens. The displacement of the member at that location was measured using an LVDT (Linear Variable Differential Transducer), which was positioned in the centre of the slab at the bottom. Two strain gauges were installed, one at 300mm from the top of the column and the other at 75mm from the top of the slab. Figure 4 depicts the test configuration.

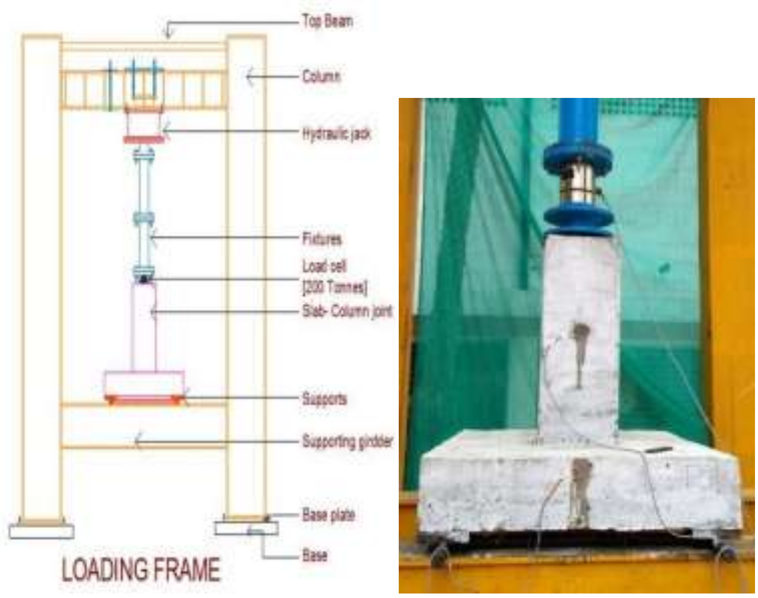


Figure 4: Test setup

EXPERIMENTALSTUDYUSING ETABS FOR ANALYSIS

The computer application ETABS was created especially for the purpose of creating buildings. It gives the structural engineer all the resources needed to make, edit, examine, plan, and improve building models. The ease-of-use, productivity, and power of this single Windows-based, graphical user interface are unequalled. These features are fully incorporated into it. The innovative and ground-breaking new ETABS is the most complete integrated software suite for structural analysis and building design. The most recent version of ETABS provides users with unmatched 3D object-based modelling and visualisations, lightning-fast linear and nonlinear analytical power, sophisticated and detailed design capabilities for a variety of materials, and perceptive graphical representations, reports, and schematic drawings that make it simple for them to understand analysis and design results easily and quickly. The result of 40 years of continuing study and development is this version of ETABS.

Every step of the engineering design process is integrated by ETABS, from the first stages of concept development through the creation of schematic drawings. Model creation has never been simpler thanks to straightforward drawing controls that enable quick floor and elevation frame development. CAD drawings may be used as templates for ETABS objects to be overlaid or they can be immediately transformed into ETABS models. Steel joists, composite beams, composite columns, concrete and masonry shear walls, as well as the capacity check for steel connections and base plates, are all included in the design of steel and concrete frames (with automated optimization). Models may be generated accurately, and all outcomes may be displayed right on the building. For every analysis and design output, comprehensive and individualised reports are provided. For concrete and steel buildings, schematic construction drawings of the frame plans, schedules, details, and cross-sections may also be produced.

Whether structural engineers are constructing one-story industrial buildings or the highest commercial high-rises, ETABS offers an unmatched set of capabilities. From its inception many years ago, ETABS has been known for being incredibly powerful yet simple to use. Our most recent update upholds that legacy by giving engineers the cutting-edge tools they need to be as productive as possible.

Table 5: Slab Data

Load (KN)	Deflection in mm			
	Centre location	**Location A**	**Location B**	**Location C**
7.75	0.18	0.09	0.06	0.12
8.30	0.28	0.17	0.12	0.21
15.00	0.96	0.35	0.28	0.42
21.58	2.52	2.42	2.11	2.88
27.4	4.84	3.64	3.28	4.36
33.20	7.48	6.12	5.13	5.42

In the above table 5 the deflections along with the load are mentioned. The load is increasing from 7.75 KN to 33.20 KN for various locations.

IV. RESULT AND DISCUSSION

Crack pattern:

The control specimen, specimen FS1, abruptly failed in punching shear. Figure 5 depicts the specimen's cracking pattern. The slab's face also developed into a frustum pyramid. Also, the column and the top and bottom faces of the slab developed cracks, which are signs of punching.

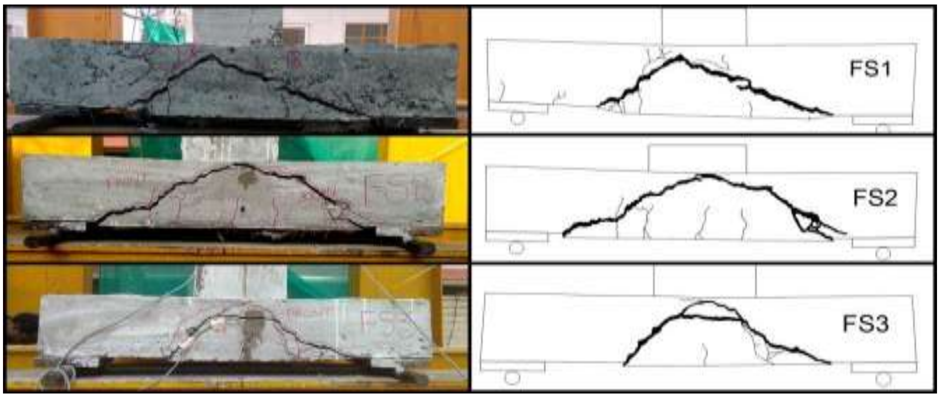


Figure 5: Observed crack pattern of flat slab specimens.

Shear reinforcement was seen in specimens FS2 and FS3, and they had crack patterns that matched slab FS1's. Nonetheless, early fractures were visible, and after more pressure, FS2 and FS3 collapsed as a result of punching shear and were ductile in character. Figure 5 displays the fracture pattern for the specimens FS2 and FS3.

Load Vs Deflection:

The specimen FS1 experienced brittle failure with a load of 310kN and a deflection of 8.19mm. With a deflection of 9.98mm, FS2 had a maximum load bearing capability of 445kN and a breaking load of 300kN. At a deflection of 8.78mm, FS3 had a breaking load of 206kN and a load bearing capability of 378.5kN. Figure 6 depicts the load Vs displacement graph for the three flat slab specimens.

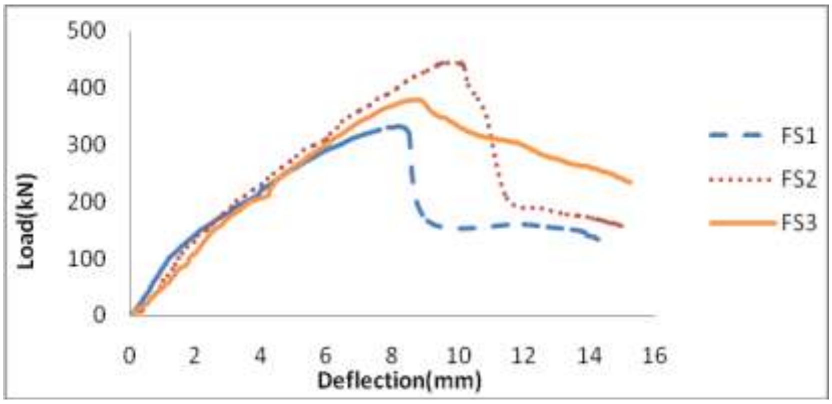


Figure 6: Load Vs displacement graph of flat slab specimens.

Stiffness Degradation:

A body's ability to resist deformation when under load is referred to as stiffness. Figure 7 displays the graph between the specimens' stiffness and deflection. In other words, the three slab specimens' stiffness deterioration is depicted on the graph. The stiffness of the specimen's changes when the weight is applied. The stiffness gradually began to reduce as soon as the force was applied to the specimens. Yet when punching took place, stiffness decreased immediately in FS1 and FS2, but more so in FS1. In FS3, stiffness gradually decreased till failure.

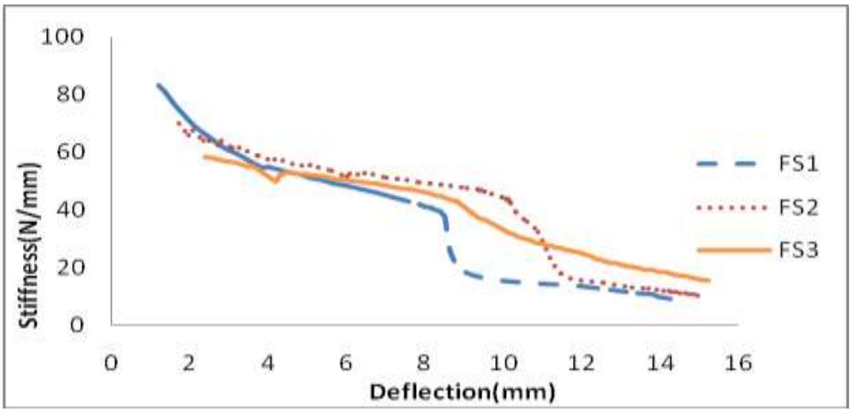


Figure 7: stiffness degradation of flat slab specimens.

Stress Vs Strain:

The stress-strain relationship between the three flat slab specimens is shown in Figure 8. Originally, when a load is applied to the specimens, the relationship between stress and strain was direct. Nevertheless, there was a quick decrease in stress in FS1 and FS2, a steady decrease in FS3, and the specimen's flexibility vanished when punching occurred in the slab. It is obvious that FS2 is under more stress than the other two specimens.

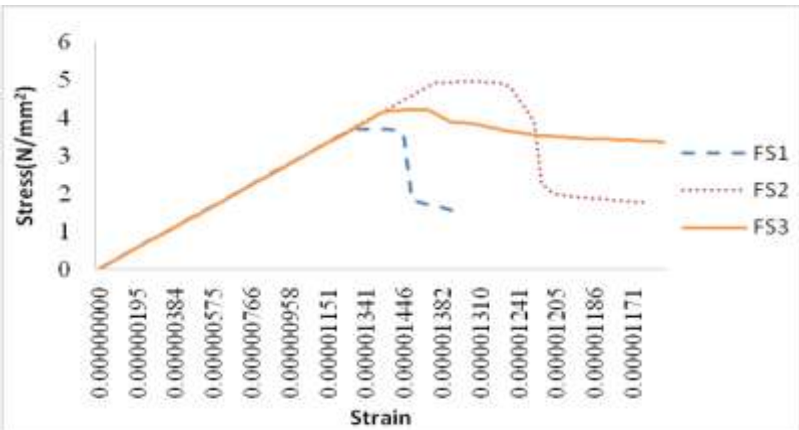


Figure 8: Stress Vs strain graph of flat slab specimens.

Load Vs Strain:

Figure 9 depicts the load-strain relationship between the three flat slab specimens. As more force was put on the specimens, their strain rose proportionately. Even without an additional increase in load, the strain in the specimens rose quickly after the maximum load bearing capacity of the specimen was achieved. In FS1, punching resulted in a quick decline in load while maintaining a constant strain in the specimen. In FS2, the load decreased somewhat but not as much as in FS1, and the strain slightly rose. In FS3, there was a significant rise in strain even with a slight drop in load following punching.

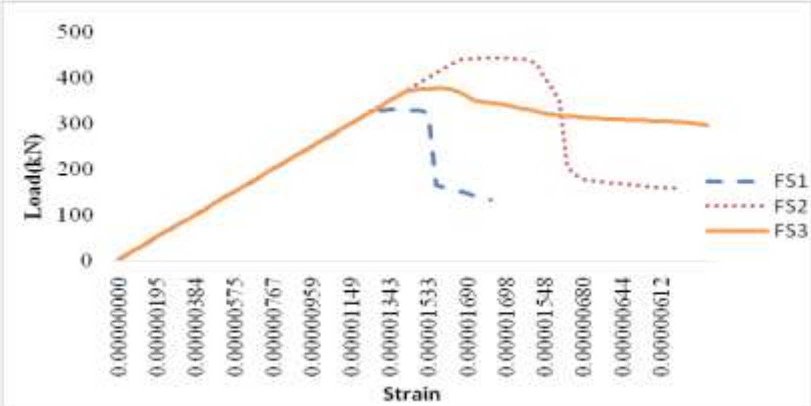


Figure 9: Load Vs strain graph of flat slab specimens.

Shear Strength Vs Drift Ratio:

A normalised graph between shear strength and drift ratio for each flat slab specimen is shown in Figure 10. The ratio of greatest drift to specimen height is known as the drift ratio. The shear strength of the three specimens initially rose with an increase in drift ratio during loading, and the graph was almost linear. Punching caused the shear strength of FS1 and FS2 to decline immediately, whereas FS3's shear strength reduced over time. In FS2, shear strength was greatest, whereas in FS1, it was weakest.

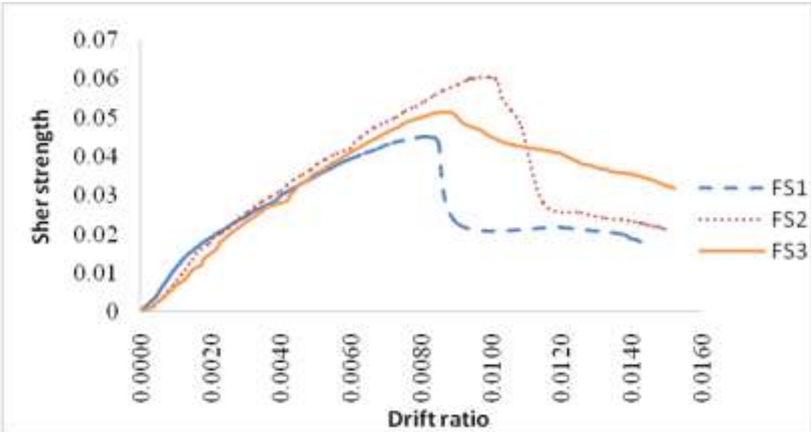


Figure 10: Normalized graph of flat slab specimens.

ETABS Analysis and Design

Table 6: Story Data

Name	Type	Story Range	X Origin M	Y Origin m	Rotation Degree
G1	Cartesian	Default	0	0	0

Table 6 above includes the following information: category, story range, and locations.

Table 7: Grid Data

Name	Height Mm	Elevation mm	Master Story	Similar To	Splice Story
Story 1	2000	2000	Yes	None	No
Base	0	0	No	None	No

Table 7 above lists the height, elevation, and other information.

Table 8: Material Properties – Summary

Name	Material	Shape
COLUMN 1	M25	Concrete Rectangular

Name	Design Type	Element Type	Material	Total Thickness Mm
DROP 1	Slab	ShellThin	M25	160
Slab1	Slab	ShellThin	M25	160

Name	Type	E MPa	ν	Unit Weight kN/m³	Design Strengths MPa
A416Gr270	Tendon	196500. 6	0	76.97 29	Fy=1689.91 Fu=1861.58
A615Gr60	Rebar	199947. 98	0.3	76.97 29	Fy=413.69 Fu=620.53
M25	Concrete	25000	0.2	24.99 26	Fc=25
Mild250	Rebar	200000	0	76.97 29	Fy=250 Fu=410

The materials' complete specifications are listed in table 8 above.

Table 9: Frame Sections

Strength of an element is significantly influenced by the type of structural element, material, and design.

Table 10: Shell Sections

According to the IS Code, M-25 concrete with a 160mm thickness was to be utilised. Table 10 illustrates the same.

Table 11: Frame Assignments

Story	Label	Unique	Design Type	Length Mm	Analysis section	Direction section	Min. Number Station
Story1	C1	1	Column	2000	COLUMN 1	N/A	3
Story1	C2	2	Column	2000	COLUMN 1	N/A	3
Story1	C3	3	Column	2000	COLUMN 1	N/A	3
Story1	C4	4	Column	2000	COLUMN 1	N/A	3

The specifics of the structural elements are listed in Table 11 above.

Table 12: Load Patterns

Name	**Type**	**Self-Weight Multiplier**
Dead	Dead	1
Live	Live	0

A structural part must bear two weights: its own weight and its live weight. The same is shown in table 12 above.

Table 13: Shell Loads – Uniform

Story	**Label**	**Unique Name**	**Load Pattern**	**Direction**	**Load kN/m²**
Story1	F1	1	Dead	Gravity	4
Story1	F1	1	Dead	Gravity	15
Story1	F2	2	Dead	Gravity	4
Story1	F2	2	Dead	Gravity	15
Story1	F3	3	Dead	Gravity	4
Story1	F3	3	Dead	Gravity	15
Story1	F4	4	Dead	Gravity	4
Story1	F4	4	Dead	Gravity	15
Story1	F5	5	Dead	Gravity	4
Story1	F5	5	Dead	Gravity	15

The loading patterns for several stories are provided in table 13 above.

Name	**Type**
Dead	Linear Static
Live	Linear Static

Table 14: Load Cases

Table 14 shows the many load types, including static and dynamic loads.

Table 15: Concrete Slab Design Summary: Flexure and Shear Data

Story	Strip Name	Span ID	FT op Combo	FB ot Combo	V Combo	Location	FT op Moment kN-m	FT op Area Mm^2	FB ot Moment kN-m	FB ot Area Mm^2	V Force kN	V Area Mm^2/m
Story1	CSN1	Span 1	DSlbU4	DSlbU4	DSlbU4	Start	80.8837	2055	37.3966	840	22.0982	0
Story1	CSN1	Span 1	DSlbU4	DSlbU4	DSlbU4	Middle	0.0175	0	55.1441	1384	55.7821	0
Story1	CSN1	Span 1	DSlbU4	DSlbU4	DSlbU4	End	80.8837	2055	37.3966	840	55.7821	0
Story1	MSN1	Span 1	DSlbU4	DSlbU4	DSlbU4	Start	13.5865	284	39.2812	857	27.3914	0
Story1	MSN1	Span 1	DSlbU4	DSlbU4	DSlbU4	Middle	0	0	71.9694	1697	39.8072	0

Story1	MSN1	Span 1	DSlbU4	DSlbU4	DSlbU4	End	13.5865	284	39.2812	857	39.8072	0
Story1	CSN2	Span 1	DSlbU4	DSlbU4	DSlbU4	Start	80.8837	2055	37.3966	840	22.0982	0
Story1	CSN2	Span 1	DSlbU4	DSlbU4	DSlbU4	Middle	0.0175	0	35.5439	1384	55.7821	0
Story1	CSN2	Span 1	DSlbU4	DSlbU4	DSlbU4	End	80.8837	2055	37.3966	840	55.7821	0

Table 15 above contains all the information on the structural element analysis performed with the ETABS programme.

V. CONCLUSION

This study includes a brief introduction to flat slabs and discusses the problem of punching shear failure. Several remedies, such as various forms of punching shear reinforcement, were also offered in order to prevent the failure caused by punching. Three flat slabs were also cast, of which two specimens had punching shear reinforcement in the form of structural shearbands and shear stirrups, and they have been tested for punching. This experiment's goal was to examine and assess how flat slabs behaved both with and without punching shear reinforcement. The following is a list of the inferences made from the experimental programme.

- It is discovered that flat slab specimens with punching shear reinforcement have a higher load bearing capability than flat slab specimens without punching shear reinforcement.
- FS1 failed due to brittle failure, whereas FS2 and FS3 failed due to ductile failure.
- In comparison to specimens without punching shear reinforcement, specimens with shear reinforcement have higher shear strengths. It demonstrates that FS1 was less able than FS2 and FS3 to survive the failure brought on by the imposed stress.
- In comparison to FS2 and FS3, FS1 has significantly more stiffness deterioration.
- The stresses created in FS2 and FS3 are greater than those in FS1, indicating that the specimens with shear reinforcement have a greater capacity to support loads.
- When shearband reinforcement is applied over the top mat of slab reinforcement, it has shown out to be quicker and easier to apply than shear stirrup reinforcement.
- ETABS helps in demonstrating more deflection for lateral stresses.
- It covers every detail regarding the flat slabs.
- As flat slab building offers so many benefits, it is a growing technology in India.
- When it comes to modern building, which demands structural integrity as well as a high standard of appearances, a flat slab may be a far better solution.

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