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Comparative Study of Analysis of Flat Slab and Conventional Slab Using ETAB Software

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ABSTRACT

In today's construction activity the use of flat slab is quite common which enhances the weight reduction, speed up construction, and economical. Similarly from the beginning conventional slab has got place in providing features like more stiffness, higher load carrying capacity, safe and economical also. For analysis material properties like grade of concrete steel, density, modulus of elasticity, must be defined initially and also various loads like dead load, live load, SDL. In this present work direct approach is adopted for manual design of flat slab and check for punching shear using software. Flat slabs are more vulnerable to punching shear because of absence of beam. Analysis of flat and conventional slab structures has been done using ETABS software.

Keywords: Flat Slab, Conventional Slab, Punching Shear, ETABS

I. INTRODUCTION

The infrastructure facilities of India have increased due to urbanization. the land area has decreased. this had lead to the development of medium to sky rise buildings. the growth of population put pressure on the limited land space. it leads to the city residential development. the cost of land has become high. there was also the need to preserve the area of important agricultural production. all these factors are responsible for the drive of residential building rising upward. tall commercial buildings help business activities to be close to each other. they are also developed in the city centres as a symbol of prestige for corporate. business and tourists are now attracting high rise buildings. building design and construction methods have evolved in the search for the efficient use of resources. the civil construction sector uses large volume of natural resources and energy, thereby causing serious environmental impacts.

Flat slabs were originally invented in USA in the year 1906. this was the start of this type of construction. many slabs were load tested 1910-20 in USA. in 1914 Nicholas proposed a method of analysis of these slab based on simple statics, this method is known as direct design method. supporting the slab by beam and beams by column is the common practice of design and construction. this may be called as beam-column construction. but such type of construction reduces the available net clear ceiling height. flat plate or slabs economical as they have no beams and can reduce the floor height by 10-15%. when the beams are avoided then we can increase the room height

So now a days slabs are directly put on column for aesthetic and architectural point of view and the loads are directly transferred to the columns, such slabs are called Flat slabs. Flat slab reduces dead weight and enhances the floor area. Flat slab construction is mainly used in offices, warehouses, foundations etc although they can be used in construction of roadways and paths.

Flat slabs are subjected both to vertical and lateral loads. Lateral loads due to wind and earthquake governs the design rather than the vertical loads. The buildings designed for vertical load may not have the capacity to resist lateral loads.

One of the major concerns of flat slab is punching shear. Punching shear failure is caused by the vertical shear and unbalanced moment borne by slab column connection, which makes the flat slab connections a

weak link in the whole flat slab structure, and then leading to serious damage or even collapse. Unbalanced moments commonly occur in buildings with flat slabs, caused by unequal spans or loading on either side of the column. In the presence of such moments, the phenomenon of punching become unsymmetrical, and the punching strength of slab decreases. This results in column breaking through the portion of surrounding slab. Punching shear failure arises from the formation of diagonal tension cracks around the loaded area, which results in conical failure surface. To prevent punching shear failure the strong concrete should be used, design the reinforcement correctly that is reinforce each possible failure plane, deepen the slab, making the column larger, introducing drop panels or flared column heads. The reinforcement put in is usually vertical and transverse the potential failure line.

II. OBJECTIVES

The following are the main objectives of the study.

- To compare the values of punching shear in manual design of flat slab and analysis using the software.
- To compare the analysis results of both flat slab and conventional slab.

III. METHODOLOGY

Single storey RC flat slab building and conventional slab structure are modelled in ETABS 15.2.0 version software. RC flat slab building was analysed manually using Direct Design method and compared the result with software. For the manual design flat slab building is strengthened using drop and column head. Code followed for the design is Indian Standard 456-2000. The modelled buildings are checked for the errors before analysing and the results are extracted after analysing. The results are exported and tabulated.

IV. RESULT AND DISCUSSION

Design of flat slab (direct design method)

This work has been analysed using ETAB software. For the analysis material properties like grade of concrete, steel must be defined initially and also the various loads like dead, live, SDL needs to be define earlier.

Table1 : Details of structures

Structure	Flat slab
Number of storey	Single
Storey height	4 m
Column	0.9 m x 0.6 m
Floor finishes	1.0 kN/m^2
Live load	1.5 kN/m^2
Total design load	9.875kN/m^2
Punching shear(τ_v) (manual)	0.538Mpa
Punching shear(τ_v)(software)	0.63Mpa
τ_c	1.12Mpa $\tau_v < \tau_c$ (safe).
Thickness of flat slab	150 mm
Thickness of drop	290 mm
Size of drop	2.3 m x 2.3 m
Thickness of normal slab	150 mm
Grade of concrete for beam and slab	M_{20}
Grade of steel	Fe 415
Restraints	Fixed support

ETABS analysis procedure

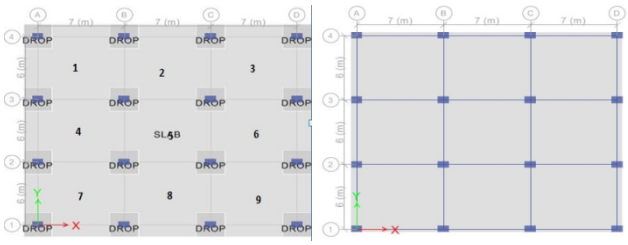
ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS Version 8 features an intuitive and powerful graphical interface coupled with unmatched modelling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of nonlinear behaviours, making it the tool of choice for structural engineers in the building industry.

Dating back more than 30 years to the original development of TABS, the predecessor of ETABS, it was clearly recognized that buildings constituted a very special class of structures. Early releases of ETABS provided input, output and numerical solution techniques that took into consideration the characteristics unique to building type structures, provided a tool that offered significant savings in time and increased accuracy over general purpose programs. The model of ETAB structure is shown in fig 1 and

analysis result is shown in fig 2.The following are the procedure to analyse :

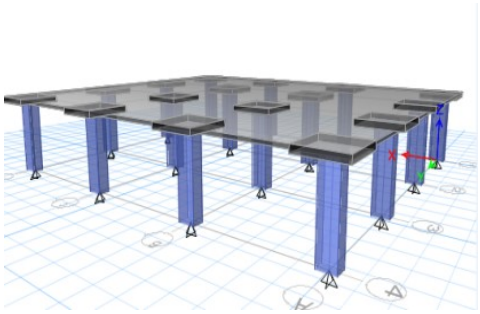
- Define plan grids and storey data
- Define material properties
- Define frame sections
- Define slab sections
- Define load cases
- Draw beam objects
- Draw column objects
- Assign slab sections
- Assign restraints
- Assign slab loads
- View input data in tabular form
- Run the analysis
- View analysis result graphically

Model description



(a) (b)

Figure 1: layout of model a) flat slab model b) conventional slab model



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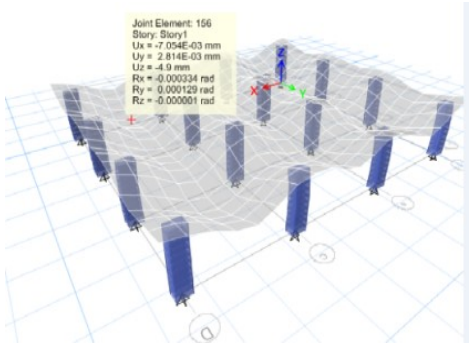

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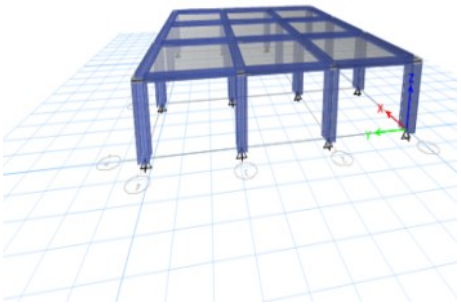

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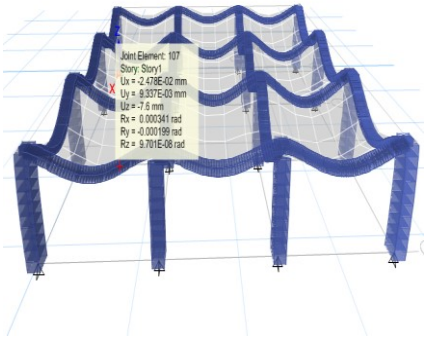


(d)

Figure 2 : a)Flat slab building before analysis. b)Flat slab building after analysis. c) conventional slab building before analysis. d) conventional slab building after analysis.

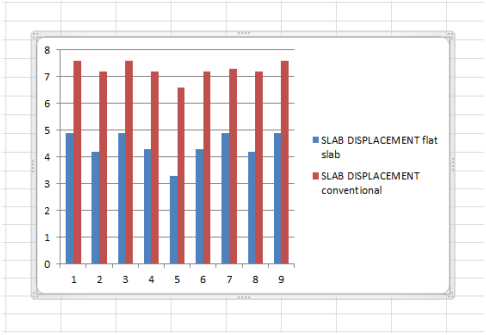
In the analysis of a building structure by means of ETABS software, various results based on shell displacement, joint displacement, bending moment, joint reactions, design reactions, storey forces, shell stresses, shell forces etc are obtained. Out of which the values concerned with displacement and shell stresses are tabulated in table 1 and 2 respectively for comparison of Flat slab and Conventional slab.

Table 2 : Slab Displacement Result

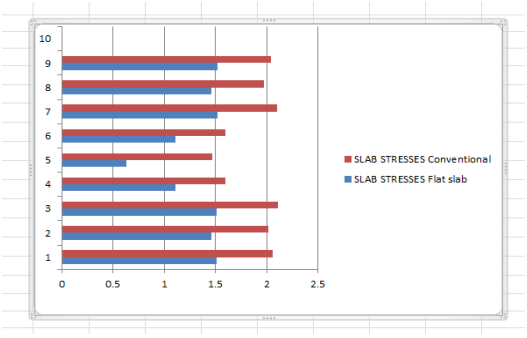
SHELL NAME	DISPLACEMENT (mm) FLAT SLAB CONVENTIONAL SLAB	
1	4.9	7.6
2	4.2	7.2
3	4.9	7.6
4	4.3	7.2
5	3.3	6.6
6	4.3	7.2
7	4.9	7.3
8	4.2	7.2
9	4.9	7.6

Table 3 : Slab Stress Result

SHELL NAME	SHELL STRESSES (MPa) FLAT SLAB CONVENTIONAL SLAB	
1	1.51	2.06
2	1.46	2.02
3	1.51	2.11
4	1.11	1.60
5	0.63	1.47
6	1.11	1.60
7	1.52	2.10
8	1.46	1.97
9	1.52	2.04



(a)



(b)

Figure 3:(a) displacement bar chart. (b) stress bar chart

V. CONCLUSION

Flat slab are generally adopted in commercial spaces since we need a larger grid spacing, aesthetic appearance and for facilitating the services. An RC Flat slab building with single storey was manually designed. Analysis of Flat slab and conventional slab were done using ETABS software. The punching shear value of Flat slab obtained from software analysis was compared with manual design.

- Punching shear value obtained from Direct Design Method was 0.538 MPa which was within the permissible limit. So the depth of slab is sufficient for punching around drop panel.
- Punching shear value of the middle strip of Flat slab obtained from software analysis is 0.63 MPa which is comparable with the manual design value.
- The value of maximum displacement of Flat slab is less at middle strip portion and is equal to 3.3 mm.
- In comparison with conventional slab structure, displacement is greater than that of Flat slab.
- The value of shell stresses of Flat slab is lesser than that of conventional structure.
- Thus it can be concluded that Flat slab buildings are better option in construction.

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