Study on the Behaviour of Thin Plate Structures

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Abstract: *Thin plate structures are widely used nowadays for industrial, commercial, and institutional structures. The main drawback is that the slab fails under punching shear. The main reason is that the thickness of the slab is very less as it cannot withstand heavy loads. Punching shear failure can be avoided by providing drop panel and column capital. But in case of thin plate structures providing drop panels will not be recommended. To prevent punching shear failure different trials have been approached for a model structure with seismic load. The inference from the behaviour of the structure is learned and further developments are concluded.*

Keywords: Punching shear, Thin plates, Seismic load

I. INTRODUCTION

A plate is a structural element which is thin and flat. A plate is said to be thin when its thickness is too less compared to the lateral dimensions. The supports of the plates can be anything such as simply supported, fixed or cantilever. Plates are usually flat which develops moments, twisting moments and shear force. Loads for the plates are perpendicular to the surface resulting to moments and shear. In thin plates, the straight line normal to the middle plane remains normal even after deformation. Thin plates are widely used nowadays for structures that does not requires beam. Plate structures are aesthetic compared to conventional structures.

The main disadvantage of thin plate structure is at slab-column junction. This part fails under punching shear. Punching shear effect will not be more in gravity loads, while it is more in lateral loads. Seismic and wind loads develop more punching failure. For thin plate structures high performance concrete is recommended. The effect of punching shear can be reduced for a minimum amount by using high grade concrete, but the practical and economical factors are to be considered. The load distribution through beams are not present in plate structures, hence leading to the high resultant values in columns. The reinforcement is to be provided in such a way that it withstands the shear failure.

II. OBJECTIVES

To model a structure as thin plates without beams. Applying all conventional gravity loads. Assigning lateral seismic loads to the structure. Analysing the behaviour of thin plate structure and to check for failure due to punching shear failure. Modifying the structure to reduce the punching shear failure and to conclude the behaviour.

III. MODEL ANALYSIS

A structure of 6 story of height 3.05m with 2 bays of each 8m on both the directions. The column sizes are 380x380 mm and the slab is of 125mm thick. Dead load and live load are applied along with seismic load. Load combinations as specified in Indian code are assigned then the structure is analysed. Grade of concrete is M30 and steel is Fe500.

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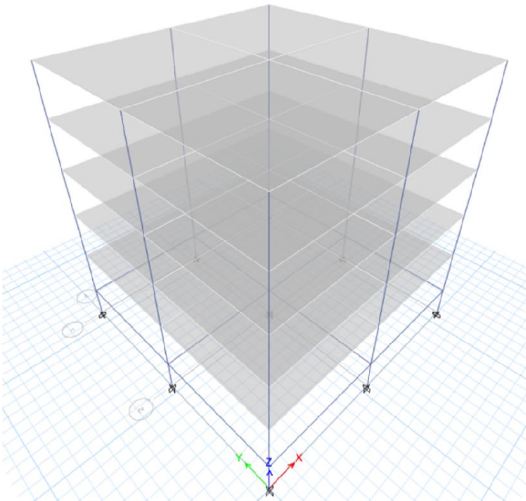

Fig-1. Thin plate model

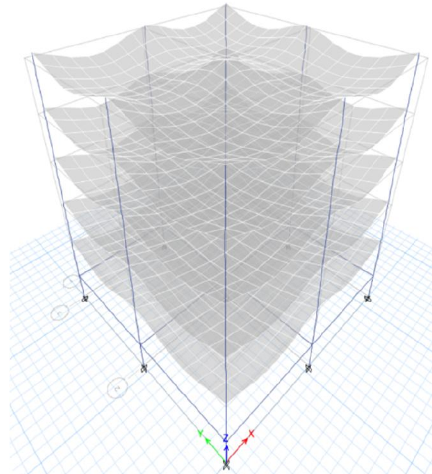

Fig-2. Deformed structure

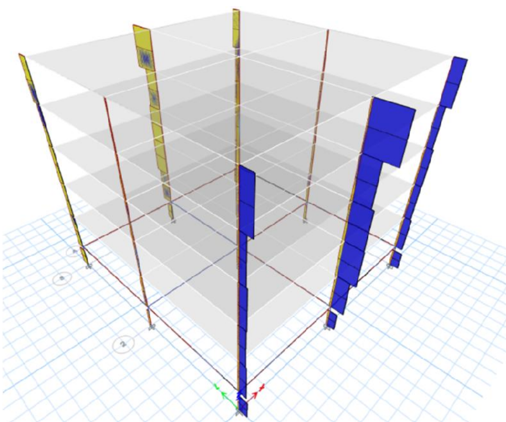

Fig-3. Column shear

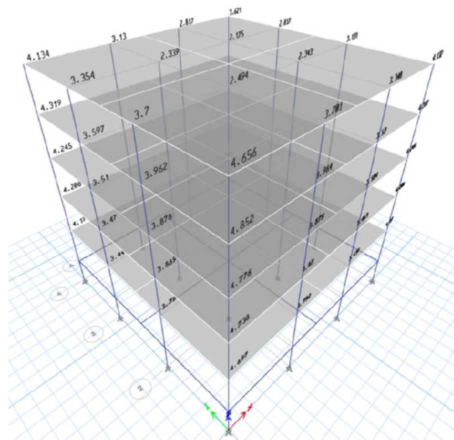

Fig-4. Punching shear check

The column is provided with large spans in between. This has a series effect on punching shear. To reduce this effect the structure is updated with adding extra few columns.

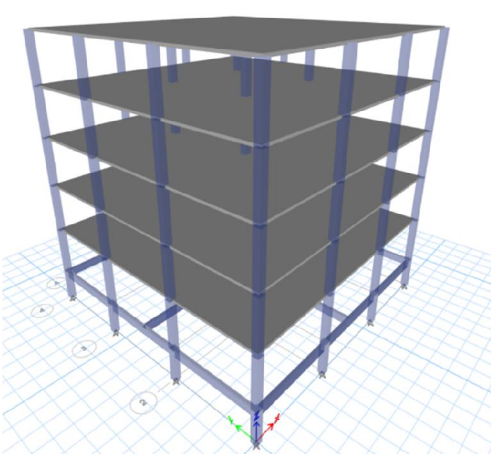

Fig-5. Structure with extra columns

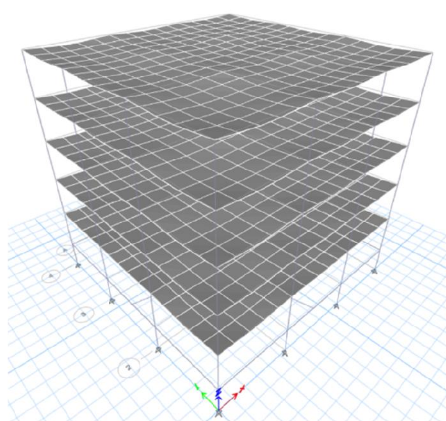

Fig-6. Deformed structure

Deformation of the entire slab is reduced when compared to the previous model. Thus this way of modification helps in control of punching shear. Though the entire punching shear failure is not reduced. The structure has to be further modified to take shear in control

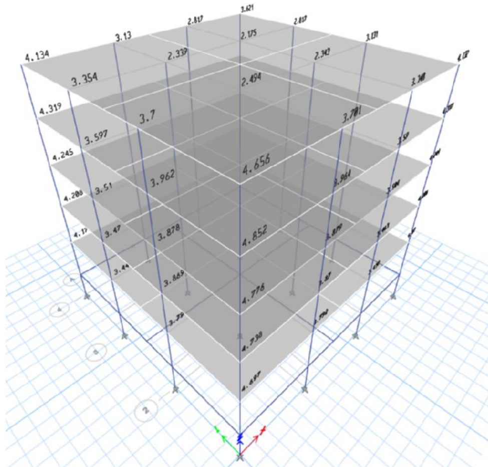

Fig-7. Punching shear result

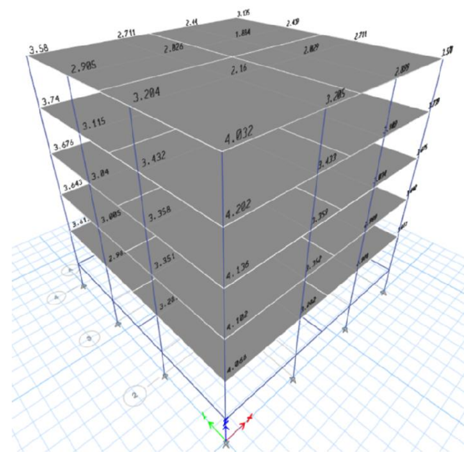

Fig-8. Punching shear result

The structure is slightly modified by increasing the grade of concrete as M50

Increasing the grade of concrete has very less impact on controlling the punching shear. While going for even higher grade there may be variation.

Providing additional reinforcements in the column slab interactions can reduce the shear. Also providing shear studs will reduce punching shear.

IV. CONCLUSIONS

Thin plate structures are now widely used for industrial, institutional, and commercial structures. The punching shear failure is the only disadvantage of such structures. Research are continued to prevent such failures as it will cause a huge damage to the structure when fails. Providing additional columns will reduce the shear effect to a considerable limit but adding more columns will create architectural imbalance. Increasing the grade of concrete for slab will reduce the effect by only a considerable amount. Further modification like providing additional reinforcement in column-slab joint like more bars of largest diameter rod can prevent the shear cracks. Providing shear studs will reduce the failure. Hence strengthening the column and slab junction is the recommended way to prevent failure.

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