# NUMERICAL ANALYSIS OF FLAT PLATE SLAB STRUCTURAL SYSTEM

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## ABSTRACT

*The flat plate slab directly rests on columns which causes excessive shear stresses surrounding the support region.In this numerical study the flat plate is modeled as a plate element in G+ 2 building structuresin staad pro V8i for calculating the shear stresses and moment values .Both plays a vital role in the design process. For comparison the same model with beam spanning between columns is prepared with same value of loading.The analysis of both the models was made for moment and shear. The concentration of shear stresses surrounding the support region and momentvalues are examined.*

***Keyword**: Flat plate, shear, numerical modeling*

## Introduction

The different roofing systems are available as per the requirement which includes economy, aesthetics and other parameters. Apart from all the relevant considerations structural stability plays a crucial role in the design system. One of the conventional roofing adopted systems adopted is the inclusion of beams between columns to support the slab which provides the required structural stability .The another system adopted for roofing is the flat plate or flat slab.The flat plate or flat slab is the slab without beams which directly rests on the columns. As the beams are excluded there is a concentration of shear stresses surrounding the column. If a proper care is not taken the structure may leads to catastrophe so proper care to be taken surrounding these critical regions. To enhance the shear resistance capacity surrounding these regions additional componenet in the form of drop or capital is provided or higher concrete grade can be attempted. The shear reinforcement can also be provided. The drop and column capital form the components of flat slab and the slab which directly rests on columns without these components refereed as flat plate. As the slab rests directly on the column, the region surrounding the column is subjected to higher shear stresses which are to be properly addressed.

This work aims at to study the primary design criteria's, moment and shear stress for the flat plate and to compare the result with slab and beam frame system. The model of flat plate and slab beam system is prepared by using Staad Pro V8i.

## Literature Review

N. Girish &N.Lingeshwaran (2018) , aims to study the performance of reinforced concrete flat slabs equipped with different punching shear reinforcement parameters. Three flat slab specimens were cast where two specimens contain punching shear reinforcement in the form of shear stirrups and structural shearbands. The deflection, strain and crack pattern were observed and recorded.

K. N. Kadam & SaurabhIngole (2019) ,this paper represents a numerical analysis of flat slab with the opening adjacent tocolumn face. The results are obtained for all the cases without providing anyshear reinforcement so that the effect of size and location of the opening in the flatslab can be studied and compared.

L. Majtánová& J. Halvonik,(2018)the paper deals with calibration of the numericalmodel of flat slab specimens using results taken from the experimental program. The task was to find thesuitable nonlinear material model for concrete and reinforcement, choose the proper boundary conditions andthe correct load application. The correct adjustment of the numerical model allows carrying out parametricstudy of flat slabs with shear reinforcement.

Taehun Ha et.al.(2015), this study experimentallyinvestigates the effects of openings on the punching shear strength of flat-plate slabs without shear reinforcement.Tests were performed on eight

flat-plate slab specimens considering the layout and number ofopenings as test variables. The failure characteristics of each specimen are examined, and the effects ofthe test variables on the punching shear strengths of the test specimens are investigated.

Georgewill V.A. et,al ,(2019), this study reviewed punching shear failure of flat slab system. Firstly, the merits of flat slab system compared to normal framed structure were appraised. Due to complex mechanisms that occur during punching shear failure, it has been a subject of intense experimental, analytical and experimental investigations. This study focuses more on finite element models developed by previous researchers. Two concrete failure criteria namely: Total strain cracked model (T-S model) and damaged plasticity models (DPM) were compared.

Priya M P &Santhi A S (2018), the paper presents an experimental study on the behavior of the flat slab against punching shear under different support conditions. Nowadays flat slabs are widely using for different concretestructures because of its several advantages. In order to conduct the study, six slab-columnspecimens of the flat slab were casted and subjected to test with four, three and two sides rigidlysupported. The tests were conducted to study the punching shear capacity and the crack patternof the slab-column connection of the flat slab. It was observed that the four side supported slabcolumnconnection of the flat slab enhance more punching shear strength capacity than threeand two sides supported.

S Durgadevagi and NA Jabez (2016),present study is aimed to know the variation of displacement, strain and stresses, in slab with different boundary conditions. The different slab size has been designed for uniform factor load of 12 kN/m2. This factored load has been applied on the slab to calculate the maximum and minimum displacement, strain and stresses at each slab has been noted down. The results shows that displacement is highest in slab having simple support on all sides and stresses are least in same slab along the edges. Also slab with fixed support on all sides shows least displacement and highest stresses along the edges of the slab.

## Numerical Modeling

A G+2 , four continuous span of 5 m x 6m flat plate structure with spandrel beams is modeled in staad pro V8i. A flat plate is modeled using plate elements in staad pro v8ias shown in the figure .The another model with beams spanning between columns is also made for the same span of 5m x 6mas shown in the fig.Both the above models were subjected to a gravity load of 20kN/$m^2$, the self weight is not taken into account while was analysis made on staad pro V8i. The analysis of both the models was made for moment and shear. The concentration of shear stresses is critical and so examined[4]. The intermediate floor is considered for the results and discussion.

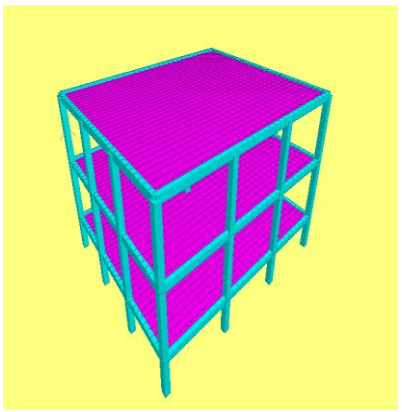


Fig: Model with flat plate

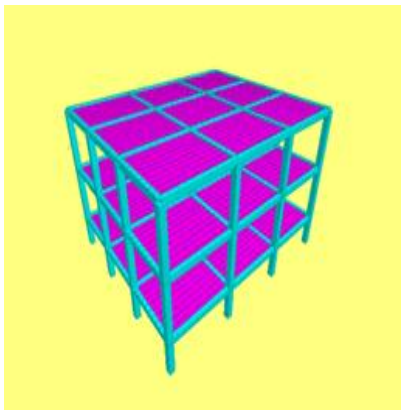


Fig: Model with beams

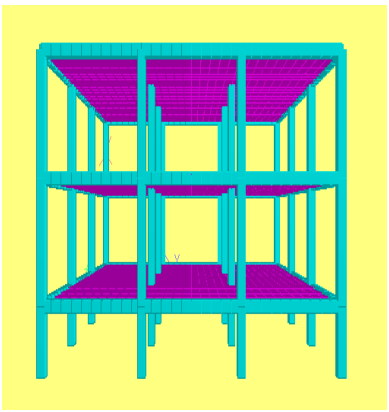
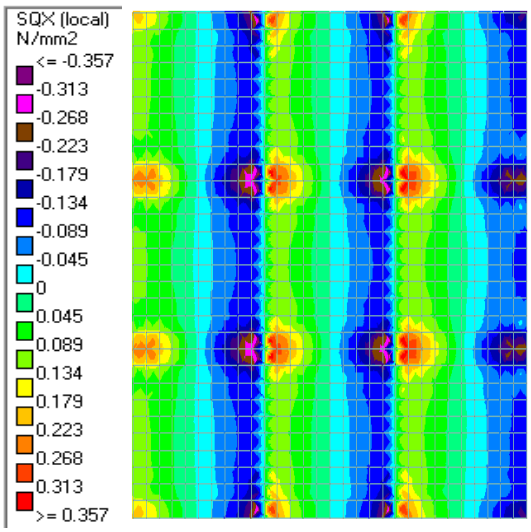


Fig: Building Model

## Results & Discussion

The analysis of intermediate floor is considered for the shear stresses as shown in the fig below.



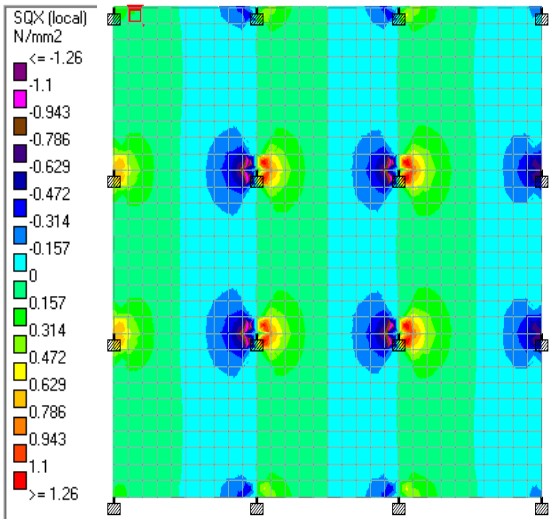
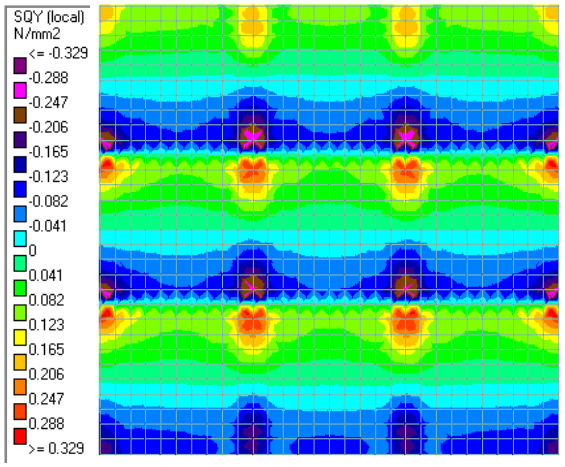




Fig: Slab Model with Beams Fig: Flat Plate Model

The shear stresses are compared for different depths of flat plate and for slab with beams as shown below.



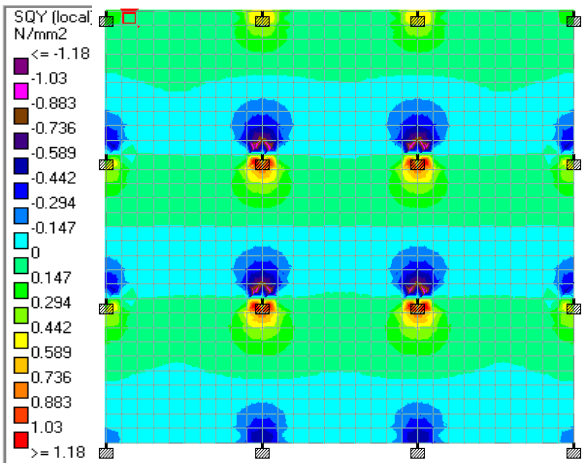
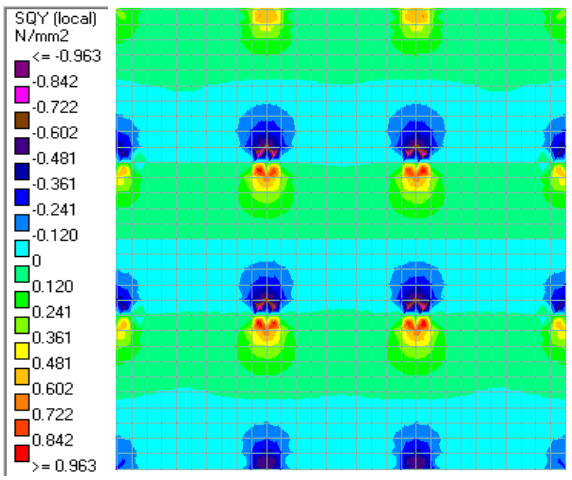




Fig: Slab Model with Beams Fig: Flat Plate Model 200 mm



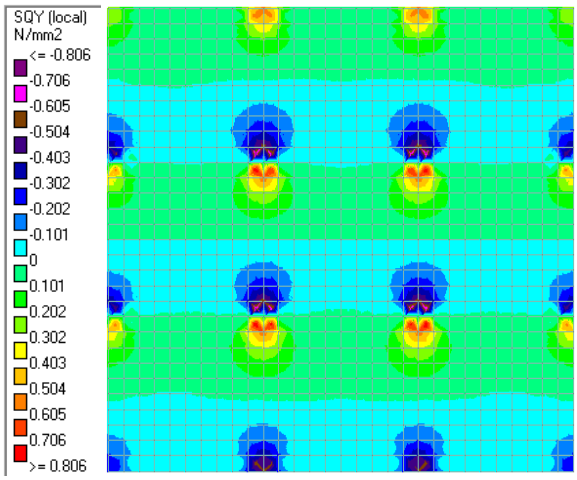




Fig: Flat Plate Model 250 mmFig: Flat Plate Model 300 mm

The moment values are compared for flat plate and for slab with beams as shown in the figure below.

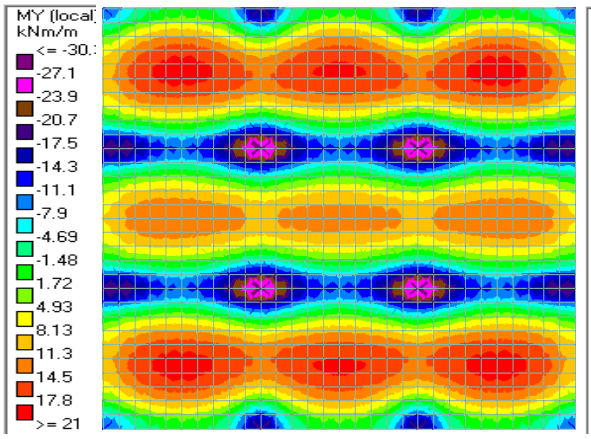



Fig: Slab Beam Model My

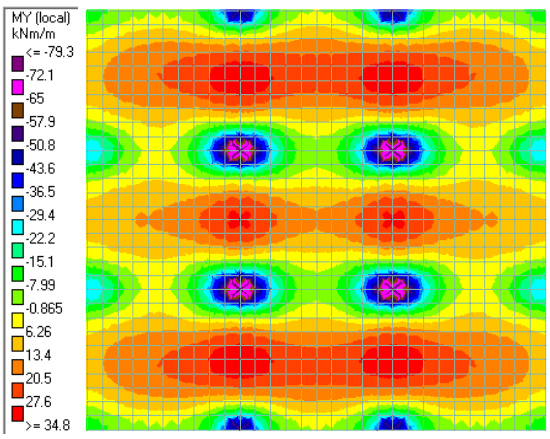



Fig: Flat Plate Model My

## Comparative Statement for Shear Stresses and Moment

Table 1: Maximum Values of Shear Stress and Moment

| Description | Thickness mm | SQY $N/mm^2$ | SQX $N/mm^2$ | MX kN-m |
|---|---|---|---|---|
| Flat Plate | 200 | -1.18 | -1.26 | -79.3 |
| Flat Plate | 250 | -0.963 | -1.03 | --- |
| Flat Plate | 300 | -0.806 | -0.861 | ---- |
| Slab with Beam | 200 | -0.329 | -0.357 | -30 |

## Summary & Conclusion

The flat is modeled in staad pro V8i for calculating the shear stress and moment values .Both plays a vital role in the design process. Forcomparison the same model with beam spanning between columns is prepared with same value of loading. The maximum shear stress is found near the support for both the cases. The value of shear stress is very less when the slab is supported on beam. The study extends for the increasing depths of slabs to enhance the shear resisting capacity without shear reinforcement; accordingly as the thickness of the slab gets increased the shear stress gets reduced. It was observed the shear stress gets reduced away from the support. It concludes that the area surrounding the support to be observed carefully in design process. It was also observed that for the case that when the beam is spanning between columns both the moment and shear values are very less as compared with flat plate. The moment values are also increased in flat plate as compared with slab with beam. It concludes that the economical design will obtained for slab with beam case and as the values of shear and moment are greaterfor flat plate it should be carefully observed, design and detail.

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