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Comparative Study on Seismic Analysis of Multi Storey Building Having Diaphragm Discontinuity Using Etabs

Md Shehzad Choudhary[1],Syed Arfath[2],Md Mansoor Ahmed[3], Nadeem Pasha[4]
PG STUDENT, Structural Engineering, Khaja Banda Nawaz College of Engineering,Gulbarga[1]
Professors, Department of Civil Engineering , Khaja Banda Nawaz College of Engineering,Gulbargs[2,3,4]
Email:mdshehzad77@gmail.com[1],nadeempasha48@yahoo.in[4]

Abstract- At present many buildings have irregular configuration both in elevaton and plan.These buildings may get collapse due to the devastating earthquakes in future.The seismic behaviour of the structures get decreased due to structural irregularities.The openings in the floors of buildings are provided may be due to the architectural purposes, staircases, lighting etc. The stresses are develpoed in buildings due to these openings. In this study a attempt is made to know the difference between a building without diaphragm discontinuity and a building with diaphragm discontinuity.In this project a regular 15 and 20 storey RC buildings having shear wall are modelled with and without diaphragm discontinuity and are analysed by ETABS (2013). Response spectrum method is adopted for the analysis and the parameters like storey dispacement, storey drift, storey shear and modal period are compared and studied.
Index Terms-Diaphragm discontinuity; shear wall; Response spectrum analysis; ETABS.

1. INTRODUCTION

In many countries, strong earthquakes have taken the life of millions of people due to the impact of strong vibration on buildings. To decrease the response of earthquake on the structures and save the life of people, many architects and engineers are trying to use best method possible which can reduce the seismic effect on the structures.According to Indian Standard, structures are classified as structurally regular or irregular.Regular structures has no significant discontinuities in plan, vertical or lateral force resisting systems. Buildings having irregularity can cause damage easily.

During strong earthquakes behaviour of the multi storeyed buildings depends on the distribution of mass, stiffness, strength in both horizontal and vertical planes of buildings.The weakness in a building may be created by discontinuities in stiffness, mass or strength along the diaphragm. Shear walls which behave like vertical cantilevers are most commonly used to resist the lateral load effectively.

1.1 Diaphragm discontinuity

The discontinuities or variations in stiffness and mass in the form of slab openings and variation in slab thickness is defined as diaphragm discontinuity.

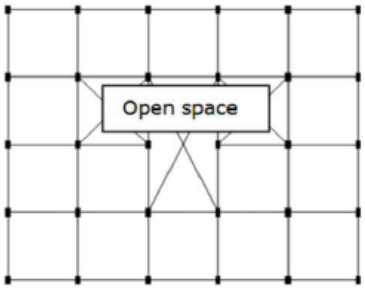


Fig1 : Diaphragm Discontinuity

In structural engineering, a diaphragm is a structural system used to transfer lateral loads to frames or shear walls. Lateral loads are mainly earthquake and wind loads.

2. OBJECTIVES

(1). To model and analyse the seismic response of multi storey building having diaphragm discontinuity using ETABS.
(2). To study the seismic performance of 15 & 20 storey building with different slab openings.
(3). To study the effect of variation of slab thickness on the performance of building.

(4). To study and compare the results such as storey displacement, storey shear, storey drift & modal period and compare them with regular model

3. ANALYTICAL MODELLING

In this study,the seismic peformance of 15 and 20 storey building having shear wall with & without diaphragm discontinuity is modelled and results are compared by using software ETABS(2013).

3.1 Description of the building models

For both 15 & 20 storey building, Model reg is considered as regular model without any diaphragm openings. The various increasing percentage area of slab openings are considered from Model 1 to Model 5. And the models with different slab thickness are considered as Model A, Model B & Model C. Shear wall of 230mm thickness is provided at the corners of all the models in a building.

The models are desribed as follows:-

- Model reg: Regular model without diaphragm discontinuity.
- Model 1: Model with 24% of slab openings.
- Model 2: Model with 30% of slab openings.
- Model 3: Model with 36% of slab openings.
- Model 4: Model with 42% of slab openings.
- Model 5: Model with 48% of slab openings.
- Model A, Model B & Model C: Model with varying slab thickness.

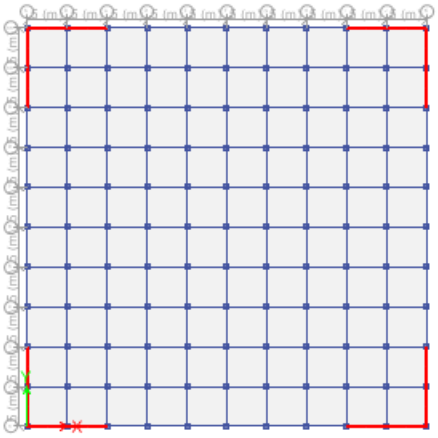


Fig2: Model Reg.

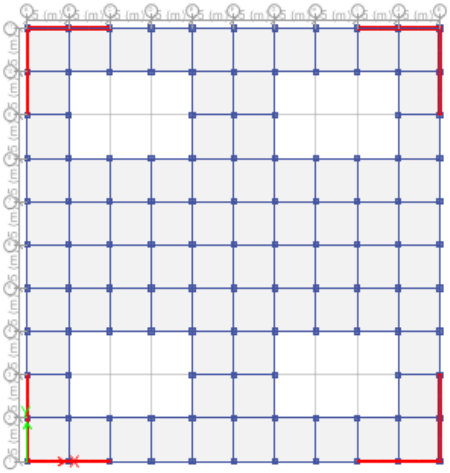


Fig3: Model 1

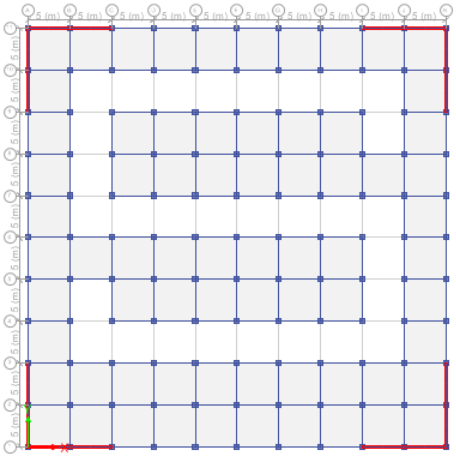


Fig4:Model 2

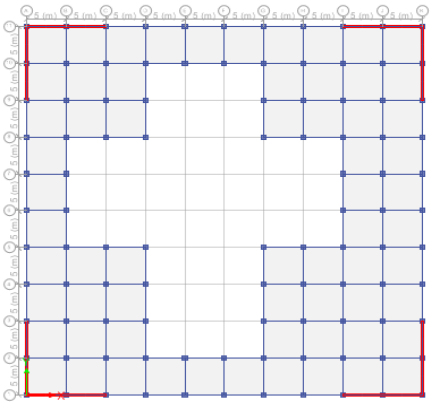


Fig5: Model 3

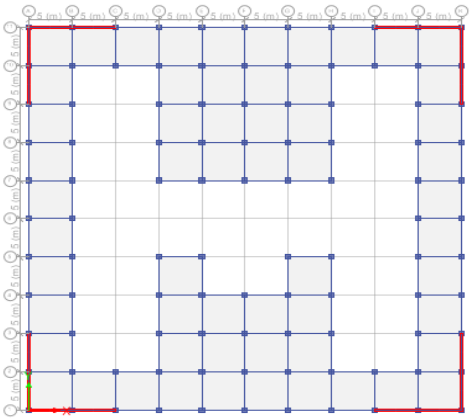


Fig6: Model 4

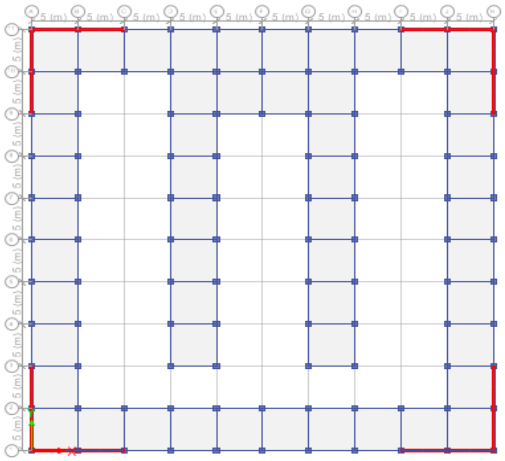


Fig7: Model 5

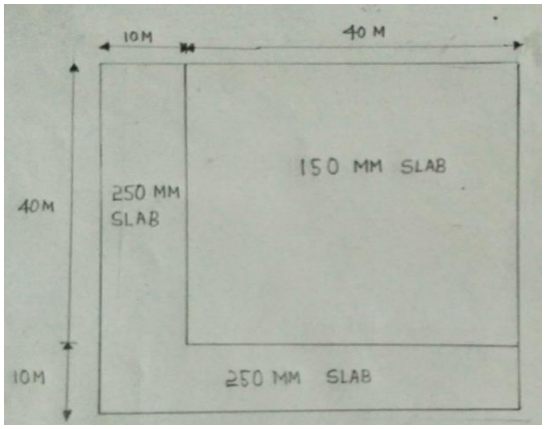


Fig8: Model A

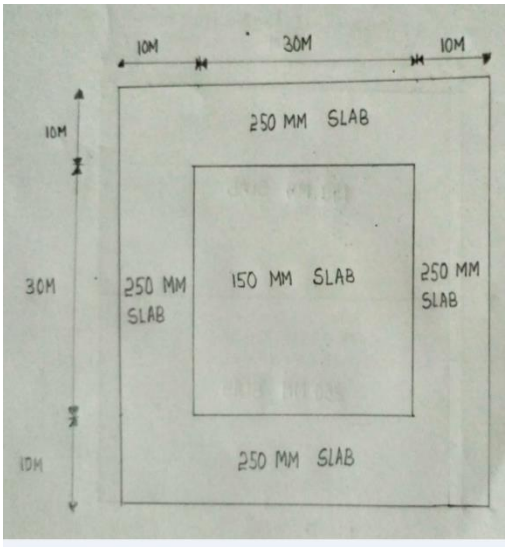


Fig9: Model B

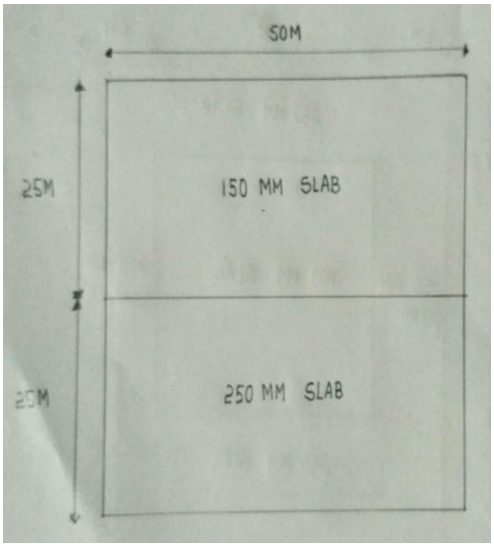


Fig10: Model C

4. DESIGN DATA

The structural details of models are as follows:-

- No of storeys= 15 and 20
- No of bays = 10 bays in both direction
- Spacing of bays = 5m in both directions
- Storey height = 3.2m
- Bottom storey height = 3m
- Beam size = 0.23m x 0.45m
- Column size = 0.6m x 0.6m
- Slab thickness = 0.15m

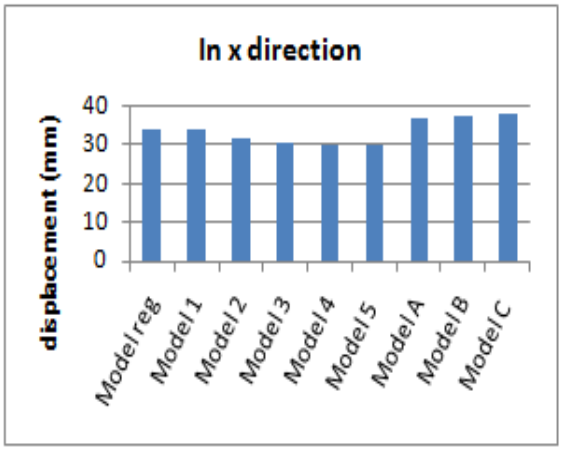
- Grade of materials = M30 and Fe 500
- Seismic zone = 4
- Floor finish = 1 KN/sqm
- Soil type = soft soil (type 3)
- Live load = 3 KN/sqm
- Response reduction factor = 5
- Importance factor = 1

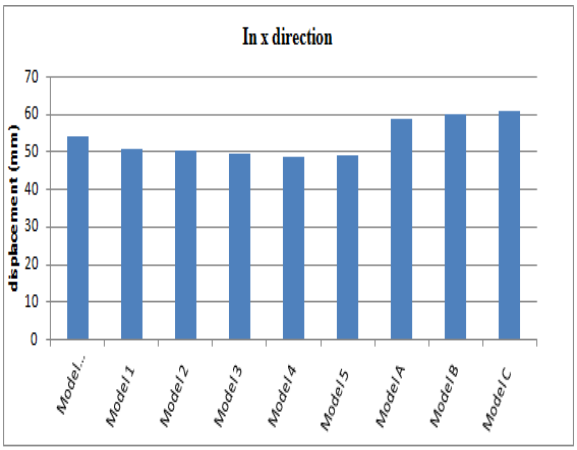
5. RESULTS

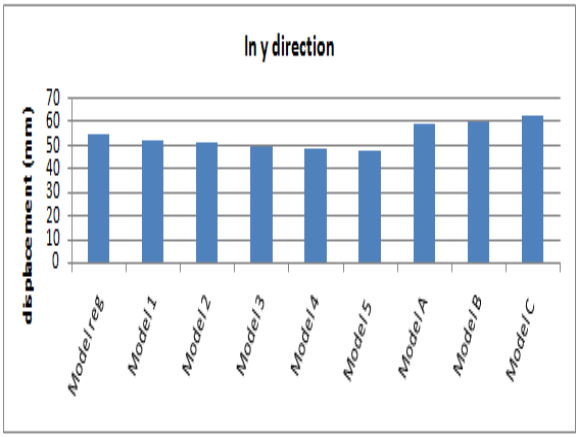
The analysis results such as storey dispacement, storey drift, storey shear & modal period in x&y direction obtained from response spectrum method are compared and discussed below

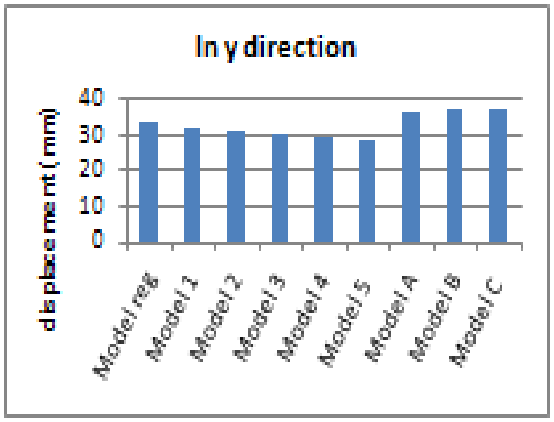
5.1 Storey displacement

5.1.1 For 15 storey





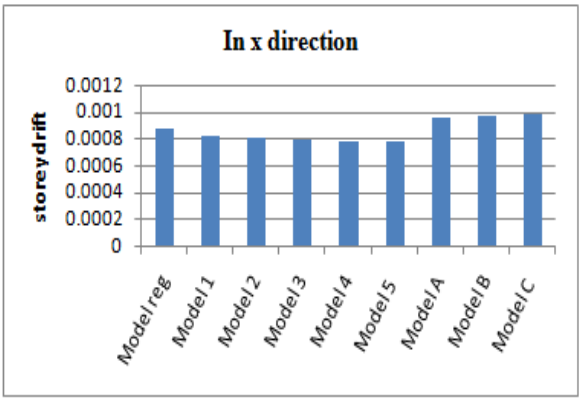


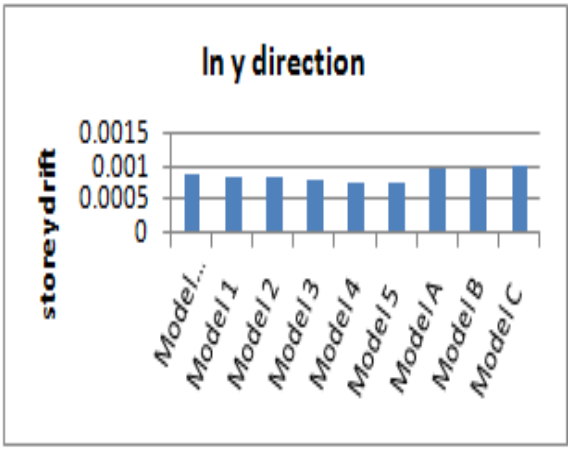


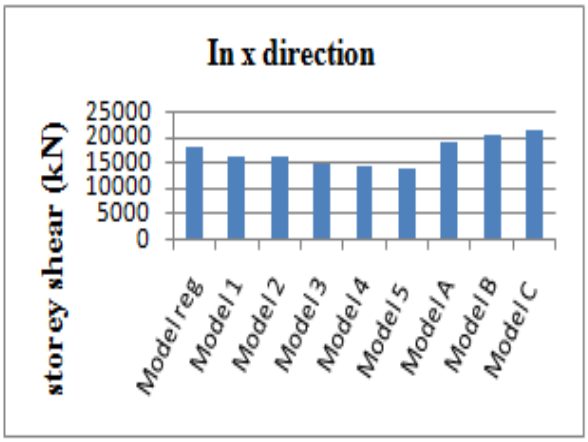
5.1.2 For 20 storey

5.2 Storey drift

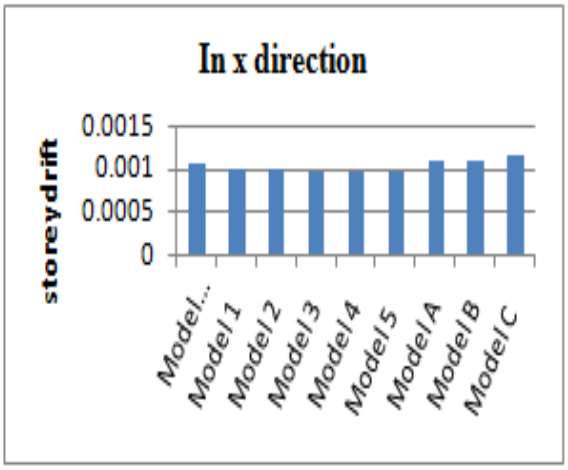
5.2.1 For 15 storey

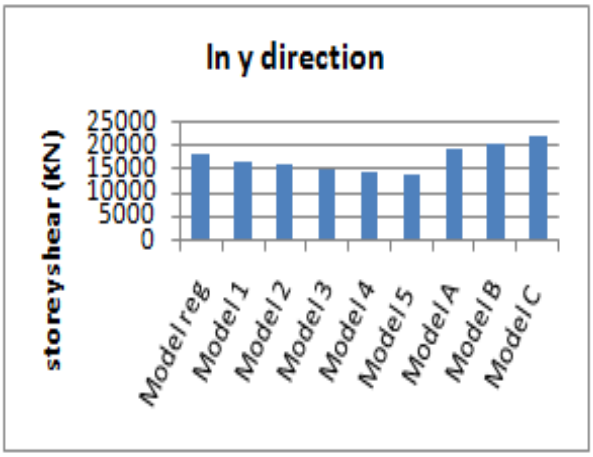


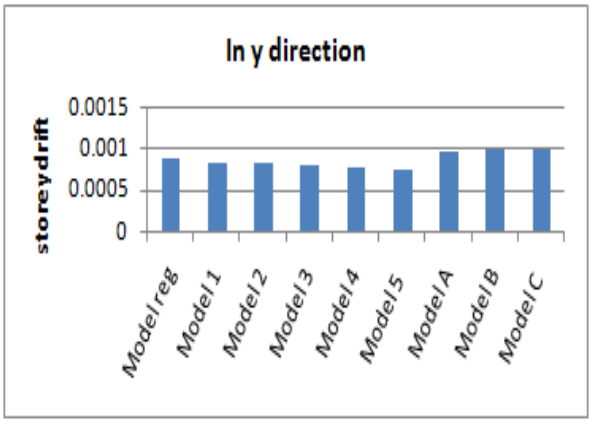




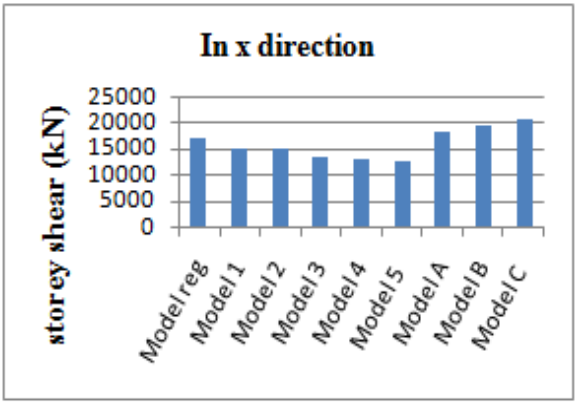
5.2.2 For 20 storey





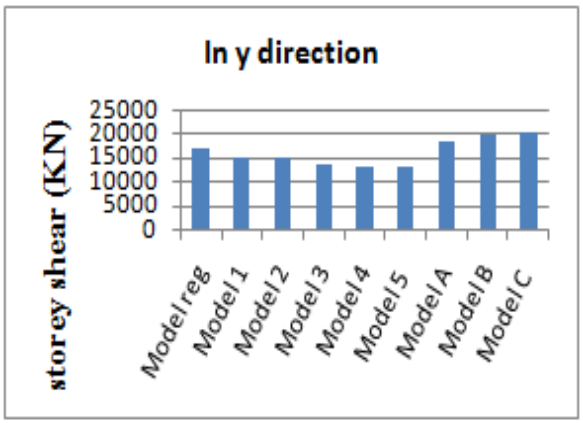


5.3.2 For 20 storey



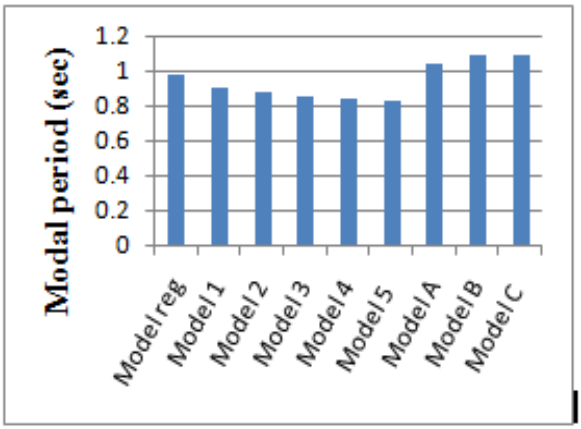
5.3 Storey shear

5.3.1 For 15 storey

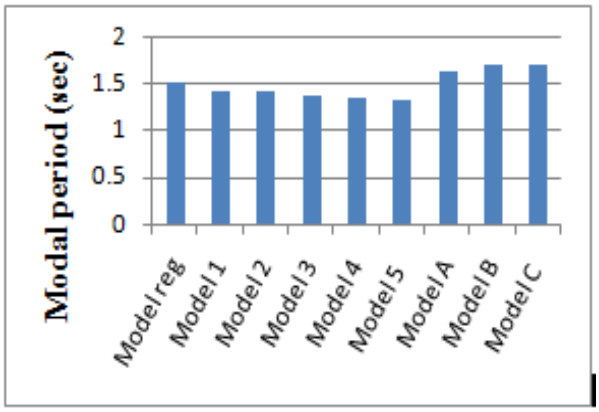


5.4 Modal Period

5.4.1 For 15 storey



5.4.2 For 20 storey



From the above graphs of both 15&20 storey it is observed that the slab opening models (i.e Model 1 to 5) have less storey displacement,storey drift, storey shear& Modal period than regular model (Model reg) in both x & y direction. As the percentage area of slab openings increases, it is seen that storey displacement, storey drift, storey shear & Modal period decreases. The models with different slab thickness (i.e Model A, B, C) have more displacement than Model reg in both x&y direction. It is seen that as the variation in thickness of slab increases then storey displacement, storey drift, storey shear & Modal period also increases.

6. CONCLUSIONS

(1). The models having slab openings has lower storey displacement, storey drift, storey shear, modal period than the regular building model.
(2). For 15 storey building, when there is increase in percentage area of slab openings it is found that there is decrease in the storey displacement, storey drift, storey shear and modal period in both x & y directions.
(3). Also for 20 storey building, when there is increase in percentage area of slab openings it is found that there is decrease in the storey displacement, storey drift, storey shear and modal period in both x & y directions.
(4). The result values such as storey dispacement, storey shear,storey drift and modal period for 20 storey is found to be greater than that of 15 storey.
(5). The models with variation in slab thickness (Model A,Model B,Model C) is found to have more storey displacement, storey drift, storey shear & modal period than the regular model for both 15 & 20 storey.
(6). It is found that storey displacement, storey drift, storey shear & modal period increases when there is in increase in variation of thickness of slab for both 15 & 20 storey.
(7). The study shows that variation in the slab thickness reduces the performance of the buildings during earthquakes.
(8). It is found that the slab openings in a building having shear wall gives better performance during earthquakes.

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