SEISMIC ANALYSIS OF MULTISTORIED BUILDING WITH DIAPHARGMS DISCONTINUITY

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Abstract - *At present many buildings have irregular configuration both in elevation 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 developed 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 and also using the different stiffness modifiers like factored and unfactored stiffness modifiers. In this project a regular 15 storey RC buildings having slab opening at central, corner and peripheral opening are provided with different stiffness modifiers according to code IS 16700:2017 are modelled and are analysed by ETABS (2018). Response spectrum method is adopted for the analysis and the parameters like storey displacement, storey drift, base shear are compared and studied.*

Key Words*: Diaphragm discontinuity; stiffness modifiers; 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 storied 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 Diaphragms 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.

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.

1.2 Stiffness modifiers.

Stiffness modifiers are the factors to increase or decrease some properties of the cross section like area, inertia, torsional constant etc. Generally they are used to reduce stiffness of concrete sections to model cracked behavior of concrete. They are applied to concrete members because its cracks under loading. In Rcc member, the crack will generate in tension zone of concrete due to the application of different loads. Due to these cracks moment of inertia of Rcc member is lesser than gross moment of inertia hence to account for reduced moment of inertia of cracked section ,the concept of stiffness is introduced in code IS 16700:2017.

2. Objectives of the project

1. To study the behavior of structures with slab irregularities at different location using different stiffness modifiers.

2. To compare the behavior of different discontinuities in diaphragms systems during earthquake loading.

3. To study comparative knowledge on various seismic parameters such as base shear storey displacement and storey drift at each storey using response spectrum method.

3. Methodology

1. General Description of the model involves the present study; an attempt is made to investigate the seismic effect on reinforced cement concrete building with slab opening. The Analysis of (G+15) storied R.C.C. framed building is carried out using ETABS commercially available software. The lateral load analysis carried out on different types of structures. Analysis is carried out in zone IV. The type of soil is taken for analysis is type II medium soil after analyzing different models in ETABS software, the parameters

such as Maximum Storey Displacement, Base Shear, and Storey Drift are obtained. Finally the results obtained are compared of all the models. The methodology of the project fallows as.

1) Plan of multistory building (G+15)
2) Modeling different models in e-tabs software.
3) Results and discussion
4) Conclusion

3.1. ANALYTICAL MODEL.

In this study, the seismic performance of G+15 storey building having slab opening at centre corner and peripheral opening provided with using different stiffness modifiers and are modeled and results are compared by using software ETABS(2018).total 12 models are considering for the study .such as

1. **Model 1:**Regular frame factored stiffness modifiers
2. **Model 2:** Regular building unfactored stiffness modifiers
3. **Model 3:** Regular building
4. **Model 4:** Centre opening factored stiffness modifiers
5. **Model 5:** Centre opening unfactored stiffness modifiers
6. **Model 6:** Centre opening
7. Model 7: Corner opening factored stiffness modifiers
8. Model 8: Corner opening unfactored stiffness modifiers.
9. model 9:Corner opening
10. Model 10: Peripheral opening factored stiffness modifiers.
11. Model 11: Peripheral opening unfactored stiffness modifiers.

12 Model 12: Peripheral opening.

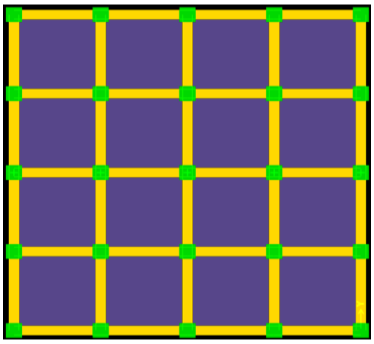
GENERAL DESCRIPTION OF MODELS.

Type of building	Residential building
Type of frame	Moment resisting frame
storey's	15
Total height of building	45 m
Thickness of wall	230mm
Live load	5 kn/m2
Grade of concrete	M40
Grade of Steel	Fe-500
Density of brick	20kn/m2
Size of beam	B1=450mm*600mm
Size of column	C1=750mm*750mm
Thickness of slab	200mm
Zone	IV
Reduction factor	4
Zone factor	0.24
Importance factor	1.2
Type of soil	II
Damping	5%

1) Model Regular frame factored stiffness modifiers

2) Model Regular frame unfactored stiffness modifiers

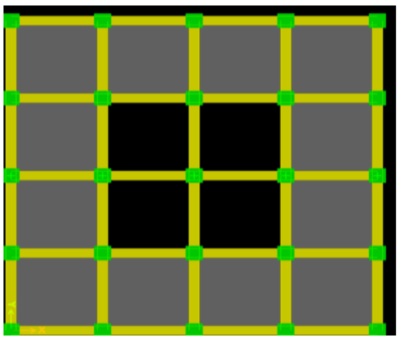
3) Model regular frame



4) Model with central opening factored stiffness modifiers

5) Model with central opening unfactored stiffness modifiers

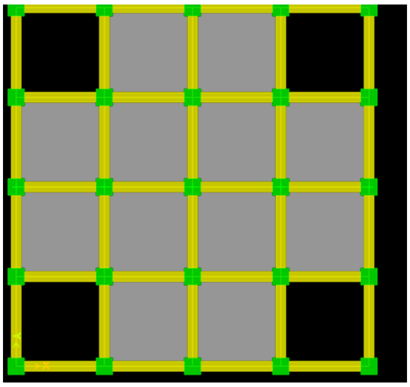
6) Model with central opening.



7) Model with corner opening factored stiffness modifiers.

8) Model with corner opening unfactored stiffness modifiers.

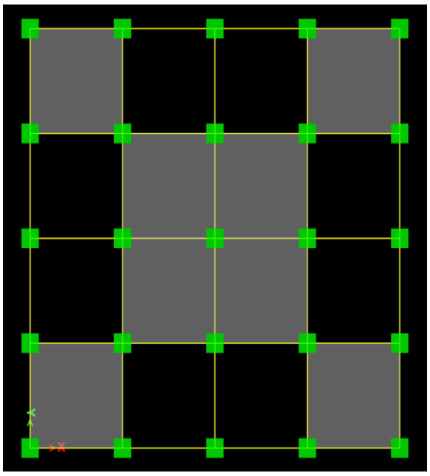
9) Model with corner opening.



10) Model with peripheral opening factored stiffness modifiers.

11) Model with peripheral opening factored stiffness modifiers.

12) Model with peripheral opening.



3.2 METHOD OF SEISMIC ANALYSIS. In this method, multiple modes of response of a building to an earthquake are taken into account. The response of the different models are combined to provide an estimate of the total response of the structure using the modal combination methods such as,

- Absolute Sum (ABS) method
- Square root of Sum of Squares (SRSS)
- Complete Quadratic Combinations (CQC)

It is the maximum expected lateral force that will occur due to seismic ground motion at the base of the structure.

$V_b = A_h \times W$

Where

A_h = Design Horizontal Acceleration Spectrum Value, using the fundamental natural period

(T) in the considered direction of vibration and it can be determined by the relation $A_h = (Z/2) * (I/R) * (S_a/g)$

Z = Seismic Zone Factor given in table 3 of IS 1893(part 1) page 10.

I = Importance Factor

R = Response Reduction factor

S_a/g = Response Acceleration Coefficient

W = Seismic Weight of the Building.

3.3) Load calculation

Load calculations are done using Indian standards such as:-

- IS: 875(Part – 1)-1987 for Dead loads (Unit weight of Building materials and Stored materials).
- IS: 875(Part –2)-1987 for Imposed loads.
- IS: 1893(Part 1)-2016 for Seismic loads.

4. RESULTS.

1) STOREY DISPLACEMENT

Earthquake analysis of multistory (G+15) story is carried out by response spectrum method for various type of models .The storey displacement was obtained for the various models and the results obtained are tabulated as below along with the corresponding graphs. The limiting value for the displacement is **H/500 = 45000 / 500 = 90 mm**. The results of the Displacement values obtained are well within the limit.

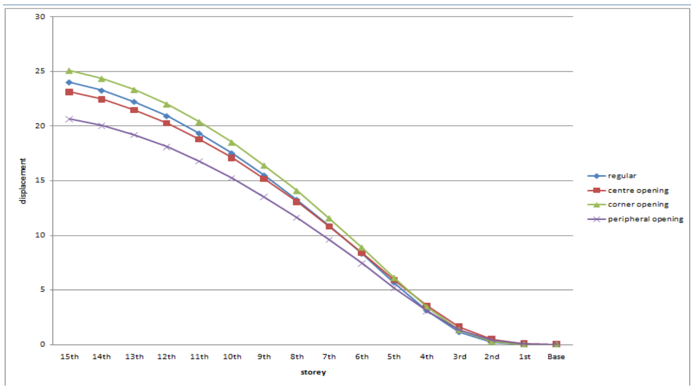


Fig.1.Storey displacement in x direction of Regular model

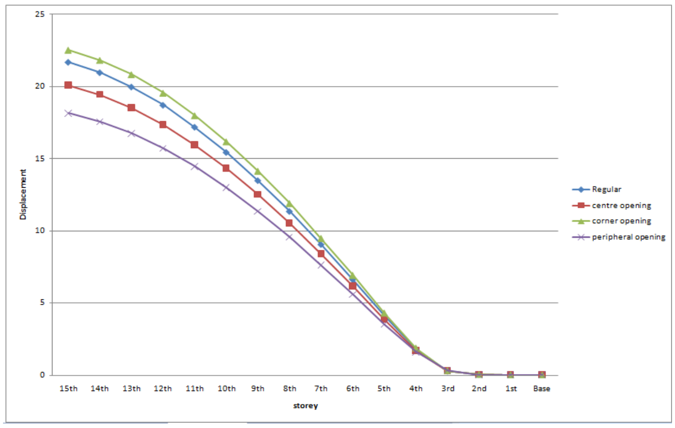


fig.2. Storey displacement in y direction of Regular model

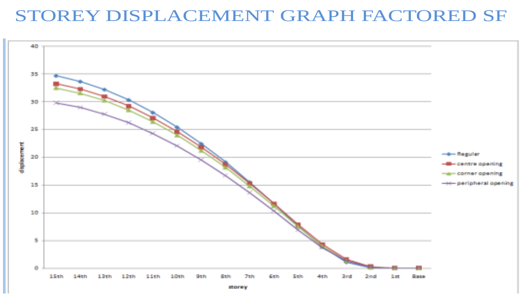


fig.3 storey displacement in x direction of factored stiffness modifiers models.

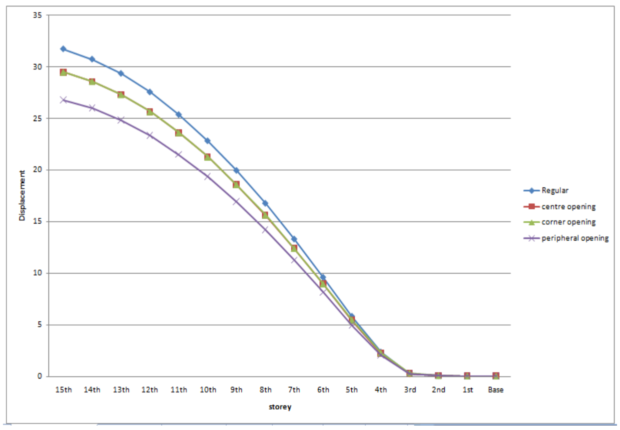


fig.4 storey displacement in y direction factored stiffness modifiers models.

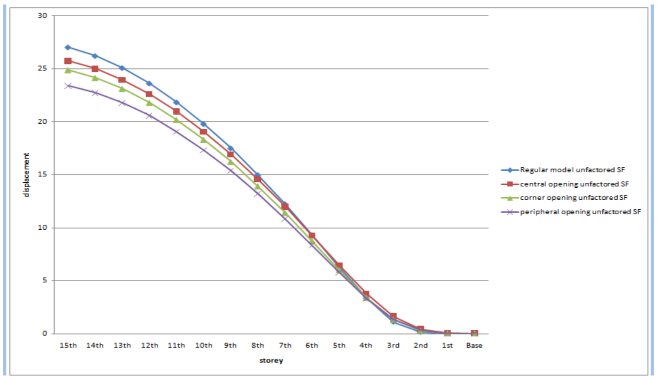


Fig.5 storey displacement in x direction unfactored stiffness modifiers.

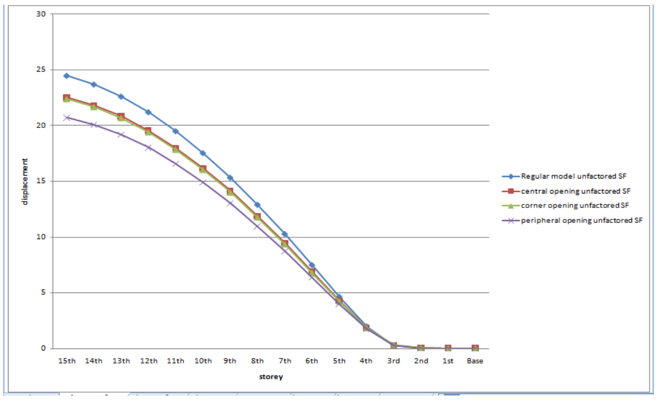


Fig.6 storey displacement in y direction unfactored stiffness modifiers.

Discussion.

1. The maximum displacement regular building when it compares to central opening 3.8% displacement is decreased in both x and y direction.
2. The maximum displacement regular building when it compares to corner opening 4.2% value is increased in both x and y direction .
3. The maximum displacement of regular building when it compares to peripheral opening 14% value is decreased in both x and y direction.
4. The maximum displacement regular building when it compares to central opening factored stiffness modifiers 4% displacement is decreased in x direction and 7.03% decreased in y direction.
5. The maximum displacement regular building when it compares to corner opening factored stiffness modifiers 6.3% value is decreased in x direction and 7.03% in y direction .
6. The maximum displacement of regular building when it compares to peripheral opening factored

stiffness modifiers 14% value is decreased in x direction and 15% in y direction.

7. The maximum displacement regular building when it compares to central opening unfactored stiffness modifiers 4.73% displacement is decreased in x direction and 6.18% decreased in y direction.

8. The maximum displacement regular building when it compares to corner opening unfactored stiffness modifiers 8% value is decreased in x direction and 8.46% in y direction .

9. The maximum displacement of regular building when it compares to peripheral opening factored stiffness modifiers 13.5% value is decreased in x direction and 15.28% in y direction .

Storey Drift.

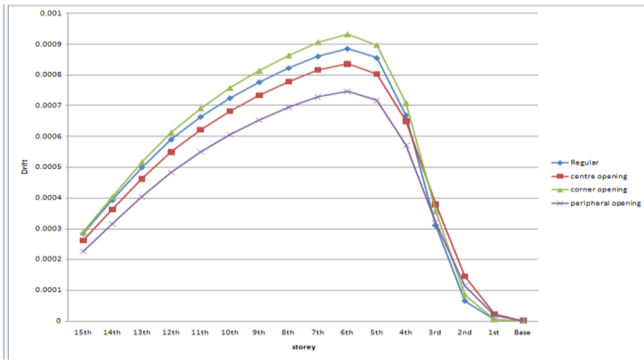


Fig.7.storey drifts value in x direction Regular model.

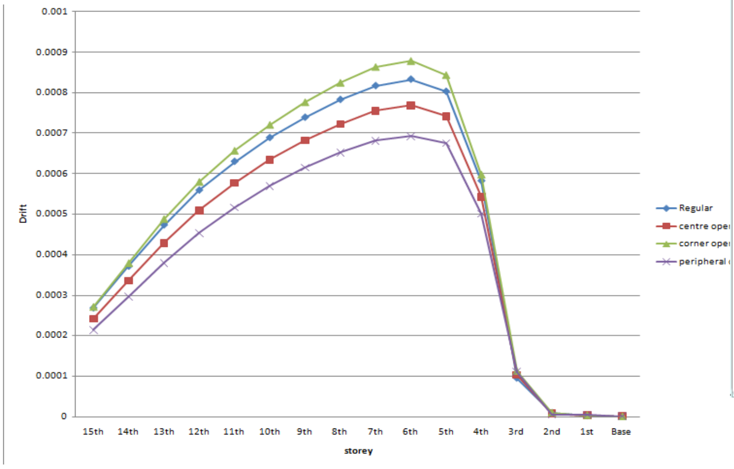


Fig.8.storey drifts value in y direction Regular model

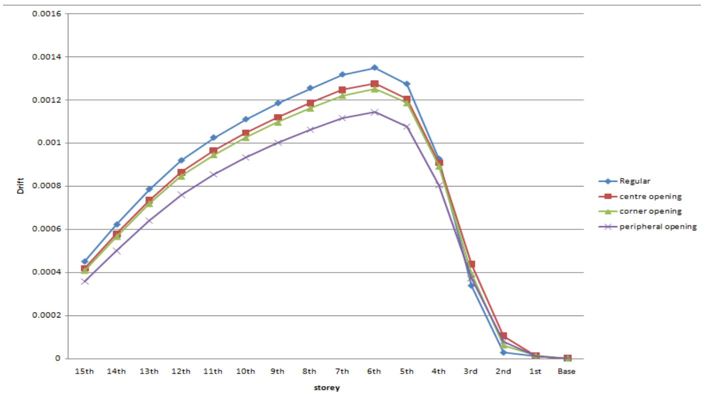


Fig.9.storey drift value in x direction factored model.

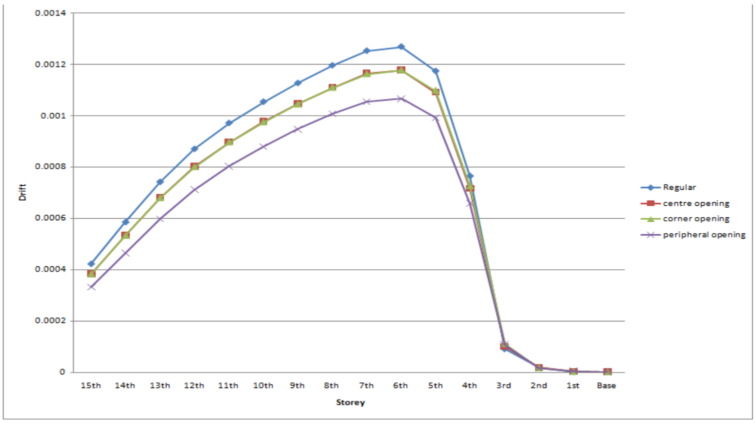


Fig 10.storey drift value in y direction factored model.

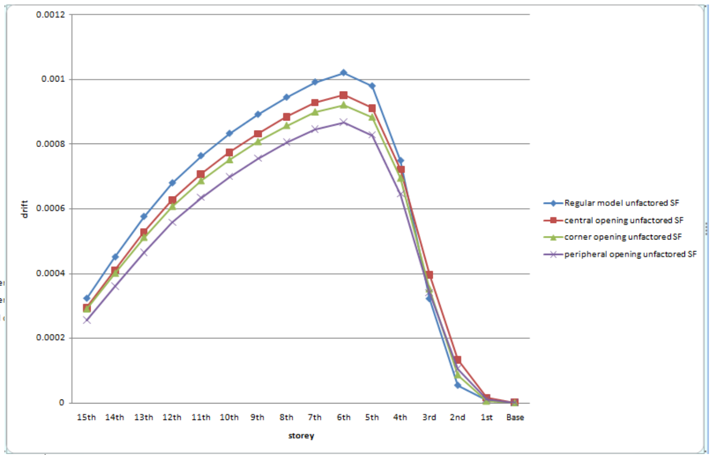


Fig 11.storey drift value in x direction unfactored stiffness modifiers model.

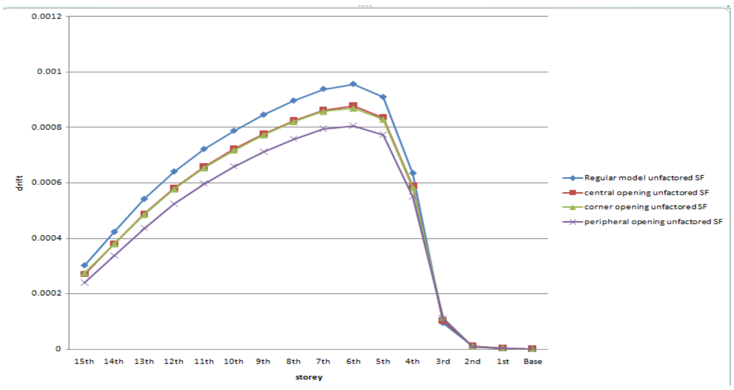


Fig 12.storey drift value in x direction unfactored stiffness model

Discussion.

1. The earthquake analysis G+15 multistoried carried out by the response spectrum method using the stiffness modifiers and following results observed.
2. It is observed that maximum storey drift value is at 6th storey in both x and y direction.
3. The maximum storey drift of regular building when it compares to central opening the drift value decreased up to 4% in both x and y direction .
4. The maximum storey drift of regular building when it compares to corner opening the drift value increases up to 4% in both x and y direction .
5. The maximum storey drift of regular building when it compares to peripheral opening drift value decreased about 16% in both x and y direction .
6. The maximum drift regular building when it compares to central opening factored stiffness modifiers 5% drift is decreased in both x and y direction.
7. The maximum drift regular building when it compares to corner opening factored stiffness modifiers 7.32%% value is decreased in x and y direction.
8. The maximum drift of regular building when it compares to peripheral opening factored stiffness modifiers 15.24% of drift value is decreased in x direction and 15% in y direction.
9. The maximum drift regular building when it compares to central opening factored stiffness modifiers 9% drift is decreased in both x and y direction.
10. The maximum drift regular building when it compares to corner opening factored stiffness modifiers 9.6%% value is decreased in x and y direction.
11. The maximum drift of regular building when it compares to peripheral opening factored stiffness modifiers 14.98% of drift value is decreased in x direction and 15% in y direction.

BSAE SHEAR.

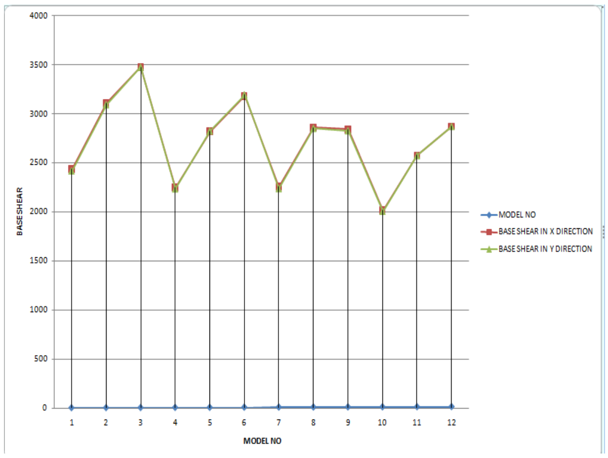


fig.13 Base shear value in x and y direction.

Discussion.

- The maximum base shear value is observed in model no 1 regular building without slab opening factored stiffness modifiers.
- The maximum base shear value when it compares to central opening to regular building with using stiffness modifiers reduced about8.5% in both x and y direction.
- The base shear value reduced up to 18.30% in corner opening.
- The base shear value reduced up to 17.45% in peripheral opening.
- For using stiffness modifiers with factored the base shear value in increased.
- Due to slab opening drawing lesser base shear in both x and y direction

5. CONCLUSIONS.

- It is observed that storey drift value in structure without slab opening has more drift when it compares to structure with slab opening.
- It is observed that storey displacement value in structure without slab opening has more

displacement when it compares to structure with slab opening.

- Structure with more number of opening has less displacement and drift.
- 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.
- Structure with unfactored stiffness modifiers has less deflection compared factored modifiers.
- From Maximum Storey drift and Base shear view, slab openings at centre is found to be more effective in resisting lateral forces.

REFERENCES

1. MdShehzad Choudhary1,SyedArfath, (2018) presented paper on "Comparative Study on Seismic Analysis of Multi Storey Building Having Diaphragm Discontinuity Using Etabs.
2. ReenaSahu , Ravi Dwivedi(2017) presented paper on "seismic analysis of RC frame with diaphragm discontinuity"
3. ARYA.V .AISHWARYA (2017) presented paper on the "Analysis of building with varying percentage of the diaphragm openings"
4. Babita Elizabeth Baby, Sreeja S (2015) [2] published paper on "Analysis of Buildings with Slab Discontinuity
5. P.Suneetha[] , "Effect of Diaphragm Discontinuity on RC building.
6. Vinod V, Pramod Kumar H V presented paper on "Influence of stiffness discontinuous diaphragm characteristics on the seismic behavior of rc structure."
7. Reshma K Bagawan1 and M Q Patel(2018) presented paper on "Seismic Performance Study of RC Framed building with Diaphragm Discontinuity"
8. Dona MeriyaChacko, AkhilEliyas(2017) presented paper on "Seismic Analysis of Fixed Base and Base Isolated RC Buildings Having Diaphragm discontinuity.

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