BEHAVIOURAL STUDY FOR SEISMIC RESPONSE OF HIGH RISE BUILDING HAVING DIFFERENT DIAPHRAGM DISCONTINUITY IN PLAN

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Abstract: ***It is comprehended that buildings which are regular in elevation and plan perform much better than those which have irregularity in elevation and plan under seismic loading. Irregularity may cause interruption of force flow and stress concentration. Irregularities are not avoidable in construction of buildings. However a detailed study to understand structural behavior of the buildings with irregularities under seismic loading is essential for appropriate design and their better performance. Opening are common in building nowadays. When subjected to lateral load, building with slab opening are often vulnerable to damage. Correct location of opening can offer efficient strength and serviceability to the structure. In present study,G+18 storey building with Different Diaphragm Discontinuity at different location such as at corner, at center, 'c' shape opening at periphery, 'H' shape opening at center in plan Were Analyzed by response spectrum analysis Using ETABS 2016 to determine the Seismic Response of the Building and Compare Parameters. The result are summarized on basis of Displacement, Base Shear, Story Drift and Fundamental Natural Period.***

Index Terms – Irregularity, Diaphragm Discontinuity, Seismic, Structural parameter

I. INTRODUCTION

Numerous structure in the present day situation have irregular configurations in both plan and elevation. Buildings with asymmetrical distribution of stiffness, mass and many buildings in the present day scenario have irregular configurations in both strength super severe damage during earthquakes. Such building undergo torsional movements. An ideal multi story building designed to resist lateral loads because of earthquake would consist of only symmetric distribution of mass and stiffness in plan at each story and a uniform distribution along the height of the building. Such a building would respond only laterally and is considered as torsional balanced building. Be that as it may, it is very difficult to achieve such a condition because of restrictions such as architectural requirements and functional needs.

In Asymmetric building, the center of rigidity of a building does not coincide with the center of building mass and hence torsion and stress concentrations occur in the building when it is subjected to the seismic loads. The existence of an asymmetry in the plan is usually leading to an increase in stresses of certain elements that consequently results in a significant destruction. The analysis of the seismic response of irregular structures is complex due to nonlinear and inelastic response and more troublesome than that of regular structures. A building may be asymmetric due to the following factors:

a. A small part is of different elevation.
b. The floor area is reduced from a certain story upwards.
c. Elevators shafts or columns are asymmetrically arranged.
d. A part is of different stiffness.

Diaphragm Discontinuity:

Diaphragm discontinuity includes those having openings greater than 50% of the total diaphragm area or changes in the effective diaphragm stiffness of more than 50% from one story to the next story. Discontinuities in the lateral stiffness of the diaphragm are due to openings, cut-outs, adjacent floors at different levels or change in the thickness of diaphragm. Floor diaphragm openings are typically for the purpose of stairways, shafts or other architectural features.

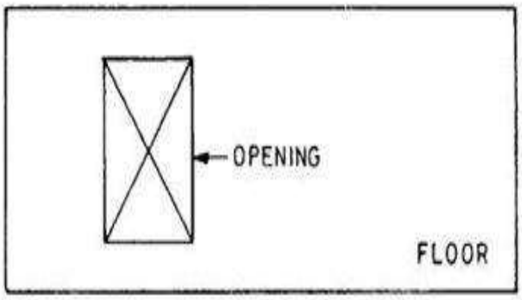

Figure 1. Diaphragm discontinuity

Diaphragm is used for reducing the degree of freedom of building. Use of diaphragm constraint for building structures eliminates the numerical accuracy problems. Assigning diaphragm is also useful in the lateral dynamic analysis of buildings. After assigning diaphragm constraint at each story, only three DOF's are considered; lateral displacement in two principal directions and one rotation. Diaphragm's can be modelled into three basic actions namely, rigid action, semi-rigid action and flexible action.

II. IMPLEMENTATION WORK

In the present paper an action is made on the seismic behavior of multistory building by using diaphragm and there different discontinuity in plan. On the intention a regular G+18 storey buildings with different slab opening such as at corner, at center, 'c' shape opening at periphery, 'H' shape opening at center have analyzed and modeled by **response spectrum analysis** using **ETABS 2016**. Lateral load analysis as per the seismic code IS: 1893(part 1)-2016 is carried out for building having different diaphragm discontinuity and to study the effect of seismic load and comparative study between the response spectrum analysis for both X and Y direction.

Plan detail:

In the present paper, we study on G+18 story commercial building having different diaphragm discontinuity and vertical irregularity. There are nineteen story buildings having 58 m height and 74 m x 54 m plan area. Analyze the building for seismic loads as per IS 1893(Part 1): 2016.

No of story	G+18
Plan area	74X54 m^2
Concrete grade	M30
Steel grade	HYSD415
Size of Beam	B1-230 mmX600 mm(for 6m and 8m)
	B2-300 mmX350 mm(for 4m and 5m)
Size of Column	C1- 525 mmX750 mm
	C2- 600 mmX900 mm
Each story height	3 m
Thickness of Slab	150mm
Thickness of wall	230 mm
Floor finish	1 kN/m^2
Live load	3 kN/m^2(IS 875 part 2-1987)
Terrace WP	1 kN/m^2
Earthquake loading(IS 1893:2016)	
location	Surat
Zone factor(Z)	III(0.16)
Importance factor(I)	1.5(cl 7.2.3,table 8,pg-19)
Response reduction factor R	5(cl 7.2.6,table 9,pg 20)
Time period	0.606 sec for X-direction
	0.710 sec for Y-direction
Wind loading(IS 875,part 3:2015)	
Basic wind speed V_b	44 m/s
Terrain category	2
Importance factor	1
Risk coefficient(k_1 factor)	1
Topography(k_3 factor)	1

Table 1. Basic data for study

Main plan (regular building):

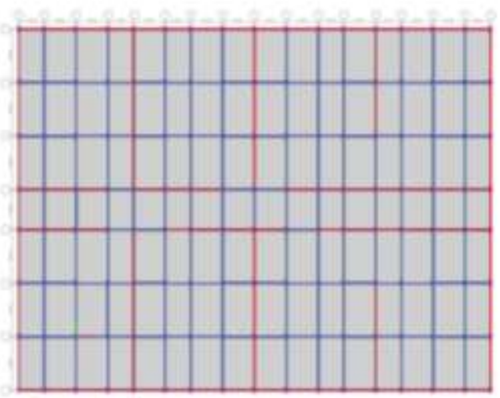

Fig. 2 Plan of regular building

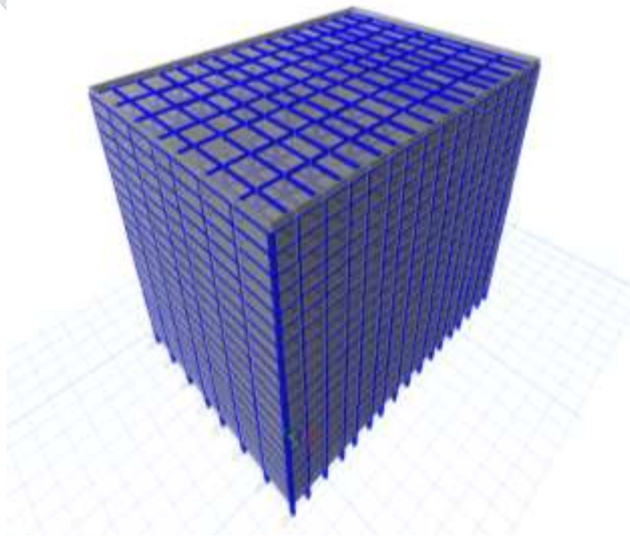

Fig. 3 3D model of regular building

Different diaphragm discontinuity:

According to IS 16700-2017, the maximum area of opening in any floor diaphragm shall not exceed 30 percentage of plan area of diaphragm. Transfer of lateral force from diaphragm to lateral load resisting vertical element shall be ensured using collector elements, if required. So, in all type of diaphragm discontinuity, **22 percentage** opening are provided. Location of opening are different but percentage of opening area are same. According to IS 1893(part 1):2016, Opening in slabs result in flexible diaphragm behavior, and hence the lateral shear force is not shared by the frames and/or vertical member in proportion to their lateral translational stiffness. The problem is particularly accentuated when the opening is close to the edge of the slab.

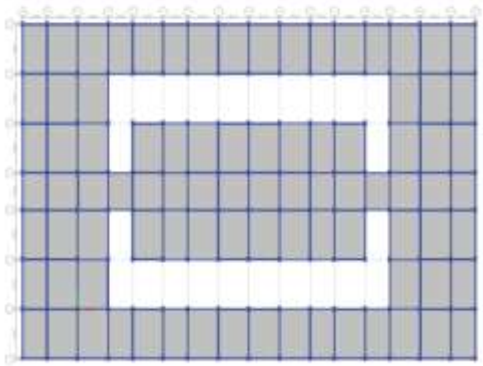

Fig.4 Plan of opening type 1

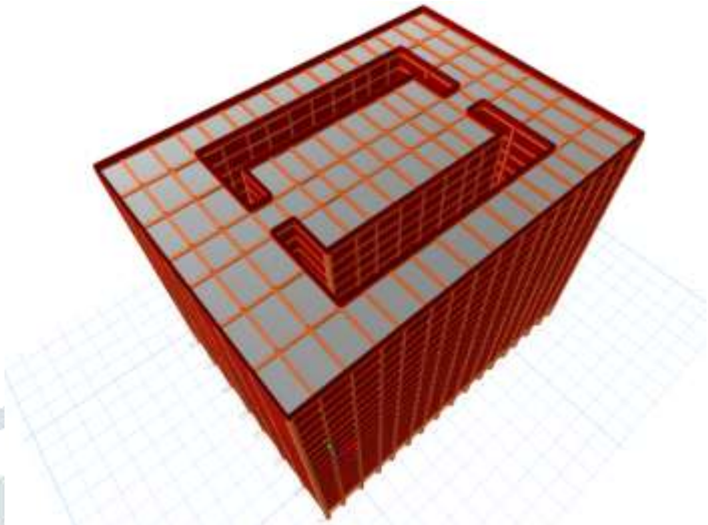

Fig.5 3D model of opening type 1

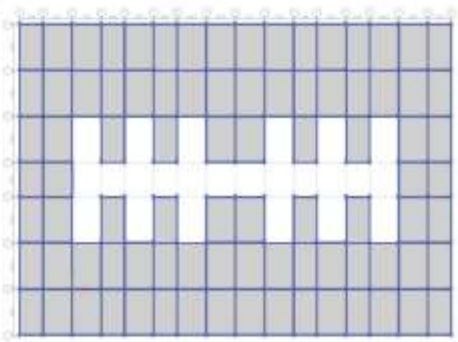

Fig.6 Plan of opening type 2

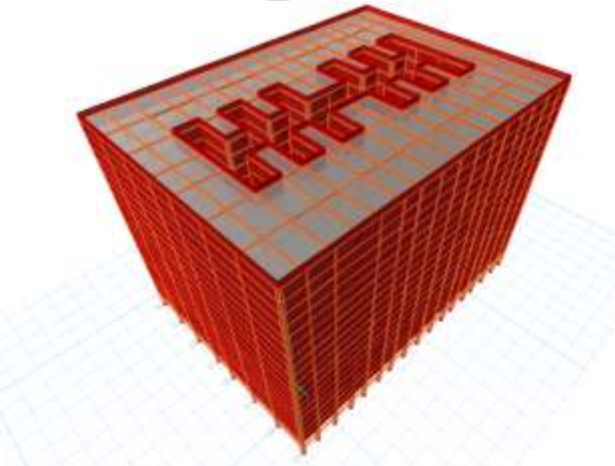

Fig.7 3D model of opening type 2

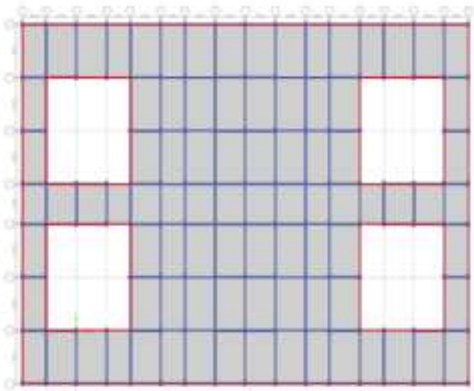

Fig.8 Plan of opening type 3

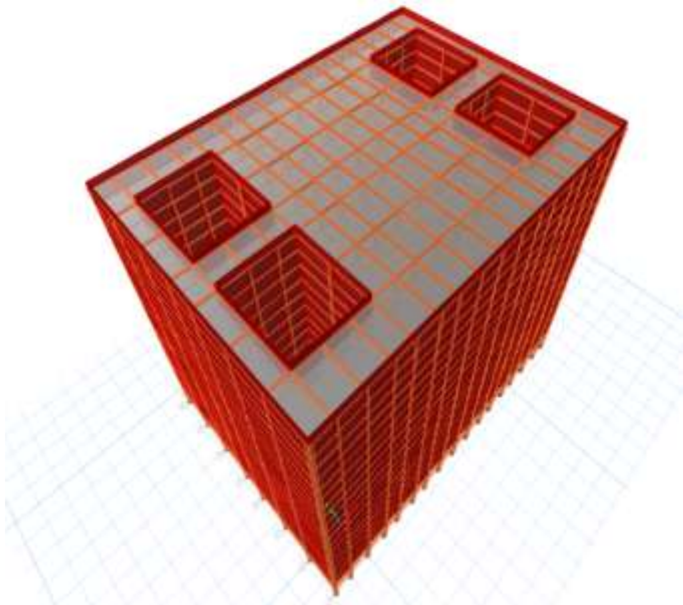

Fig.9 3D model of opening type 3

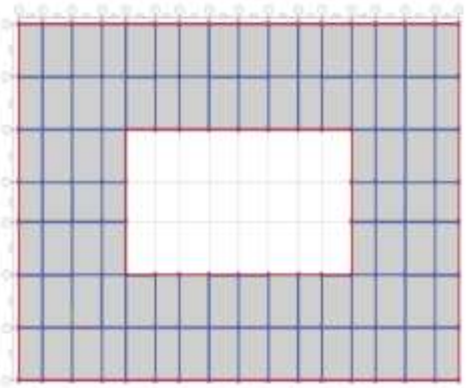

Fig.10 Plan of opening type 4

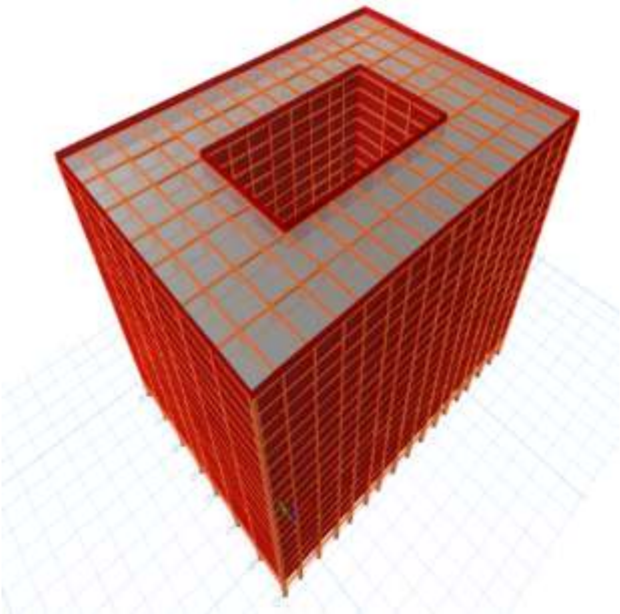

Fig.11 3D model of opening type 4

III. RESULTS AND DISCUSSION

Code limitation

- As per IS 16700:2017, cl 5.4.1, pg-5 maximum displacement shall be limited to H/250 when factored earthquake load is applied and H/500 when factored wind load applied.H is total height of building from ground level to terrace. For this study total building height is 58m (from ground level to terrace).So, permissible maximum story displacement value is 232 mm for this study.

- As per IS 1893 (part 1):2016, cl 7.11.1.1 story drift in any storey shall not exceed 0.004 times the storey height. Here each story height is 3m.So, allowable storey drift is 12m for this study.

Comparison of displacement

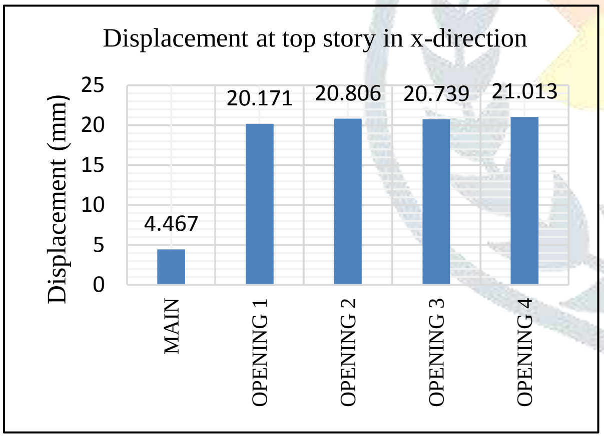

Chart 1. Displacement in X-direction

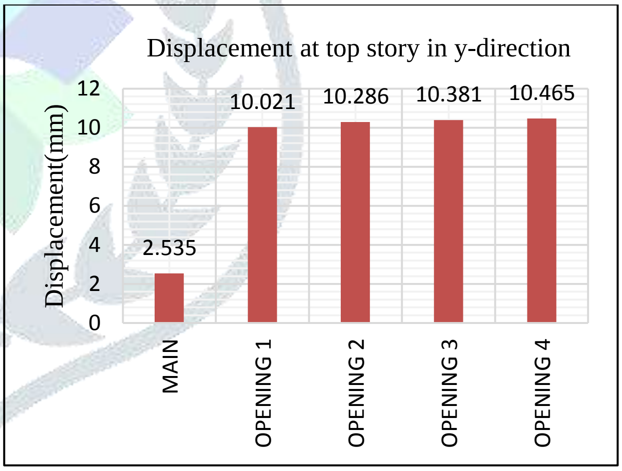

Chart 2. Displacement in y-direction

Comparison of base shear

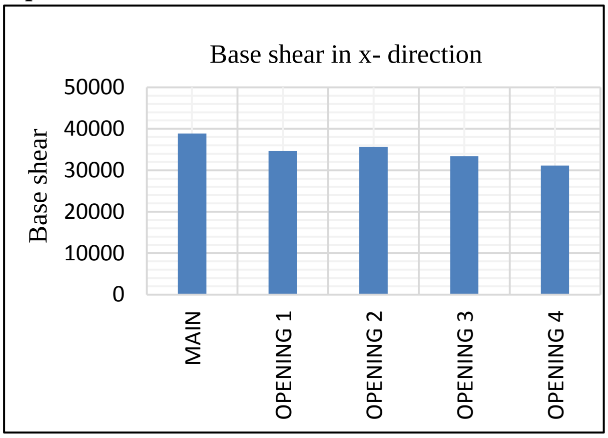

Chart 3. Base shear in X direction

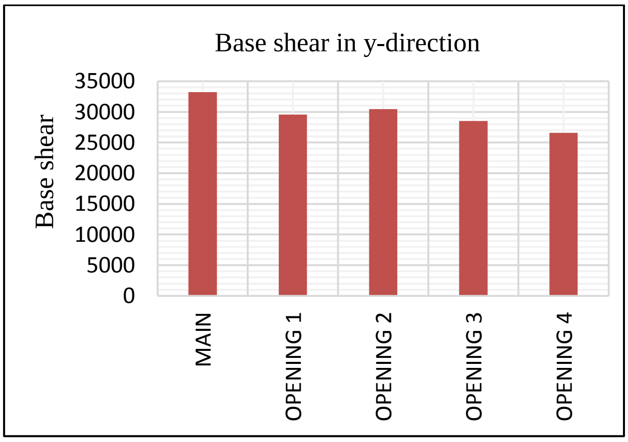

Chart 4. Base shear in Y-direction

Comparison of story drift

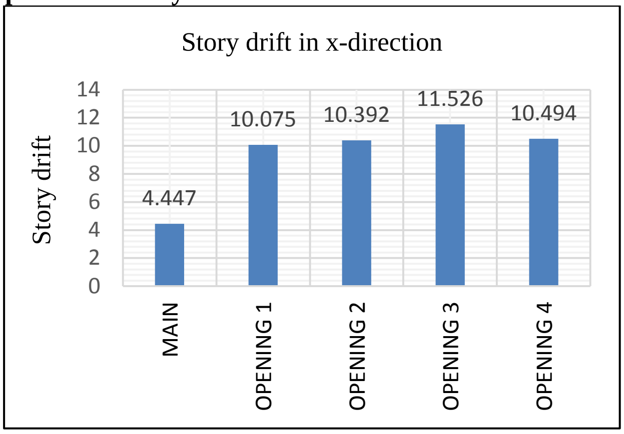

Chart 5. Story drift in X-direction

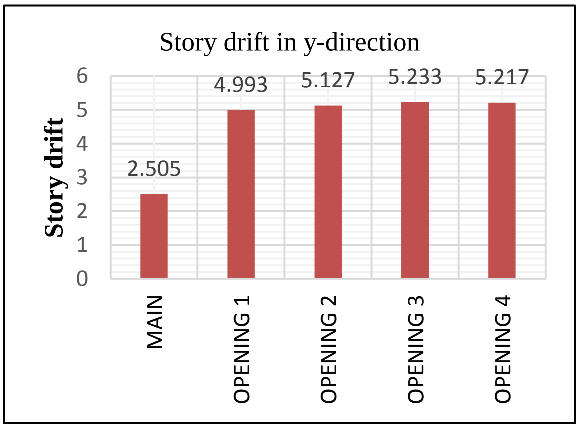

Chart 6. Story drift in Y-direction

Comparison of time period

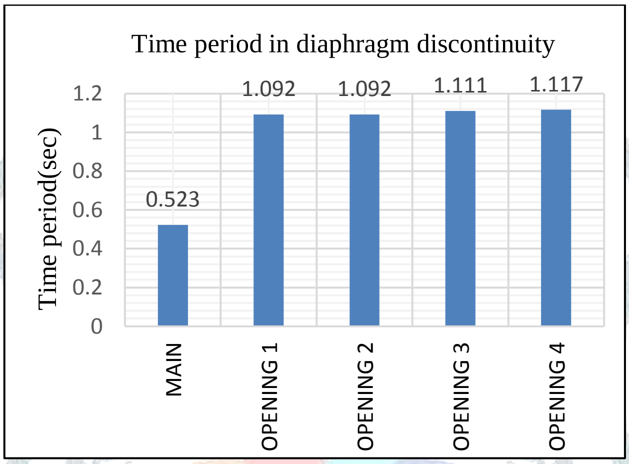

Chart 7. Time period of different diaphragm discontinuity

IV. CONCLUSION

In this project, G+18 story building analyzed with different diaphragm discontinuity. Result shows that regular building giver better performance compare to irregular building. Results are so higher in irregular buildings.

- According to result, **Base shear** is almost same in all type of diaphragm discontinuity, but base shear is 14% decrease in irregular building compare to regular building. But base shear decrease if opening provided at center compare to other opening.
- The regular model show 80% less **Displacement** compare to diaphragm discontinuous building. When opening provided at center, displacement is higher compare to other opening.
- **Story drift** is 63% increase in irregular building compare to regular building.
- Discontinuous diaphragm makes the building flexible. **Natural time period** of building with different diaphragm discontinuity is found 53% more than the regular building.

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