JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Seismic Analysis of RC Framed Structure With and Without Openings

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Abstract : Due to the increase in the demand of the people regarding some marvelous designs that are expected from the architects, architects are designing some irregular shaped designs that are a big challenge for the structural engineers to convert these designs into reality. As the irregularities increases in the structure there are some unwanted stresses that are created at various locations of the structure that causes the failure of the structure. These stresses if not taken under consideration can result into loss of life and capital invested in it. Some of the locations that are present in the structures are some discontinuities that are created due to staircase opening in the slab or some architecture openings in the structures. In this research an attempt has been made to investigate that what are the effects of these discontinuities in the structure under the application of the seismic loads on the building. The analysis is done through a dynamic or non-linear method called as RESPONSE SPECTRUM.

IndexTerms **– Diaphragm, Discontinuities, ETABS, Response Spectrum, Seismic**

I. INTRODUCTION

If a structure is having a diaphragm discontinuity, it may can lead to the severe stresses that are produced in the building at such locations. During the application of such severe forces on the structure the building must be design to resist such forces. For a structural engineer it is very much necessary that each and every aspect of the building must be checked and analyzed. In multistoried framed building, damages from earthquake generally initiate at locations of structural weaknesses present in the lateral load resisting frames. This behavior of multistoried framed buildings during strong earthquake motions depends on the distribution of mass, stiffness, strength in both horizontal and vertical planes of buildings. In few cases, these weaknesses may be created by discontinuities in stiffness, strength or mass along the diaphragm.

II. CONCEPT OF 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. According to IS 1893-2002 part 1, diaphragm is a horizontal, or nearly horizontal system, which transmits lateral forces to the vertical resisting elements, for example, reinforced concrete floors and horizontal bracing systems.

III. METHODOLOGY

Response Spectrum Method: Response spectrum method is a method in which there is a plot of curves shown between the maximum response of Single Degree of Freedom system which is subjected to a specified seismic or earthquake ground motion and with its time period (or frequency). In response spectrum analysis, the maximum response plotted against of undamped natural period and for various damping values and can be expressed in terms of maximum absolute acceleration, maximum relative velocity or maximum relative displacement.

IV. MODELLING AND ANALYSIS

For the structural analysis, a building plan of size 36m x 36m has been considered and for the sake of the load applications, the building is considered as a residential building. Considering a generic storey height of 3m, the structure has been analyzed. In order to investigate the effects of seismic forces on the structure which is having a diaphragm discontinuity, two models were taken into consideration, i.e., model 1 with 0% opening and model 2 with 10% openings. Further details have been described in the following table:

Particulars	Details
Plan size	36m X 36m
Usage	Residential building
Storey height	3m
No. of storeys	G + 10
Length of grid in X direction	6m
Length of grid in Y direction	6m
Slab thickness	200mm
Column size	500m X 500m
Beam size	350m X 500m
Grade of concrete	M30
Grade of steel	Fe500
Density of concrete	25KN/m^3

TABLE 1 MODELLING DETAILS OF BUILDING

Earthquake Zone	III
Zone Factor	Z = 0.16 (clause 6.4.2)
Importance Factor	I =1 (clause 7.2.3)
Type of soil	Medium soil(clause 6.4.2.1)
Response Reduction Factor	R = 5 (clause 7.2.6)

TABLE 2 SEISMIC DATA:- IS 1893:2016 (part 1)

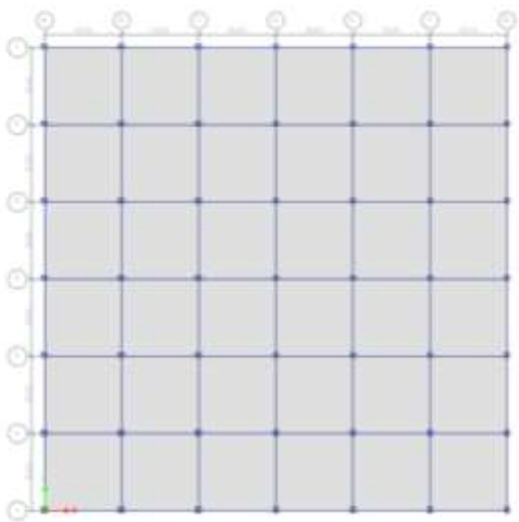

FIG. 1 PLAN OF MODEL 1

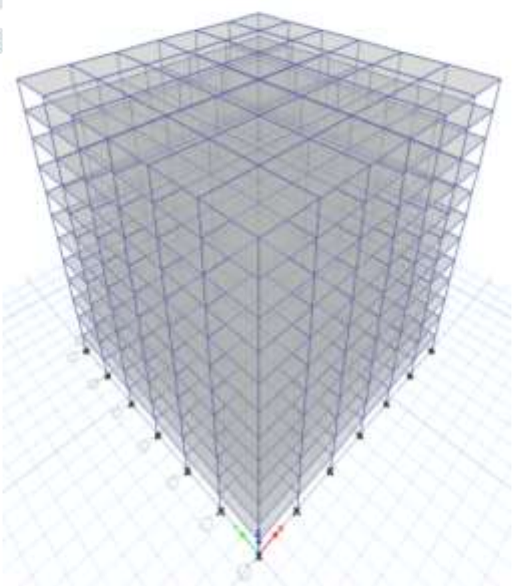

FIG. 2 3D VIEW OF MODEL 1

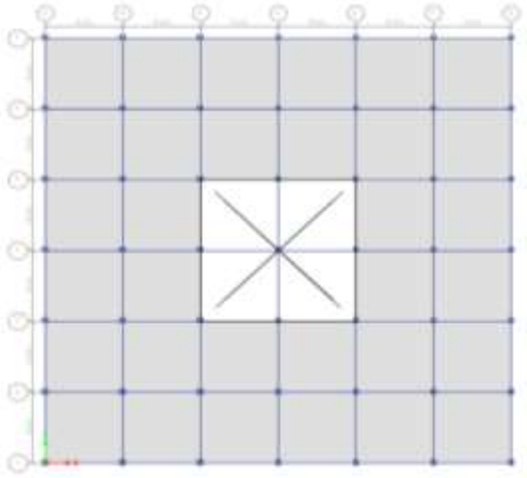

FIG. 3 PLAN OF MODEL 2

V. RESULT AND DISCUSSION

Result discussed in the study are in the terms of:

1. Time period
2. Base shear
3. Storey displacement
4. Storey drift

4.1 Time Period:

All the objects or materials of any structure model have a tendency to vibrate. The rate at which any structure tends to vibrate in its fundamental time period (natural time period) or un-damped ` 27 free vibration of a structure. The natural time period of vibration (Tn) of any structure in sec are given below:- Tn =2Π√ (m/k) Where, Tn= Natural Period in (sec) m= mass k= Stiffness. The unit of natural time period is "second".

MODAL CASE	MODEL 1 TIME PERIOD	MODEL 2 TIME PERIOD
1	1.542	1.498
2	1.542	1.498
3	1.405	1.401
4	0.506	0.492
5	0.506	0.492
6	0.462	0.46
7	0.295	0.286
8	0.295	0.286
9	0.269	0.268
10	0.204	0.197
11	0.204	0.197
12	0.186	0.185

TABLE 3 TIME PERIOD

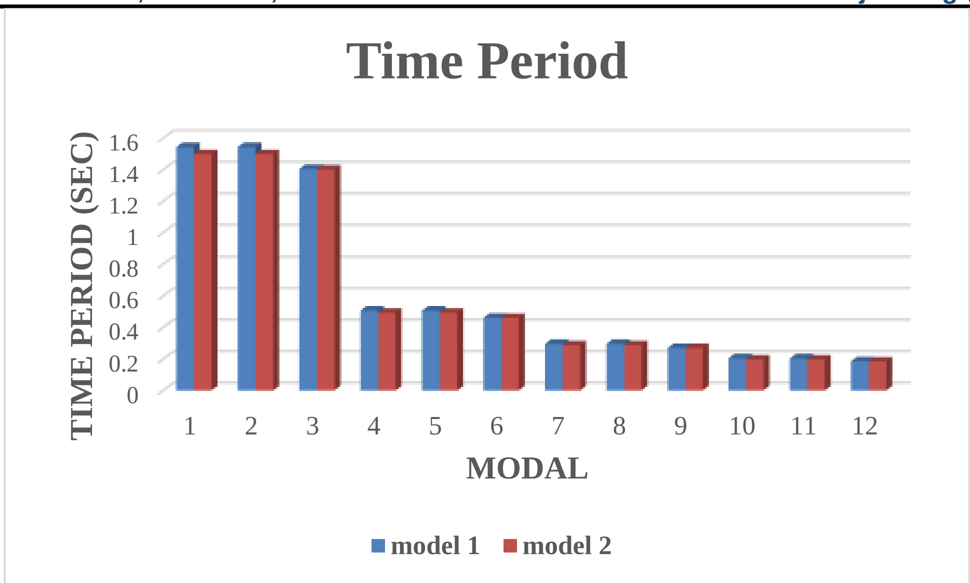

FIG. 4 COMPARISION OF TIME PERIOD

4.2 Base Shear:

Base shear is a shear which relates the degree evaluation of the expected lateral forces which are considered due to unstable ground motion at the base of a structure or model.

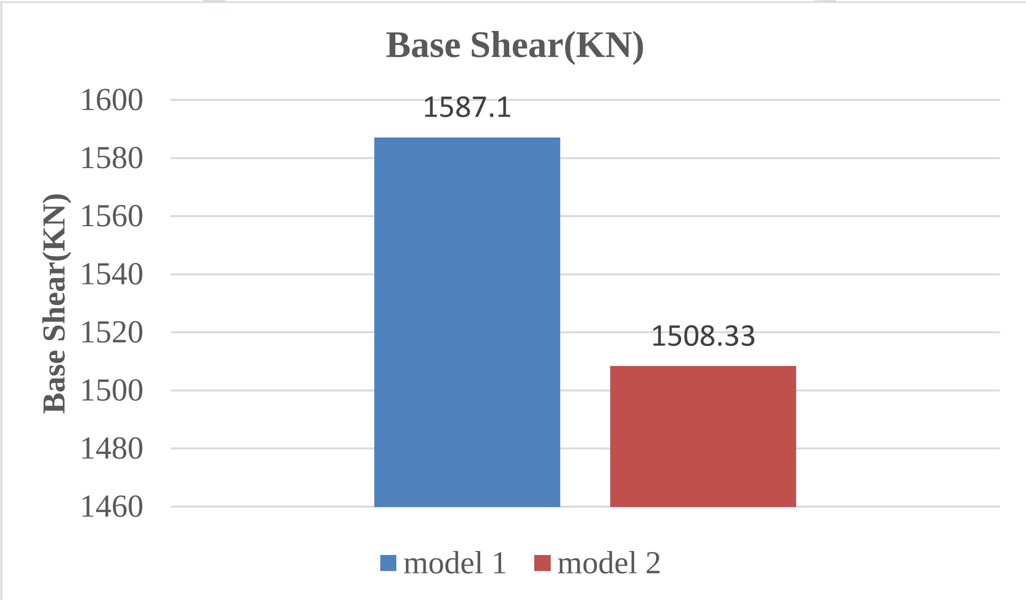

FIG. 5 COMPARISION OF BASE SHEAR

4.3 Storey Displacement:

The storey displacement can be defined as the displacement of any storey with regarding to displacement of ground or displacement of any storey with regarding to ground level due to lateral loads is known as storey displacement.
According to IS 1893:2016, allowable displacement is calculated as H/250, Where H is total height of building above the ground level in millimeters (mm).

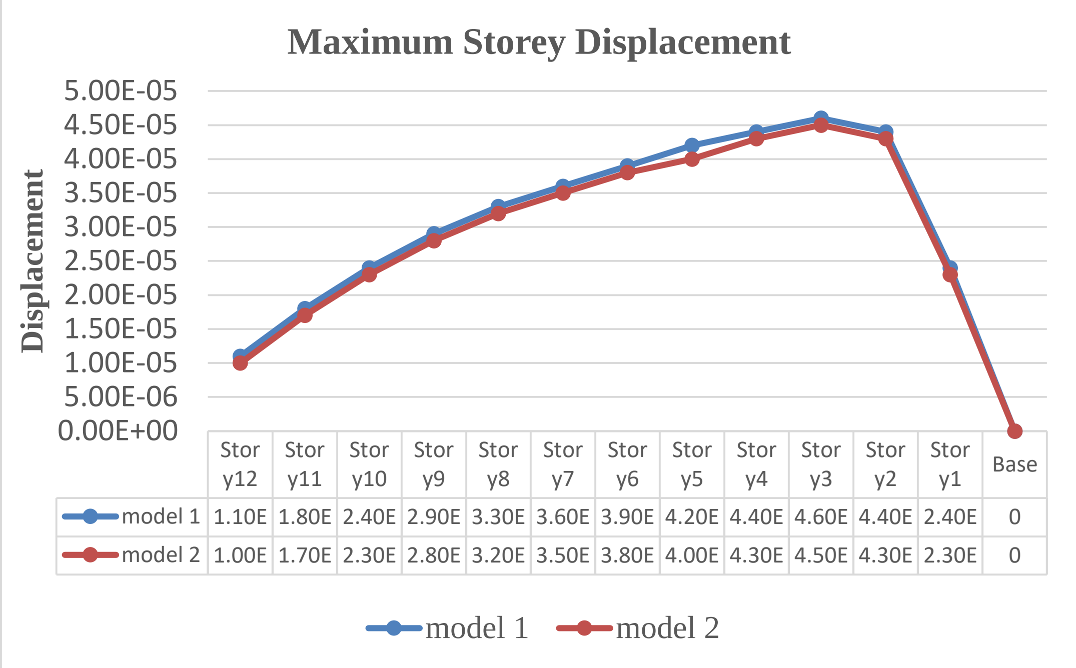

FIG. 6 COMPARISION OF STOREY DISPLACEMENT

4.4 Storey Drift:

Storey drift of a building is a drift can be defined as the horizontal displacement undergone by the building with respect to its base subjected to horizontal or lateral forces such as wind and earthquake loads. Thus, it can be defined as the displacement of one floor level of the building with respect to its adjacent level above or below the considered floor level. Considering as per IS 1893:2016, the storey drift not be more than 0.004H, where H is the height of storey.

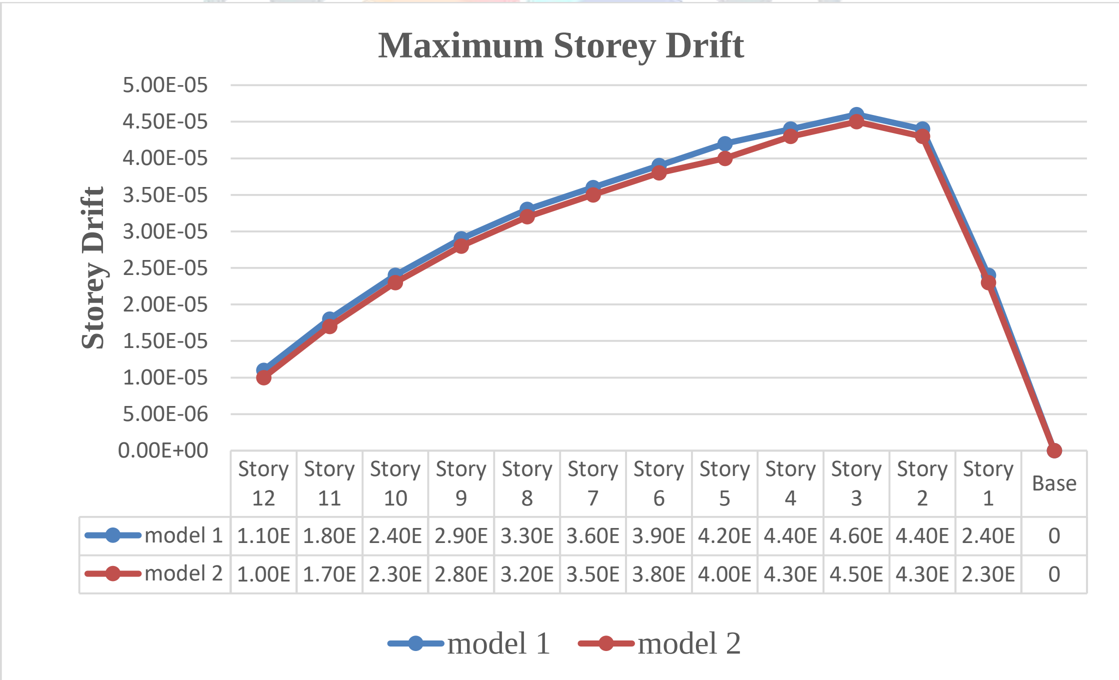

FIG. 7 COMPARISION OF STOREY DRIFT

VI. CONCLUSION

In this research it is observed that as the percentages of the openings or the percentages of discontinuities is increased the engineering parameters like Time Period (T), Storey Displacement, Storey Drift etc, are reduced resulting in reduction in the oscillation of the building under the application of the earthquake forces. Also, the Base Shear is also decreased that means that as the percentage of the openings is increased the lateral force that is applied at the bottom of the building is reduced up to a great extent.

VII. REFERENCES

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