# Comparison of Regular and Irregular Building Considering Irregularity Using ETABS

*Nirmal S. Mehta[1], Tejal D. Patel[2], Prit P. Suthar[3], Yash B. Soni[4],*

Department of Civil Engineering, U. V. Patel College of Engineering,
Ganpat University, India[1,2,3,4]

***Abstract***

*Irregularities are not avoidable in construction of buildings. However, the behavior of structures with these irregularities during earthquake needs to be studied. Present study represents the behavior of regular and irregular building. In this present study five storey building is considered having 5 bays in both direction with 4meter bay span. The building is modelled in ETABS-2013. In this paper two types of irregularities are considered like re-entrant corner and diaphragm discontinuity. Here four models of diaphragm discontinuity and four models of re-entrant corner are prepared. Four models of diaphragm discontinuity are denoted as D1, D2, D3 and D4, similarly for models of re-entrant corner are denoted as R1, R2, R3 and R4. For analysis purpose various loads are considered like dead load, live load and earthquake load in X and Y-direction. Various loads combinations are considered according to IS-1893:2002. The various parameter like storey drift, storey displacement, torsional displacement and height to weight ratio are considered for comparison. It is observed that storey drift and storey displacement for D1 model as compared to other model in Y-direction is greater than the X-direction. Value of torsional displacement is only existing for model R1 and R4. Torsional displacement is zero for remaining model other than R1 and R4 due to symmetry structure. It is also observed that value of displacement and drift is also depend on the height to weight ratio. Further it is observed that value of displacement and drift decrease as the height to weight ratio increases.*

***Keywords:*** *Re-entrant corner, Diaphragm discontinuity, Storey drift and displacement, Torsional displacement.*

## INTRODUCTION

Many buildings in the present scenario have irregular configurations both in plan and elevation, which in future may subject to devastating earthquakes hence it is necessary to identify the performance of the structures to withstand against disaster primarily due to earthquake. Irregularities are not avoidable in construction of buildings; however, the behaviour of structures with these irregularities during earthquake needs to be studied so that adequate precautions can be taken. A detailed study of structural behaviour of the buildings with irregularities is essential for design and behaviour in earthquake. For this study the model having 5 bays in X-direction and 5 bays in Y-direction have been considered for the analysis. The distance between 2 successive grids in both direction is considered as 4m. In the present study, the behaviour of five-storey R.C frame buildings having irregularities confirming to IS 1893 (Part 1): 2002 subjected to an earthquake, are discussed after analyzing in ETABS software. Gravity loads and laterals loads as per IS 1893-2002 are applied on the structure.

Dubey and Sangamnerker, 2011 investigated the seismic behaviour of asymmetric buildings. The main objective is to understand different irregularity and torsional response due to plan and vertical irregularity, and to analyses "T"-shaped building while earthquake forces acts. It was observed that the building with the irregularities are prone to earthquake damage [1].

Banginwar, Vyawahare and Modani, 2012 investigated the effect of the building plan configuration on the seismic behaviour of the building by response spectrum method. It was observed that the plan configuration of the structure has the significant effect on the response of the structure in terms of storey drift, displacement and storey shear. It was also observed that building with severe irregularity shows more displacement [2].

Alavi and Rao, 2013 investigated the effect of plan irregular building in high seismic zone. The main objective of their study is to understand the behaviour of the irregular buildings in the high seismic

zone. It was observed that building with severe irregularity are more vulnerable than those with less irregularity especially in high seismic zones [3].

Maske and Pajgade, 2013 investigated the torsional behaviour of asymmetric buildings. The main objective of the study was to study the influence of the torsion on the behaviour of the structure. It was observed that adopting approximate method in analysis can result in the inaccurate assessment of the building [4].

## MODELLING

As shown in Figures from 1 to 8, all the model has been made using various geometric shapes in ETABS. The first 4 models have diaphragm discontinuity and other four models has Re-entrant corners. The model D1 has 0% discontinuity, model D2 has 4% discontinuity, model D3 has 12% discontinuity and last model D4 has 36% discontinuity. Here in the model R1, Re-entrant corner are 40% in X direction and 80% in Y direction, the model R2, Re-entrant corner are 40% in X direction and Y direction, the model R3 Re-entrant corner are 60% in X direction and 40% in Y direction and at least the model R4 Re-entrant corner are 60% in X direction and 60% in Y direction. Here it is concluded that all the models R1, R2, R3 and R4 has more than 15% Re-entrant corner of its plan direction in the given direction. Table 1 shows the parameter considered in modelling.

*Table-1 Considered Parameters*

| | |
|---|---|
| Size of column = 300mm × 550mm | Grade of Steel = Fe415 |
| Size of beam = 230mm × 300mm | Grade of concrete = M25 (column, Beam, Slab) |
| Thickness of slab = 150mm | Diaphragm-Rigid |

## RESULT AND DISCUSSION

The value of displacement and drift is depended on the height to weight ratio. Weight is inversely proportional to the ratio. Further it is observed that value of displacement and drift decrease as the height to weight ratio increases.

*Table-2 Height to Weight Ratio*

| Shape | Height to weight Ratio |
|---|---|
| D1 | 5.79272E-06 |
| D2 | 4.56237E-06 |
| D3 | 4.83205E-06 |
| D4 | 6.29592E-06 |
| R1 | 1.08828E-05 |
| R2 | 1.08828E-05 |
| R3 | 7.59494E-06 |
| R4 | 6.6553E-06 |

The storey drift and storey displacement for D1 model as compared to other model in Y-direction is greater than the X-direction. As the storey height increases the displacement also increases. The Figure 9 shows the drift and displacement in X and Y-direction for various diaphragm discontinuity model and Figure 10 show the drift and displacement in X and Y-direction for various Re-entrant corner model. Value of torsional displacement is only existing for model R1 and R4 because of their asymmetry nature. Torsional displacement is zero for remaining model other than R1 and R4 due to symmetry structure.

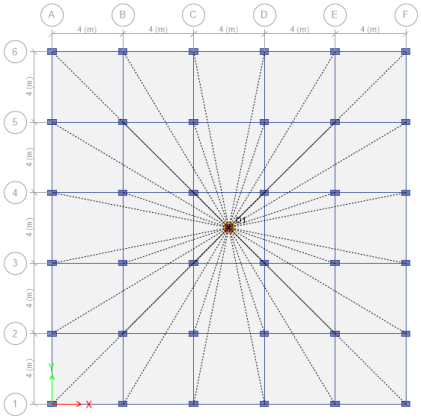

*Fig-1 Model-D1*

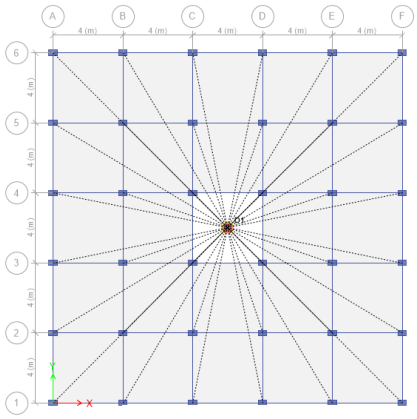

*Fig-2 Model-D2*

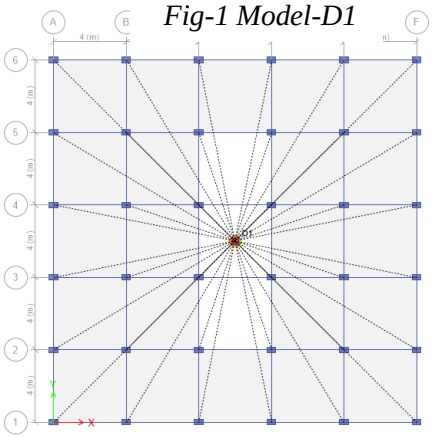

*Fig-3 Model-D3*

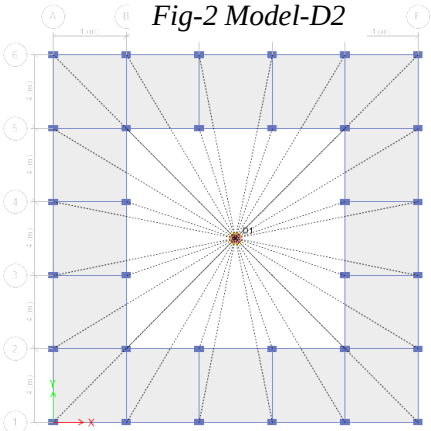

*Fig-4 Model-D4*

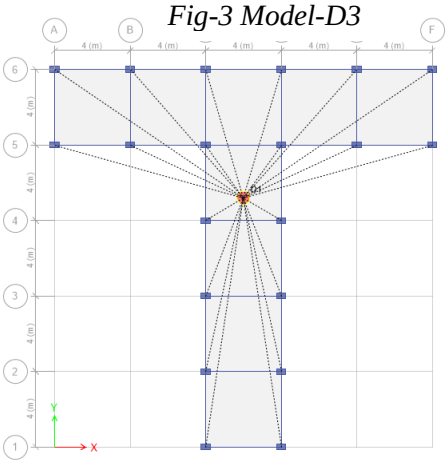

*Fig-5 Model-R1*

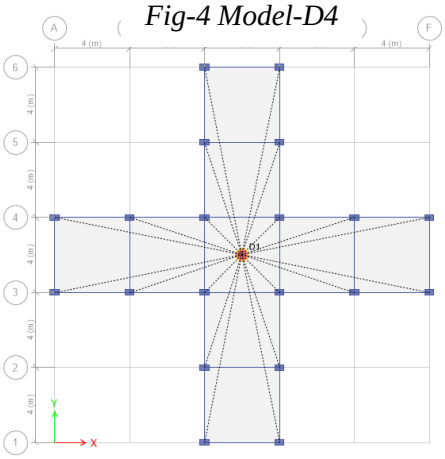

*Fig-6 Model-R2*

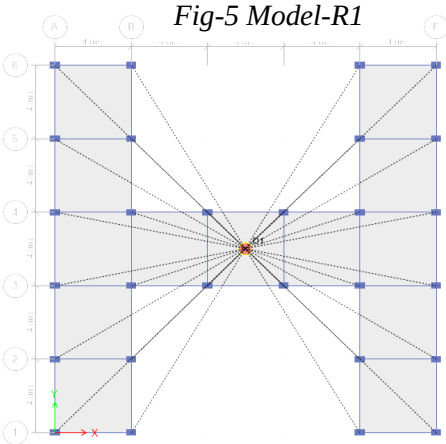

*Fig-7 Model-R3*

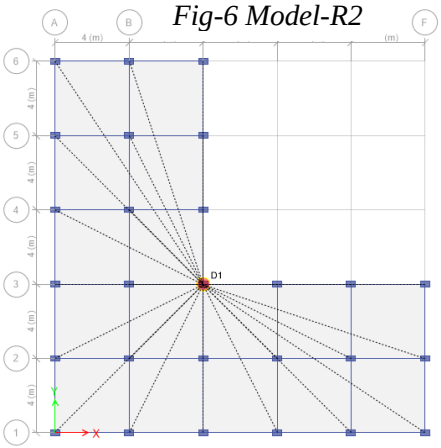

*Fig-8 Model-R4*

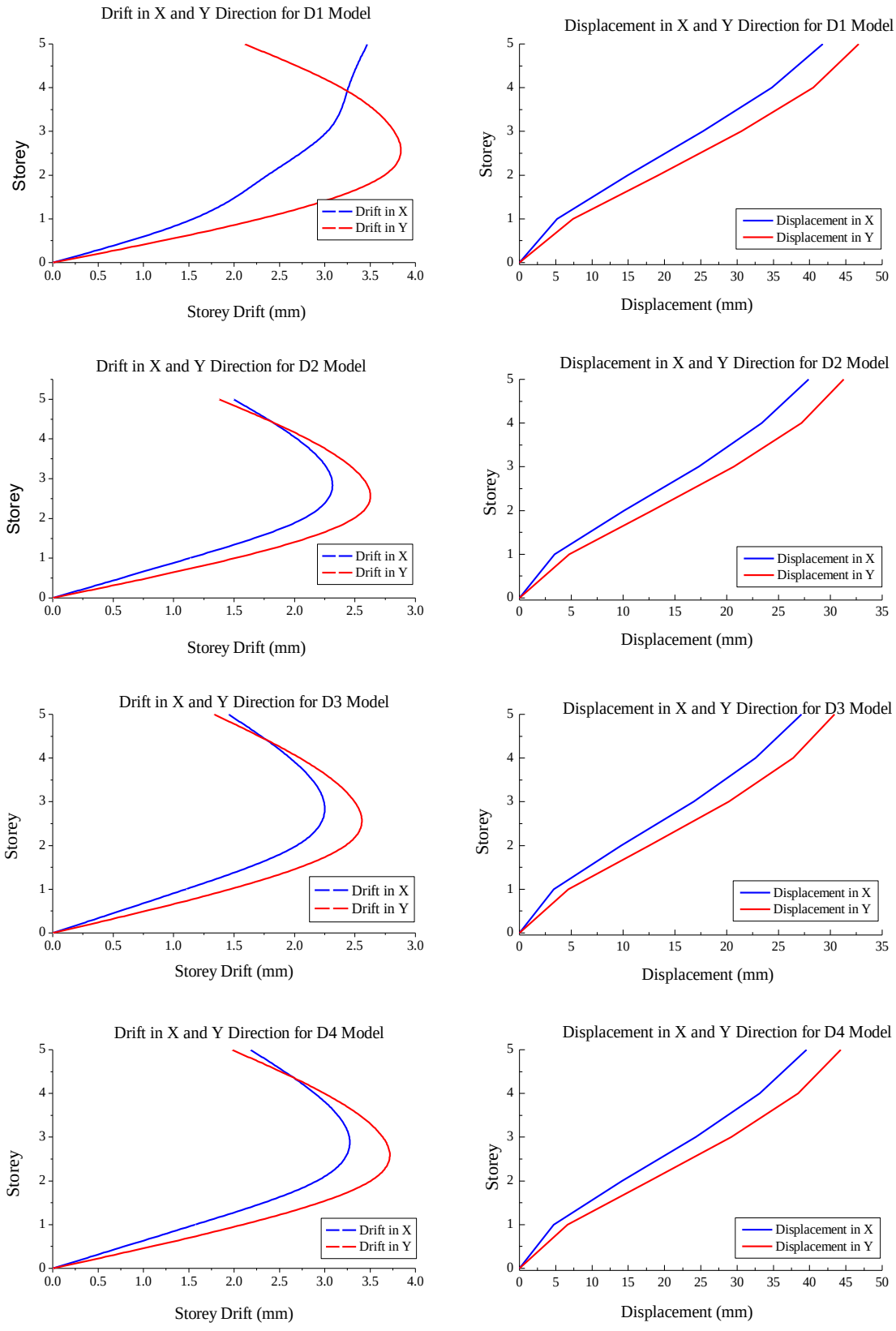


***Fig-9*** *Drift and Displacement in X and Y-Direction for Diaphragm Discontinuity*

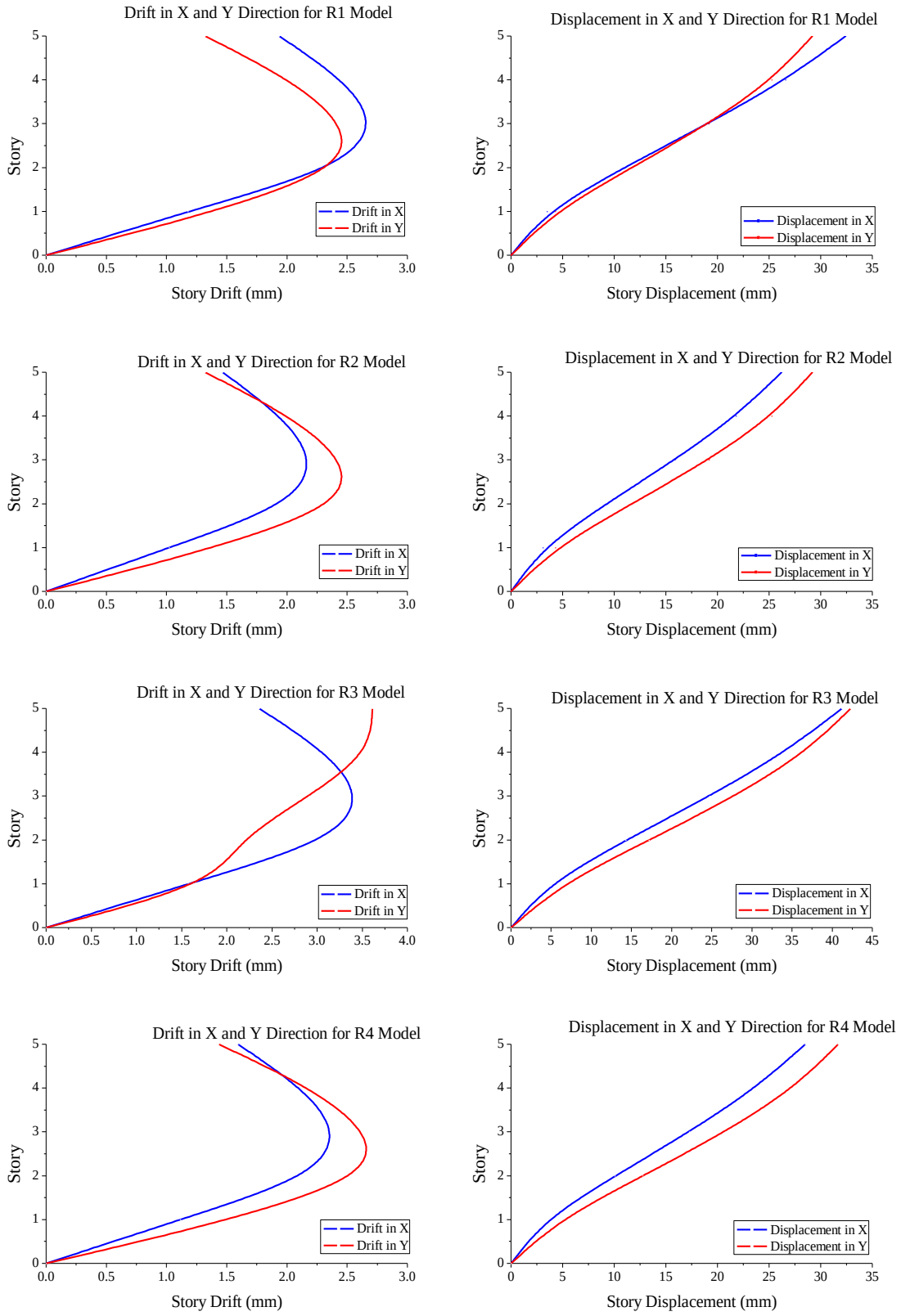


*Fig-10 Drift and Displacement in X and Y-Direction for Re-entrant Corner*

## CONCLUSION

1. Storey drift and storey displacement for D1 model as compared to other model in Y-direction is greater than the X-direction.
2. Torsional displacement of R1 model is 57.9 % greater than R4 model.
3. Displacement and drift decreases as the height to weight ratio increases and visa-versa.

## REFERENCES

[1] Dubey, S. K., & Sangamnerkar, P. D. (2011). Seismic Behaviour of Asymmetric RC Buildings. International Journal of Advanced Engineering Technology, 6.

[2] Banginwar, R. S., Vyawahare, M. R., & Modani, P. O. (2012). Effect of Plans Configurations on the Seismic Behaviour of the Structure by Response Spectrum Method. International Journal of Engineering Research and Applications (IJERA), 5.

[3] Alavi, A., & Rao, S. P. (2013). Effect of Plan Irregular RC Buildings in High Seismic Zone. Australian Journal of Basic and Applied Sciences, 6.

[4] Maske, S. G., & Pajgade, P. S. (2013). Torsional Behaviour of Asymmetrical Buildings. International Journal of Modern Engineering Research (IJMER), 4.