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COMPARATIVE SEISMIC RESPONSE OF PODIUM TYPE BUILDING CONSIDERING DIFFERENT IRREGULARITIES

Abhishek Ramjiyani[1], Nirav Katarmal[2]

[1]*Student (M.E. Structural Engineering), Department of Civil Engineering, HJD-ITER, Kera - Gujrat, India*
[2]*Assistant Professor, Department of Civil Engineering, HJD-ITER, Kera - Gujrat, India*

Abstract — ***The space requirement is the major problem which results into the congestion of structures and also they are very unsafe whenever lateral forces i.e. earthquakes forces are experienced by the structures. Podium is the structure which is used as a multi-usage platform for making the regular or irregular structures. Podium may consist of commercial to certain height, residential and also for many other purposes. Hence in order to fulfil the space requirement and also for the safety purpose the podium structure and its analysis is been made. In the present study the dynamic analysis is been done. Also the dynamic analysis is been carried out by the response spectrum method. The aim of present work is to study the performance of podium type building with different irregularities under dynamic loading for different storey heights and to compare the results in terms of different parameters. For comparison 15, 20 and 25 storeys buildings having same podium size respectively are considered. For dynamic analysis of members IS: 1893-2002 design code is considered. For modelling and analysis of structural member in terms of time period, storey displacement, storey drift, storey shear and torsion effect under dynamic loading. For the dynamic analysis ETAB V.16 software is used.***

Keywords- Podium Type Building, Response Spectrum Analysis, Irregular Building, Dynamic Analysis, ETAB Software.

I. INTRODUCTION

Nowadays population is a major problem and is increasing day by day thus resulting in construction of more vertical housing due to shortage of land. Podium is the multi-tasking structures in which large variation in plan and elevation is seen. Typically, the podium levels serve as a horizontal separation between different building occupancy types above and below the podium. Often times, this is residential over parking or commercial uses such as retail businesses or restaurants. Nowadays, the podium structures are more popular in metro-cities like Mumbai, Delhi, Bangalore, etc., where space plays an important role. Structure has the stiffness variation while observing the elevation of the podium structure. Thus in order to make the structure more stable and to withstand desirable seismic forces engineer has to design the structure by using proper techniques and many design software. By using proper design techniques and software, stability of the building can also be achieved if each and every member of the structure are properly analyzed and designed for the worst condition of seismic forces.

II. MODELING OF STRUCTURES

In the present study, three different irregular podium building Rectangular Building, T-Shape Building and C-Shape Building having 15, 20 and 25 storey heights for the each building types are considered. For analysis of the building by dynamic response spectrum method which gives the seismic response of the structure by considering the seismic zone V and different soil conditions as soil type II (Medium). In this study, different study parameters are storey displacements, storey drift, storey shear, time period & torsion effect. Analysis is done using ETAB V16 Software.

A. BUILDING PODIUM DATA:

Table 1. Podium Storeys and Heights Details

STOREY	PODIUM	TYP. PODIUM HEIGHT
15	3 STOREY	3.2 M
20	5 STOREY	3.2 M
25	7 STOREY	3.2 M

B. BUILDING MODEL DATA:

- Typical Plan Dimension 48m x 48m
- Typical Storey Height 3m
- Typical Podium Height 3.2m
- Height of Structure 45.6m, 61m & 76.4m
- Number of Storey 15, 20 & 25
- Thickness of Slab 150mm
- Thickness of Wall 230mm
- Size of Column 450mm x 450mm
- Size of Beam 300mm x 450mm
- Concrete Grade M-30
- Steel Grade Fe-500
- Earthquake Zone V
- Importance Factor 1.5
- Response Reduction Factor 3
- Type of Soil II
- Damping 5 %
- Dead Load on Slab 1.5 kN/m2
- Imposed Load on Slab 4 kN/m2
- Density of Concrete 25 kN/m3
- Density of Steel 78.5 kN/m3
- Density of Masonry 20 kN/m3

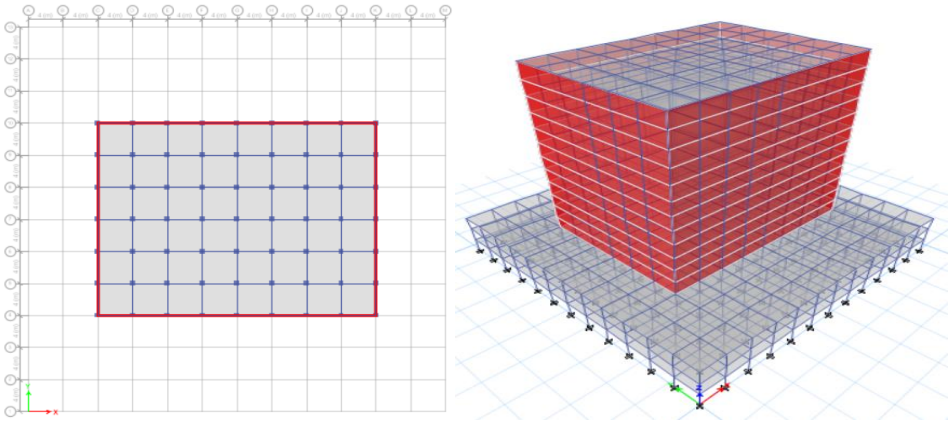

Figure 1. 15 Storey Rectangular Building Plan and 3D View

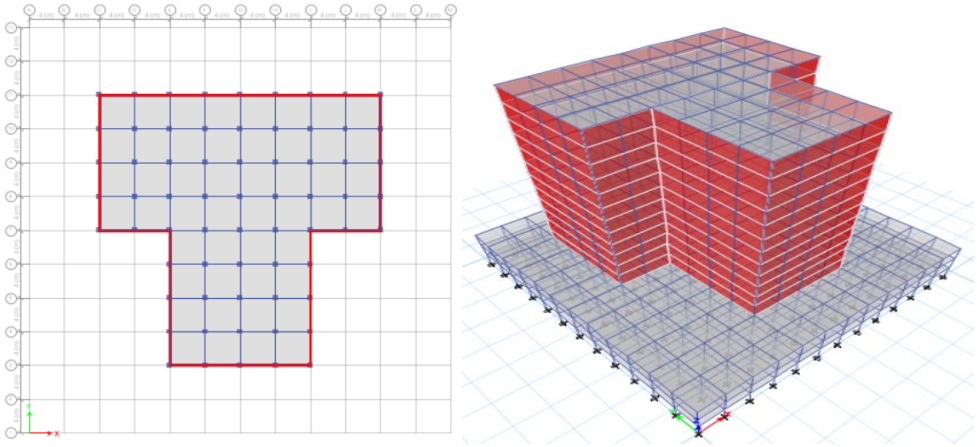

Figure 2. 15 Storey T-Shape Building Plan and 3D View

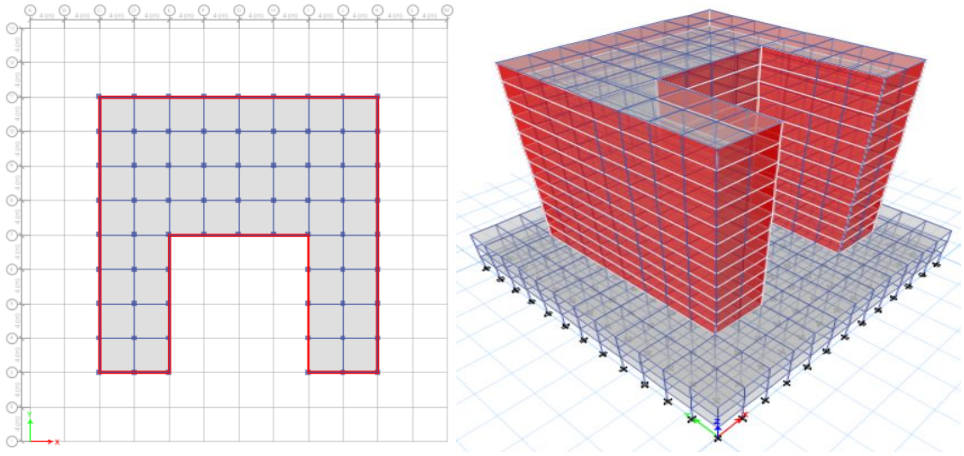

Figure 3. 15 Storey C-Shape Building Plan and 3D View

III. RESULTS AND DISCUSSIONS

Dynamic analysis is carried out for response spectrum method and seismic response of the buildings are studied using ETAB 2016. The results Storey displacement, storey drifts, storey shear and time period values are taken from the software. Torsion effect is also considered. The comparison between all three models for the parameters mentioned above presented in Graphs below. Here, Results are shown for Soil type II & Seismic Zone V.

A. STOREY DISPLACEMENT:

The following graphs are showing results for storey displacement in EQ x & EQ y direction.

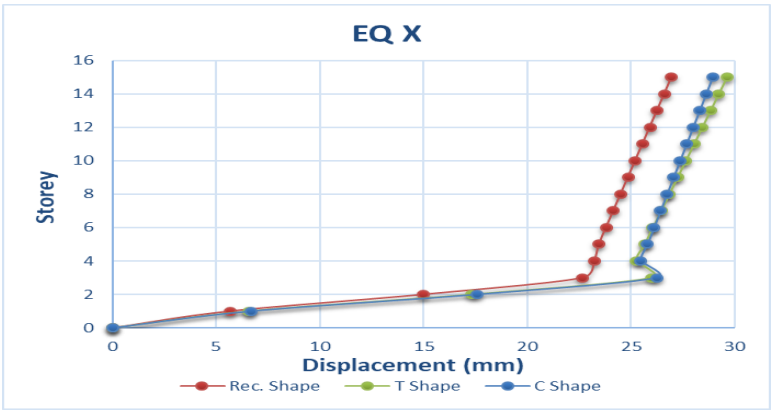

Figure 4. 15 Storey Models Storey Displacement in EQ x

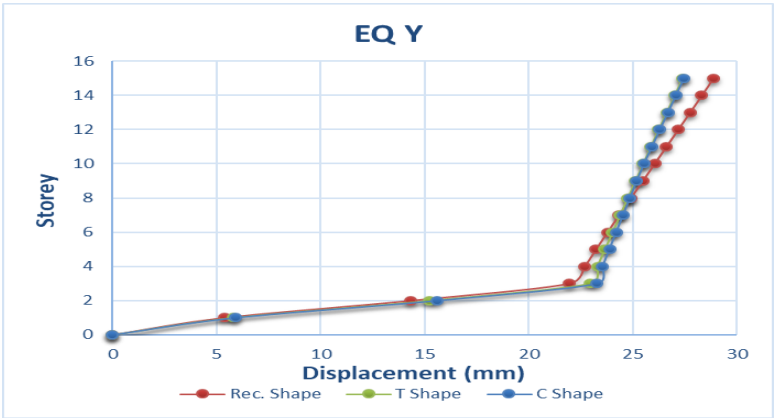

Figure 5. 15 Storey Models Storey Displacement in EQ y

B. STOREY DRIFT:

The following graphs are showing results for storey drift in EQ x & EQ y direction.

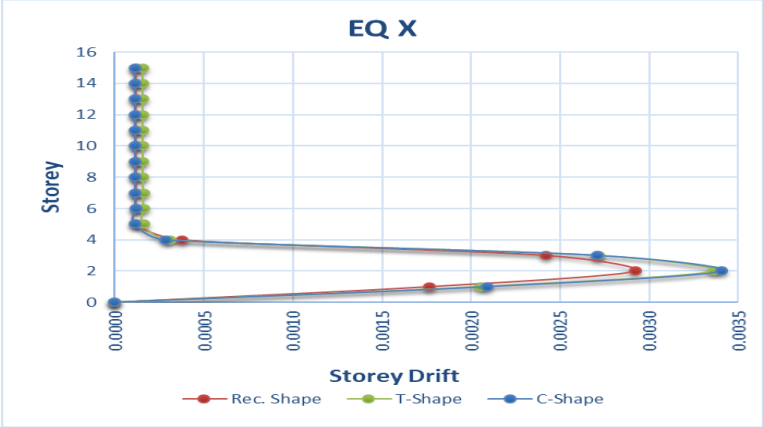

Figure 6. 15 Storey Models Storey Drift in EQ x

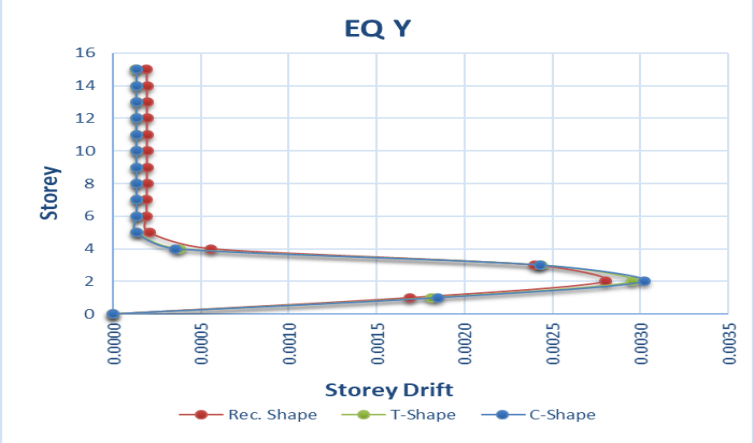

Figure 7. 15 Storey Models Storey Drift in EQ y

C. STOREY SHEAR:

The following graphs are showing results for storey shear in EQ x & EQ y direction.

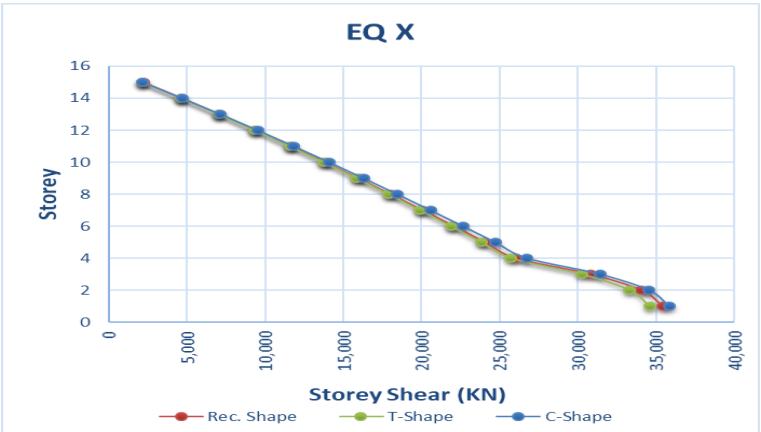

Figure 8. 15 Storey Models Storey Shear in EQ x

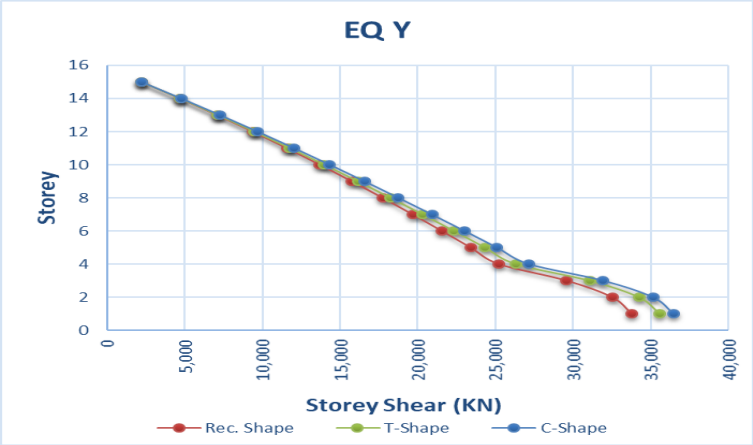

Figure 9. 15 Storey Models Storey Shear in EQ y

D. TORSION EFFECT:

The results obtained from software are shown that all 15 storey building models are safe in torsion effect for both direction X and Y.

Table 2. 15 Storey Models Torsion in X and Y Direction

Direction	Rec. Shape	T-Shape	C-Shape
X	1.00	1.07	1.05
Y	1.00	1.00	1.00
Torsion Check	< 1.2 = SAFE	< 1.2 = SAFE	< 1.2 = SAFE

E. TIME PERIOD:

The following graphs are showing results for 15 storey time period for all building models.

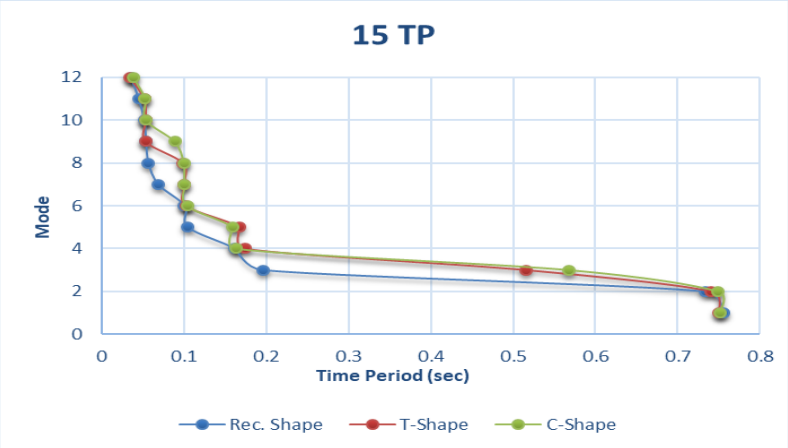

Figure 10. 15 Storey Models Time Period

IV. CONCLUSIONS

From the dynamic analysis of 15 storey podium type irregular buildings the following conclusions are obtained:

1. The values of storey displacement for T-shape building is more about 9-14 % and for C-shape building is about 7-16 % than the Rec. shape building.

2. The values of storey drift for T-shape building is more about 15-25 % and for C-shape building is about 5-16 % than the Rec. shape building.

3. The values of storey shear for T-shape building is more about 2-5 % and for C-shape building is also about 1-3 % than the Rec. shape building.

4. T-shape building has more irregularity as compared to other buildings. Hence, T-shape building shows more signs of distress compared to Rec. shape and C-shape building.

5. As the mass of upper building is almost same in Rec. Shape, T-shape and C-shape buildings, we are getting approximately same values for base shear by response spectrum analysis in all podium type building. So we must use dynamic analysis method for irregular buildings.

6. Time period in first two or three mode is same for all podium buildings. But Time period for T-shape building is higher and for C-shape building is almost same compared to Rec. shape building.

7. Torsion values for 15 storey models are safe in both X-direction and Y-direction. Similarly 20 storeys and 25 storeys models are also safe in Torsion for both the directions.

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