Pushover Analysis on Plan Irregular Buildings

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Abstract:The generalized non-linear static analysis procedure characterized by use of a static pushover analysis method to represent the structure's lateral forces resisting capacity is used in this study. For pushover analysis different shapes of building have been considered like square shape, rectangular shape, L shape, T shape, H shape, plus shape and C shape with constant floor area as 900 m^2. The capacity spectrum graph is plotted for push x and push y from where performance point is found for each building for 15 storey building and is located in seismic zone five using sap2000 software.
The graph is plotted shear force vs. shape of building, displacement vs. shape of building, spectral displacement vs. shape of building and spectral acceleration vs. shape of building and from this the best shape of building is evaluated.

***IndexTerms*–Pushover Analysis, Capacity Curve, Displacement, Acceleration, Base Shear.**

I. INTRODUCTION

Pushover analysis is an approximate analysis method in which the structure is subjected to monotonically increasing lateral forces with an invariant height-wise distribution until a target displacement is reached. Pushover analysis consists of a series of sequential elastic analysis, superimposed to approximate a force-displacement curve of the overall structure.

II. OBJECTIVE

The main objective of the study is to determine the performance point and capacity curve of different shape building.

III. PUSHOVER ANALYSIS METHODOLOGY IN SAP2000

The ATC 40 provides detailed guidelines about how to perform a nonlinear static pushover analysis. The most important parts of this method are the construction of the Capacity Spectrum and the design Response Spectra and finding of the point of intersection of the capacity and the response spectra [1]. The intersection defines the performance level of thestructure for the design earthquake. The following procedure is based on the ATC 40.

- Make the 3D model of different shape in sap 2000
- Assign all the properties and load on slab
- Assign hinge properties (Beams – Default M_3) and (Column – Default PM_2M_3) [1]
- Give load cases with the pushover load in X and Y direction (Push X and Push Y) [6]
- After Checking all the loads and properties Run the analysis
- Check the deformed shape of the structure in push x and push y loads, also observe the hinge formed on beam and column
- Compare the capacity curve of base shear and displacement due to push x and push y.

IV. STRUCTURAL MODELING AND ANALYSIS

Table 1 Structural Data

Type of building	Educational building
Number of storey	15
Floor height	4 m
Floor area	900 m^2
Slab thickness	200 mm
Column size	700x700 mm
Beam size	350x450 mm
Each Bay Length	6m
Wall thickness	300mm and 200mm
Grade of concrete	M25
Steel	Fe415
Live load	5kN/m^2
Floor finish	1kN/m^2
Seismic zone	Five [6]

4.1Considered Geometry

For modeling, we considered different shape of building such as square shape, rectangular shape, L shape, T shape, H shape and C shape with consent floor area as 900 m^2. Also we tried to keep same number of columns on floor in all shapes means that the overall stiffness of all models is approximately same. Bellow figures shows the plan of building with 3-D view and hinge formed in building.

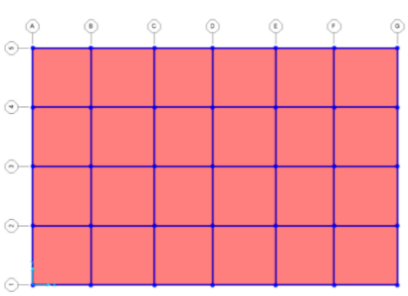
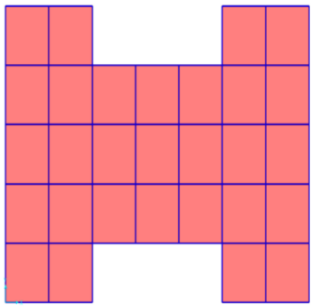
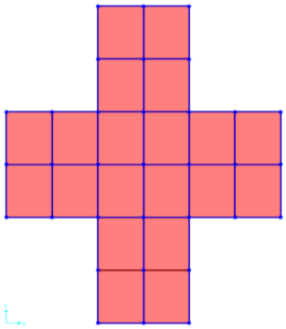

Figure 1Rectangular shapeFigure 2H shapeFigure 3 Plus shape

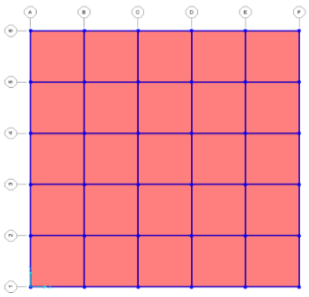
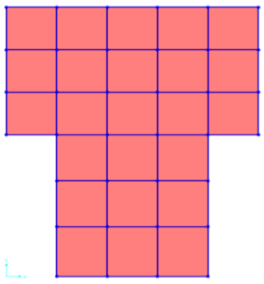
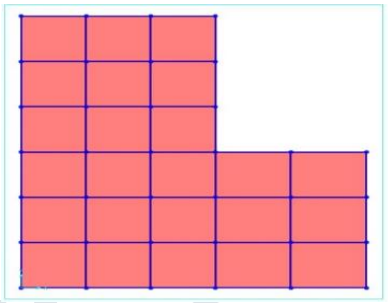

Figure 4 Square shape Figure 5T shapeFigure 6 L shape

4.2 Analysisof Square Shape Building

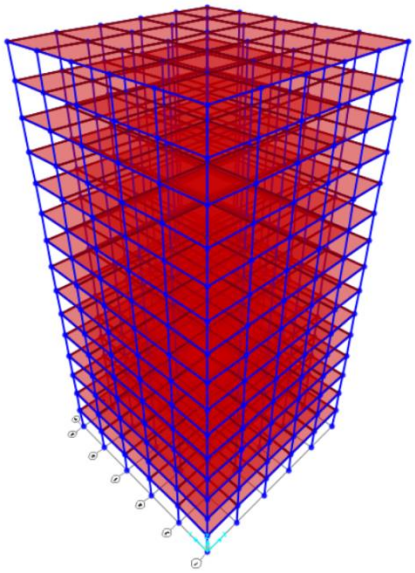
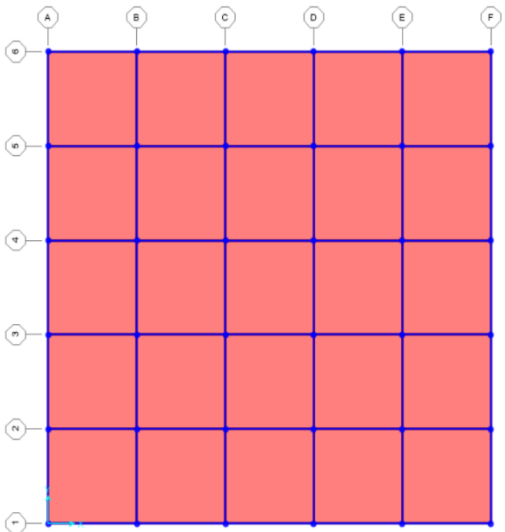

Figure 7 3D view Figure 8 Plan

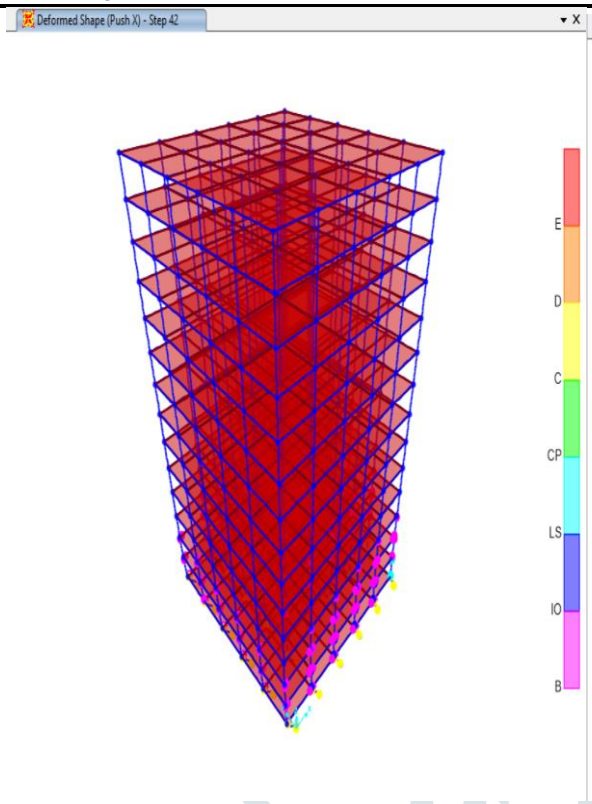

Figure9 Hinges form Push X

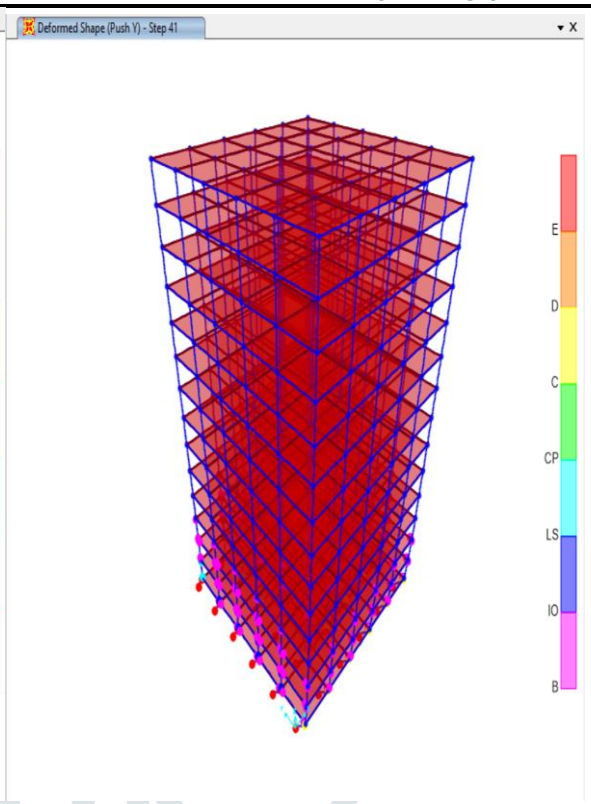

Figure 10 Hinges form Push Y

4.3 Performance Pointand Capacity Curve

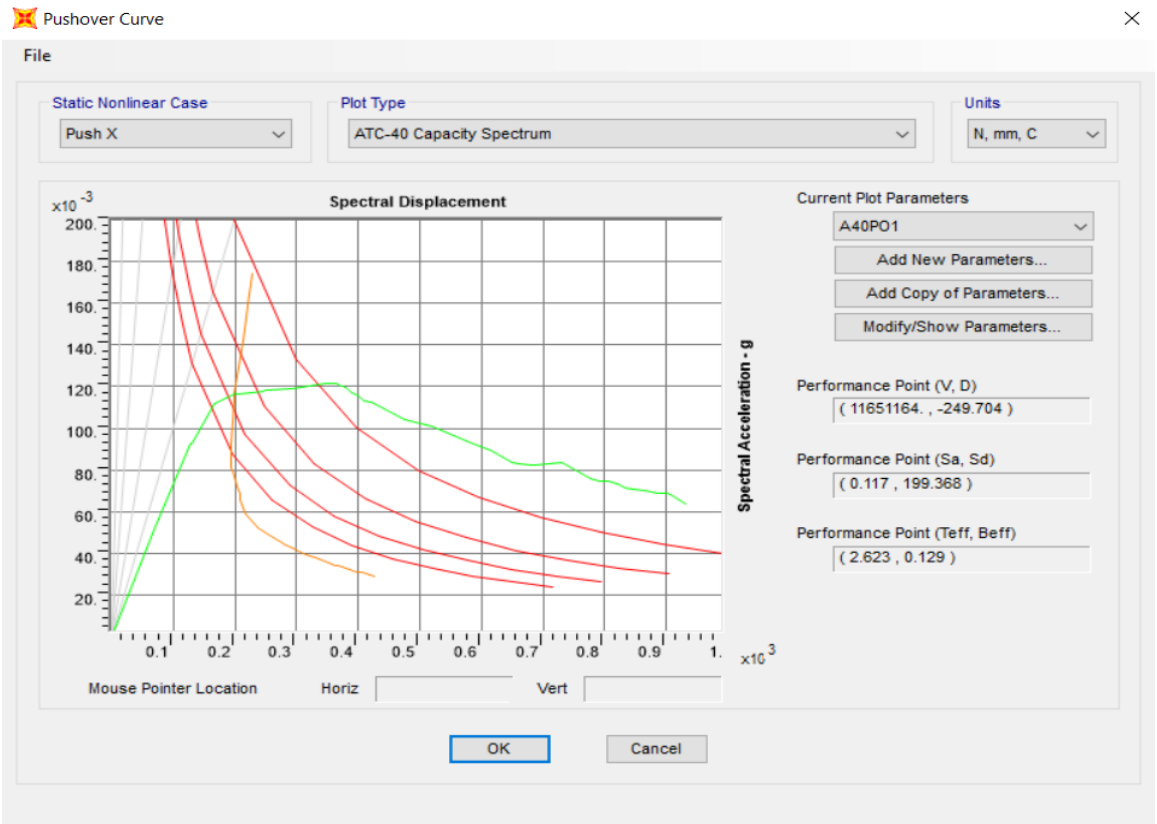

Figure 11 Capacity Curve for Push X

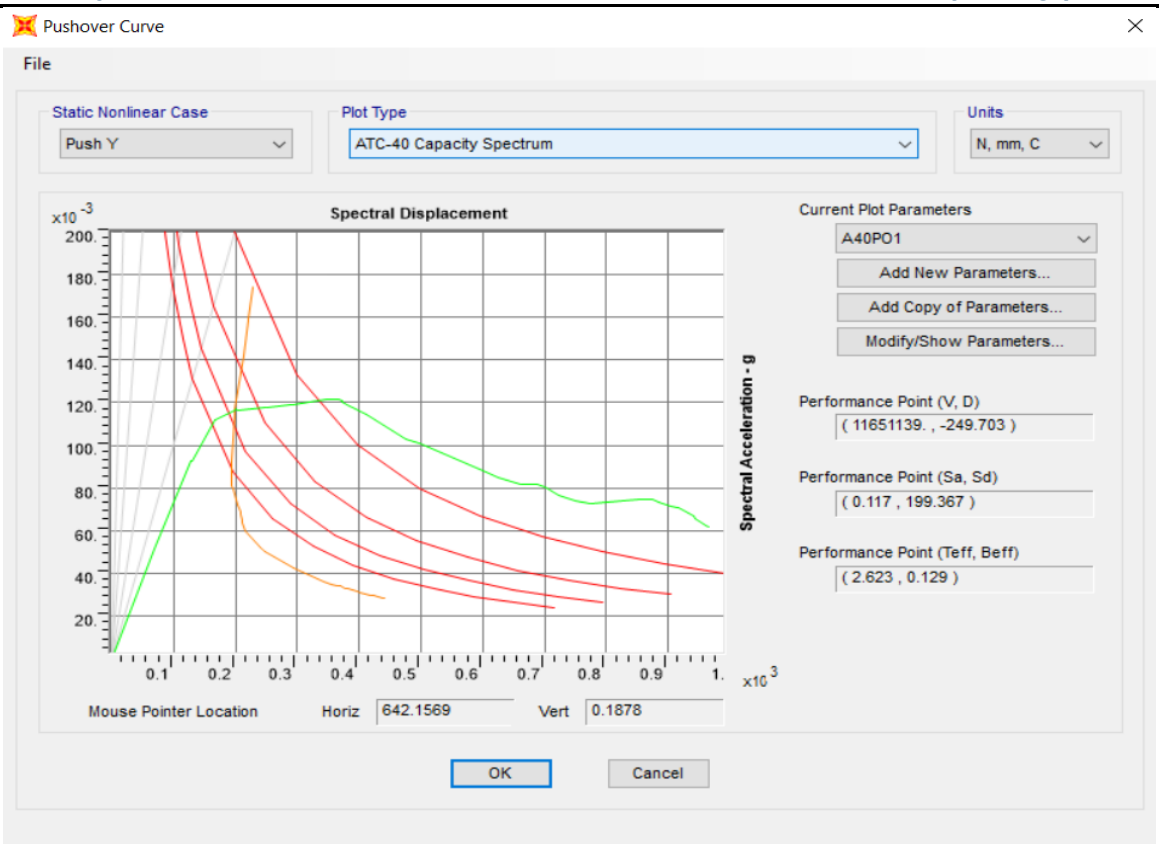

Figure 12 Capacity Curve for Push Y

V. GRAPHICAL REPRESENTATION

5.1 Comparisonof Shear Force

The performance point in different shape of building such as square shape, rectangular shape, L shape, T shape, H shape, plus shape and C shape has been found from sap2000 software of shear force and graph is plotted shear force vs. shape of building for push x and push y as shown as bellow. While comparing of shear force in plus shape of building is less compared to another shape building and is more in H shape.

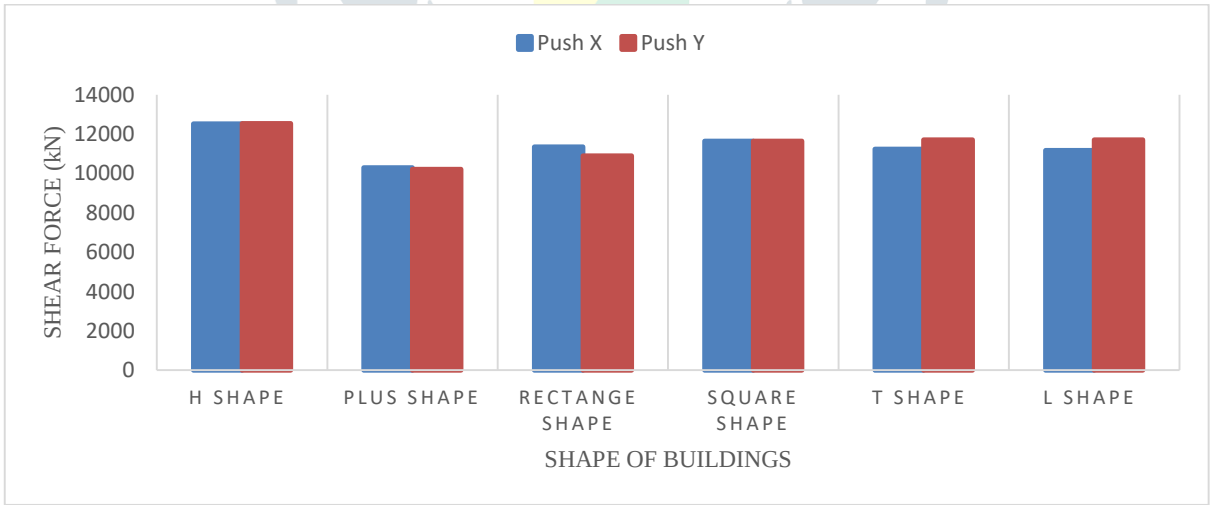

Figure 13 Graph of Comparison of Shear Force

5.2 Comparison of Displacement

The performance point in different shape of building such as square shape, rectangular shape, L shape, T shape, H shape, plus shape and C shape has been found from sap2000 software of displacement andbar graph is plotted for displacement vs. shape of building for push x and push y as shown as bellow. Whilecomparing the displacement in T shape of building is less compared to another shape building and is more in plus shape.

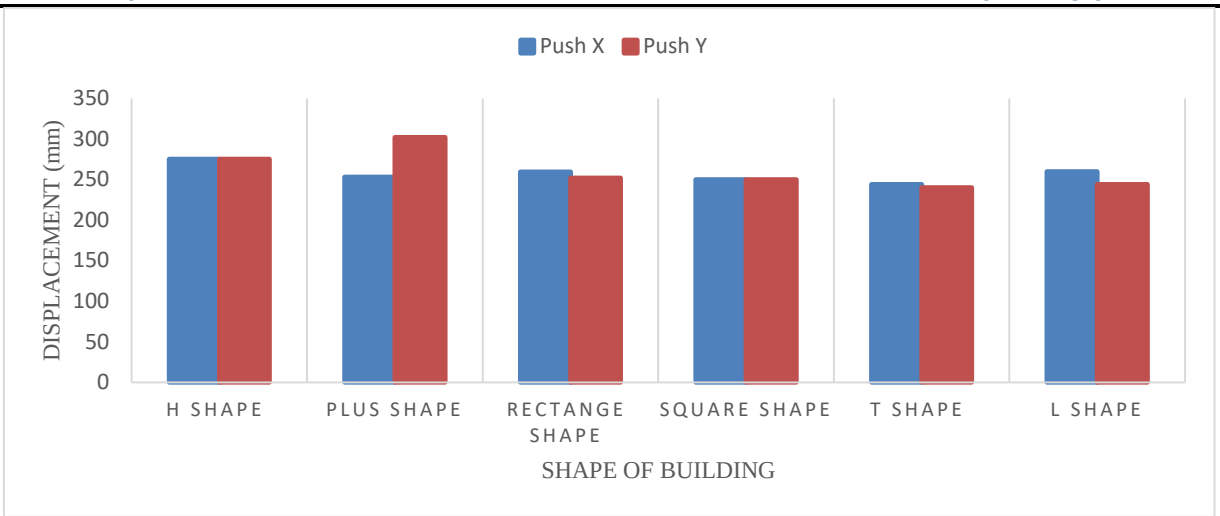

Figure 14 Graph of Comparison of Displacement

5.3 Comparison of Spectral Acceleration

The performance point in different shape of building such as square shape, rectangular shape, L shape, T shape, H shape, plus shape and C shape has been found from sap2000 software for spectral acceleration and bar graph is plotted for spectral acceleration vs. shape of building for push x and push y as shown as bellow. While comparing the spectral acceleration in plus shape of building is less compared to another shape building and is more in T shape.

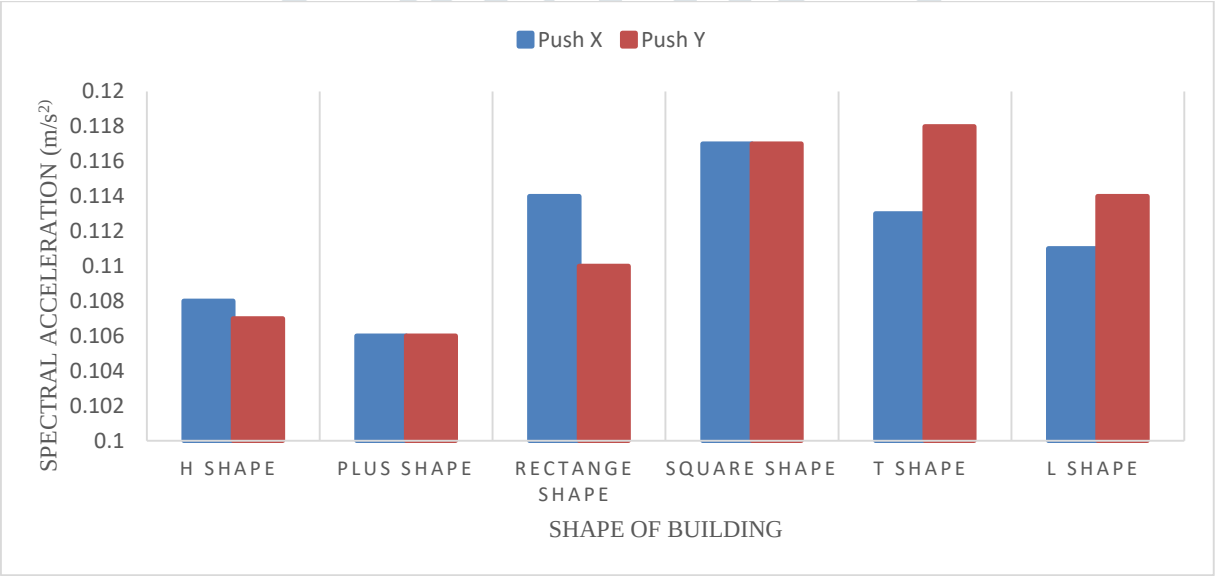

Figure 15 Graph of Comparison of Acceleration

5.4 Comparison of Spectral Displacement

The performance point in different shape of building such as square shape, rectangular shape, L shape, T shape, H shape, plus shape and C shape has been found from sap2000 software of spectral displacement and bargraph is plotted spectral displacement vs. shape of building for push x and push y as shown as bellow. While comparing the spectral displacement in square shape of building is less compared to another shape building and is more in plus shape.

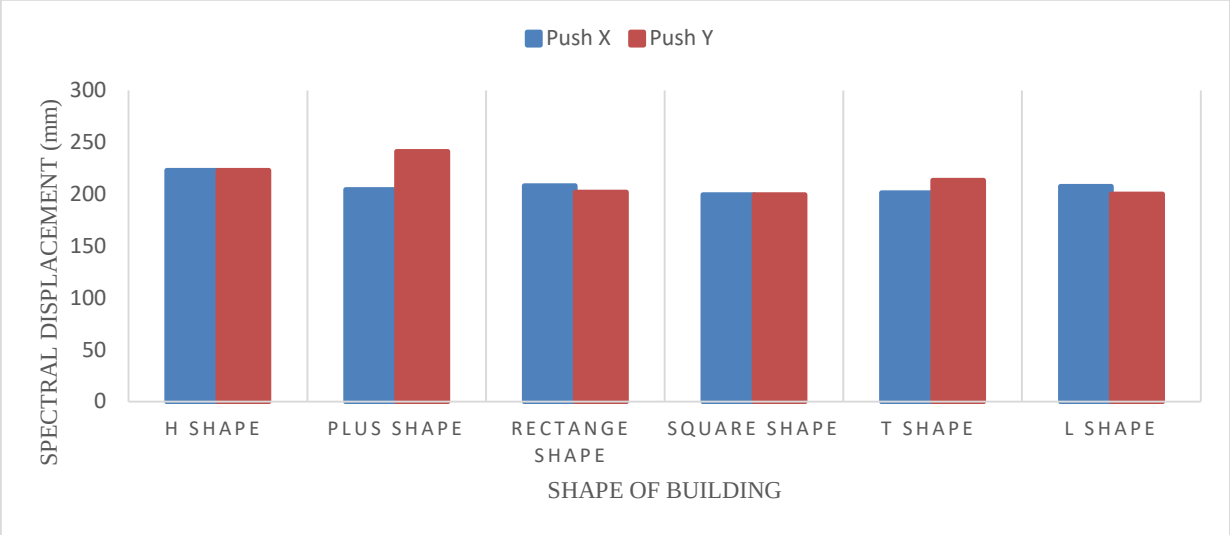

Figure 16 Graph of Comparison of Displacement

VI. CONCLUSIONS

- The pushover analysis the H shape has high shear capacity and plus shape has least shear capacity for both push x and push y.
- The design displacement in H shape is high and least in square shape for both push x and push y.
- The design spectral acceleration is high in T shape and least in plus shape for push y and it is high in square shape and least in plus shape for push x.
- The design spectral displacement is high in plus shape and least in square shape for push y and it is high in H shape and least in square shape for push x and it is high in H shape and least in square shape for both push x and push y.
- The square shape building takes maximum shear force at minimum displacement and damping ratio is also less at performance point than all the other shapes So, we should prefer the square shape building.

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