Comparative Study of Performance based Pushover Analysis of Building Structure

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Abstract— In the age of development of urban cities and high rise building structures it is very much essential to design earthquake resistance structures .There are various method introduced to design such structures out of which pushover analysis is most approximate method to find out the behaviour and effects of structure under earthquake Loadings. The Paper aim evaluate 2d 10,15 and 20 storey structure with and without shear wall and compare the performance of structure under such Loadings, to study the inelastic responses using pushover analysis and compare the differences in pushover curve of structure with shear wall and without shear wall.

Key words: Pushover Analysis, Shear Walls, Earthquake Loadings

I. Introduction

The earthquake is a natural disaster which can occur any time and at any place which can lead to a lot of destruction such as structural collapse and also causes damages to structures reducing the structural strength which can lead to loss of human life and damages to properties. So to avoid these consequences it is always a matter of concern to design the structure which are earthquake resistance in earthquake prone areas .For designing such structures the use of pushover analysis method is became very trending as it is comparatively easier than other methods and is more approximate compare to other methods of analysis .The pushover analysis method has a good application capability to estimate seismic demands. It allows to understand the structural members behaviour ,the computation pattern needs and changes in the lateral load patterns.by utilizing this technique higher mode effect can be defined at various load pattern so as to estimate target displacement which will help to estimate seismic demand for performing pushover analysis .this method help in the study of load deflection pattern ,crack patterns in different loading conditions .thus in this paper the pushover analysis is utilized by using SAP2000 for study of concrete behaviour and characteristics under different loading conditions of 2d 10,15 and 20strorey building structure with and without shear wall and comparing the results obtained by the analysis to understand the behaviour and characteristics changes of structure in earthquake design by provision of shear wall in the structure

II. Pushover Analysis

The pushover analysis is a static nonlinear analysis process in which the load distribution pattern throughout the height of the structure is predefined and then lateral loads are incrementally increased till the structure reaches a collapse mechanism .The various behaviour and characteristics can be defined by utilizing pushover analysis method such as it can be used to study the behaviour and characteristics whole structure as well as members ,ultimate load and maximum inelastic deflection are obtained. This analysis method works step by step in which the Load is increased at each step and the structural modal experience push at each step. Thus we obtain results as pushover curves such as base reaction vs monitored displacement curve, joint displacement, base reactions and structural ductility as well as we can see the deformation

III. Objective of Project

The Main aim of this project is to study the behaviour of 10,15 and 20 storey building structure with and without shear wall and understand the changes cause by provision of shear wall in a RC structure under earthquake loadings and compare the results obtained by using the pushover analysis method by utilizing of SAP2000 software for performing analysis

1) To study and compare the changes in the deformation pattern of structure with and without shear wall
2) To study and compare the changes in pushover curves
3) To study and compare the target displacement in both cases
4) To study and compare the Joint displacement in both cases
5) To study and compare base reactions in both cases

IV. Modelling of Structure

In case of without shear wall all the structure we are using are four bay in x direction of 5 meters and height of each storey is set to 4 meters the no of storey is set 10 ,15 and 20 for structure of 2d 10, 15 and 20 storey respectively .In all the structures we are using the columns of size 0.4m x 0.35m and beam of size 0.35m x0.25m the column .the analysis mode is set 2 dimensional analysis mode .the concrete material used is m 20 concrete and rebar used is Fe415 of Indian standard 456:2000 the supports are fixed and material is assigned to columns and beams also default hinge properties are used for beams and columns .the load cases used in this project are 1)dead load 2)live load 3) lateral loads due to earthquake forces 4) pushover load case

The earthquake force is set at corner top left point joint and dead load distribution at each level in set and the model is created the figure below shows the elevation plane of 2d 10, 15 and 20 storey building structure.

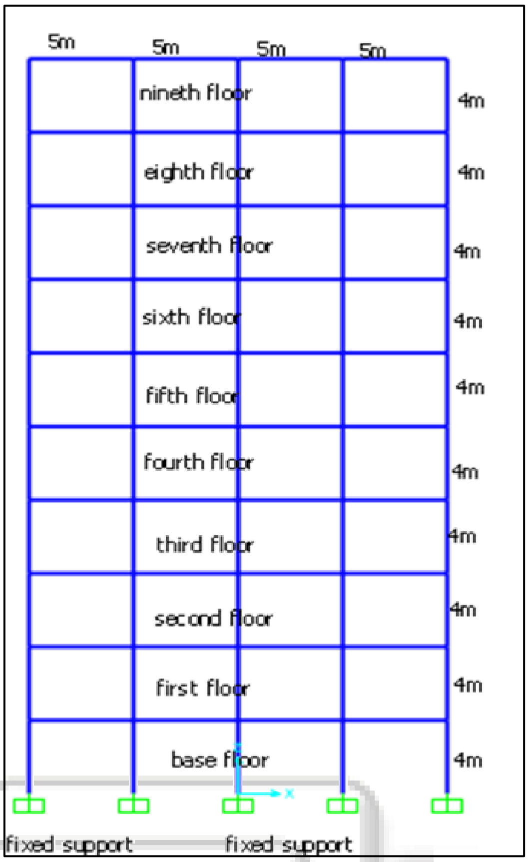


Fig. 4.1: elevation plane of 10 storey 2d building structure without shear wall

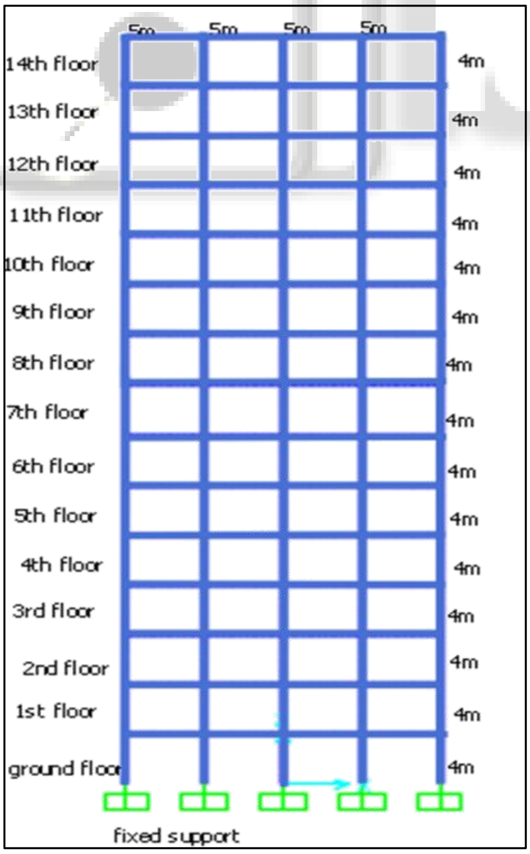


Fig. 4.2: elevation plane of 2d 15 storey building structure without shear wall

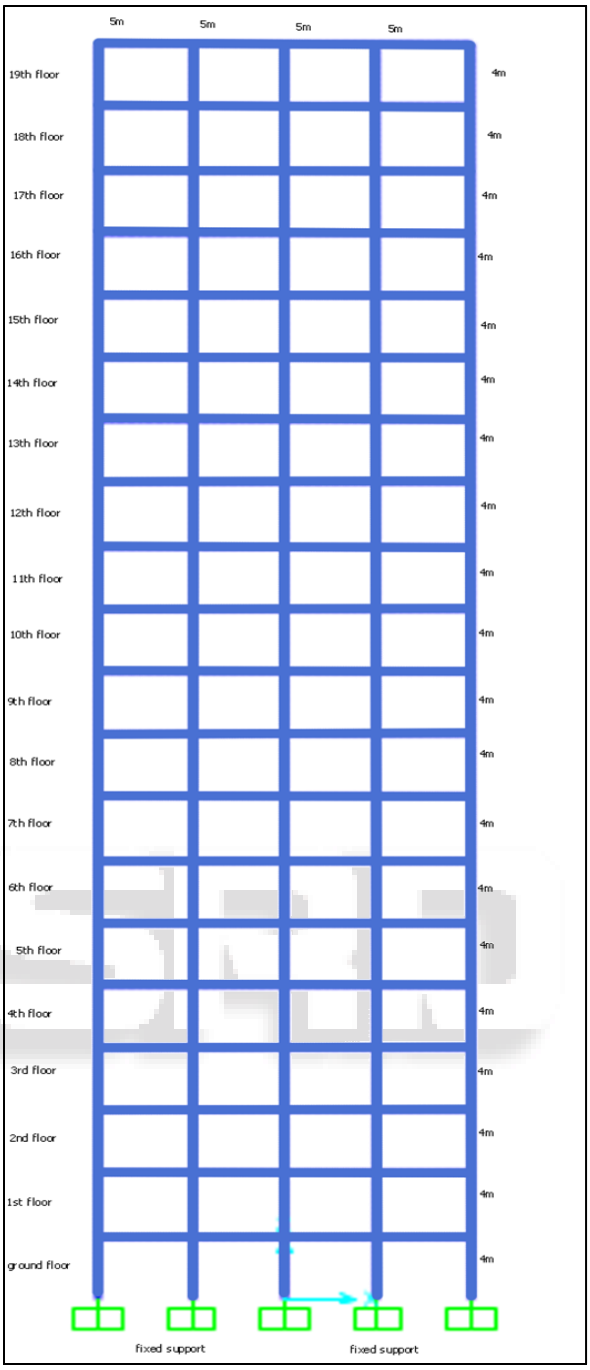


Fig. 4.3: elevation plane of 2d 20 storey structure

for second case of with shear wall all structure is created as above mentioned process first then shear wall is provided at the middle two bays throughout the height of the frame and assigned diaphragm to it and the cut section is defined at the base level of the structure then model is created the elevation plane is shown below.

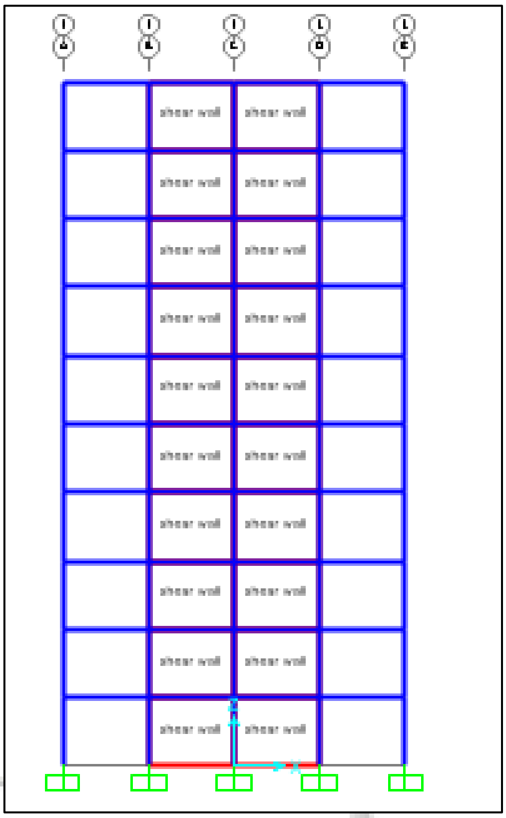


Fig. 4.4: elevation plane of 2d 10 storey building structure with shear wall

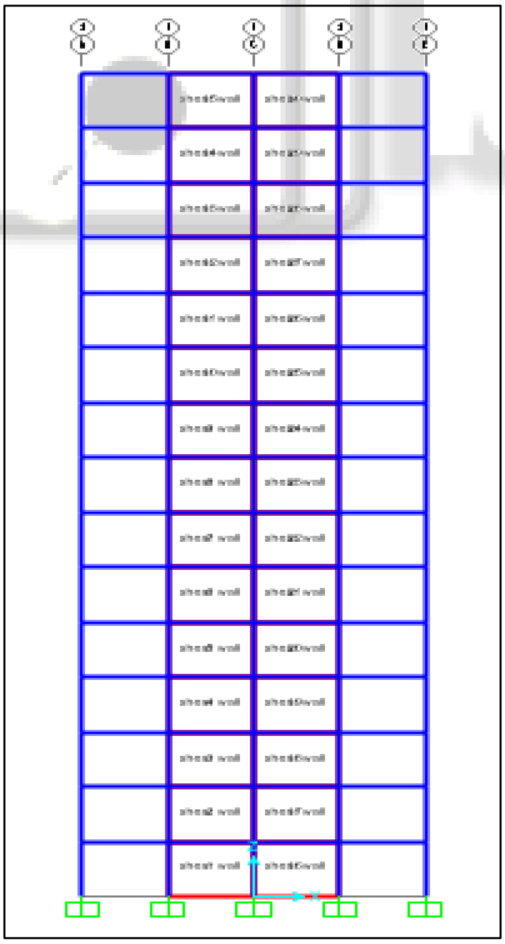


Fig. 4.5: elevation plane of 2d 15 storey building structure with shear wall

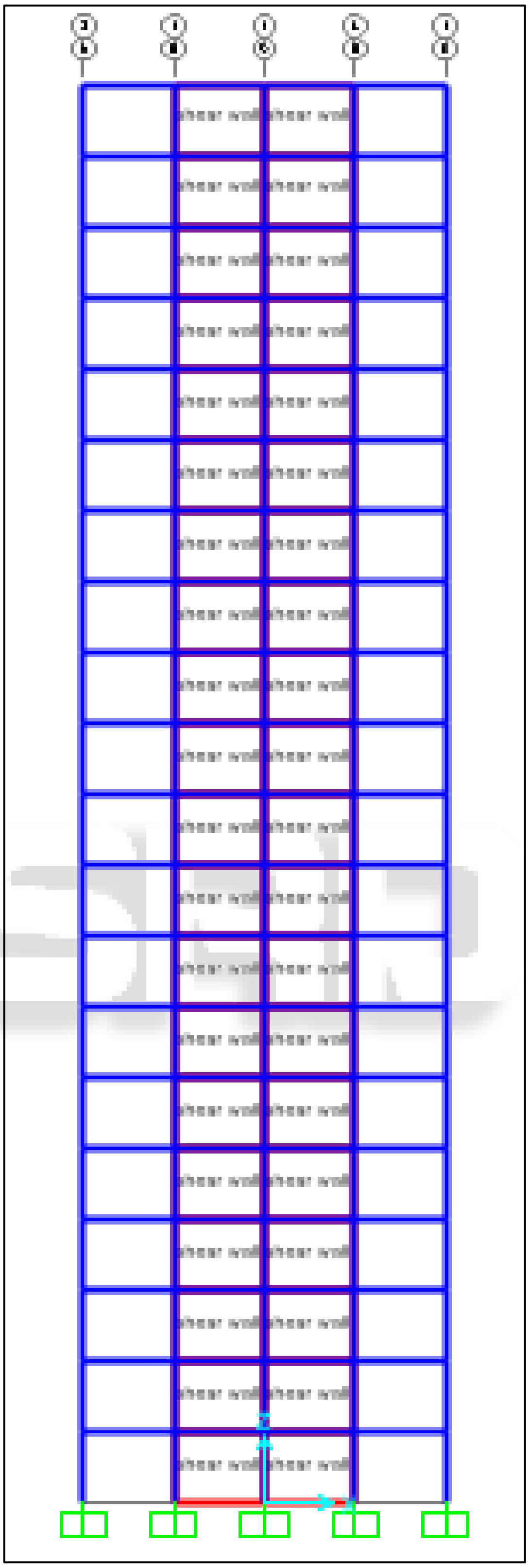
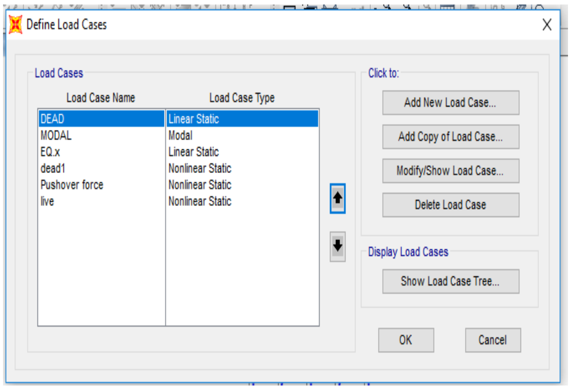


Fig. 4.6: elevation plane of 2d 20 storey building structure with shear wall

V. Analysis of Structure

After setting up all necessary data and assigning them for each members. We will run the analysis where we will set the load cases to act on the model in analysis calculation we will set them as shown below

A. All Load Cases



Then we will run the analysis .the software will take all the necessary information and do computation which is based on finite element analysis

VI. Results and Discussions

In the present study we will see the variation in the pushover curve of 2d 10,15 and 20 storey building structure with and without shear wall .The pushover curve for the 2d 10, 15 and 20 storey building structure with and without shear walls are given below

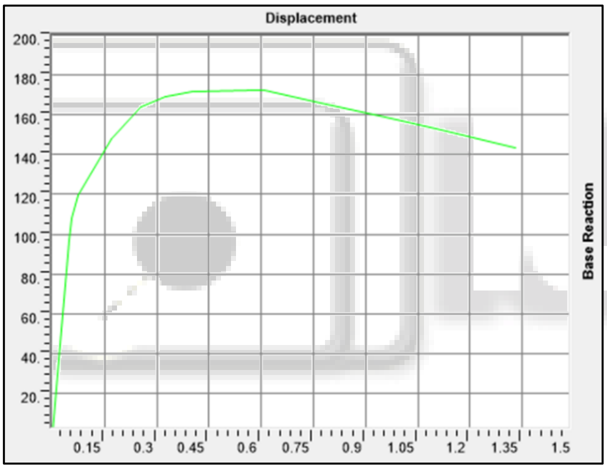


Fig. 6.1: Resultant base shear vs monitored displacement curve for 10 storey RC frame without shear wall

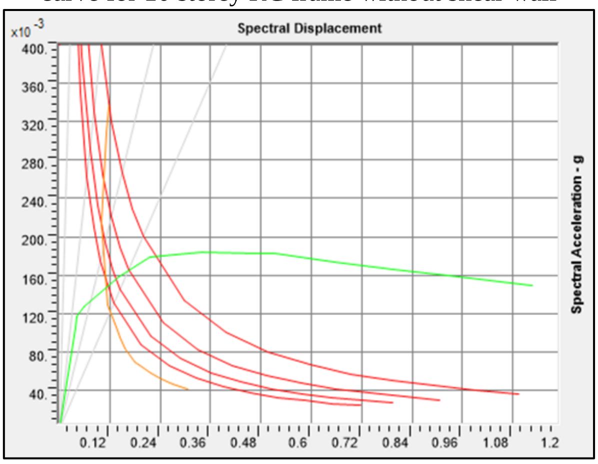


Fig. 6.2: ATC-40 Capacity Spectrum curve for 10 storey RC frame without shear wall

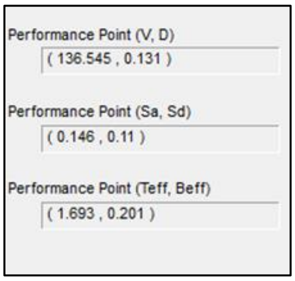


Fig. 6.3: performance point and displacement result in ATC-40 Capacity Spectrum for 10 storey RC frame without shear wall

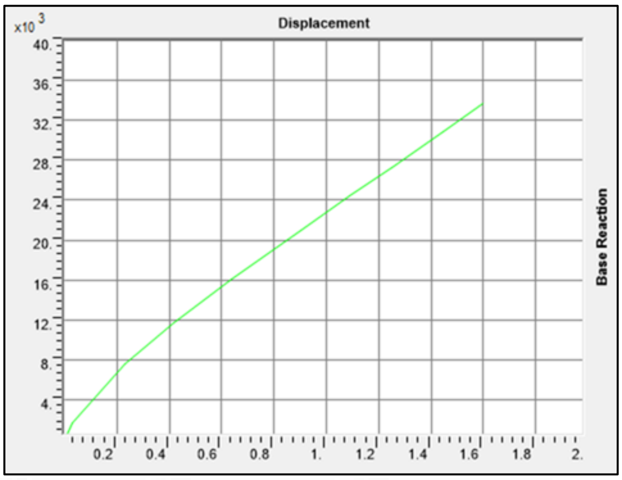


Fig. 6.4: Resultant base shear vs monitored displacement curve for 10 storey RC frame with shear wall

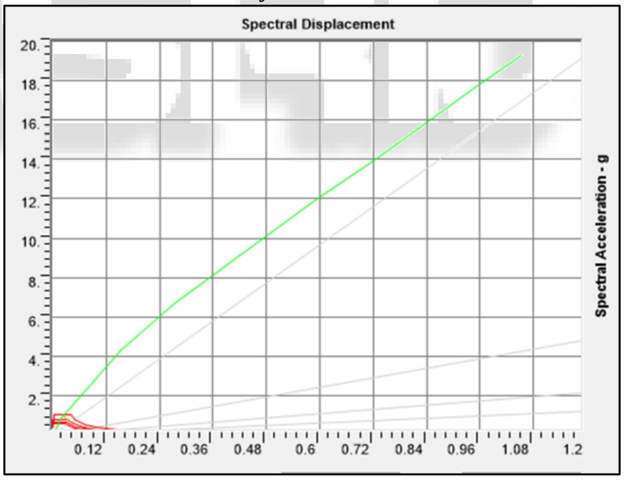


Fig. 6.5: ATC-40 Capacity Spectrum curve for 10 storey RC frame with shear wall

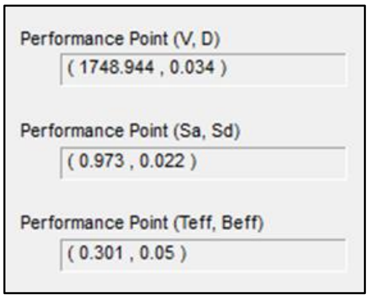


Fig. 6.6: performance point and displacement result in ATC-40 Capacity Spectrum for 10 storey RC frame with shear wall

From the above pushover curve of 10 storey building with and without shear walls it has been observed that at performance point the base shear is136.545 and dsplacement is 0.131 in without shear wall frame while in frame consisting of shear wall it is seen that at performance point base shear is 1748.944 and displacement is 0.034

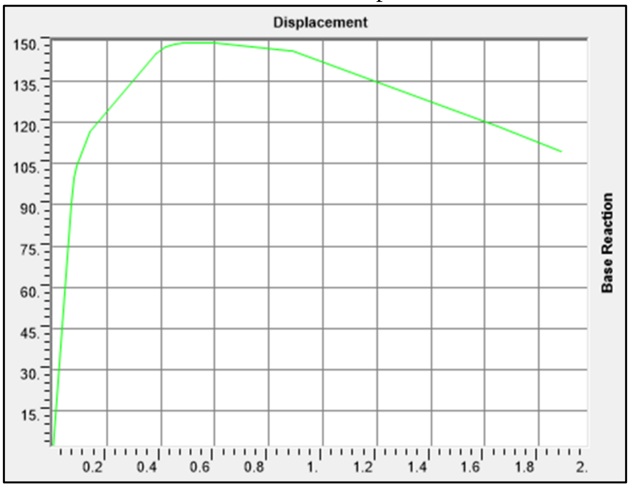


Fig. 6.7: Resultant base shear vs monitored displacement curve for 15 storey RC frame without shear wall

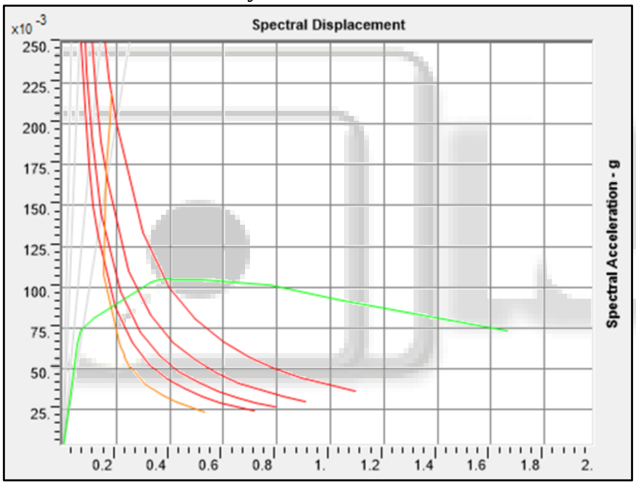


Fig. 6.8: ATC-40 Capacity Spectrum curve for 15 storey RC frame without shear wall

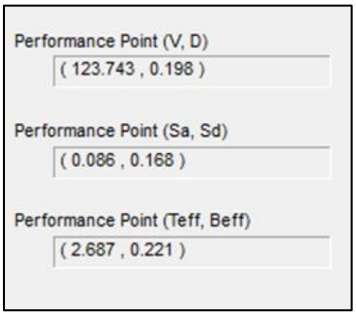


Fig. 6.9: performance point and displacement result in ATC-40 Capacity Spectrum for 15 storey RC frame without shear wall

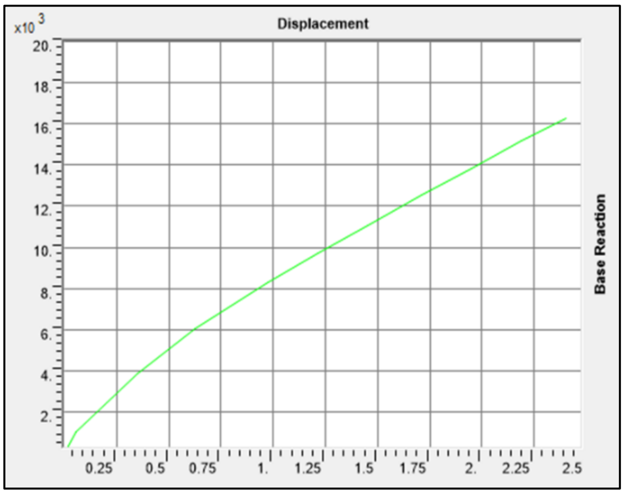


Fig. 6.10: Resultant base shear vs monitored displacement curve for 15 storey RC frame with shear wall

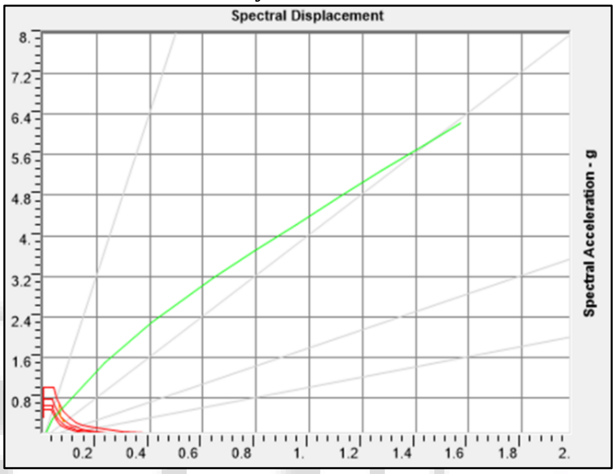


Fig. 6.11: ATC-40 Capacity Spectrum for 15 storey RC frame with shear wall

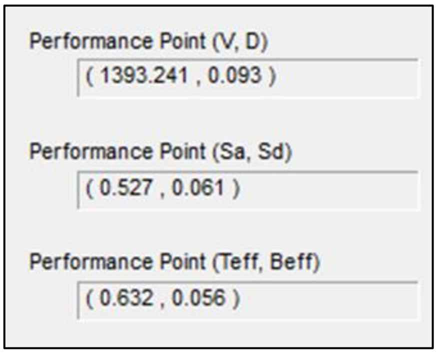


Fig. 6.12: performance point and displacement result in ATC-40 Capacity Spectrum for 15 storey RC frame with shear wall

From the above pushover curve of 10 storey building with and without shear walls it has been observed that at performance point the base shear is123.743 and displacement is 0.198 in without shear wall frame while in frame consisting of shear wall it is seen that at performance point base shear is 1393.241 and displacement is 0.093

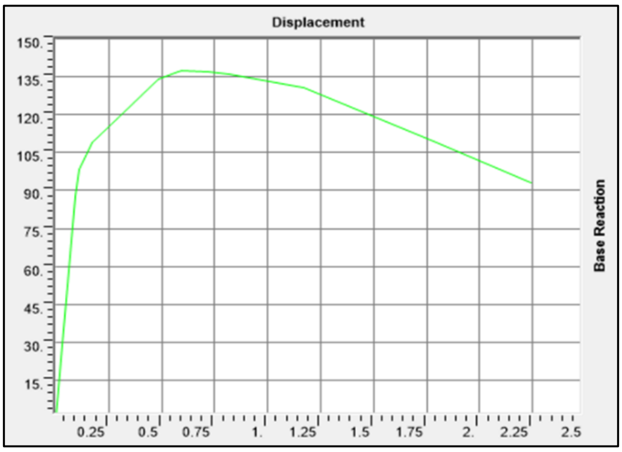


Fig. 6.13: Resultant base shear vs monitored displacement curve for 20 storey RC frame without shear wall

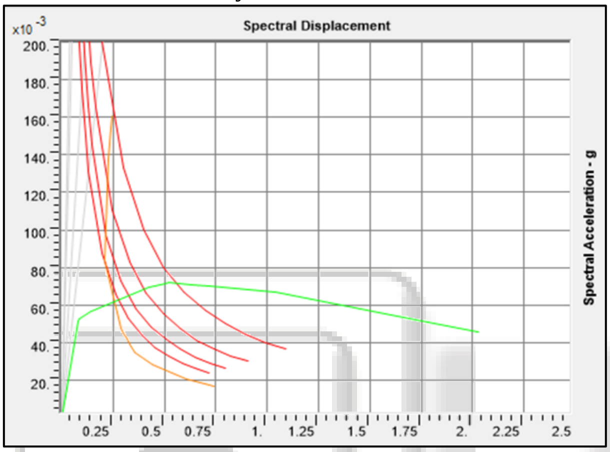
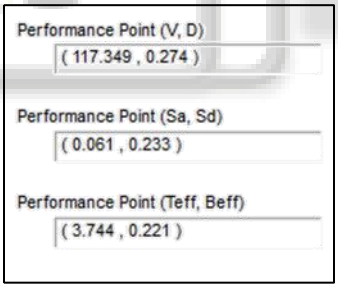


Fig. 6.14: ATC-40 Capacity Spectrum for 20 storey RC frame without shear wall



Performance Point (V, D)
(117.349 , 0.274)

Performance Point (Sa, Sd)
(0.061 , 0.233)

Performance Point (Teff, Beff)
(3.744 , 0.221)

Fig. 6.15: performance point and displacement result in ATC-40 Capacity Spectrum for 20 storey RC frame without shear wall

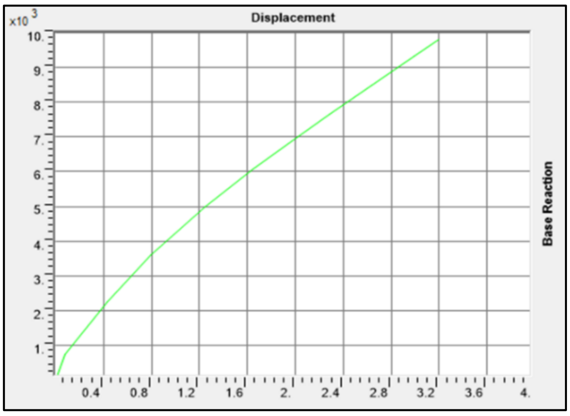


Fig. 6.16: Resultant base shear vs monitored displacement curve for 20 storey RC frame with shear wall

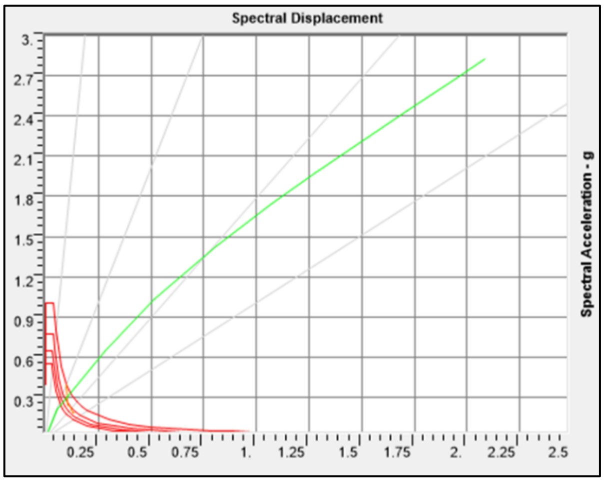
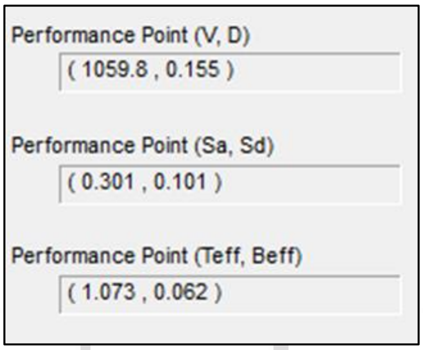


Fig. 6.17: ATC-40 Capacity Spectrum for 20 storey RC frame with shear wall



Performance Point (V, D)
(1059.8 , 0.155)

Performance Point (Sa, Sd)
(0.301 , 0.101)

Performance Point (Teff, Beff)
(1.073 , 0.062)

Fig. 6.18: performance point and displacement result in ATC-40 Capacity Spectrum for 20 storey RC frame with shear wall

From the above pushover curve of 10 storey building with and without shear walls it has been observed that at performance point the base shear is117.349and displacement is 0.274in without shear wall frame while in frame consisting of shear wall it is seen that at performance point base shear is 1059.8 and displacement is 0.155

VII. Conclusion

From the present study it can be concluded and is observed that the performance point of the building structure consisting of shear wall to bear isgreater in every case with that means more base reactions wiith less displacement hence it can be said that the building frames consisting of shear wall are more resistance to earthquake forces

References

[1] Vojko Kilar and Peter Fajfar "Simplified pushover analysis of building structures" Eleventh world conference on earthquake engineering(1998) -1011.
[2] V.S. Tsiggelis, A M Athanatopoulou, I E Avramidis "Spectral pushover versus static and model pushover analysis" 14th world conference on Earthquake Engineering (2008)
[3] A.S. Elnasha "Advanced inelastic static (pushover) analysis for earthquake applications" Structural Engineering and Mechanics, Vol. 12, No. 1 (2001) 51-69
[4] H. Moghaddam and I. Hajirasouliha "An investigation on the accuracy of pushover analysis for estimating the

seismic deformation of braced steel frames" Journal of constructional steel research, 64(4). 343-351.
[5] R. Hasan, L. Xu, D.E. Grierson "Push-over analysis for performance-based seismic design" Computers and Structures 80 (2002) 2483–2493.