Seismic Analysis of Residential Building for Different Zones using Etabs

Mindala Rohini, T. Venkat Das

Abstract: An earthquake occurs in the form of seismic waves due to sudden release of energy and results in ground shaking. During earthquake, seismic waves propagate through the soil which results in structural damage due to movements within the earth's crust. It impacts the behavior of interaction of components like building, foundation, underlying soils and also overall system behavior.When earthquake occurs, the behavior of a building depends on distribution of mass, strength and stiffness. Generally, the buildings are subjected to various types of forces throughout their existence. The forces can be static forces due to dead and live loads and dynamic forces due to earthquake. In this study, the analysis is carried out for seismic response of (G+15)residential building for zone-III and Zone-V regions through response spectrum method and time history method in ETABS. The parameters likestorey displacement, storey drift and storey shear are observed for specified zones.

Index terms: Response Spectrum Method, Storey Displacement, Storey Drift,Storey Shear, Time History Method.

I. INTRODUCTION

Seismic wavescauseground motions much larger on soil surface when compared to rock base. Structures situated on such type of sites results in more damage than the sites which are nearer to rock surface. The human has been fighting with various natural disasters like cyclones, earthquakes, floods, volcanic eruptions etc., which causes enormous losses to life and property. To fight against these disasters, technologies like developing warning system for disaster, adopting prevention measures etc., has improved. It comes suddenly for seconds and causes low, medium and huge loss of life and property depending on the magnitude of the earthquake. It can be controlled but cannot be completely avoided. So, preventing earthquake and reduction strategy is a global concern today. The rivalry headed for new heights are impossible without challenges. When the height of the building increases, the toughness of the structure becomes more significant. With the increase in number of storeys in tall structures, it faces various loading effects with very high loading values due to lateral loads like earthquake forces. These are attaining importance and every designer should deal to provide adequate stability and strength against lateral loads.

In this paper, an analysis is done by using ETABS for (G+ 15)storey RC building under seismic loads for zone III and Zone V regions. Numerous load combinations are observed in accordance with IS 1893 (Part 1):2002. A study is done to carry out dynamic analysis of four different shapes of structure: Rectangular, L-shaped etc. and comparing results for different types of moments, forces and displacements. The values of joint displacement are maximum for L-shaped structure and lowest in rectangular shaped structure[1].A study is done to carry out seismic analysis of multi-storied buildings using ETABS. The different parameters taken are mass irregularity, different building shapes etc. As storey number decreases, torsion irregularity coefficients increases[2].A building with different heights is analyzed for wind and earthquake loads. If lateral systems are provided, the displacement, shear, moment decreases which results in increasing the stiffness of the structure to resist lateral loads [3].

II. RESEARCH SIGNIFICANCE

The objective of this paper is to study the seismic analysis of residential building for Zone-III and Zone-V regions using ETABS. The modeling and analysis can be prepared for RC multi-storey building for various types of zones. With increase in time, population of India is increasing. So, there is a need for more housing and infrastructure facilities. In recent years, people were shifting to urban places due to jobs and for living purposes which results in large population in cities. So, number of structures and buildings required is very high in cities. This increases pressure on agriculture land near cities. The land becomes scarce which results in multi-storey structures in cities. Since the land is limited, there is a need for vertical improvement in the form of tall structures. This results in saving the agriculture land to grow food items. From this, multi-storied buildings are important to be considered.

III. METHODS CONSIDERED

A. Response Spectrum Method

It is linear dynamic analysis. It determines the response in each mode of vibration and overlay the responses in several modes toattain the total response. Response may be in the appearance of deformation, acceleration etc. A graph between maximum response and natural period is called response spectrum.

B. Time History Method

It is nonlinear dynamic analysis. In this method, the building is subjected to accelerations from earthquake records which represent the expected earthquake at the base of the structure. It gives the structural response through and after the time of application of load.

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IV. MODEL DESCRIPTION

The analysis is carried out for proposed building using ETABS. The plan of a residential building is shown in Fig. 1. The elevation of the proposed building can be observed in Fig. 2. The plan consists of ground floor and followed by fifteen upper floors. The total height of building is 51m.

Number of Stories: (G+15)
Grade of Concrete:
Beams, Columns and lift wall = M30
Slabs = M25
Reinforcement:
Longitudinal bars = Fe500
Stirrups ties = Fe250
Live load = 4KN/m^2
Height of each floor: 3.0m
Density of concrete: 25KN/m^3
Thickness of slab: 150mm
Damping: 0.05

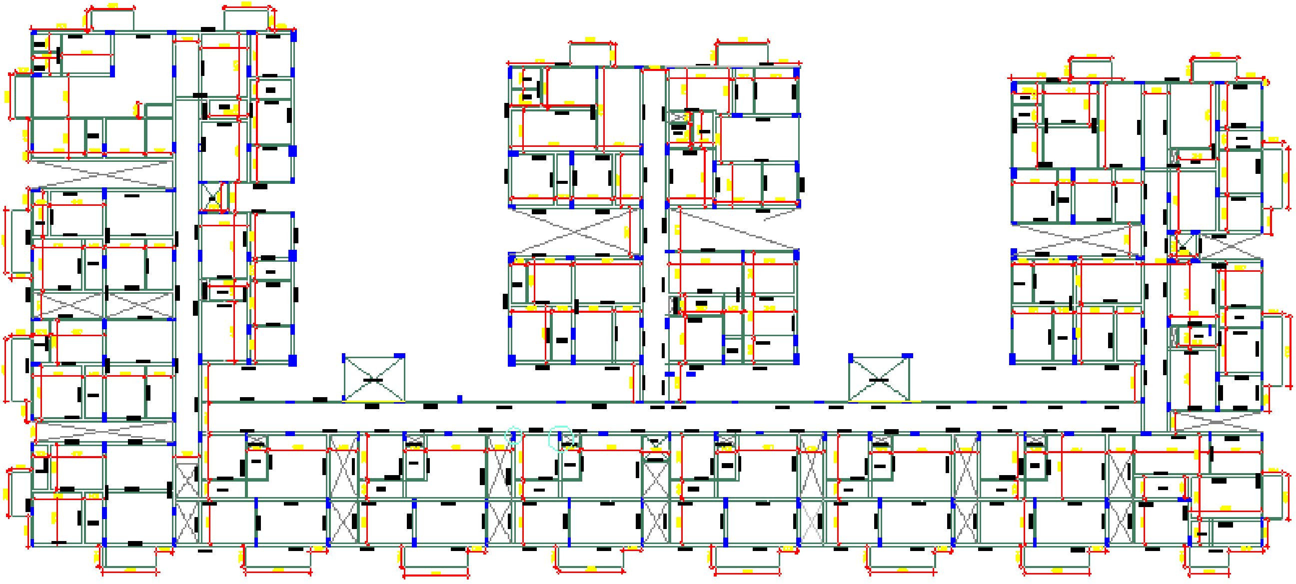

Fig.1: Plan of (G+15) multi-storied building.

Table I: Column sizes

Column	Size	Column	Size
C1	0.6×0.2	C6	0.75×0.2
C2	0.45×0.2	C7	0.75×0.285
C3	0.75×0.45	C8	0.2×0.6
C4	0.2×0.75	C9	0.2×0.45
C5	0.2×0.9	C10	0.9×0.2

Table II: Beam sizes

BEAM	SIZE
B1	0.2×0.375
B2	0.2×0.3
B3	0.15×0.3
B4	0.2×0.45
B5	0.2×0.6

V. SEISMIC CONDITIONS AND PARAMETERS

Table III: Zone –III

CATEGORY	PARAMETER
Zone	3
Zone Factor	0.16
Importance Factor	1
Response Reduction Factor	5

Table IV: Zone –V

CATEGORY	PARAMETER
Zone	5
Zone Factor	0.36
Importance Factor	1
Response Reduction Factor	5

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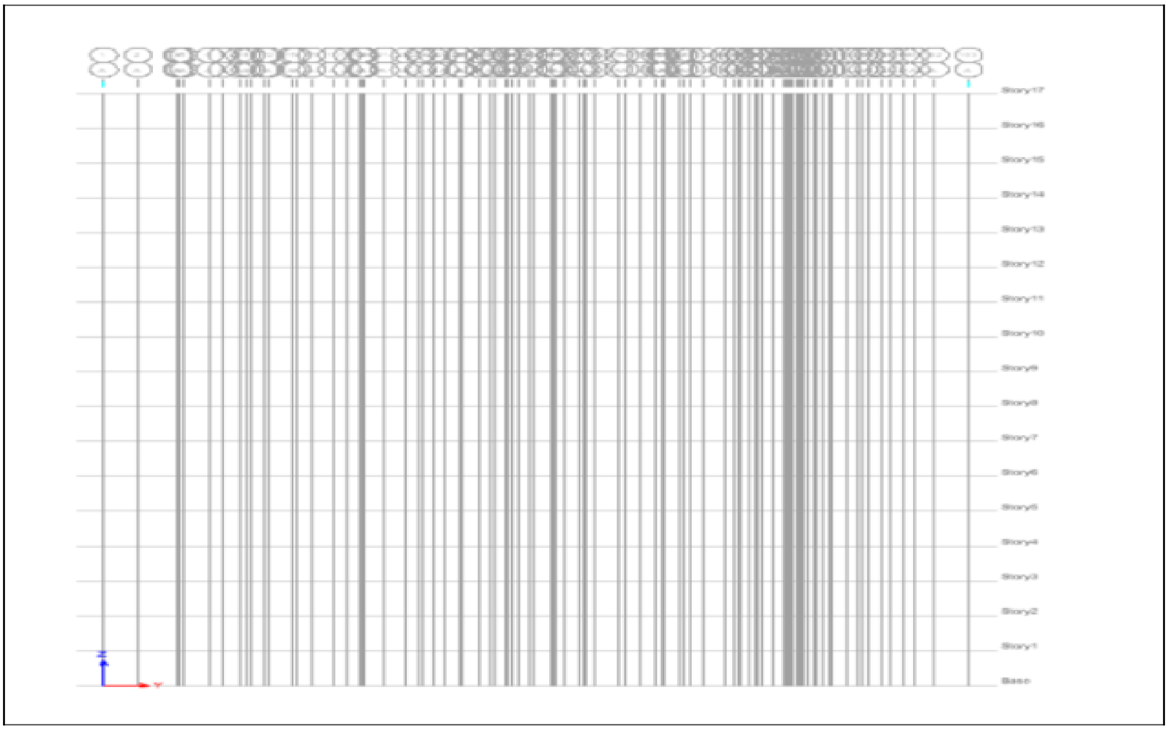

Fig. 2:Elevation of (G+15) multi-storied building in ETABS

Where storey 1 – Ground floor
Storey 2 – Storey 1, and so on
Storey 16 – Storey 15
Storey 17 - Terrace

VI. MODELLING

In this study, analysis of (G+15) residential building for zone III and zone V are carried out for earthquake forces using ETABS.

A. Methods of analysis of structure

The seismic analysis for the buildings which are not resistant to earthquake forces should be carried out. In this, the building is subjected to dynamic analysis as specified by code IS: 1893-2002 (Part I). It can be done either by response spectrum method or time history method.

B. Loads acting on (G+15) multi-storey building

The loads which acts on tall building is different from other buildings like low-rise buildings in several ways like gravity loads from top to bottom on the floors, significance of dynamic effects etc. So, it is important to assess the loads of multi-storied buildings correctly for safe and economical design. Dead loads can be assessed accurately but other loads cannot be assessed. From previous field observations and experience, live loads can be estimated to some extent. It is difficult to predict earthquake load and its estimation depends upon probabilistic approach.

VII. RESULTS

The comparison between response spectrum analysis and time history analysis are done for the parameters like storey displacement, storey drift and storey shear.

A. Storey displacement

Storey displacement is defined as the displacement compared to base of the structure. When seismic force affects the structure, storey displacement is important to be considered. It depends on the height of the structure. For lateral loads, tall structures are more flexible than other structures. The values of displacement at top storey are higher than at bottom storey. Thestoreydisplacement for Zone-III in response spectrum and time history methods isshown in Fig. 3. The storey displacement for Zone-V in response spectrum and time history methods is shown in Fig. 4.

B. Storey Drift

It is defined as the movement of a storey compared to the next storey. Its maximum value should be 0.004 of height of the storey. Generally, its value is maximum at mid stories. Thestorey drifts for Zone –III in response spectrum and time history methods are shown in Fig. 5.The storey drifts for Zone-V in response spectrum and time history methods are shown in Fig. 6.

C. Storey Shear

The seismic force at the base of the building is called base shear. The lateral forces due to earthquake at different floors is called storey shear. Its value is maximum at bottom storey and minimum at top storey.Thestorey shear for Zone –III in response spectrum and time history methods are shown in Fig. 7.The storey drifts for Zone-V in response spectrum and time history methods are shown in Fig. 8.

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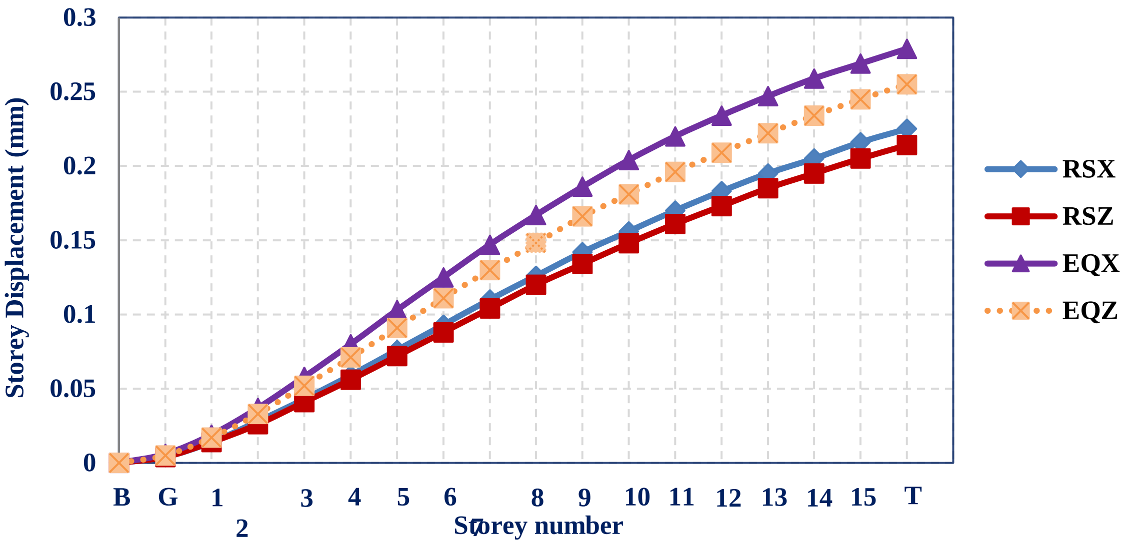

Fig. 3: Storey displacement for Zone-III in Response Spectrum method and Time History method

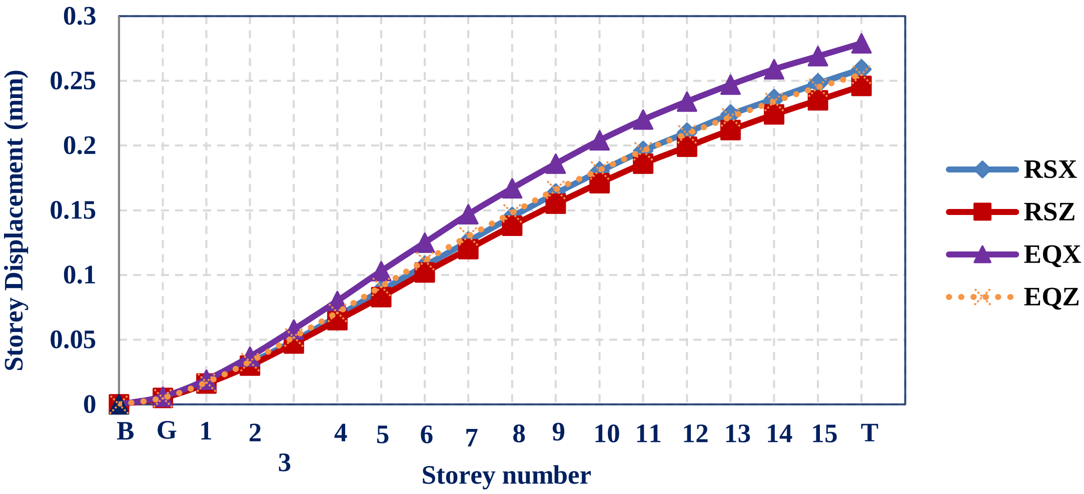

Fig. 4: Storey displacement for Zone-V in Response Spectrum method and Time History method

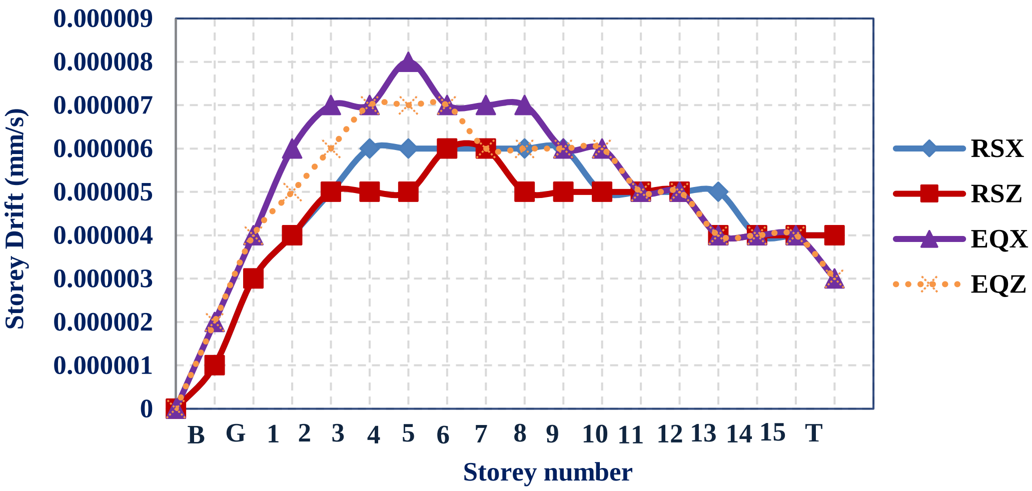

Fig. 5: Storey drift for Zone-III in Response Spectrum method and Time History method

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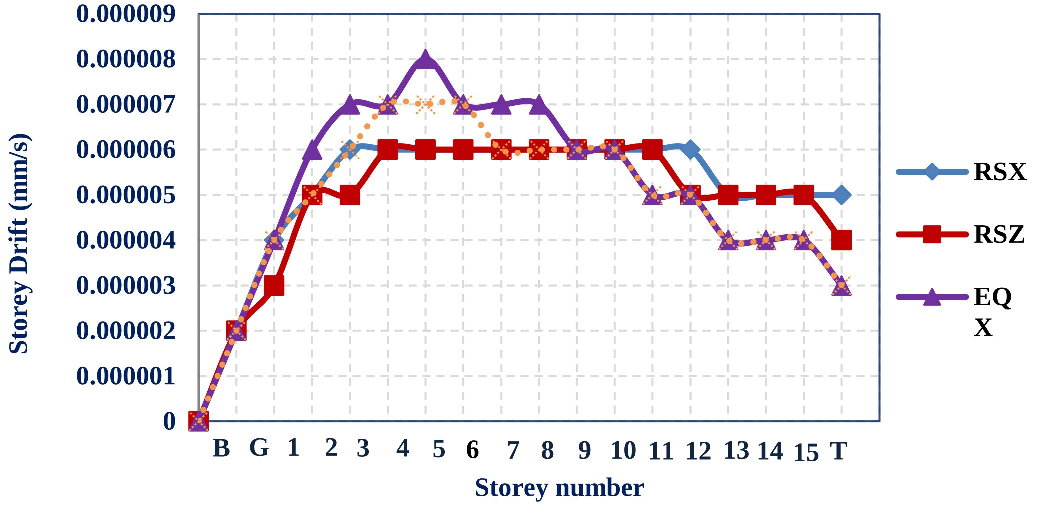

Fig. 6: Storey drift for Zone-V in Response Spectrum method and Time History method

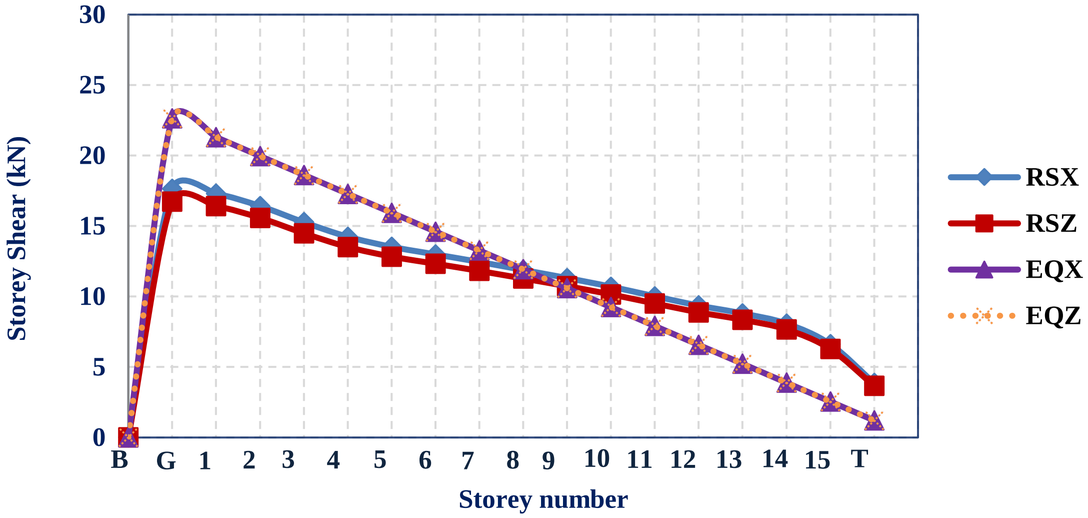

Fig. 7: Storey shear for Zone-III in Response Spectrum method and Time History method

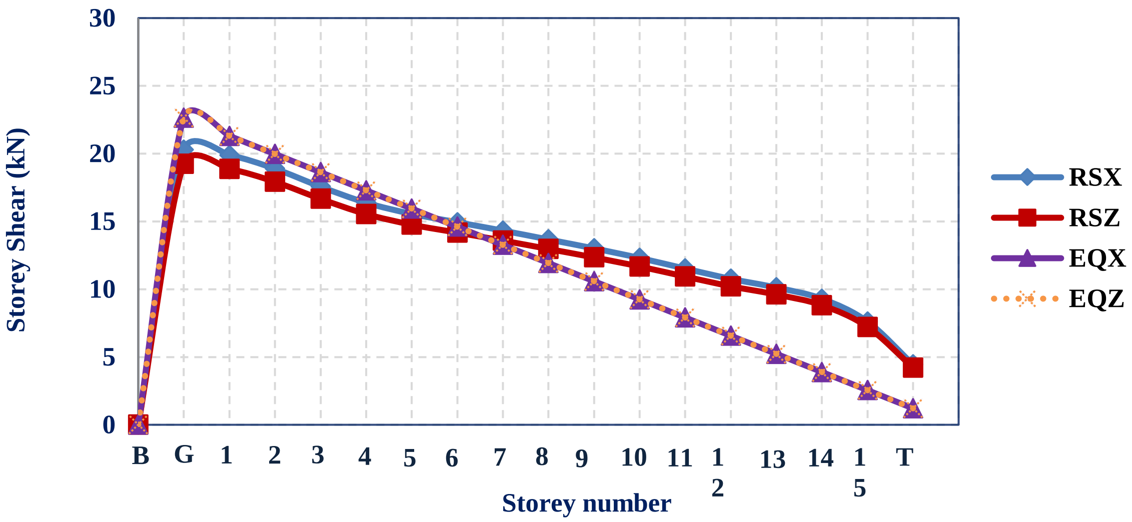

Fig. 8: Storey shear for Zone-V in Response Spectrum method and Time History method

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VIII. CONCLUSIONS

1. In Zone-III and Zone-V, the storey displacement values obtained from both the analysis is evident that the storey displacement is more in top storey. The value of storey displacement in Zone-V is greater than Zone-III.
2. The storey drift is maximum for time history method for EQX load case in 5th storey.
3. For Zone-III, in case of RSZ, the maximum storey drift can be observed in 6th and 7th storey. In case of RSX, it can be observed in 4th to 9th storey.
4. For Zone-V, in case of RSZ, the maximum storey drift can be observed in 4th to 11th storey and for RSX, it can be observed for 3rd to 12th storey.
5. The storey shear in both response spectrum method and time history method is maximum at the ground. Its value is higher for Zone-V than Zone-III.

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