Comparison of Seismic Analysis of Multi Storyed Building Using Shear Wall and Bracing in all Seismic Zones of India

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ABSTRACT - Looking to the past records of earthquakes, there's expansion inside the interest of quake opposing structures which may be fulfilled by giving the shear wall frameworks inside the structure. Furthermore inferable from the principal quakes inside the new taps the codal arrangements updated and executing extra weightage on seismic tremor style of construction. Typically shear divider will be illustrated as the underlying vertical part that is prepared to oppose a blend of shear, second and hub load iatrogenic by parallel burden and gravity load move to the wall from various help. This research work centers on the correlation of seismic investigation of private structures utilizing supporting and shear walls. The investigation of the building is conveyed in each of the four seismic which are Zone II, Zone III, Zone IV and Zone V. This investigation contains understanding the key parts responsible for the construction to perform severely during a seismic tremor, with the goal that they acquire their reasonable attributes for the further quakes. Demonstrating of the design will be done through STAAD professionals. V8i programming. Times pan of the design in bidirectional is reestablished from the programming itself just according to IS 1893(part 1):2002

Keyword- STAAD professional V8i software, displacement, axial force, bending moment, base shear

I. INTRODUCTION

The primary requirement of humans on planet earth is food, clothing and shelter. Prehistoric men and women used to live on trees but steadily they started developing the shelters for protection against natural calamities like rains, cold etc. and also from attack against wild animals. Soon humans rew in knowledge and they started living together, forming communities to ensure additional security and man became a social animal. Now these communities developed and started exploding forming villages which later on transformed into cities and became the commercial centers of a region. Soon within these commercial centers, land for horizontal expansion became extinct. The social animal started expanding vertically constructing multi-storied structures. These multi-storied edifice were susceptible against natural hazards like earthquake which was life threatening for the residents. With the advancement in engineering practices, researchers developed systems which reduced the effects of seismicity on the engineered structures.

The height of a building is comparative and cannot be described in complete terms neither in relation to height nor the number of stories. But, from an engineer's eye, the tall building or multi- storyed building can be described as the one which, in terms of its height, is affected by lateral forces due to wind or earthquake or both to a limit that they play an essential role in the structural design. Tall structures have allure mankind from the rise of civilization. The Egyptian Pyramids, are one of the seven wonders of world, built in 2600 B.C. are among such ancient tall structures. Such structures were made to defend and to display pride of the population in their advancement.

Due to urbanization and increasing population in our country there is a growing demand for high-rise buildings. Earthquake and wind load are the biggest problem for such buildings. Due to its unpredictability and the huge power of destruction, earthquake is the most destructive. Earthquakes do not kill themselves, but there is a huge loss of human life and properties are caused by the destruction of structures. Building construction collapses during earthquake, and is the reason for direct harm of human life. Several researches have been directed to investigate the failure of various types of buildings under various seismic stimuli throughout the world in the last few decades. The recent destruction of high-rise and low-rise buildings in a devastating earthquake proves that the process of such kind of time is needed to develop a county like India. Therefore, seismic behaviour of asymmetric building structures has become the subject of active research across the world. Many discoveries have been made on elastic and unbalanced seismic behaviour of asymmetric systems to know the cause of seismic vulnerability of such structures.

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1.1 Seismic Isolation System

The technique of seismic isolation is now widely used in many parts of the world. A seismic isolation system is typically placed below the foundation of the structure. This isolation device is a flexible system due to which it possesses good energy absorbing capability. On the arrival of earthquake this system partially reflects and partially absorbs some of the earthquake input energy before this energy gets transmitted into the structure. The net effect is a reduction of energy dissipation demand on the structural system, resulting in an increase in its survivability. Some of the seismic isolation devices proposed for dissipation of energy include Elastomeric Bearings, Lead Rubber Bearings, Combined Elastomeric and Sliding Bearings, Sliding Friction Pendulum Systems and Sliding Bearings with Restoring Forces.

1.2 Bracing

The use of a steel setting structure is a possible decision for retrofitting an upheld generous edge for dealt with seismic shows. Steel upholds give required strength and robustness, consume less room, are easy to manage during improvement, can similarly be used as an underlying part and is monetary. Steel upholds are convincing as they take up center point stresses and on account of their solidness, decline evasion alongside the heading of their bearing.

Figure.1 RC building with exterior bracing system

1.3 Shear wall

Shear divider is an upward part that can oppose horizontal powers coordinated along its direction. Shear dividers are primary framework comprising of supported boards, otherwise called Shear Panels. Substantial Shear dividers are far reaching in numerous tremor inclined nations like Canada, Turkey, Romania, Colombia, and Russia.

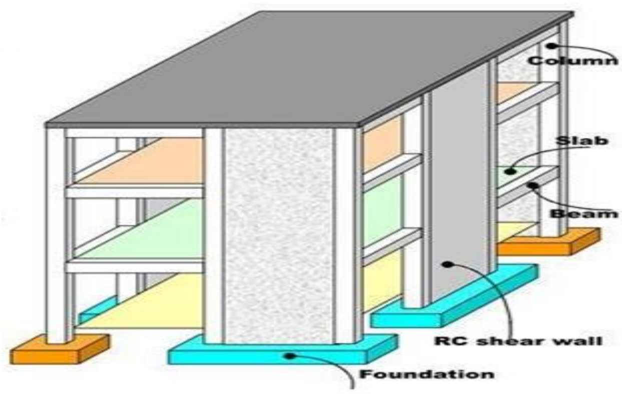

Figure 2. Showing a Shear Wall in Building

1.4 Objectives of Work

The recent study is an attempt towards analysis of the structure during the earthquake.

1. To make a residential building is analyzed, RC outlined structure considering distinctive seismic tremor forces II, III, IV and V by reaction spectra technique and track down the base shear an incentive for various constructions.
2. To carry out the Seismic analysis of RC frame with bare and different position of shear wall and braced frame is carried out using Linear static analysis method as per IS 1893 (Part I): 2002[22] by using STAAD-PRO software.
3. To analysis various sorts of models are thought of and examination of seismic execution is completed.
4. To analyze the models for hub powers, minutes, sidelong removals, max shear power and max twist and graphical and even portrayal of the information is introduced.

II. LITERATURE REVIEW

The research of various authors has been portrayed further.

Montuori R. et al. (2018) intended to research the impact of the supporting plan on the seismic exhibitions of Moment Resisting Frames-Eccentrically Braced Frames (MRF-EBF) double frameworks, planned by two plan draws near: the first is the Theory of Plastic Mechanism Control (TPMC) while the subsequent one depends on Euro code 8 (EC8) plan arrangements In examination with the upset Y-conspire, the ghastly speed increase prompting the breakdown decreases on normal of about 10%, 20% and 35% if there should be an occurrence of K-plot, D plan and V-conspire, individually. Specifically, if there should be an occurrence of constructions planned by TPMC the outcomes acquired show that V-plot structures consistently display the most noticeably awful exhibitions autonomously of the quantity of stories.

M. S. Speicher et al. (2019) Developed a shape memory compound (SMA) based verbalized quadrilateral (AQ) propping framework and tentatively tried for seismic opposing applications. Framework gives both reemerging and damping in an adaptable game plan. Driven by SMA's interesting capacity to recuperate strains of up to around 8% through dispersion less stage change, the foundation of the propping proposed thus is the capacity to change the energy scattering in a returning hysteretic circle using an AQ game plan. The framework kept up with strength, pliability, and reappearing subsequent to being cycled to 2% float, which is a commonplace most extreme in underlying frameworks if non-primary components are to be protected. An insightful contextual analysis exhibited that shape memory compound frameworks will in general circulate the deformity all the more equally over the tallness of the design contrasted with customary frameworks, which is an advantageous seismic presentation trademark. It is

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imagined that, by utilizing a similar fundamental supporting arrangement, a wide scope of power twisting reactions can be available to an architect.

III. METHODOLOGY

The present study is an exertion towards investigation of the design during the tremor. G+14 stories private structure is thought of. To dissect a multi-storeyed RC outlined structure considering distinctive quake forces II, III, IV and V Zone by reaction spectra technique and track down the base shear an incentive for various constructions. Seismic examination of RC outline with exposed and diverse situation of shear divider and supported casing is completed utilizing Linear static investigation strategy according to IS 1893 (Part I): 2002[22] by utilizing STAAD-PRO programming .For this investigation various kinds of models are thought of and correlation of seismic execution is done

The methodology worked out to achieve the mentioned objectives is as follows:

1. Modeling of the selected building in Staad pro. V8i Software.
2. Retrieved time period of structure from the software.
3. Nine models as per the Indian code specification were prepared with II to V Zone.
   (a) Models including Bare frame
   (b) Frames with shear walls
   (c) Frames with bracings.
4. Applied calculated Lateral seismic forces and load combinations as per IS 1893-2002.

Analyzed the models for axial forces, moments, lateral displacements, max shear force and max torsion and graphical and tabular representation of the data is presented.

IV. METHODS OF ANALYSIS

4.1 Equivalent static analysis

All designs against earthquake load should be considered on the dynamic nature of the load. However, for ordinary general structures, analysis by parallel linear analysis method is sufficient. This is allowed in most exercises for regular, low-rise buildings. Dynamic analysis is not included in this system, however, it is estimated to be responsible for the mobilization of the project. Firstly, the design base shear is calculated for the entire building, and then it is circulated with the height of the building. At each floor level, thus obtained, the lateral forces are distributed for different side load resistance elements. (Duggal S.K., 2010).

4.2 Nonlinear Static Analysis-

This is a convenient method in which the analysis is done under permanent vertical load and gradually increases the lateral load to estimate the pattern of distortion and damage to the structure. Nonlinear static investigation is the technique for seismic examination in which the structure is spoken to by the conduct bend, which demonstrates the connection between the base shear compel and the uprooting of the rooftop. It is otherwise called sucker examination.

4.3 Response Spectrum Method

In this method, peak responses of a structure are received directly by earthquake responses during earthquake. The maximum reaction is made for the undamped normal period next and for various splashing esteems, and can be communicated as far as greatest relative speed or most extreme relative uprooting. (Duggal S.K., 2010).

4.4 Seismic Analysis As Per IS: 1893-2002

The accurate seismic analysis of the structure is extremely complex and to deal with this complexity, the number of researches was done in a sophisticated and easy manner to design the earthquake resistant structures with the purpose of dealing with the complex dynamic effects of seismic induced force in the structures. Various methods of seismic analysis have been developed to determine lateral force, which are completely linear elastic to non-linear incompatible analysis.

Many of the analysis techniques are being used in design and incorporated in codes of practices of many countries. However, since in the present study our main focus is on the Indian Standard codal provisions, the method of analysis described in IS 1893 (Part 1): 2002 are presented in this paper.

4.5 Load Combinations

Load combinations that are to be used for Limit state Design of reinforced concrete structure are listed below.

1. 1.5(DL+LL)
2. 1.2(DL+LL±EQ-X)
3. 1.2(DL+LL±EQ-Y)
4. 1.5(DL±EQ-X)
5. 1.5(DL±EQ-Y)
6. 0.9DL±1.5EQ-X
7. 0.9DL±1.5EQ-Y

V. STRUCTURAL MODELLING

5.1Modeling of Building Frame

Metallic braces is the easiest and shear walls simplest way of reducing response of building which gave rise to nine models for the analysis

1. Model in -BFB- Bare frame RCC Building
2. Model in -BX1- Framed building with Bracing at the exterior side along X-direction.
3. Model in -BY2- Framed building with Bracing at the exterior side along Z-direction.

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4. Model in -BXY3- Framed building with Bracing at the exterior side along X and Z-direction.
5. Model in -BEC4- Framed building with Bracing at the exterior side around the corners.
6. Model in -SW1- Framed building with Shear wall at the exterior side along X-direction.
7. Model in -SW2- Framed building with Shear wall at the exterior side along Z-direction.
8. Model in -SW3- Framed building with Shear wall at the exterior side along X and Z-direction.
9. Model in -SW4- Framed building with Shear wall at the exterior side around the corners.

This arrangement of supporting is utilized in light of the fact that offbeat propping frameworks comprise of a connection component that goes through inelastic twisting for energy dispersal. This connection is conceivably pillar component of edge structure which is more reasonable for steel structures and not for supported substantial designs and a shear wall is a primary board that can withstand the effect of parallel powers on it.

Table 1. Specifications of the building

Specifications	Data
Model	G+14
Plan Size	28m x 21m
Plan Size	588m^2
Floor to Floor Height	3m
Total Building Height	45
No. of bays along X direction	6
No. of bays along Z direction	8
Bay Length along X direction	3.5m
Bay Length along Z direction	3.5m
Concrete grade used	M 30
Frame type	SMRF
Column size	0.40m X 0.50m
Beam size	0.30m X 0.40m
Transverse Beams	0.25m X 0.35m
Slab Thickness	0.115m
Inner Wall Thickness	0.115m
Outer wall	0.23m
Density of Brick	20 kN/m3
Grade of Concrete	M-30
Unit Weight of Concrete	25 kN/m3
Grade of Steel	Fe 415
Seismic Zone	Zone II,III,IV,V
Zone Factor corresponding to seismic zone	0.10,0.16,0.24,0.36
Importance Factor	1.0
Live Load	3.5 kN/m3
Floor finish	1 kN/m3
Depth of Foundation	2.5 m
Soil Type	Medium Soil
Damping Ratio	5%
Size of thickness of shear wall	0.2 m
Section for steel bracing	ISA 110 X 110 X 10mm

5.2 Modeling of Braced Frame

For supports point area ISA 60 X 40 X 6 is utilized. There are four preliminary areas in the structure where supports are set and investigated for their impact on sidelong solidness. Supports are demonstrated as pivotal power individuals having stuck end associations. Bracings are of X-type demonstrated all through the stature of the structure. The four areas are as per the following:

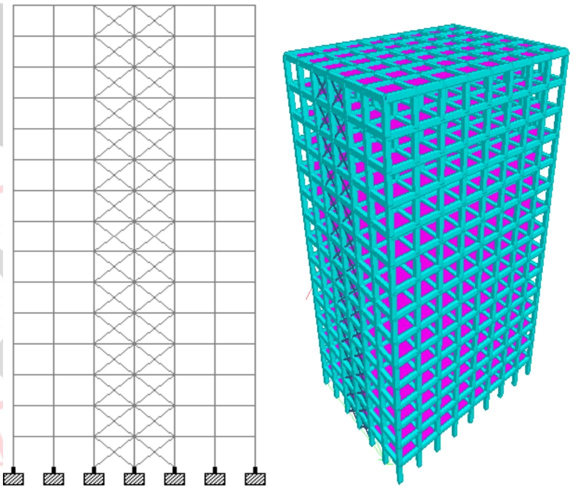

Figure 3. Framed building with Bracing at the exterior side along X-direction

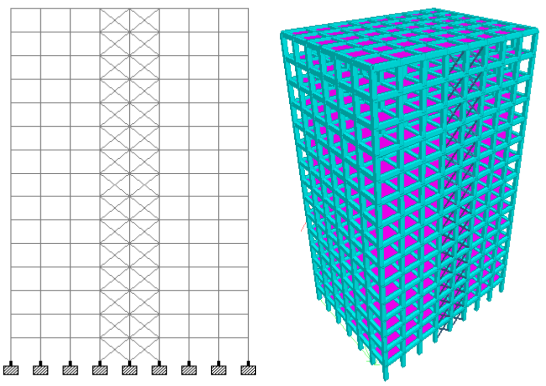

Figure 4. Framed building with Bracing at the exterior side along z-direction.

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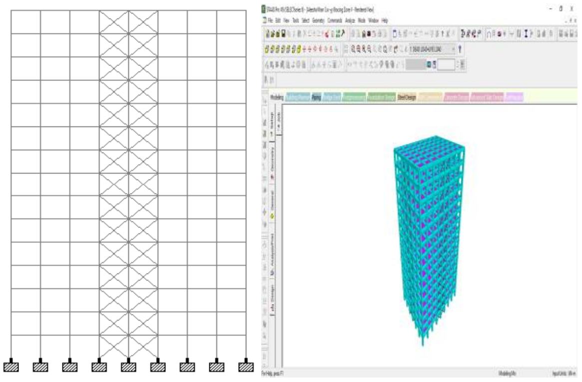

Figure 5. Framed building with Bracing at the exterior side along X and z-direction.

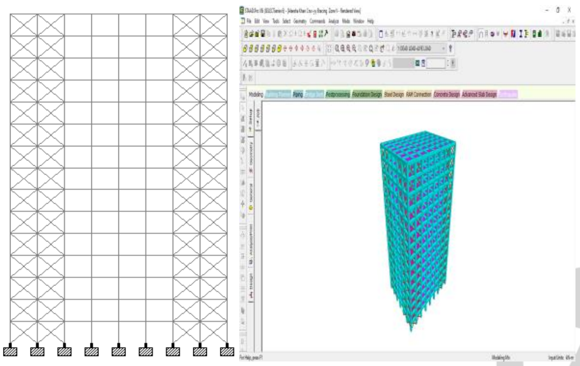

Figure 6. Framed building with Bracing at the exterior side around the corners.

5.3 Modeling of Shear Wall Frame

Shear Wall considered is of 250mm thickness, and put along the whole stature of the construction. Shear divider has been demonstrated as rectangular segment by expanding width to 3.5m i.e, the separating between two segments. The shear walls are placed in the exact locations as that of bracings, and the analysis is done. The four locations are as follows:

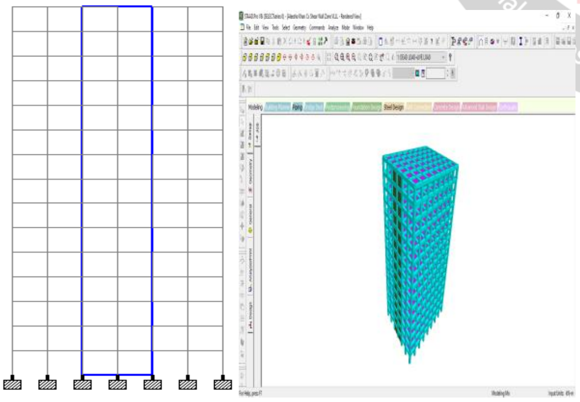

Figure 7. Framed building with Shear wall at the exterior side along X-direction.

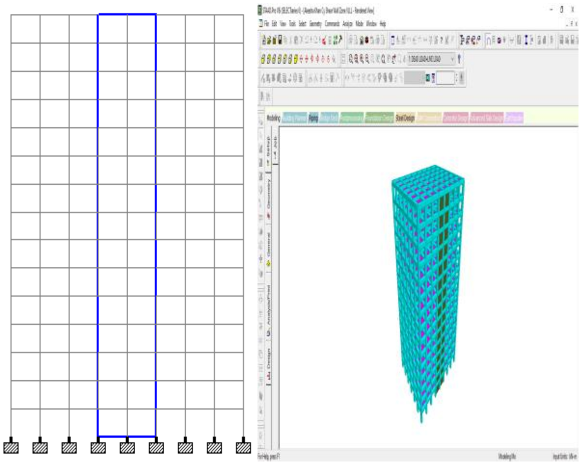

Figure 8. Framed building with Shear wall at the exterior side along Z-direction.

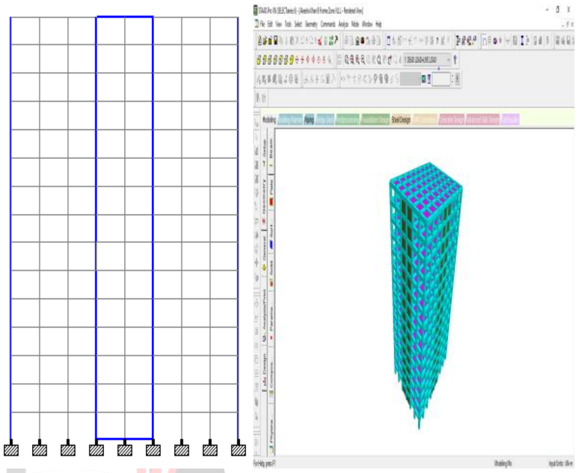

Figure 9. Framed building with Shear wall at the exterior side along X and Z-direction.

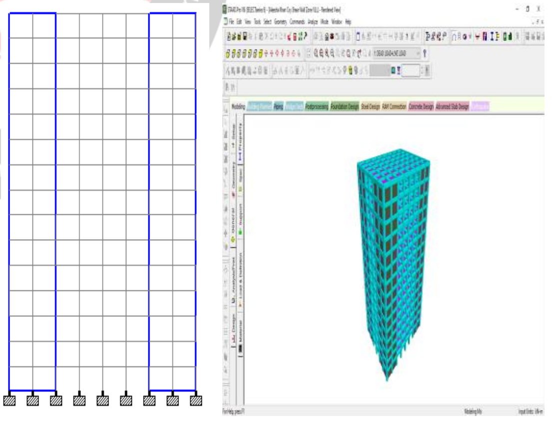

Figure 10. Framed building with Shear wall at the exterior side around the corners

VI. RESULTS

The result is based on the responses of the bare frame model and the changes in the responses after using bracings and shear wall. The results include changes in time periods for axial forces, moments, lateral displacements, max shear force and max torsion for along X and Z direction considered individually for different earthquake intensities II, III, IV and V by response spectra method.

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6.1 Base Shear Calculations

Load and base shear calculation has been done as per IS 1893-2002. The base shear is determined and circulated all through the tallness at each floor of the structure.

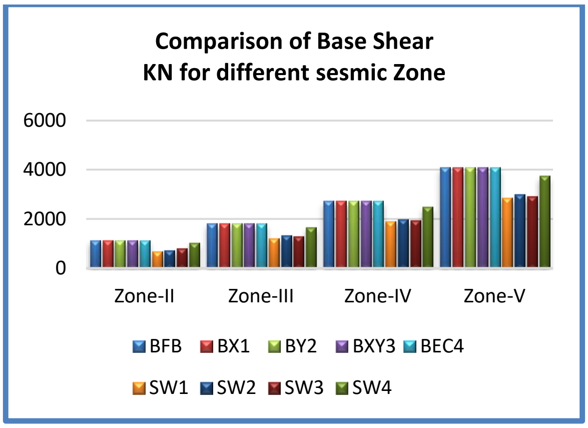

Figure-11: Comparison of Base Shear

Table. 2 Base Shear Calculations for Zone- II, III, IV & V

Zone	Model Type	Total Mass KN	Base Shear in X- dir KN
II	BFB	51331.76	1140.42
	BX1	51289.17	1139.47
	BY2	51331.76	1140.42
	BXY3	51331.76	1140.42
	BEC4	51289.17	1139.47
	SW1	35518.14	693.52
	SW2	37518.18	733.52
	SW3	36557.55	812.19
	SW4	46864.05	1041.16
III	BFB	51331.76	1824.67
	BX1	51289.17	1823.16
	BY2	51331.76	1824.67
	BXY3	51331.76	1824.67
	BEC4	51289.17	1823.16
	SW1	35518.14	1213.64
	SW2	37518.18	1333.64
	SW3	36557.55	1299.5
	SW4	46864.05	1665.86
	BFB	51331.76	1824.67
	BX1	51289.17	1823.16
IV	BFB	51331.76	2737.01
	BX1	51289.17	2734.74
	BY2	51331.76	2737.01
	BXY3	51331.76	2737.01
	BEC4	51289.17	2734.74
	SW1	35518.14	1909.25
	SW2	37518.18	2000.46
	SW3	36557.55	1949.25
	SW4	46864.05	2498.79
	BFB	51331.76	4105.51
V	BX1	51289.17	4102.11
	BY2	51331.76	4105.51
	BXY3	51331.76	4105.51
	BEC4	51289.17	4102.11
	SW1	35518.14	2853.87
	SW2	37518.18	3000.69
	SW3	36557.55	2923.87
	SW4	46864.05	3748.19

6.2 Maximum Displacements

The maximum lateral displacement for structures are presented in Table – 3

Zone	Soil Type	Model Type	Max Delf. mm in Z- dir
II	Medium	BFB	282.907
		BX1	218.138
		BY2	208.318
		BXY3	143.817
		BEC4	147.543
		SW1	102.435
		SW2	92.145
		SW3	49.153
		SW4	52.965
III	Medium	BFB	356.139
		BX1	235.978
		BY2	229.864
		BXY3	223.845
		BEC4	215.134
		SW1	181.754
		SW2	132.765
		SW3	89.346
		SW4	78.165
		BFB	356.139
		BX1	235.978
IV	Medium	BFB	476.985
		BX1	381.289
		BY2	343.876
		BXY3	310.652
		BEC4	279.432
		SW1	386.534
		SW2	332.125
		SW3	298.125
		SW4	289.214
V	Medium	BFB	502.697
		BX1	381.289
		BY2	385.567
		BXY3	345.765
		BEC4	312.765
		SW1	476.876
		SW2	434.765
		SW3	3.75.674
		SW4	311.765

Table-3: Maximum lateral displacement for Zone- II, III, IV &V

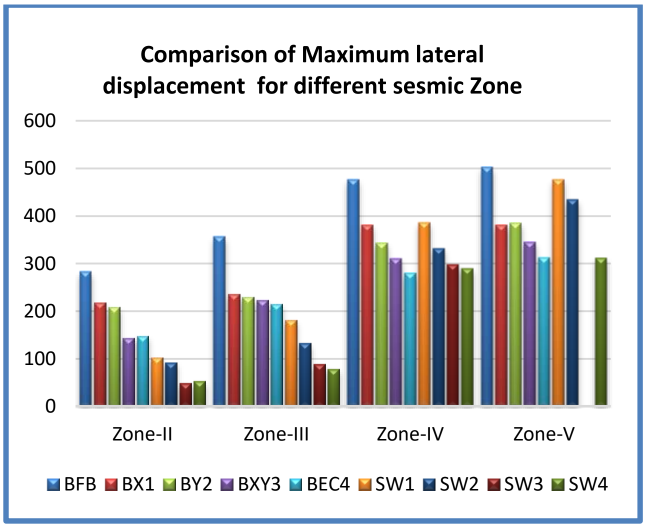

Figure 12: Comparison of Maximum lateral displacement

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VII. CONCLUSIONS

In this study, the analysis of multistoried buildings are done by STAAD PRO software using response spectrum analysis and we have got the following conclusions.

1. The area of shear-wall and support part has huge impact on the seismic reaction than the plane casing.
2. Shear wall development will give enormous solidness to the structure by decreasing the harm to the design.
3. Shear wall components are a lot of proficient in diminishing sidelong relocation of edge as float and flat diversion actuated in shear divider outline are significantly less than that instigated in supported edge and plane edge.
4. The area of shear- wall (SW4) is ideal as they are viable in decreasing activities actuated in outline with less even diversion and float.
5. Shear wall development will give huge firmness to the structure by decreasing the harm to the construction.
6. The idea of utilizing steel supporting is one of the favorable ideas which can be utilized to fortify or retrofit the current designs.
7. Steel bracings can be utilized as an option in contrast to the next reinforcing or retrofitting methods accessible as the all-out weight on the current structure won't change essentially.
8. Steel bracings lessen flexure and shear requests on shafts and sections and move the sidelong loads through hub load system.
9. The sidelong relocations of the structure contemplated are diminished by the utilization of X kind of supporting frameworks.
10. The structure outlines with X supporting framework will have least conceivable bowing minutes in contrast with different sorts of propping frameworks.
11. Using steel bracings the absolute load on the current structure won't change fundamentally.
12. The parallel uprooting of the structure is decreased by 35% to 45 % by the utilization of X Type steel supporting framework, and X propping type diminished most extreme removal.

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