Design of High Rise Buildings with Different Structural Framing Systems Using Shear Wall in Seismic Zones

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ABSTRACT

Looking to the preceding statistics of earthquakes, there might also be expansion indoors the hobby of quake opposing constructions which can additionally be fulfilled with the resource of giving the shear wall frameworks indoors the structure. Furthermore inferable from the foremost quakes interior the new taps the codal preparations up to date and executing increased weightage on seismic tremor trend of construction. Typically shear divider will be illustrated as the underlying vertical area that is equipped to oppose a combo of shear, 2nd and hub load iatrogenic by means of the usage of parallel burden and gravity load pass to the wall from a range help. This search for work services on the correlation of seismic investigation of personal constructions making use of supporting and shear walls. The investigation of the developing is conveyed in each and every of the four seismic which are Zone III and Zone IV. This investigation consists of draw close the key elements to blame for the improvement to function severely in the direction of a seismic tremor, with the intention that they accumulate their smart attributes for the in addition quakes. Demonstrating of the design will be carried out by STAAD professionals. V8i programming. Times pan of the diagram in bidirectional is reestablished from the programming itself truly in accordance to IS 1893(part 1):2002

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

1. 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.

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.

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 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.

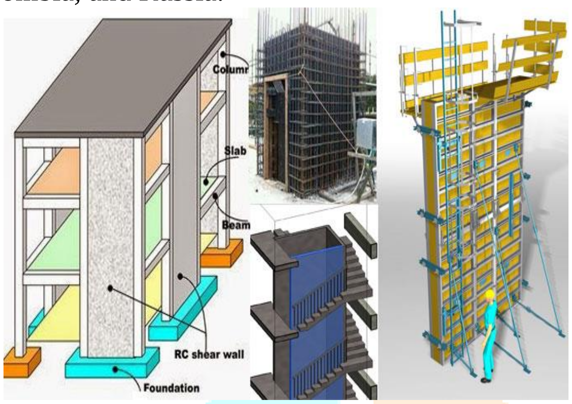

Figure 1. Showing a Shear Wall in Building

1.3 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 III and IV 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 is carried out using Linear static analysis method as per IS 1893 (Part I): 2002 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.

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

Vishal Yadav and Sandeep Singla (2019)

From the beginning of life on Earth it is evident that natural catastrophes cause a lot of destruction to human life and property. One of the major natural phenomena is the Earthquake. Sudden shaking of ground is a difficult challenge to any structure standing on earth. Due to Improper design of the structure without seismic resistance many buildings have collapsed and lives have lost during earthquakes. Different shapes & materials of buildings have been used to achieve the strength required to withstand the earthquake. In modern era, lots of seismic force resisting techniques are being used to make a structure/building earthquake resistant. These techniques include introducing Shear walls, Bracings, base isolation, column jacketing etc. to enhance the structure. In this paper, I present a Comparative analysis of earthquake resisting techniques on a G+10 story building with the help of different types of Shear walls & Bracings, using softwarehe examination is done between: an un-Resisting structure, equal shear dividers, L-formed shear divider, inclining bracings, X-molded bracings and V-formed bracings. The utilization of shear dividers and bracings assists with fortifying then construction to make it more Earthquake safe. The examination in done on a G+10 working for seismic zone III according to IS 1893:2002 codal arrangements.

3. 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 III and IV 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 wall 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 III and IV Zone.
   (a) Models including Bare frame
   (b) Frames with shear walls
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 graphical and tabular representation of the data is presented.

4. 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

5. STRUCTURAL MODELLING

5.1Modeling of Building Frame

Shear walls simplest way of reducing response of building which gave rise to nine models for the analysis

1. Model in -BFM- Bare frame Model Building
2. Model in -SW1- Framed building with Shear wall at the exterior side along X-direction.
3. Model in -SW2- Framed building with Shear wall at the exterior side along Z-direction.
4. Model in -SW3- Framed building with Shear wall at the exterior side along X and Z-direction.
5. 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 2. 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 III and IV
Zone Factor corresponding to seismic zone	0.16 and 0.24
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

5.2 Modeling of Bare Frame

The isometric 3D view and plan of the building model is shown as figure. The support condition is considered as fully fixed

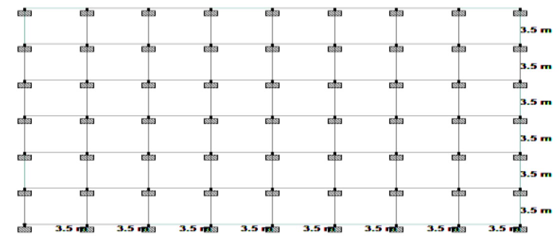

Figure 3. Plan of the building

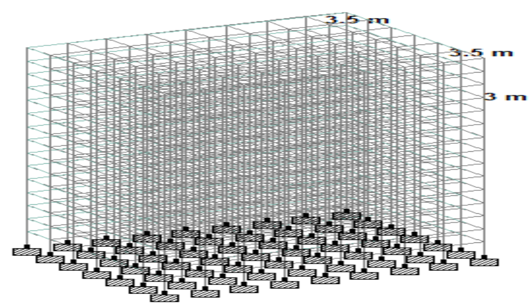

Figure 4. Model of the building

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:

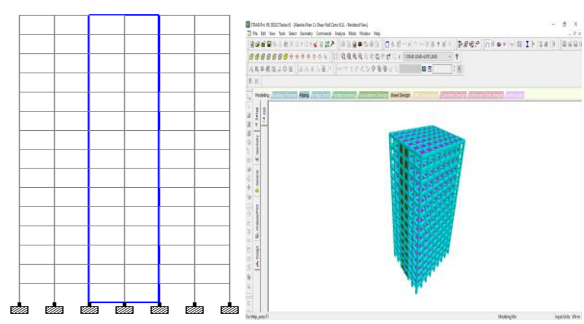

Figure 5. Framed building with Shear wall at the exterior side along X-direction. Zone- III & IV

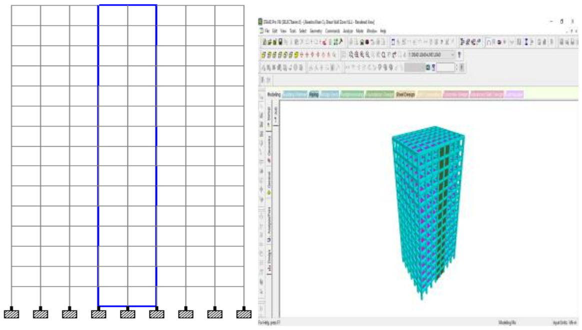

Figure 6. Framed building with Shear wall at the exterior side along Z-direction, Zone- III & IV

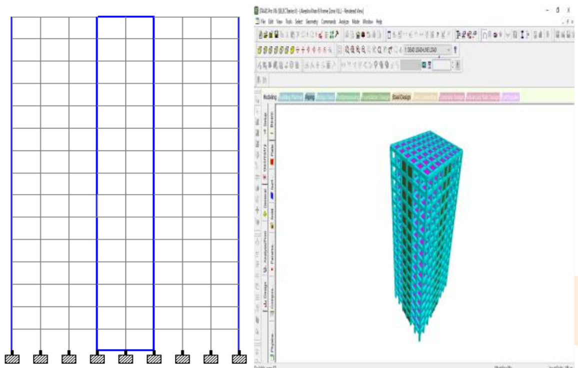

Figure 7. Framed building with Shear wall at the exterior side along X and Z-direction, Zone- III & IV

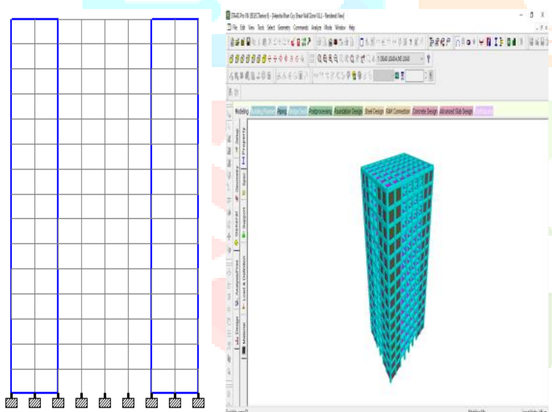

Figure 8. Framed building with Shear wall at the exterior side around the corners, Zone- III & IV

6. 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 III and IV 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.

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

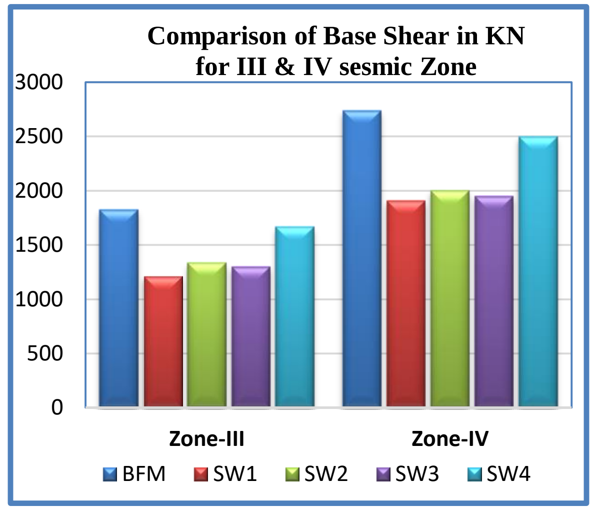

Figure-9: Comparison of Base Shear

6.2 Maximum Displacements

The maximum lateral displacement for structures are presented in Table 3

Table-3: Maximum lateral displacement for Zone- IV and IV

Zone	Model Type	Total Mass KN	Base Shear in X- dir KN
III	BFB	51331.76	1824.67
	SW1	35518.14	1213.64
	SW2	37518.18	1333.64
	SW3	36557.55	1299.5
	SW4	46864.05	1665.86
IV	BFB	51331.76	1824.67
	SW1	35518.14	1909.25
	SW2	37518.18	2000.46
	SW3	36557.55	1949.25
	SW4	46864.05	2498.79

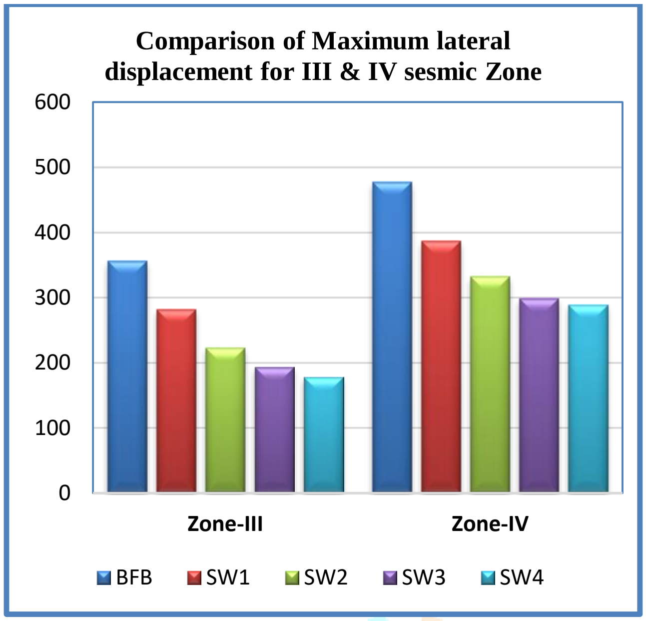

Figure 10: Comparison of Maximum lateral displacement

6.3 Maximum Axial Force on columns

Table-4: Maximum Axial Force for Zone-III abd IV

Zone	Soil Type	Model Type	Max. Axial Force KN-m
III	Medium	BFB	3662.431
		SW1	5141.555
		SW2	3446.125
		SW3	3009.234
		SW4	2703.727
IV	Medium	BFB	4465.085
		SW1	6211.149
		SW2	3453.888
		SW3	3016.997
		SW4	2830.390

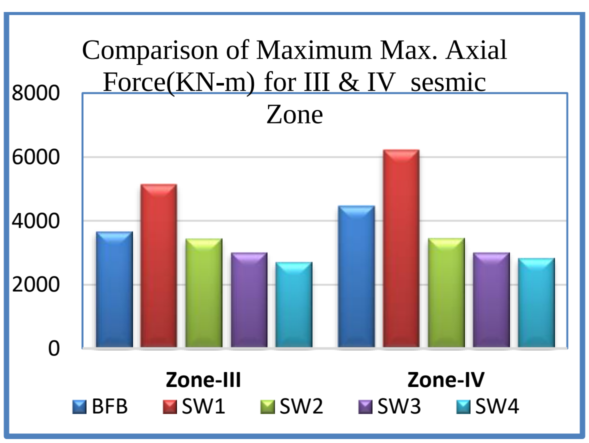

Figure 5.11: Comparison of Maximum. Axial Force

7. 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 shear wall supporting is one of the favorable ideas which can be utilized to.

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