Seismic Analysis of a Regular High-Rise Structure Subjected to Various Load Resisting Systems

Avinash Kumar Sharma[1], Rahul Krishna K. R[2], Ankush Kumar Jain[3]

[1]M. Tech Student of Structural Engineering, Poornima University, Jaipur
[2] MTech Student of Structural Engineering, Poornima University, Jaipur
[3]Assistant Professor, Structural Engineering Department, Poornima University, Jaipur

---***---

Abstract - *Since the beginning, high-rise structures have been the architectural expression of visions, supremacy and monetary affluence. The contest for taller, slender and more efficient high-rises lingers however, with the necessity for even improved structural systems to reach new heights. Lateral forces consisting wind & earthquake loads plays a significant role in the design of structure situated in high seismic zones. In this paper, the eminence is given on the structure with two different load resisting systems. The results are obtained in terms of shear force, bending moment, node displacement, support reactions & axial force by using STAAD.Pro V8i software. Two different types of structural system used are Shear wall & Bracing system.*

Key Words: Seismic performance, Shear wall, X type bracing system, Equivalent static analysis & STAAD.Pro etc.

1.INTRODUCTION

A structure is endangered by a large number of different loads. They can be static or dynamic, come from exterior or interior of the structure. Simple classification of them may be based on its direction; vertically or horizontally. Vertical loads, also known as gravity loads, generally consist of self-weight, live load and snow loads. Horizontal, or lateral loads, may occur in the form of wind load, tilt and seismic responses. In all cases, irrespective of the direction of the loads, the building's key job is to transfer these loads to the ground. On the way, down, different set-ups in the form of instability or breakage can befall in parts. Where exactly these instabilities occur depends a lot on the selected structural system.

1.1 Structural systems

Two types of structural system used in the research work are

1. Shear walls - Specially designed reinforced concrete walls parallel to the directions of load are used to resist a large part of the lateral loads caused by wind or earthquakes by acting as deep cantilever beams fixed at foundation. These elements are called as shear walls.
2. Braced frames - A braced frame attempts to improve upon the efficiency of pure rigid frame action by providing a balance between shear racking and bending. This is achieved by adding truss members, such as diagonals, between the floor systems. The shear is now primarily absorbed by the diagonals and not by the girders. The diagonals carry the lateral forces directly in predominantly axial action, providing for nearly pure cantilever behavior. All members are subject to axial loads only, thereby creating an efficient structural system

The performance of both the structural systems are analyzed & compared against bare frame model to identify the most efficient structural system in terms of various strength & stiffness parameters.

1.2 DATA CONSIDERED

For the analytical purpose a twelve storied (G+11) high-rise regular RCC Structure with 5 bays of 3.2m along both x & z direction was selected. The storey height of ground floor was taken as 3.5m while all other storeys were designed for 3m. The structure was assumed to be situated in seismic zone v with zone factor 0.36 & importance factor on sub-soil type 2 (medium).

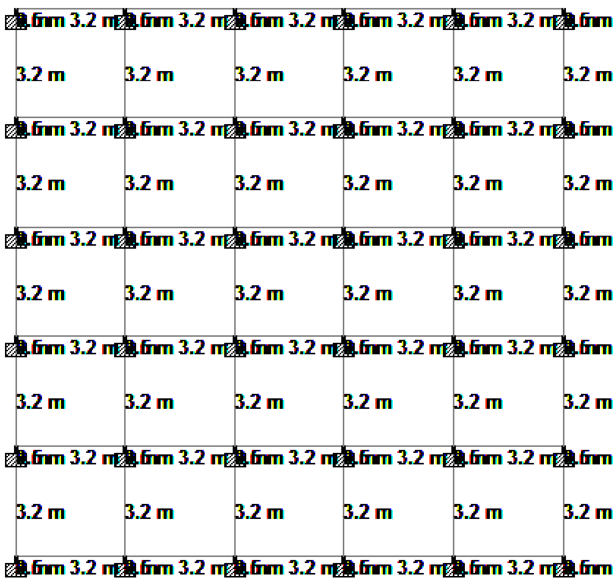

Fig -1: Plan of Proposed Frame

Type of Structure	SMRF
Number of Storeys	12
Type of Building	Residential
Location	Bhuj, Gujrat, India
No of Bays	x-5, z-5
Total Height	41.13
Seismic zone	v
Zone factor	0.36
Importance factor	1
Bracing Member	ISA 110x110x12
Shear wall thickness	300mm
Size of Beam	300x450mm
Size of Column	450x600mm
Grade of Concrete	M-25
Grade of Steel	Fe-415

Table -1: Building description

2. PROBLEM MODELLING

A twelve storey high rise regular RCC structure subjected to seismic load is analyzed with two different types of load resisting systems as per equivalent static analysis method by using STAAD.Pro V8i software. The braced frame analyzed is concentric X type & the shear wall used is of thickness 300 mm. The results are obtained in terms of Shear force, bending moment, node displacement, support reactions & axial force. Both the bracings & shear walls are provided along all the four outer corners of the building throughout the height of the structure. Building is designed as per IS 456-2008 & seismic load is applied as per IS 875(i)-1987. Various load combinations applied on the structure are as follows.

S.no	Load Combinations
1	1.5 (DL + LL)
2	1.5 (DL + ELX)
3	1.5 (DL+ELX+LL)
4	1.5 (DL + ELZ)
5	1.5 (DL+ELZ+LL)

Table -2: Load Combinations

Following three different types of models with above specified dimension & properties are considered: -

Model 1 Bare frame

Model 2 Shear wall

Model 3 X Braced frame

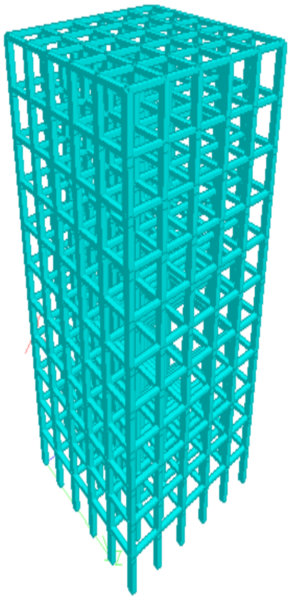

Fig -2: Model1

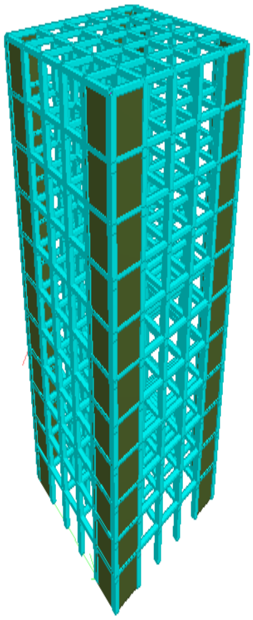

Fig -3: Model2

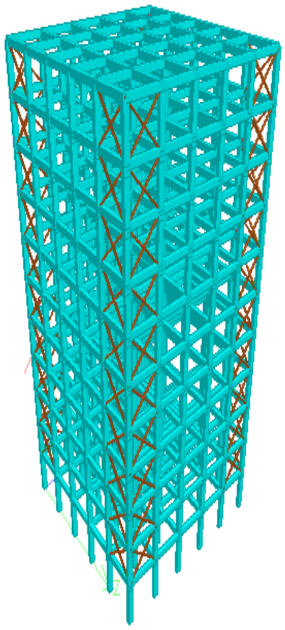

Fig -4: Model 3

3. RESULT

The results were obtained in terms of shear force, bending moment, node displacement, support reactions & axial force.

3.1 Shear force

	FX	FY	FZ
BF	2191.224	134.08	5.876
SW	4958	66.968	31.31
XB	2108.879	122.764	25.735

Table -3: Comparison of SF

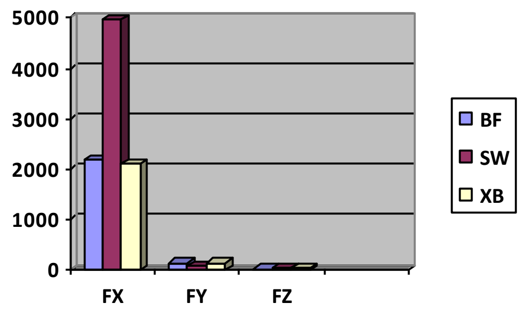

Chart -1: Comparison of SF

Model 3 with X braced system gave best results.

3.2 Bending moment

	MX	MY	MZ
BF	0.191	434.071	355.566
SW	8.546	142.559	151.026
XB	5.901	193.967	209.847

Table -4: Comparison of BM

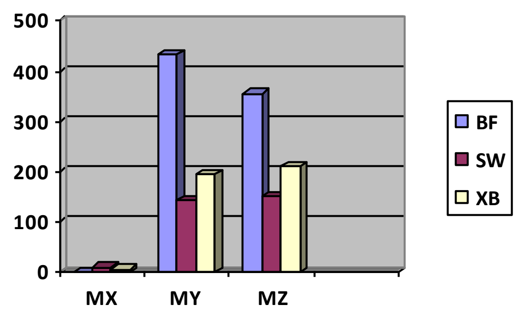

Chart -2: Comparison of BM

Model 3 with X braced system gave best results.

3.3 Node displacement

	X	Y	Z	Rst
BF	149.428	1.011	136.178	149.429
SW	68.4	3.557	66.488	68.419
XB	58.511	2.04	79.754	79.839

Table -5: Comparison of ND

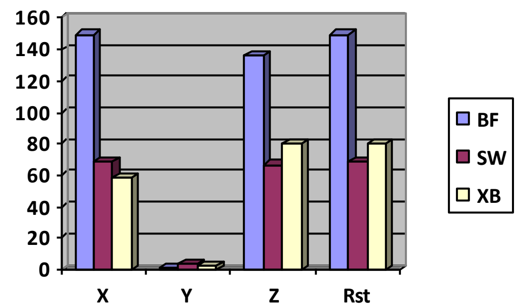

Chart -3: Comparison of ND

Model 3 with X braced system gave best results.

3.4 Support reactions

	FX	FY	FZ
BF	1.999	2191.224	2.226
SW	1157.258	7960.257	1179.404
XB	4.228	2108.879	2.469

Table -6: Comparison of SR

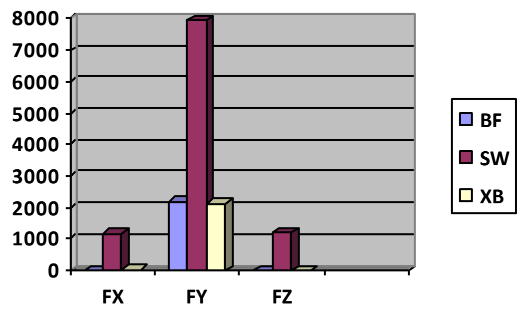

Chart -4: Comparison of SR

Model 2 with Shear wall gave best results.

3.5 Axial force

	FX
BF	2191.224
SW	4958.82
XB	2108.879

Table -7: Comparison of AF

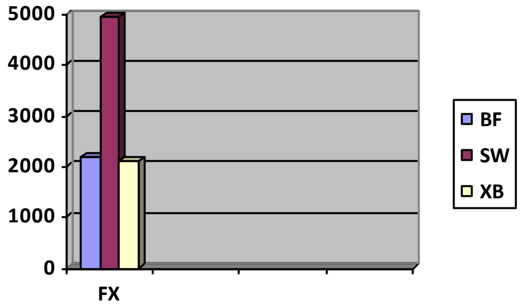

Chart -5: Comparison of AF

Model 3 with X braced system gave best results.

4. CONCLUSIONS

Following conclusions were drawn based on the analysis carried out

- The performance of the structure enhanced with the provision of Braced frame system in terms of Shear force, Node displacement & Axial force.
- Model with shear wall is found most efficient in terms of Support reactions & Bending moment.
- Provision of X braced frame reduced S.F, N.D & A.F by 3%, 49% & 3% respectively.
- Provision of Shear wall controlled B.M by 61% & provided maximum support reaction by 78%.
- X braced system was found overall most efficient in terms of structural strength & stiffness.

REFERENCES

[1] Karthik. K. M, Vidyashree. D, "Effect of Steel Bracing on Vertically Irregular R.C.C Building Frames Under Seismic Loads", International Journal of Research in Engineering and Technology, Volume: 04, Issue 06, PP 90-96, June-2015.

[2] Prof. Bhosle Ashwini Tanaji, Prof. Shaikh A. N." Analysis of Reinforced Concrete Building with Different Arrangement of Concrete and Steel Bracing" IOSR Journal of Mechanical and Civil Engineering, Volume 12, Issue 5 Ver. V, PP 8-12, October 2015

[3] Adithya. M, Swathi Rani K.S, Shruthi H K, Dr. Ramesh B.R, "Study on Effective Bracing Systems for High Rise Steel Structures", SSRG International Journal of Civil Engineering, Volume 2, Issue 2, PP 19-22, February 2015 .

[4] Krishnaraj R Chavan, H.S Jadhav, "Seismic Response of RC Building with Different Arrangement of Steel Bracing System", International Journal of Engineering Research and Applications", Volume 4, PP 218-222, July 2014