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Determination of Seismic parameters of R.C.C. Building Using Shear Core Outrigger, Wall Belt and Truss Belt Systems

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Abstract— *Structural analysis has been done since decades to study the behavior of lateral load resisting systems and for that outrigger structural system has done a tremendous job in this regard. The present work is to study high-rise G+10 3D computer model RCC structure under the influence of earthquake forces. The outrigger location used according to Taranath method. Response spectrum method is used for observing the performance of total seven different cases which include regular, shear core, outrigger and wall belt and outrigger and truss belt supported system. These are studied and parameters such as Base shear, column axial forces and member shear forces were examined. Efficient cases for all the parameters have discussed in this article too.*

Keywords— Seismic forces, Outrigger, Shear core, Staad Pro, Response spectrum analysis, Belt supported system, truss supported system.

I. INTRODUCTION

The examination of the seismic activities of the earth artificially via structural software reveals that whenever the R.C.C. multistory structure has located around the area of epicenter of any earthquake, the waves creates a harmful effect on it.

So, to counteract the lateral forces in the design of tall structures, the parameters to be maintained are strength, resistance against lateral deflection, stability to avoid structural and non-structural destruction. For the design requirements, structural examiners have offered new systems to maintain the above parameters are to use shear wall, truss systems, moment resisting frames, base isolation systems and one of them is outrigger and belt supported systems. In this system, when the structure rotates against lateral effects undergoes deflection and rotation. To counteract this, stiff core is provided in the middle of structure connected by stiff arms that resists the whole structure and transfer all the lateral loads around the beam-column connections. Hence the performance of the multistory building depends upon the stiffness generated system.

II. OBJECTIVE OF THE PRESENT STUDY

The objectives of this work are as follows:

- Determination of effective case among general, shear core outrigger and belt wall supported system as well as shear core outrigger and truss supported system.
- To determine Base shear response when seismic forces are applied in X, Y and Z direction to the structure.
- To examine column Axial Forces for total seven cases with efficient case to determine minimum axial force.
- To find member Shear Forces and Bending Moment values with efficient case of all 7 cases.
- To determine and compare member Torsion values.
- To show whether truss is better or shear wall at an optimum outrigger height of structure.

III. PROCEDURE AND 3D MODELLING OF STRUCTURE

In this paper, G + 10 storey residential building with 43.26m height having 5 bays of 3 m each in X direction and 7 bays of 3 m each in Z direction for complete 7 cases that are mentioned in table 1 and figure 1 & 2. Depth of foundation taken as 3m and height of each floor is taken as 3.66m. According to several cases mentioned in table, acronym such as S1 to S7 used to represent “Structure” and T1& T2 used to represent as “Type” were made. Indian Standard code 1893 (part 1): 2002 has used for seismic analysis of all cases, various parameters were taken presumed that the structure has located in seismic zone IV and on rested over hard soil.

Several data used in this study for modeling and loadings are as follows:

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- Length and width of building = 15 m and 21 m respectively.
- Thickness of slab and Shear wall = 125 mm and 230 mm.
- Beam, bracings and column size = 600 mm x 300 mm, 230 mm x 230 mm & 500 mm x 500 mm.
- Dead load as floor finish load = 1 KN/m^2 (intermediate floors).
- Wall load = 17.934 KN/m and 4.9 KN/m for intermediate floors with 3.66 m wall height and for terrace periphery with 1 m height (roof).
- Water proofing and terrace finish load = 2KN/m^2 and 1KN/m^2 respectively for roof.
- Live load as per IS 875 part II = 4 KN/m^2 for intermediate floors and 1.5 KN/m^2 for roof.

Design factors for Zone IV are as follows:

- Zone factor Z=0.24 (ZONE IV)
- Response reduction factor R = 5
- Importance factor I = 1
- The fundamental natural period (Ta) for X and Z direction has taken as 1.2978 & 0.8496 seconds

3D models constructed in Staad pro, a complete software tool for analysis has used for total seven Cases and work has evaluated.

Table.1: Different Cases with respect to building configurations

S. No.	CASES	Building Configurations
1	S1	Regular building on plane ground
2	S2	Regular building with shear core
3	S3	Building with shear core and wall outriggers
4	S4	Shear Core outrigger and wall belt supported system
5	S5	Shear Core outrigger and truss belt supported system
6	S6	Shear Core outrigger and truss belt supported system optimum bracing T 1
7	S7	Shear Core outrigger and truss belt supported system optimum bracing T 2

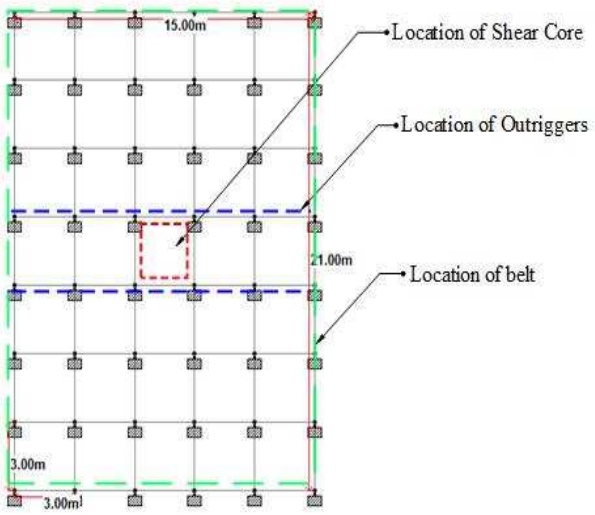
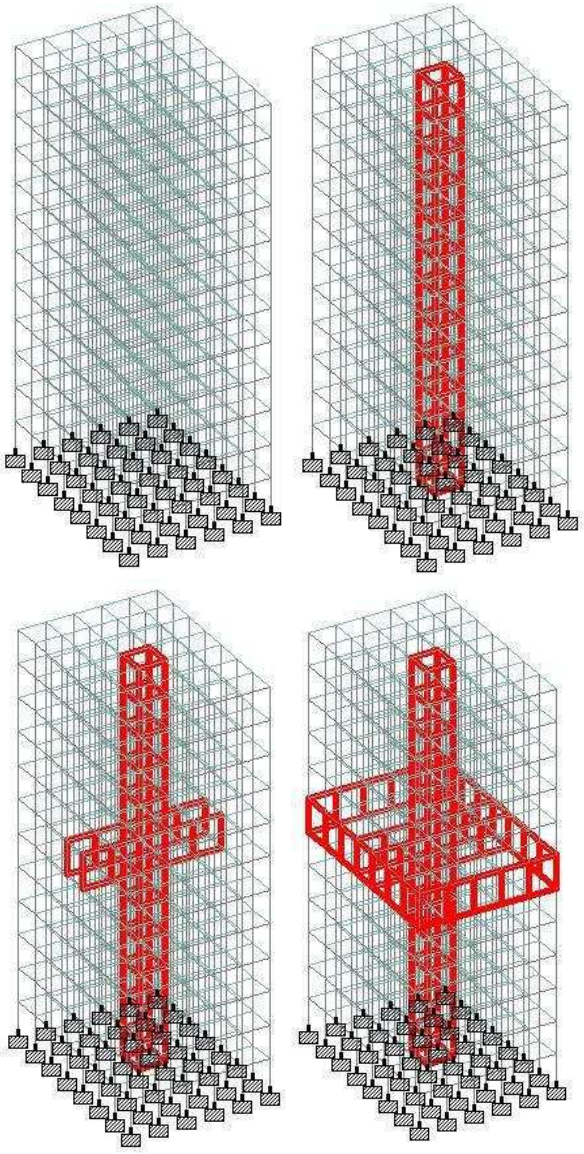


Fig. 1: Typical floor plan



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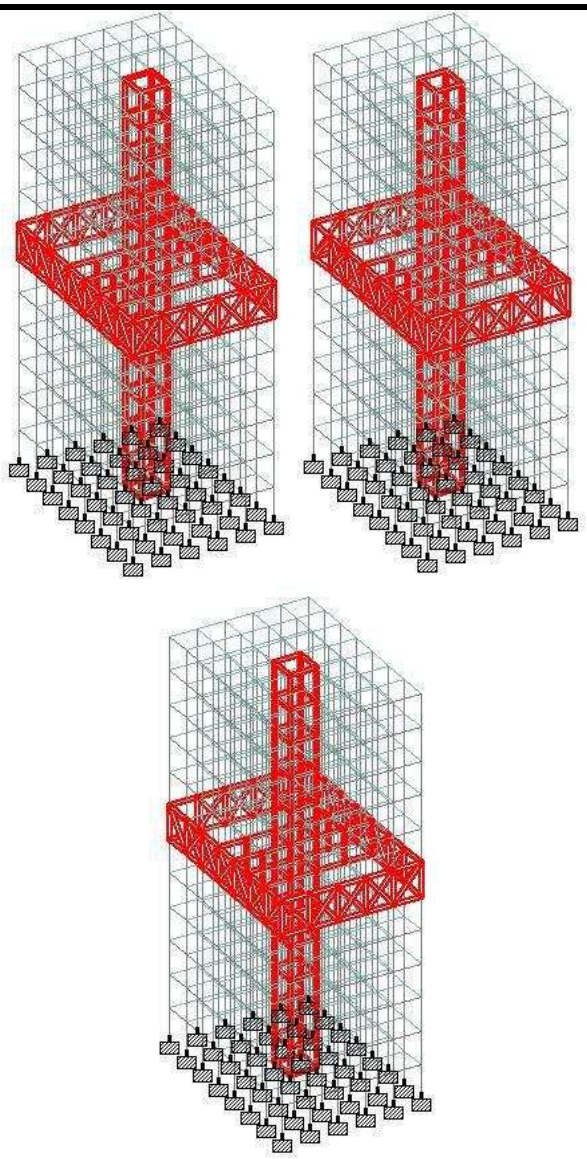


Fig. 2: 3D view of various cases of multistoried structure

Structure 1 (S1) Regular building on plane ground

Structure 2 (S2) Regular building with shear core

Structure 3 (S3) Building with shear core and wall outriggers

Structure 4 (S4) Shear Core outrigger and wall belt supported system

Structure 5 (S5) Shear Core outrigger and truss belt supported system

Structure 6 (S6) Shear Core outrigger and truss belt supported system optimum bracing T 1

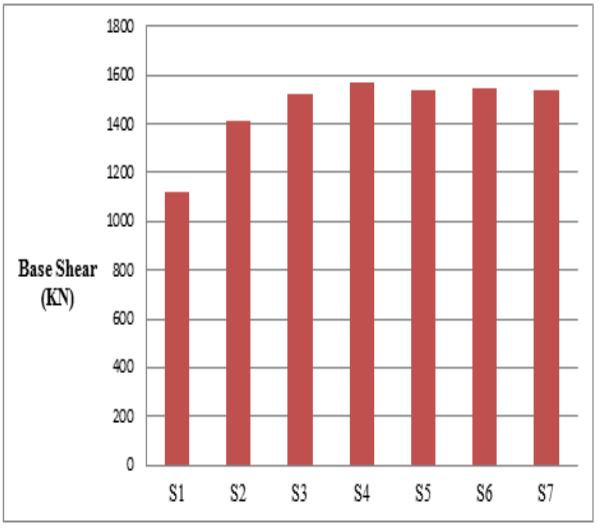
Structure 7 (S7) Shear Core outrigger and truss belt supported system optimum bracing T 2

IV. RESULTS ANALYSIS

Since for the analysis of seismic effects, all the cases of the structures have been analyzed for seismic shake for longitudinal along with transverse direction. Various loads along with load combinations as per IS 456-2000 and IS 1893 – 2002 part 1, applied on all the cases and reflective result parameters have been analyzed with each other to determine the efficient case. Results are shown both in tabular form as well as graphical form.

Table 2: Base shear

CASES	Base Shear (KN)	EFFICIENT CASE
S1	1118.21	Other than regular building, regular building with shear core shows minimum base shear value of 1410.49 KN, so; the efficient Case for this parameter will be S 2.
S2	1410.49	
S3	1526.25	
S4	1571.74	
S5	1541.56	
S6	1545.91	
S7	1540.56	



Graph 1: Base shear comparison

Table 3: Column Axial Force comparison

CASES	Column Axial Force (KN)	EFFICIENT CASE
S1	4058.136	Other than regular building, Case S 2 i.e. regular building with shear core shows itself an efficient case with minimum value of 3956.154 KN.
S2	3956.154	
S3	4135.927	
S4	4180.142	
S5	4137.749	
S6	4135.572	
S7	4138.083	

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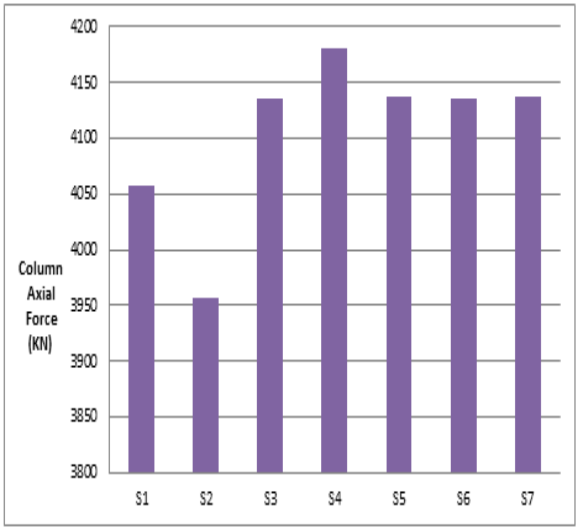
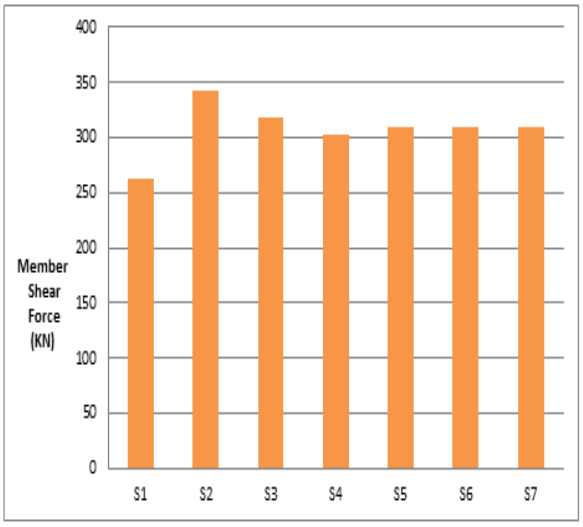


Graph 2: Column Axial Force comparison

Table 4: Member Shear Force comparison in Y direction

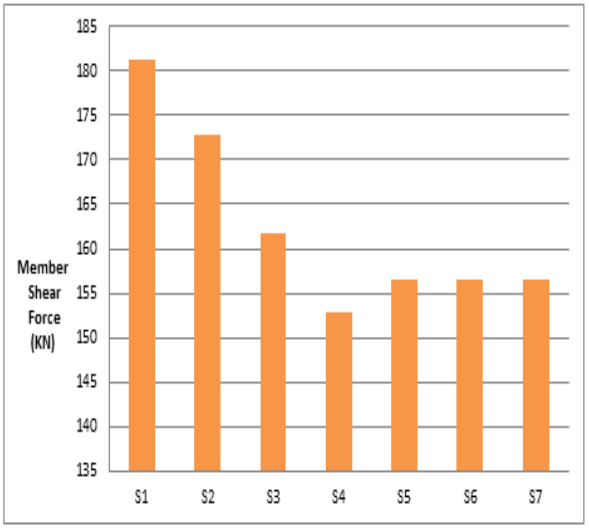
CASES	Member Shear Force (KN)	EFFICIENT CASE
S1	262.746	Other than regular building, Case S 4 shows least shear forces values among all with a value of 303.269 KN and hence Case S 4 has shown itself as an efficient case of shear forces in Y direction.
S2	343.141	
S3	317.867	
S4	303.269	
S5	310.162	
S6	310.201	
S7	310.203	



Graph 3: Member Shear Force comparison in Y direction

Table 5: Member Shear Force comparison in Z direction

CASES	Member Shear Force (KN)	EFFICIENT CASE
S1	181.303	Other than regular building, Case S 4 shows least shear forces values among all with a value of 152.903 KN and hence Case S 4 has shown itself as an efficient case of shear forces in Z direction.
S2	172.711	
S3	161.76	
S4	152.903	
S5	156.473	
S6	156.519	
S7	156.573	



Graph 4: Member Shear Force comparison in Z direction

Table 6: Member Bending Moment comparison

CASES	Member Bending Moments (KNm)	EFFICIENT CASE
S1	368.569	Other than regular building, Case S 4 shows least member bending moment values among all with a value of 439.536 KNm.
S2	507.066	
S3	465.636	
S4	439.536	
S5	451.977	
S6	452.113	
S7	452.156	

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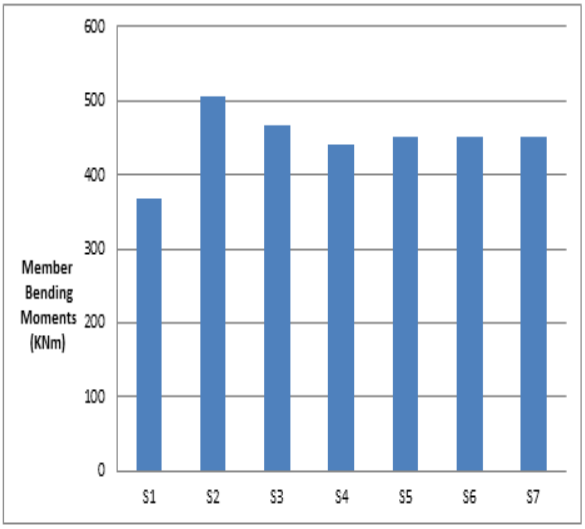
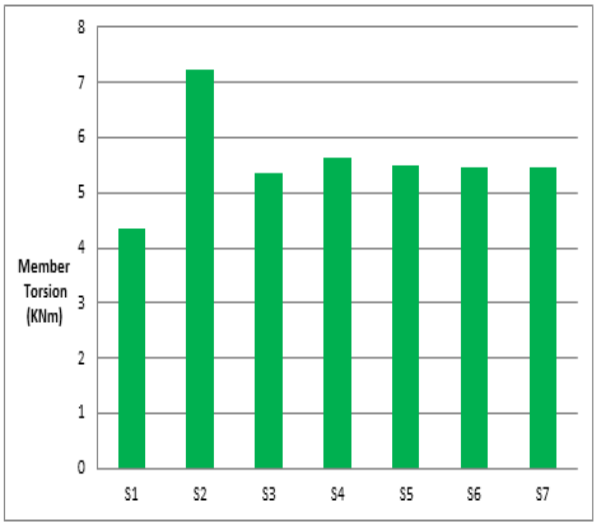


Graph 5: Member Bending Moment comparison

Table 7: Member Torsion value comparison

CASES	Member Torsion (KNm)	EFFICIENT CASE
S1	4.358	Other than regular building, Case S 3 shows least torsional values among all with a value of 5.349 KNm and hence Case S 3 has shown itself as an efficient case.
S2	7.241	
S3	5.349	
S4	5.642	
S5	5.496	
S6	5.475	
S7	5.468	



Graph 6: Member Torsion value comparison

V. CONCLUSION

The following conclusion has been investigated by comparing various cases are as follows:-

- Base Shear shows minimum response value other than general structure which seems very effective under seismic effect is Regular building with shear core.
- To resist moment, buildings are recommended to be designed as Shear Core outrigger and wall belt supported system shows least value among all cases.
- If column design is the main criteria, building axial forces shows a least value when only Shear Core system will be used.
- Shear Core outrigger and wall belt supported system will again be effective in shear forces for both Y and Z directions in members.
- Member torsion values have seen effective and efficient case for building with shear core and wall outriggers.
- Overall parameter controlling case among all is Shear Core outrigger and wall belt supported system.
- Wall belt system is more effective than truss belt system which has seen in this work.

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