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Comparative analysis for the effect of different positions and palcement of Outrigger systems in Tall structures In Siesmic Zone V.

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ABSTRACT :

An outrigger is stiff beam that connects the shear wall to exterior columns. When the structure is subjected to wind load, the outrigger and column resist rotation of the core and thus lateral deflection and base moment is resisting significantly Outriggers are considered as an effective system to alleviate the responses caused due to the lateral loads on high rise buildings. The concept of outrigger system which has a conventional and a virtual outrigger at different levels has been proposed. This study analyzes the static and dynamic behavior of outrigger system based on stiffness of core, stiffness of outrigger and alternate outrigger, length of the outrigger arm, and height of the building as varying parameters, and investigated on optimal positions of outrigger system under earthquake loads. The dynamic behavior was evaluated using nonlinear earthquake response using Indian Standard codes. Analytical models of 17 stores having building heights of 59.5m, respectively were considered for the parametric study. The optimal positions for hybrid outrigger system were obtained based on the response from absolute maximum inter storey drift ratio (ISDmax), roof displacement (disproof),

SYSTEM DEVELOPMENT

GENERAL

The system development phase of my dissertation project involves the design, implementation, and evaluation of a computational framework for the seismic analysis of a G+17 RCC framed structure with outriggers. This phase is crucial in achieving the overall research objectives, which are to reducee the lateral displacement of the building. The focus of this project is on the outrigger system. For the seismic analysis of this high-rise structure, the response spectrum method is used, which is a linear dynamic method. This analysis was performed using the ETABS software. The data required for the analysis of the structure and models for this study are explained below.

PROBLEM STATEMENT

In the present work G+17 multistorey building is considered for analysis using ETABS software according to IS 1893-2016 and IS 16700-2017. For present work response spectrum method.

A G+17 multistorey RCC framed structure is modelled with floor height of 3.5m using ETABS software and the element sizes are changed according to the design requirements. The model is analyzed with four different framed system i.e., one is RCC framed structure, a shear wall, outrigger system and outrigger system with shear wall. The geometric parameters for models are considered as shown in Table 1.1.

Table 1.1 : Geometric parameters of model

Type of structure	SMRF
No. of storeys	G+17
Overall height of building	59.5m
Floor dimensions	15m x 15m
Grade of Steel	Fe500
Grade of Concrete	M40
Column dimensions	800mm x 800mm

Beam dimensions	300mm x 600mm
Slab thickness	125mm
outrigger dimension	Concrete 450x450
Shear wall thickness	230mm
External wall thickness	230mm
Internal wall thickness	230mm
Bottom storey height	3.5m
Typical storey height	3.5m

LOADINGS

The loads which are considered for this analysis are Dead loads, Live loads from IS 875:2015 code and Earthquake loads from IS 1893:2016 code.

Dead Load: Is 875 part-1 (Code of Practice for design loads- DEAD LOAD) The dead load includes the self-weight of the beam, column and slab.
Floor finish = 1kN/m2
Terrace water proofing = 1kN/m2
External wall load on periphery = 14kN/m2 Internal wall load = 14kN/m2

Live Load: IS 875 part 2 (Code of Practice for design loads- IMPOSED LOAD) Live load on all floors = 2kN/m2
Live load on top floor = 2kN/m2

Earthquake Load: IS 1893:2016 (Criteria for Earthquake Resistant Design of Structures) Seismic Zone = V
Importance factor = 1 Response reduction factor = 5 Type of soil = Medium soil

LOAD COMBINATIONS

The load combinations considered for the analysis according to IS 1893:2016 is as shown in table 1.2.

Table 1.2 : Load combinations considered for seismic analysis

Sr.	Design load combinations
1	1.5DL+1.5LL
2	DL+LL
3	1.2 [DL+LL±EQX] 1.2 [DL+LL±EQY]
4	1.2 [DL+LL±EQX] 1.2 [DL+LL±EQY]
5	0.9DL±1.5(EQX) 0.9DL±1.5(EQY)

MODELS USED FOR ANALYSIS

Four types of models of G+15 multistorey building is prepared for analysis are as following.

Model 1: G+17 RCC framed structure.
Model 2: G+17 framed structure with shear wall and one side outrigger system.
Model 3: G+17 framed structure with shear wall.
Model 4: G+17 framed structure with two side outrigger system

RESPONSE SPECTRUM METHOD

This method uses response spectrum analysis to study a G+17 multistorey building that is shaken sideways by earthquakes in seismic zone IV. The analysis assumes a response reduction factor of 5 and an importance factor of 1. The analysis compares seismic parameters such as how stiff, how much displaced, how much tilted, how much sheared, and how much twisted each storey.

STOREY STIFFNESS

This term measures how much a storey resists bending or changing shape when a sideways force pushes on it. It is important for understanding how a building reacts to earthquakes or strong winds. Stiffness (K) = Load (P)/Displacement (Δ)
The stiffness of each storey in the X direction for both RCC framed structures and outrigger structures has been compared and is presented in tabulated form, as well as visually represented in Figure 4.1. The detailed results are provided in Table 4.1.

Table 2.1 : Storey Stiffness in the X direction in zone V

STIFFNESS X-DIRECTION				
SR. NO.	CONVENTIONAL	OUTRIGGER WITH SHEAR WALL	SHEAR WALL	TWO SIDE OUTRIGGER SYSTEM WITH SHEAR WALL
1	159057.03	155713.134	125604.828	177185.962
2	296263.373	333996.023	267835.786	383985.586
3	361494.767	471116.966	372588.745	549479.814
4	394085.346	580010.687	447380.851	691484.346
5	412709.335	690256.075	502307.781	867843.024
6	424955.112	847658.136	544637.782	1221353.656
7	433929.936	799593.336	579400.426	1006937.78
8	441162.006	799649.976	610562.883	957564.115
9	447651.974	830941.924	641716.665	982448.602
10	454175.416	886229.696	676348.702	1053728.323
11	461524.064	1001239.055	718396.978	1247519.955
12	471030.18	1277093.732	773614.015	1877669.65
13	485565.702	1192921.043	852199.784	1486424.945
14	511835.748	1245441.707	974700.126	1443830.049
15	568043.205	1445342.562	1190629.878	1616125.959
16	722634.542	1929861.317	1659322.175	2098374.868
17	1613266.837	4182576.48	3751632.527	4432674.042

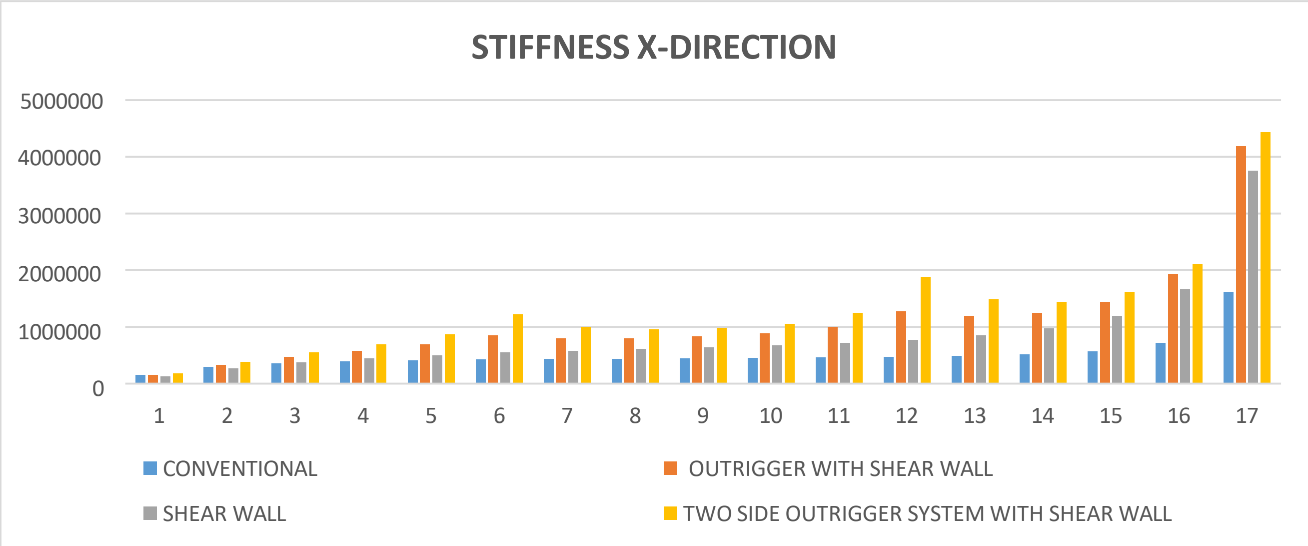


Figure 2.1 : Storey stiffness in the X direction in zone V

STOREY DRIFT IN X DIRECTION IN ZONE IV

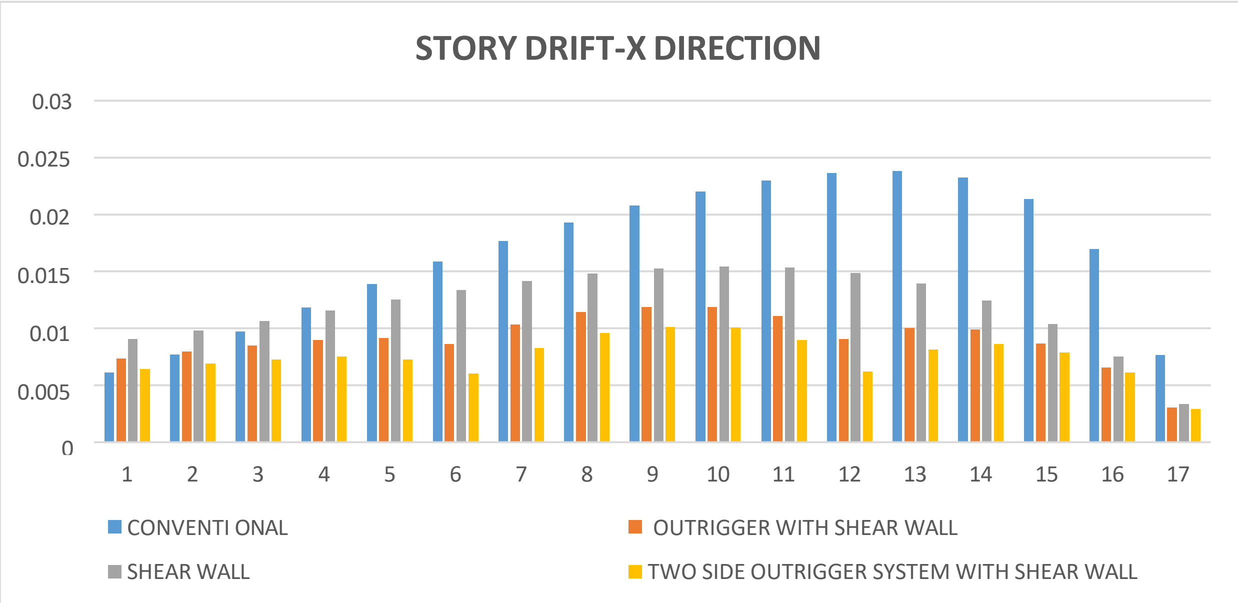
The storey drift of RCC and OUTRIGGER structures in X direction in zone V are compared and presented in tabulated form and also represented in graphical format. The tabulated result and graphical representation are shown in table 2.1.7 and figure 2.1 respectively.

Table 2.2 : Storey drift in X direction in zone V

STORY DRIFT-X DIRECTION				
SR.	**CONVENTIONAL**	**OUTRIGGER WITH SHEAR WALL**	**SHEAR WALL**	**TWO SIDE OUTRIGGER SYSTEM WITH SHEAR WALL**
1	0.006094	0.007363	0.009047	0.006436
2	0.007703	0.007939	0.009819	0.006904
3	0.009711	0.008479	0.010646	0.007286
4	0.011821	0.008971	0.011568	0.007539
5	0.013893	0.009131	0.012505	0.007265
6	0.015857	0.008641	0.013393	0.006006
7	0.017673	0.010344	0.01418	0.008253
8	0.019317	0.011398	0.014814	0.009584
9	0.020769	0.011871	0.015248	0.010122
10	0.022005	0.011871	0.015434	0.010067
11	0.022985	0.011071	0.015316	0.008956

12	0.023637	0.009058	0.014833	0.006214
13	0.023821	0.010043	0.013912	0.008149
14	0.023258	0.009879	0.012463	0.008632
15	0.021376	0.00867	0.010375	0.007864
16	0.01699	0.006561	0.007515	0.006123
17	0.007637	0.003038	0.003334	0.002909

Figure 2.2 : Storey drift in X direction in zone V



STOREY DRIFT IN Y DIRECTION IN ZONE IV

The storey drift of RCC and OUTRIGGER structures in Y direction in zone IV are compared and presented in tabulated form and also represented in graphical format. The tabulated result and graphical representation are shown in table 2.2 and figure 2.2 respectively.

Table 2.3

Storey drift in Y direction in zone V

STORY DRIFT-Y DIRECTION				
SR.	**CONVENTIONAL**	**OUTRIGGER WITH SHEAR WALL**	**SHEAR WALL**	**TWO SIDE OUTRIGGER SYSTEM WITH SHEAR WALL**
1	0.006094	0.008881	0.009047	0.008684
2	0.007703	0.009654	0.009819	0.009415
3	0.009711	0.010484	0.010646	0.010179

4	0.011821	0.011423	0.011568	0.011006
5	0.013893	0.01245	0.012505	0.01181
6	0.015857	0.01349	0.013393	0.01254
7	0.017673	0.014076	0.01418	0.0133
8	0.019317	0.014646	0.014814	0.014027
9	0.020769	0.015098	0.015248	0.014519
10	0.022005	0.015332	0.015434	0.014703
11	0.022985	0.015346	0.015316	0.014527
12	0.023637	0.015065	0.014833	0.013951
13	0.023821	0.013953	0.013912	0.013103
14	0.023258	0.012473	0.012463	0.011884
15	0.021376	0.010439	0.010375	0.010005
16	0.01699	0.007624	0.007515	0.007317
17	0.007637	0.003412	0.003334	0.003278

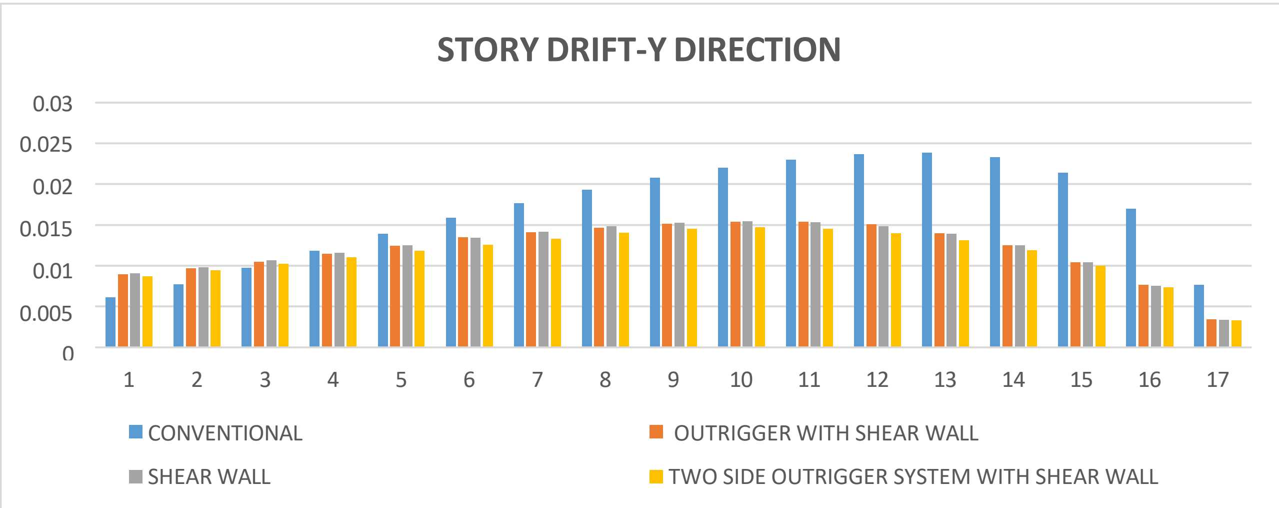


Figure 2.3 : Storey drift in Y direction in zone V

CONCLUSIONS

GENERAL

The recent literary work done with regard to without outrigger, with outrigger are reviewed and the following observations are drawn.

CONCLUSIONS

1. Lateral load resisting systems are essential for tall buildings, as they can withstand lateral forces more effectively than traditional building systems.

2. The structure’s performance depends on the material, the module size, and the shape of the building.
3. The load types and the number of stories affect how systems work. The structure’s shape limits the number of stories that some systems can handle well.
4. Different structures may need different lateral load resisting systems. The best system depends on the structure and is not the same for all. Therefore, each structure should be tested with different systems before choosing one.