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"Analysis of RCC Building with Regular and Dumbbell Shaped Shear Wall In Different Types of Zones Using Etabs Software"

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Abstract— *in structural engineering, a shear wall is a vertical element of a seismic force resisting system that is designed to resist in-plane lateral forces, typically wind and seismic loads. In many jurisdictions, the International Building Code and International Residential Code govern the design of shear walls.*
A shear wall resists loads parallel to the plane of the wall. Collectors also known as drag members; transfer the diaphragm shear to shear walls and other vertical elements of the seismic force resisting system. Shear walls are typically light-framed walls with shear panels, reinforced concrete walls, and reinforced masonry walls.
The G+15 story structures situated in earthquake zones III, IV and V will be considered for study. All frames are designed under same gravity loading. Response spectrum method is used for seismic analysis. ETABS software is used and the results are compared.
The results were obtained in the form of top story displacement, Story drift, Base shear and displacement.
Key words: *ETABS, Earthquake load, wind load, dumbbell shaped shear wall, response spectrum analysis.*

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I. INTRODUCTION

General Introduction

The basic function of shear wall is to increase the rigidity for lateral load resistance along with providing adequate stiffness and strength to the structure. Shear wall is a structural system composed of shear panels to counter the effects of lateral load acting on the structure.

Reinforced concrete shear-wall buildings intensively used than other lateral force resisting systems due to their lower cost, fast construction, and considerable stiffness efficiency. The lateral load resisting systems subjected to high level of dynamic energy raised from seismic loads behave nonlinearly and the capacity design concept will apply to capture the failure mechanism due to the formation of plastic hinges at sections of maximum straining actions. However, the current codes provisions don't distinguish between the requirements of the design of low, medium and high-rise buildings with shear wall lateral resisting elements and this may lead to undesirable results.

Shear wall is a structural system composed of shear panels to counter the effects of lateral load acting on the structure. Depending upon the zone, wind loads and seismic loads are the most common loads for which the shear walls are designed. The basic function of shear wall is to increase the rigidity for lateral load resistance along with providing adequate stiffness and strength to the structure. Reinforced concrete shear wall provides a significant amount of strength and stiffness to the building in the direction of their orientation which considerably reduces lateral sway of the building.

They are usually conceived as vertical plates supported at the foundation and are expected to function only under the action of in-plane horizontal and vertical forces. However, depending upon the architectural and structural layout of the building, shear walls may have a more complex shape. Often the walls are of a central core forming boxes, or are cast between two columns leading to I structure or dumbbell shapes. Shear wall must meet appropriate criteria for strength, stiffness and in earthquake areas, also for ductility. Depending on the moment to shear ratio at each horizontal cross section of the wall, the behavior can be controlled by shear and flexure.

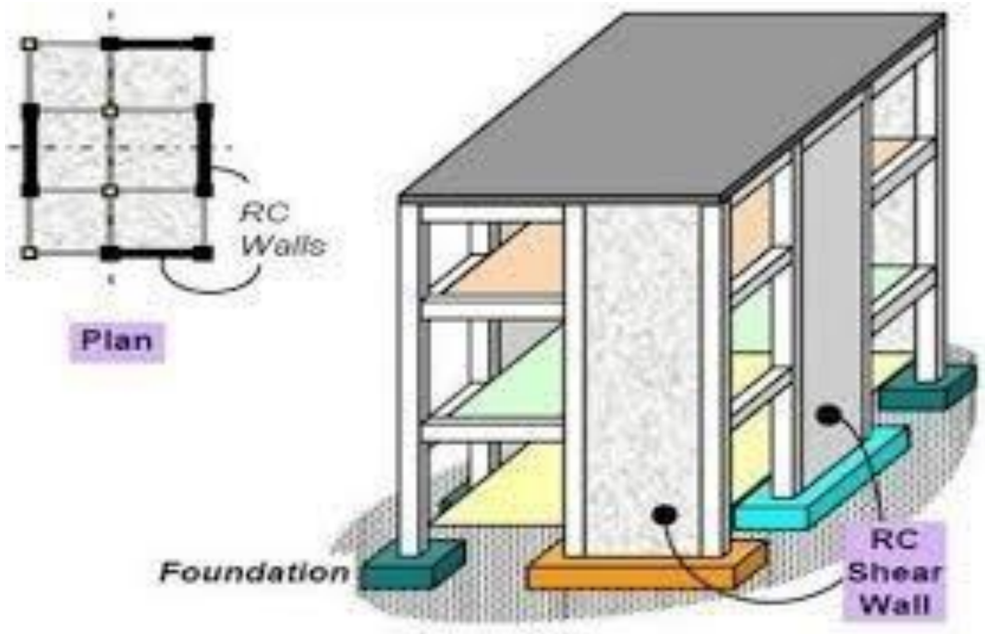


Fig 1.1 R C shears wall location.

In India, very few buildings are designed properly by structural engineers. Proper analysis and design of building structures that are subjected to static and dynamic loads is very important. Another important factor in the analysis of these systems is obtaining acceptable accuracy in the results. The object of this study is to model and analyze shear wall-frame structures having regular and irregular shear wall in the structure and we will also discuss various factor considered in model analysis.

II. RESEARCH OBJECTIVE

Based on the literature review presented in Chapter 2, the salient objectives of the Present study have been identified as follows,

Based on literature following are the objectives

1. Analysis of Multistoried building manually with the use of latest software with and without dumbbell shaped shear wall.
2. To compare the analytical results of regular shaped and dumbbell shaped shear wall buildings.
3. To check effectiveness of dumbbell shaped shear wall in comparison to regular shaped shear wall.
4. To study seismic performance of response spectrum method using different location of shear wall.

III. PROJECT STATEMENT

The study will give more knowledge which result into benefits for future implementation with the help of RCC building actual Analysis and design. To study the effect of Regular wall building and dumbbell shaped building.

i) Response Spectrum Method

A response spectrum is simply a plot or steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by same base vibration. The resulting plot can then be used to pick off the response of any linear system, given its natural frequency of oscillation. One such use is in assessing the peak response of building to earthquake. The science of strong ground motion may use some values from the ground response spectrum for correlation with seismic damage.

In technical terms it can be said that it is the representation of the maximum response of idealized single degree of freedom having certain period and damping during earthquake ground motion. The maximum response is plotted against the undammed natural period and for various damping values can be expressed in terms of maximum relative velocity or maximum relative displacement. The characteristics of seismic ground vibrations expected at any location depends upon the magnitude of earthquake, its depth of focus, distance from the epicenter, characteristics of the path through which the seismic waves travel, and soil strata on which the structure stands. The random earthquake ground motions, which cause the structure to vibrate, can be resolved in any three mutually perpendicular directions.

IV. PROBLEM FORMULATION

Multi-storied Reinforced concrete building, moment resisting space frame have been analyzed using professional software. Model of Multistoried building frame and dumbbell shaped shear wall is analyzed by response spectrum Method. The plan dimensions of buildings are shown in table below. The plan view of building, elevation of different frames is shown in figures below. 1.3

Table 1. Detailed Features of Building

Sr. No.	Parameters	Values
1	Material used	Concrete-M25 and M30
		Reinforcement Fe-415&500Mpa
2	Plan dimension	21.75 x 17.85
3	Height of each Story	3.0m
4	Height of ground Story	1.2m
5	Density of concrete	25KN/m^3
6	Poisson ratio	0.2-concrete and 0.15-steel
7	Density of brick	20KN/m^3
9	Code of Practice adopted	IS456:2007, IS1893:2016
10	Seismic zone for IS1893:2002	III
12	Importance factor	1
13	Response reduction factor	5
14	Foundation soil	Medium
15	Slab thickness	150mm
16	Wall thickness	230mm
17	Floor Finish	1KN/m2
18	Live load	2.5 KN/m2
19	Earthquake load	As per IS 1893-2016
20	Wind load	As per IS 875- 2015
24	Model to be design	G+20
25	Ductility class	IS1893:2016 SMRF
26	Dumbbell Size	300 x 450 mm
27	Basic wind speed (Vb)	39 m/sec
28	Terrain category	2
29	Risk coefficient	1
30	Topography factor	1
31	Parapet wall ht.	0.9m

Load case and load combination

Unless otherwise specified, all loads listed, shall be considered in design for the Indian Code following load combinations shall be considered,

Load case

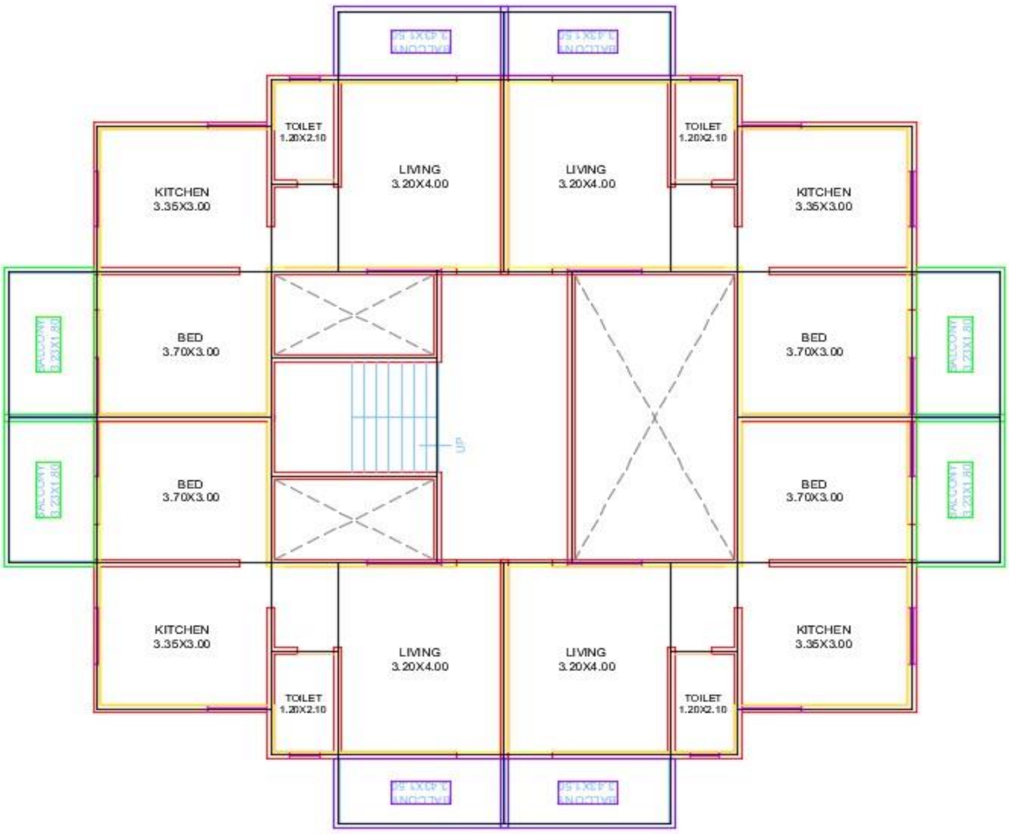
1) DL: Dead load
2) LL: Live load
3) EQ: Earthquake load
4) W: Wind Load

Load combination

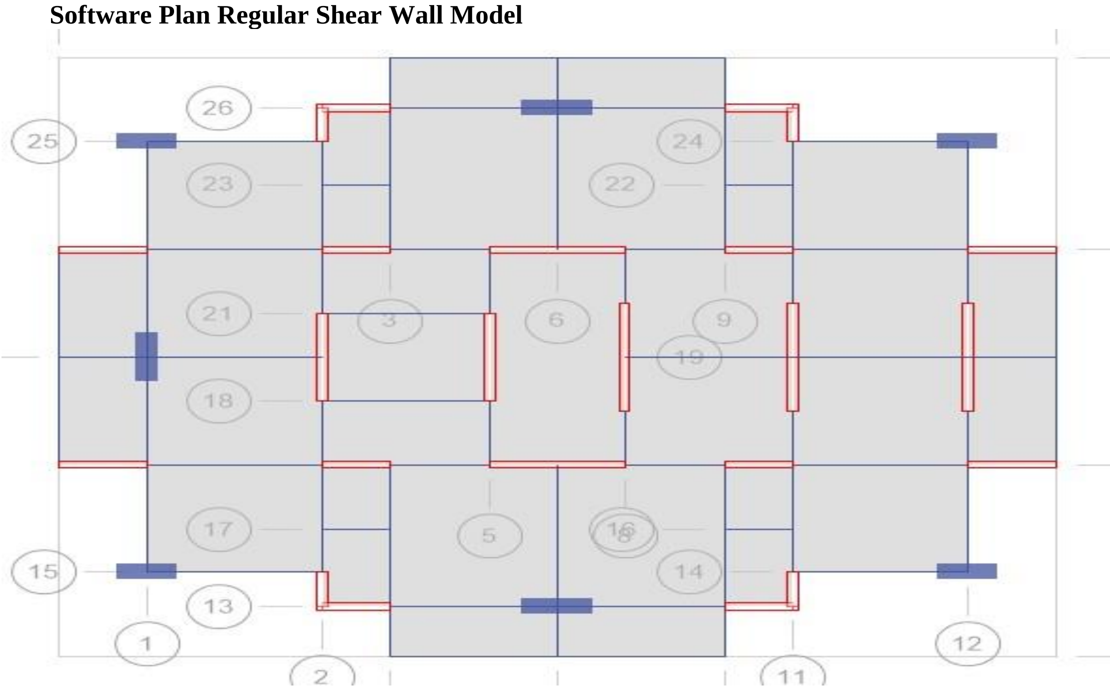
1) 1.5DL+1.5LL
2) 1.2DL+1.2LL + 1.2EX
3) 1.2DL+1.2LL- 1.2EX
4) 1.2DL+1.2LL+ 1.2EY

5) 1.2DL+1.2LL - 1.2EY
6) 1.2DL+1.2LL+1.2WLX
7) 1.2DL+1.2LL-1.2WLX
8) 1.2DL+1.2LL+1.2WLY
9) 1.2DL+1.2LL-1.2WL

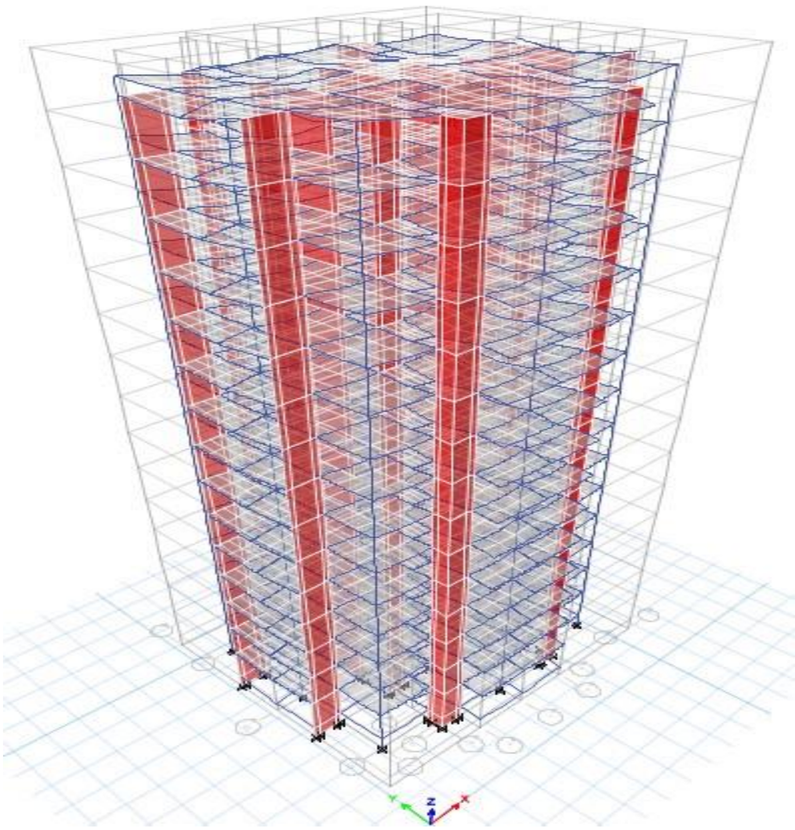
A. Building Plan



B. Software Plan Regular Shear Wall Model



C. G+15 Story 3D Model



V. RESULTS

In the present study, Relative Analysis of RCC structure with different shape of shear wall building i. e Regular shear wall and Dumbbell shaped shear wall building with G+15 story building.

Table 2. Base Shear Results for Regular Shear Wall and dumbbell shaped share wall building at zone V.

Load Pattern	**Z**	**Soil Type**	**I**	**R**	**Base Shear (kN)**	**Base Shear (kN)**
					Regular shear wall	Dumbbell shaped wall
EQ+X	0.36	II	1.2	5	2135.7832	2034.239
EQ-X	0.36	II	1.2	5	2135.7832	2034.239
EQ+Y	0.36	II	1.2	5	1981.0868	1866.6552
EQ-Y	0.36	II	1.2	5	1981.0868	1866.6552

Graph 1 Base Shear vs. Regular Shear Wall and Dumbbell Shaped Share Wall System

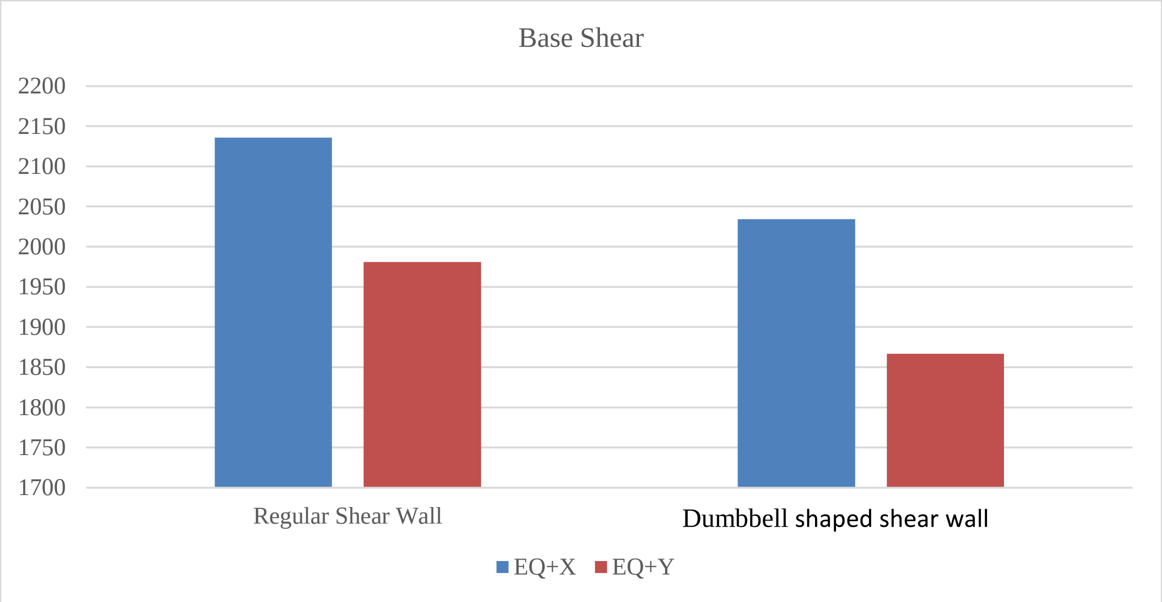
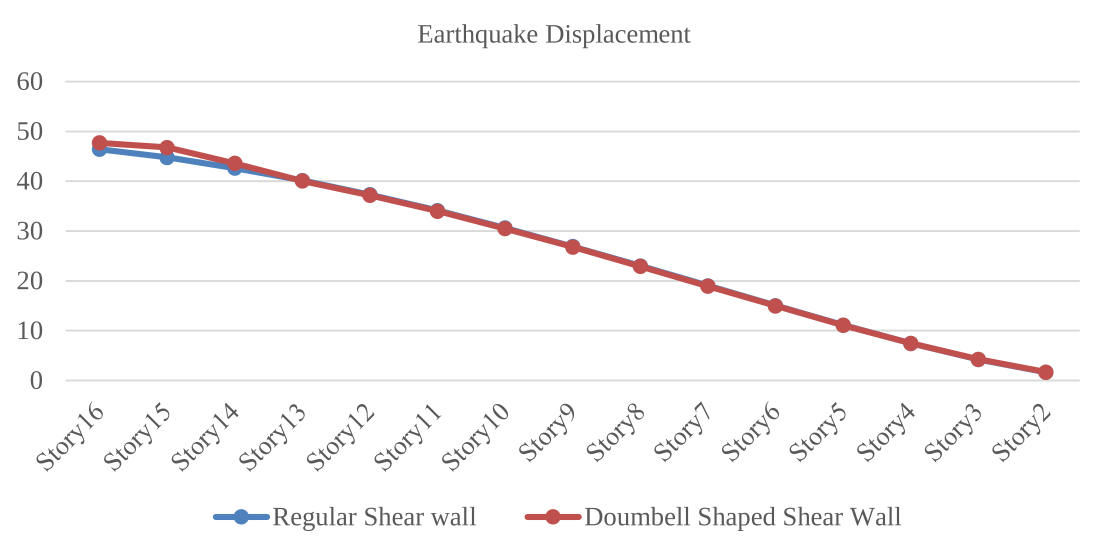


Table 3 Earthquake Displacement Results for Regular Shear Wall and dumbbell shaped share wall Building at Earthquake zone V.

TABLE: Diaphragm Center of Mass Displacements			
Story	**Load Case/Combo**	**UX (mm)**	**UX (mm)**
		Regular Shear wall	Dumbbell shaped shear wall
Story16	EQ+X	46.428	47.72
Story15	EQ+X	44.773	46.784
Story14	EQ+X	42.64	43.583
Story13	EQ+X	40.16	40.058
Story12	EQ+X	37.315	37.188
Story11	EQ+X	34.126	33.993
Story10	EQ+X	30.633	30.511
Story9	EQ+X	26.906	26.798
Story8	EQ+X	23.014	22.92
Story7	EQ+X	19.029	18.95
Story6	EQ+X	15.037	14.978
Story5	EQ+X	11.141	11.107
Story4	EQ+X	7.477	7.472
Story3	EQ+X	4.23	4.249
Story2	EQ+X	1.664	1.688

Graph 2 Earthquake Displacement vs. Regular Shear Wall and dumbbell shaped share wall Building

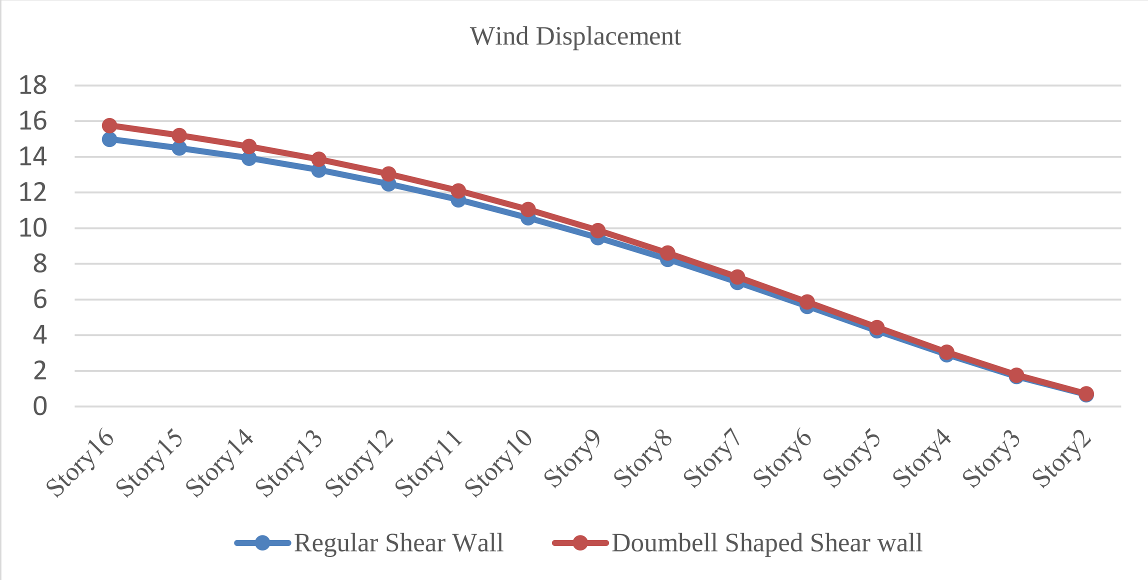


The earthquake displacement in regular shear wall building as compare to Dumbbell shaped shear wall building, displacement increased 1.00197 times as compare to Dumbbell shaped shear wall but relatively both building shows good performance in earthquake displacement.

Table 3 Wind Displacement Results for Regular Shear Wall and dumbbell shaped share wall Building at 39 m/sec basic wind speed.

	TABLE: Diaphragm Center of Mass Displacements					
Story	Load Case/Combo	UX	UX	X	Y	Z
		mm	mm	m	m	m
Story16	WL+X	14.99	15.754	10.4432	12.0377	46.2
Story15	WL+X	14.493	15.203	10.4732	12.1134	43.2
Story14	WL+X	13.925	14.582	10.4735	12.1148	40.2
Story13	WL+X	13.261	13.867	10.4735	12.1148	37.2
Story12	WL+X	12.486	13.042	10.4735	12.1148	34.2
Story11	WL+X	11.595	12.101	10.4735	12.1148	31.2
Story10	WL+X	10.587	11.045	10.4874	12.0388	28.2
Story9	WL+X	9.469	9.878	10.4871	12.0388	25.2
Story8	WL+X	8.257	8.612	10.4871	12.0388	22.2
Story7	WL+X	6.966	7.264	10.4871	12.0388	19.2
Story6	WL+X	5.618	5.86	10.4871	12.0388	16.2
Story5	WL+X	4.249	4.436	10.4871	12.0388	13.2
Story4	WL+X	2.911	3.046	10.4871	12.0388	10.2
Story3	WL+X	1.681	1.768	10.4871	12.0388	7.2
Story2	WL+X	0.675	0.717	10.4871	12.0388	4.2

Graph 3 Wind Displacement vs. Regular Shear Wall and dumbbell shaped share wall Building System



The Wind displacement in regular shear wall building as compare to Dumbbell shaped shear wall building, the Dumbbell shaped shear wall building displacement increased 1.05096 times as compare to Regular shear wall but relatively both building shows good performance in Wind displacement.

Conclusions

In the present study, Relative Analysis of RCC structure with different shape of shear wall building i. e regular shear wall and dumbbell shaped shear wall building with G+15 story building.

The structures are analyses for earthquake zone V with medium soil and Results Compare. It has been made on different structural parameters viz. base shear, Earthquake displacement, Wind displacement, story force and modal mass participations etc. Grounded on the analysis results following conclusions are drawn.

1. Analysis of RCC building with different shape of shear wall structure i.e. Regular shear wall and Dumbbell shaped shear wall with medium soil condition at zone V. the base shear in x- direction, Regular shear wall building structure, the base shear is increased 1.049 times as compare to Dumbbell shaped shear wall building, in base shear in Y- direction, Regular shear wall building structure, the base shear is increased 1.061 times as compare to Dumbbell shaped shear wall building.
2. The Structure, Regular shear wall and Dumbbell shaped shear wall structure with analysis at zone V. but results indicate that variation of base shear increase in regular shear wall building, as compare to Dumbbell shaped shear wall building, means Self weight of regular Shear wall structure is maximum hence Dumbbell shaped shear wall structure is economical as compare to regular shear wall building.
3. Comparing The earthquake displacement in regular shear wall building as compare to Dumbbell shaped shear wall building, displacement increased 1.00197 times as compare to Dumbbell shaped shear wall but relatively both building shows good performance in earthquake displacement.

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