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Comparing Design, Analysis and Estimation of a Residential Building with and Without Shear Wall in Zone 4

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ABSTRACT - - In the seismic design of buildings, reinforced concrete structure walls, or shear walls, act as a major earthquake resisting members. Structural walls provide a resistance against the lateral loads system. The properties of these seismic shear walls dominate the response of the building, it is important to evaluate the seismic response of the walls appropriately. Shear walls are generally used in high-rise buildings subject to lateral wind and seismic forces. In reinforced concrete framed structures the effects of wind forces increase in significance as the structure increases in height. Codes of practice impose limits on horizontal movement or sway. As we know that in the present scenario buildings with shear walls are gaining more popularity than buildings without shear wall in earthquake prone areas due to its capability to the resistance during earthquake. In this paper 2 storey RCC building is considered for the seismic analysis which is located in zone IV is considered for the analysis. Two models are considered for the analysis out of which one is bare frame model and the other structure with shear wall at various positions is considered. The purpose of standards is to ensure and enhance the safety, keeping careful balance between economy and safety. In the present study G+2 building of 37'6"×33'4" Is designed using STADD PRO software. In order to design them, it is important to first obtain the plan of the particular building that is, positioning of the particular rooms (Drawing room, bed room, kitchen toilet etc.) such that they serve their respective purpose and also suiting to the requirement and comfort of the inhabitants. Thereby depending on the suitability; plan layout of beams and the position of columns are fixed.

Key Words: Shear Wall, Base Shear, Staad Pro, storey displacement, seismic zones

I. INTRODUCTION

Comparative study of a building is to check and compare the strength of the building with and without shear wall. The major criteria now-a-days in designing RCC Structures in seismic zones are control of lateral displacement resulting from lateral forces. In this thesis effort has been made to investigate the effect of Shear Wall position on lateral displacement and Storey Drift in RCC Frames. The major criteria now-a-days in designing RCC structures in seismic zones is control of lateral displacement resulting from lateral forces. In this thesis effort has been made to investigate the effect of Shear Wall position on lateral displacement and Storey Drift in RCC Frames. Looking at the past records of Earthquake, there is increase in the demand of Earthquake resisting Building. It was observed that Multi storeyed R.C.C. Buildings with shear wall is economical as compared to without shear wall. Due to major earthquakes in the recent pasts the codal provisions are revised and implementing more weightage on earthquake design of structure.

1.1 OBJECTIVES

To study the storey displacement, bending moment, shear forces of structure with and without shear wall.
To calculate and Compare the cost of G+2 Residential Building with and without Shear wall.

1.2 LITERATURE REVIEW

P.P.Chandurkar, Dr.P.S.Pajgade. (2013):- In this paper studied the seismic analysis of the RCC building with and without shear wall for 10 storey building. The main focus of this paper will be solution the shear wall location in multi storey building. Four different models should be considered in zone II zone III zone IV zone V. These four seismic zones and four models should be calculated the parameters like storey displacement,

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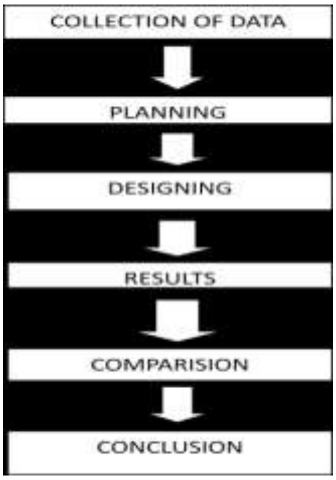
storey drift. Also calculate the total cost for the ground floor with the both cases replacing column with shear wall. The whole analysis is carried out by using ETAB v.9.5.0 software. For ten storey or below ten storey building the shear wall will not effective. But in high rise building it is effective and also economical. Providing of shear wall at adequate locations substantially reduces the displacements due to earthquake.

Varsha R.Harneanalysed:- A six storey building subjected to earthquake loading in zone II using STAAD Pro and calculated earthquake load using seismic coefficient method (IS 1893 Part II). Four different cases were analysed comprising of a structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross type shear wall. The lateral deflection of column for building with shear wall along periphery is reduced as compared to other types of shear walls .It was found that shear wall along periphery is most efficient among all the shear walls considered.

M. S. Aainawala et. al. (2014): Comparative study of multi- storeyed R.C.C. Buildings with and without Shear Walls: He did the comparative study of multi-storeyed R.C.C. Buildings with and without Shear Walls. They applied the earthquake load to a building for G+12, G+25, G+38 located in zone II, zone III, zone IV and zone V for different cases of shear wall position. They calculated the lateral displacement and story drift in all the cases. It was observed that Multistoreyed R.C.C. Buildings with shear wall is economical as compared to without shear wall. As per analysis, it was concluded that displacement at different level in multistoreyed building with shear wall is comparatively lesser as compared to R.C.C. building without shear wall. This is important for building design and use of shear walls.

1.3 METHODOLOGY



II. MODELLING AND ANALYSIS

We collected the information about the Zone IV, Area of the building, desired plans for G+2 building with and without shear wall and the data of loads.

2.1 MODELLING

1. G+2 BUILDING WITHOUT SHEAR WALL IN ZONE -IV
2. G+2 BUILDING WITH SHEAR WALL IN ZONE -IV

ANALYSIS DATA

Table 2.1 Data for Analysis

PLAN SIZE	11.43m X 10.16m
NO.OF STOREYS	2
STOREY HEIGHT	3.2004m
WALL THICKNESS	0.23m
SLAB THICKNESS	0.1524m
COLUMN SIZE	0.3048mX0.3048m
BEAM SIZE	0.3048mX0.3048m
GRADE OF STEEL	Fe 415
GRADE OF CONCRETE	M20
DEAD LOAD	14KN / m
LIVE LOAD	3.81KN / m
SOIL CONDITION	Medium
THICKNESS OF SHEAR WALL	0.1524m

PLANNING

Data Required for Modeling:-

Length of the bay	11.43m
Height of the bay	9.6012m
Width of the bay	10.16m
No of bays along the length	3
No of bays along the height	3
No of bays along the width	2

Table 2.2 Building Dimensions

Fig. 2.1 2BHK Plan

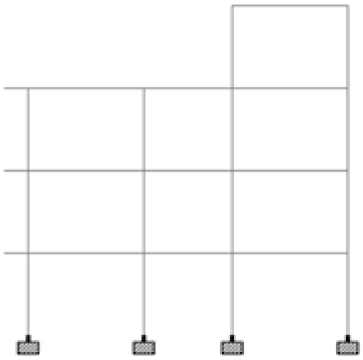


Fig. 2.2 Front view of the building

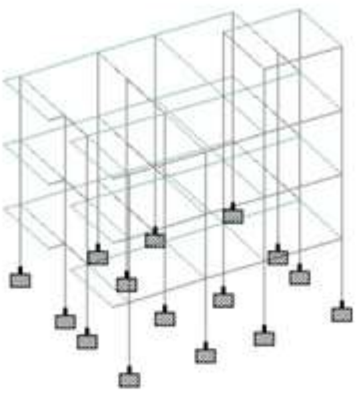


Fig. 2.3 Isometric view

DESIGNING

Fig. 2.4 3D Rendered Model without Shear Wall

Fig. 2.5 3D Rendered Model with Shear Wall

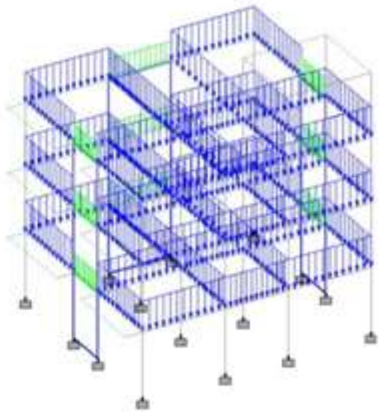


Fig. 2.6 Dead Load

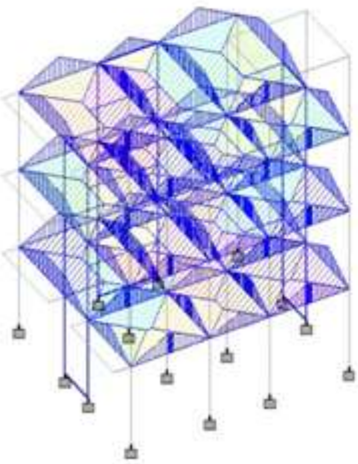


Fig. 2.7 Live Load

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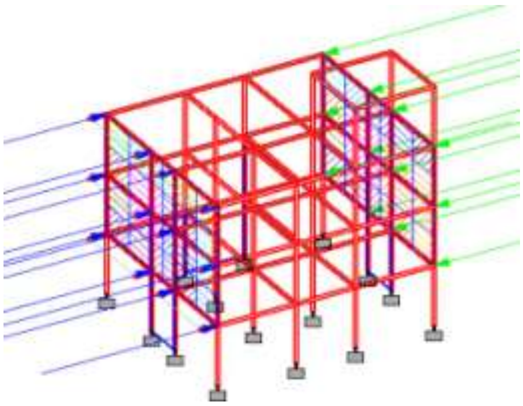

Fig. 2.8 The wind load acting on building in W+X Direction

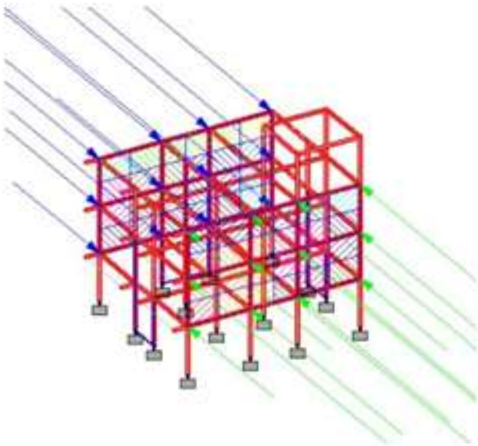

Fig. 2.9 The wind load acting on building in W+Z Direction

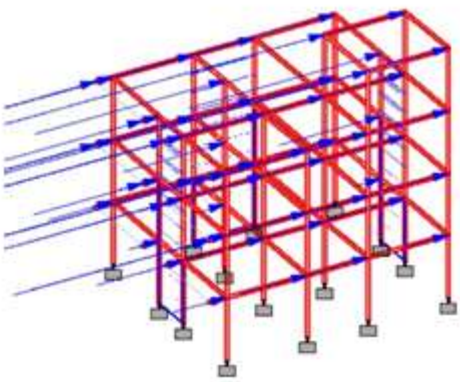

Fig. 2.10 Seismic Load Acting on Building EQ+X

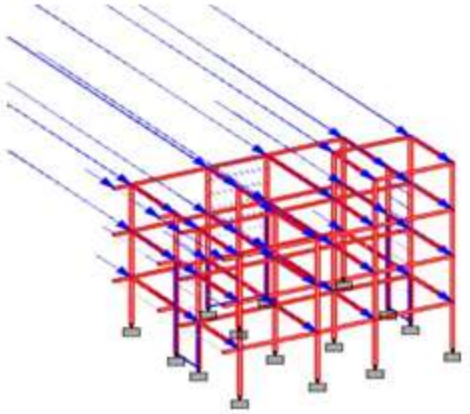

Fig. 2.11 Seismic Load Acting on Building EQ+Z

III. SHEAR WALL

1. While columns and load-bearing walls keep buildings standing up, carrying the compression load of the structure down to its foundation, the shear wall is what keeps structures from blowing over, resisting the lateral forces of wind and seismic activity.
2. Shear walls are especially important in high rise buildings. In residential buildings, shear walls provide all of the lateral supports for the building and reduce lateral sway of the building.
3. Almost all houses have external shear walls, but internal shear walls are typically found only in larger houses and high-rise buildings subject to lateral winds and seismic forces. The taller the building, the greater the need for internal shear walls and a lateral force resisting system.
4. Shear wall behavior depends upon Material used, wall thickness, wall length, wall positioning in building frame also.

3.1 ADVANTAGES OF SHEAR WALLS

1. Easy to Construct.
2. Easily Implemented at the Site.
3. Minimum Earthquake Damage.

3.2 STAAD. PRO

STAAD Pro is a Structural Analysis and Design Program Software.
It includes a state-of-the-art user interface, visualization tools and international design codes.
It is used for 3D model generation, analysis and design The commercial version of STAAD Pro supports several steel, concrete and timber design codes.
It is one of the software applications created to help Structural Engineers to automate their tasks and to remove the tedious and long procedures of the manual methods.

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IV. RESULTS AND DISCUSSIONS

Table 4 MAXIMUM DISPLACEMENT

Model Name	Maximum displacement(in)
Seismic Zone	Zone IV
Without Shear Wall	0.023
With Shear Wall	0.015

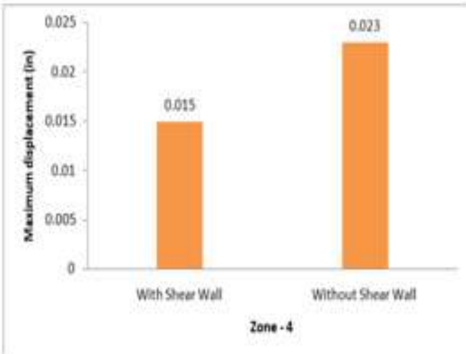
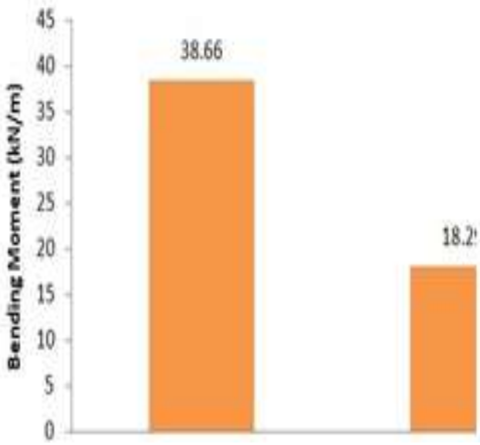


Table 4.1 Combination Stress values

4.1 BENDING MOMENT

Table 4.1 Bending Moment values

Model Name	Bending Moment (kN/m)
Seismic Zone	Zone IV
Without Shear Wall	38.66
With Shear Wall	18.29

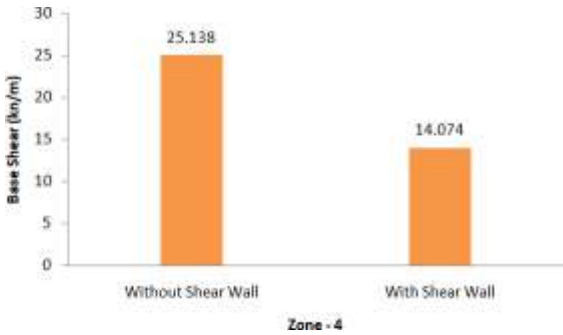


Graph 4.1 Comparison of Bending Moments

4.2 BASE SHEAR

Table 4.2 Base Shear values

Model Name	Base Shear (kN/n)
Seismic Zone	Zone IV
Without Shear Wall	25.138
With Shear Wall	14.074



Graph 4.2 Comparison of Base Shear

4.3 ESTIMATION

Table 4.3(a) : Rate Analysis without Shear wall

SNO.	DESCRIPTION	REQ. QUANTITY	RATE(IN RS.)	PER	AMOUNT(IN RS.)
1	EARTHWORK	21.675	150	CUBIC METRE	3251.25
2	SAND LAYER	33.839	1480	CUBIC METRE	50081.72
3	PCC	11.81	3450	CUBIC METRE	40744.5
4	DPC	0.762	330	SMT	251.46
5	RCC	111.495	3800	CUBIC METRE	423681
6	BRICK MASONARY (1:6)	131.62	4800	CUBIC METRE	631776
7	FLOORING (100mm, 1:2:4)	102.54	700	SQUARE METRE	71778
8	PLASTERING(1:4)	1723.9	300	SQUARE METRE	517170
9	WHITE CEMENT	1723.9	110	SQUARE METRE	189629
10	DISTEMBER	1723.9	125	SQUARE METRE	215487.5
11	PAINT(non texture)	1723.9	200	SQUARE METRE	344780
12	MARBLE FLOOR	298.502	1000	SQUARE METRE	298502
13	DOORS	25	6500	NUMBER	162500
14	WINDOWS	9	3500	NUMBER	31500
				TOTAL	2981132.43
	CONTIGENCIES		4%		119245.297
	WORK CHARGE ESTABLISHMENT		2.50%		74528.311
	CONTRACTOR		10%		298113.243
				GRAND TOTAL	3473019.281

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Table 4.3(b) : Rate Analysis with Shear wall

SNO.	DESCRIPTION	REQ. QUANTITY	RATE(IN RS.)	PER	AMOUNT(IN RS.)
1	EARTHWORK	21.675	150	CUBIC METRE	3251.25
2	SAND LAYER	33.839	1480	CUBIC METRE	50081.72
3	PCC	11.81	3450	CUBIC METRE	40744.5
4	DPC	0.762	330	SMT	251.46
5	RCC	111.495	3800	CUBIC METRE	423681
6	SHEAR WALL	18.66	3500	CUBIC METRE	65310
7	BRICK MASONAR	106.521	4800	CUBIC METRE	511300.8
	(1:6)				
8	FLOORING	102.54	700	SQUARE METRE	71778
	(100mm, 1:2:4)				
9	PLASTERING(1:4)	1723.9	300	SQUARE METRE	517170
10	WHITE CEMENT	1723.9	110	SQUARE METRE	189629
11	DISTEMBER	1723.9	125	SQUARE METRE	215487.5
12	PAINT(non texture	1723.9	200	SQUARE METRE	344780
13	MARBLE FLOOR	298.502	1000	SQUARE METRE	298502
14	DOORS	25	6500	NUMBER	162500
15	WINDOWS	9	3500	NUMBER	31500
				TOTAL	2925967.23
	CONTIGENCIES		4%		117038.68
	WORK CHARGE		2.50%		73149.181
	ESTABLISHMENT				
	CONTRACTOR		10%		292596.72
				GRAND TOTAL	3408751.811

It is clear from the table 4.3(a) & table 4.3(b) that rate of G+2 residential building without shear wall is around
Rs. 34,73,019.28 & rate of building with shear wall is Rs. 34,08,751.81
There is a difference of total Rs. 64,267.19. Therefore shear wall is cost effective.

V. CONCLUSIONS

In zone-4 the maximum displacement is 34.7% less in building with shear wall when compared to building without shear wall.
In zone-4 the Bending moment is 52.6% less in building with shear wall when compared to building without shear wall.
In zone-4 the base shear is 44.01% less in building with shear wall when compared to building without shear wall.
The Cost of building is 1.85% less in building with shear wall when compared to building without shear wall.
Hence we can conclude that shear wall in building reduces maximum displacement, bending moment, combination stresses and cost of the building. So building with shear wall is better when compared to building without shear wall.

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