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Controlling Seismic Effect on the Structure by Optimum Placement of Shear Wall

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Abstract — *From the past records of earthquake, there is increase in the demand of earthquake resisting building which can be fulfilled by providing the shear wall systems in the buildings. In this research paper, the work has been carried out for the best performance of lateral load resisting system by orienting the shear wall in various positions in the structure. This study consists of a lateral load resisting system with various positioning of shear wall with unsymmetrical plan. Earthquake zone III for medium soil has been considered. Static Method of Analysis (IS-1893-2002) and ETABs Software is used to analysis the structure. Different configurations of system are as follows: Bare Frame, Shear Wall on edges in X-Direction, Shear Wall on edges in Y-Direction, Shear Wall on edges in XY-Direction, Shear Wall in Core X-Direction, Shear Wall in Core Y-Direction and Shear Wall in Core XY-Direction.*

Keywords*- Lateral Load Resisting System, Shear Wall, Static Method of Analysis, Unsymmetrical Plan, Base Shear, Displacement*

I. INTRODUCTION

Due to increase in demand of earthquake resisting building, the concept of Lateral-force-resisting element is most widely used concept in every structure. The three principal types of resisting elements are *shear walls*, *braced frames*, and *moment- resisting frames.* A *shear wall* is a vertical structural element that resists lateral forces in the plane of the wall through shear and bending. A *braced frame* is a truss system of the concentric or eccentric type in which the lateral forces are resisted through axial stresses in the members. *Moment-resisting frames* carry lateral loads primarily by flexure in the members and joints. Thus, shear walls are more preferable to provide from structural as well as architectural point of view.

Most RC buildings with shear walls also have columns; these columns primarily carry *gravity* loads (*i.e.*, those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry *large* horizontal earthquake forces, the overturning effects on them are large. Shear walls should be provided along preferably *both* length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a *moment-resistant frame*) must be provided along the other direction to resist strong earthquake effects.

II. OBJECTIVE OF STUDY

a. To obtain strength and stiffness in structure by providing shear-wall.
b. To obtain best performance of structure in terms of base shear and displacement.
c. To study the Optimum location of shear wall having uniform thickness throughout the building.

III. LITERATURE REVIEW

➢ **Anuj Chandiwala, "Earthquake Analysis of Building Configuration with different positions of Shear Wall"**

Research Paper aims to focus on behavior of building when subjected to lateral force and how it will resist the lateral forces by different placement of shear wall in building. It also provides different analysis method of determining earthquake forces. Analysis was done on 10 storey RC building and results were obtained by placing the shear wall in different position and to obtain best result.

➢ **Anshul Sud, Raghav Singh Sekhawat, Poonam Dhiman, "Best placement of Shear wall in an RCC space frame based on Seismic Response"**

This paper represents an analysis of RCC frame placed in Zone-V with shear wall placed in different direction in terms of maximum displacement storey drift and base shear. The best orientation of shear wall in structure is decided on the basis of the results obtained from analysis. It also suggests to place shear wall symmetrically to avoid torsion.

1**General Concepts on Earthquake Resistant Building**

The theory presents certain principles on which a structure can resist the earthquake force and minimize the damage. Certain planning aspect regarding the geometry of building are discussed such as simplicity, symmetry, regularity, etc are discussed. How the design of structure shall be done is also been discussed here.

- **P.P. Chandurkar, Dr. P.S. Pajgade, "Seismic Analysis of RCC Building with and without Shear Wall"**

Research Paper focuses to determine the solution of location of shear wall in RC building to resist the lateral load acting on it by carrying out modeling of RC building with lateral load resisting system for different zones. Parameters such as Storey Drift and Lateral Displacement are calculated by replacing column with shear wall.

- **C. V. R. Murty, Rupen Goswami, A. R. Vijayanarayanan, Vipul V. Mehta, "Earthquake Behavior of Buildings"**

This book overall covers the brief topics related to Earthquake Behavior of Building. It provides a detailed description on earthquake capacity of building having elastic and inelastic behavior. It also includes some important tips related to design of earthquake resistant building.

- **Lakshmi K.O., Prof. Jayasree Ramanujan, Mrs. Bindu Sunil, Dr. Laju Kottallil, Prof. Mercy Joseph Poweth, "Effect of shear wall location in buildings subjected to seismic loads"**

This study aims at comparing various parameters such as storey drift, storey shear, deflection, reinforcement requirement in columns etc of a building under lateral loads based on strategic positioning of shear walls. Shear wall systems are one of the most commonly used lateral load resisting systems in high rise buildings. Based on linear and nonlinear analysis procedures adopted, the effects of shear wall location on various parameters are compared.

- **Mr. K. Lova Raju , Dr. K.V.G. D. Balaji, "Effective location of shear wall on performance of building frame subjected to earthquake load"**

This paper deals with various position of shear wall in building frame and analysis of it. In this study, the focus is to identify effective location of shear wall in multi-storey building. Comparison is made of 8-storey building in four different zones. Analysis is carried out with the help ETABs Software.

IV. METHODOLOGY

A. MODEL DATA

a. Grid Data

No. of grids in X-Direction	7
No. of grids in Y-Direction	5
Distance between gridlines	5 m

b. Storey Data

Name	Height (mm)	Elevation (mm)
Story5	3500	17500
Story4	3500	14000
Story3	3500	10500
Story2	3500	7000
Story1	3500	3500
Base	0	0

c. Materials

Name	Type	E (MPa)	Unit Weight (kN/m^3)	Design Strengths
HYSD415	Rebar	200000	76.9729	Fy=415 MPa,
M25	Concrete	25000	24.9926	Fc=25 MPa

d. Frame Section

Name	Material	Shape	Size (mm)
B1	M25	Concrete Rectangular	550x650
B2	M25	Concrete Rectangular	400x600
C1	M25	Concrete Rectangular	600x600
C2	M25	Concrete Rectangular	500x500

e. Shell Section

Name	Design Type	Element Type	Material	Total Thickness Mm
S1	Slab	Membrane	M25	150
SW	Wall	Shell-Thin	M25	230

f. Seismic Load Calculation

Following data are taken into consideration for calculating the lateral seismic load for EQ-X and EQ-Y.

Sr. No.	Factor	Value
1	Seismic Zone Factor	III
2	Response Reduction Factor	3
3	Important Factor	1
4	Soil Type	II
5	Spectral Acceleration Coefficient	2.50
6	Time Period EQX	0.28 s
7	Time Period EQY	0.35 s

B. Orientation of Shear wall in structure with 3-D View

a. Bare Frame Structure

b. Shear wall at corner in X- Direction

c. Shear wall at corner in Y- Direction

d. Shear wall at corner in XY- Direction

e. Shear wall at core in X- Direction
f. Shear wall at core in Y- Direction

g. Shear wall at core in XY-Direction

C. Load Combination

a. 1.5DL + 1.5EQX
b. 1.5DL + 1.5EQY
c. 1.5DL - 1.5EQX

d. 1.5DL - 1.5EQY

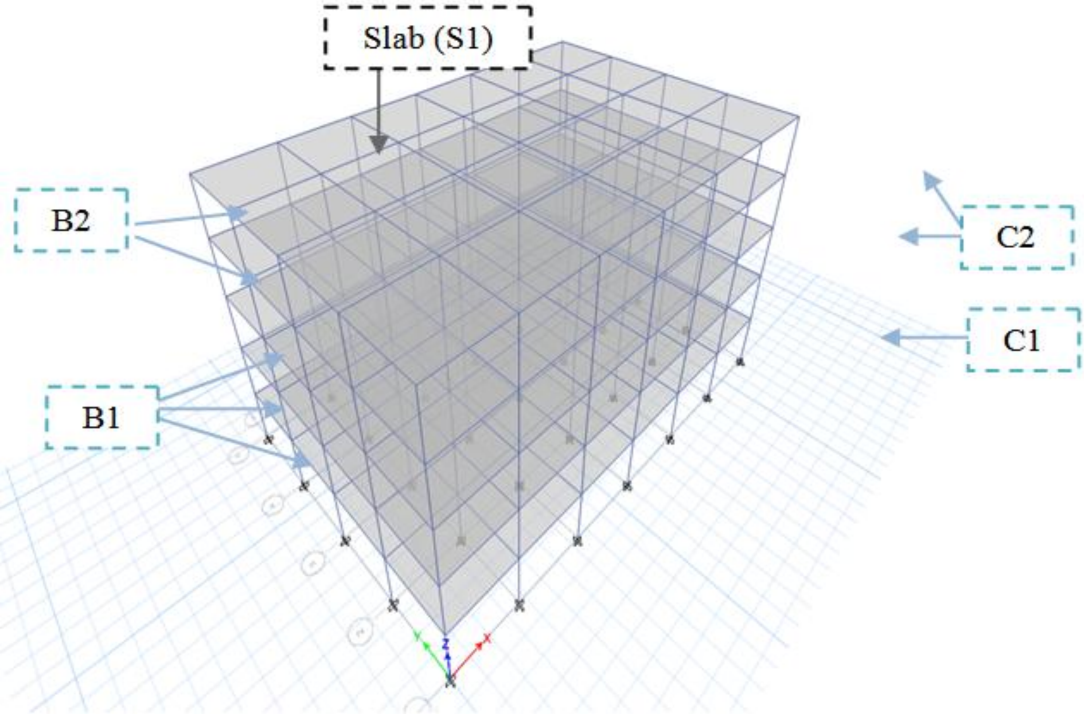
e. 1.2DL + 1.2LL + 1.2EQX

f. 1.2DL + 1.2LL + 1.2EQY

g. 1.2DL + 1.2LL - 1.2EQX

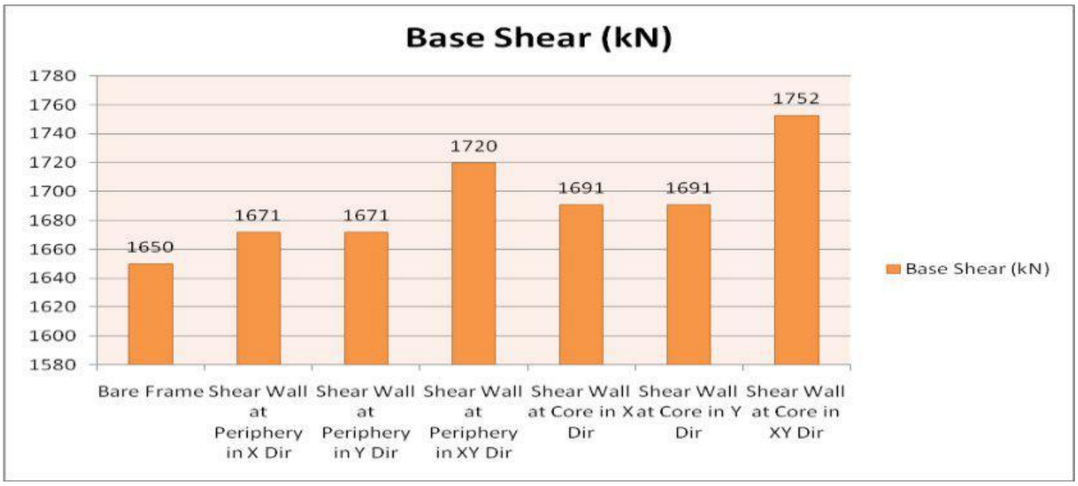
h. 1.2DL + 1.2LL - 1.2EQY
i. 1..5DL + 1.5LL

D. **Isometric View of Proposed Model**



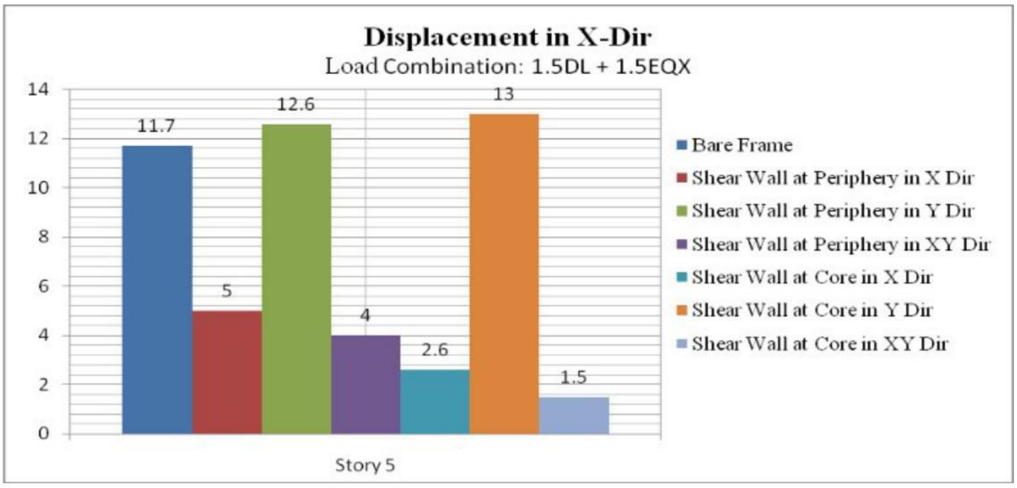
V. RESULTS

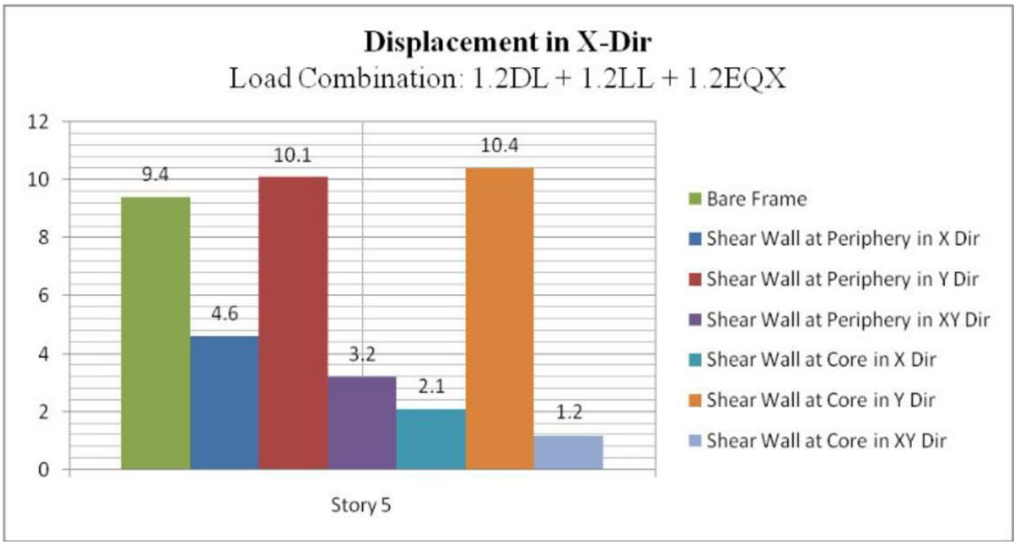
A. **Base Shear Results**
The graphical representation of Base Shear is shown for different frames

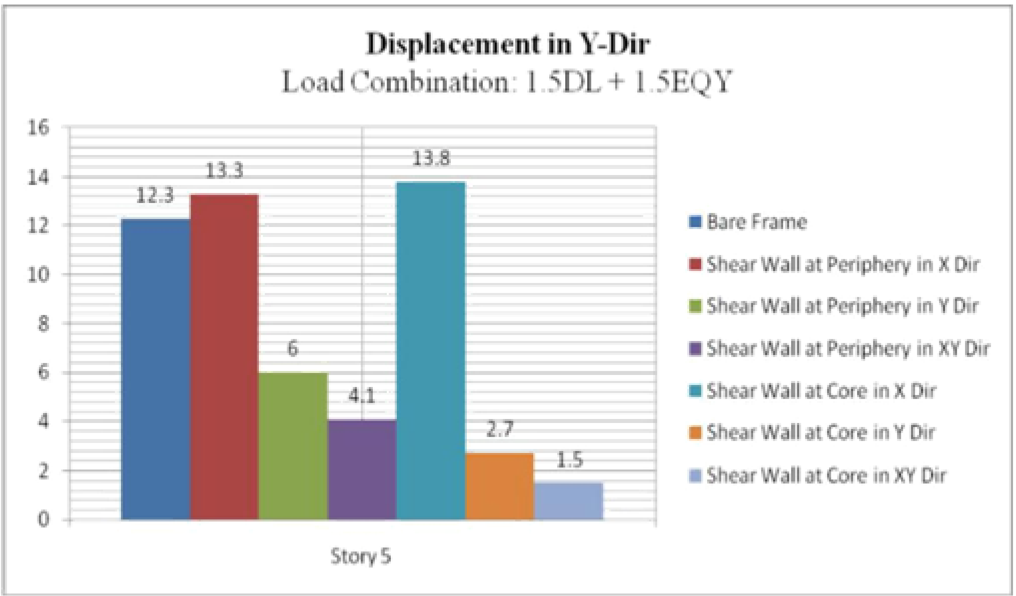


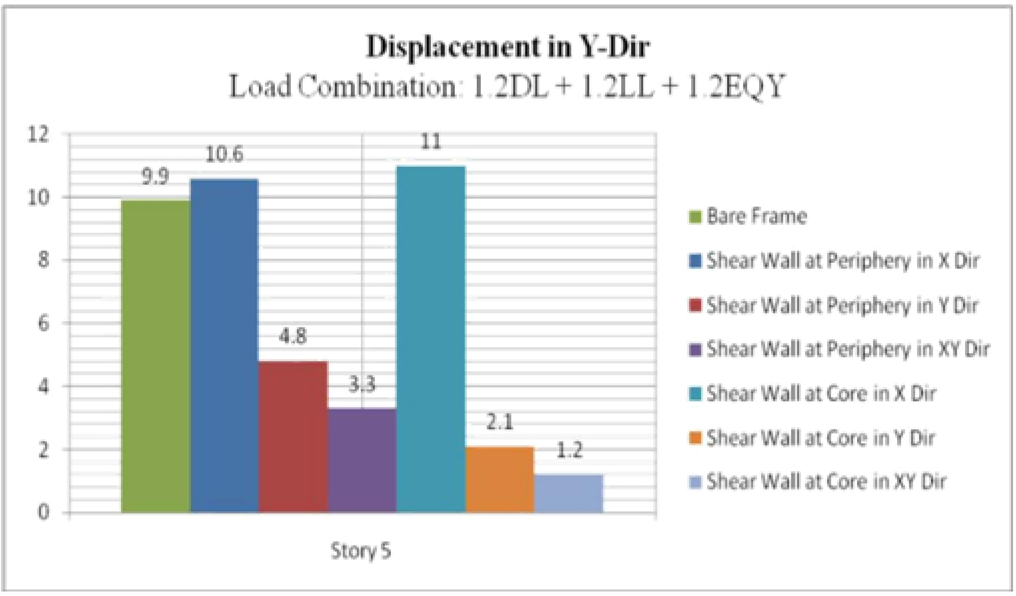
B. Maximum Displacement

Considering load combination 1.5DL + 1.5EQX, 1.5DL + 1.5 EQY, 1.5DL + 1.5LL + 1.5EQX, 1.5DL + 1.5LL + 1.5EQY, maximum story displacement is shown by graphical representation for 5th story.









VI. CONCLUSION

A. Only placing shear wall does not reduce displacement, but its direction and orientation is very vital parameter. From the above graphs, considering above load combination and displacement in both the directions, it can be analyzed that even a bare frame without shear wall has lesser displacement as compared to those having shear wall perpendicular to earthquake direction.

B. Placing the shear wall at core XY reduces the displacement almost 2.66 times as that placed at the exterior periphery in XY direction.

C. Placing the shear wall at core X reduces the displacement almost 2.0 times as that placed at the exterior periphery in X direction.

D. Placing the shear wall at core Y reduces the displacement almost 2.0 times as that placed at the exterior periphery in Y direction.

E. Base Shear value changes due to placement of shear wall too. It not only increases by placing shear wall but also increases as we move the shear wall towards the inner core.

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