Study of Shear Wall in Multistoried Building with Different Thickness and Reinforcement Percentage on Sloping Ground

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Abstract- **In the present study investigated about the different thickness of shear walls in the different terrain. In this project we have considered two elevated structures such as 10 and 15 stories on sloping ground due to drastic increment of population. We have used shear wall of thickness of 5", 10",15" and 20" at a uniform location, Sloping ground of 25o and used the seismic zone as IV and V. It is analysed by static analysis method by using ETABS 2015.we have studied parameters such as Storey displacement, Storey drift, Base shear, Storey shear and Modal time period.**

Index Terms- Shear Wall, ETABS, earthquake resistant design, Design of shear Wall, Sloping ground, Percentage of Reinforcement in Shear Wall

1. INTRODUCTION

Shear wall may be defined as structural elements, which provide strength, stiffness and stability against lateral loads deriving strength and stiffness mainly their shape in many cases, high rise buildings are designed as a framed structure with shear walls that can effectively resist horizontal forces. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation. Shear walls in high seismic regions require special detailing.

The use of shear wall structure has gained popularity in high rise building structure, especially in the construction of service apartment or office/ commercial tower. It has been proven that this system provides efficient structural system for multi-story building in the range of 30-35 story's. In the past 30 years of the record service history of tall building containing shear wall element, none has collapsed during strong winds and earthquakes.

2. FUNCTION OF SHEAR WALL

Shear wall systems are one of the most commonly used lateral load resisting systems in high-rise buildings. Shear walls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous in many structural engineering applications. Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings. Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive sideway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less non-structural damage.

The properties of seismic shear walls dominate the response of the buildings, and therefore it is important to evaluate the seismic response of the shear walls appropriately. Also it is necessary to find out the effective location of shear wall in the structure.

3. OBJECTIVES

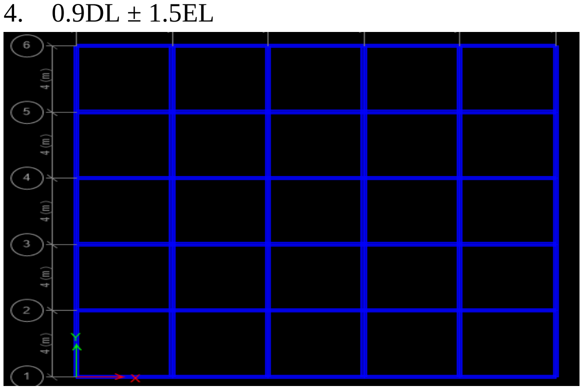
- To study behavior of shear wall with different thickness and determining required percentage of reinforcement on sloping ground.
- To study the variations of displacement with respect to different thickness of shear walls.
- To study the variations of base shear with respect to different thickness of shear walls.
- To study the variations of storey shear with respect to different thickness of shear walls.
- To study the variations of storey drift with respect to different thickness of shear walls.
- To study the variations of mode period with respect to different thickness of
- shear walls To suggest a suitable configuration of building to be used in hilly areas.

4. METHODOLOGY

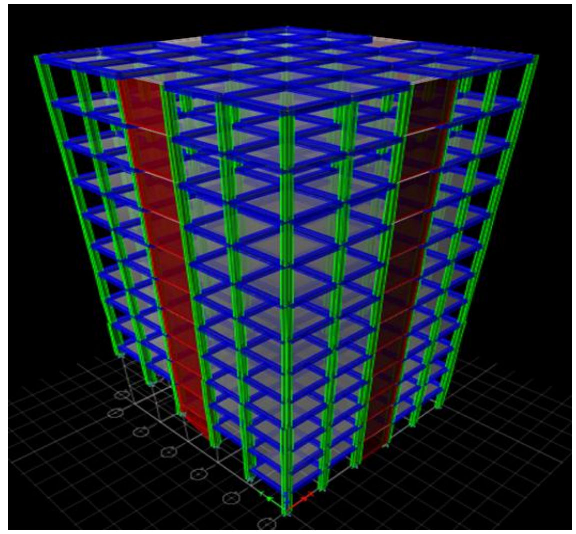
To study and evaluate the behavior of reinforce concrete buildings resting on the sloping ground, equivalent static analysis of a RC- building with fixed base is done considering different types of shear walls using ETABS. To study behavior of shear wall with different thickness and determining percentage of reinforcement on sloping ground .Equivalent static Analysis of all building models, in terms of base shear and roof displacement is presented and compared with the different thickness of shear wall.

Load Combination

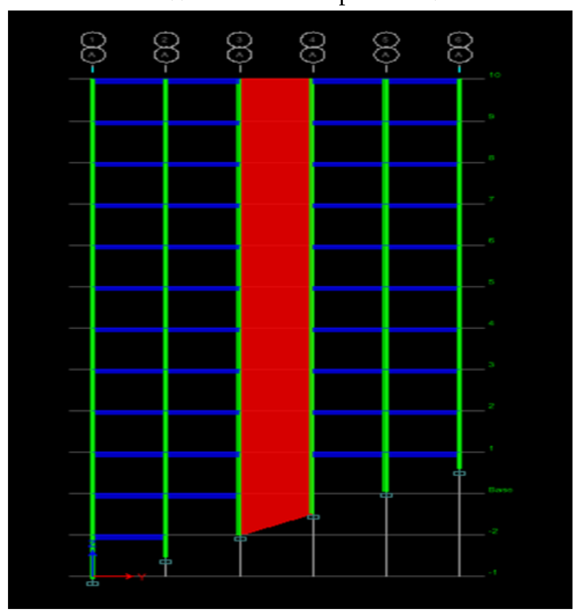
1. 1.5 (DL + LL)
2. 1.2 (DL + LL ± EL)
3. 1.5 (DL ± EL)
4. 0.9DL ± 1.5EL



Floor Plan



Shear Wall for 25o slope - 3D View



Shear Wall for 25o slope - Elevation View

4.1 Details of Structural Members considered for Analysis and Design

Material Properties

Young's Modulus (E) for M30 Concrete = 27.376x106 kN/m2

Density of Concrete = 25kN/m3

Density of Masonry Unit = 20kN/m3

Poisson's Ratio = 0.2

Member Properties

Slab thickness = 150mm

Column Size from Level (-3) to Level (2) = 450mmx900mm (M30)

Column Size from Level (3) to Level (10) = 350mmx750mm (M30)
Beam Size = 300mmx450mm (M25)
Masonry Wall Thickness = 230mm
Shear Wall Thickness = 125mm, 250mm, 375mm, 500mm
Support Type = Fixed

Loads Considered
Wall Load = 14.03 kN/m
Live Load = 3.00 kN/m2
Live Load on Roof = 1.50 kN/m2
Floor Finish = 1.00 kN/m2

Seismic Data
Zone Factor = 0.24 (Zone IV and Zone V)
Importance factor = 1
Response Reduction Factor = 3
Soil type = II

Percentage of Reinforcement for Different Thickness of Shear Wall

Percentage of Reinforcement in Zone IV

Storey	Pier Label	5 inch	10 inch	15 inch	20 inch
10	P1	0.25	0.25	0.25	0.25
9	P1	0.25	0.25	0.25	0.25
8	P1	0.25	0.25	0.25	0.25
7	P1	0.56	0.25	0.25	0.25
6	P1	1.03	0.25	0.25	0.25
5	P1	1.75	0.44	0.36	0.34
4	P1	2.17	0.63	0.5	0.48
3	P1	2.03	0.67	0.53	0.52
2	P1	2.95	0.86	0.74	0.72
1	P1	3.2	0.87	0.75	0.72
G	P1	3.99	0.96	0.78	0.75
10	P2	0.25	0.25	0.25	0.25
9	P2	0.25	0.25	0.25	0.25
8	P2	0.25	0.25	0.25	0.25
7	P2	0.52	0.25	0.25	0.25
6	P2	0.92	0.25	0.25	0.25
5	P2	1.63	0.45	0.37	0.35
4	P2	2.18	0.65	0.5	0.49
3	P2	2.25	0.73	0.57	0.53
2	P2	3.64	1.23	0.99	0.87
1	P2	4.44	2.51	2.2	2.11
10	P3	0.25	0.25	0.25	0.25
9	P3	0.25	0.25	0.25	0.25
8	P3	0.25	0.25	0.25	0.25
7	P3	0.52	0.25	0.25	0.25
6	P3	1	0.25	0.25	0.25
5	P3	1.71	0.4	0.31	0.3
4	P3	2.14	0.56	0.48	0.47
3	P3	2.02	0.61	0.5	0.5
2	P3	2.95	0.83	0.71	0.69
1	P3	3.22	0.86	0.74	0.71
G	P3	3.98	0.97	0.79	0.75
10	P4	0.25	0.25	0.25	0.25
9	P4	0.25	0.25	0.25	0.25
8	P4	0.28	0.25	0.25	0.25
7	P4	0.47	0.25	0.25	0.25
6	P4	0.93	0.25	0.25	0.25
5	P4	1.65	0.4	0.3	0.29
4	P4	2.09	0.54	0.47	0.46
3	P4	1.98	0.58	0.5	0.49
2	P4	2.86	0.67	0.53	0.52
1	P4	3.46	0.66	0.52	0.51
G	P4	4.01	0.57	0.48	0.47
-1	P4	8.18	1.42	0.39	0.37
-2	P4	4	0.4	0.29	0.25

Percentage of Reinforcement in Zone V

Storey	Pier Label	5 inch	10 inch	15 inch	20 inch
10	P1	0.25	0.25	0.25	0.25
9	P1	0.25	0.25	0.25	0.25
8	P1	0.25	0.25	0.25	0.25
7	P1	0.57	0.25	0.25	0.25
6	P1	1.14	0.45	0.41	0.39
5	P1	2.01	0.74	0.65	0.6
4	P1	2.83	1.09	0.93	0.86
3	P1	2.36	1.07	0.94	0.9
2	P1	3.05	1.38	1.25	1.2
1	P1	3.11	1.42	1.28	1.23
G	P1	4.41	1.49	1.29	1.22
10	P2	0.25	0.25	0.25	0.25
9	P2	0.25	0.25	0.25	0.25
8	P2	0.25	0.25	0.25	0.25
7	P2	0.52	0.25	0.25	0.25
6	P2	1.21	0.45	0.4	0.39
5	P2	2.14	0.75	0.67	0.62
4	P2	2.98	1.12	0.97	0.88
3	P2	2.63	1.12	0.97	0.9
2	P2	3.81	1.77	1.59	1.42
1	P2	4.82	3.65	3.4	3.25
10	P3	0.25	0.25	0.25	0.25
9	P3	0.25	0.25	0.25	0.25
8	P3	0.25	0.25	0.25	0.25
7	P3	0.53	0.25	0.25	0.25
6	P3	1.14	0.4	0.36	0.35
5	P3	2	0.67	0.58	0.55
4	P3	2.82	1.01	0.86	0.83
3	P3	2.36	1.07	0.94	0.9
2	P3	3.04	1.37	1.23	1.19
1	P3	3.1	1.42	1.26	1.22
G	P3	4.42	1.49	1.27	1.22
10	P4	0.3	0.26	0.25	0.25
9	P4	0.25	0.25	0.25	0.25
8	P4	0.3	0.25	0.25	0.25
7	P4	0.48	0.25	0.25	0.25
6	P4	1.09	0.38	0.34	0.32
5	P4	1.76	0.65	0.54	0.51
4	P4	2.46	0.92	0.83	0.81

3	P4	2.14	0.88	0.83	0.82
2	P4	2.57	1.01	0.89	0.87
1	P4	2.81	1.02	0.87	0.86
G	P4	2.64	0.85	0.78	0.75
-1	P4	6.49	1.07	0.52	0.51
-2	P4	3.19	0.58	0.49	0.47

5. CONCLUSION

1. One observation of the study is the steep increase of reinforcement percentage when the seismic zone changes from Zone-IV to Zone-V.
2. It can be concluded that increase of shear wall thickness is not always beneficial for earthquake resistance design.
3. From overall observation it is found that shear wall thickness of 10 inch for 10 storey and 15 storey level provides proper seismic safety with minimum amount of reinforcement (in case of Zone-IV to Zone-IV). Shear wall thickness of 20 inch provides proper seismic safety.
4. However in most cases it is found that the reinforcement percentage is more in case of 20 inch thick shear wall than the wall with thickness of 10 inch.
5. It can be concluded that 10 inch shear wall thickness will be sufficient in case of the low rise to medium rise building, which will provide lot of cost benefit.
6. In case of Zone-V only 10 inch thickness is found to be most safe and economical thickness.
7. It can conclude that however thickness of shear wall increases the displacement goes on decreases.
8. It can conclude that increasing shear wall thickness the time period goes on decreases.
9. It can conclude that increasing the thickness of shear wall the base shear is also increases

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