ANALYSIS OF MULTI-STORIED BUILDING OF VARYING THICKNESS OF SHEAR WALL ON SLOPING GROUND

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Abstract—This study is to investigate the effect of different thickness of shear wall on sloping ground of multi-storied buildings. Building models with shear walls are developed using ETABS. The location of the shear walls are kept same and a comparative study is done for different thickness of the shear wall for different height of the building. In each of the cases corresponding Investigate is done for the effect of different thickness of shear wall on multi-storied building.

- Total number of models are considered =16
- Thickness of shear wall 5”,10”,15” and 20” are considered
- Zones to be consider (Zone-II and Zone-V).
- Height of structure is considered as 10 storey and 15 storey.

Keywords—Sloping ground, Seismic forces, Shear wall, RCC Building, Structural analysis, ETABS.

I. INTRODUCTION

Shear Walls are uniquely composed structural walls incorporated in the buildings to restrict horizontal forces that are convey in the plane of the wall due to wind, earthquake and distinctive forces. They are fundamentally flexural members and normally gave in high rise structures to avoid the total fall of the tall structure under the seismic forces.

Walls can be designed as plain concrete walls when there is only compression with no tension in the section. else, they should be composed as reinforced concrete walls.

The value of the Shear Walls in the confining of structures has sometimes been recognized. At the point when arranged in favourable places of structures, they give an sufficient power to oppose horizontal force resisting system, while at the same time satisfying other functional requirements. For structures up to 20 stories the utilization of shear walls is a decisions matter. For structure is more than 30 stories, shear walls may become basic from view point of economy and avoid of lateral deflection, Because a vast part of side long force on the structure and the lateral shear force usually from it is often assigned to such structural walls is known as “Shear Walls”.

Shear walls are behaves like vertical oriented wide beams that conveys earthquake forces downwards to the establishment. That is the reason, it is always suitable to reliable them in structure built in regions likely to earthquake of high amount of intensity or large winds.

II. RELATED WORK

Sanjay Sengupta (2014)¹¹—In this present study investigation done on the effect of varying thick of the shear wall and determining the corresponding percent of reinforcement in varying thickness of shear wall. For modelling and analysis developed by using the ETABS with. The position of shear walls are not changed and kept as same and a study they have done by varying thickness of the shear wall for different heights of structure (5 storied, 10 storied and 15 storied). In each cases following requirement reinforcement is found out. It is watched that for a steady thickness of shear divider, support rate increments with increment of the both seismicity and number of storie. It is likewise
watched that for all the zones, the support rate increments if the shear divider thickness increments for a specific scope of thickness and after that abatements for a specific scope of thickness. Along these lines the outcomes demonstrate that expansion of shear divider thickness isn't generally successful for seismic tremor safe outline.

G.S Hiremath¹, Md Saddam Hussain² (2014)[2] - In the present study, investigation of 25 stories working in zone IV is given some preparatory investigation to decrease the impact of quake strengthened solid shear walls are utilized as a part of the building. These can be utilized for enhancing seismic reaction of structures. The arrangement of shear walls in working to accomplish unbending nature has been discovered successful and prudent. Shear dividers are anything but difficult to develop and are productive, both regarding development cost and viability in limiting seismic tremor harm in structural and non-basic components (like glass windows and building substance). This investigation expects to chip away at impact of expansion of shear divider at various area and setup, additionally think about have been finished with changing thickness of shear divider. The outcomes are arranged by performing weakling investigation utilizing ETABS v 9.7.1 as relocations and story float.

Varsha R. Harne (2014)[3] - In this paper, accordingly, essential fixation is to choose the response for shear wall zone in multi-story building. A RCC working of six story set in NAGPUR subjected to seismic tremor stacking in zone-II is considered. A shudder stack is processed by seismic coefficient method using IS 1893 (PART– I):2002. These investigation were performed using STAAD Pro. An examination has been done to choose the nature of RC shear mass of a multi-storeyed working by changing shear divider territory. Three exceptional occasions of shear divider position for a 6 story building have been destitute down. Circuit of shear divider has ended up being unavoidable in multi-story attempting to contradict sidelong powers.

Prasad Ramesh Vaidya (2015)[4] - This examination investigates the seismic execution of shear divider developing inclining ground. The rule objective is to appreciate the lead of the developing inclining ground for better places of shear dividers and to think about the amleness of shear divider on slanting ground. The execution of building has been considered with the help of four numerical models. Exhibit one is of edge create essential structure and other three models are of twofold kind (shear divider plot coordinated effort) fundamental system with three particular spots of shear dividers. Response extend examination is finished by using restricted segment programming SAP 2000. The execution of working concerning movement, story coast and most prominent powers in portions has been displayed in this paper.

S K Hirde and N K Shelar (2015)[5] - In this paper they cleared up about The RCC building models having G+6 stories with shear dividers and without shear dividers laying on plain and slanting ground (incline 1V:2.33H) are considered for the examination. The response extend examination of building is finished using essential outlining programming SAP 2000 V 15.2.2 and the seismic execution of working with various shear dividers setups is stood out from reverence with parameters like base shear, level movement, day and age and part controls.

S. Swathi , G.V. Rama Rao, R. A. B. Depaa (2015)[6] - In uneven domains structures depend on inclining grounds. Exactly when the inclining areas go under the seismic zones, these structures are significantly vulnerable against tremors. This is a direct result of the way that the areas in the ground story are of different statures with the end goal that portion in one end is a short section and fragment in inverse end is a long fragment. Nearby this if the building has an open ground story, the seismic vulnerability is further additions. This paper deals with the relationship of seismic execution of sensitive story developing slanting grounds and fragile story building retrofitted with shear divider.
The purpose of the paper is to check if the seismic execution of the structure is upgraded when it is retrofitted with shear divider.

Ashwinkumar B. Karnale and D.N. Shinde (2015)[7] - The study shows the results for different courses of action of shear dividers for 6 story A case system structure that contains reinforced strong building. The results considered in light of effect saw in view of stature of structure having shear divider. In this paper The examination is enhanced the circumstance sidelong stacking. Weights used are indistinguishable static load as tremor stack. Results obtained from examination plotted to balance and with think about lead of RCC enclosed structures with shear dividers. The usage of shear divider is capable at corner of the structure. in addition, less convincing when used as a piece of low climb building.

S.P.Pawar and Dr.C.P.Pise (2016)[8] - The structures orchestrated on slant inclines in seismic tremor slanted locales are generally capricious, torsional coupled. Thusly, subjected to genuine mischief when affected by shake ground development. Such structures have mass and strength moving along the vertical and level planes, occurring the point of convergence of mass and point of convergence of inflexible nature don't blend on various floors, they ask for torsional examination, despite flat powers under the action of tremors. This examination moves with an examinations on the seismic lead of structures laying on inclining ground with a shear dividers. It is watched that the seismic direct of structures on slanting ground differentiate from various structures. The distinctive floors of such structures step backs towards slant. Most of the examinations agree that the structures laying on inclining ground has higher migration and base shear diverged from structures laying on plain ground and the shorter section attracts more powers and experience hurt when subjected to seismic tremor. Progress back building could exhibit all the more unprotected against seismic excitation. Seismic Performance, Sloping ground, Step back working with incline 100,200,300, Shear divider with different game plan.

III. OBJECTIVES

1. To study behaviour of shear wall with different thickness on sloping ground.
2. To study the variations of displacement with respect to different thickness of shear walls.
3. To study the variations of base shear with respect to different thickness of shear walls.
4. To study the variations of storey shear with respect to different thickness of shear walls.
5. To study the variations of storey drift with respect to different thickness of shear walls.
6. To study the variations of mode period with respect to different thickness of shear walls.
7. To suggest a suitable configuration of building to be used in hilly areas.

IV. METHODOLOGY

The present study is an effort towards analysis of the structure located on a sloping ground during the earthquake. An ordinary moment resisting building of G+9 and G+14 stories located over a medium soil is considered. The number of bays will be kept as 5 along both direction and the bay size will be kept as 5m with the storey height being 3.5m. Slope of the ground will be kept at 25°. The building will be analysed considering zone II and V by response spectra method using ETABS 2015 software. Three dimensional space frame analysis will be carried out for four different building configurations resting on sloping ground under the action of seismic load. The configurations include the thickness of shear wall like 5”, 10”, 15”, and 20” on two different height building of 10 and 15 storeys. The main frame remains same having constant height, constant area and constant exposures in all sides and materials with same properties are considered for all configurations.
The Various building models considered are:

- Model 1: Building with shear walls with thickness 125mm
- Model 2: Building with shear walls with thickness 250mm
- Model 3: Building with shear walls with thickness 375mm
- Model 4: Building with shear walls with thickness 500mm

Same models are consider for zone II and zone V in different height of building of 10storey and 15 storey.

V. STRUCTURAL MODELLING AND LOADING

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

The material and sectional properties in the analysis of different building compositions are as per IS 456:2000. Dead loads and live loads are compared as per IS 875 (part 1):1987 and IS 875(part 2):1987 respectively. Lateral load parameters are considered confirming to IS 1893 (Part 1): 2002. The load combinations are considered as per IS 875 (Part 5): 1987

![Fig 1: Bare Frame Model Elevation for 25° slope](image1)

![Fig 2: Bare Frame Model 3D View for 25° slope](image2)
VI. RESULTS AND DISCUSSIONS

In this presence study the behaviour of each model is captured and results are tabulated in form of percentage of reinforcement in shear wall, lateral displacement, storey drift, base shear, storey shear, and time period response spectrum analysis. The performance of all the models are observed and compare with the suitable model.
6.1 Storey Displacement:
Maximum Lateral Storey Displacement in Storey 10 and Zone II

Maximum Lateral Storey Displacement in Storey 15 and Zone II

Maximum Lateral Storey Displacement in Storey 10 and Zone V
Maximum Lateral Storey Displacement in Storey 15 and Zone V

Observation and Discussion on Lateral Displacement
By studying table 5.1 to table 5.8 and comparing their values it is observed that displacement values are higher in zone v when compare to zone ii, however thickness of shear wall is increases the displacement goes on decreases. The displacement Values in the structure is goes on increases from lower storey to the higher storey in the structure.

It is observed that the displacement value in X-Direction is more when compare to Y-Direction. This is majorly due to effect of sloping ground on the structure.

6.2 Storey Drift:
The maximum permissible Drift for an RC structure as IS 1893 – 2002 is 0.004 times of the storey height. The maximum storey drift values for all building models in X and Y direction mentioned below.

Storey Drift in 10 Storeys and Zone II
Storey Drift in 15 Storeys and Zone II

Storey Drift in 10 Storeys and Zone V

Storey Drift in 15 Storeys and Zone V
Observation and Discussion on Storey Drift
By studying it can be observed that drift values are more are less similar in Zone II and Zone V. In 10 storeys building drift values are goes on increases from base up to storeys 6 and reduces goes on to higher stories. In 15 storied building storeys drift is gradually increases from base to storey 9 and decreases higher storeys.
Then it observed that however thickness of shear wall increases slightly increases in storey drift also and in storey drift values in X direction is lesser when compare to Y direction due to effect of sloping along the Y direction.

6.3 Storey Shear:
The storey shear for each model is obtained from ETABS 2015 and values are plotted against the storey level.

Storey Shear in 10 Storeys and Zone II

Storey Shear in 15 Storeys and Zone II
Observation and Discussion on Storey Shear

By Studying we can conclude that storey shear is highest at the base of the structure or where structure meets the ground. This is because of bottom storey is level that is directly contact with the ground and feels the maximum effect of lateral forces.

6.4 Base Shear:
The base shear all values are obtained from ETABS 2015 and listed below
Base Shear 10 Storeys and Zone II

Base Shear in 10 Storeys along X Direction in Zone II

Base Shear in 10 Storeys along Y Direction in Zone II

Base Shear 10 Storeys and Zone V

Base Shear in 10 Storeys along X Direction in Zone V

Base Shear in 10 Storeys along Y Direction in Zone V
Observation and Discussion on Base Shear
By studying it can be observed that however the thickness of shear wall increases the base shear values also goes on increases. For change in thickness of shear wall the values increased about 6%.

6.5 Modal Time Period:
Time period required for each mode shape is obtained from ETABS and graph is plotted for Mode Shape vs. Time Period.
Observation and Discussion on Modal Time Period
By studying it observed that modal time period is more 5 inch shear wall compare to other shear wall. The thickness of shear wall increases time period goes on decrease.

VII. CONCLUSIONS
1. From the result it is concluded that when the seismic zone changes from Zone-II to Zone-V the percentage of Reinforcement increases.
2. It is concluded that for better earthquake resisting design the thickness of shear wall is not useful.
3. From overall observation it is found that shear wall thickness of 10 inch for 10 storey and 15 storey levels provide proper seismic safeties with minimum amount of the reinforcement (in case of Zone II to Zone V). The thickness of 20 inch shear wall provides proper seismic safety.
4. It can be conclude that 10 inch shear wall thickness will be the sufficient in the case of the low rises to medium rises buildings, which will provided the lot of cost benefits.
5. In case of Zone V only 10 inch thick wall is founded to be most safe and economic thickness.
6. As the thickness of shear wall increases the displacement goes on decreases.
7. It can conclude that increasing shear wall thickness the time period goes on decreases.
8. It can conclude that increasing the thickness of shear wall the base shear is also increases.
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