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Positioning of Shear Wall In L- Shaped Unsymmetrical Building on The Sloping Ground.

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Abstract

Shear wall is most commonly used lateral load resisting systems in high-rise multistoried structure. Shear walls have a efficient characteristics like in plane stiffness and strength, which can be used to resist large horizontal loads and support gravity loads, making them advantageous in structural engineering applications. In this research work main focus is to determine effective positioning shear wall location in multistory building on the sloping ground nature. A RCC building of G+7 storey placed in sloping terrain subjected to earthquake loading in zone-V is considered. An earthquake load is calculated by seismic coefficient method using IS 1893 (PART–I):2016. These analyses were performed using STAAD Pro. A study has been carried out to determine the various parameters like storey shear in the sloping ground G+7 storey building by Introducing various shapes and locations of the shear wall. Seven different cases of shear wall position for a G +7 storey building have been analyzed. Integration of shear wall has become necessity in multi-storey building to resist lateral forces and provide stiffness to structure.

Key Words: Multi-storied sloping ground building, RC structure, seismic analysis, RC shear wall, STADD Pro Software.

1. Introduction

In developing country like India, industries are growing rapidly everywhere in the country. Growth and rapid urbanization in the hilly region have accelerated the real estate development due to population density in the hilly region that increased enormously. A scarcity of plain ground in hilly area compels the construction activity on slopping ground.

While constructing the multistoried building on slopping ground, it is important to consider the natural calamities factors like earthquake, wind forces and also uneven settlement loads, in addition to the weight of structure and occupants, create bending and twisting forces on the high-rise buildings. To overcome such situation, Shear wall plays vital role to maintain stability and rigidity of multistoried structure by positioning them in proper manner.

2. Building Description

In this work the structure which is taken into account for the purpose of analysis has been designed as a practical office building in nature.it will be an unsymmetrical building for G +7 Storey building. Having three depth of grids to make it structure on the sloping ground. The total length of building in X direction will be 52.5 meters and length in Z direction will be 30 meters. Width of the building will be 7.5 meters throughout the structure. The total height of building will be 24 meters in Y direction. M25 grade of concrete and Fe500 steel has been used. The detailed parameters for the building are explained in detailed further below-

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2.1 Salient Features of Building

The structural parameters of the buildings are explained as below -

- The geometrical shape of the structure is taken as "L" Shaped Building i.e., Asymmetrical in Geometry.
- Building will have three different depths of height as the building is situated on sloping ground.
- Grid 01 is consisting of two columns which are at height of 3meters from the ground.
- Grid 02 is consisting of four groups of columns which are at height of 2 meters from the ground.
- Grid 03 is consisting of sixteen columns which are at height of 1 meter from the ground.
- So as basically we are designing this building as a practical building so considering it as the multistoried structure as an office building.
- The multistoried structure is framed RC structure so there is grid of primary beams of 7.5m x 7.5m which is further divided into grids of 3.75m x 3.75m by provision of secondary beams which will be resting on the primary beam structure. Basically, the secondary beams will intersect each other at the same level in the grid formation.
- Structure will be consisting of 7 Primary grids in horizontal (x) direction and 4 primary grids in vertical (Z) direction in plan.
- It consists of G+7 floors(Y) direction situated on the Sloping Ground.
- The dimensions for beam will be 230mm X 600mm for overall except lift and staircase and 230mm X 450mm for beams provided for staircase and lift shaft.
- The dimension for columns will be 300mm X 450mm to 300mm X 750mm except lift and staircase and 230mm X 400mm for columns provided for staircase and lift shaft.
- Slab will be of depth 135mm RCC slab.

2.2 Plan and Framing Plan of Building

The structure which is considered for analysis is designed as the office building. Fig. 01 shows the detailed plan of the structure which includes various units in the building.

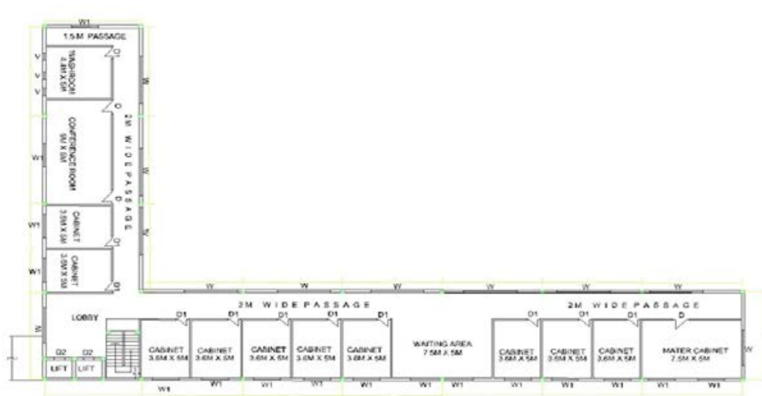

Fig. 01 – Plan of Building

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The framing plan of the unsymmetrical building is shown in fig 02 in which the beams which are shown in green colour represents the primary beam of the structure which will directly rest on the columns of building forming the grid pattern and the beams which are shown in red colour represents the secondary beams in structure which are rested at the middle of primary beam. Secondary beams intersect each other at the same level. The green coloured rectangles give the location of the columns situated in the structure.

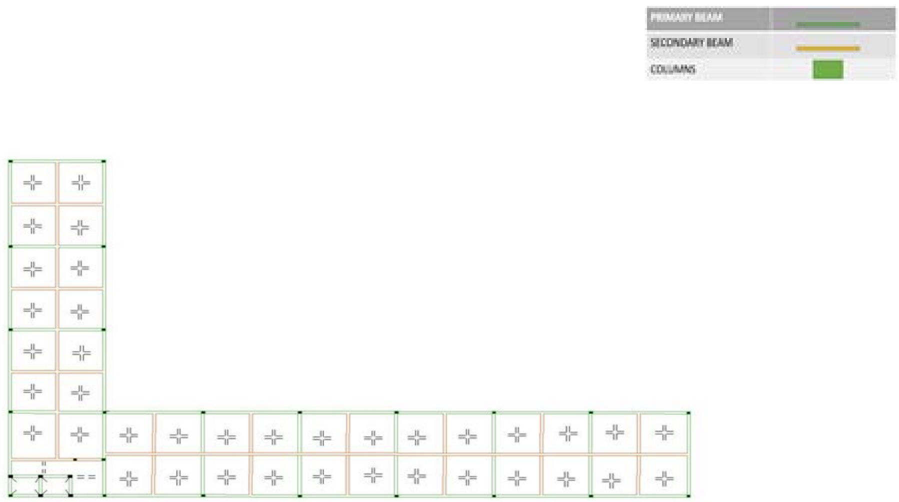


Fig. 02 – Framing Plan of Building

As explained in the sailent features of building the building is placed on the sloping ground.Grid 01 and Grid 02 is taken in the shorter leg og building which is having sloping height 3m deep for grid 01 and 2m deep for grid 2. remaining grid 03 is stiuated at height of 1m from the ground surface. In this paper the building is divided into three grids as expalined above.the pictorial view of structure has been shown in fig. 03 which shows sloping postioning of building.

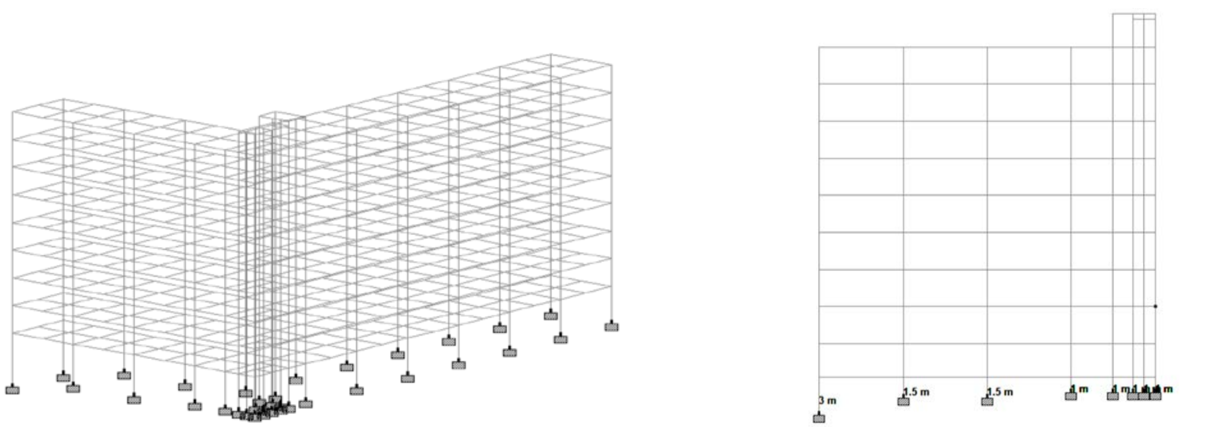
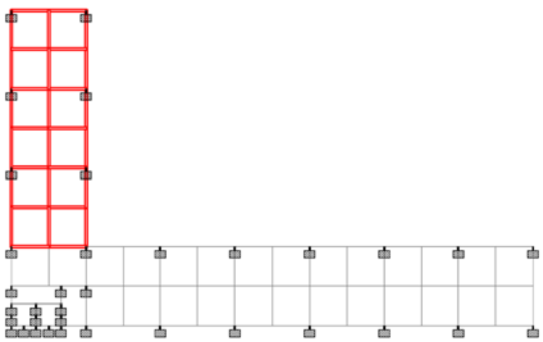


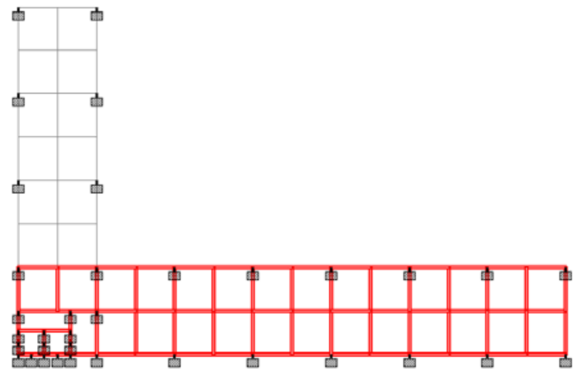
Fig. 03 – 3-D View of Structure

3. Modelling and Analysis

The main objective of paper is to determine which leg of L shaped unsymmetrical building contributes more base shear to the structure. for that purpose, building is divided into two parts for analysis explained as below-



Shorter Part



Longer part

Shorter Part: consist of Grid 01 and Grid 02
Longer part- consist of Grid 03
Here in this study, we have considered total seven models for the study. First model consist of bare frame and the remaining six models are equipped with shear walls of different shapes and at different locations .and analysis is done for the all models shown below.
The detailed positioning and shapes of shear wall in the structure are shown in the figures no 04, 05, 06, 07 ,08,09,10 and 11 as below –

Fig. 04 – Model 01

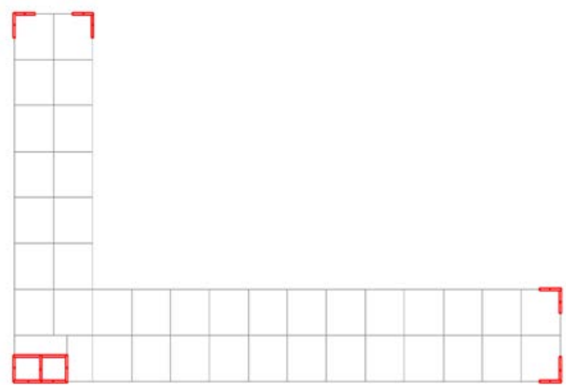


Fig. 05 – Model 02

Model 1: In this model only the shear wall is provided in the lift section and remaining structure is analysed for framing structure with insertion of brick masonry walls in between the framing structure. Model 2: this model is same as the model 1 with the inclusion of shear walls at corner of the building. Model 3: this model consists of shear walls provided at the corners of the shear walls such that it will cover throughout the entire width space of structure at extreme ends on both sides. Model 4: In this model arrangement of shear wall is done such that it will run through the outer periphery of the building in the alternative manner in each side as shown in fig. Model 5: In this model the shear wall is provided in the pattern of boxes which is situated at particular locations in the building as shown in fig. Model 6: In this model the shear wall is provided at the outer periphery of building particularly at the junction in L shaped building in parallel manner as shown in fig. Model 7: In this model the shear walls is provided as double c shaped placed adjacent to each other in both leg of building as shown in fig.

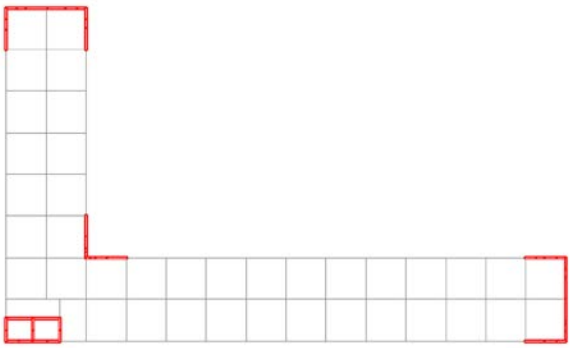


Fig. 06 – Model 03

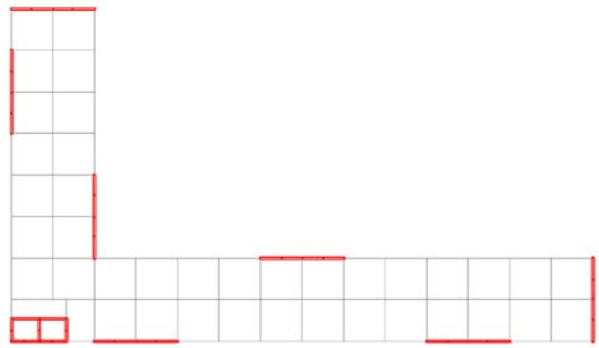


Fig. 07 – Model 04

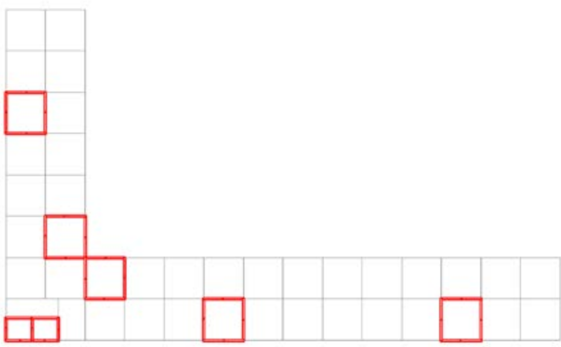


Fig. 08 – Model 05

Fig. 09 – Model 06

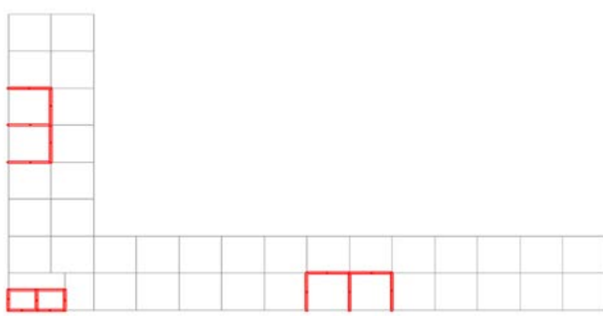


Fig. 10 – Model 07

4. Results

4.1 Design Seismic Base Shear

The contribution of base shear in longer leg and shorter leg of unsymmetrical building carried by columns only is shown in fig. 10 Which clearly indicates that longer leg of building is subjected to maximum shear as compared to shorter one.

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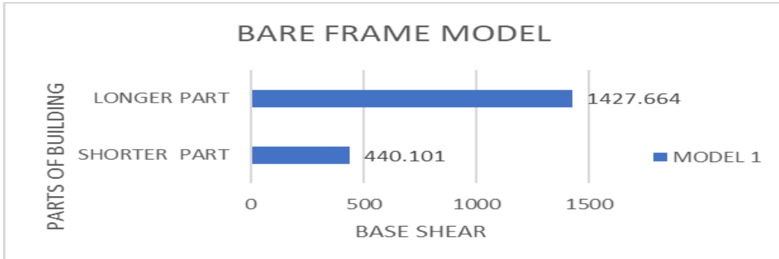

Fig. 11 – comparison of base shear in parts of building

The comaprison of indiviually shear wall located structure with respect to bare frame structure has been shown in the fig. 12, 13, 14, 15, 16 and fig. 17. Here also the comaprison is done by dividing the structute into two parts as mentioned above i.e with respect to longer and shorter leg of the structure.

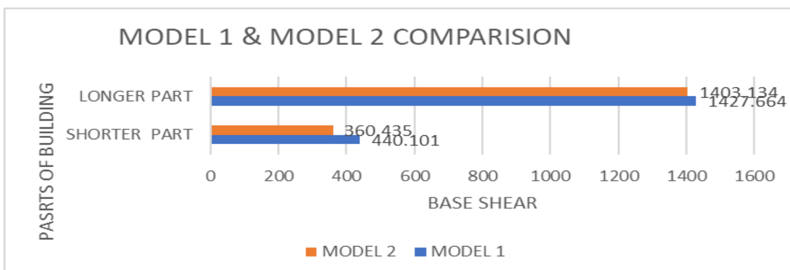

Fig. 12 – comparison of base shear in model 1&2

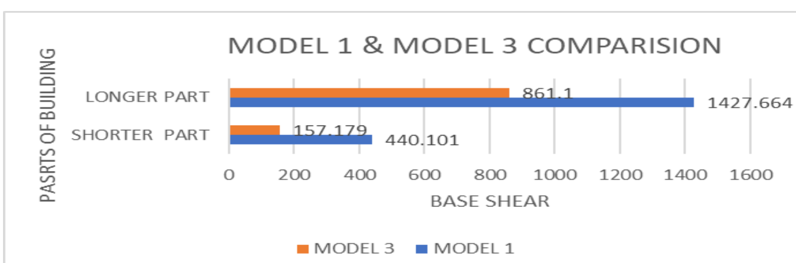

Fig. 13 – comparison of base shear in model 1&3

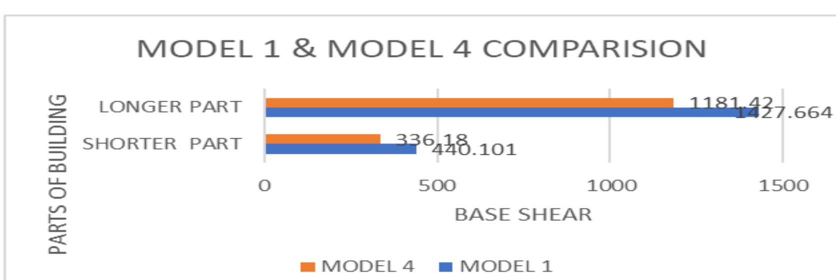

Fig. 14 – comparison of base shear in model 1&4

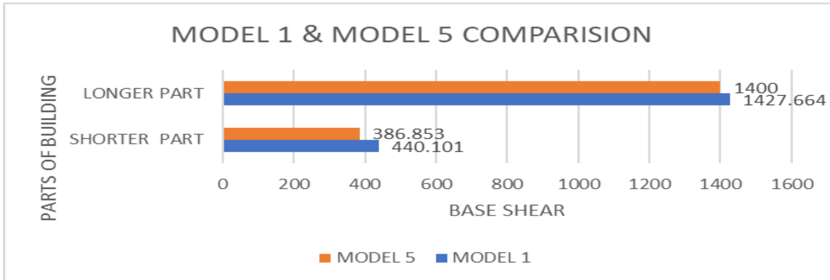

Fig 15 – comparison of base shear in model 1&5

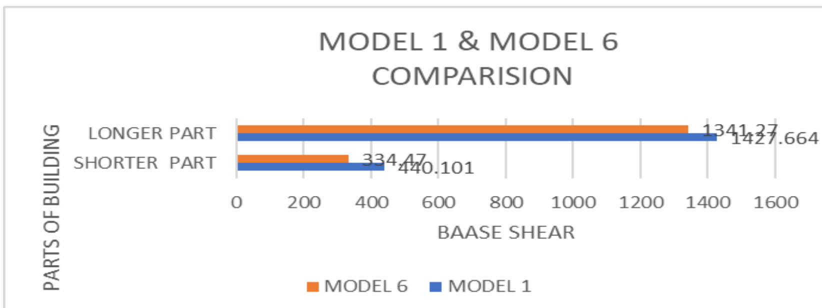

Fig. 16 – comparison of base shear in model 1&6

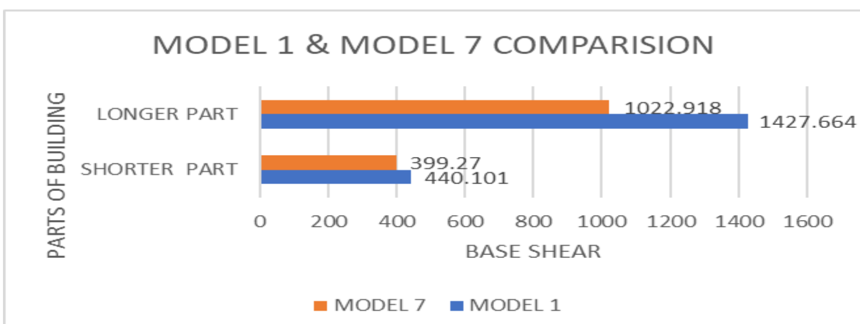

Fig 17 – comparison of base shear in model 1&7

The total comparision of design base shear of all seven numbers of models has been shown in the fig. 18 as given below-

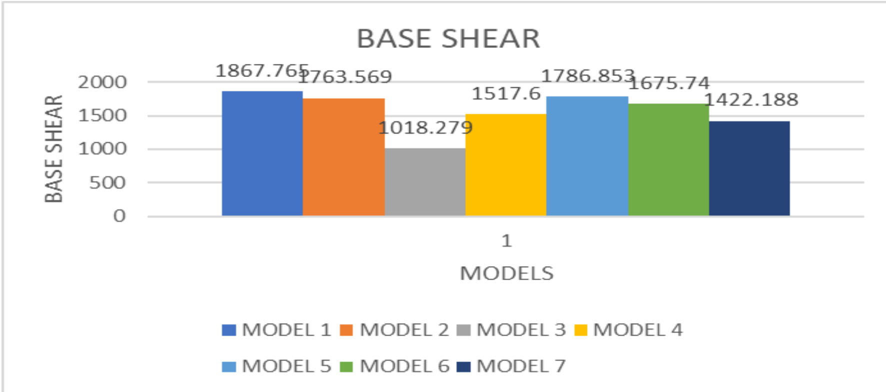

Fig. 18 – comparison of base shear in all models

As the base shear contribution for each model has been calculated sepeartly for longer and shorter part of the building so fig. 19 and fig. 20 represents the percentage reduction on each part of building with repect to the model 01.

Percentage base shear reduction in the shorter part of building of all the models i.e., model 2, 3, 4, 5, 6, and 7 with respect to model 1 has shown in fig 19 which gives a clear idea about which type of shear wall location is efficient for desgin base shear reduction.

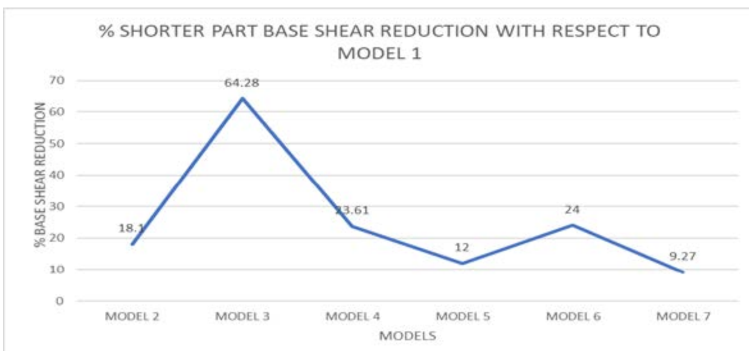

Fig. 19 – comparison % base shear reduction on shorter part of building of all models

Percentage base shear reduction in the Larger part of building of all the models i.e., model 2, 3, 4, 5, 6, and 7 with respect to model 1 has shown in fig 19 which gives a clear idea about which type of shear wall location is efficient for desgin base shear reduction.

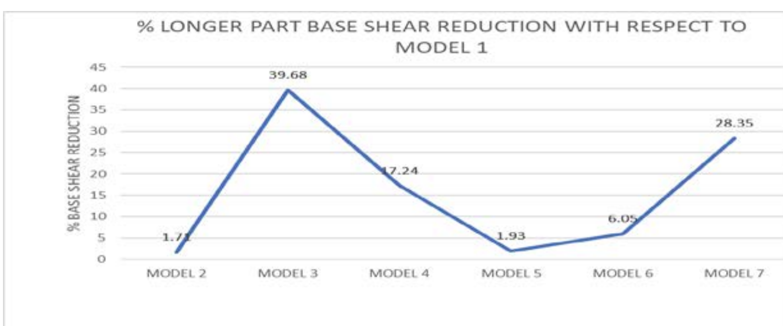

Fig. 20 –comparison % base shear reduction on longer part of building of all models

5.Conclusion

- the shape of shear wall and its positioning have a significant influence on desgin base shear reduction for the building.
- The longer part of the building is largely influnced by the design base shear as compaerd to the shorter part of the building.
- Model 03 comes out to be effective in case of desgin base shear reduction with respect to bare frame frame model 01 followed by model 06 in the shorter leg of the structure.
- Model 03 comes out to be effective in case of desgin base shear reduction with respect to bare frame frame model 01followed by model 07 in the longer leg of the structure.
- Model 03 comes out to be the efficient postioining of shear wall among all the models provided considering both the parts(shorter leg + longer leg) of the building as compared to the other shear wall locations in model when compared to model 01.
- Provision of L Shaped shear wall at the corners of the building covering sufficnent width on both the sides proves to be most efficient as compared to other shear wall locations as well as shapes.

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