OPTIMAL LOCATION OF SHEAR WALL IN HIGH RISE BUILDING SUBJECTED TO SEISMIC LOADING

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Abstract: Shear walls are the structural elements which are used to resist horizontal forces which are parallel to the vertical walls in structures. Shear walls are fundamentally given in working to support gravity loads and simultaneously resist large horizontal loads on the plane of the wall. These horizontal forces may include incorporate wind, quake and different other forces. To avoid the total collapse of the high rise buildings shear walls are mainly provided usually in high rise buildings under seismic forces. Henceforth it is essential to consider the effective, efficient and perfect area of the shear wall in the structure. In this project, study of high rise building with 15 storeys in zone iv is considered for all the symmetrical as well as unsymmetrical building models. Two different type of models are considered in every shape of building by changing location of shear wall in structure plan viz., at corners of the building and central core section of the building. In this seismic analysis Storey drift and Displacement are important parameters considered and analysed by using standard package Etab-2013. Production of 3D building model for both Equivalent static method and Response spectrum methods.
Keywords: Shear wall, Etab-2013, Equivalent static method and Response spectrum method.

I. INTRODUCTION

Normally shear wall can be defined as "structural vertical member that is able to resist combination of shear, moment and axial load created by lateral load and gravity load transfer to the wall from other structural member". Reinforced concrete walls, which include lift wells or shear walls, are the standard necessities of multi storey building. Design by coinciding centroid and mass centre of the building is the ideal for a structure. A provision of shear wall represents a structurally efficient way to stiffen a building structural system because the primary function of a shear wall is to increase the rigidity for lateral load resistance. In modern-day tall buildings, shear walls are typically used as a vertical structural element for resisting the lateral masses that can be prompted by the effect of wind and earthquakes which cause the failure of structure as proven in parent shear walls of varying sections i.e. square shapes to greater irregular cores consisting of channel, T, L, Barbell shape, Box and so forth can be used. Provision of walls allows to divide an enclose area, whereas of cores to include and bring services together with elevator. Wall openings are necessarily required for building windows in outside partitions and for doors or corridors in internal walls or in carry cores. The dimensions and location of openings may additionally vary from architectural and purposeful factor of view. Using shear wall structure has gained reputation in excessive rise constructing structure, especially in the production of residency or office/ commercial tower. Inside the past 30 years of the record service history of tall constructing containing shear wall detail, none has collapsed at some stage in sturdy winds and earthquakes (FINTEL, 1995)

1.1 RC shear wall:

Strengthened concrete (RC) buildings additionally have vertical plate-like RC partitions called shear wall with slabs, beams and columns. Those walls usually start at foundation level and are non-stop during the building top. Their thickness may be as low as 150mm, or as high as 400mm in high-rise buildings. The overcoming success of buildings with shear walls in opposing strong earthquakes is decorated in the quote, "we cannot allow to build concrete buildings designed to resist strong earthquakes without any shear walls." as said by mark fintel, consulting USA engineer. RC shear walls inside the route of their orientation gives large strength and stiffness to buildings, which considerably reduce lateral sway of the building and thereby reduces harm to structure and its parts. Due to the fact shear walls includes large horizontal earthquake forces, the overturning results on them are large. To reduce ill effect of twist in buildings shear walls in buildings must to be symmetrically positioned in plan. They could be placed symmetrically along one or both directions in plan. Shear walls are more effective when they provided along exterior perimeter of the building such a plan increases resistance of the building to twisting moments.

1.2 Function of Shear Wall:

Shear walls should provide the required lateral energy to withstand horizontal earthquake forces. While shear walls are strong enough, they will transfer those horizontal forces to the following detail in the load path underneath to them. Certain study of strength of RC shear wall at exceptional position on multi path may be different shear walls, floors, foundation walls, slabs or footings. Shear walls also provide lateral stiffness to save the roof or floor above from excessive sideways. When shear walls are stiff enough, they will avoid floor and roof framing members from shifting out of their support. Additionally, buildings which might be suitably strong will commonly suffer less non-structural harm.

1.3 Objective of the study

The principal objectives of the study are as follows:

- To study the optimal locations or positions of shear walls in different shape of buildings.

- To study the performance of the buildings with shear wall at different locations in design.
- Both Equivalent static analysis and Response spectrum analysis are carried out.
- To determine the important parameters like Displacement and Story drifts.
- Comparing the variations of the results and studied.

II. MODELLING AND ANALYSIS

The analysis is carried out for shear wall model using ETABS and the parameters considered for studies are maximum storey Displacement and Storey drift. The analysis is performed for zone IV both in Equivalent static and Response spectrum analysis methods are carried out.
For this project, (G+15) storey building with a 3-meter height for every storey, with plan 30mx24m is taken. Building has six bays of 5m in X and 4m in Y directions. The plan layout, elevation of Shear wall building models are shown in fig. below.

2.1 Model Details

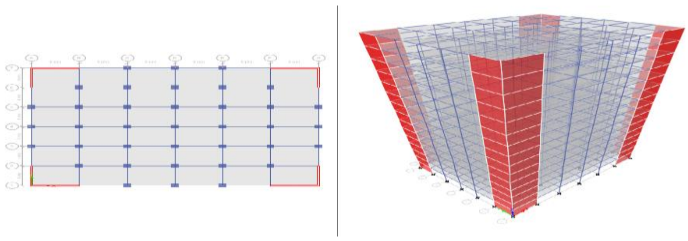
Model 1- model is assigned with symmetrical rectangle in plan and consists of shear walls at each four corners of the building.
Model 2- model is assigned with symmetrical rectangle in plan and consists of shear walls at central core part of the building.
Model 3- model is unsymmetrical ‘T’ in shape and consists of shear walls at the corner edges of the building.
Model 4- model is unsymmetrical ‘T’ in shape and consists of shear walls at middle core of channel type.
Model 5- model is symmetrical ‘H’ in shape and consists of shear walls at the corner edges of the building.
Model 6- model is symmetrical ‘H’ in shape and consists of shear walls at central core part of the building.

2.2 Types of models

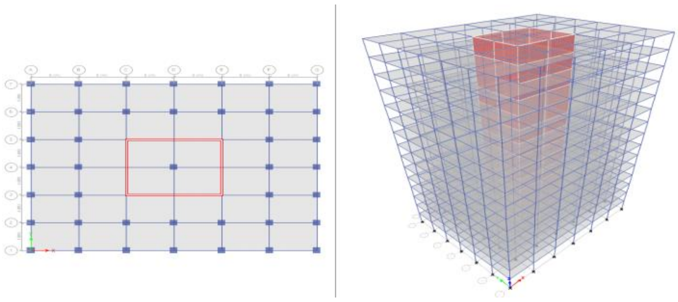
This includes the group of models, which are having the same positioned shear walls in the structure. Depending on positions of shear walls in structures, we can have mainly two types of models as shown below
TYPE-1 MODELS: this type of models includes the Model-1, Model-3 and Model-5 where shear walls are located at the corner parts of the buildings.
TYPE-2 MODELS: this type of models includes the Model-2, Model-4 and Model-6 where shear walls are located at the central core parts of the buildings.

2.3 Plan and 3D elevations of the models:

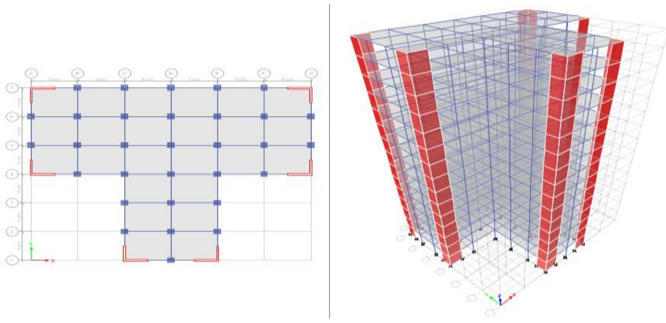
MODEL-1



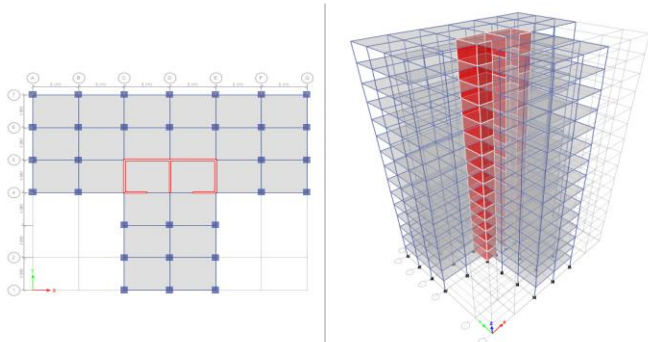
MODEL-2



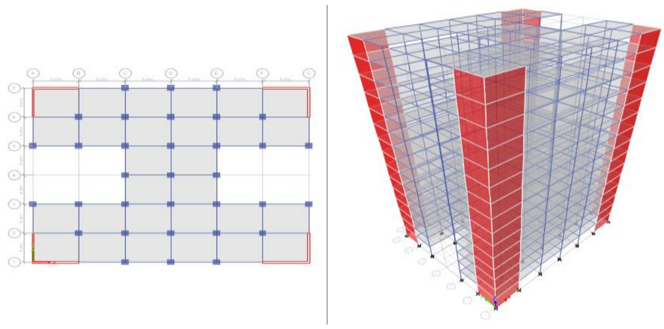
MODEL-3



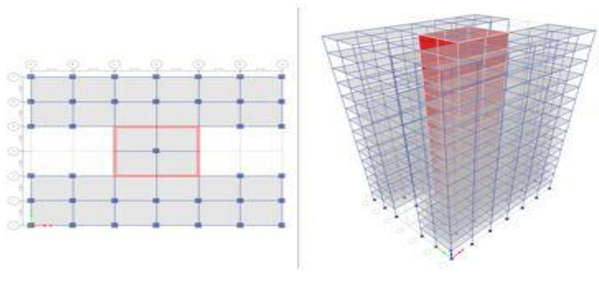
MODEL-4



MODEL-5



MODEL-6



2.4 Building Configurations for the Models

Table 4.1: Building Configuration

No. Of Stories	G+15
Height Of Each Storey	3m
Shear Wall Thickness	200mm
Grade Of Steel	Fe500
Grade Of Concrete	M30
Depth Of Slab	220mm
Size Of Columns	800x800mm
Size Of Beams	200x600mm

Table 4.2: Loadings

Live load	3 kN/m²
Floor finish	1.5 kN/m²
Parapet loading	5 kN/m²
Seismic loading	IS 1893
Soil type	II
Response reduction, R	5
Importance factor, I	1
Zone factor	0.36 (zone IV)

III. RESULTS

The analysis of all the models considered are carried out by both Equivalent Static Method (EQX) and Response Spectrum Methods (RSX) of analysis and the results are obtained for the parameters like Storey drift and storey Displacement for all the models with respect to storey level as shown in graph

A. Storey displacement

Storey displacement for different location of shear wall building models obtained from Equivalent static analysis (EQX) and Response spectrum (RSX) method is shown in table below which gives the value of storey displacement for all the models in mm.

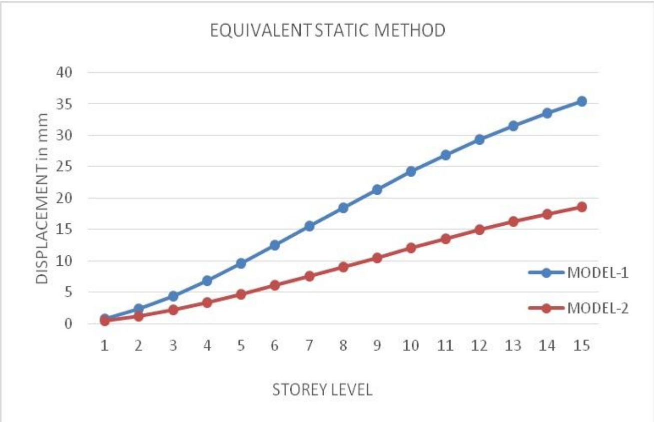


Fig.1: Comparison of model-1 and model-2 Storey displacements for equivalent static analysis

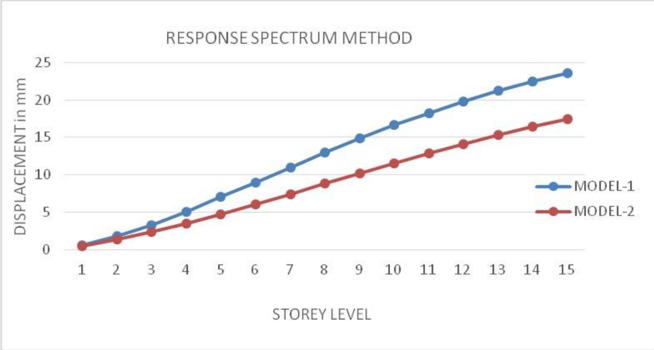


Fig.2: Comparison of model-1 and model-2 Storey displacements for response spectrum method

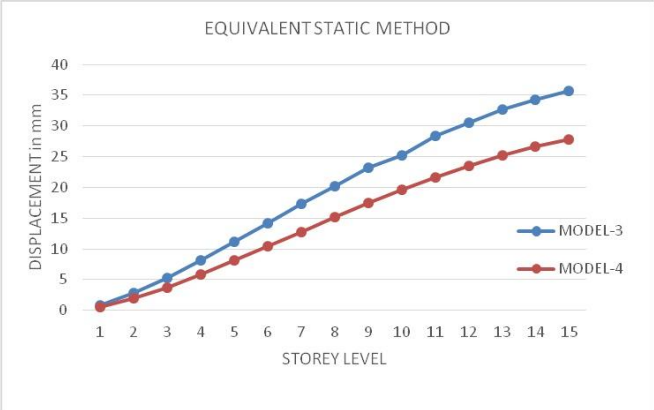


Fig.3: Comparison of model-3 and model-4 Storey displacements for equivalent static analysis

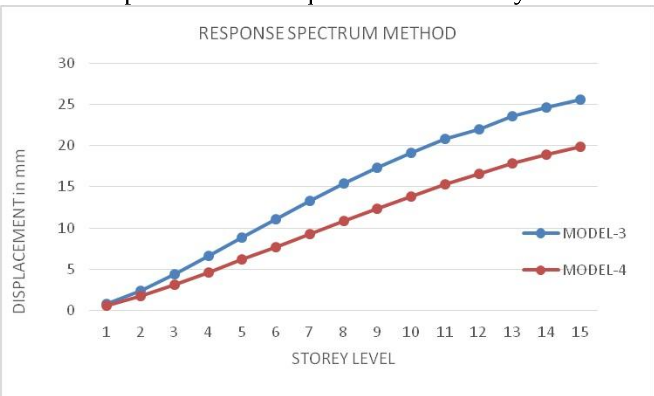


Fig.4: Comparison of model-3 and model-4 Storey displacements for response spectrum method

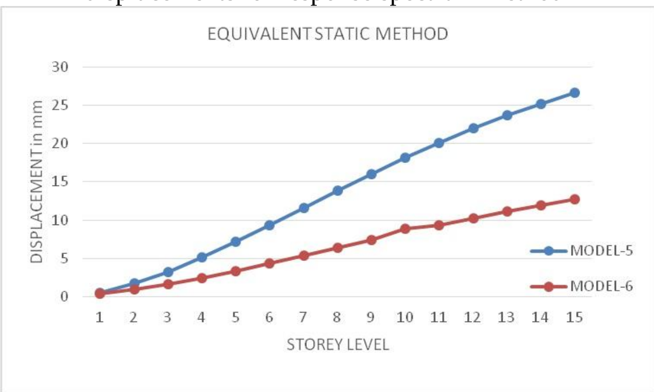


Fig.5: Comparison of model-5 and model-6 Storey displacements for equivalent static analysis

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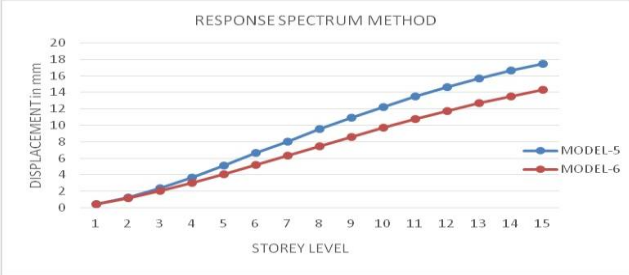

Fig.6: Comparison of model-5 and model-6 Storey displacements for response spectrum method

3.2 Storey drift

Story drift can be defined as the lateral displacement of one level relative to the level above or below it. As per Clause no. 7.11.1 of IS 1893 (Part 1): 2002, the storey drift in any storey due to specified design lateral force with partial load factor of 1.0, shall not exceed 0.004 times the storey height. Maximum drift permitted = 0.004 x 3000 = 12mm. By comparing the storey drift values obtained for Type-1 and Type-2 methods, it could be seen that inter story drift has considerably been reduced in Type-2 models when compared to the in Type-1 models.

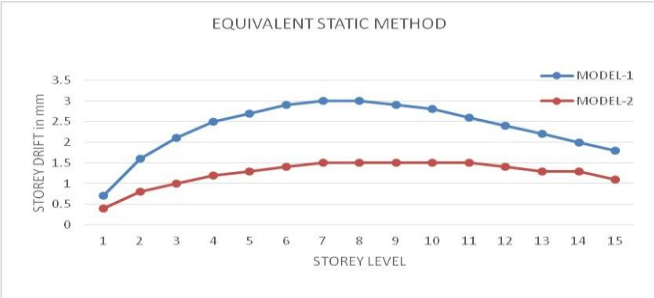

Fig.7: Comparison of model-1 and model-2 storey drift for equivalent static analysis method

Fig.8: Comparison of model-1 and model-2 storey drift for response spectrum method

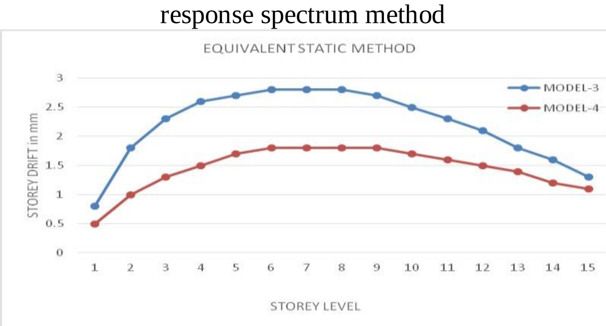

Fig.9: Comparison of model-3 and model-4 storey drift for equivalent static analysis method

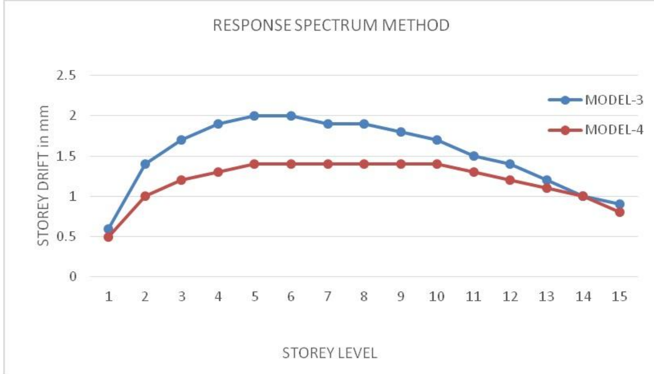

Fig.10: Comparison of model-3 and model-4 storey drift for response spectrum method

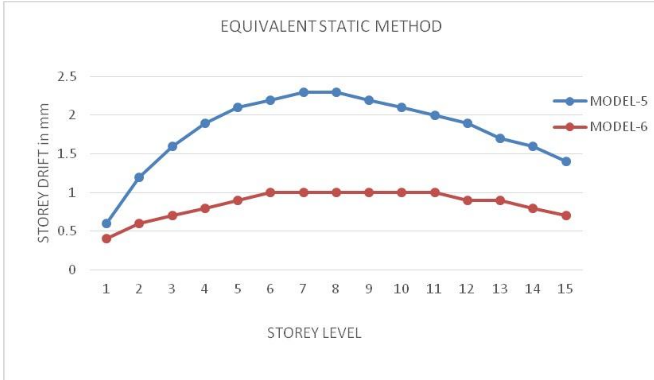

Fig.11: Comparison of model-5 and model-6 storey drift for equivalent static analysis method

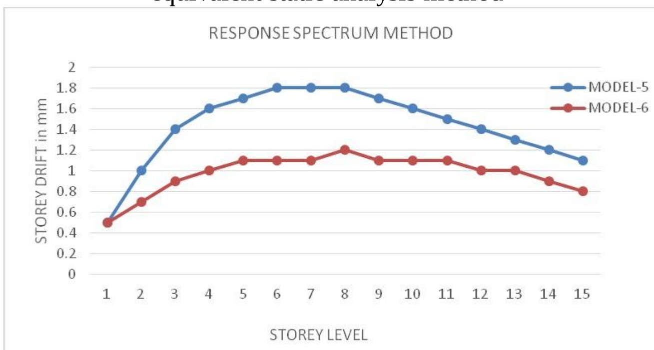

Fig.12: Comparison of model-5 and model- 6 storey drift for response spectrum method

IV. CONCLUSION

- It is observed from the above analysis that, the storey displacement seen in TYPE-1 models where shear walls provided at corners of the building shows maximum displacement compared to the TYPE-2 models having shear wall at central core location of the building.
- Maximum Lateral Displacement always occurs at the top most level for both type of locations of shear walls in all models.
- On observing, storey drift ratios at all the stories in the TYPE-2 models are less than those in TYPE-1 model. Here, as one can see the storey drift ratio is very low in bottom stories and very high at the middle stories and finally decreases towards the

upper stories.

- Reduction of storey drifts due to introduction of shear wall at the core sections of the building, which enables the structure to behave as almost ideally stiff. In this way, the damage risk of the structure & non-structural elements is minimized.

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