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EVALUATION OF PERFORMANCE LEVEL OF SYMMETRIC AND ASYMMETRIC BUILDING BY ADOPTING A DUAL SYSTEM OF FRAMING

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ABSTRACT

In the common practice, the building in the earthquake prone areas are very much easily influenceable to severe damage. The structure used to be designed in the earthquake prone areas the design shall not only be consider to withstand the gravity load but also the lateral load which will create the high stresses and structure may be safely resists the seismic forces. Here the study is carried out to analyze the behavior of both the symmetric with asymmetric building under seismic forces by considering the building with the dual system were the building along with the rcc members also includes the shear wall. Amongst the other lateral load resisting system the shear wall is the most widely used to resists the lateral loads in the world of construction.The effects of placing the shear wall at different position in the building models were the building does not contains the brick or infill walls in the buildings. The seismic analysis includes the linear and non-linear static method and the linear dynamic method of analysis. The displacements at each storey level has been compared by performing static method and response spectrum method for all the building models symmetric as well as asymmetric.

KEYWORDS: Dual system, ETABS v 9.7, Placing of shear walls, symmetry and asymmetry.

INTRODUCTION

In general,as the height of the building increases,its overall response to lateral loads such as (earthquake and wind) increases.The lateral load effects on buildings can be resisted by Frame action,shear walls,or combination of both called as (dual system).Inter-storey drift and lateral displacement are the two essential parameters used to predict the lateral stability and stiffness of lateral load resisting system of building.It is a notorious reality that the whole world is interacting a intimidation of the natural severe disasters from a long period.There is a record that other than the various natural disasters, the earthquake was a major natural disaster affecting the natural economy by resulting into the consequences of the loss of completely destruction of the properties and also the lost of human lives.It is recorded that the Indian subcontinent faced a severe earthquake in the world.In the performance based procedure, the desired levels of seismic performance for a building for specified levels of earthquake ground motion are specified. In this dissertation, hypothetical multistorie buildings (i.e., seventeen storeyed without infill) located in zone V of medium soil sites has been analyzed and designed for load combinations given in code and evaluated using Response Spectrum method.Selection of such a strong and stiff enough lateral load resisting system which will acts as a barier for the drift within permissible code limits that should be the main aim of the structural designers.As it is well known for the structural engineers who are very much familiar towards the lateral loads resisting systems to resist the wind and earthquake loads they are namely(Moment resisting frames,Shear walls or bearing wall and Dual system).Here we consider the first model as a bare frame and rest of three models are with dual system to resist the lateral loads used to be acting on the building.

Dual system:In this system to resist the lateral loads it consists of both the shear walls(bearing walls) and moment resisting frames such that both together will contribute their response towards the lateral loads on reach.

- The two systems considered in dual system are designed in such a manner to resist the total designed load in proportion to their respective lateral stiffness considering the dealings of dual system at all floors.

- Other than the shear walls present in the structure there are the moment resisting frame in the structure which are designed in such a manner that they would carry about 25% of the calculated base shear of the structure
- This is how the Dual System contribute the effective action to resists the seismic forces on reaching the building structure.

REVIEW

(**M.Ashraf ;2008**)[1] It is found that the structural elements columns,beams and the slab the force they carry in the building are increased on the grids which are present against or opposite to the changing location of the shear walls in the structure away from the centre of the building.This study was carried on the building which was a multi-storey building with the maximum configuration of the building structure.

(Anshuman et al:2011)[2] To study the behavior of the structure under the action of the shear wall in the structure ,a symmetric structure with the rectangular in its base shape was chosen and the study was carried out to find the proper location of the shear wall within the structure based on the characteristics such as the elasto-plastic and elastic action of behavior and the result was found to be that the top displacement was reduced and exhibits within the permissible limits by the application of the Shear walls into the structure with the moment resisting frame which in combination of these two popularly known as the Dual system.

(**Romy Mohan,et al;2011**)[3]There are different kinds of shear wall shapes used in the structure with the different location carried out within the building,but the highly effective in action for the lesser lateral displacements with high strength and an increase in the stiffness for the structure was found to be the Rectangular shape of the shear wall.

(**Mrugesh D.Shah 2011**)[4] He concluded that from the various results which has shown the performance point values by considering the infill wall in bare frame.The performance point for the bare frame without infill has the lesser value when compared with bare frame with infill wall.The performance point values has increases even more when the bare frame bears the strut or the shear walls.He also concluded that as the number of bays increases the lateral load carrying capacity increases but no increase has seen in the lateral displacement.However the increase in number of stories has increased the lateral displacement but not the lateral load carrying capacity.

MATERIALS AND METHODS

ANALYTICAL MODELLING:SYMMETRIC BUILDING MODELS:

Model 1: Building has no walls in the first storey and the building is modeled as bare frame. However masses of the walls are included. In addition to wall masses the other load like floor finish and imposed live load is added at each storey.

Model 2: Building is provided with dual system which consists of both the moment resisting frames and shear walls,the shear walls are placed at the periphery of the building halfly to the width of the wall and also shear wall are placed at the inner part of the building.

Model 3: Here the building is also provided with dual system but the shear wall provided at corners along longitudinal direction is full to the width of the wall and at transverse direction shear walls are placed half to the width of the wall and also building consists of shear walls at the inner portion of the building.

Model 4: Here in model 04 the building is same when compared with model 02 but the placement of shear walls are opposite in both the direction as placed in model 02 building.

ASYMMETRIC BUILDING MODELS:

Model 1: Building has no walls in the first storey and the building is modeled as bare frame. At the 13th storey the portion of the building that is three bays along the transverse direction are not considered and along longitudinal direction till the roof the bays not considered. However masses of the walls are included. In addition to wall masses the other load like floor finish and imposed live load is added at each storey.

Model 2: Building is provided with dual system which consists of both the moment resisting frames and shear walls,the shear walls are placed at the periphery of the building halfly to the width of the wall and also shear wall are placed at the inner part of the building.The building has two bays along transverse direction and five bays along longitudinal direction from 13th storey.

Model 3: Here the building is also provided with dual system but the shear wall provided at corners along longitudinal direction is full to the width of the wall and at transverse direction shear walls are placed half to the width of the wall and also building consists of shear walls at the inner portion of the building. The building has two bays along transverse direction and five bays along longitudinal direction from 13th storey.

Model 4: Here in model 04 the building is same when compared with model 02 but the placement of shear walls are opposite in both the direction as placed in model 02 building.The 13th storey consists of L type shear wall at the inner part.The building has two bays along transverse direction and five bays along longitudinal direction from 13th storey.

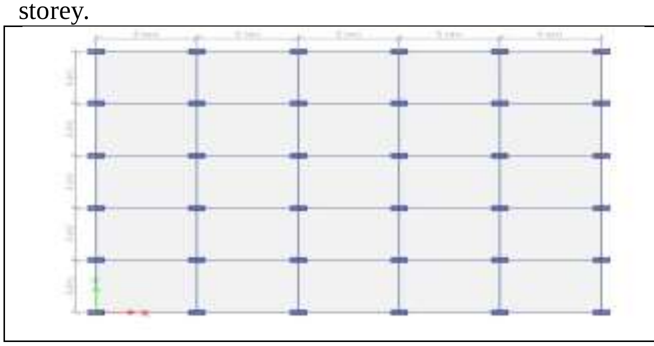

FIGURE 1.1 Plan Layout Model -1

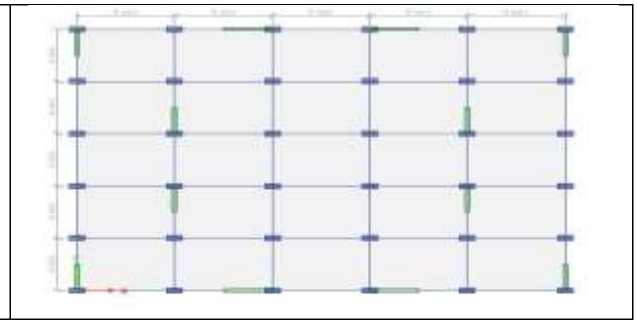

FIGURE 1.2 Plan Layout Model -2

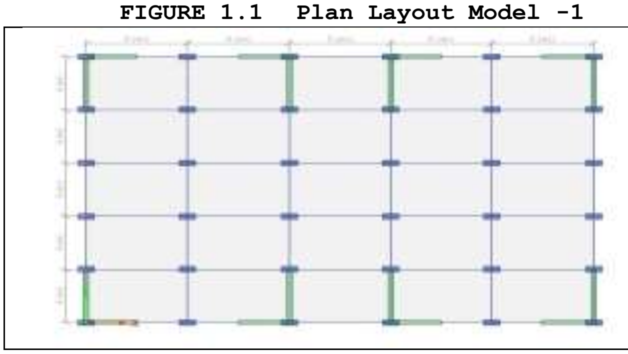

FIGURE 1.3 Plan Layout Model -3

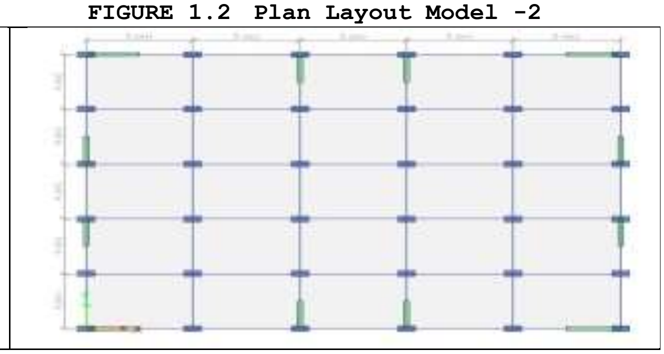

FIGURE 1.4 Plan Layout Model -4

ASYMMETRIC BUILDING MODELS:

Model 1: Building has no walls in the first storey and the building is modeled as bare frame. At the 13th storey the portion of the building that is three bays along the transverse direction are not considered and along longitudinal direction till the roof the bays not considered. However masses of the walls are included. In addition to wall masses the other load like floor finish and imposed live load is added at each storey.

Model 2: Building is provided with dual system which consists of both the moment resisting frames and shear walls,the shear walls are placed at the periphery of the building halfly to the width of the wall and also shear wall are placed at the inner part of the building.The building has two bays along transverse direction and five bays along longitudinal direction from 13th storey.

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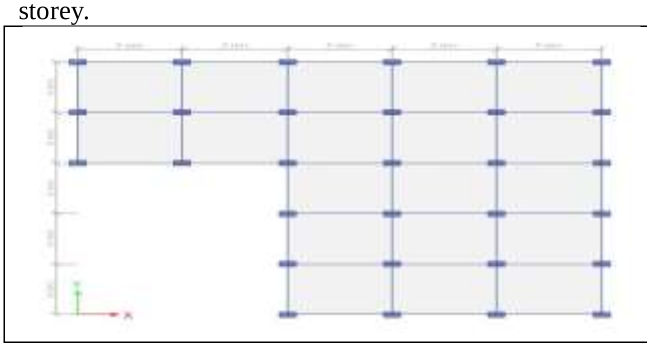

FIGURE 1.5 Plan Layout Model -1

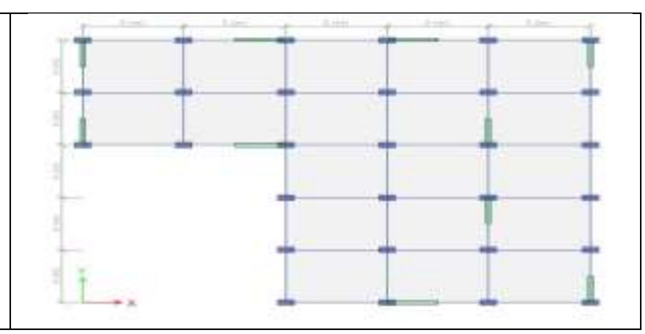

FIGURE 1.6 Plan Layout Model -2

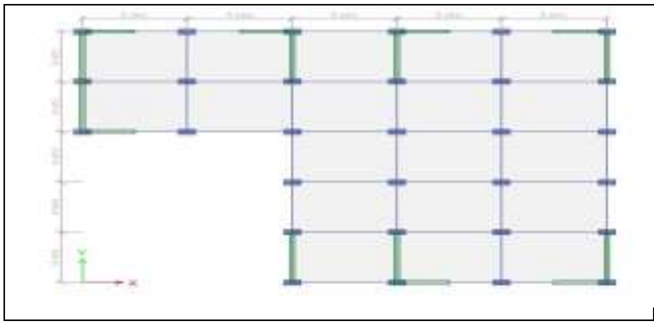

FIGURE 1.7 Plan Layout Model -3

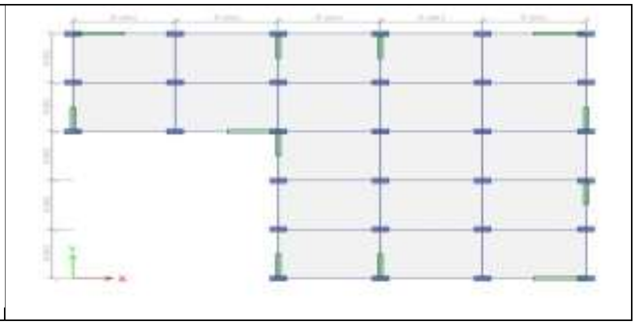

FIGURE 1.8 Plan Layout Model -4

ADVANTAGES OF MOMENT RESISTING FRAMES:

- The use of moment resisting frames in the seismic design of the structure helps by the process of inelastic energy dissipation to resist the earthquake force.
- Moment resisting frame in the structure acts in such a way that the magnitude of the imposed load on the foundation gets reduced.
- Special moment resisting frame creates the strong column-weak beam state where it will distributes the inelastic response amongst different stories.
- Eliminates the formation of the instability due to P-Delta effects under the gravity load associated with the lateral drift due to seismic force.
- By the use of the moment reisting frame in the structure bending rigidity and the strength of the frame increases.
- In the special moment frames to resist the flexural,axial and shearing actions the beam-column connection are proportioned and detailed which leads to a ductile flexural response at the yielding region.
- Resistance offered to lateral forces achieved by the rigid frame action by the development of bending moment and shear force in the frame members and joints

Design Data:Material Properties:

Young's modulus, E is = $22.360\text{x}10^6$ kN/m²
Density of the concrete is = 30kN/m³
The dead load intensities assumed are:
Roof finish = 1kN/m²
Floor finsh = 1kN/m²

The live load intensities:
Live load or imposed load = 3.0KN/ m²

Properties of the members are:
Slab thickness = 0.150m
Size of the column = (0.4m x 0.8m)
Size of the beam = (0.30m x 0.60m)
Wall thickness = 0.23m

The live load in the Earthquake calculation on the slab is given in the clause no 7.3.1 and 7.3.2 of the IS 1893 (Part-I)- 2002 is obtained as:
For the Roof (clause no 7.3.2) = 0
For the Floor (clause no 7.3.1) = $0.25\text{x}3.0=0.75\text{kN/m}^2$
IS: 1893-2002 Equivalent Static method

The Design Spectrum
Earthquake ZoneV
So the zone factor, Z (from the table -2) = 0.36
The Importance factor, I (from the table -6) = 1.0
The Response reduction factor, R (from the table -7) = 5.0
Fundamental Natural period in longitudinal and transverse direction for without infill is given by,
$T_a=0.075*53.2^{0.75}=1.477$ sec.
For medium soil sites, $S_a/g = 1.36/T$
Spectral acceleration, $S_a/g =1.36/1.477=0.9207\text{m/sec}^2$Same as for model 2, model 3,and model 4.
Fundamental Natural period, in both directions is same for all model as building is analysed by cosidering without infill**.**The storey height is kept to 3.2m above the bottom storey,and the bottom storey height is of 2.0m

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RESULTS AND DISCUSSION

The past studies for the symmetric and asymmetric building were analyzed by the consideration of the shear walls in the presence of the brick walls in the building. But here it would be quite interesting by framing the building structure with the Dual System of framing the structure. Where the structure contains the shear walls with the structural elements ignoring the brick wall in the design consideration. But however the design contains the wall load effect in it.An attempt has been made to evaluate the effect of the shear walls location in the different places of the structure with moment resisting frames only. The following results shows the displacement, base shear and the maximum displacement offered by the models under non-linear pushover analysis with performance point of the models.The results and discussion may be combined into a common section or obtainable separately. They may also be broken into subsets with short, revealing captions.

\LATERAL DISPLACEMENT OF THE MODELS

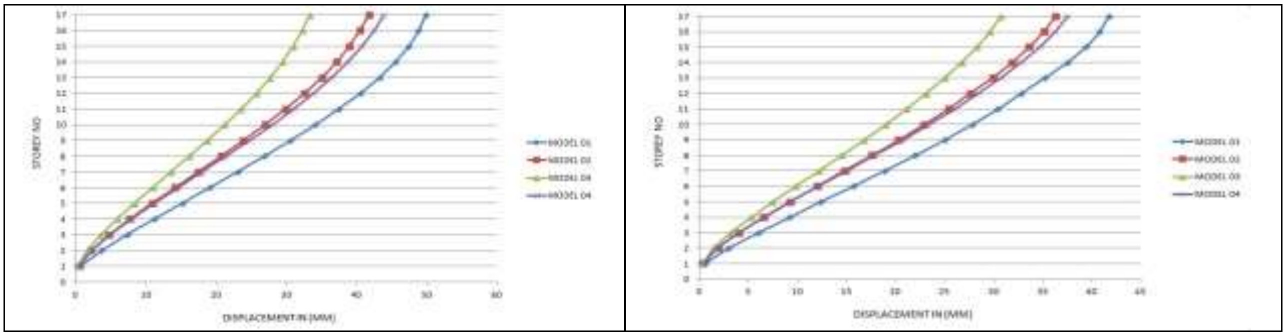


Figure2.1 and 2.2 Displacement by Equivalent static method along longitudinal direction(symm and asymm).In **Equivalent static analysis** it has been found that model -2, model-3,and model-4 has 16.23%, 33.06%, 1.20% respectively less displacement as compared to the model-1 in longitudinal direction.

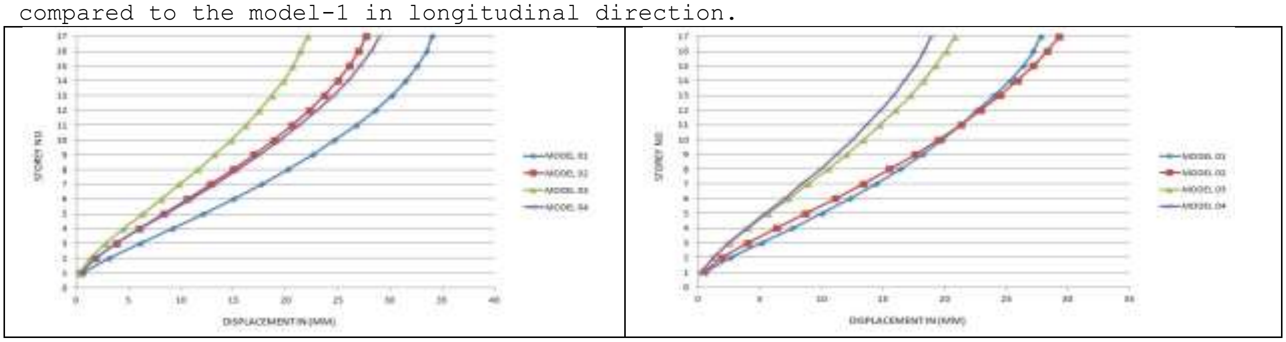


Figure2.3and2.4Displacement by Response spectrum method along longitudinal direction(symm and asymm).In **Response spectrum analysis** it has been found that model -2, model-3, and model-4, has 18.52%, 38.82%, 14.7%, respectively less displacement as compared to the model-1 in longitudinal direction.

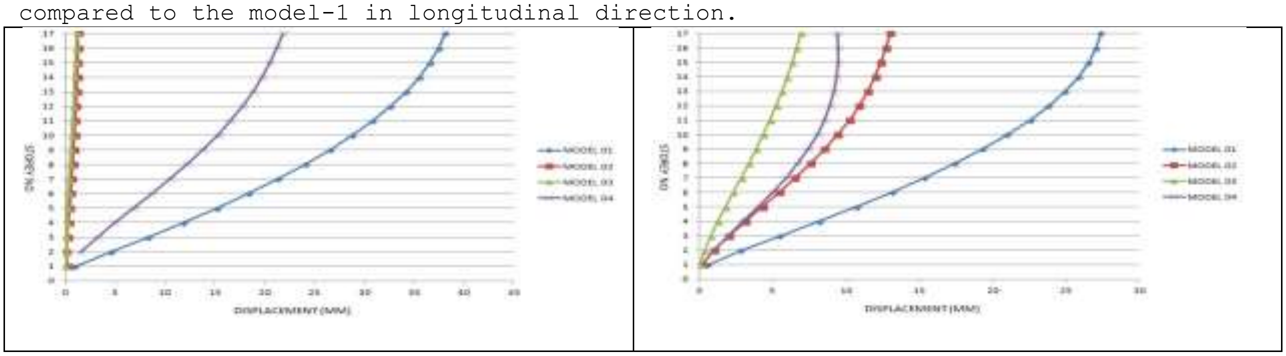


Figure 2.5 and 2.6 Pushover analysis displacements along longitudinal direction both for symmetry and asymmetry building models.

MAXIMUM DISPALCEMENT BY PUSHOVER ANALYSIS

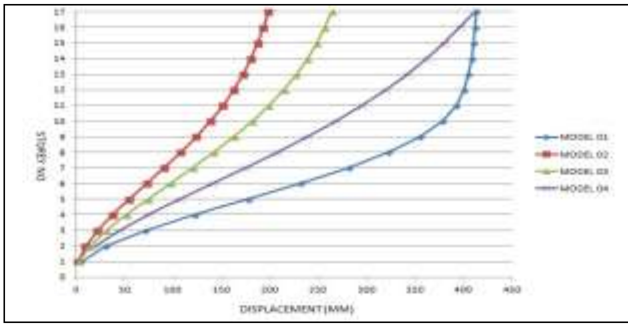


Fig2.7 Max displ of symmetry model

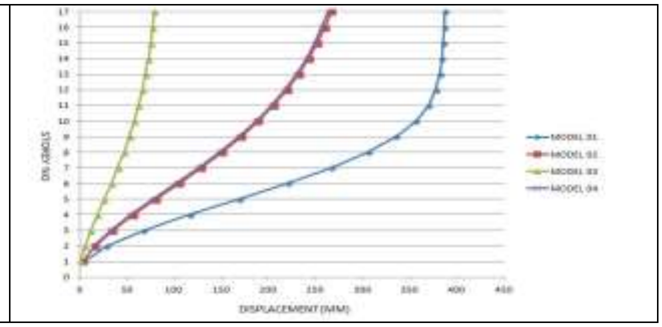


fig2.8 Max displ of asymmetry model

Design Seismic Base Shear for Symmetric building and Asymmetric building in Longitudinal and Transverse direction.

SYMMETRIC BUILDING

MODEL NO	VBX (KN)	VBY (KN)
01	3154.873	2713.287
02	3901.704	3868.594
03	5064.964	4856.122
04	3753.297	3832.856

ASYMMETRIC BUILDING

MODEL NO	VBX (KN)	VBY (KN)
01	3108.59	2670.52
02	4055.73	3814.65
03	5205.13	5081.12
04	3898.35	3942.37

FIGURE SHOWS DISTRIBUTION OF BASE SHEAR

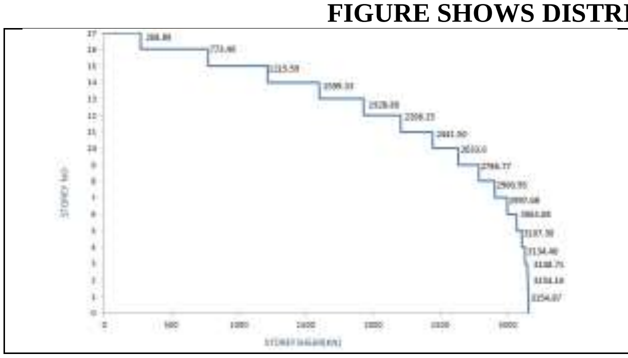


Fig3.1Storey shear Model-1 symm bldg

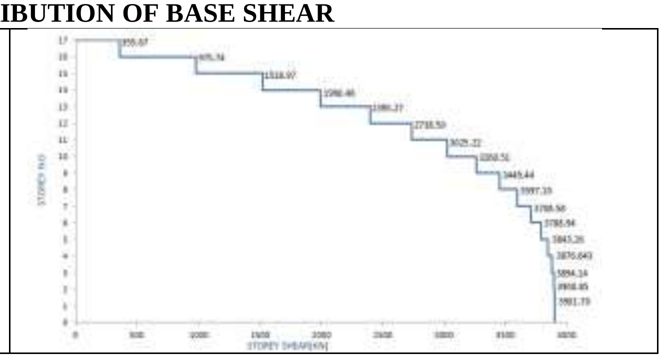


Fig3.2Storey shear Model-2 symm bldg

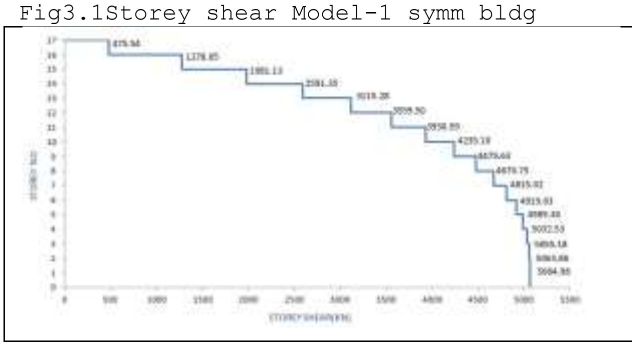


Fig3.3Storey shear Model-3 symm bldg

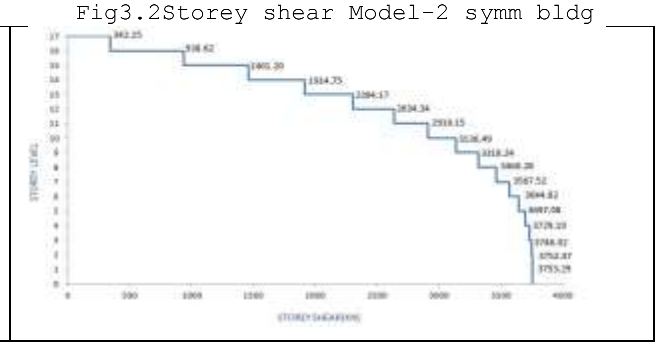


Fig3.4Storey shear Model-4 symm bldg

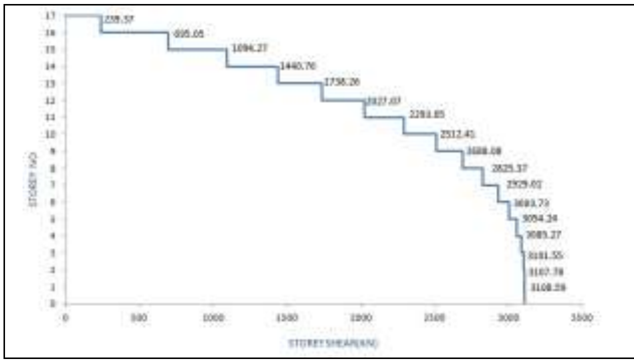


Fig3.5Storey shear Model-1 asym bldg

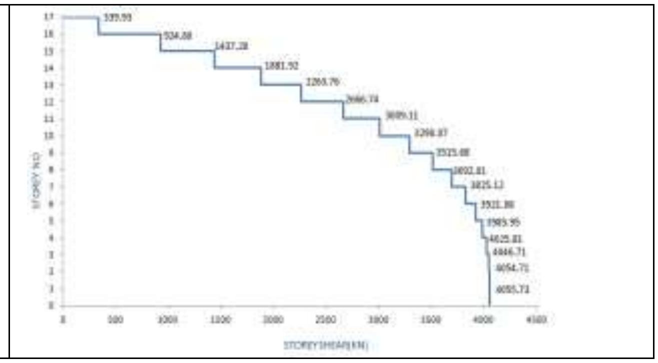


Fig3.6 Storey shear Model-2 asym bldg

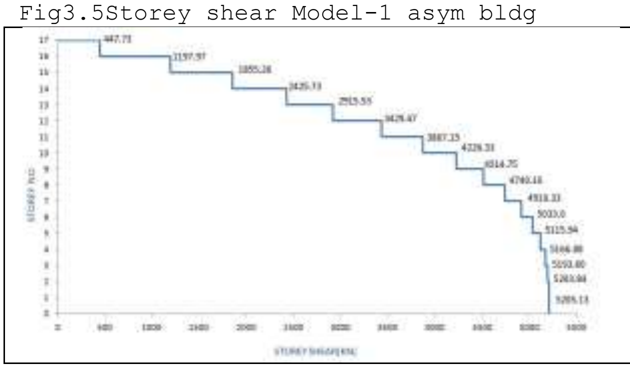


Fig3.7Storey shear Model-1 asym bldg

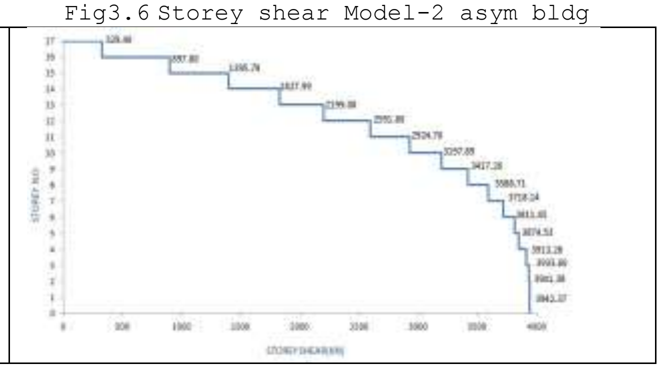
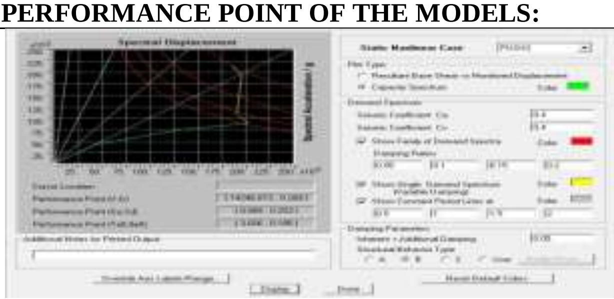


Fig3.8 Storey shear Model-2 asym bldg

Necessity of non-linear static push over analysis (NISA):-

The day by day improvement in the technologies of the seismic responsiveness resistance wall lead to the requirements for the up gradation in the design codes. The last two decades for India where the building suffers from the seismic deficiency because of the unawareness towards the performance of the structure under seismic action. The RC building has shown the various types of damages when the earthquake has taken place. This shows the construction how it is executed to counteract the central forces around the globe and forced to the implementation of the seismic design in the construction plastic both for existing and new structures. The following are the few parameters used in non linear push over analysis.

PERFORMANCE POINT OF THE MODELS:



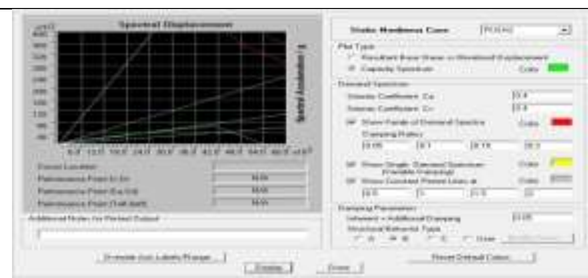


Figure 4.1 and 4.2Performance point of the Model-3 both symmetry and asymmetry building has better performancealong longitudinal direction.

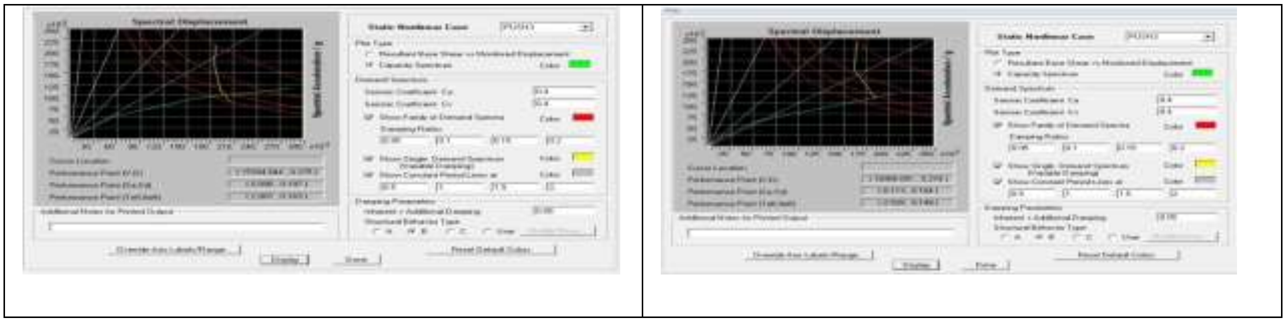


Figure 4.3 and 4.4Performance point of the Model-4 both symmetry and asymmetry has better performance along transverse direction.

CONCLUSION

1. Fundamental natural period decreases when effect of shear wall is considered.
2. Storey drifts are found within the limit as specified by code (IS 1893-2002 Part-1) in both linear static and linear dynamic (Response spectrum method) of analysis.
3. Base shear is more in asymmetric buildings compared to symmetric buildings.
4. Base shear and Displacement at first hinge is less in asymmetric building compare to symmetric building.
5. Ductility ratio is maximum for the bare frame structure and reduces as the shear wall is place in its effective place.Which indicates that the building shows the adequate warning before collapse.
6. Bare frame shows the higher response reduction factor as compared to the other models .It shows that bare frame are counteract the lateral forces even after first hinge.
7. The reduction in the displacements and the storey drifts was seen when the shear walls were introduced along with the moment resisting frames.
8. The structure gets influenced by the effect of shear wall when subjected to lateral loads. Shows the effective resistance against the seismic forces.
9. It could be seen that the ductility ratio is maximum for the bare frame model.
10. However the demand of ductility is reduced by providing the shear walls at the various locations of the structure.
11. One of the best response from the building was seen that the structure indicates or provides the sufficient time for the structure before getting completely collapse.
12. The analysis shows the lesser displacement of the structure by the provision of the shear walls associated with the structural elements

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