Seismic Response of Multistory Flat Slab Building with And Without Shear Wall

Romil Gupta[1], Sumit Pahwa[2]
[1]Dept of Civil Engineering
[2]Associate Professor, Dept of Civil Engineering
[1, 2] Alpine Institute of Technology, Ujjain

Abstract- *The aim of the present study is to compare the behavior of multi-storey building having flat slab with or without shear walls and to analyze the effect of building height on the performance under earthquake forces. Also effect of with or without shear wall for flat slab building on seismic behavior with varying thickness and varying position of shear wall are studied. In this work, the effects of varying seismic zones on these buildings are also carried out. For that, G+9 and G+19 Storey models, each of plan size 20X20m are selected. For stabilization of the variable parameters, shear wall are provided at corners, center and along the periphery. To study the effect of varying thickness and different location of shear wall on flat slab multi-storey building, static analysis (Equivalent Static Analysis) in software STAAD Pro is carried out for zone IV and V. The seismic parametric studies comprise of lateral displacement, storey drift, drift reduction factor and contribution factor.*

Keywords- Lateral displacement, Storey drift, Drift reduction factor, Contribution factor. Flat Slab, Shear Wall

I. INTRODUCTION

One of the major problems in the modern construction world is the problem of vacant land. This scarcity in urban areas has led to the vertical construction growth of low-rise, medium-rise, tall buildings and even sky-scraper (over 50 meters tall). These buildings generally used Framed Structures subjected to the vertical as well as lateral loads. In these structures, the lateral loads from strong winds and earthquakes are the main concerns to keep in mind while designing rather than the vertical loads caused by the structure itself. These both factors may be inversely proportional to each other as the building which is designed for sustaining vertical loads may not have the capacity to sustain or resist the above mentioned lateral loads. The lateral loads are the foremost ones as they are in contrast against one another as the vertical loads are supposed to increase linearly with height; on the other hand lateral loads are fairly variable and increase rapidly with height. When lateral loads of a uniform wind or an earthquake load arrives the overturning moment at base of the structure is humongous and varies proportionally to square of the building height. This causes the building to act as cantilever as these lateral loads are notably higher in the topmost storey rather than the bottom storey. These lateral forces from the sideways tend to sway the frame. The seismic prone areas where the chances of earthquakes are comparatively higher the buildings collapsed which have not been designed in concern to these seismic loads. All these above mentioned reactions make it very important to study the causes and effects of lateral loads.

For buildings taller than 15 to 20 stories, pure rigid frame system is not adequate because it does not provide the required lateral stiffness and causes excessive deflection of the building. These requirements are satisfied by two ways. Firstly, by increasing the members size above the requirements of strength but this approach has its limitation and secondly, by changing the structural form into more stable and rigid to restrict deformation. This increases the structure's stability and rigidity and also restricts the deformation requirement.

In this study, the response of multistoried R C Flat slab under the vertical and lateral loads has been done. Main concerned is to increase the lateral stiffness of flat slab structure under lateral loading and to minimize the displacement. This study also concerned about the special features like shear wall in our structure

II. METHDOLOGY & MODELLING

There are different cases considered for varying building height, varying thickness and position of shear wall to analyze structure, so that proper position of shear wall can be predicted.

Case A– Ten Storey (i.e. G+9) building.

Model I – Flat slab building without shear walls.
Model II – Flat slab building with shear walls at corners.
Model III – Flat slab building with shear walls along periphery.
Model IV – Flat slab building with shear walls at center.

Case B – Twenty Storey (i.e. G+19) building.

Model I – Flat slab building without shear walls.

Case B1- Full Height Shear wall

Model II – Flat slab building with shear walls at corners.
Model III – Flat slab building with shear walls along periphery.
Model IV – Flat slab building with shear walls at center.

Case B2- Stepped Shear wall

Model II – Flat slab building with shear walls at corners.
Model III – Flat slab building with shear walls along periphery.
Model IV – Flat slab building with shear walls at center.

Case B3- Curtail or Part Shear wall

Model II – Flat slab building with shear walls at corners.
Model III – Flat slab building with shear walls along periphery.
Model IV – Flat slab building with shear walls at center.

2.1 Development of Models

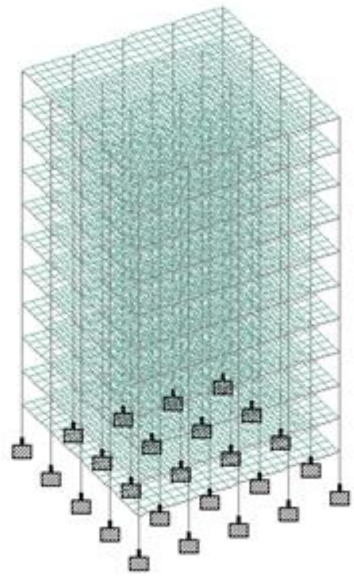
2.1.1 Case A- Models for Ten Storey (i.e. G+9) building.

Model I: Plan Area is 20m x 20m, shear wall is not provided.

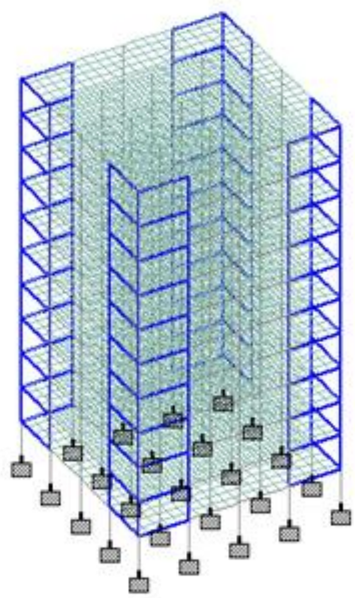
Model II: Plan Area is 20m x 20m, shear wall of thickness 150mm is provided up to ten storey at all the corners in adjacent panels.

Model III: Plan Area is 20m x 20m, shear wall of thickness 150mm is provided up to ten storey at along the periphery.

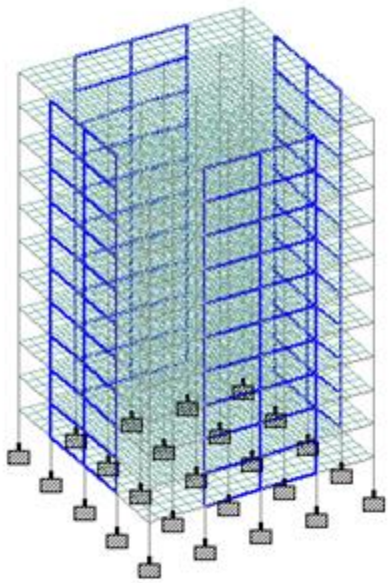
Model IV: Plan Area is 20m x 20m, shear wall of thickness 150mm is provided up to ten storey at center.
Static analysis is carried out for Zone IV and V for all the models of ten storey building.



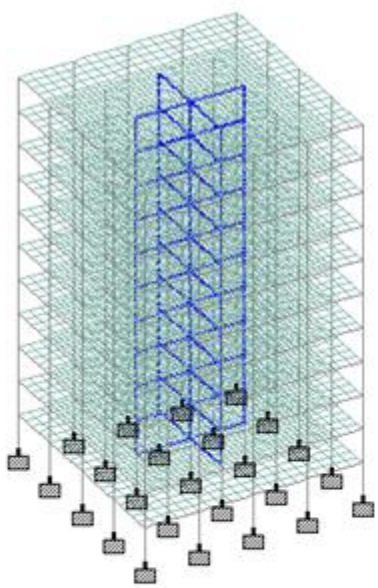
Model I



Model II



Model III



Model IV

Figure 2.1- Models of Ten storey building

(Thickness of shear wall is 150mm throughout the height for all models)

2.1.2 Case B- Models for Twenty Storey (i.e. G+19) building.

Model I: Plan Area is 20m x 20m, shear wall is not provided.

Case B1: Full height shear wall

Model II: Plan Area is 20m x 20m, shear wall of thickness 250mm is provided up to twenty storey at all the corners in adjacent panels.

Model III: Plan Area is 20m x 20m, shear wall of thickness 250mm is provided up to twenty storey at along the periphery.

Model IV: Plan Area is 20m x 20m, shear wall of thickness 250mm is provided up to twenty storey at center.

Case B2: Stepped shear wall

Model II: Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 150mm for next ten storey at all the corners in adjacent panels.

Model III: Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 150mm for next ten storey at along the periphery.

Model IV: Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 150mm for next ten storey at center.

Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 200mm for next ten storey at all the corners in adjacent panels.

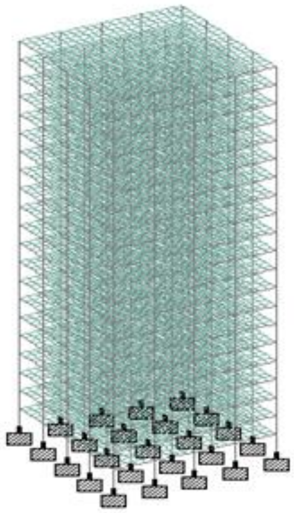
Case B3: Curtailed or part shear wall

Model II: Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 200mm for next five storey and then curtail the shear walls at all the corners in adjacent panels.

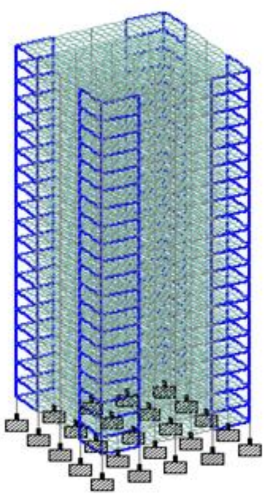
Model III: Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 200mm for next five storey and then curtail the shear walls at along the periphery.

Model IV: Plan Area is 20m x 20m, shear wall of thickness 250 mm is provided for bottom ten storey, 200mm for next five storey and then curtail the shear walls at center.

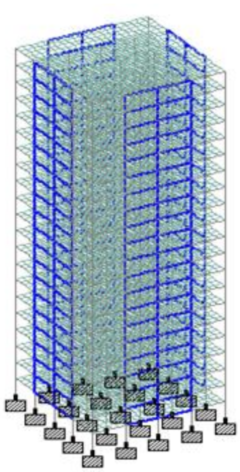
Static analysis is carried out for Zone IV and V for all the models of twenty storey building.



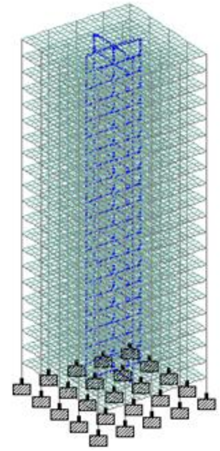
Model I



Model II



Model III



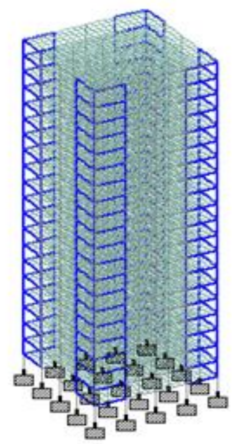
Model IV

Case B1: Full height shear wall

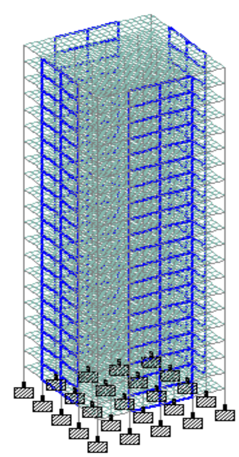
Thickness of shear wall is 250mm throughout the height for Models II to IV

Case B2: Stepped shear wall

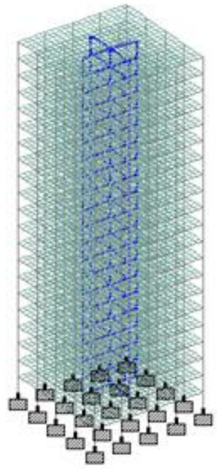
Thickness of shear wall is 250mm for bottom 10 storey and 150mm for next 10 storey for Models II to IV.



Model II



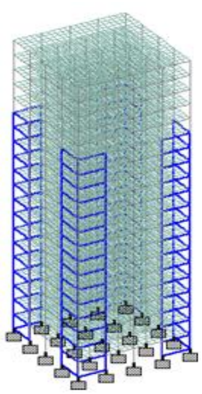
Model III



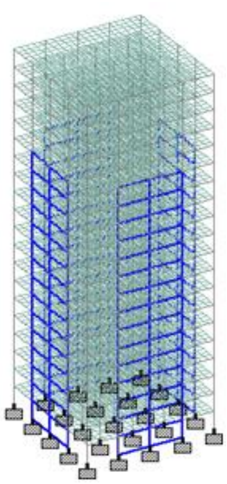
Model IV

Case B3: Curtailed or part shear wall

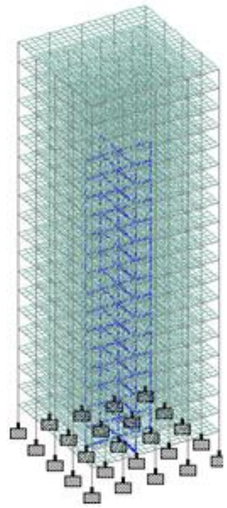
Thickness of shear walls are 250mm for bottom 10 storey and 200mm for next 5 storey and then curtail the shear walls for Models II to IV.



Model II



Model III



Model IV

Figure 2.2- Models of Twenty storied building

III. RESULT & DISCUSSION

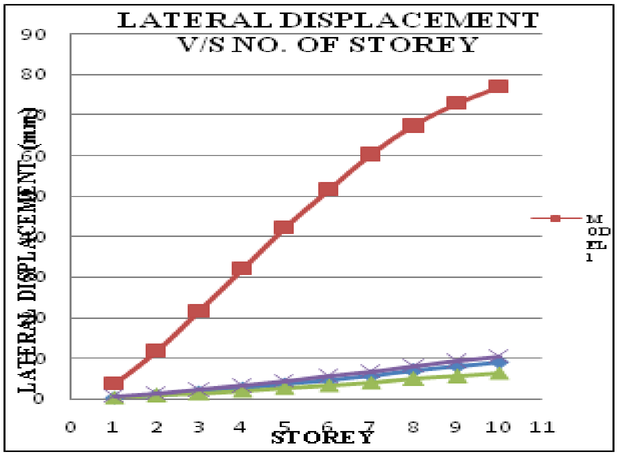
The equivalent static analysis is performed on curtailed or part, stepped and full height shear wall for different location and position of shear wall having different building heights are assessed for building areas through various cases for two earthquake zones i.e. Zone IV and V.

The analysis results obtained using staad pro software is shown in various graphs for various parameter as follows:

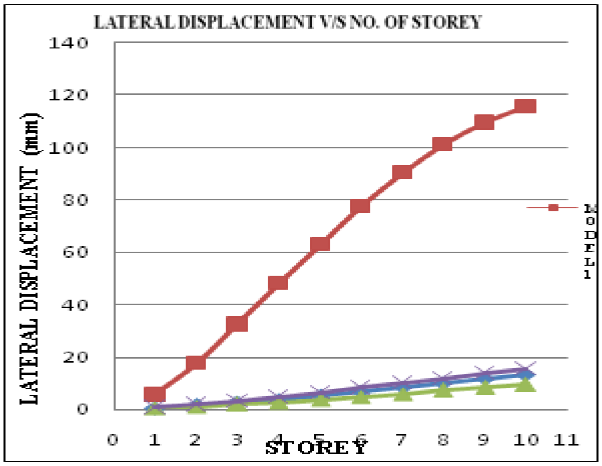
- Graphical representation showing the variation of lateral displacement without shear wall, with full shear wall, stepped shear wall and part or curtailed shear for different position of shear wall is presented
- Graphical representation showing the variation of storey drift without shear wall, with full shear wall, stepped shear wall and part or curtailed shear for different position of shear wall is presented

3.1 Graphs for Lateral Displacement

3.1.1 Comparison of lateral displacement for different models of ten storey building

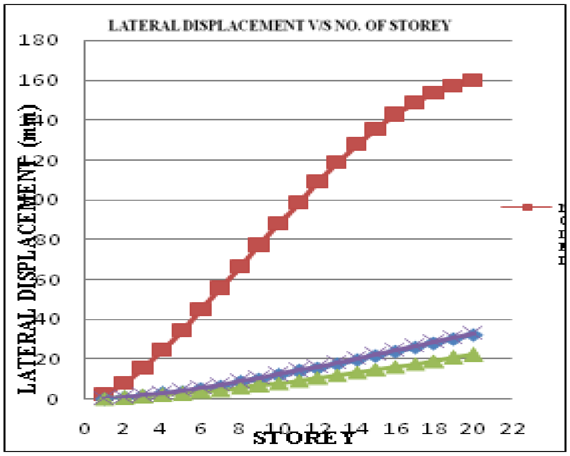


Graph 3.1.1.1 Static analysis for zone IV.

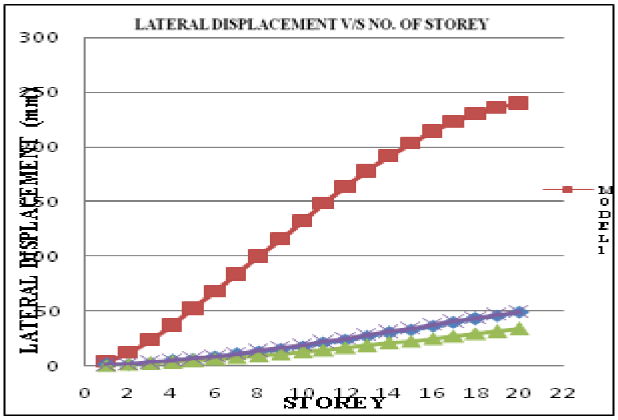


Graph 3.1.1.2 Static analysis for zone V.

3.2.2 Comparison of lateral displacement for different models of twenty storey building (full shear wall).

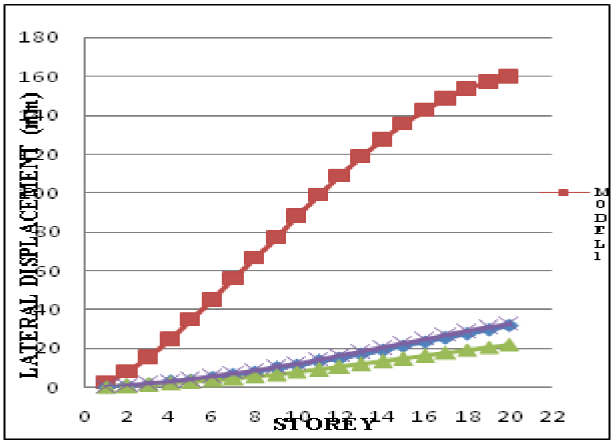


Graph 3.2.2.1 Static analysis for zone IV.

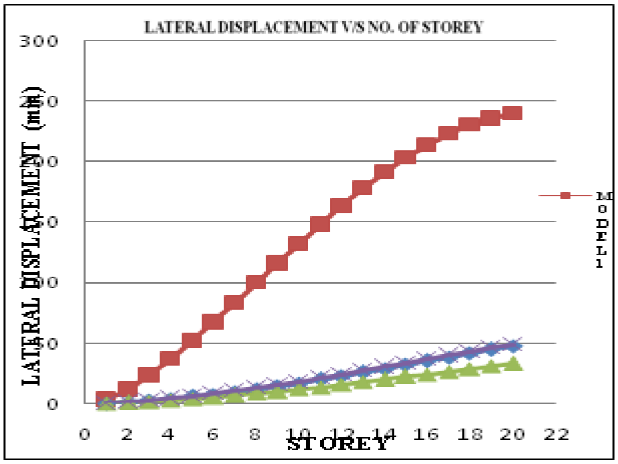


Graph 3.2.2.2 Static analysis for zone V.

3.2.3 Comparison of lateral displacement for different models of twenty storey building (stepped shear wall).

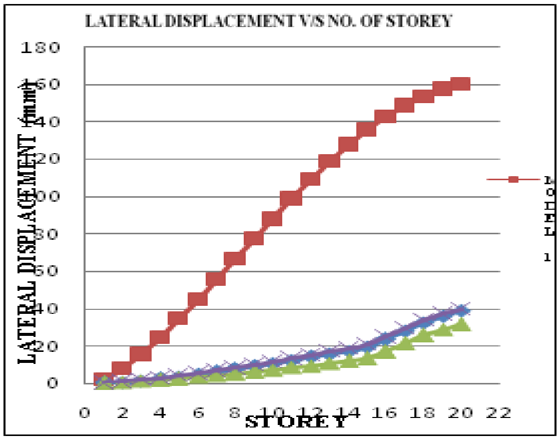


Graph 3.2.3.1 Static analysis for zone IV

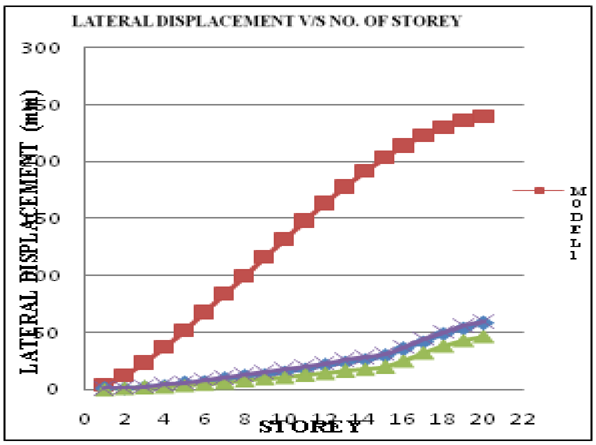


Graph 3.2.3.2 Static analysis for zone V.

3.2.4 Comparison of lateral displacement for different models of twenty storey building (curtailed or part shear wall).



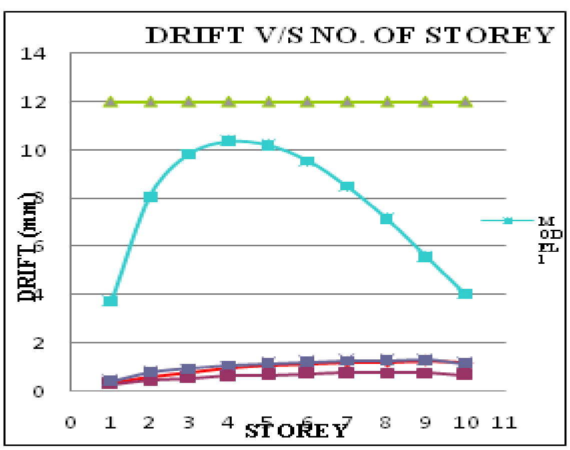
Graph 3.2.4.1 Static analysis for zone IV



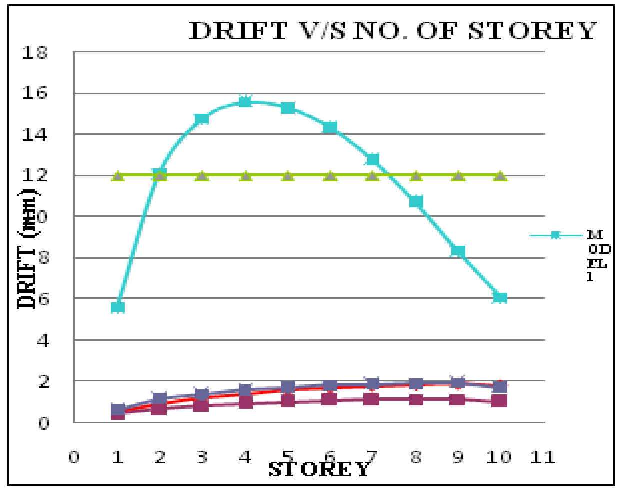
Graph 3.2.4.2 Static analysis for zone V.

3.2 **Graphs for Storey Drift**

3.2.1 Comparison of storey drift for different models of ten storey building.

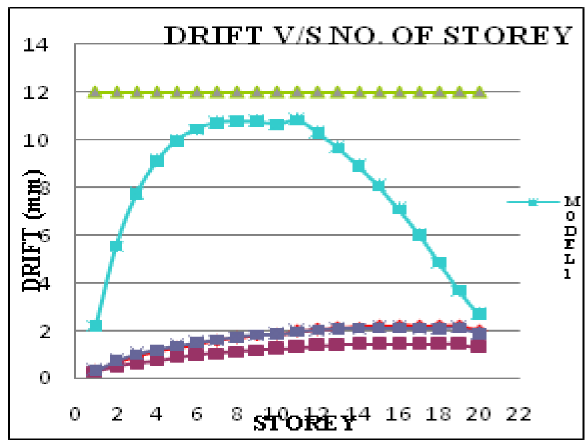


Graph 3.2.1.1 Static analysis for zone IV

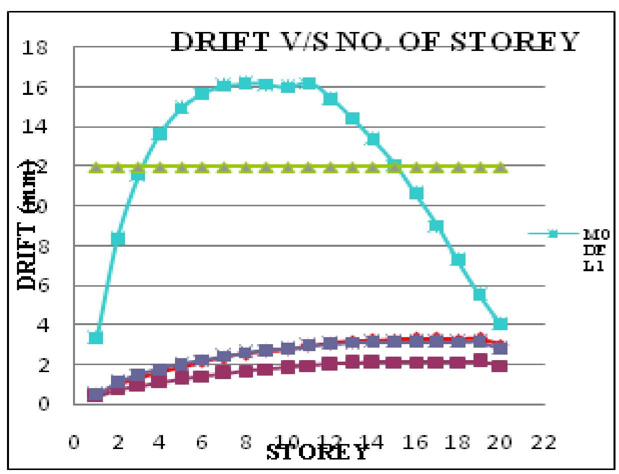


Graph 3.2.1.2 Static analysis for zone V.

4.2.2 Comparison of storey drift for different models of twenty storey building (full shear wall).



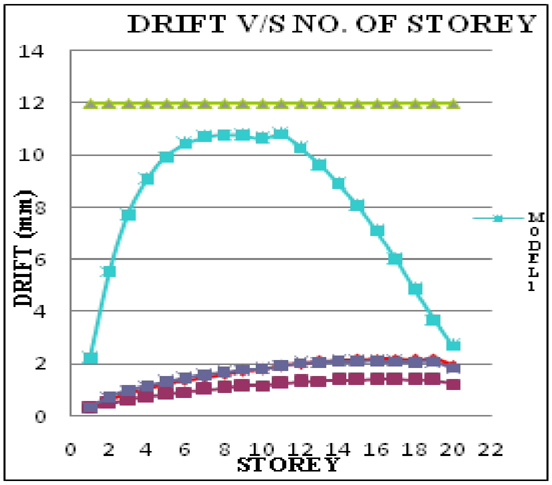
Graph 3.2.2.1 Static analysis for zone IV.



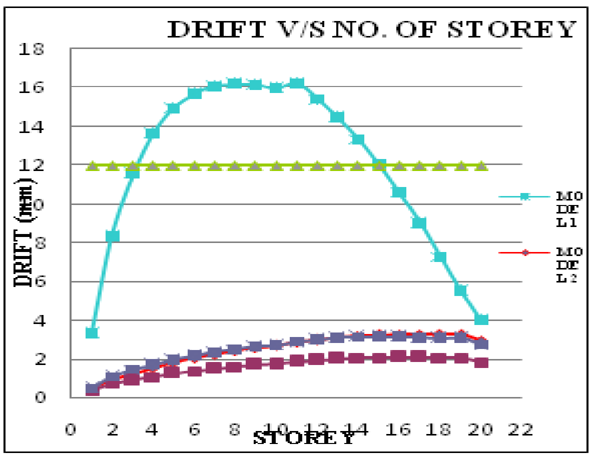
Graph 3.2.2.2 Static analysis for zone V.

4.3.3 Comparison of storey drift for different models of twenty storey building (stepped shear wall).

.

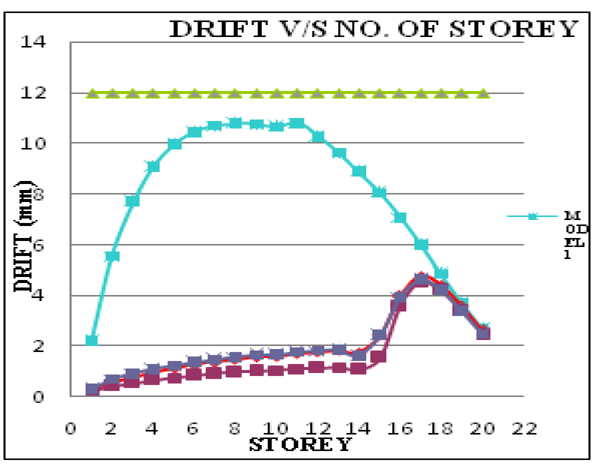


Graph 3.3.3.1 Static analysis for zone IV

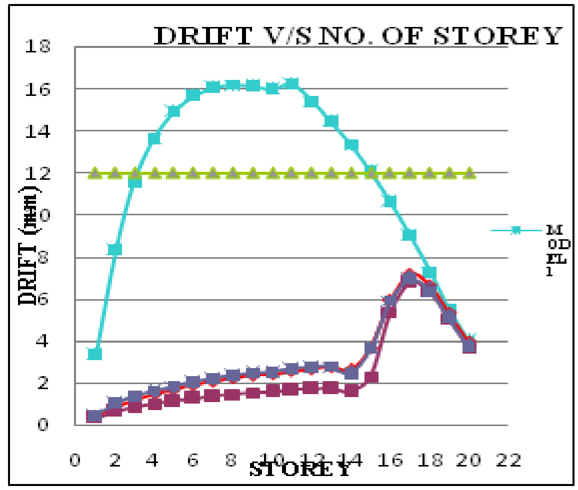


Graph 3.3.3.2 Static analysis for zone V.

<u>4.3.4 Comparison of storey drift for different models of twenty storey building (curtailed or part shear wall).</u>



Graph 3.3.4.1 Static analysis for zone IV.



Graph 3.3.4.2 Static analysis for zone V.

IV. CONCLUSION

4 Buildings with shear walls are preferred because of notable difference in lateral displacement and storey drift. The presence of shear wall reduces drift values in the range of 70% to 90% in static analysis.

5 The maximum lateral displacement is found for flat slab building without shear wall and minimum for flat slab building with shear wall. Lateral displacement is maximum at top storey and minimum at bottom storey for all type of building. Thus the lateral displacement increases drastically with the storey level. The presence of shear wall reduces storey displacement in the range of 92% to 75% in static analysis.

6 There are no remarkable changes in the drift values with the change in position of shear walls and with the change in thickness of shear walls with height. However at the level where shear walls are curtailed, a sudden change is observed, still the effect is negligible.

7 In both G+9 and G+19 building having no shear wall, the drift in the middle 60%- 70% storey are observed to be more than the permissible limit as building height increases beyond 30m in zone V but for building with RC shear wall, drift is within the permissible limit. However drift at various storey in G+9 and G+19 building with and without shear wall is within the permissible limits for zone IV.

REFERENCES

[1] Navyashree K1, Sahana T.S2: Use of Flat Slabs in Multi-Storey Commercial Building Situated in High Seismic Zone IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[2] Sumit Pawah1, Vivek Tiwari2, Madhavi Prajapati3: Analytical Approach to StudyEffectof Shear Wall onFlat Slab&Two Way Slab International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 7, July 2014

[3] Greeshma. S 1and Jaya.K.P 2 SEISMIC BEHAVIOUR OF SHEAR WALL - SLAB CONNECTION

[4] Shahzad Jamil Sardar and Umesh. N. Karadi: EFFECT OF CHANGE IN SHEAR WALL LOCATION ON STOREY DRIFT OF MULTISTOREY BUILDING SUBJECTED TO LATERAL LOADS International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 9, September 2013

[5] Durgesh Neve1, R. P.Patil 2 Survey Paper on Analysis of Flat Slab Resting on shear walls International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 05 | May-2016 e-ISSN: 2395 -0056

[6] Dhanaji R. Chavan1, Mohite D. D.2, Dr. C. P. Pise3, Pawar Y. P.2, Kadam S. S.2, Deshmukh C. M.2 :Behaviour Of Multi-Storied Flat Slab Building Considering Shear Walls: A Review Dhanaji R. Chavan.et.al. Int. Journal of Engineering Research and Application www.ijera.com ISSN : 2248-9622, Vol. 6, Issue 10, (Part -2) October 2016, pp.10-14

[7] Rajib Kumar Biswas1, Md.Meraj Uddin2, Md.Arman Chowdhury3, Md.Al-Imran Khan4 Comparative Analysis of a 15 Story Flat Plate Building with and Without Shear Wall and Diagonal Bracing Under Wind and Seismic Loads IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 9, Issue 2 (Sep. - Oct. 2013), PP 97-101

[8] Kalyanshetti M.G.†, Halkude S.A.†# and Tambake R.N.†* Effect of Shear Wall in the Seismic Analysis of Building Frames Considering Soil Structure Interaction– A Study by Winklerian Approach International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161