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Design and Analysis of High Rise Building Using Composite Technique Flat Slab and Shear Wall

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Abstract –

In couple of decades there is a considerable increase in the number of tall buildings, both residential and commercial, and modern trend is towards taller structures. Flat slab/plate is most widely used systems in reinforced concrete construction in offices, residential and industrial buildings in many parts of the world. This system having advantages that it reduces cost of form work and construction time, easy installation and requires the least story height. The flat plate system, in which columns directly support floor slabs without beams. Shear walls are relatively thin, vertically deep reinforced column used in structure which provide stability to structures from lateral loads like wind, seismic loads. In the present work, the effect of with and without shear wall of flat slab building on the seismic behavior of high rise building with different position of shear wall studied. For that, 11 storey models are created in Etabs. To study the effect of different location of shear wall on high rise structure, linear dynamic analysis (Response spectrum analysis) in software ETABs is carried out. Seismic parameters like time period, base shear, storey displacement and storey drift are checked out.

***Key Words*:Time History Analysis, Shear wall, Flat Slab, Displacement etc.**

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1.INTRODUCTION

In tall buildings lateral loads are premier one which will increase rapidly with increase in height. The design takes care of the requirements of strength, rigidity and stability. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces.Mohamed Abdel et al. [1] studied the base shear ratio, period of vibration and displacement for six and ten storey building using Etabs. All models were studied using various shear wall locations and they identified that an appropriate FE model of SW dominant flat-plate R/C buildings, which can be used to study its dynamic behavior.

Kim et al. [2] proposed an efficient method for a three-dimensional analysis of a high-rise building structure with shear walls. Three-dimensional super elements for walls and floor slabs were developed and a substructure was formed by assembling the super elements to reduce the time required for the modeling and analysis. Static and dynamic analyses of example structures with various types of opening were performed to verify the efficiency and accuracy of the proposed method. They concluded that the proposed method is very useful for an efficient and accurate analysis of high-rise building structures with significantly reduced computational time and memory.

Aksogan et al. [3] studied the forced vibration analysis of amulti-bay coupled shear wall on an elastic foundation. Theiranalysis considers shear walls with a finite number of stiffening beams, the properties of which vary from span to span and/or from section to section in the vertical direction. They employed continuous connection method (CCM) to find the structure stiffness matrix. The structure mass matrix was found with the lumped mass assumption. A time-history analysis was carried out using the Newmark numerical integration method to obtain the response. The response obtained by the present method was then compared with those obtained using SAP2000 structural analysis program. They found a good match between the results of present method and the results of the SAP2000 program.

Tuken [4] proposed an analytical method to determine the sway of a mixed structure (frame + shear wall) subject to seismic forces. The validity of the analytical method was tested on 3-D buildings of different heights. He also obtained the sway response using SAP2000 and found that the sway results obtained by the analytical method matches well with the results of SAP2000.

Fayazuddin Ahmed Syed et al. [5] proposed a flat plate floor system with and without shear wall, the Shear walls with flat plates contribute towards reducing the column axial force even in the middle frame region also. In the case of other building frames there is similar reduction in column axial force when wind is acting.

Husam Omar, Glenn Morris [6] they studied a review about a procedure which is described for performing a linear structural analysis of laterally loaded three-dimensional flat plate structures, with or without shear walls.

H.S. Kim, D.G. Lee [7] they studied a review about the Flat Plate system which has been adopted in many buildings constructed recently due to the advantage of reduced floor heights to meet the economical and architectural demands.

2. ANALYTICAL WORK

Time history method is used for the analysis of structure. It is an analysis of the dynamic response of the structures at each increment of time, when its base is subjected to a specific ground motion time history. In this method, the structure is subjected to real ground motion records. This makes this analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions or in forces are calculated as function of time, considering dynamic properties of building structure.

Total two numbers of earthquake records were used; the maximum PGA on the basis of acceleration gravity for Imperial Valley (El Centro) (1979) and Kern city (1952) are 0.314 and 0.275 respectively. Acceleration component and properties of earthquake is shown in table 1.

Table 1: Properties of earthquake records

Record	Imperial valley (1979)	Kern city (1952)
Station	EC meloland overpass	Taft Lincoln tunnel
PGA(g)	0.348	0.275
Magnitude	6.5	7.5

An 11 storey building with RC shear wall and without shear wall with flat slab is taken for this study. The different location of shear wall is used to study the effect of changing location. The presence of Shear Wall is a structural system providing stability against wind, earthquake and blast and deriving its stiffness from inherent structural forms. The behavior of building is studied for different parameters like story drift, story shear, time period; etc.

A. Assumptions:

The height of one floor is of 3.6m each. In this way 10 numbers of total models are analyzed.
The different components of conventional R.C.C structure, flat slab and shear wall are as follows:
Grade of concrete M25
Columns of the building is of 230mm x 600mm,
Beam size of the building is of 230mm x 450mm,
Slab thickness of the building is of 150mm,
Flat slab thickness 250mm,
shear wall thickness 250mm,
Size of drop 5000mm x 50000mm x 300mm

B. Types of Cases Used for Analysis of Structure:

There are different cases considered to analyze 11-storey structure having height 39.5m, so that proper provision of shear wall can be predicted.

1. Performance of flat slab building with C type shear wall.
2. Performance of flat slab building without shear wall.
3. Building with L type shear wall and flat slab.
4. Building with shear wall along periphery with flat slab.
5. Building with non-parallel shear wall along periphery with flat slab.

Following figures shows the model of different cases done in ETABS software.

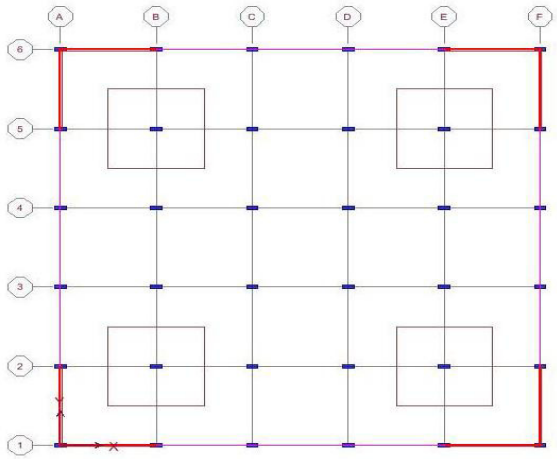

Fig -1: Building with L type shear wall with flat slab

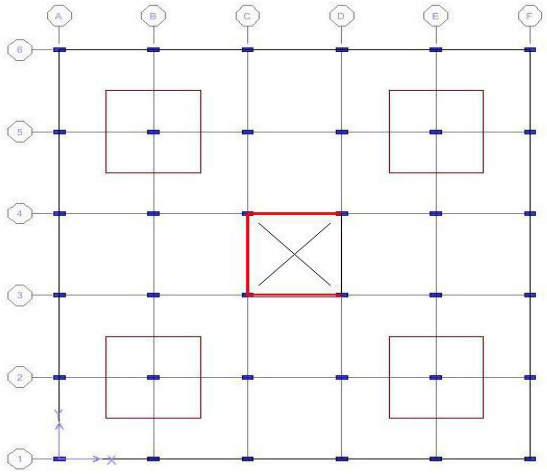

Fig -2: Building with Core shear wall with flat slab

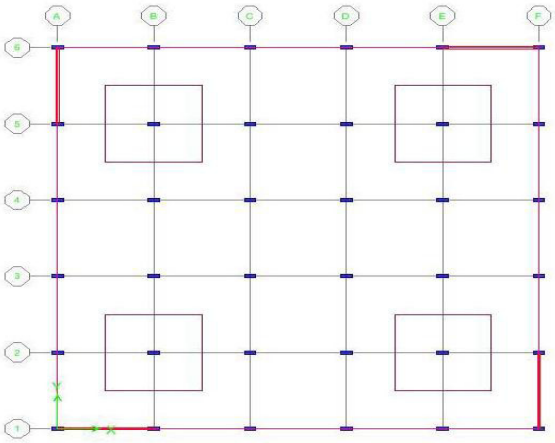

Fig -3: Building with non-parallel wall with flat slab

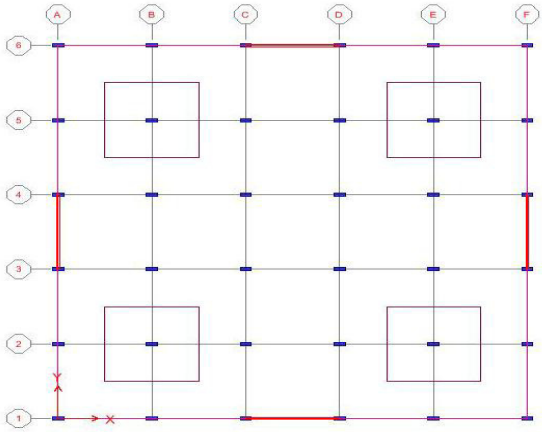

Fig -4: Building with shear wall at periphery with flat slab

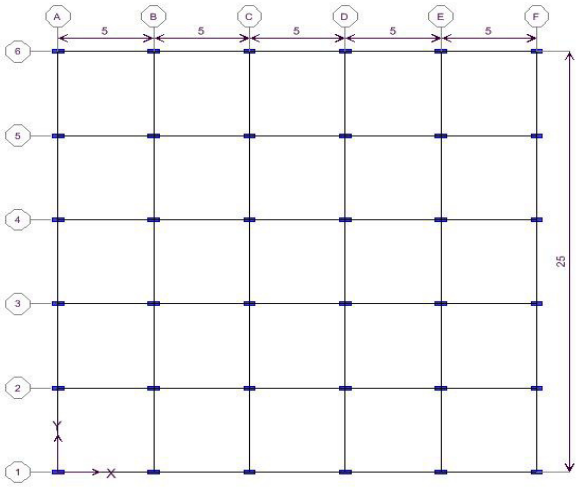

Fig -5: Building with conventional beam, slab and column

3. RESULTS AND DISCUSSION

In this study, G+11 RC structures with conventional and flat slab along with variation of different location of shear walls has been considered. Seismic responses including displacements, time period and base shear were assessed under two earthquake records.

The seismic responses of all these models have been determined using time history analysis. The time history records are shown in the figure below i.e. figure 6 to 8, and the obtained results are summarized as follows.

1.The critical response depends on the earthquake characteristics and particularly frequency content of earthquake records.

2.It is observed that the displacements for models with shear wall are less than the models without shear wall.

3.Provision of flat slab increases the value of base shear than conventional slab.

4.Considering shear wall location C-type and L-type and periphery shear wall increases the base shear.

5.Considering among the same model i.e. shear wall and another shear wall with flat slab, it is observed that provision of flat slab increases the displacement in some cases but in most of the cases displacement decreases due to provision of shear wall and flat slab than in case of conventional slab.

6.Base shear goes on increasing with provision of flat slab and shear wall than conventional slab.

7.Base shear and displacements are directly proportional to the height of the structure.

8.There is sudden change in displacement values for Imperial Valley earthquake. All the models show maximum displacement for imperial valley earthquake data and minimum responses for kern earthquake data for all variations of shear wall and flat slab.

9.Considering C shaped shear wall it is observed that structure undergoes in torsion for mode 1 as shown in figure 9.

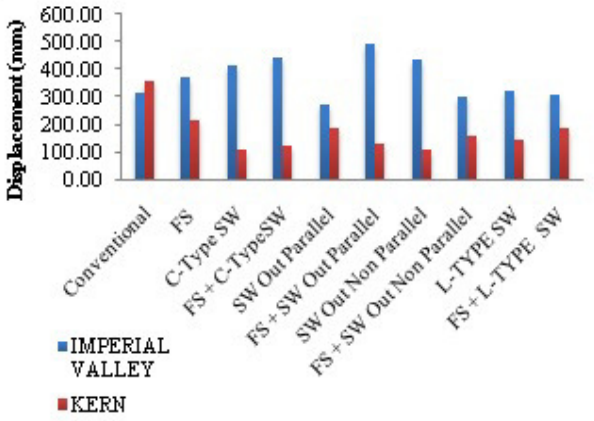

Fig -6: Displacement graph

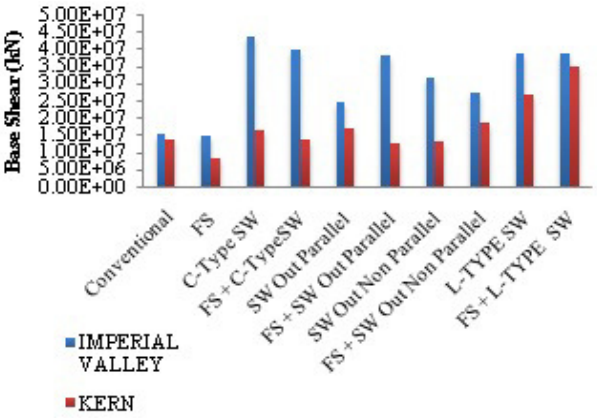

Fig -7: Base Shear graph

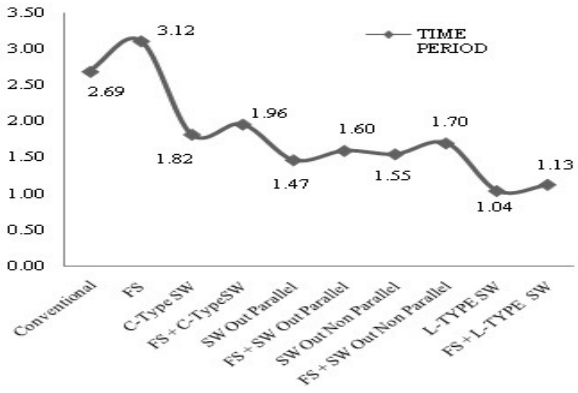

Fig -8: Time Period variation graph

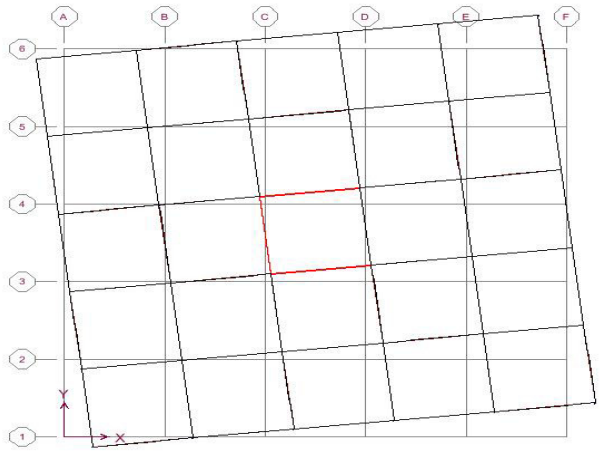

Fig -9: Torsional mode for C-shape shear wall with and without flat slab

4. CONCLUSION

This paper represents the summary of the study, for conventional R.C.C. structure and Flat slab structure along with different location of shear wall, on the basis of results following conclusion have been drawn.

1.The natural time period increases as the height of structure increases irrespective of type of structure. However, the time period is same for flat slab structure and flat slab with shear wall.

2.In comparison of the conventional structure to flat slab structure, the time period is more for conventional structure than flat slab structure because of monolithic construction.

3.Base shear increases with the height of the structure. Base shear of conventional R.C.C. structure is less than flat slab structure.

4.Displacement increases in case of flat slab structure than conventional structure but displacement decreases in case of structure along with flat slab with shear wall.

As a result, structure with flat slab and shear wall sustain additional and maximum load as redistribution reduces as the number of members reduces in selected lateral load resisting system.

5. REFERENCES

[1] Mohamed Abdel-Basset Abdo, Modeling of shear-wall dominant symmetrical flat-plate reinforced concrete buildings. International Journal of Advanced Structural Engineering 2012.

[2] Kim, H., Lee, D., Kim, C.K. Efficient three-dimensional seismic analysis of a high-rise building structure with shear walls. Engineering Structure 27(6), 963–976 (2005)

[3] Aksogan, O., Bikce, M., Emsen, E., Arslan, H.M., A simplified dynamic analysis of multi-bay stiffened coupled shear walls. Advance Engineering. Software 38, 552–560 (2007)

[4] Tuken A., Analysis and assessment of seismic drift of reinforced concrete mixed (shear wall-frame) structures. Technology 7(4), 523–532 (2004)

[5] Fayazuddin Ahmed Syed, B. Dean Kumar, Y. Chandrasekhar, B.L.P. Swami. Comparative Analysis of Flat Plate Multistoried Frames with and Without Shear Walls under Wind Loads. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-1, October 2012.

[6] Husam Omar, Glenn Morris, Analysis of laterally loaded flat-plate structures, Canadian Journal of structural engineering, Vol.18, No.1, 1991, pp.109-117.

[7] H.S. Kim, D.G. Lee, Efficient Analysis of Flat Plate Structures subjected to Lateral Loads, Science Direct, Engineering StructuresJournal, Vol.27, Issue.2, January 2005, pp 251-263.

[8] Bryan Stafford Smith and Alex Coull. Tall Building Structure Analysis and Design. A Wiley-intersceince Publication, New York-1991.

