# Effect of Shear wall on Performance of Flat Slab

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**ABSTRACT**:
**Flat slabs is innovative system for construction slab ,in which slab directly rest on columns.Flat slab structure have advantages over conventional structure such as economy in construction, its architectural appearance, flexibility and speed of the construction. However because of absence of beams in flat slab, lateral stiffness is considerably reduced hence flat slab structure more flexible to seismic loading as compare with conventional structure. This objective of this work is to study effect shear wall on seismic performance of flat slab structure.**

**Keywords: Flat slab RC structure, Seismic response, Static analysis, Dynamic analysis.**

## I. INTRODUCTION:

Flat slabs is system of construction is one in which the beams used in the conventional methods of constructions are done away with. The slab directly rests on the column and load from the slab is directly transferred to the columns and then to the foundation. To support heavy loads the thickness of slab near the support with the column is increased and these are called drops, or columns are generally provided with enlarged heads called column heads or capitals. These increasing thickness of flat slab in the region supporting columns provide adequate strength in shear and to increase the amount perimeter of the critical section, for shear and hence, increasing the capacity of the slab for resisting two-way shear and to reduce negative bending moment at the support. Flat slabs have been widely used in building construction due to their advantages in reducing storey height and construction period as compared with conventional structure, leading to a reduction of construction costs. Provision of the flat slab building in which slab is directly rested on columns, have been adopted in many buildings constructed recently due to the advantage of reduced floor to floor heights to meet the economical and architectural demands.

Because of absence of deep beam Flat slab building structures which are more significantly flexible than conventional concrete frame/wall or frame structures, thus becoming more vulnerable to seismic loading. Thus the seismic analysis of these structures is necessary to know the vulnerability of these structures to seismic loading.

The flat slab structure are more respond to seismic loading as compare with conventional structure hence additional measure are required to improve their seismic performance. Therefore, flat slab structure constructed in earthquake prone region additional measures should be taken such as provision of shear wall in order to reduce the seismic response of flat slab RC structure.

## II. METHODS OF DESIGN OF FLAT SLAB

Following are the methods used for analysis of flat slab

1. The direct design method
2. The equivalent frame method

METHODS OF SEISMIC ANALYSIS

A. Linear static analysis
B. Linear dynamic analysis

## III. PROBLEM FORMULATION, MODELLING AND ANALYSIS.

Following are the models used for analysis
Case 1)-

i. 8 storey Flat Slab RC structure having plan dimensions 30 m x36 m.
ii. 8 storey flat slab structure with shear wall having plan dimensions 30 m x36 m.

Case 2)-

i. 12 storey Flat Slab RC structure having plan dimensions30 m x36 m.
ii. 12 storey flat slab structure with shear wall having plan dimensions 30 m x36 m.

Case 3)-

i. 18 storey Flat Slab RC structure having plan dimensions 30 m x36 m.
ii. 18 storey flat slab structure with shear wall having plan dimensions 30 m x36 m.

All above model are analysed and comparison is made between these analysis. To know vulnerability of the structure to seismic loading.

*Details of Modelling:*

i. Storey height -3.2m
ii. Plinth level-0.8m
iii. Thickness of flat slab- 220mm
iv. Thickness of drop is -270mm.
v. Thickness of shear wall is- 150mm.
vi. Size of column -0.45m to 1.2m.
vii. Size of beam -300mm to 600mm.

*Loading Details:*

*1 . Gravity loads-*

i. Live load at typical floor-4 kN/m2
ii. Live load at top floor -2 kN/m2
iii. Floor finish load at typical floor -1.0 kN/m2
iv. Floor finish load at top floor -2.0 kN/m2

2. Detail of Earthquake loading-

1. Static analysis
   a. Location of zone- IV.
   b. The direction of excitation -X.
   c. Importance factor -1
   d. Response reduction factors- 5

2. Dynamic analysis-
   a. Location of zone- IV.
   b. The direction of excitation -X.
   c. Damping-5%.

## IV. RESULTS

1. Base shear - Base shear is the total design lateral force ($V_B$) along any principal direction, which is determined by following expression

$$V_B = A_h W$$

Where
Ah = Design horizontal acceleration spectrum
W = Seismic weight of building.

TABLE I
BASE SHEAR COMPARISON of above models

| Model | Linear static analysis | Response spectrum analysis |
|---|---|---|
| Case 1- 8 storey Structure | | |
| Flat slab structure | 1647.89 | 1523.60 |
| Flat slab structure with shear wall | 5392.65 | 4631.04 |
| Case 2- 12 storey Structure | | |
| Flat slab structure | 2190.05 | 1845.76 |
| Flat slab structure with shear wall | 5618.61 | 4930.89 |
| Case 3- 18 storey Structure | | |
| Flat slab structure | 3380.73 | 2647.29 |
| Flat slab structure with shear wall | 6397.51 | 5543.13 |

From above result shows that flat slab structure are more flexible. The flexibility of flat slab can be reduced by providing shear wall.

2. Storey drift-

Storey drift is the total lateral displacement that met in a single storey of a high-rise building. The drift in a storey is computed as a difference of deflections of the floors at the top and the bottom of the storey under consideration. It is one of the predominantly important engineering response quantity and indictor of structural performance, in particular for multi-storey buildings. Storey drift is considered as unique standard for structural behaviour conclusion.

According IS 1893 (Part 1): 2002 maximum allowable storey drift Should not be exceed shall 0.004 times the storey height under consideration. For all the analysis of the above model storey drift should not exceed 12.8mm.

**Comparison of Storey Drift for different cases**

Case 1- 8 storey structure

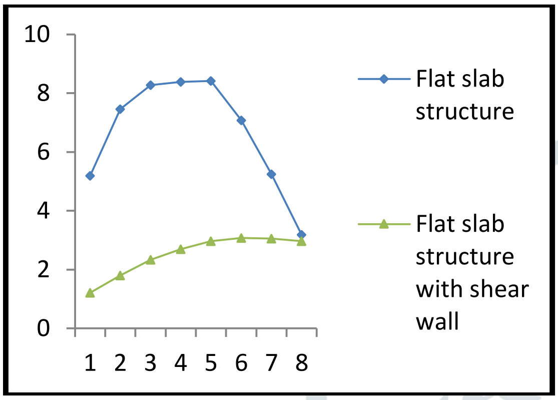


*Figure 1. Linear Static Analysis*

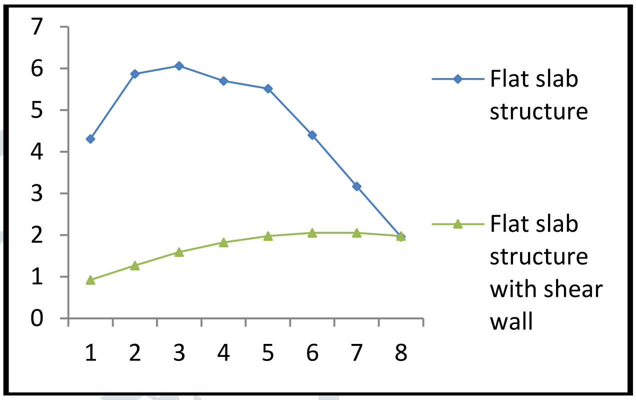


*Figure 2. Linear Dynamic Analysis.*

The plot of drift values shows that provision of shear wall imparts uniform stiffness to the flat slab structure and it reduces the drift values of mid-storey almost by 50%, thus proving the reliability of shear wall in case of multi-storey structures.

Case 2- 12 storey structure

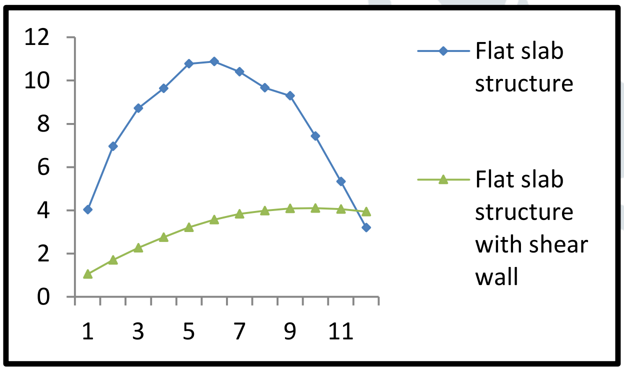


*Figure 3.Linear Static Analysis.*

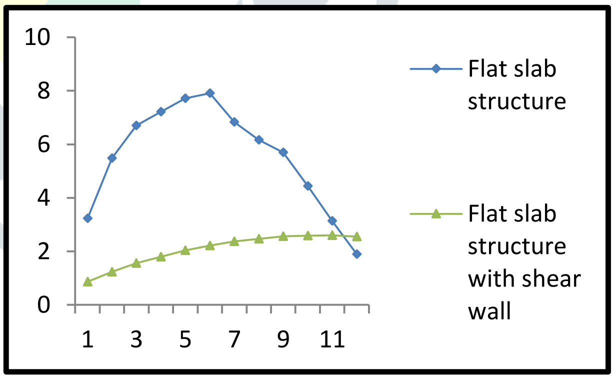


*Figure 4.Linear Dynamic Analysis*

The plot of drift values shows that provision of shear wall imparts uniform stiffness to the flat slab structure and it reduces the drift values of mid-storeys almost by 50%, thus proving the reliability of shear wall in case of multi-storey structures.

Case 3- 18 story structure

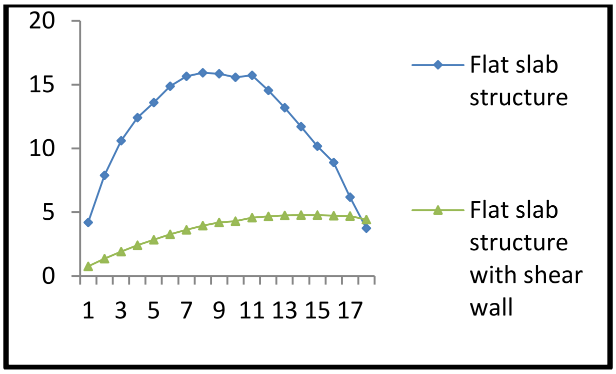


Figure5. Linear Static Analysis

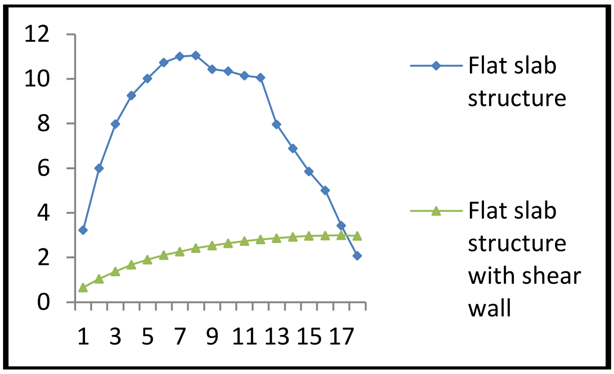


Figure 6. Linear Dynamic Analysis

In case of 18 storey structure in zone IV, Storey drift of flat slab structure differs very much from conventional RC framed structure and **exceed permissible values (storey drift being more than 12 mm)** when analyzed by linear static analysis. Thus, multi-storey flat slab structure essentially demand lateral load resisting system such as in-plane shear wall in order to bring storey drift values within permissible limits.

**Comparison of Displacement for different cases**

**Case 1** -8 storey structure

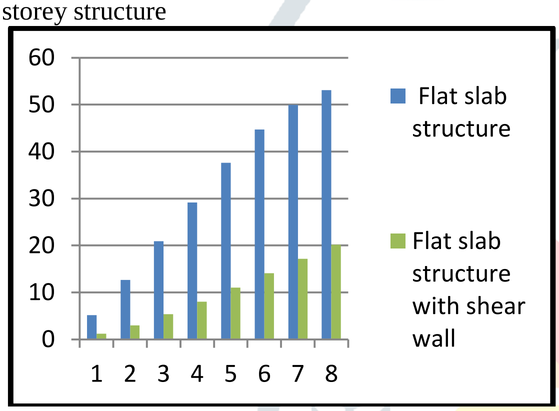


Figure 7. Linear Static Analysis.

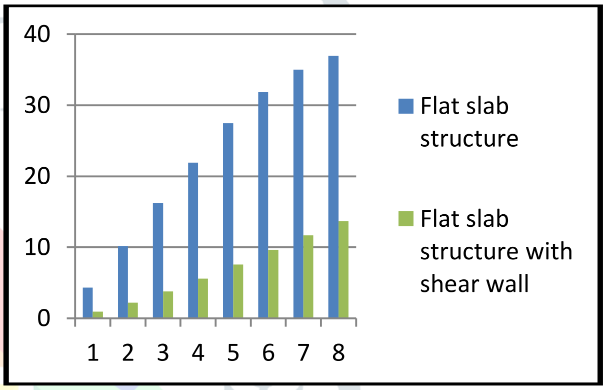


Figure 8. Linear Dynamic Analysis

Maximum displacement attained by flat slab structure with shear wall is much lesser than that in case of flat slab structure without shear wall. Both the analysis viz. linear static analysis and linear dynamic analysis emphasis that multi-storey flat slab structures are to be accompanied with the shear wall for better performance of flat slab structure during earthquake.

**Case 2**-12 storey structure

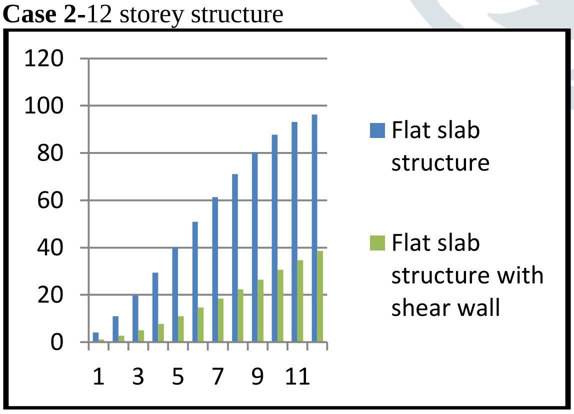


Figure 9. Linear Static Analysis

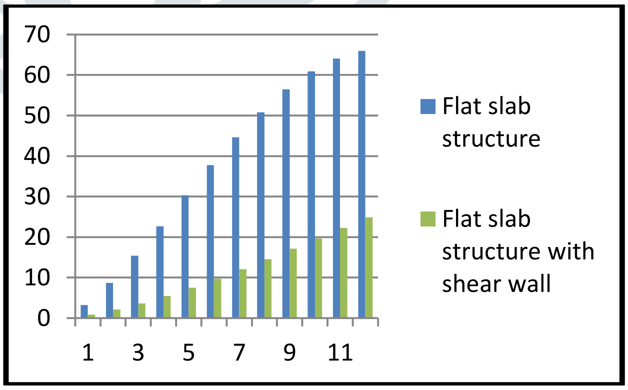


Figure10. Linear Static Analysis.

Figure 9 and figure 10 shows the significant reduction in maximum displacement of flat slab structure after the application of shear wall.

**Case 3**- 18 storey structure

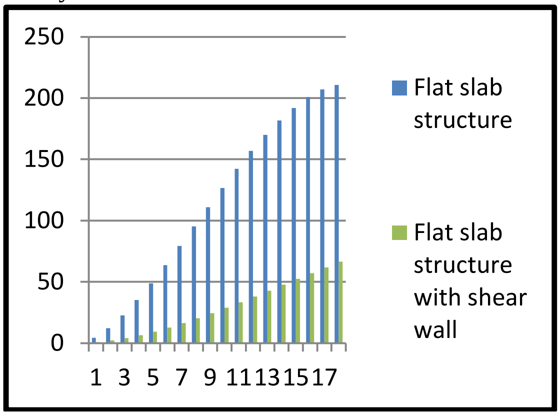


Figure11. Linear Static Analysis.

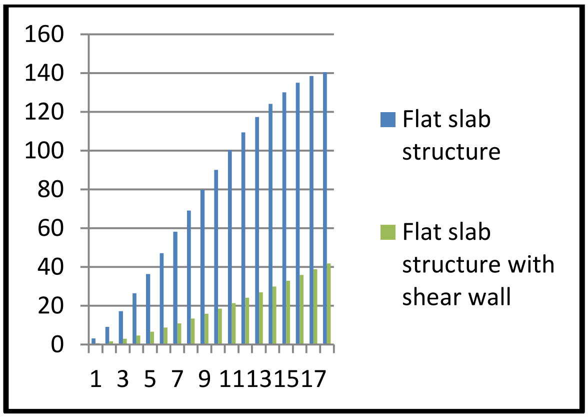


Figure12. Linear Dynamic Analysis

Maximum displacement attained by flat slab structure with shear wall found to be reduced by more than 60% than that in case of flat slab structure without shear wall. Hence such a multi-storey structure having 18 numbers of storeys must be accompanied with lateral load resisting element such as shear wall to bring the displacement values to the desired level as in this case.

## V. Conclusion

1. For all case, flat slab structure without shear wall design base shear less as compare with conventional structure which is due to the flexibility of flat slab structure.
2. In case of flat slab storey drift is more and this storey drift can be reduced by provision of shear wall to flat slab structure.
3. The displacement of the flat slab structure considerably reduced by provision of shear wall.

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