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STUDY ON SEISMIC ANALYSIS OF BUILDINGS WITH RC SHEAR WALL AND COMPOSITES SHEAR WALL

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Abstract:

Now a day's concrete has become an ideal material for building construction because of its ease of work and it is made by locally available material which is generally present in every part of world. As increase in population in urban area of our country, there is a scarcity of the land so there is need to developed high rise building to full fill the housing demand. To make earthquake resisting building shear wall is one of the best option. Shear wall is commonly designed to resist the lateral loads such as wind or earthquake load which causes damage to the buildings. The main objective of this research work is to compare RC shear wall and Composite shear wall provided at different locations of the building. Out of five models, chosen for study, it was observed that Composite shear wall provided at side center gives better response against seismic excitation. All analysis is performed by Response Spectrum Analysis using ETABS 2017 software. Overall after the analysis and results made in observation with Model 1, Model 2, Model 3, Model 4 and Model 5, we can conclude that in high seismic zone (zone IV as taken in analysis) to make earthquake resistant building, shear wall is necessary.

Keywords — **Response Spectrum Analysis, Time period, Mode Shape, R.C Shear Wall, Composite Shear Wall.**

I. INTRODUCTION

A framed structure could be a structures having combination of beam, column, slab, wall (shear wall) to resist gravity and lateral masses. Typically, these structures square measure wont to overcome giant moments developed because of applied load either by earthquake or live loading. In a RCC framed structure, the load is transferred from a block to the beams then to the columns and any to lower columns and at last to foundation that successively transfers it to the soil. The walls in such structures square measure created once the frame is prepared and aren't meant to hold any load. As against this, in an exceedingly load bearing structure, the masses square measure directly transferred to the soil through the walls, that square measure capable of carrying them.

Reinforced Concrete shear wall (RCSW)

Reinforced Concrete Shear wall (RCSW) is slender structural member which oppose lateral forces in their own plane and act as cantilever, and provide large stiffness to the building system in direction of their orientation, which significantly reduces lateral displacement of the building and thereby reduces impair to structure and its components. It provided in both direction length and width of building. Like moment-resisting frames, shear walls alone cannot resist loads applied in the direction perpendicular to their plane. Thus, to resist lateral loads in both horizontal plan directions, buildings need to be provided with walls in both directions.

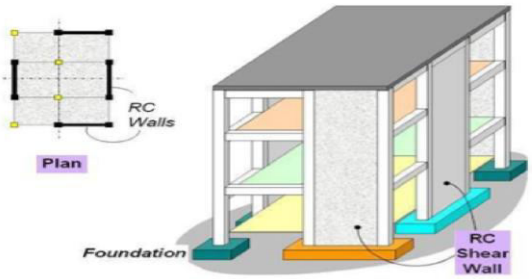


Fig.1 R.C Shear wall

Composite Shear Wall (CSW)

The concrete filled double-skin steel-plate composite (CFDSC) wall, which consists of two steel faceplates on the exterior surfaces and the infill concrete, is becoming increasingly attractive as the main lateral resistance component. The CFDSC wall takes advantages of both RC wall and steel plate wall. The infill concrete could prevent the local buckling of the steel plates, while the strength and ductility of the inner concrete are enhanced due to the confinement from the outer steel plates.

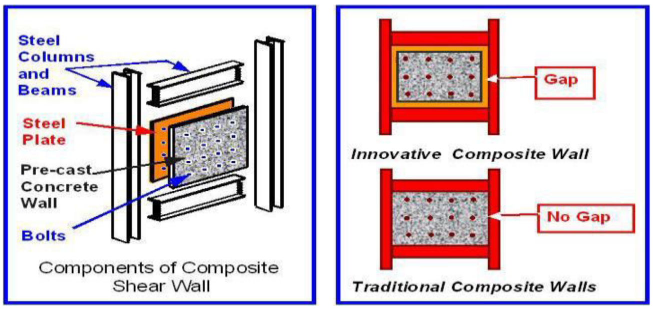


Fig.2 Composite Shear Wall

II. OBJECTIVE

- To study the behavior of building for regular plan under seismic loads and load combinations as per IS 1893:2016.
- To evaluate the response of RC multi-storey building (G+25) with RC shear wall (RSW) and Composite shear wall (CSW).
- To determine seismic parameters that are time period, mode shape, base shear, storey shear, storey displacement, storey drift, stiffness.

III. METHODOLOGY

The important factors for the seismic analysis of RC multi-story structures are chosen with appropriate methodology and structural modeling which reflects the actual behavior of the system.

RC multi-story buildings are adequate for resisting the vertical load but unstable to horizontal loads. When such building is designed without shear wall, beam and column size are quite heavy and there is problem arises at beam column joint

DESCRIPTION OF BUILDING

TABLE 1- BUILDING DESCRIPTION

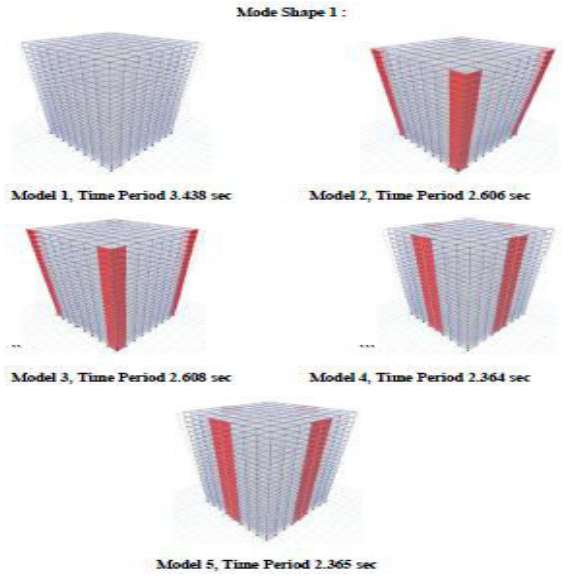
S.NO	Structural Part	Dimension
1.	Length in X-direction	48m
2.	Length in Y-direction	48m
3.	No of bays in X-direction	8No@6
4.	No of bays in Y-direction	8No@6
5.	Floor to floor height	3m
6.	Total height of the building	75m
7.	Thickness of slab	150mm
8.	Thickness of R.C shear wall	250mm
9.	Thickness of Composite shear wall	250mm
10.	Column size	(600x600)mm
11.	Beam Size	(300x500)mm

TABLE 2-MATERIAL PROPERTIES

S.NO	Material	Grade
1.	Concrete (beam column)	M35
2.	Concrete slab	M30
3.	Rebar	Fe 500

TABLE 3-SEISMIC DATA

1.	Earthquake zone	Vi
2.	Zone factor	0.24
3.	Damping ratio	5%
4.	Importance factor	1.5
5.	Types of soil	Mediam soil
6.	Response reduction factor	5
7.	Time period	Program calculated
8.	Time history data used	Noida



IV. ANALYSIS

Earthquake or seismic analysis is a subset of structural analysis which involves the calculation of the response of a structure subjected to earthquake excitation. This is required for carrying out the structural assessment, structural design and retrofitting of the structures in the regions where earthquakes are prevalent. Various seismic data are necessary to carry out the seismic analysis of the structures.

Parameter consider for analysis

- Time Period
- Mode Shape
- Base Shear
- Story Displacement
- Story Drift
- Story Stiffness

V. RESULTS AND DISCUSSION

As observed from study, shear wall is acting as lateral force resisting system in minimizing the impact of earthquake excitation on the 25 story (G+24) multi-storey building. Composite shear wall reduces the time period of oscillation, story displacement, and story stiffness of the building more as compared to RC shear wall.

1. NATURAL TIME PERIOD (Tn)

Following is the maximum natural time period for one complete cycle of oscillation of (G+25) multi-story building models in seismic zone IV.

Table 4-

Maximum Natural Time Period Variation

Model	Maximum Natural Period
MODEL 1(Without shear wall)	3.458sec
MODEL 2(With RCSW at corer)	2.707sec
MODEL 3(With CSW at corner)	2.804sec
MODEL 4(With RCSW at side centre)	2.648sec
MODEL 5(With CSW at side centre)	2.364sec

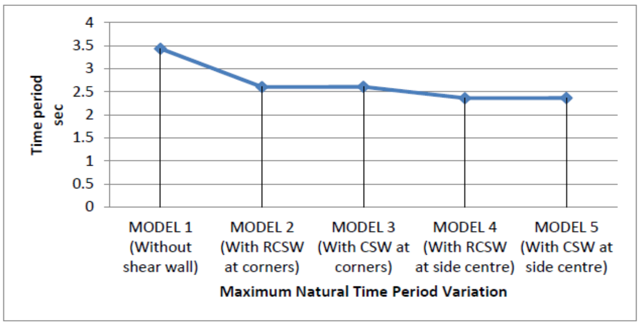


Fig. 3 Maximum Time Period variations

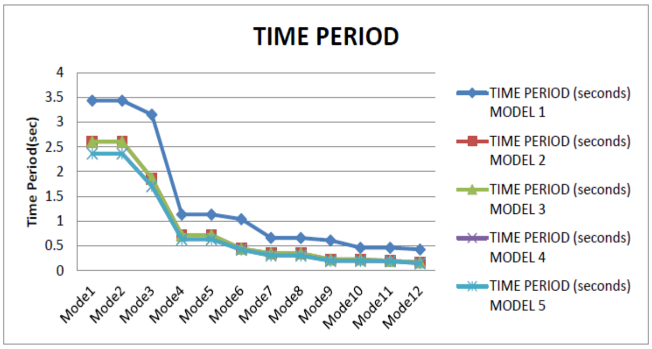


Fig. 4 Natural time period v/s Mode

2. BASE SHEAR (VB)

FOLLOWING IS THE MAXIMUM BASE SHEAR FOR A (G+24) MULTI STOREY BUILDING MODELS WITH AND WITHOUT SHEAR WALLS LOCATED IN SEISMIC ZONE IV

Model	Maximum base shear
MODEL 1(Without shear wall)	666209.58kN
MODEL 2(With RCSW at corner)	729756.178kN
MODEL 3(With CSW at corner)	454128.482kN
MODEL 4(With RCSW at side centre)	844223.438kN
MODEL 5(With CSW at side centre)	534073.445kN

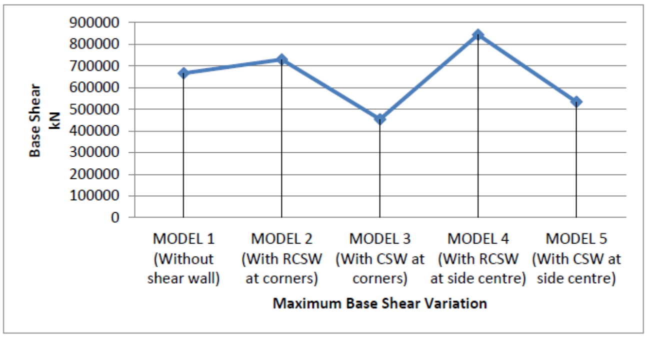


Fig. 5 Maximum Base Shear variations

3. STORY DISPLACEMENT

Story displacement may be defined as the lateral displacement of any particular story from its mean position with respect to the base of the structure. The variations of maximum story displacement for different models are shown

Model	Maximum storey displacement
MODEL 1(Without shear wall)	364.64mm
MODEL 2(With RCSW at corner)	230.84mm
MODEL 3(With CSW at corner)	159.45mm
MODEL 4(With RCSW at side centre)	212.57mm
MODEL 5(With CSW at side centre)	146.64mm

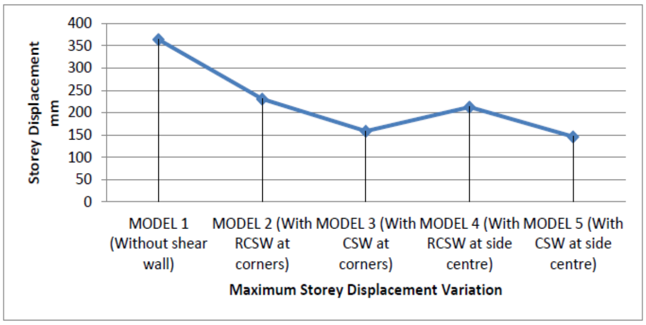


Fig. 6 Maximum Story Displacement variations

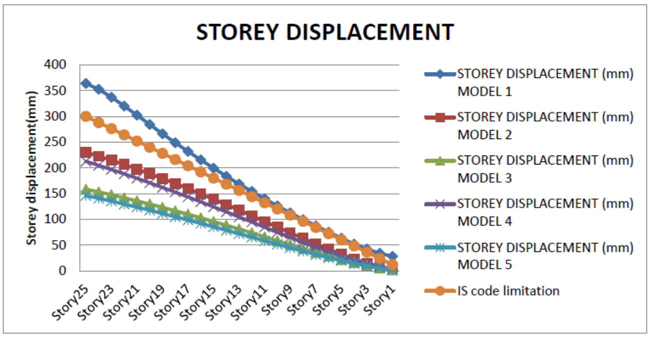


Fig. 7 Comparison of Storey Displacement in X Direction

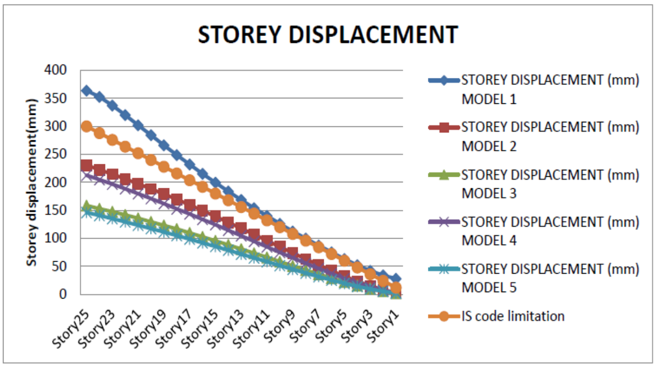


Fig.8 Comparison of Storey Displacement in Y Direction

4. STORY DRIFT

The maximum story drift for the multi-story building models with and without shear wall are given

Model	Maximum storey drift
MODEL 1(Without shear wall)	18.004mm
MODEL 2(Witth RCSW at corner)	11.559mm
MODEL 3(With CSW at corner)	7.977mm
MODEL 4(With RCSW at side centre)	10.954mm
MODEL 5(With CSW at side	7.278mm

centre)	

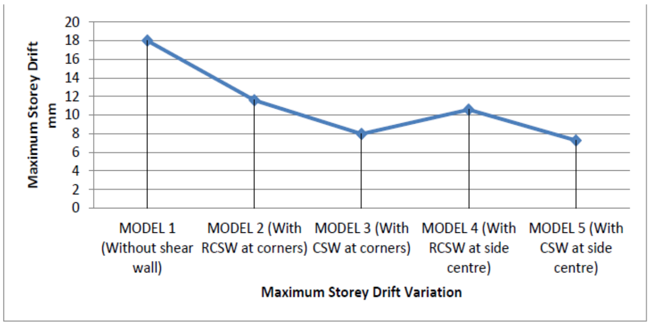


Fig.9 Maximum Story Drift variations

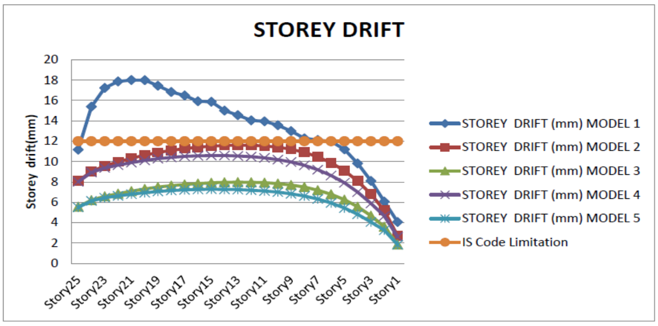


Fig.10 Comparison of Storey Drift in X Direction

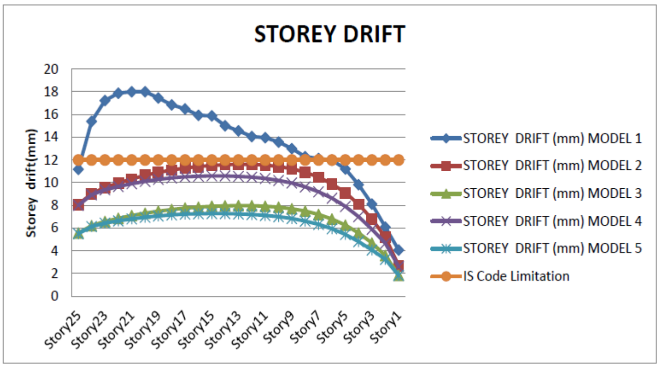


Fig.11 Comparison of Storey Drift in Y Direction

5. STORY STIFFNESS

Model	Maximum storey stiffness
MODEL 1(Without shear wall)	3541171kN/m
MODEL 2(With RCSW at corner)	16552257kN/m
MODEL 3(With CSW at corner)	16492487kN/m
MODEL 4(With RCSW at side Centre)	19238562kN/m
MODEL 5(With CSW at side Centre)	18784559kN/m

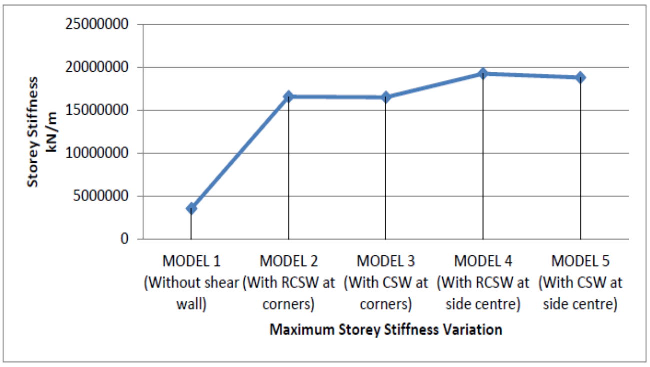


Fig.12 Maximum Story Stiffness variations

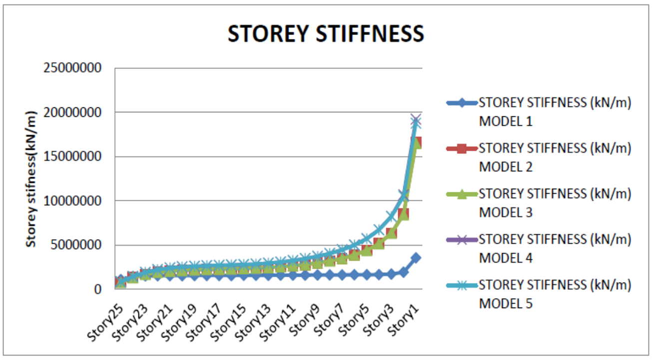


Fig.13 Comparison of Storey Stiffness in X direction

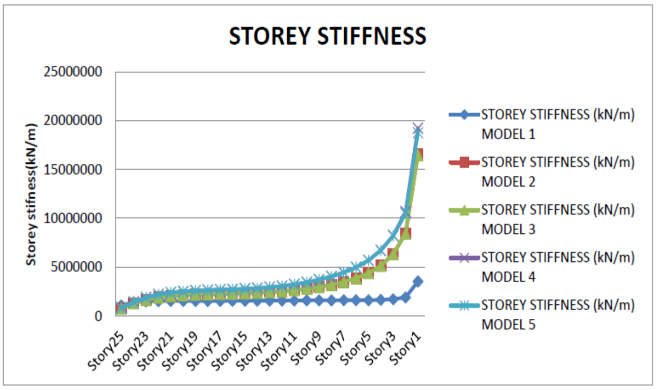


Fig.14 Comparison of Storey Stiffness in Y direction

VI. CONCLUSIONS

This research has concluded the following contents-

- Maximum time period of Model 5 is 31.21% less than model 1. It shows model 5 is
  stiffer as compared to model 1,2,3,4. Therefore, buildings with composite shear wall as better.
- As observed from the analysis, base shear of building without shear wall is less than buildings with RC shear wall but base shear of building with Composite shear wall is the least which is due to more flexibility in the structure.
- From the analysis it was observed that the maximum story displacement is comparatively lesser for model 5 (CSW at side Centre) in comparison to all other models.
- From the above analysis it was observed that story drift reduces after the addition of shear wall in the buildings. Among all models the value of story drift is minimum in Model 5. Hence Composite shear wall provided at side centuries best in case of story drift for this type of building.
- From the analysis, it was observed that maximum story stiffness was observed in model 4 (RC shear wall at side Centre) which is slightly more than the stiffness of model 5 (CSW at side Centre).
- Hence, to increase the performance of structure under horizontal loads, particularly when speaking about seismically prone areas, addition of Composite shear wall to buildings is a better and cheaper solution as compared to RC shear wall.
- Composite shear walls are less thick, cost effective and more reliable as compared to RC shear wall.

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