STUDY OF SEISMIC PERFORMANCE OF RC BUILDING WITH FLAT PLATE INFLUENCED BY CONCRETE WALL

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Abstract - ***In present construction era, the available net clear ceiling height is reduced by beams. Hence, in warehouses and public halls beams are avoided and slabs are immediately supported by columns and is termed as Flat plate (without beams and drops). This type of construction is aesthetically captivating also and even which is simple to construct and is economical. Unfortunately, the structural efficiency is obstructed by its poor presentation under seismic loading in which concrete slab fractures along the supporting columns. It is necessary to analyze behavior of the flat slab building with different shear wall positions. Hence in this work, G+9 multi storyed RC building having a flat slab with shear wall provided at center, at diagonal corners, at mid along X direction, at mid along Y direction and finally at mid along X&Y direction is considered. The analysis is done using ETABS software. To study the performance and behavior of flat plate in RC multistoryed building- base shear, time period, maximum story displacement and maximum story drift in X and Y direction for seismic zone V is studied.***

Key Words: *Flat plate, seismic loading, ETABS.*

1. INTRODUCION

In modern era, infrastructure has led to scarcity of land space, also when the space matter comes into account, the maximum space utilization and aesthetics is the main concern of the present day architects and designers. So, to overcome this problem construction of tall buildings has been triggered. Also, the elements like Flat plates are introduced which is economical and faster in construction. It is provided in RC multistorey buildings. In order to protect these type of building from lateral loads it is a must to provide a lateral load resisting system like shear wall when earthquake resistance is concerned. Because absence of deep beams or shear wall in the flat plate system give rise to excessive lateral deformation.

1.1 Concept of Flat Plate

In engineering design practice, flat plate structures as shown in Fig.1 are designed primarily for gravity loads, these structures are not designed for lateral seismic load and it is susceptible to progressive brittle punching shear failure. This failure may lead to progressive collapse of the whole flat plate building. So, to overcome they are influenced with shear wall for resisting lateral load because column resisting immediately on floor slab for which sufficient strength and ductility should be provided to control large inelastic deformation without failure. So, these concrete walls will ensure their ability to undergo the maximum earthquake induced lateral drift without losing the gravity load carrying capacity. Hence, it becomes more important to give further attention to the study of this structurally attractive system, yet disputable in terms of its seismic efficiency, susceptibility and reliability. Flat plate structures is used for a lightly loaded structures like warehouses, offices and apartments with relatively short spans.

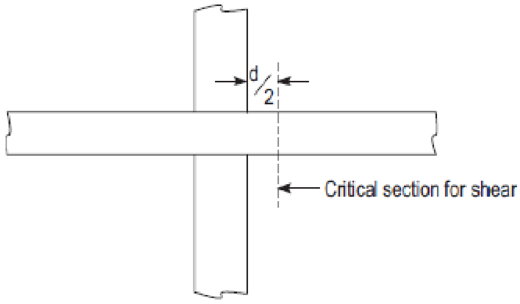

Fig -1: Flat Plate Structure

2. ADVANTAGES AND DISADVANTAGES OF FLAT PLATE

a. No complicated form work is needed for beams
b. In usual cases, shear reinforcement at the column is not required.
c. Rapid construction speed
d. Reduces overall height of a building
e. Reduces in self weight

Disadvantages:

a. It is economical for a medium span
b. Not suitable for supporting brittle masonry partitions.
c. Deflection tend to be very large due to the lesser thickness of plate

3. PRELIMINARY DATA FOR ANALYSIS

- Type of Structure : Multi Storeyed RC Rigid Jointed Plane Frame (Special Moment Resisting Frame)
- Number of Stories: Ten (G+9) ; 35m X 25m
- Seismic Zone : V (Table 2, IS 1893 (Part- 1):2002)
- Floor Height: 5m for Ground Floor, 4m for other Floors & 3m below plinth.
- Grade of Concrete: M40 for Ground, First & Second Floors Columns.
- M35 for Other Floors Columns & Shear wall.
- M25 for Beams, Slabs
- Size of Columns : 600mmX600mm
- Size of Beams : 600mmX300mm
- Depth of Slab : 200mm thick
- Thickness of Shear Wall : 200mm
- Imposed Load : 3.0KN/m2
- Floor Finish & Partitions : 2.0 KN/m2
- Specific Weight of RCC : 25 KN/m3
- Type of Soil : III
- Response Spectra : As per IS 1893 (Part- 1) 2002
- Damping : 5%
- Importance Factor : 1.5
- Response reduction Factor : 5.0
- Structural Software : ETABS Version ultimate 15.0

Plan of and analytical model with a location of shear wall at different positions is given in below Fig 2 to Fig 7

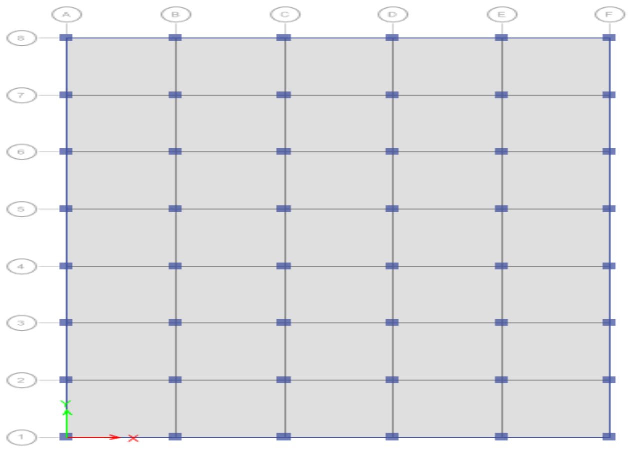

Fig-2: Model 1(Without Shear wall)

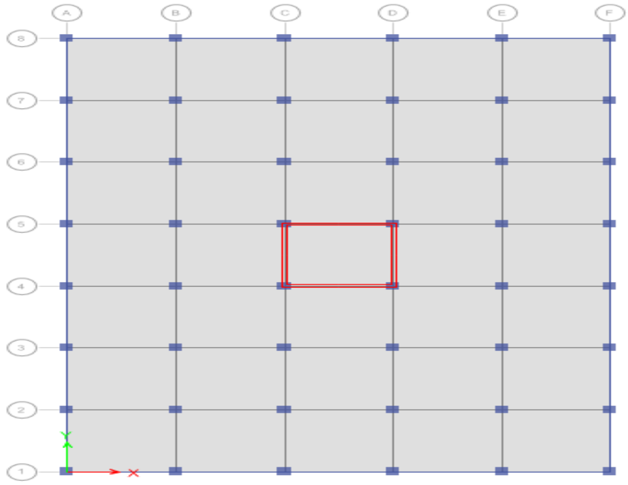

Fig-3: Model 2(Shear wall at centre)

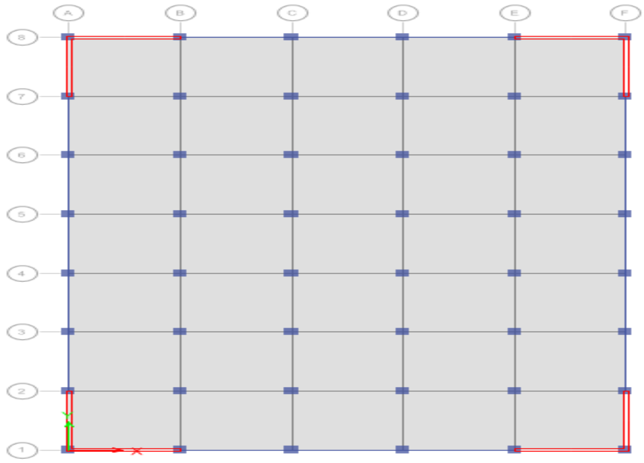

Fig-4: Model 3(Shear wall at diagonal corners)

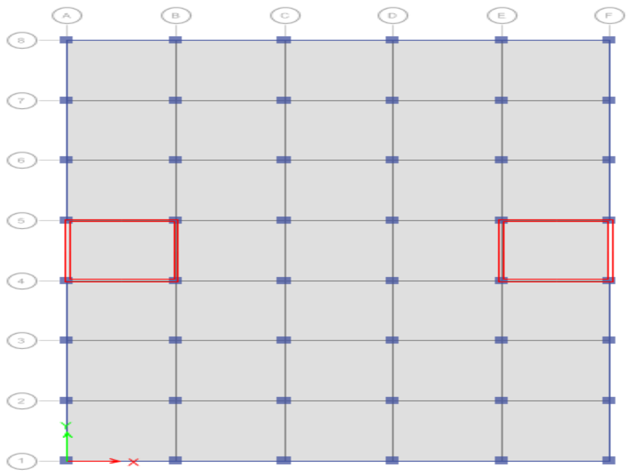

Fig-5: Model 4(Shear wall at mid along Y direction)

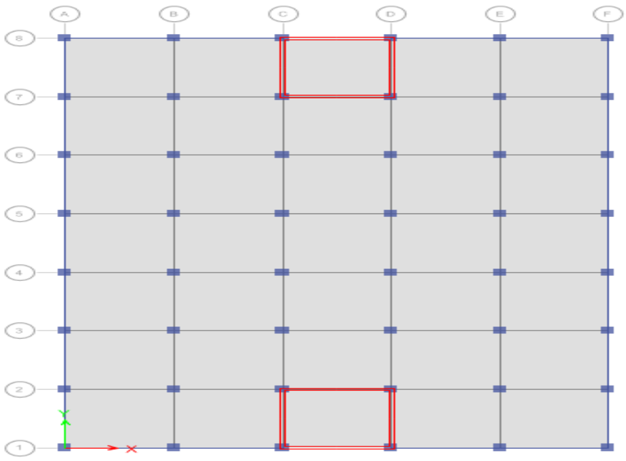

Fig-6: Model 5(Shear wall at mid along X direction)

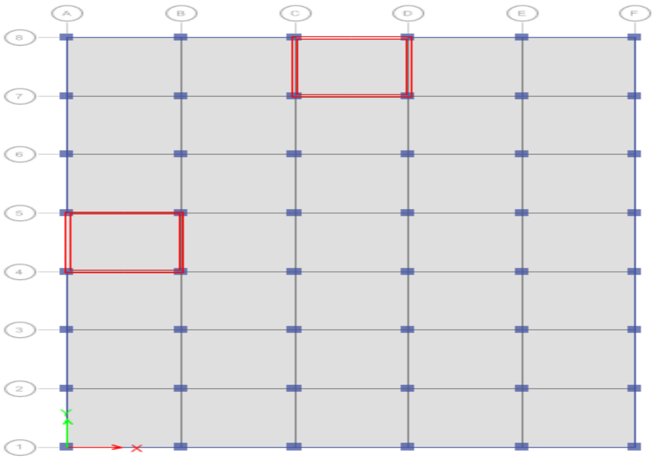

Fig-7: Model 6(Shear wall at mid along X&Y direction/ adjacent faces)

The analysis and design of RC Tall building with concrete wall by hand calculation is very complex and delaying process. So for each model described in the problem statement is analysed and designed with the help of structural analysis software "ETABS". After Analysis using ETABS, the following are the results obtained as shown in Table 1. Table 1 shows the tabulation of base shear; time period, scale-up factor and storey drift values for all the models.

Model No.	Story Type	Base Shear in KN				Scale up factor		Time Period in secs			Max. Story Displacement at Story-10 in mm		Max. Story Drifts of 10th floor in mm	
		Equivalent Static Method		Response Spectrum										
		X	Y	X	Y	X	Y	Mode1	Mode 2	Mode 3	X	Y	X	Y
1	G+9	9053.64	9053.64	3360.71	3664.82	3.96	3.63	2.907	2.696	2.086	352	300.4	3.33	2.64
2	G+9	9278.69	9278.69	6246.02	6370.71	2.18	2.14	1.739	1.669	1.596	153	139.7	3.99	3.54
3	G+9	9109.46	9109.46	6998.74	7149.43	1.91	1.87	1.417	1.375	0.772	103	96.5	2.81	2.59
4	G+9	9409.13	9409.13	7300.01	7571.35	1.89	1.82	1.413	1.334	1.044	103.2	90.9	2.91	2.47
5	G+9	9415.14	9415.14	7437.45	7431.86	1.86	1.86	1.373	1.370	0.902	96.5	96.9	2.66	2.68
6	G+9	9405.17	9405.17	5269.34	6119.57	2.62	2.26	1.568	1.363	0.938	141.2	107.9	3.02	2.60

From the above results obtained, the following charts can be drawn. Chart-1, 2, 3, 4 &5 shows the graphs of time period, base shear, scale up factor, maximum story displacements and maximum story drifts versus different models.

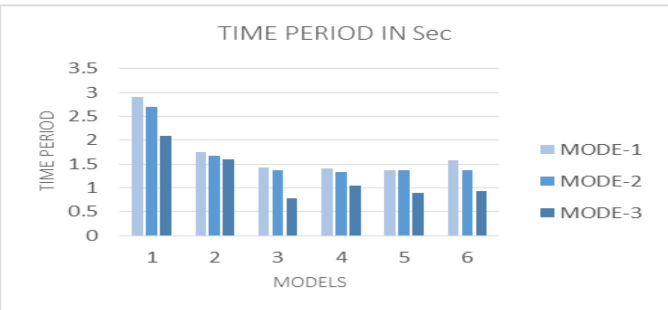

Chart -1: Time period versus different models

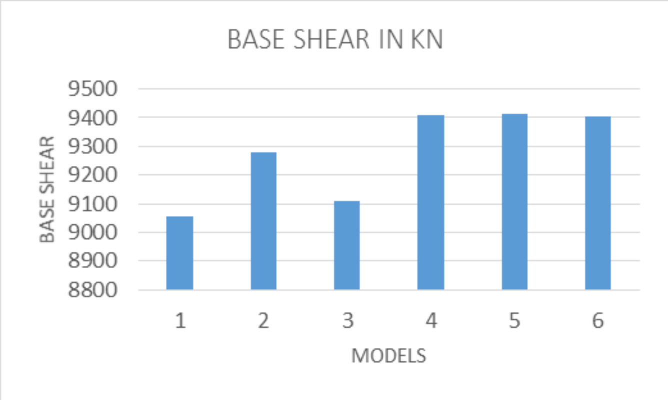

Chart -2: Base shear versus different models

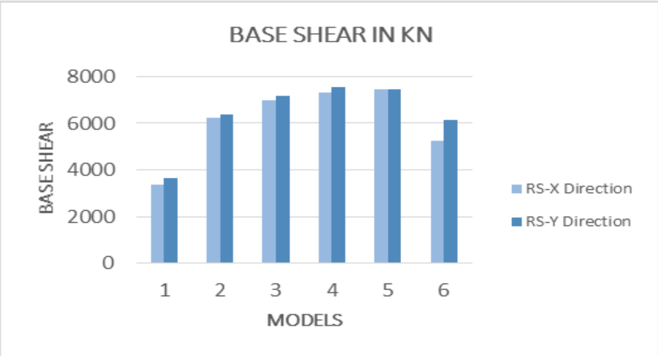

Chart -3: Base shear versus different models

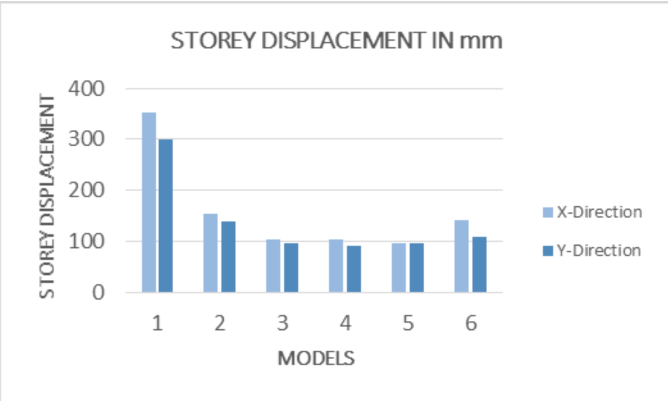

Chart -4: Maximum story displacements versus different models

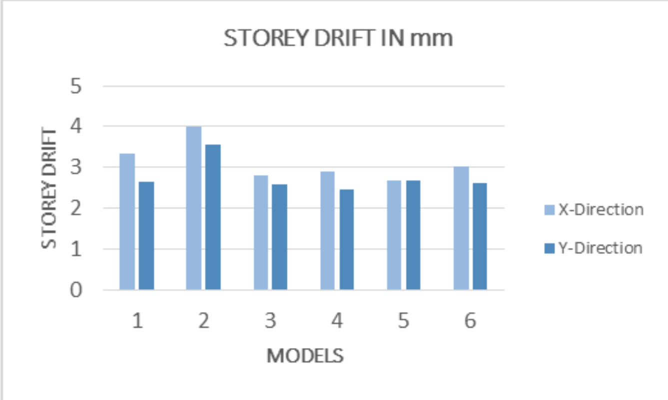

Chart -5: Maximum story drifts versus different models

3. CONCLUSIONS

This study has investigated the performance of RC building with a flat plate influenced by shear wall for the models 1 to 6 for Zone V and Soil type III to study the various parameters like base shear, time period, story displacement and story drift. So based on the results conclusions were drawn:

a. Time period will be very less i.e., 0.772 when shear wall is constructed at diagonal corners. In other models comparatively less and high for Model1.
b. Presence of shear wall increases the stiffness thereby decreases the Displacement. With reference to the above statement, displacement decreases in Model 2 to Model 6 compared to Model 1. Evidently, Model 5 shows comparatively less displacement than other.
c. Flat plate building with no shear wall having more scale up factor in X and Y direction compared to other models having shear wall at different direction. And, scale up factor is less in the model when shear wall is located along X-direction.
d. Maximum story drift is less when shear wall is constructed along X-direction and also gives better execution towards structural system.

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