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Parametric Study of Conventional Slab and Flat Slab in a Multi Storey RC Building

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Abstract: **Flat slab system is a construction in which beams are not used as in the case of conventional slabs. In such way the economy of project, architectural appearance, speed of construction, less weight of super structure are the advantages possessed by a flat slab over a conventional RC framed structure. However, because of no use of beams in flat slab the lateral stiffness is reduced which effects the overall performance of flat slab when subjected to seismic excitation.Inthe present study, two different types of slabs namely conventional and flat slabs were taken in a G+15 multistoreybuilding and the seismic behaviour of the two systems were compared in seismic zone IV .The analysis was done using elastic time history method analysis in ETABS2016 software according to rules and regulations of Indian standard code.**

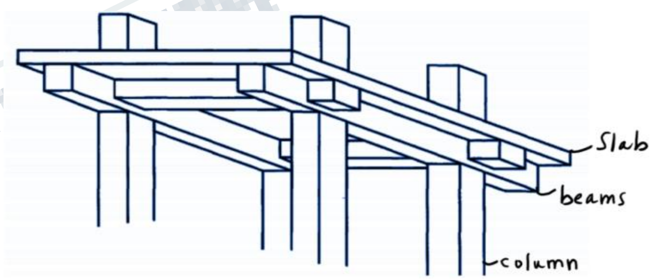
Keywords: conventional slab, flat slab, RC building, time history method, story drift, displacement, time period and base shear.

INTRODUCTION

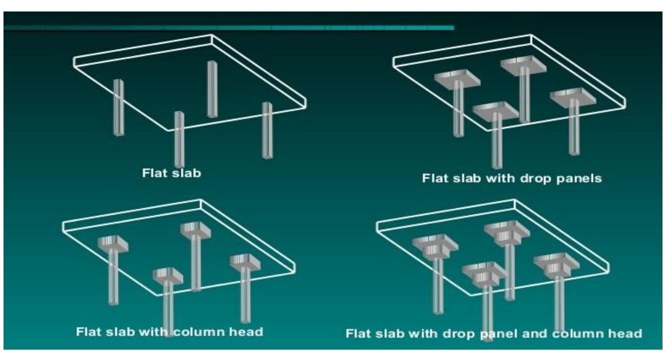
Earthquake resistant design of RC buildings has been a much widely researched area since the development of earthquake engineering. Recently the earthquakes occurring have resulted in huge loss of life and property and hence the requirement of such structures has arised which are resistant to earthquake or result in least amount of destruction. Seismic determination of high rise multi story building is very important in order to analyze the response of structure subjected to earthquake. For a developing country like India, steel reserves are still not adequate and hence raw material for RC concreting are highly being used as it also results in lower cost and less skilled labour are required. The conventional slab system and flat slab system behave differently when subjected to earthquake excitation. Therefore, seismic analysis of their behavior becomes very necessary.

Flat slab is a beamless slab with or without drops supported by columns with or without flare heads unlike the conventional slabs system where the beams are used. The load is transferred in flat slab from slab to columns and then directly to the footing. In order to provide additional shear strength and to reduce the amount of negative reinforcement in support region., the flat slabs are usually thickened near columns. Flat slabs are provided in malls, theatres and other structures where large beam and free spaces are required. Generally shear walls are required when earthquake resistance is considered. Such slabs can be designed to resist both vertical and lateral loads in low seismicity zone (zone II) however for high seismicity (zone III, IV, V) code does not permit flat slab construction without any resisting system or lateral force resisting system.

In case of conventional slabs, the load from slabs is first transferred to beams and then to columns and hence the weight of structure increases and the formwork is also costly and complicated when compared to flat slab structures. In these kind of slabs, the thickness of slab is small whereas depth of beam is large and hence more formwork is needed as compared to that of flat slabs. In this type of slab the dead load is more than flat slab and also there is extra requirement of flat attractive appearance of ceilings.



CONVENTIONAL SLAB SYSTEM
FIG 1.1



FLAT SLAB SYSTEM

FIG 1.2

2. STRUCTURAL DETAILS

In the present study three models were generated by using ETABS software. All the models were analyzed in seismic zone IV in a G+15 multistory building by using elastic time history method analysis.

MODEL 1- CONVENTIONAL SLAB
MODEL 2- FLAT SLAB
MODEL 3- FLAT SLAB WITH SHEAR WALL.

Structural data is as follows:

1	Building type	Commercial building
2	Plan dimensions	49X28m (X*Y)
3	No. of stories	G+15
4	Floor to floor height	3m
5	Total height of building	45m
6	Slab thickness for conventional slab	150mm
7	Slab thickness for flat slab	180mm
8	Thickness of shear wall	200mm
9	Column size	600x600mm
10	Beam size	500x250mm
11	Live loads	3 KN/m^2
12	Seismic zone	IV
13	Importance factor	1.5
14	Soil type	IV
15	Grade of concrete(slab, beam)	M 30
16	Grade of concrete(column)	M 35
17	Reinforcement	Fe415

TABLE 1.1

The plan view and the 3 dimensional view of the models have been shown as follows:

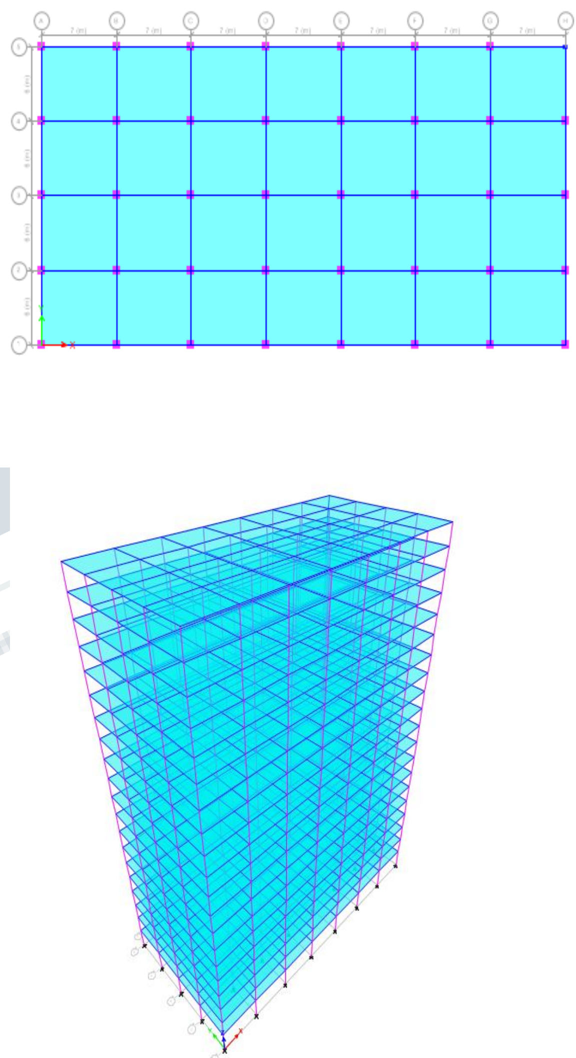
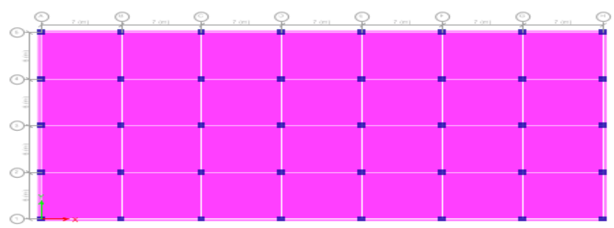


Fig 1.3- Plan and 3d view of conventional slab



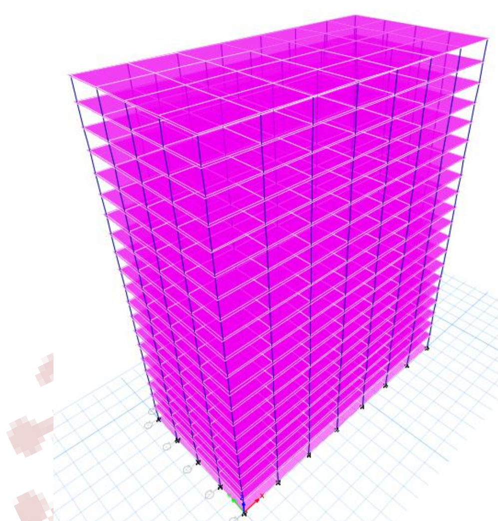
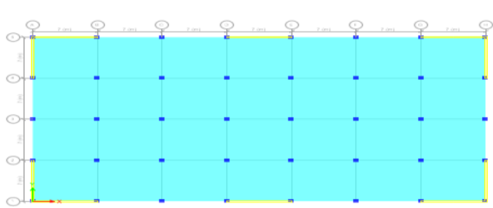


Fig 1.4- Plan and 3d view of flat slab without shear wall



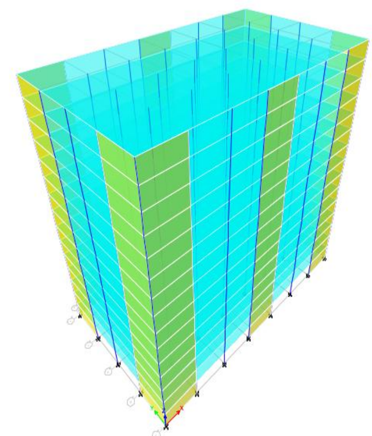


Fig 1.5- Plan and 3d view of flat slab with shear wall

3) RESULT AND DISCUSSION:

In this section, the results obtained from all the three models analzed by using ETABS software have been mentioned for various parameters like story drift, story displacement, time period and base shear.

3.1) STORY DRIFT:

Story drift can be understood as the difference between one story with respect to the other story. It is an important criteria which depicts the performance of structure as per IS 1893:2002 part 1, clause 7.11.1; story drift should be less than 0.004 times the height of the story under consideration. In this case it should be less than 12.

Story	MODEL 1	MODEL 2	MODEL 3	IS CODE 1893:2002
	mm	mm	mm	mm
Story15	2.698	11.241	4.455	12
Story14	3.804	12.822	4.52	12
Story13	4.962	14.813	4.553	12
Story12	6.012	16.891	4.553	12
Story11	6.912	18.854	4.511	12
Story10	7.657	20.576	4.42	12
Story9	8.258	21.971	4.274	12

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Story8	8.724	22.972	4.069	12
Story7	9.069	23.506	3.801	12
Story6	9.3	23.476	3.469	12
Story5	9.411	22.734	3.068	12
Story4	9.356	21.043	2.599	12
Story3	8.963	18.022	2.055	12
Story2	7.693	13.07	1.444	12
Story1	3.87	5.196	0.704	12

Table 1.2

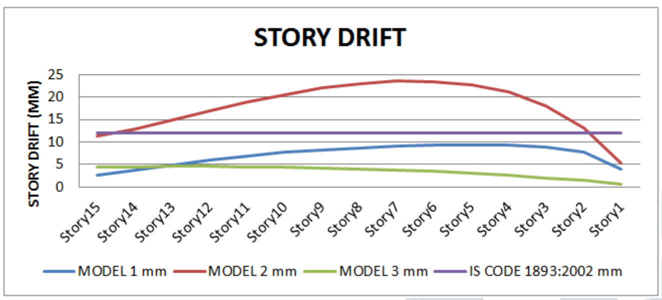

Fig 1.6

3.2) STORY DISPLACEMENT:

Story displacement is an important criterion when structures are subjected to lateral loads like earthquake and wind loads. Height of structure and slenderness of the structure are important factors for determining story displacement because structures are more vulnerable as height of building increases by becoming more flexible to lateral loads. The displacement is maximum at top and bottom at base of structure. According to IS 1893:2002; maximum allowable deflection is calculated as h/250, where h is the height of the storey from the ground level.

Story	MODEL 1	MODEL 2	MODEL 3	IS CODE 1893:2002
	mm	mm	mm	mm
Story15	106.438	256.529	52.494	180
Story14	103.745	246.069	48.038	168
Story13	99.949	234.04	43.519	156
Story12	94.998	220.034	38.966	144
Story11	89.001	203.964	34.413	132
Story10	82.106	185.942	29.902	120
Story9	74.467	166.204	25.482	108
Story8	66.229	145.073	21.209	96
Story7	57.527	122.936	17.14	84
Story6	48.48	100.249	13.338	72
Story5	39.204	77.564	9.87	60
Story4	29.817	55.575	6.802	48
Story3	20.485	35.207	4.203	36
Story2	11.544	17.753	2.148	24
Story1	3.87	5.086	0.704	12

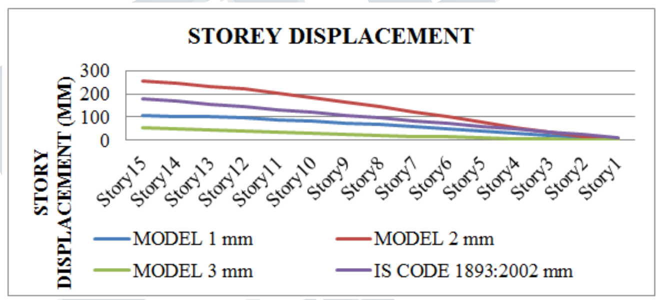

Fig 1.7

3.3) TIME PERIOD:

Greater the time period the more flexible is the structure or lesser the time period more rigid the structure. Time period has been calculated in the following table for seismic zone IV.

Case	MODEL 1	MODEL 2	MODEL 3
	sec	sec	sec
Modal	2.59	4.756	1.124
Modal	2.503	4.657	0.992
Modal	2.372	4.361	0.597
Modal	0.838	1.407	0.235
Modal	0.812	1.384	0.202
Modal	0.768	1.297	0.128
Modal	0.475	0.698	0.105
Modal	0.463	0.692	0.089
Modal	0.437	0.648	0.066

Modal	0.317	0.409	0.059
Modal	0.31	0.407	0.055
Modal	0.292	0.381	0.048

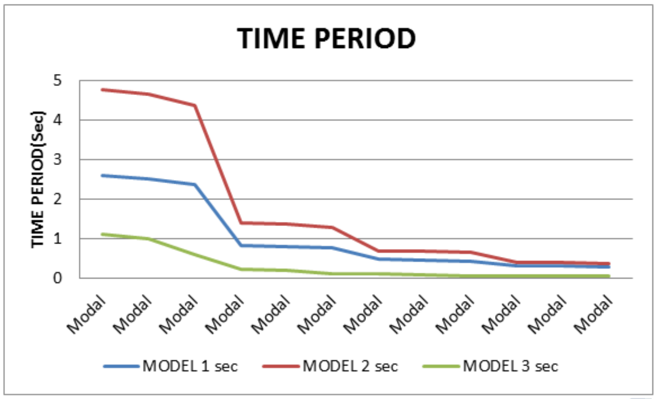

Fig 1.8

3.4) BASE SHEAR:

Base sear calculation depicts the automatically generated lateral seismic loads for load pattern EQ- X and EQ- Y according to IS1893:2002.

Story	MODEL 1	MODEL 2	MODEL 3
	kN	kN	kN
Story15	530.8352	224.4948	744.538
Story14	486.7515	211.3627	757.1935
Story13	419.699	182.2464	652.8862
Story12	357.6133	155.2869	556.3054
Story11	300.4945	130.4841	467.4511
Story10	248.3426	107.8381	386.3232
Story9	201.1575	87.3489	312.9218
Story8	158.9393	69.0164	247.2469
Story7	121.6879	52.8407	189.2984
Story6	89.4033	38.8217	139.0764
Story5	62.0856	26.9595	96.5808
Story4	39.7348	17.2541	61.8117
Story3	22.3508	9.7054	34.7691
Story2	9.9337	4.3135	15.4529
Story1	2.4834	1.0784	3.8632
Base	0	0	0

Table 1.5

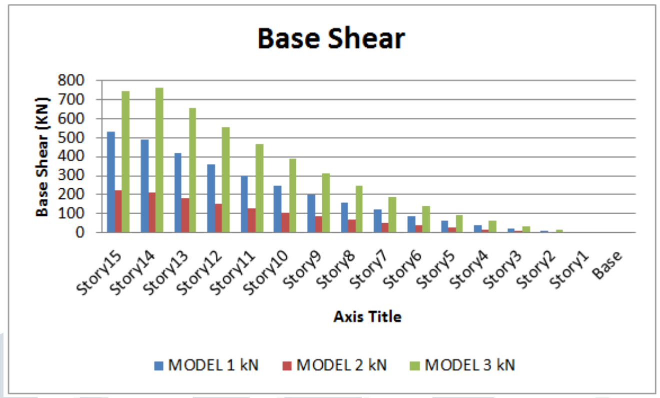

Fig 1.9

4) CONCLUSION:

- With references to the output, story drift reduces after the addition of shear wall in flat slab building. Story drift in flat slab structures without placement of shear wall is more when compared to conventional slab hence stating the importance of shear wall.
- The story displacement increases with the height of the structure. The displacement is reduced by 70%-80% in case of flat slab with shear wall. It means after the addition of shear wall the flat slab building lateral deflection reduces due to increase in rigidity but in absence of shear wall the performance of conventional is better than flat slab.
- The natural time period is reduced to 755-80% after the placing of shear wall. The conventional structure is less flexible than flat slab without shear wall.
- Base shear increases with increase in mass and stiffness of building and hence the base shear is maximum for flat slab with shear wall. 60%-70% increase in base shear is noticed when shear wall is added.

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