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Comparison Of Behavior of Flat Slab And Flat Plate Built With Shear Wall At Different Locations Subjected To Siesmic Loading

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Abstract- Flat slab building structure, possesses major advantages over traditional slab-beam-column structure .due to the absence of beams, it can accommodate reduced floor height , easier from work ,lesser construction time ,and better architectural function . however the structural effectiveness of flat slab construction is hindered by its vulnerability even under seismic events of moderate intensity .the flat slab structures are significantly more flexible than traditional concrete frame as it cause excessive deformation which in turn cause damage of both structural and non- structural members under seismic excitations . therefore additional measures for the design of these structures in seismic regions are needed such as a possible combination with other seismic resistant structural system .In the present study an investigation is carried out in order to identify the seismic response of flat plate and flat slab id structural system ,consisting of with or without core wall, at different locations (center , bottom left , bottom right , top left and top right)and shear wall at periphery of building compared with grid slab structure.The analysis is carried out by using E-Tab V9.7.4,a commercially available structural analysis and design software .results of the study are deemed very useful in the selection and preliminary design of the basic structural system.

Keywords: Base shear, Time period, Storey drift, Displacement, Static and Dynamic analysis (EQX,EQY).

1 . INTRODUCTION

Design of earthquake resistant structure is a continuing area of research and development, ever since the earthquake engineering started .according to IS code, seismic zone of an Indian map shows around 60% of land area is prone from moderate to severe earthquake and the result losses in terms of lives and property about 95% of human casualties in last 20 years is reported, due to earthquake is attributed to improper analysis, design and construction practices. In India, at present, due to fast growing population and economy there is an. Increased demand on infrastructure facilities. In order to cater to the demand, vertical development is the only option. Vertical development brings challenges such as lateral loads due to wind and earthquake. Adoption of appropriate structural configuration plays a vital role in earthquake resistance design. Now a days, the trend of irregular plan and high rise structure in city area are most common due to increase in population, increase in land value and limited availability of land. Conventional construction practice is to support slab by beam, beam by column, and column by footing. This is called beam –slab load transfer system. Flat slab types of structure possess major advantages over conventional beam-slab system because of the lower floor to floor height, lesser construction time and architectural functionality.

2. MATERIALS AND METHODOLOGY

The present objective of this work is to study and understand the High-rise structure torsional behavior for irregular RC Flat slab and flat plate structure. The structure is studied for without core wall and with core wall at different location. The structure is considered at critical Zone factor 4. The proposed model is conventional RCC structure. The model is 20 storey with 3m each storey height. The plan is irregular ‘L’and’T’ shaped structure. Modeling and analysis of structure is planned to carried out using ETABs software. The below Table1 shows material properties and design parameters used.

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Table 3.1: Structural properties.

STRUCTURAL PROPERTIES	STRUCTURE TYPE		
	GRID SLAB	FLAT SLAB	FLAT PLATE
HEIGHT OF BUILDIG	60m	60m	60m
NUMBER OF STOREYS	20	20	20
HEIGHT OF EACH STOREY	3m	3m	3m
CONCRETE GRADE	M35 FOR SLAB M40 FOR COLUMN and SHEAR WALL		
STEEL GRADE	Fe 500	Fe 500	Fe 500
COLUMN SIZE	850 X 850mm	850 X 850mm	850 X 850mm
SLAB THICKNES	100mm	DROP=400mm SLAB=300mm	400mm
SHEAR WALL THICKNESS	NIL	200mm	

3. RESULTS AND DISCUSSIONS

Parameters discussed in this report are displacement, time period, story drift and base shear for both dynamic and static analysis. Models have been analysed for flat plate and flat slab for core wall at different locations and shear wall at periphery of the building. The results are summarized in the following tables and graphs.

3.1 BASE SHEAR:

Dynamic analysis might be performed either by Time History method or Response Spectrum method. In any case, the design base shear (Vb) should be compared with a base shear (V'b) calculated utilizing a fundamental period Ta, as per clause 7.6 IS 1893(part 1)2002. Where Vb is not exactly V'b, all the reaction.

Values shall be scaled by $\frac{V'}{Vb}$ As per clause 7.8.2 IS1893 (Part1)2002.

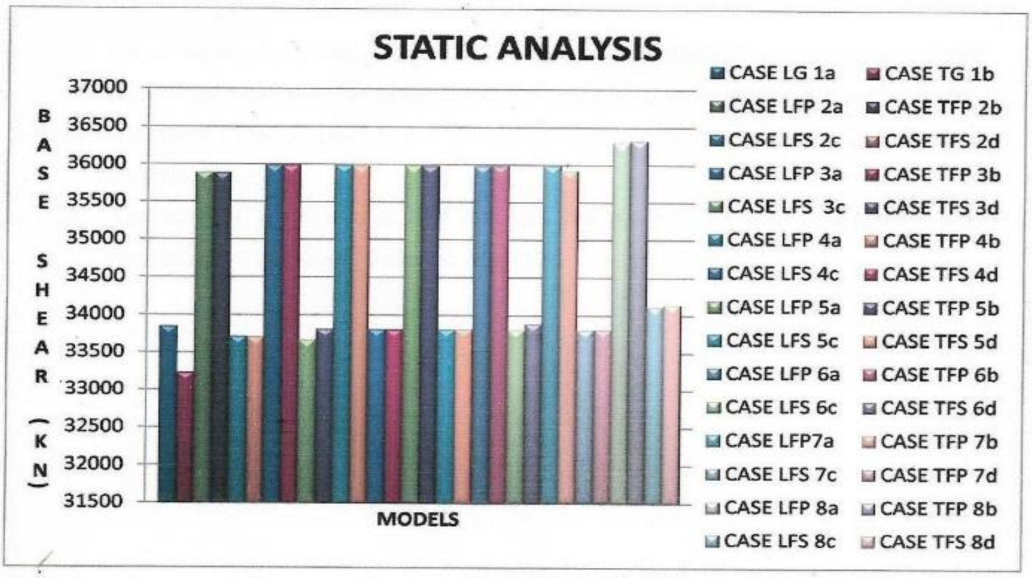

Fig. 1: Plot of Base shear for different models in X direction.

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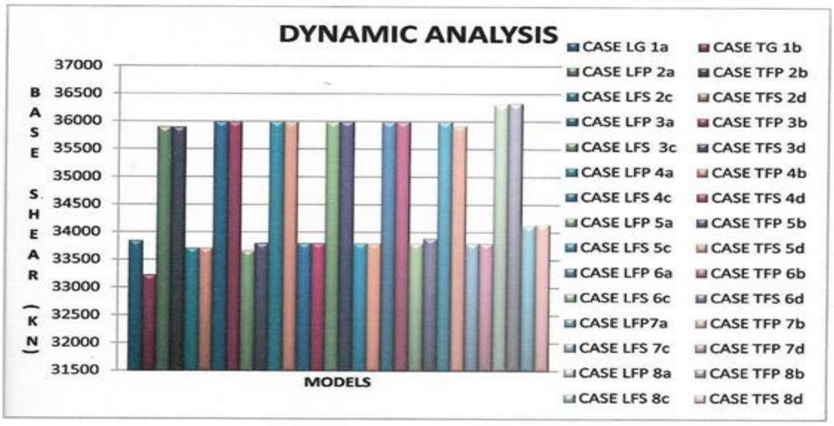

Fig. 2: Plot of Base shear for different models in X direction.

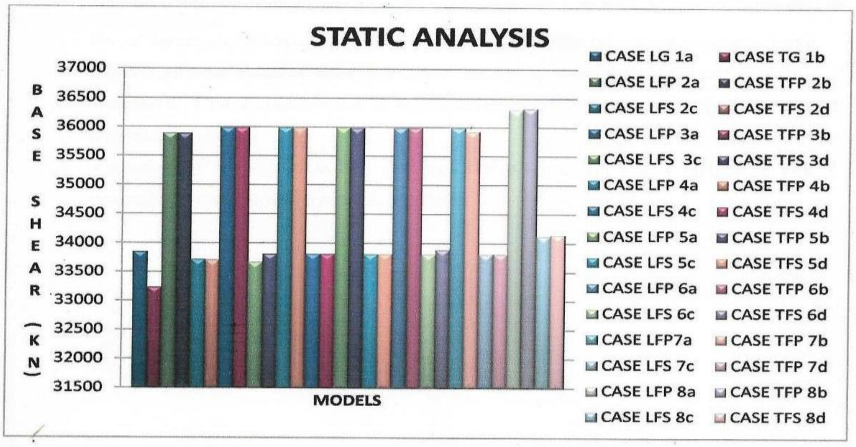

Fig.3: Plot of Base shear for different models in Y direction.

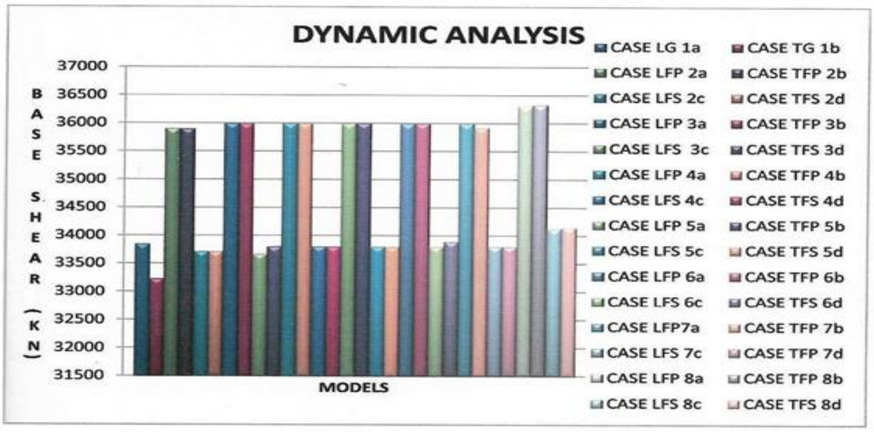

Fig.4: Plot of Base shear for different models in Y direction.

From The result obtained by analytical models, the following can be inferred

- Maximum Base shear is observed in flat plat with shear wall structural system. The increase in base shear in flat plate structural system containing shear wall is due to the increased stiffness of structural system containing shear wall. This results in relatively higher base shear in the structural system compare to grid slab structural system without shear wall.
- Variation of base shear is 0% to 0.02% in X and Y direction, for both static and dynamic analyses.

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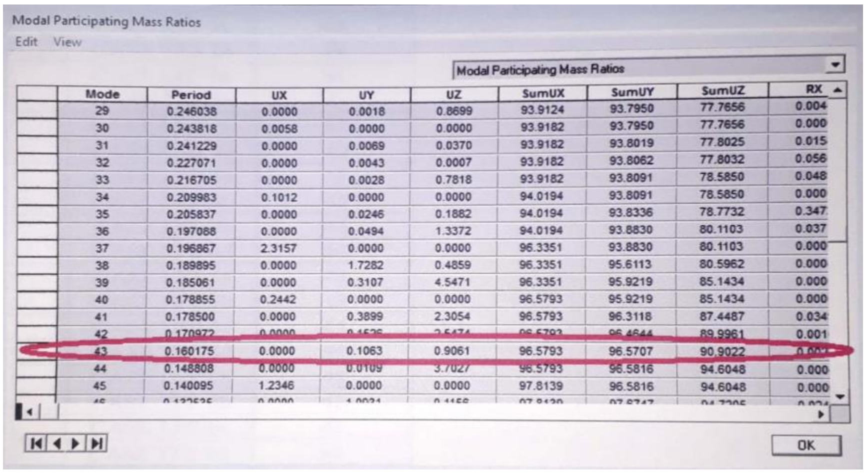
- Variation of base shear in flat slab and flat plate is 6% (2281KN) in X and Y direction, for static and dynamic

analyses Since the system consist of shear wall, it adds stiffness to the whole structure. Based on increasing stiffness of the structure the shear force will be more when compare to the structural system which does not contain shear wall.

- The structural grid system, flat plate and flat slab structural system with shear wall resulted in similar stiffness of the entire structural system. This similarity of stiffness in both the structural system resulted in similar base shear. this similarities of stiffness in grid structural system and flat slab and flat plate structural system without shear wall is due to stiffness of beams and column in grid slab structural system and the stiffness imparted by shear wall in flat plate and flat slab structural system.
- The variation in base shear is just 6% for flat slab and flat plate structural shear wall system is due to similar stiffness imparted by shear wall at different location which are similar in both flat slab and flat plate structural system in shear wall.

3.2 TIME PERIOD:

Number of modes to be considered: The number of modes to be adopted as a part of the analysis ought to be such that the entirety of modal masses of all modes considered is no less than 90 percent of aggregate seismic mass, as per clause 7.8.4.2 IS1893:2002.


Modal Participating Mass Ratios

Mode	Period	UX	UY	UZ	SumUX	SumUY	SumUZ	RX
29	0.246038	0.0000	0.0018	0.8699	93.9124	93.7950	77.7656	0.004
30	0.243818	0.0058	0.0000	0.0000	93.9182	93.7950	77.7656	0.000
31	0.241229	0.0000	0.0069	0.0370	93.9182	93.8019	77.8025	0.015
32	0.227071	0.0000	0.0043	0.0007	93.9182	93.8062	77.8032	0.056
33	0.216705	0.0000	0.0028	0.7818	93.9182	93.8091	78.5850	0.048
34	0.209983	0.1012	0.0000	0.0000	94.0194	93.8091	78.5850	0.000
35	0.205837	0.0000	0.0246	0.1882	94.0194	93.8336	78.7732	0.347
36	0.197088	0.0000	0.0494	1.3372	94.0194	93.8830	80.1103	0.037
37	0.196867	2.3157	0.0000	0.0000	96.3351	93.8830	80.1103	0.000
38	0.189895	0.0000	1.7282	0.4859	96.3351	95.6113	80.5962	0.000
39	0.185061	0.0000	0.3107	4.5471	96.3351	95.9219	85.1434	0.000
40	0.178855	0.2442	0.0000	0.0000	96.5793	95.9219	85.1434	0.000
41	0.178500	0.0000	0.3899	2.3054	96.5793	96.3118	87.4487	0.034
42	0.170972	0.0000	0.1526	2.5474	96.5793	96.4644	89.9961	0.001
43	0.160175	0.0000	0.1063	0.9061	96.5793	96.5707	90.9022	[illegible]
44	0.148808	0.0000	0.0109	3.7027	96.5793	96.5816	94.6048	0.000
45	0.140095	1.2346	0.0000	0.0000	97.8139	96.5816	94.6048	0.000

Fig 5: For CASE TFS 8d at which 90% of mass participation is achieved

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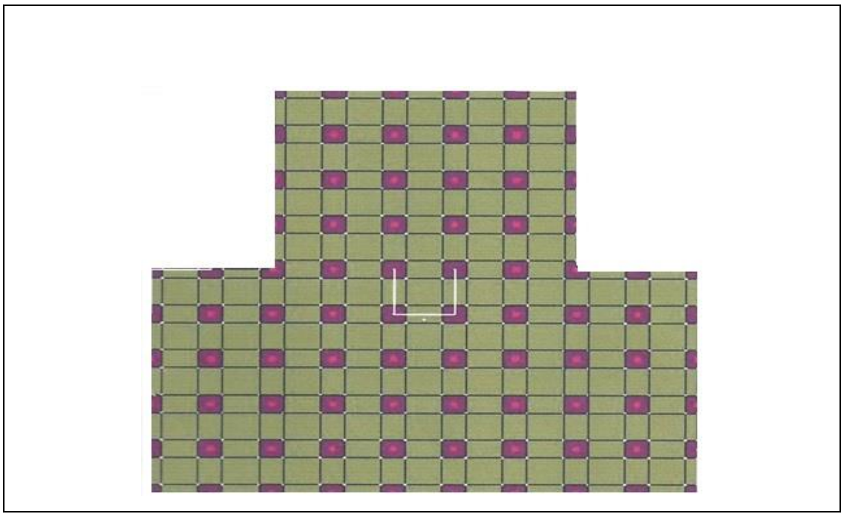

Fig 6 .TFS 8d: Flat slab 'T' Shear wall at periphery of structural system.

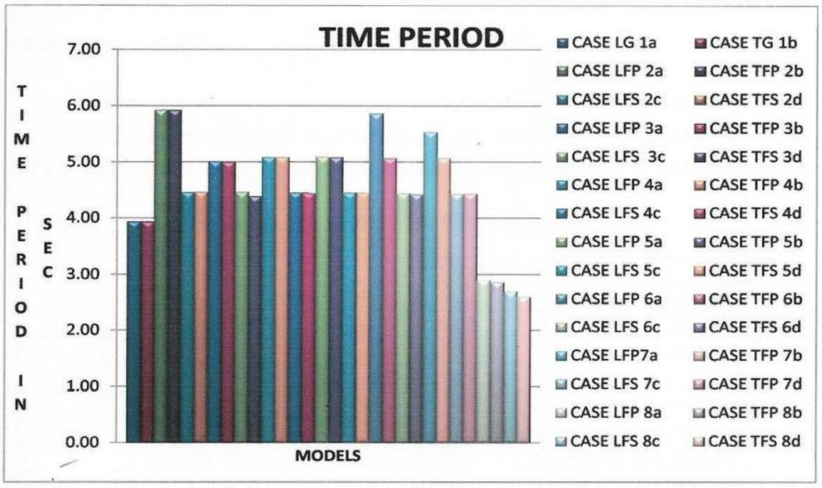

Fig. 7: Plot of time period for different models.

From the result obtained by the analytical models, the following can be inferred

- Minimum time period is observed in flat slab with shear wall at periphery of structural system.
- Maximum time period is observed in flat plate 'L' and 'T' type plan irregular structural system without core wall.
- The stiffness imparted by core shear wall is relatively more than the stiffness imparted by shear wall at the periphery. This results in maximum time period in structural system containing shear wall at periphery and minimum in structural system with core shear wall comparatively.
- Variation of flat slab to flat plate is 25% (1.466 sec).
- First and second mode time period will be comparatively more, after second mode time period will drastically reduce.

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- If structural stiffness of the building is less, then time period is more , by providing the lateral load resisting system , time period can be reduced from 40%to 50%(1.769 sec to 3.04sec) for flat slab to flat slab with shear walland flat plate to flat plate shear wall respectively

CONCLUSION

1. In comparison of flat plate to flat slab, it can observed that flat plate structural system is weak in resisting lateral load as compared to flat slab structural system
2. The first and second time period will be comparatively more, subsequently second mode time period will drastically reduce.
3. The natural time period increases as the storey stiffness of the structure decreases. (The natural time period and stiffness of the structure are inversely proportional to each other. Where other variables of structures are same).
4. Column moments are more in flat plate compared to flat slab.
5. Column moments are more in static method compared to dynamic method.
6. The time period is less in flat slab with shear wall at periphery compared to all other structural model considered for the study.
7. When the stiffness and mass of the structure increases then base shear will increase. Base shear will be more in a flat plate structural system compared to flat slab structural system.
8. Storey drift in structure will be more in static analysis compared to dynamic analysis (response spectrum).
9. Tall buildings coupled with flat plate and flat slab structures which are vulnerable against horizontal load, hence shear wall must be provided to reduce deflection, natural time period and storey drift.

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