

# Comparative Analysis of Lateral Load Resisting Systems with Bare Frame

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**Abstract**— Flat slabs which are commonly used are adopted by the residential buildings flooring system, parking areas, commercial complexes. Flat slabs are preferred by architects and builders because of their aesthetic view and economic to construct. In this thesis, the seismic performance of reinforced concrete (RC) flat slab building with bare frame and lateral load resisting systems such as shear wall, bracings and base isolators is investigated. An eight storey (G+7) building structure is considered for seismic design. Seismic zone-2 and zone-5 are considered for design as per IS 1893 (part1): 2002. Both static and dynamic behavior of the RC flat slab building with bare frame fixed at base and with shear wall, bracings and base isolators are investigated. The effectiveness of 3 types of lateral load resisting systems RC in rehabilitating the eight storey building is studied.

**Key words:** Bare Frame, Shear Wall, Bracings and Base Isolators, Mode Shapes, Displacement, Acceleration

## I. INTRODUCTION

Earthquake resistant design of RC buildings is a well progressing area of study now a days. Earthquake resistant design of structures has become a worldwide area of interest. The structure damages due to some reason during earthquakes .Although there is a lot of weaknesses in the structure, because of code imperfections or error analysis and design, the entire disaster is caused by structural configuration system.

Flat slabs which are commonly used are adopted by the residential buildings flooring system, parking areas, commercial complexes. They are quite easy in construction. Flat slabs are preferred by architects and builders because of their aesthetic view and economic to construct. As the flat slab floor system can handle heavier loads is often adopted in high rise buildings and many other structures, where larger spans are also required.

This paper contains study of the flat slabs with 2 models of flat slabs with shear walls, 2 bare frame, 2 models of flat slab with bracing, 2 models of flat slab with base isolation, is studied. This analysis is done by equivalent force method and response spectrum analysis. Base shear, displacement and acceleration results are obtained by equivalent force and response spectrum method .zone II and V are adopted for all cases taking soil type 2 as per IS 1893: 2002 (part1) is considered and analysed by ETABS.

## II. LITERATURE REVIEW

Apostolska and Necevsk-Cvetanovsk. “Seismic Performance of Building with flat slab, study disclose system of flat slab with certain modifications (design of beam in the perimeter of the building and/or RC walls) can achieve rational factor of behaviour considering EC8 and can be consider as a system with allowable seismic risk. Modifications with additional construction elements

improve small bearing capacity of the system and increase strength and stiffness, improving seismic behaviour of flat-slab construction system.

Fayazuddin Ahmed Syed et al. “Comparative Analysis of Flat Plate Multi-storeyed Frames With and Without Shear Walls under Wind Loads” the paper presents, numerical studies for multistoried frames with conventional beam supported slab, flat plate floor system, flat plate floor system with shear walls. A Comparison of Critical Column Axial Forces, Column moments, Lateral Drift (in mm) due to static and wind loads on the structures located at Hyderabad at a basic wind speed of 44 m/s has been observed during analysis.

## III. METHODOLOGY

### A. Modeling

Modeling is carried out using ETABS software of 2015 version.

### B. Salient Features of the Building

#### 1) Grid System-Grid Dimensions (Plan)

Number of bays = 6 bay by 5 bay

i.e. Number of bays in X-direction = 7 bay

Number of bays in Y-direction = 6 bay

#### 2) Story Height

Number of Storeys = 8 Storey (G +7)

Depth of foundation = 1.5 m

Bottom storey = 4.0 m

Other storeys = 3.0 m

#### 3) Structural Elements Dimension

Beam size = 0.2 m x 0.6 m

Column size = 0.6 m x 0.6 m

Flat Slab thickness = 0.20 m

Drop thickness = 0.350 m

### C. Material Properties

#### 1) Concrete (IS456:2000)

Grade of Concrete: M25 and M30

M25 for beams and Flat slabs

M30 for columns

Compressive strength of concrete, fck = 25000 kN/m<sup>2</sup> and 30000 kN/m<sup>2</sup>

Density of Concrete (weight per unit volume) = 25 kN/m<sup>3</sup>

Modulus of Elasticity of concrete,

$E_f = (5000\sqrt{fck}) = 22.36 \times 10^6$  kN/m<sup>2</sup> and  $27.38 \times 10^6$  kN/m<sup>2</sup>

Poisson's ratio of concrete = 0.2

No. of storeys	Displacement (MM)			
	Model-1	Model-3	Model-5	Model-7
STOREY-8	11.2	4.8	3.2	48.1
STOREY-7	10.6	4.1	3	43.5
STOREY-6	9.5	3.4	2.7	37.7

STOREY-5	8.1	2.6	2.2	30.6
STOREY-4	6.5	1.8	1.8	22.7
STOREY-3	4.7	1.1	1.3	14.4
STOREY-2	2.8	0.5	0.8	6.9
STOREY-1	0.2	0.1	0.1	0
BASE	0	0	0	0

Table 1: Displacement (MM)

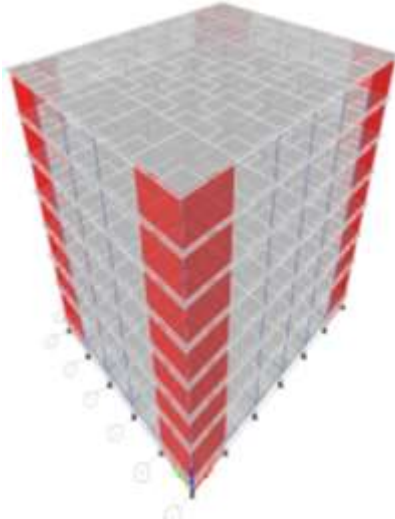


Fig. 1: Mathematical model of the G+7 storey building

#### IV. RESULTS AND DISCUSSIONS

This research work is carried out to compare the dynamic response of RC flat slab with bare frame and flat slab with L-shear wall, bracings, and base isolators for different zones. Totally eight models are considered for the linear dynamic analysis which includes modal analysis, Equivalent static force method and response spectrum analysis. From modal analysis, mode period, modes shapes are obtained. From Equivalent static force method base shear, maximum storey drift, displacement and acceleration results are obtained. From response spectrum analysis base shear, displacement, acceleration and maximum storey drift results for zone-5 and zone-2, soil type-2 as per IS 1893-2002(part-1) are obtained.

##### A. Time Period with Mode Shapes

Mode period (sec)			
Models	Mode-1	Mode-2	Mode-3
Model-1	0.831	0.756	0.731
Model-2	0.444	0.402	0.268
Model-3	0.464	0.446	0.292
Model-4	1.143	1.137	1.108

Table 2: Comparison of mode period for different models

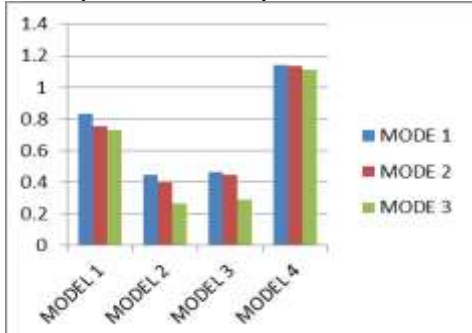


Fig. 2: Comparison of mode period for different models

##### B. Storey Displacement

Comparison of Displacement Along X Direction In Zone II For Different Models

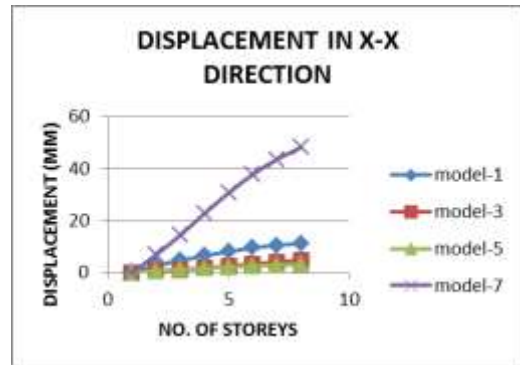


Fig. 3: Comparison of Displacement Along X Direction In Zone II For Different Models

From Fig 5.19, it is observed that, there is a increase in displacement which is nearly 98% in storey-8 compared to ground floor and the displacement goes on decreases from storey-8 to ground floor in X-X direction both in Equivalent static force and response spectrum .This shows the displacement value is more in top floor compared to bottom floor because stiffness participation factor is more in ground floor compared to top floor both in X-X direction.

It is observed that, there is a increase in displacement which is nearly 90% to 99% in storey-8 compared to ground floor for all models (i.e. . model-1 ,model-3,model-5,model-7) and the displacement goes on decreases from storey-8 to ground floor in X-X direction both in Equivalent static force and response spectrum method for all models(i.e. model-1 ,model-3,model-5,model-7).

DISPLACEMENT (MM)				
No. Of storeys	Model-2	Model-4	Model-6	Model-8
STOREY-8	40.3	19.8	11.5	62.8
STOREY-7	38	17.2	10.7	58.8
STOREY-6	34.2	14.4	9.6	52.6
STOREY-5	29.2	11.3	8.1	44.5
STOREY-4	23.3	8.3	6.4	35
STOREY-3	16.9	5.3	4.7	24.5
STOREY-2	10.1	2.8	2.9	13.7
STOREY-1	0.9	0.3	0.4	1.6
BASE	0	0	0	0

Table 3: Comparison of Displacement Along X Direction In Zone V For Different Models



Fig. 4: Comparison of Displacement Along X Direction In Zone V For Different Models

C. Storey Acceleration

ACCELERATION (MM)				
No. Of storeys	Model-1	Model-3	Model-5	Model-7
STOREY-8	0.43	0.64	0.56	1.45
STOREY-7	0.39	0.52	0.52	1.23
STOREY-6	0.35	0.43	0.46	1.12
STOREY-5	0.32	0.38	0.41	1.03
STOREY-4	0.29	0.34	0.36	0.97
STOREY-3	0.25	0.28	0.3	0.86
STOREY-2	0.2	0.2	0.23	0.7
STOREY-1	0.02	0.05	0.04	0.12
BASE	0	0	0	0.01

Table 4: Comparison of Acceleration Along X Direction In Zone II For Different Models

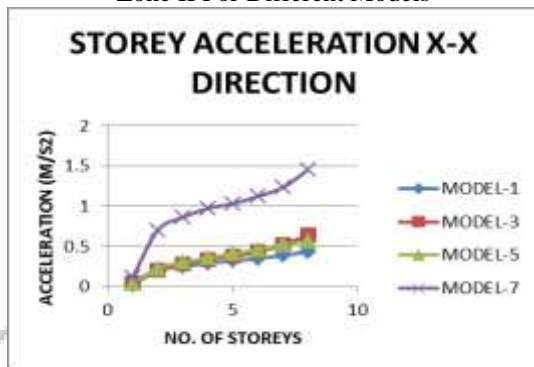


Fig. 5: Comparison of Acceleration Along X Direction In Zone II For Different Models

ACCELERATION (MM)				
No. Of storeys	Model-2	Model-4	Model-6	Model-8
STOREY-8	1.56	2.28	2.03	0.33
STOREY-7	1.39	1.87	1.85	0.22
STOREY-6	1.27	1.57	1.67	0.2
STOREY-5	1.15	1.37	1.48	0.21
STOREY-4	1.05	1.21	1.3	0.22
STOREY-3	0.92	1.02	1.09	0.22
STOREY-2	0.71	0.75	0.82	0.17
STOREY-1	0.08	0.15	0.14	0.06
BASE	0	0	0	0.02

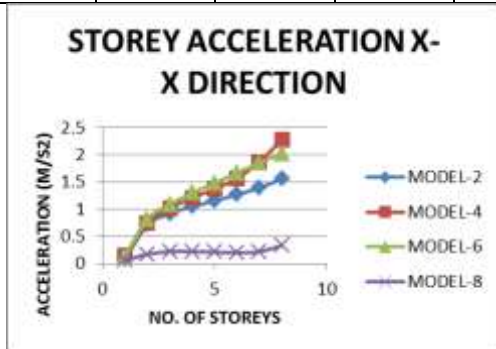


Fig. 6: Storey Acceleration X-X Direction

V. CONCLUSIONS

This thesis presents the summary of the study, for RC Flat slab building for bare and shear wall with different location. The effect of seismic load has been studied for the five types of building with bare and shear wall with different location.

On the basis of the results following conclusions have been drawn.

- 1) The natural mode (time) period increases as the height of building (No. of stories) increases, However, the time period is more for flat slab with bare frame and bare frame with isolators compared with that of flat slab with shear wall and bracings for both the zone (i.e, zone-2 and zone-5) because of stiffness participation factor is less in bare frame.
- 2) For flat slab building with bare frame, response acceleration decreases with increase in the height of building, however, for flat slab with shear wall, bracings and base isolators; this change is not significant because in all structures less members are stiffened. Flat slab with bare frame is having less acceleration value compared with that of flat slab with shear wall, bracings and base isolators for both zone (i.e, zone-2 and zone-5).
- 3) For all the structure, displacement increases as the height increases. Displacement of flat slab R.C.C building with bare frame is more than the flat slab building with shear wall, bracings and base isolators for both zone (i.e, zone-2 and zone-5) because of stiffness participation factor is more in shear wall, bracings and base isolators building compared with that of flat slab with bare frame.
- 4) The thesis concludes that building with bracings system is more effective to resist lateral loads (i.e. Earthquake static and dynamic load) compared to shear wall, bare frame, and building with base isolators.

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