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COMPARATIVE STUDY OF FLAT SLAB BUILDING WITH TRADITIONAL TWO WAY SLAB BUILDING UNDER THE SEISMIC EXCITATION

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Abstract: Flat-slab building structures possesses major advantages over traditional slab-beam-column structures taking a advantages of reduced floor height , shorter construction time, architectural –functional and economical aspects. Because of the absence lateral load resisting elements, flat-slab structural system is significantly more flexible for lateral loads then traditional RC frame system and that make the system more vulnerable under seismic excitation. Flat slab structure is most vulnerable to the seismic excitation therefore the careful analysis of flat slab is important. In this paper the seismic analysis on flat slab is performed and compared it with the conventional RC building. To improve the performance of flat slab system shear wall and beam at periphery is applied and the seismic response of the same is determined and compared it with the flat slab building.

Keywords: Flat Slab, Shear Wall, Peripheral Beam, Conventional Building, Lateral Displacement, Storey Drift.

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INTRODUCTION

Earthquake resistant design of RC buildings is a continuing area of research since the earthquake engineering has gained prominence across the globe. Earthquakes occurred in past, have shown that poorly designed and constructed structures result in great destruction. Hence, there is a need to determine seismic response of tall buildings for designing earthquake resistant structures. The type of building based on slab system, i.e., Flat slab building and traditional slab building i.e. two way slab or grid slab building.

Flat slabs have been widely used in building construction due to their advantages in reducing storey height and construction period (compared with RC frames with beams and columns), leading to a reduction of construction costs. Two- way slab, the slab is supported by beams, the load of both slab and beams is conveyed to columns and footings. Flat slabs are extensively used to resist wind and seismic forces in low-to-moderate seismicity regions compare to two way slab. The behavior of this type of structural system under gravitational loads is well established. The flat slab is often thickened closed to supporting columns to provide adequate strength in shear and to reduce the amount perimeter of the critical section, for shear and hence, increasing the capacity of the slab for resisting two-way shear and to reduce negative bending moment at the support. Flat slab Building structures are significantly more flexible than traditional concrete slab under seismic excitations. In the present study to improve the performance of flat slab building shear wall and beam at periphery is introduce. Shear wall is design to resist the lateral forces acting on its own plane hence it helps in improving the performance of flat slab building.

1. Analysis Approach

In this paper the seismic analysis of flat slab building, flat slab building with shear wall and flat slab strengthen by perimetric beam is done and their results compare with the traditional two way slab building. For the analysis purpose the finite element based software ETABS Nonlinear version 9.7.3 is used.

2. Structural Modeling of Building:

In the present study the G + 6 storey having a plan dimensions of 22 x 14 m flat slab building with and without shear wall, with beam at periphery and traditional two way slab building situated in earthquake zone V is analyzed. The various properties and aspects of the buildings given below.

3.1 Material properties:

M-25 grade of concrete and Fe-415 grade of reinforcing steel are used for all members of the frame structures. Elastic material properties of these materials are taken as per Indian Standard IS 456 (2000). The modulus of elasticity (*Ec*) of concrete is taken as:

Ec = 5000 $fck^{0.5}$ MPa

Density of reinforced concrete = 25 kN/m^3

Density of brick masonry = 18 kN/m^3

3.2 Structural element sizes:-

Column size 450 x 450 mm.

Beam size 230 x 400 mm.

Thickness of flat slab 150 mm.

Thickness of convectional two way slab 120 mm.

Thickness of shear wall 200 mm

Thickness of wall 230 mm

Thickness of interior wall 115 mm

3.3 Description for Loading

1. Dead load

a. Wall load with 230 mm thickness = 0.23 x 2.6 x 18 = 10.764 kN/m

b. Wall load with 115 mm thickness = 0.115 x 2.6 x18 =5.382 kN/m

c. Floor finish = 1.5 kN/m^2

d. Self weight of the building is automatically considered by ETABS software

2. Live load

Live load of 3 kN/m^2 is considered on the building.

3. Earthquake force data

Earthquake load for the building has been calculated as per IS-1893-2002:

i. Zone (Z) = V

ii. Response Reduction Factor (RF) = 5

iii. Importance Factor (I) = 1

iv. Rock and soil site factor (SS) = 2

v. Type of Structures = 1

vi. Damping Ratio (DM) = 0.05

4. Loading Combination

$1.5\ (DL + LL)$

$1.2(DL + LL \pm EQX)$

3. $1.2(DL + LL \pm EQY)$

$1.5(DL \pm EQX)$

$1.5(DL \pm EQY)$

$(0.9DL \pm 1.5EQX))$

$(0.9DL \pm 1.5EQY)$

3.4. Building geometry:

The building (G+6) having a four bay in x-direction and three bay in the y-direction having typical storey height of 3 m. at each floor as shown in fig 1. And fig.2

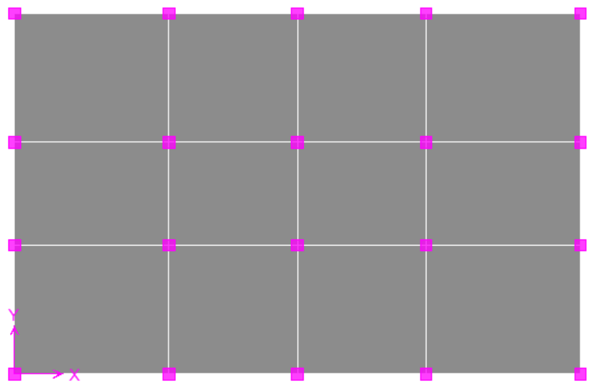

Fig. 1 plan of the building

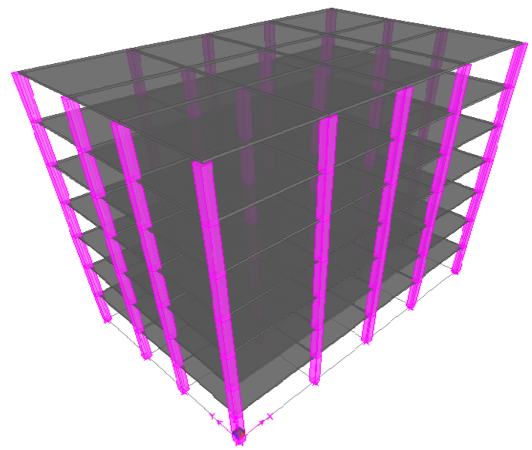

Fig 2 3D view of building in ETABS

4. RESULTS AND DISCUSSION

The equivalent static load analysis is performed on the four different structure viz. flat slabs building with and without shear wall; flat slab with beam at periphery and conventional two way slab building. The results obtained from this analysis are discussed below.

1. Storey Displacement

The storey displacement due to the earthquake forces are computed in table 1. And the graph of the same is shown in fig. 3. The maximum displacement is found for the flat slab building and least for the flat slab building with shear wall.

Table 1 lateral displacement of building in meter

Story	Flat slab building	Building with Perimetric beam	Conventional building	Flat slab with SW
Story1	0.0138	0.0081	0.0078	0.0015
Story2	0.0329	0.0225	0.0213	0.0049
Story3	0.0529	0.0377	0.0355	0.0096
Story4	0.0716	0.052	0.0489	0.0152
Story5	0.0875	0.0641	0.0602	0.0212
Story6	0.0992	0.073	0.0685	0.0273
Story7	0.1065	0.0781	0.0732	0.0332

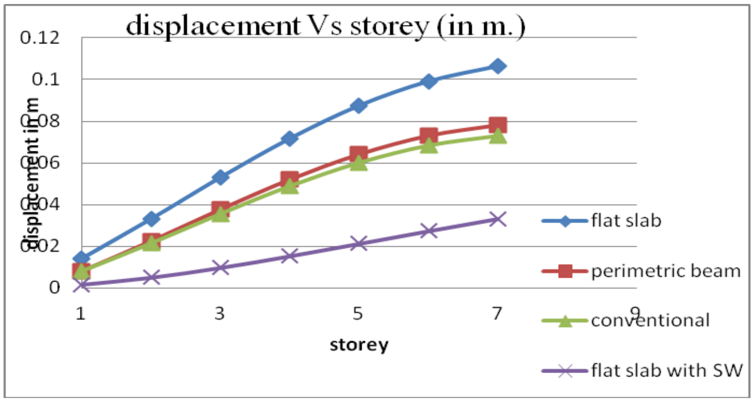

Fig. 1 displacement of the building with resp. to storey height

Storey drift:-

It is the displacement of one level relative to the other level above or below IS 1893. The storey drift in Y- direction is shown in the table 2 and also the graph of the same is drawn in fig.04

Table 2 storey drift

Story	Flat slab building	Building with perimetric beam	Flat slab building with SW	Conventional building
Story1	0.003888	0.002494	0.000685	0.002396
Story2	0.005104	0.004273	0.001589	0.004066
Story3	0.005231	0.004486	0.002165	0.004255
Story4	0.004867	0.004197	0.002471	0.003976
Story5	0.004132	0.003572	0.002562	0.003383
Story6	0.003049	0.00263	0.002502	0.002486
Story7	0.001823	0.00152	0.002366	0.001427

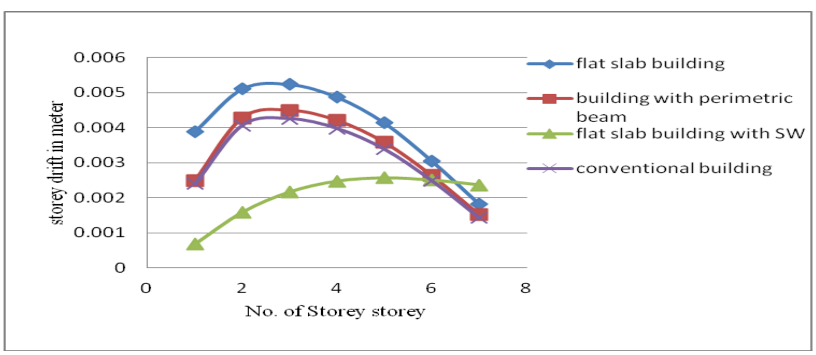

Fig. 2 storey drift verses storey

Base shear, axial force and Moment:

Table 3 shows the maximum values of axial force, bending moment and shear force for the considered loading condition. The bending moment is found maximum for the flat slab with beam at periphery. Axial force is least in the flat slab building.

Table 3 Axial force, bending moment and shear force

	Axial force	bending moment	shear force
Flat slab building	37261.87 kN	260833.125kN.m.	2865.29 kN
flat slab with SW	40884.38 kN	286190.625 kN.m	3092.29 kN
flat slab with perimetric beam	41811.18 kN	292678.05 kN.m	3167.48 kN
conventional building	41461.93 kN	77966.35 kN.m	3119.42 Kn

5. CONCLUSIONS.

This paper presents a summary of the study, for conventional R.C.C building and flat slab building with and without shear wall and building with beam at periphery for seismic zone v. The effect of seismic load has been studied for these four types of buildings. On the basis of the results following conclusions have been drawn:

1. The storey displacement is found maximum for the flat slab building as compared to conventional RC building and flat slab with shear wall the maximum displacement of the flat slab building is due to the absence of lateral load resisting system.

2. The storey displacement is found least for the flat slab with shear wall. Displacement of the flat slab building is 31.36% larger than the conventional RC slab building therefore in the seismically active region the shear wall is advisable.

3. For all the cases considered drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey.

4. It is found that flat slab structures exhibit higher flexibility compared to traditional frame structures. In order to limit deformation demands under the seismic excitations, combination with other stiffer structural systems as shear-walls is advisable.

5. The axial force is found least in flat slab building as compared with other buildings. The bending moment is found maximum in the flat slab building and least in the conventional RC building.

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