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PARAMETRIC STUDY OF FLAT LAB STRUCTURE WITH SOFT STOREY AGAINST EARTHQUAKE FORCES

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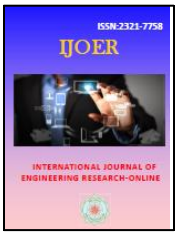

ABSTRACT

The demand of business activities in the existing and developing cities is increasing tremendously. Due to this there is a hike in the availability of land for carrying business activities. So, the scarcity of land in these cities led to the development of high rise buildings. The requirements of the commercial buildings are faster construction, flexibility in room layout, less building height and availability of parking place. Flat slab construction places no restrictions on the positioning of horizontal services and partitions and can minimize floor-to- floor heights when there is no requirement for a deep false ceiling. Flat slabs have a lower stiffness in comparison to a beam-column floor plan which can lead to relatively large deflections during earthquakes.

In the present study a parametric investigation was carried out in order to identify the seismic response of flat slab building subjected to earthquake forces. A nine storied structure was taken for the analysis to identify the seismic response and therefore strengthening by providing shear wall at various locations to reduce the lateral forces of the structure.

Key words: Flat slab, Soft storey, Shear wall, Seismic force, Equivalent strut, storey shear, storey drift, time period.

1. INTRODUCTION

Flat slabs system of construction is one in which the slab directly rests on columns and load from the slab is directly transferred to the columns and then to the foundation. To support heavy loads the thickness of slab near the support with the column is increased and these are called drops, or columns are generally provided with enlarged heads called column heads or capitals. Absence of beam gives a plain ceiling, thus giving better architectural appearance and also less vulnerability in case of fire than in usual cases where beams are used.

In general normal frame construction utilizes columns, slabs & beams. However it may be possible to undertake construction without providing beams. In such a case the frame system would consist of slab and column without beams. These types of slabs are called flat slab, since their behaviour resembles the bending of flat plates.

1.1 Components of Flat Slabs

1.1.1 Drop Panel

To resist the punching shear which is predominant at the contact of slab and column support, the drop dimension should not be less than one -third of panel length in that direction.

1.1.2 Column Heads

Certain amount of negative moment is transferred from the slab to the column at the support. To resist this negative moment the area at the support needs to be increased this is facilitated by providing column capital/heads.

Flat slabs are appropriate for most floor situations and also for irregular column layouts, curved floor shapes, ramps etc. The benefits of choosing flat slabs include a minimum depth solution, speed of construction, flexibility in the plan layout (both in terms of the shape and column layout), a flat soffit (clean finishes and freedom of layout of services) and scope and space for the use of flying forms.

The flexibility of flat slab construction can lead to high economy and yet 2 allow the architect great freedom of form. Examples are solid flat slab, solid flat slab with drop panel, solid flat slab with column head, coffered flat slab, and coffered flat slab with solid panels.

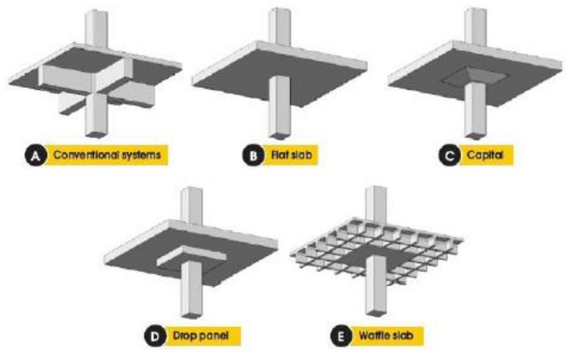

Fig 1.1: Different types of flat slab

A flat slab is a flat section of concrete. These slabs are classically used in foundations, although they can also be used in the construction of roadways, paths, and other structures. Depending on the size and complexity of a flat slab, it may need to be designed by an engineer who is familiar with the limitations and needs of slabs, or it may be possible for a handy do it yourself to make one in an afternoon for a simple project.

Typically, a flat slab is made with reinforced concrete, in which rebar is criss-crossed in the forms to provide support and reinforcement once the concrete is poured and hardened. The slab design is designed to be reinforced in several directions so that it can withstand stresses such as shifting ground, earthquakes, frost, and so forth. Failure to fully reinforce a flat slab can cause it to crack or give along weak lines in the concrete, which will in turn cause instability.

For some sites, a flat slab is poured in situ. In this case, the site is prepared, forms for the concrete are set up, and the reinforcing rebar or other materials are laid 3 down. Then, the concrete is mixed, poured, and allowed to cure before moving on to the next stage of construction. The time required can vary considerably, with size being a major factor; the bigger the slab, the more complex reinforcement needs can get, which in turn adds to the amount of time required for set up. Once poured, the slab also has to be examined and tested to confirm that the pour was good, without air pockets or other problems which could contribute to a decline in quality.

In other cases, a flat slab may be prefabricated off site and transported to a site when it is needed. This may be done when conditions at the site do not facilitate an easy pour, or when the conditions for the slab's construction need to be carefully controlled. Transportation of the slab can be a challenge if it is especially large. Barges, cranes, and flatbed trucks may be required to successfully move it from the fabrication site to the site of the installation.

The flat slab structure foundation also has some problems. It can settle on uneven ground, allowing the structure to settle as well, for example, and during seismic activity, a slab foundation cannot hold up if the soils are subject to liquefaction. A flat slab can also become a major source of energy inefficiency, as structures tend to lose heat through the concrete.

Advantages of flat-slab reinforced concrete structures are widely known but there are also known the disadvantages concerning their earthquake resistance. It is remarkable that both Greek codes, Reinforced Concrete Code and Seismic Code do not forbid the use of such structural systems however both Codes provide specific compliance criteria in order such structures to be acceptable. The advantages of these systems are:

1. The ease of the construction of formwork.
2. The ease of placement of flexural reinforcement.
3. The ease of casting concrete
4. The free space for water, air pipes, etc between slab and a possible furred ceiling.
5. The free placing of walls in ground plan.
6. The use of cost effective pre-stressing methods for long spans in order to reduce slab thickness and deflections as also the time needed to remove the formwork.
7. The reduction of building height in multi-storey structures by saving one storey height in every six storey's thanks to the elimination of the beam height.

These structural systems seem to attract global interest due to their advantages mainly in countries in which the seismicity is low. The application of flat-slab structures is restrained due to the belief that such structures are susceptible to seismic actions. Moreover, it is known that in Central America, at the beginning of 1960's, flat-slab structures displayed serious problems during earthquake actions.

1.2 Soft Storey

It is the one which the lateral stiffness is less than 70 % of that in the storey above or less than 80% of the average lateral stiffness of the three storeys above.

By Providing Stiff Column at Open Ground Storey Stiffness of column is directly proportional to its load carrying capacity i.e. higher the stiffness, higher is the load carrying capacity. Stiffness can be increased by increasing the size of these loads carrying member as they are able to bear the excessive load during earthquake. By Providing Brick Infill with Column at Open storey Masonry in fill has several advantages like good sound and heat insulation properties, high lateral strength and stiffness. This increases strength and stiffness of RC frame and hence to decrease lateral drift, energy dissipation capacity due to cracking of infill and friction between in fill and frame

Reinforced concrete frame buildings are becoming progressively common in India. Many RCC buildings constructed in having a feature open the ground level storey for the purpose of parking, i.e. partition walls are not provided in between the columns in the ground storey The two distinct characteristic of the building having stilt parking are as follows - Difference in flexibility, i.e. the relative horizontal displacement in the ground storey is much larger than upper story having both columns as well as wall. This flexible ground storey is also called soft storey. Ground storey having only columns are weaker than upper storey having both column and walls i.e. the lower storey can bear the horizontal earthquake force less efficiently than the upper storey.

Fig 1.2: Soft storey

1.3 Causes of Soft Storey

There are many practical reasons for having fewer walls at the ground level of a building. A building may have larger public spaces at this entry level, such as lobbies, large meeting rooms or open-plan retail space. In urban locations, residential buildings sometimes have fewer walls at the ground level to allow for parking underneath the building which is shown in figure below.

1.3.1 Irregularity in strength and stiffness of weak and soft storey

A weak storey is defined as one in which the storey's lateral strength is less than 80 percent of that in the storey above. The storey's lateral strength is the total strength of all seismic resisting elements sharing the storey shear for the direction under consideration i.e. the shear capacity of column or the shear wall or the horizontal component of the axial capacity of the diagonal braces. The deficiency that usually makes a storey weak is inadequate strength of frame columns. A soft storey is one in which late al stiffness is less than 70% of that in the storey immediately above, or less than 80% of the combined stiffness of the three stories above. The essential characters of a weak or soft storey consist of a discontinuity of strength or stiffness, which occurs at the second storey connections. This discontinuity is caused by lesser strength, or increased flexibility, the structure results in extreme deflections in the first storey of the structure, which in turn results in concentration of forces at the second storey connection. The result is a concentration of inelastic action.

1.3.2 Building with Soft Storey

In case building with a flexible storey, such as the ground storey consisting of open spaces for parking that is stilt buildings. A special arrangement needs to be made to increase the lateral strength and stiffness of the soft/open storey. Dynamics analysis of building is carried out including the strength and stiffness effects of infills and inelastic deformations in the members‟ .particularly, those in the soft storey, and the members designed accordingly

LITERATURE REVIEW

Jaswant N Arlekar et al (1997) this paper argues to adopt immediate measures to prevent the indiscriminate use of soft storey in a building. This paper brought out the errors involving in modelling the building as complete bare frame and neglecting infill panel in the upper storeys. Static and dynamic analysis is carried out on different models to study the effects of soft storey and presence of infill wall in the model. This study concludes that building with first soft storey exhibits poor performance during earthquake. It is necessary to increase the stiffness of first storey by atleast 50%. Adequate stiffness and lateral strength can be adopted by providing stiffer columns. Soil flexibility is the main criteria to finalise the analytical model of the building.

C. V. R Murthy, Sudhir Jain (2000) in this paper seismic behaviour of weak storey is studied for which different building models are consisting of various storeys, storey heights and span with some existing building damaged during earthquakes. The results are compared with the building code. It gives the idea of precautions to be taken while analysing design and construction of building with structural irregularity. It also tells about effect of infill wall material on seismic performance. It concludes, the building designed according to latest building code and to reconstruct or reinforce the existing buildings according to updated codes by adopting different retrofitting techniques. It also suggests to use light weight infill wall for building with soft storey.

Robin Davis et al (2004) In this paper two buildings are located in moderate seismic zone Structurally symmetric (bare frame) is compared to the building with plan and vertical irregularity (soft Storey) Infill wall on the upper floor are modelled using equivalent stiffness strut approach. Equivalent static analysis, response spectrum and Non-linear pushover analysis is performed to determine the structural response of building to earthquake. This study concludes that presence of masonry infill panel considerably increases total storey shear bending moment in the ground floor column and failure occurs due to soft storey mechanism. Hence present structures with soft storey need to be retrofitted.

3.0 Geometry of the Building

3.1 General Layout

A commercial building with nine (C+G+7) storeys having identical floor plan of 27 m x 45 m dimensions are considered for this study. The floor plans were divided into seven by five bays in such a way that centre to centre distance between two grids is 9 meters and 9 meters respectively.

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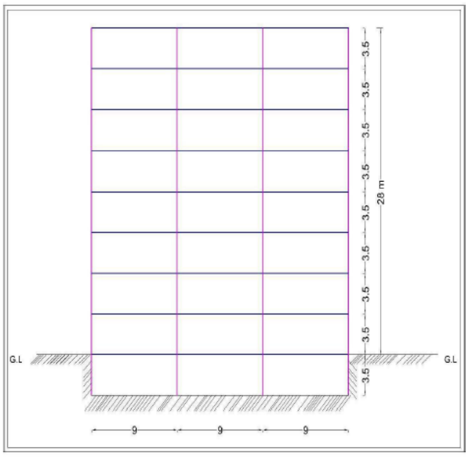

Fig: 3.1 Elevation of the proposed structure

The height of the building above ground level is taken as 28 m with a storey height of 3.5 m each.

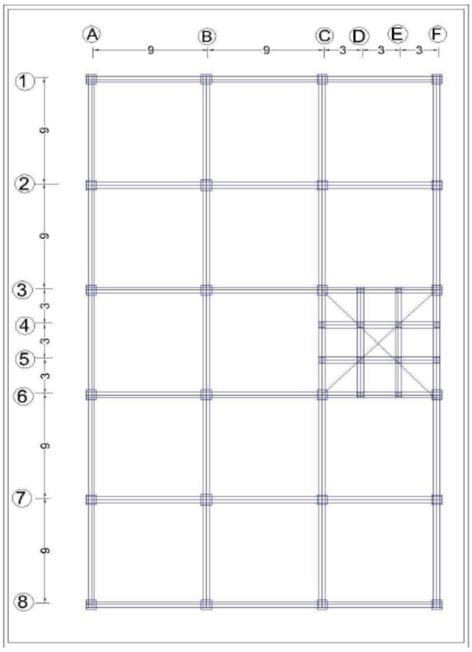

Fig: 3.2 central line plan of structure

3.2 Dimensions of Structural Members:

Various structural members of the building are assumed with the following dimensions for the feasibility of load calculations.

3.3 Miscellaneous Data:

Various details required for carrying out the analysis have been summarized as below

- Grade of concrete is assumed as M30
- Grade of steel is taken as Fe 500
- Unit weight of RCC is 25 kN/ m^3.
- Unit weight of brick work is 19 kN/ m^3
- Live load on floor is taken as 5.00 kN/ m2
- Live load on terrace is considered to be 1.50 kN/ m^2

Table 3.1-Dimensions of Structural Members

Parameters	Value
Number of Stories	C+G+7
Locations	Zones III & IV
Type of slab	Flat slab
Panel dimension	9 m x 9m
Height of each Storey	3.50m
Slab Thickness	0.35m
Infill Wall Thickness	
Exterior wall	0.23m
Interior Wall	0.115m

Table 3.2-Properties of Concrete

Property	Value
Grade of Concrete for all Structural Elements	M30
Modulus of Elasticity of Concrete(N/mm^2)	$E_c = 5000\sqrt{fck} = 27.4X10^6$ kN/m^2
Shear modulus	$G = 1.06 \times 10^7$ kN/m^2.
Poisson's Ratio	0.15
Density of Concrete	25 kN/m^3

3.3 Member dimensions

Beam Sizes : BM 500 mm X600 mm
Column Sizes : 800 mm x 800 mm, 900 mm X 900 mm.
Slab Thickness : 350 mm
Drop Thickness : 100 mm
Thickness of wall : 230 mm
Shear wall Thickness : 200 mm
Size of the drop : 3 m x 3 m
Width of column strip : 3 m
Width of middle strip : 6 m

3.3 MODELLING OF STRUCTURE IN E-TABS

ETABS software will be used to perform the Response spectrum analysis. The user establishes grid lines, places structural objects relative to the grid lines using points, lines and areas, and assigns loads and structural properties to those structural objects (for example, a line object can be assigned section properties; a point object can be assigned spring properties; an area object can be assigned slab or deck properties). The program simplifies seismic analysis by providing modelling features such as rigid diaphragms to model slabs and infill walls. Analysis and design are then performed based on the structural objects and. It can take the results of an analysis as input to define the hinge properties of members so that pushover analysis can be carried out. Results are generated in graphical or tabular form that can be printed to a printer or to a file for use in other programs.

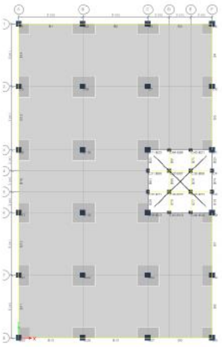

Fig: 3.3 Model 1: Flat slab structure.

Fig: 3.4 Model 1: 3D view of Flat slab structure

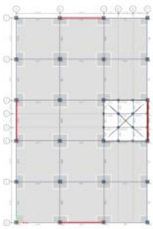

Fig: 3.5 Model 2: Flat slab structure with shear wall provided at edges

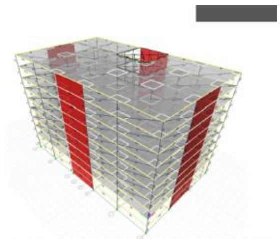

Fig: 3.6 Model 2: 3D view of Flat slab structure withshear wall provided at edge

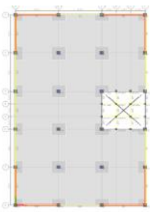

Fig: 3.7 Model 3: Flat slab structure with shear wall provided corner portion

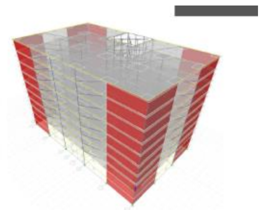

Fig: 3.8 Model 3: 3D view of Flat slab structure with shear wall provided at corner portion

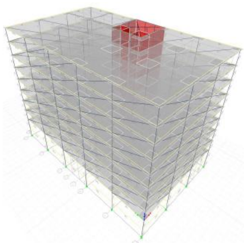

Fig: 3.9: Model 4:3D view of flat slab structure with shear wall at lift portion

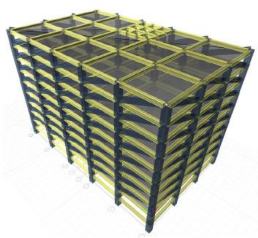

Fig: 3.10: Model 5:3D view of conventional Rcc framed

4.0 RESULTS

Linear static analyses of the five models are carried out under the action of vertical dead loads (DL), live loads (L.L) and lateral earthquake loads (EQ), and corresponding maximum force resultants of the frame are obtained for the different load combinations are compared in this section.

It was observed that force resultants, most noticeably the bending moment, reduce considerably when stiffness of infill was considered in the analytical model, because most of the lateral forces are then transferred to the infill wall as axial forces. With increase in lateral forces on the frame, area of wall in contact with RC frame reduces because of separation of wall from RC frame near the tension-diagonal joints.

Forces that require to understand the behaviour of the structure and to design the structure (i.e. Time periods, Bending Moment, storey shear forces and storey drifts) are presented.

4.1 Time Period (sec): The modal time period values for all the models presented in chapter 3are shown in table 4.1 to table 4.4. The fundamental time period of model M1 is maximum of all the other models. By observing the fundamental mode, the deflection pattern can be visualized.

TABLE 4.1: Time Periods for Different Models when infill Walls are not considered in Zone III

Mode	Time Period (Zone -III)				
	Model 1	Model 2	Model 3	Model 4	Model 5
1	1.807	0.950	0.713	1.538	1.654
2	1.738	0.945	0.706	0.892	1.568
3	1.590	0.674	0.428	0.750	1.441
4	0.576	0.256	0.199	0.479	0.515
5	0.555	0.255	0.193	0.261	0.489
6	0.500	0.199	0.199	0.238	0.453
7	0.318	0.195	0.186	0.220	0.275
8	0.300	0.178	0.173	0.203	0.262
9	0.280	0.177	0.154	0.196	0.245
10	0.209	0.173	0.154	0.185	0.178
11	0.206	0.169	0.142	0.178	0.176
12	0.205	0.158	0.139	0.171	0.172

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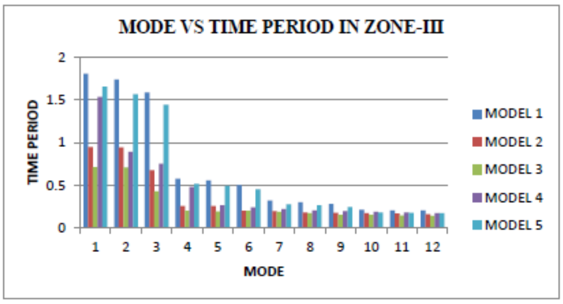

Fig 4.1: Mode vs Time period for models in zone III

TABLE 4.2: Time Periods for Different Models When infill Walls are not considered in Zone IV

Mode	Time Period (Zone-IV)				
	MODEL 1	Model 2	MODEL 3	MODEL 4	MODEL 5
1	1.726	0.942	0.708	1.559	1.616
2	1.606	0.938	0.705	0.893	1.531
3	1.452	0.641	0.417	0.742	1.410
4	0.551	0.248	0.204	0.484	0.503
5	0.513	0.247	0.194	0.265	0.478
6	0.466	0.201	0.189	0.236	0.443
7	0.305	0.196	0.188	0.218	0.268
8	0.283	0.180	0.179	0.208	0.256
9	0.259	0.177	0.162	0.202	0.240
10	0.209	0.179	0.157	0.193	0.173
11	0.205	0.164	0.146	0.184	0.171
12	0.198	0.159	0.145	0.155	0.168

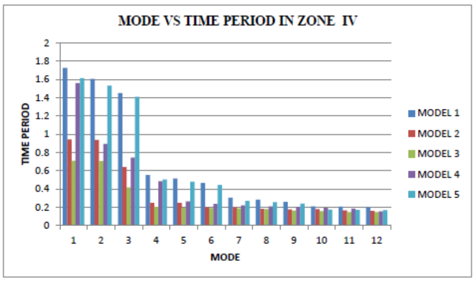

Fig 4.2: Mode vs Time period for models in zone IV

TABLE 4.3: Time Periods for Different Models When infill Walls are considered in Zone III

MODE	TIME PERIOD (ZONE -III)				
	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
1	1.514	0.860	0.667	1.226	1.413
2	1.411	0.792	0.661	0.823	1.345
3	1.301	0.585	0.403	0.691	1.170
4	0.471	0.244	0.197	0.381	0.447
5	0.409	0.231	0.189	0.229	0.427
6	0.383	0.196	0.185	0.217	0.373
7	0.257	0.188	0.183	0.203	0.243
8	0.223	0.172	0.171	0.200	0.235
9	0.209	0.170	0.153	0.193	0.206
10	0.207	0.164	0.152	0.183	0.178
11	0.200	0.163	0.139	0.174	0.175
12	0.189	0.154	0.138	0.167	0.172

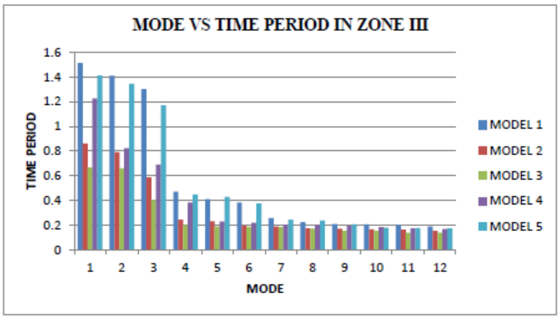

Fig 4.3: Mode vs Time period for models in zone III

TABLE 4.4: Time Periods for Different Models When infill Walls are considered in Zone IV

Mode	TIME PERIOD (ZONE-IV)				
	Model 1	Model 2	Model 3	Model 4	Model 5
1	1.420	0.859	0.667	1.228	1.358
2	1.346	0.815	0.601	0.842	1.284
3	1.160	0.554	0.392	0.684	1.119
4	0.456	0.238	0.203	0.385	0.430
5	0.43	0.231	0.193	0.230	0.411
6	0.367	0.201	0.185	0.218	0.36
7	0.253	0.196	0.184	0.205	0.235
8	0.240	0.179	0.178	0.204	0.228
9	0.208	0.175	0.160	0.198	0.202
10	0.205	0.169	0.157	0.191	0.173
11	0.203	0.158	0.145	0.181	0.171
12	0.192	0.133	0.145	0.173	0.167

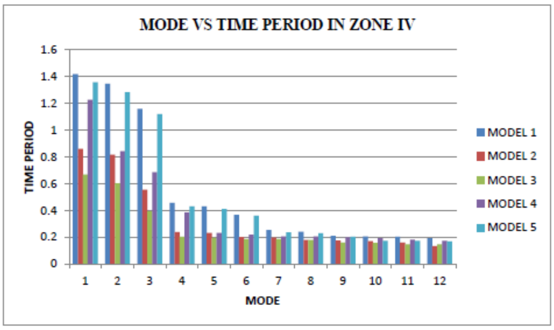

Fig 4.4: Mode vs Time period for models in zone IV

4.2 Storey Drift

Storey drift is defined as difference between lateral displacements of one floor relative to the other floor. Total storey drift is the absolute displacement of any point relative to the base. As per IS.1893-2002 CL.7.11.1 the storey drift in any storey due to the minimum specified design lateral force with partial load factor 1.00 shall not be exceeding 0.004 times the storey height. In this case storey height is 3500 mm. Therefore limited storey drift ratio is calculated as = storey drift /3500 =0.004

4.3 Storey Drift of structure without infill walls in Zone III

The Storey drift values are presented in the table 4.5 when the stiffness of infill is not considered and the structure is situated in Zone III.

Table 4.5: Storey vs Storey Drift in zone III when stiffness of infill is not considered

Storey Number	Storey Drift X 10^{-3}				
	Model 1	Model 2	Model 3	Model 4	Model 5
8	1.2	0.67	0.61	0.8	0.9
7	1.32	0.77	0.64	1.2	1.3
6	1.65	0.85	0.76	1.4	1.5
5	1.79	0.907	0.77	1.5	1.7
4	1.84	0.932	0.79	1.53	1.8
3	2.12	0.923	0.69	1.66	2
2	2.30	0.888	0.63	1.82	2.07
1	2.44	0.889	0.54	1.93	2.08
Ground	2.50	0.8	0.51	2.2	2.3
Plinth	1.80	0.5	0.32	1.1	1.5

Storey drift of M1 is largest as compared to other four models. Storey drift of model 3 is least and is 79.6 % less as compared to model 1.

4.4 Storey Drift of structure with Infill walls in Zone III

The Storey drift values are presented in the table 9.6 when the stiffness of infill is considered and the structure is situated in Zone III.

Table 4.6: Storey vs storey drift in zone III when stiffness of infill is considered

Storey number	Storey Drift x 10^{-3}				
	Model 1	Model 2	Model 3	Model 4	Model 5
8	0.79	0.53	0.31	0.69	0.76
7	1.1	0.58	0.33	0.91	1.00
6	1.4	0.60	0.34	1.08	1.20
5	1.56	0.61	0.347	1.20	1.40
4	1.6	0.60	0.338	1.29	1.50
3	1.67	0.57	0.318	1.33	1.59
2	1.7	0.56	0.286	1.32	1.59
1	1.79	0.55	0.242	1.25	1.51
Ground	1.8	0.54	0.236	1.20	1.25
Plinth	0.9	0.34	0.153	0.63	0.77

Storey drift of M1 is largest as compared to other four models. Storey drift of model 3 is least and is 80% less as compared to model 1 in zone III when stiffness of infill is considered. Storey drift of model 3 with infills is 52.18 % less than without infills in zone III.

4.5 Storey Drift of structure without infill walls in Zone IV

The Storey drift values are presented in the table 4.7 below when the stiffness of infill is not considered and the structure is situated in Zone IV.

Table 4.7: Storey vs storey drift in zone IV when stiffness of infill is not considered

Storey Number	Storey Drift x 10^{-3}				
	Model 1	Model 2	Model 3	Model 4	Model 5
8	1.2	1.2	0.9	1.4	1.2
7	1.9	1.4	0.99	1.9	1.6
6	2.5	1.5	1.0	2.3	2.1
5	3	1.8	1.07	2.6	2.4
4	3.1	1.6	1.07	2.8	2.43
3	3.2	1.5	1.02	2.9	2.5
2	3.3	1.4	0.9	2.97	2.89
1	3.8	1.2	0.8	3.0	2.9
Ground	3.92	1.1	0.7	3.7	2.6
Plinth	3.0	0.7	0.4	2.1	1.5

Storey drift of M1 is largest as compared to other four models. Storey drift of model 3 is least and is 72.3% less as compared to model 1 when stiffness of infill is not considered.

4.6 Storey Drift of structure with infill walls in Zone IV

The Storey drift values are presented in the table 9.8 when the stiffness of infill is considered and the structure is situated in Zone IV.

Storey drift of M1 is largest as compared to other four models. Storey drift of model 3 is least and is 79.05% less as compared to model 1 when stiffness of infill is considered. All story drift are found to be within permissible limit.

Storey drift of model 3 with infill is observed 27.5 % less than the model without infill in zone IV.

Table 4.8: storey vs storey drift in zone IV when stiffness of infill is considered

Storey number	Storey Drift x 10^{-3}				
	Model1	Model2	Model3	Model4	Model5
8	1.3	0.77	0.68	1.2	1.64
7	2.1	0.82	0.73	1.3	2.1
6	2.8	0.86	0.76	1.6	2.6
5	3.3	0.87	0.77	1.9	2.9
4	3.6	0.85	0.75	2.1	3.1
3	3.7	0.81	0.71	2.2	3.2
2	3.6	0.73	0.64	2.24	3.1
1	3.5	0.61	0.54	2.13	2.9
Ground	3.3	0.52	0.48	1.7	2.6
Plinth	1.9	0.31	0.29	0.9	1.3

4.7 Manual Analysis of Flat Slab

Bending moments of flat slab

Total design B.M = Mo = 1957.3kNm

Total negative moment = 1272.2 kNm

Total positive moment = 685 kNm

The above moments are transferred to column strip and middle strip

	Column strip	Middle strip
Negative moment	954.15kNm	318.05 kNm
Positive moment	411 kNm	274 kNm

4.8 Analysis of Flat Slab in ETABS

Bending moments are taken from the software

	Column strip	Middle strip
Negative moment	1072.15 kNm	396 kNm
Positive moment	275 kNm	462.05 kNm

The bending moments obtained through ETABS are observed to be more compared to manual analysis calculations.

CONCLUSIONS

This study presents a summary of the project work, for flat slab building analysed in two seismic regions. The effect of seismic load has been studied for the five models with and without the effect of stiffness of infill masonry wall. On the basis of the results following conclusions are drawn.

The moment at plinth and ground level is found maximum. In stories above ground level, moments decrease. This phenomenon is similar in all models and in both seismic zones due to the presence of soft storey.

The stiffness due to infill walls treating it as diagonal strut influences the seismic performance of RC building. Axial forces in the columns are increased, Storey displacement and Story drift are decreased and base shear is increased with higher stiffness considering infill wall.

The base shears at plinth level are found maximum for all types of structures. In stories above plinth level, the base shear decreases as the height of the building increases. Base shear of flat slab building is less compared to the conventional R.C.C building in both zones.

Under lateral forces when strut action develops, a finite area of infill is physically connected to the beams and columns of the frame. This finite area, which can be effectively modelled using 1-strut model, is responsible for distribution of large stiffness of infill walls to a larger area on beams and columns; this prevents abrupt failure of masonry infills under increasing lateral forces.

The Maximum storey drift in bare frame is 0.0025 and infilled frame of flat slab structure is 0.00183. Thus the deflection in bare frame is observed more compared to the infill frame.

The natural period decreases as the stiffness of the building increases and this leads to increase in base shear. From analysis, it is found that for the models when stiffness of infill walls is considered, the natural period decreases by 4.44 % compared to those when stiffness of infill wall is neglected.

SCOPE OF FUTURE STUDIES

The structural behaviour of the models can be studied when soil structure interaction is considered particularly in loose soils. The response of the structure can also be compared using pushover analysis.

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