# Comparative Study on Seismic Performance of Multistorey Building With Conventional Slab And Flat Slab

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***Abstract-*** *In the modern era, the growth of population has influenced the construction of high rise buildings day by day. The construction of the building structures with conventional RC slabs are in the public eye since many decades. Although it has more stiffness and minimizes the large moments occurred due to the applied loads, it does not have the advantages in terms of architectural flexibility, easier formwork and shorter construction period compared to the flat slabs. In this study the present work is to compare the behaviour of multistory RC building having flat slab and two way slabs with beams and to study the effect of height of the building on the performance of those two types of building under seismic forces for (zone III). The present work provides a good source of information on the parameters lateral displacement, frequencies, time period and base shears for soils (medium) compared to fixed base condition using model analysis by ETABS.*

## I. INTRODUCTION

With growing population and urbanisation, there is a rise in housing demand these days. As a result, the construction industry has grown in importance. However, the fact that appropriate sites for building/construction are scarce and expensive, particularly in densely populated regions, demonstrates the need for optimal appraisal of these resources. Furthermore, when prices continue to rise, so do construction expenses; hence, dimensions and cost optimization become important, if not essential. When a building is planned, the geometrical proportions of parts that make up the structure's carrying system are generally established using technical knowledge and expertise accumulated through time. When it comes to sizing, the tensile pressures that the material will be subjected to must meet the standards. The pre-sizing specifications supplied in the building design are typically not modified substantially; sizes derived from the second or – at most third solution are used as carrier system sizes. In reality, carrier systems may be scaled in an unlimited number of ways to guarantee that all of the essential requirements are met, and the cost of any carrier system choice can change. The primary goal of engineering is to find a design that is both low-cost and meets the expected constraints.

Earthquake is a natural occurrence that happens as a result of geotechnical processes in the Earth's strata. It is extremely unpredictable and may result in significant loss of life and property if it occurs in inhabited areas. Humans are not killed by earthquakes, but structures are. As a result, it is the primary job of a structural (design) engineer to extract parameters from prior experiences and analyse all potential risks that the structure may face in the future for the goal of safe structure design. The Non-Linear Time History Analysis is the most accurate of the current approaches for analysing structures and evaluating their performance under a given load. Other traditional approaches known as Non-Linear Static methods have been developed for structures of lesser relevance or seismic danger (NSPs). The outcomes of these treatments could or might not be correct. In general, slabs are divided into two types: one-way and two-way. One-way slabs are slabs that predominantly deflect in a single direction. Two-way slabs are those that are supported by columns that are placed in rows and allow the slabs to deflect in two directions. Two-way slabs can be reinforced by putting beams between the columns, thickening the slabs around the columns (drop panels), and flaring the columns under the slabs (column capitals).

Without the need of beams, capitals, or drop panels, flat plates are solid concrete slabs of uniform depth that carry weights straight to the supporting columns. Because of their basic formwork and reinforcing bar configurations, flat plates may be built rapidly. To meet specified head room requirements, they require the shortest overall storey heights. In terms of column partitioning arrangement, they also provide the most flexibility. They also offer the most versatility in terms of column partitioning layout. For multi-story reinforced concrete hotels, apartment buildings, hospitals, and dorms, flat plates are perhaps the most widely utilized slab system today.
Flat plates may provide a difficulty when it comes to transmitting shear along the periphery of the columns. In other

words, there's a chance the columns will through the slabs. As a result, increasing column diameters or slab thicknesses, or using shear heads, is commonly required. Shear heads are made up of I or channel forms cut into the slab and put above the columns. Although such processes may appear to be costly, it should be emphasized that the minimal formwork required for flat plates generally results in such cost-effective construction that the additional expenses of shear heads are more than offset. However, for large industrial weights or lengthy spans, a different floor arrangement may be necessary. Without the use of beams and girders, concrete slabs are frequently utilized to transfer vertical loads straight to walls and columns. Where spans are short and weights are light, such as in apartment and hotel buildings, a flat plate system is utilized.A slab system with no column flares or drop panels is referred to as flat plate. Flat plates can be utilised with unevenly spaced column layouts, despite the fact that most column patterns are on a rectangular grid. They've been constructed successfully with columns, triangular grids, and other variants.

Except at the perimeter, the floor slab is supported directly on the columns without the need of stiffening beams. For spans of 4.5-6m, it has a consistent thickness of around 125-250mm. The column supports' low shear strength and hogging moment capability limit its load bearing capabilities. It's termed a flat plate because it's very thin and has a flat underside, and it has a lot of architectural appeal.

**OBJECTIVE OF THE STUDY:-**

The following are the study's major goals:

- Using linear static analysis, assess the seismic behaviour of RC framed conventional slab and flat slab structures with and without soil structure interaction (SSI).
- In Zone III, investigate the impact of soil structure interaction on conventional slab and flat slab construction.
- Equivalent static analysis was used to assess storey displacement, storey drift, base shear, and time period.

## II. REVIEW OF LITERATURE

Many Research works has been carried out to know the Seismic response of a flat slab building since from many decades. Flat slab are preferred by both architects and clients due to their aesthetic and economic advantages. Literature survey for the seismic behavior of flat slab buildings has also been concealed.

Lan N Robertson (1997)Done analysis of flat slab structures subjected to combined lateral and gravity loads. Using a three dimensional model, analysis of a flat slab building can have done when it subjected to vertical and lateral loads which includes both slab-column frame elements and the lateral framing system (shear wall) if present. This study reviews two structural analysis models and compares them to experimental test results. A two-beam analytical model more accurately predicts the test results with respect to slab moment distribution and lateral drift. Three dimensional analysis done by ETABS computer program. These models assume a uniform slab effective width coefficient and constant cracking factor for an entire span. The analytical models were unable to reproduce the slab flexural moment distribution observed in test specimen at either 0.5 or 1.5 % drift levels. By replacing the single beam element with two-beam elements connected at the point of contra flexure, the difference between cracking in the positive and negative moment regions was incorporated in to the mode.

K G Patwari (2016)Has done a comparative study of flat slab building with and without shear wall to earthquake performance. The work deals, with or without shear wall of flat slab building on the seismic behaviour of high rise building with different position of shear wall. For the analysis fifteen storey model is selected. Time history analysis in software ETABs is carried out to study the effect of different location of shear wall on high rise structure. Time period, base shear, storey displacement and storey drift like seismic parameters are checked out. Storey displacement seemed more for structures without shear wall. Storey drift values found to be not more than 0.004 times to storey height according to IS 1893:2002 (Part 1). Because of considerable difference in storey displacement, time period, base shear and storey drift building with shear wall is preferred.

M K Devtale (2016)Compared the seismic response between flat slab building and regular frame building. Seismic behavior of flat slab building has been carried out in the present study. Regular framed structure building and linear analysis of flat slab building has been carried out for this purpose. Linear analysis of flat slab building with shear wall and regular framed structure building with shear wall also had been carried out. Analysis is carried out using SAP 2000 by the method of equivalent lateral force analysis. After the analysis it is concluded thatregular frame building performed better than flat slab building with use of shear wall, the performance of flat slab building improves much more.

R.P. Apostolska, G.S. Neenska-Cvetanovska,(2008)in their paper summarise that flat slab system with certain modifications (design of beams in the perimeter of the building and/or RC walls) can achive rational factor of behaviour considering EC8 and can be condider as a system with acceptable seismic risk. Modifications with additional construction elements improve small bearing capacity of the system and increase strength and stiffness, improving seismic behaviour of flat slabs construction system.

K. S. Sable et al (2012), compared the seismic behavior of multistoried flat slab building and conventional reinforced concrete framed structure. The modelling and analysis of the structure have been performed using STAAD Pro 2007. Certain analysis were also made for the analysis such as the height of the structure was kept 17.5m, 25m, 32.5m, 39.5m and from ground these buildings are of 5 storey, 7 storey, 9 story and 11 story. Zone II was considered for the analysis. The author concluded that natural time period will increase as the height of structure increases for both but it will be same if they are provided with shear wall. As the height of the structure increases, the base shear also increases. The Conventional RCC building has less base shear as compared to the flat slab structure. The flat slab structure has more story drift then that of conventional RCC building.

Pradip S. Lande and Aniket B. Raut (2015), carried out a parametric investigation to identify the seismic response of system considering Zone V. They have considered the following elements for their works- (a) building with flat slab, (b) flat slab with parametric beam, (c) flat slab with shear walls, (d) flat slab with drop and (e) conventional building. Analyses were carried out using ETabs nonlinear version 9.7.3 for determining the seismic performance of the structure. They considered G+6 and G+12 storied building. Column size 450mm x 450mm and beam size 230mm x 400mm were considered for G+6 and column size of 650mm x 650mm and beam size 230mm x 500 mm were considered. On the basis of the work carried out, the author concluded that the storey displacement is found to be maximum for flat slab building as compared to conventional RCC building. The maximum storey drift found for G+6 building was 0.04 % of height.

R. P Apostolka et al (2008), carried out the analysis for six type of structural system for a prototype of a residential building in Skopje. To determine the seismic behavior and resistance of a flat slab structural system, they considered B+GF+4 residential building. The analyses have been carried out using finite element method and SAP 2000 version 10.0.9 software. From the analysis, they concluded that the purely flat slab RCC structural system are more flexible for the horizontal loads then other traditional RCC frame structure. Structural element modification will improve the low bearing capacity and deformability and will also increase the seismic resistance of a purely flat slab structure.

Salman I khan and R. Mundhada (2015), carried out the dynamic analysis of three different multistoried building i.e., 12, 15, 18 story. They considered all the four Seismic Zones using response spectrum method and the analyses were performed using ETabs version 9.7.3. From the analysis they concluded that the choice of the system for slab in case of multistoried RCC building is very important for resisting the internal forces. From the analysis it was found that the base shear of building with flat slab will be greater as compared to building with grid slab at the terrace level. Also the lateral displacement will be less for grid slab than those of flat slab structure. The storey drift and time period will also be more for flat slab than the grid slab.

SukanyaSawant and K.R Dhabhekar (2016), have reviewed the behavior of flat slab under dynamic loading. To carry out the analysis they considered five different model i.e. (a) commercial slab, (b) flat slab, (c) flat slab with drop, (d) flat slab with column head and (e) flat slab with column head and drop. They have worked out using ETabs considering linear static analysis and response spectrum method. Lot of research were done on flat slab building using dynamic analysis and finally they came to a conclusion that the punching shear will be more at the column support. To avoid these drop should be provided. They came to a conclusion to provide flat slab with drop and head in the Seismic Zones and the ductile detailing have to be carried out for the structure.

Mohana H. S and Kavan M. R (2015), have performed a comparative study of flat slab and conventional slab building using ETabs for all the Seismic Zones. They considered G+5 multistoried commercial building having a flat slab and conventional slab. They have carried out the analyses for base shear, storey drift, axial force and displacement. On the basis of result obtained, it is observed that the storey shear will be maximum at the ground level and will be minimum at the top storey. The axial force intensity at Zone II, III in case of conventional slab will be more as compared to flat slab. Displacement depends on the height and slenderness of building. They also found out that the displacement of structure with flat slab is slightly more as compared to the conventional slab for all Earthquake Zone. The displacement variation was 4mm for each Seismic Zone for both flat slab and conventional slab.

B. L. Gupta and Amit Gupta, has published a book on principles of Earthquake Resistance Design of Structures and Tsunami. This book deals with the basic Principles of earthquake resistant construction of structures. They have written with a view to spread awareness of mass destruction of structures due to earthquakes and safe guards against this destructions.

Basavaraj and Rashmi B. A (2015), considered G+4 and G+8 storied building for their work. In their model they have also added parameters like perimeter beam, infill walls, shear walls and they have also increased the cross sectional area of the columns. The outer beam and column size provided was 0.4m x 0.4m for G+4 storied building and for G+8 storied building, the column provided up to 5th story was 0.5m x 0.5m and from 5th to 9th story 0.4m x 0.4m column was provided and the outer beam provided was 0.4m x 0.4m. They considered Seismic Zone II for their analysis and soil type II (medium). From the analysis they concluded that the fundamental natural period of the building decrease with increase in storey stiffness due to the presence of infill walls, shear walls and perimeter beam. The presence of infill's can significantly reduce the lateral drift. Base shear will increases with increase in mass and stiffness of building, also the shear wall is very effective to resist horizontal forces during earthquake and wind forces etc.

B KaulkhereR.V , Prof G. N. Shete (2017) In the present work flat slab building of G+8 storey building models are considered. The design of flat slab building with direct design method and also they have discussed the results obtained by performing Non-linear pushover analysis on flat slab building of various shapes and different types also by using software ETAB2015. To improve performance of building,it is necessary to analysis the seismic behaviour of building, provision of flat slab with drop and without drop on the performance of these two types of buildings. As per IS 456:2000 codes provisions present work gives the information on the parameters max strip moments, base shear, max storey displacement and storey drift.

Dr. M RameGowda, Techi Tata, have presentedtwo models. First model is a commercial building consisting of flat slab with drop and second model is a commercial building consisting of slab without drop. Firstly, the behavior of both buildings were studied and analyzed separately for all seismic zones and then finally, a comparison between both structures was made. Analyses were carried out using Response Spectrum method with the help of ETAB version 15.2.0. In order to study the behaviour, only maximum values were considered for the parameters like Storey Displacement, Storey Shear, Storey Drift, Storey Acceleration and Overturning Moment. From the results generated, it is quite clear that the building consisting of flat slab with drop shows better seismic performance.

B Anjaneyulu (2016) have done analysis & design by using Equivalent Frame Method with staggered column & without staggered column as prescribed in the different codes like IS 456-2000, ACI 318-08 are compared. In this process moments are distributed as column strip moments & middle strip moments.For carrying out this project an interior panel of a flat slab with dimensions 6.6 x 5.6 m and super imposed load 7.75 KN /m2 was designed using the codes.

MdZiyauddin, Shivaraju.G.D, has carried out 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.

Rathod Chiranjeevi, Sabbineni Ramyakalacompared the behavior of multi-storey building having flat slabs with drop and conventional RC frame and study the effect of height of the building on the performance of these two types of buildings under seismic forces. The obtained results are compared in terms of Time period, Base shear, Displacement, Storey drift. On comparison the base shear for flat slab is found to be greater than conventional slab structure, the variation is 67%, 59% and 49% for six, eight and ten storey building. On comparison the displacement for flat slab is found to be less than conventional slab structure, the variation is 64 %, 56% and 41% for six, eight and ten storey building.

Kamala KumariG , Dr. S. R. K. Reddy (2015) In the present work, the location of new capital Amaravati of the state Andhra Pradesh is chosen as the study area which consists of different types of soil / rock profiles at different locations. Many high rise structures are expected in future in the new city. The influence of soil – structure interaction on seismic response of such high rise buildings is a major concern to incorporate the necessary changes in designing such structures. A twelve storied building (multi-storied building), with lower two stories for parking (soft stories) and the remaining ten stories for commercial and residential purpose, and is chosen for the analysis. This region falls under seismic zone III. Earthquake analysis is carried out when similar structure rests on different types of soils and the results of fundamental time periods, base shears and displacements are compared with the results obtained from fixed base condition. The investigation indicates the necessity of considering soil-structure interaction, particularly when the structure rests on loose soils.

Shehata E. Abdel Raheem , Mohamed M. Ahmed 2 and Tarek M.A. Alazrak (2014) In the present study the effects of SSI are analyzed for typical multi-story building resting on raft foundation. Three methods of analysis are used for seismic demands evaluation of the target moment resistant frame buildings: equivalent static load (ESL); response spectrum (RS) methods and nonlinear time history (TH) analysis with suit of nine time history records. Three-dimensional FEM model is constructed to analyze the effects of different soil conditions and number of stories on the vibration characteristics and seismic response demands of building structures. Numerical results obtained using soil structure interaction model conditions are compared to those corresponding to fixed-base support conditions. The peak responses of story shear, story moment, story displacement, story drift, moments at beam ends, as well as force of inner columns are analyzed. The analysis results of different approaches are used to evaluate the advantages, limitations, and ease of application of each approach for seismic analysis.

## III. METHODOLOGY

### 3.1 GENERAL

For the study of framed buildings subjected to seismic loads, many techniques are available. The following sorts of analytical methodologies can be generally categorized.

- Static Linear Method (Equivalent Static Method )
- Dynamic Linear Method (Response Spectrum and Linear Time History Method)
- Static Non-Linear Method (Pushover Analysis)
- Dynamic Non-Linear Method (Non-linear Time History Analysis)

Equivalent Static is used in the linear static technique to investigate the seismic performance of conventional slab and flat slab buildings with and without soil structural interaction.

#### a) Equivalent Static Method

Because the forces are based on the code-based basic period of structures with certain empirical modifiers, the corresponding static approach is the simplest way of analysis. The design base shear must be estimated as a whole, then distributed throughout the height of the building using simple equations suited for buildings with regular mass and stiffness distribution. Depending on the floor diaphragm action, the design lateral force obtained at each level is subsequently allocated to specific lateral load resisting components.

#### b) Linear Dynamic Analysis

When higher mode effects are not large, static methods are appropriate. This is usually the case with short, regular structures. As a result, a dynamic method is necessary for tall buildings, buildings with torsion anomalies, or non-orthogonal systems. The building is represented as a multi-degree-of-freedom (MDOF) system with a linear elastic stiffness matrix and an equivalent viscous damping matrix in the linear dynamic method.

#### c) Non-Linear Static Analysis

Linear methods are employed when the structure is expected to remain nearly elastic for the amount of ground motion or when the design results in a nearly equal distribution of nonlinear response across the structure. The uncertainty with linear methods rises as the structure's performance aim implies more inelastic demands, requiring a high level of conservatism in demand assumptions and acceptance criteria to avoid undesired performance. As a result, techniques that include inelastic analysis can help to minimize uncertainty and conservatism.

### 3.2 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

Constructions built to withstand earthquakes are known as earthquake-resistant structures. While no structure can be completely safe from earthquake damage, earthquake-resistant construction aims to build structures that perform better than their conventional equivalents during seismic activity.

Building standards state that earthquake-resistant constructions must be able to withstand the biggest earthquake with a reasonable chance of occurring at their site. This means that the loss of life should be minimized for uncommon earthquakes by preventing building collapse, but the loss of functioning should be restricted for more common ones.

To avoid being destroyed by earthquakes, ancient builders had little choice except to design their iconic structures to survive, often by making them extremely rigid and robust.There are now numerous design philosophies in earthquake engineering that employ experimental data, computer models, and historical earthquake observations to provide the needed performance for the seismic danger at the location of interest. These include anything from properly designing the building to ensure it is robust and ductile enough to withstand the shaking with little damage, to installing foundation isolation or employing structural vibration control technologies to reduce forces and deformations. While most earthquake-resistant structures utilise the former method, essential infrastructures, landmarks, and cultural heritage buildings require the more complex (and expensive) isolation or control techniques to survive intense shaking with minimum damage.

**3.3 CODE BOOKS:**

Code books play a major role in the analysis and design of any structure. A structure must fulfill a variety of roles. The building's usefulness for the intended purpose and occupancy, structural safety, fire safety, and sanitary, sanitation, ventilation, and daylight requirements are all among these roles. The building's design is based on the minimum criteria for each of the functions listed above. Different codes cover the minimal criteria for the structural safety of structures. Code books are used to limit the risks to life and property posed by dangerous constructions, as well as the waste created by assuming unduly large loads without adequate evaluation.

The code books referred for this project are:

- IS 875, part 1, 1987(dead loads for building and structures)
- IS 875, part 2, 1987(imposed loads for buildings and structures)
- IS 875, part 3, 1987(wind loads for buildings and structures
- IS 875, part 4, 1987(design loads for buildings and structures)
- IS 875, part 5(special loads and combinations for buildings and structures)
- SP 16 (design aids for IS 456)
- SP24 (explanatory handbook for IS 456)
- SP34 (handbook on reinforcement and detailing)
- IS 456:2000 (reinforced concrete for general building construction)
- IS 1893,part 1(A seismic Design Of Multi-storied Reinforced Concrete buildings)
- Proposed Draft Provisions and Commentary on Indian seismic Code IS 1893, part 1, 2016
- Review Of Geotechnical Provisions In Indian Seismic Code IS 1893, part 1 : 2002
- Explanatory Examples On Indian Seismic Code IS 1893, part 1

**IV. MODELLING OF G+9 STRUCTURE**

A 10-storey symmetrical frame with fixed and spring (soil condition) support is examined for the current study in order to better understand the behaviour of conventional slab and flat slab buildings in zone-III. The frame model selected for the study is illustrated below in plan, elevation, and 3D perspective. The current research looks at four different types of G+9 building models:

Model 1: G+9 Storey Conventional slab RC building in Zone III with Fixed support

Model 2: G+9 Storey Conventional slab RC building in Zone III with spring support

Model 3: G+9 Storey Flat slab RC building in Zone III with Fixed support

Model 4: G+9 Storey Flat slab RC building in Zone III with spring support

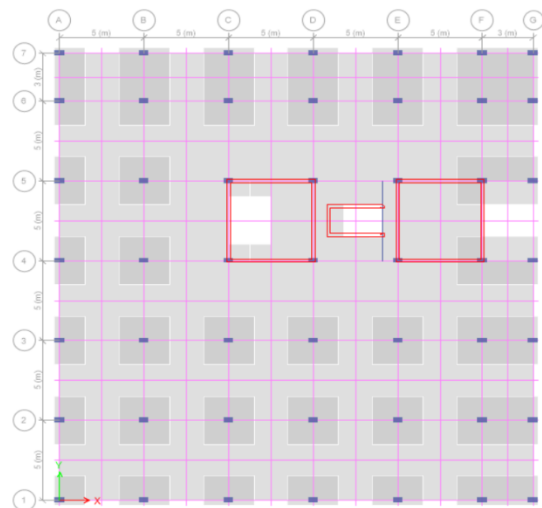



**Fig** shows Plan of G+9 Multi storied Flat Slab RC building

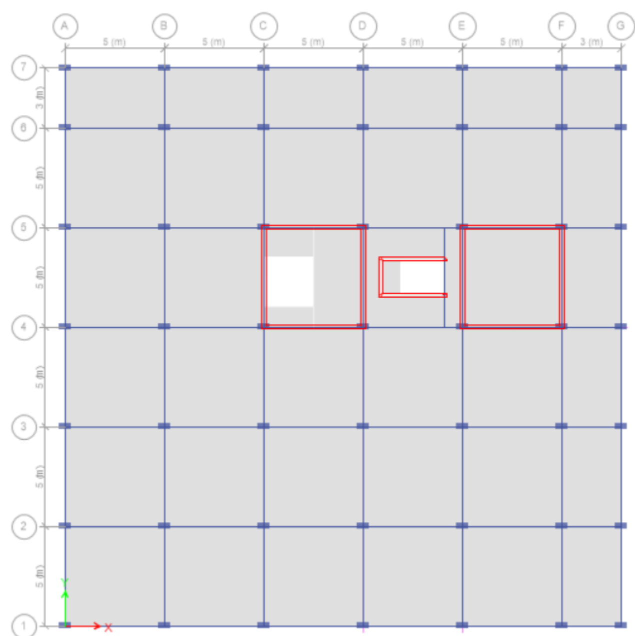



**Fig** shows Plan of G+9 Multi storied Conventional Slab RC building

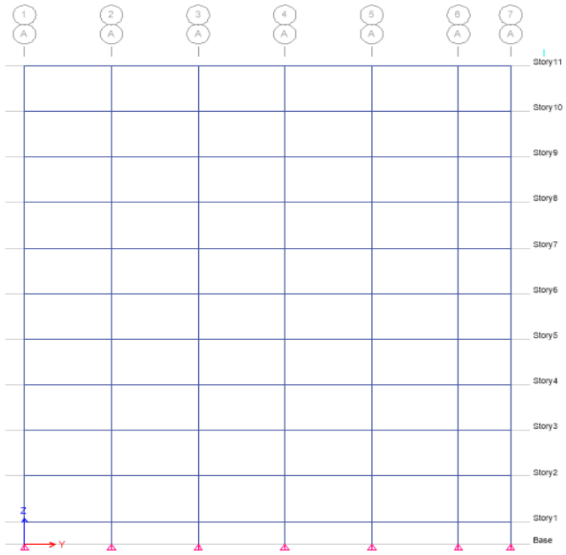



**Fig** shows Elevation of G+9 Multi storied RC building

**Table shows Preliminary data for G+9 Multi storied Building**

| | |
|---|---|
| **Structure Details** | |
| **Type of structure** | **Ordinary Moment Resisting Frame** |
| No. of Storeys | 10 |
| Total Height of Building | 31.5 m |
| Dimension in X Direction | 28m |
| Dimension in Y Direction | 28m |
| Storey Height | 3m |
| Live Load (Typical) | 3kN/sq.m |
| Floor Finish | 1.5kN/sq.m |
| Type of Soil | II Medium soil |
| Zone Factor (Z) | III-0.24 |
| Importance Factor (I) | 1 |
| Response Reduction Factor (R) | 3 |
| Slab Thickness | 150mm |
| Shear wall Thickness | 200 mm |
| Wall Thickness external | 230mm |
| Wall Thickness internal | 150mm |
| Concrete Grade | M 30 |
| Steel Grade | Fe 500 |
| Modulus of Elasticity for concrete | 27386 MPa |
| Modulus of Elasticity for Steel | 2 x $10^5$ MPa |
| Density of Brick | 20kN/m3 |
| Wall Load External (2.5 m Height ) | 11.5kN/m |
| Wall Load internal(2.5 m Height ) | 7.5kN/m |
| Parapet Wall (1.5 m Height) | 4.0kN/m |
| Response spectra | As per IS 1893(Part-1):2016 |

## V. RESULTS AND DISCUSSION

The reactions of buildings for zone - III are observed and reported here in terms of displacements, drifts, base shear, and time period, based on data derived from Equivalent static Analysis of 10 Storied Conventional & Flat RC structures with Fixed & Spring support.

### 5.2 Comparison of Lateral Displacements

Under Equivalent Static Analysis, the lateral displacements in X for conventional and flat slab buildings with fixed and spring (soil type) support were compared. The graphical representation of the displacement variations is provided.

**Table 5.1 Comparison of Lateral Displacements in X-direction for Conventional & Flat Slab building with fixed and spring support**

| **Lateral Displacement (mm)** | | | | |
|---|---|---|---|---|
| **Storey** | **Conventional Slab RC Building with fixed support** | **Conventional Slab RC Building with SSI** | **Flat Slab RC Building with Fixed support** | **Flat Slab RC Building with Spring Support** |
| Base | 0 | 0.041 | 0 | 0.108 |
| Ground Floor | 0.385 | 0.267 | 0.293 | 0.72 |
| Story1 | 1.953 | 0.866 | 1.501 | 2.34 |
| Story2 | 3.991 | 1.543 | 3.083 | 4.091 |
| Story3 | 6.338 | 2.265 | 4.923 | 5.915 |
| Story4 | 8.859 | 3.008 | 6.925 | 7.768 |
| Story5 | 11.444 | 3.75 | 9.005 | 9.615 |
| Story6 | 13.993 | 4.474 | 11.088 | 11.424 |
| Story7 | 16.423 | 5.165 | 13.107 | 13.165 |
| Story8 | 18.659 | 5.81 | 15.006 | 14.811 |
| Story9 | 20.652 | 6.4 | 16.742 | 16.343 |
| Story10 | 22.349 | 6.923 | 18.269 | 17.728 |

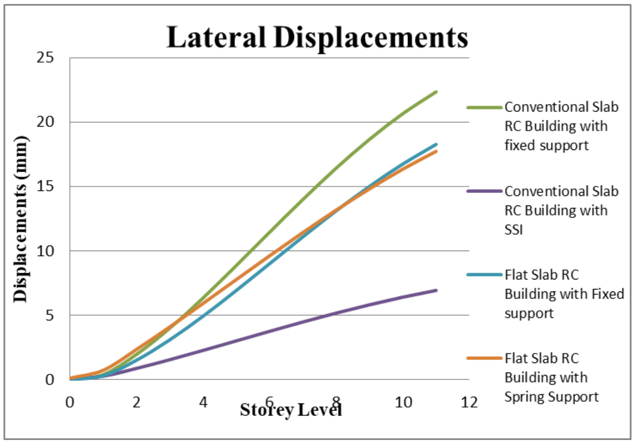
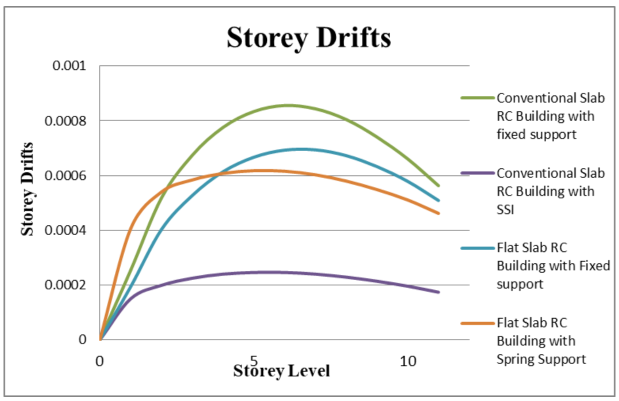
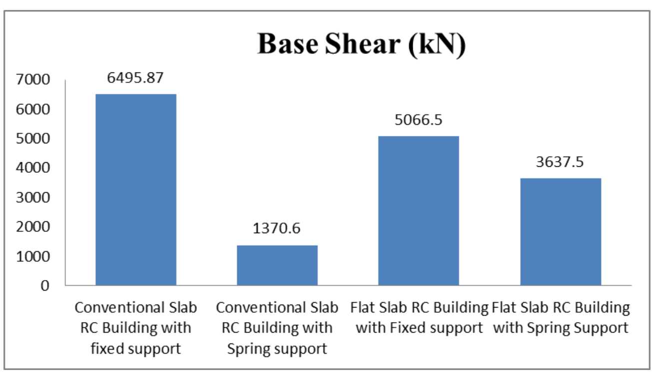



**Fig:** Storey Displacements in X-direction for Conventional & Flat Slab building with fixed and spring support




**Fig**shows the Storey Drifts in X-direction for Conventional & Flat Slab building with fixed and spring support




**Fig**showsComparision Base shear

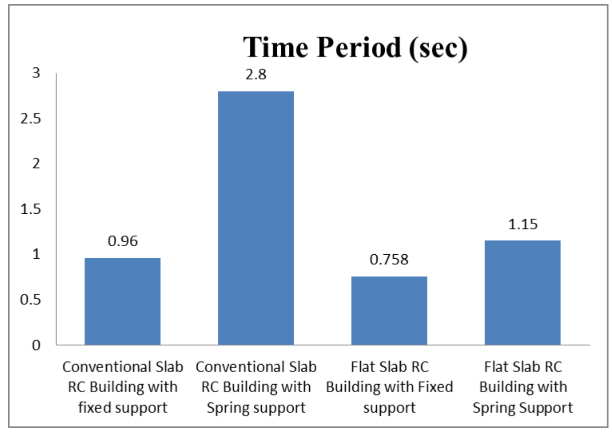



**Fig** shows the Comparision Time Period

- We can observe that the Time period for the Conventional slab building with spring support is having maximum value & Flat slab building with fixed support is having minimum value.
- Time period for Conventional slab building with fixed support has decreased by 65.71% when compared with spring support and flat slab building with fixed support has decreased by 34.09% when compared with spring support.

## VI. CONCLUSIONS

Because of the freedom to design space, quicker construction time, architectural – functional and economical features, flat-slab building structures have significant benefits over typical slab-beam-column constructions. Because of the absence of deep beams 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 events.

- The maximum displacements for both type structures are within the permissible limit.
- Displacements for Flat slab Building with spring support has been decreased by 2.96% when compared with fixed support.
- Conventional slab building with spring support has been decreased by 15.42% when compared with conventional slab building with fixed support.
- The storey drifts are maximum for conventional slab building with fixed support and lower for conventional slab building with spring support.
- Observed that behaviour of Building with soil structure interaction are found better when compared with fixed support in terms of storey drifts.
- Observed buildings with fixed support are having higher base shear when compared with spring supports/soil

structure interaction i.e., base shear increases for building without soil structure interaction.

- Base shear for Conventional slab building with Spring support/Soil structure interaction (SSI) has been decreased by 78.9% when compared with Conventional slab building with fixed support and flat slab building with spring support/SSI has been decreased by 28.2% when compared with flat slab building with fixed support.
- We can observe that the Time period for the Conventional slab building with spring support is having maximum value & Flat slab building with fixed support is having minimum value.
- Time period for Conventional slab building with fixed support has decreased by 65.71% when compared with spring support and flat slab building with fixed support has decreased by 34.09% when compared with spring support.
- When all of the given objects were compared, it was discovered that traditional slab and flat slab buildings with soil structure interaction outperformed fixed support in earthquakes.
- Hence the buildings considered without soil structure interaction are considered less safe during earthquakes.
- The stiff clay soil condition is considered to be safe, therefore it is necessary to consider Soil structure interaction while designing the structure.
- The lateral displacements, storey drift, and base shear for a convention slab with spring support are better than for a flat slab with spring and fixed supports.
- As a result, conventional slab with spring support are safer than conventional slabs with fixed support and flat slabs with both spring and fixed support.

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