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# "Flat Slab Shear Wall Interaction for Multistoried Building under Seismic Forces"

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**Abstract**

In present era, scarcity of space led to the development of tall buildings in urban areas. Generally conventional RC framed structures are used for design and construction of these buildings. Flat plate and flat slab are mostly used structural forms in RC construction in residential, industrial and commercial buildings in many areas of the world. This system provides many advantages in terms of use of space, reduce cost of formwork, shorter construction time, architectural flexibility as it require least storey height and easy installation. However, in multi-storey buildings it has week resistance to the lateral loads. Hence this work is concerned to increase the lateral stiffness of building having flat slab and to minimize the displacement under lateral loading. To provide stability to structures from seismic loads, shear wall are used.

The aim of the present study is to compare the behavior of multi-storeyed building of conventional R.C.C.,having flat slab with or without shear walls and to analyze the effect of building height on the performance under earthquake forces. Also effect of with or without shear wall for flat slab building on seismic behavior with varying thickness and varying position of shear wall are studied. In this work, the effects of seismic forces in zone V on these buildings are also carried out.

For this, G+9, G+18, G+27 and G+36Storeyed models, each of plan size 20X20m are selected. For stabilization of the variable parameters, shear wall are provided at different locations. To study the effect of different location of shear wall on flat slab multi-storey building, static analysis (Equivalent Static Analysis) in software STAAD Pro is carried out for zone V. The seismic parametric studies comprise of lateral displacement, storey drift, drift reduction factor and contribution factor.



## INTRODUCTION

### 1.1 Introduction

One of the major problems in the modern construction world is the problem of vacant land. This scarcity in urban areas has led to the vertical construction growth of low-rise, medium-rise, tall buildings and even sky-scraper (over 50 meters tall). These buildings generally used Framed Structures subjected to the vertical as well as lateral loads. In these structures, the lateral loads from strong winds and earthquakes are the main concerns to keep in mind while designing rather than the vertical loads caused by the structure itself. These both factors may be inversely proportional to each other as the building which is designed for sustaining vertical loads may not have the capacity to sustain or resist the above mentioned lateral loads. The lateral loads are the foremost ones as they are in contrast against one another as the vertical loads are supposed to increase linearly with height; on the other hand lateral loads are fairly variable and increase rapidly with height. For buildings taller than 15 to 20 stories, pure rigid frame system is not adequate because it does not provide the required lateral stiffness and causes excessive deflection of the building. These requirements are satisfied by two ways. Firstly, by increasing the members size above the requirements of strength but this approach has its limitation and secondly, by changing the structural form into more stable and rigid to restrict deformation. This increases the structure's stability and rigidity and also restricts the deformation requirement.

## 1.2 Flat Slab

In general practice of design and construction, the slabs are supported by beams and beams are supported by columns. This type of construction may be called as beam-slab construction. The available net ceiling height is reduced because of the beams. Therefore offices, warehouses, public halls and tall buildings are sometimes designed without beams and slabs are directly rest on columns. This type of beamless-slab construction called as flat slab, in which slab supported directly by columns without beams. For engineers, flat slabs construction give reduced floor height and for architectures, it give aesthetically and beautiful appearance.

### .1.2.1 Types of flat slab

Flat slabs have the following types:

1. Flat slab without drop panel and column without column head.
2. Flat slab with drop panel and column without column head.
3. Flat slab without drop panel and column with column head.
4. Flat slab with drop panel and column with column head.

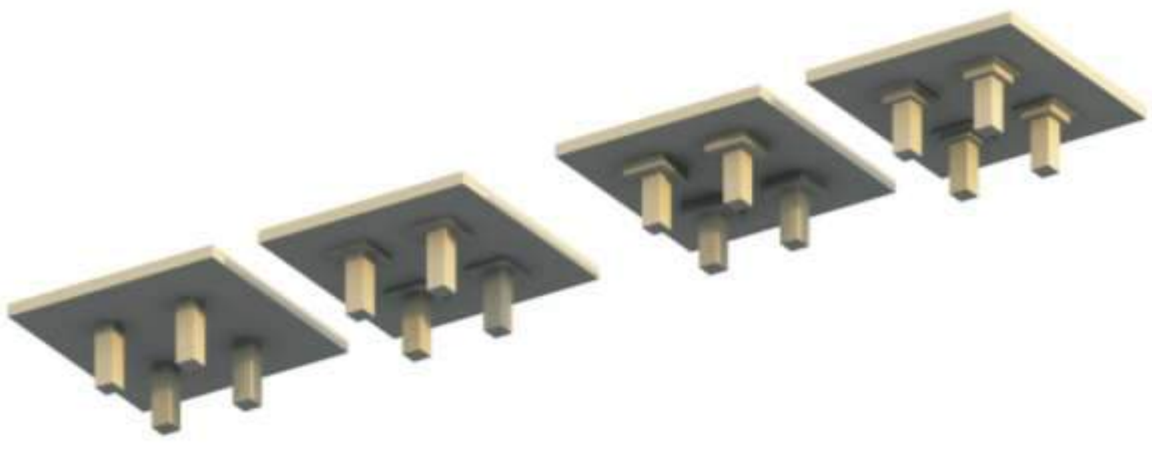


**Figure1.1- Types of Flat Slab**

**1.3 Objective of the Study**

The objectives of the present study are-

- Comparative Analysis of Natural Time Period(sec.) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.
- Comparative Analysis of Average Response Acceleration Coefficient (Sa/g) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.
- Comparative Analysis of Base Shear(Vb)(KN) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.
- Comparative Analysis of Sway (mm.) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.
- Comparative Analysis of Shear Force (KN) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.
- Comparative Analysis of Moment (KN-m) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.
- Comparative Analysis of Axial Force (KN) for 9 storeyed, 18 storeyed, 27 storeyed, 36 storeyed from frame 1 to frame 12.



## METHODOLOGY AND MODELING APPROACH

**2.1 General**

The approximation of seismic demands at functioning levels which requires an explicit consideration of the inelastic behavior of structure. Currently it is widespread to estimate seismic demands in a simpler manner by dynamic analysis. The literature survey on seismic performance of shear wall reveals that dynamic analysis is widely adopted in seismic analysis of low as well as medium rise structures. Further, no such specific study of shear wall structures of their seismic performance has been available. However by extrapolating of present methodologies for framed structure is being adopted. This methodology is divided in to description of structures, load consideration, selection of parameters for study, model development and step by step method of static analysis in STAAD PRO for current work.

**2.2 Methodology**

The objective of present work is to study behavior of shear wall flat slab interaction under the seismic loads. For this, multi-storey buildings are considered. In a multi-storey building to reduce column shear and storey drift, shear wall is provided at some specific locations and here main objective to analyze the structural behavior of the structural configuration with respect to interaction of shear wall and flat slab.An extensive survey and review of the literature on the response and behavior of shear wall flat slab interaction under seismic loading is performed.

In this attempt, following main cases will be analyzed:

Frame 1. Conventional R.C.C. structure without shear wall.

Frame 2. Conventional R.C.C. structure with Flat slab.

Frame 3. Shear wall core type with flat slab (Placings-1).

Frame 4. Shear wall core type with flat slab (Placings-2).

Frame 5. C shaped shear wall with flat slab (Placings-1).

Frame 6. C shaped shear wall with flat slab (Placings-2).

Frame 7. L shaped shear wall at corners with flat slab.

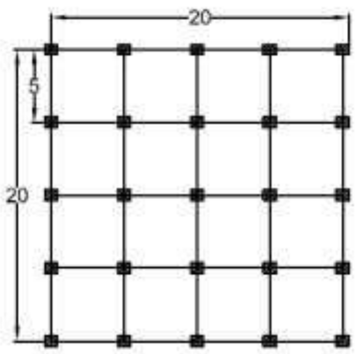
Frame 8. Parallel shear wall along periphery with flat slab.

Frame 9. Non-Parallel shear wall along periphery with flat slab.

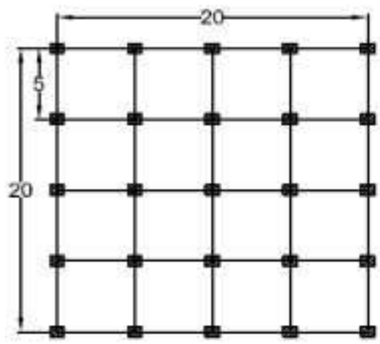
Frame 10. + Shaped shear wall at center with flat slab.

Frame 11. E Shaped shear wall with flat slab (Placings-1).

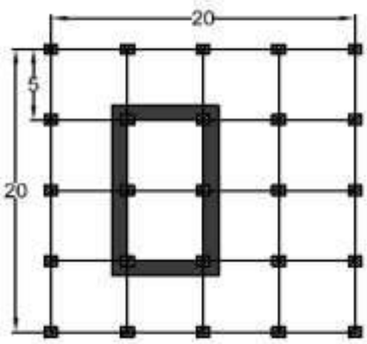
Frame 12. E Shaped shear wall with flat slab (Placings-2).



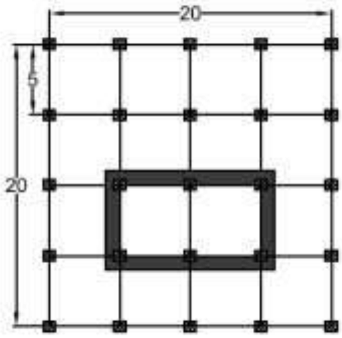

Frame 1
Simple Bare Frame



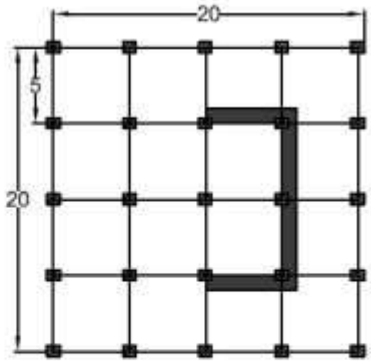

Frame 2
Bare Frame With Flat Slab



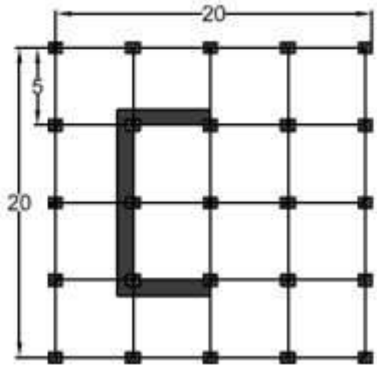

Frame 3
Shear Wall Core Type
With Flat Slab
Placing -1



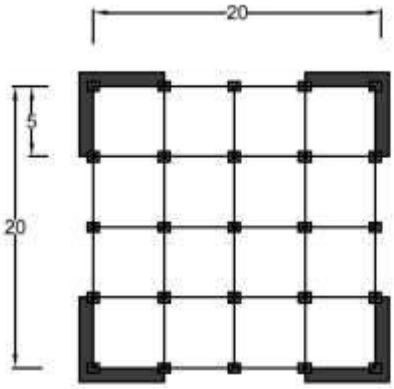

Frame 4
Shear Wall Core Type
With Flat Slab
Placing -2



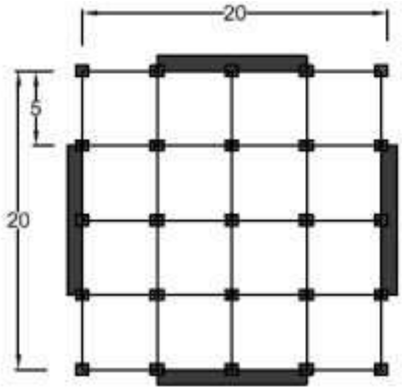

Frame 5
C Shaped Shear Wall
With Flat Slab
Placing-1



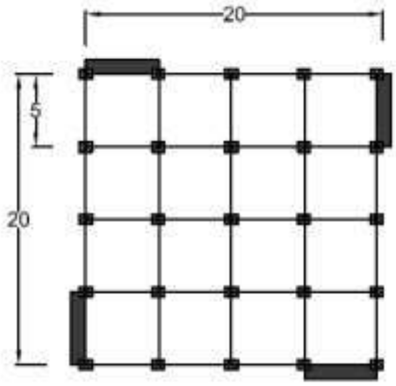

Frame 6
C Shaped Shear Wall
With Flat Slab
Placing-2



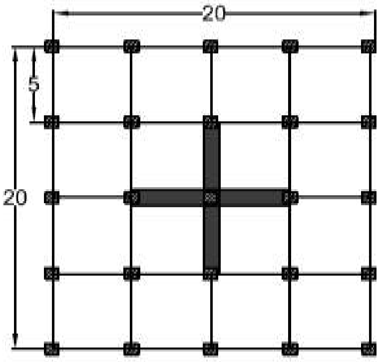

Frame 7
L Shaped Shear Wall
At Corners With Flat
Slab



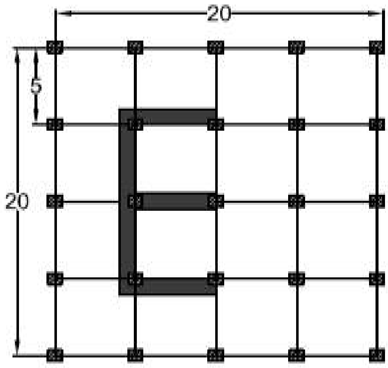

Frame 8
Parallel Shear Wall
Along Periphery With
Flat Slab



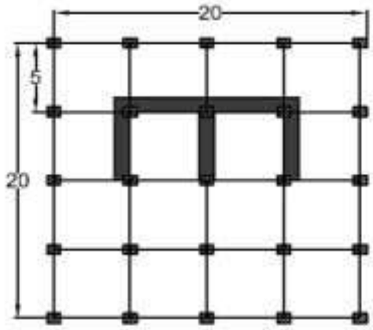

Frame 9
Non Parallel Shear
Wall Along Periphery
With Flat Slab



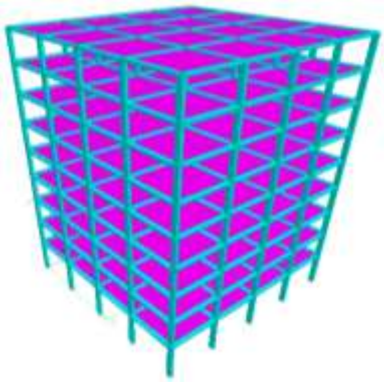

Frame 10
+ Shaped Shear Wall
At Centre With Flat
Slab

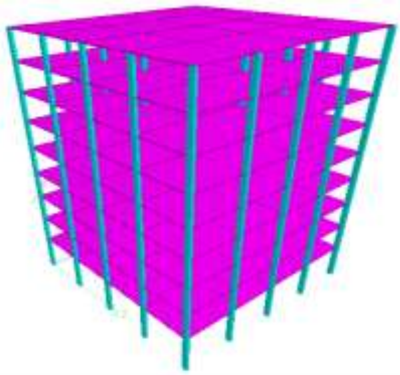



Frame 11
E Shaped Shear Wall
With Flat Slab
Placing-1




Frame 12
E Shaped Shear Wall
With Flat Slab
Placing-2





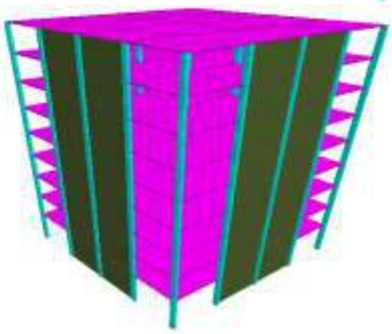


**Fig. 1** **3-D View of Conventional RCC Structure**

**Fig. 2** **3-D View of Flat slab structure**

**Fig. 1** **3-D View of Flat slab structure with shear wall**

**2.2.1 Load consideration**

1. **Dead load-** Dead Load in a building should be comprised of weight of all walls, partition, floors, roofs and should include the weight of all other permanent construction in that building. Dead Load for design purpose is assessed as per IS 875:1987 (part I). In this study, dead load is taken as self-weight by software itself.
2. **Live load-** Live Load on floor should be comprised of all loads other than dead load. Live Load for design purpose is assessed as per IS875:1987 (part II). In this study, live loads on all floor slabs: $4KN/m^2$. For determining the moments of column, allowance for reduction in live load is considered.
3. **Earthquake load-** Earthquake design is done in accordance with IS 1893 (part I):2002 and has been taken by specifying the zone in which structure is located. These RC framed building is located in zone V. The parameter to be used for analysis and design are given below:-

**Table 2.1- Earthquake Parameters**

| | | |
|---|---|---|
| Zone factor (Z) | V | 0.36 |
| Response Reduction factor (RF) | SMRF | 5 |
| Importance factor | All general building | 1 |
| Rock/Soil type | Medium soil | 2 |
| Type of structure | RC frame building | 1 |
| Damping Ratio | | 5% |
| Fundamental natural period of vibration ($T_a$) (For RCC Frame building with beams) | | $0.09*h/(d)^{0.5}$ |
| Fundamental natural period of vibration ($T_a$) (For RCC Frame building without beams) | | $0.075*(h)^{0.75}$ |

**2.2.2 Load combination**

Following load combinations with the appropriate partial safety factor satisfying IS code provision i.e. IS 456:2000, table 18, clause 18.2.3.1 and IS 1893:2002, clauses 6.3.2.1 are as follows:-

1. 1.5(DL + LL)
2. 1.2(DL + LL + EQX)
3. 1.2(DL + LL - EQX)
4. 1.2(DL + LL + EQZ)
5. 1.2(DL + LL - EQZ)
6. 1.5(DL + EQX)
7. 1.5(DL - EQX)
8. 1.5(DL + EQZ)
9. 1.5(DL - EQZ)
10. 0.9DL + 1.5EQX

11. 0.9DL - 1.5EQX
12. 0.9DL + 1.5EQZ
13. 0.9DL - 1.5EQZ

**2.2.3 Modeling Of Structures**

The main objective of the analysis is to study the different forces acting on a building with different combinations according to IS 1893 (Part 1) : 2002. The analysis is carried out in STAAD PRO V8i software. Results obtained of conventional R.C.C. structure i.e. slab, beam and column and flat slab R.C.C. structure with different combinations of shear wall for different heights according to storey are discussed in this work.

Conventional R.C.C. structure and flat slab R.C.C. are modeled and analyzed for the different combinations of static loading. These R.C.C. buildings are situated in seismic zone V.
Details of the buildings and member properties considered according to following assumptions are:-

The heights of buildings are kept as 29.80m, 58.60m, 87.40m and 116.12m from the ground. These buildings are of 9 storeyed, 18 storeyed, 27 storeyed and 36 storeyed respectively. The height of ground floor is 4.20m and above this 3.20m height follows for each storey. For different results, there is a comparison of 12 numbers of modals and analysed accordingly.

**(A) The different components of conventional R.C.C. structure are as follows:-**
Columns ofthe building are of 230mm x 450mm.
Beams size of the building is of 230mm x 400mm.
Slab thickness of the building is of 125mm.

**(B) Similarly the different components of flat slab structures are as follows :-**
Columns of the building are of 230mm x 450mm
Slab thickness of the building is of 125mm.
Shear wall thickness is of 250mm with a clear cover of 50mm.



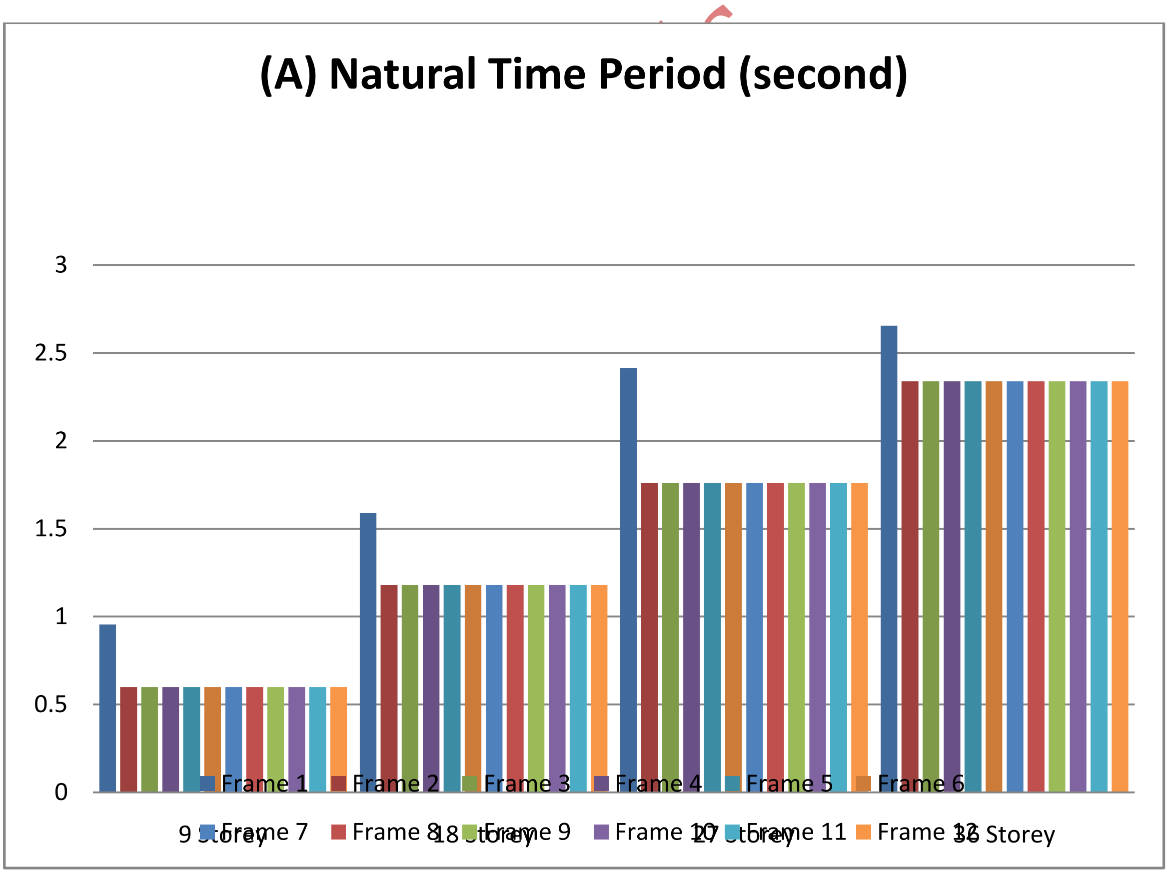
## Calculations and Results

**(A). Fundamental Natural Period :-**The approximate fundamental natural periodof vibration ( Ta), in seconds, of a moment-resistingframe building may be calculated to maximum values in comparison of different height of building with different frames is computed as :-

$T_a = 0.075\ h^{0.75}$ for RC buildings with beams.
$T_a = 0.09/\ d^{0.5}$ for RC buildings without beams.

| Sno. | Height Of Building (m) | No. of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 0.956 | 0.599 | 0.599 | 0.599 |
| 2 | 58.6 | 18 | 1.588 | 1.1793 | 1.1793 | 1.1793 |
| 3 | 87.4 | 27 | 2.4138 | 1.7589 | 1.7589 | 1.7589 |
| 4 | 116.2 | 36 | 2.6544 | 2.3385 | 2.3385 | 2.3385 |
| Sno. | Height Of | No. of Storey | Flat Slab With Different Shear Wall Placings | | | |

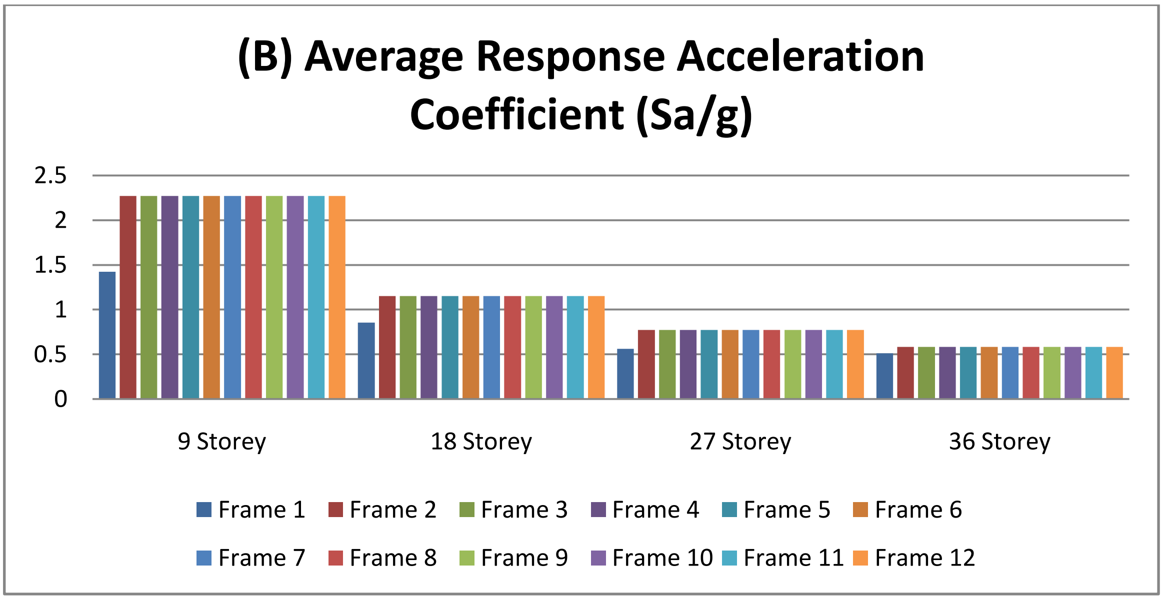
| | Building (m) | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
|---|---|---|---|---|---|---|
| 1 | 29.8 | 9 | 0.599 | 0.599 | 0.599 | 0.599 |
| 2 | 58.6 | 18 | 1.1793 | 1.1793 | 1.1793 | 1.1793 |
| 3 | 87.4 | 27 | 1.7589 | 1.7589 | 1.7589 | 1.7589 |
| 4 | 116.2 | 36 | 2.3385 | 2.3385 | 2.3385 | 2.3385 |
| Sno. | Height Of Building (m) | No. of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 0.599 | 0.599 | 0.599 | 0.599 |
| 2 | 58.6 | 18 | 1.1793 | 1.1793 | 1.1793 | 1.1793 |
| 3 | 87.4 | 27 | 1.7589 | 1.7589 | 1.7589 | 1.7589 |
| 4 | 116.2 | 36 | 2.3385 | 2.3385 | 2.3385 | 2.3385 |



**(B). Average Response Acceleration Coefficient (Sa/g) :-**Average response accelerationcoefficient is a factor denoting the acceleration response spectrum of the structure subjected to earthquake ground vibrations, and depends on natural period of vibration and damping of the structure to maximum values in comparison of different height of building with different frames is computed as :-

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 1.422 | 2.27 | 2.27 | 2.27 |
| 2 | 58.6 | 18 | 0.856 | 1.153 | 1.153 | 1.153 |
| 3 | 87.4 | 27 | 0.563 | 0.773 | 0.773 | 0.773 |
| 4 | 116.2 | 36 | 0.512 | 0.582 | 0.582 | 0.582 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 2.27 | 2.27 | 2.27 | 2.27 |
| 2 | 58.6 | 18 | 1.153 | 1.153 | 1.153 | 1.153 |
| 3 | 87.4 | 27 | 0.773 | 0.773 | 0.773 | 0.773 |
| 4 | 116.2 | 36 | 0.582 | 0.582 | 0.582 | 0.582 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 2.27 | 2.27 | 2.27 | 2.27 |
| 2 | 58.6 | 18 | 1.153 | 1.153 | 1.153 | 1.153 |
| 3 | 87.4 | 27 | 0.773 | 0.773 | 0.773 | 0.773 |
| 4 | 116.2 | 36 | 0.582 | 0.582 | 0.582 | 0.582 |



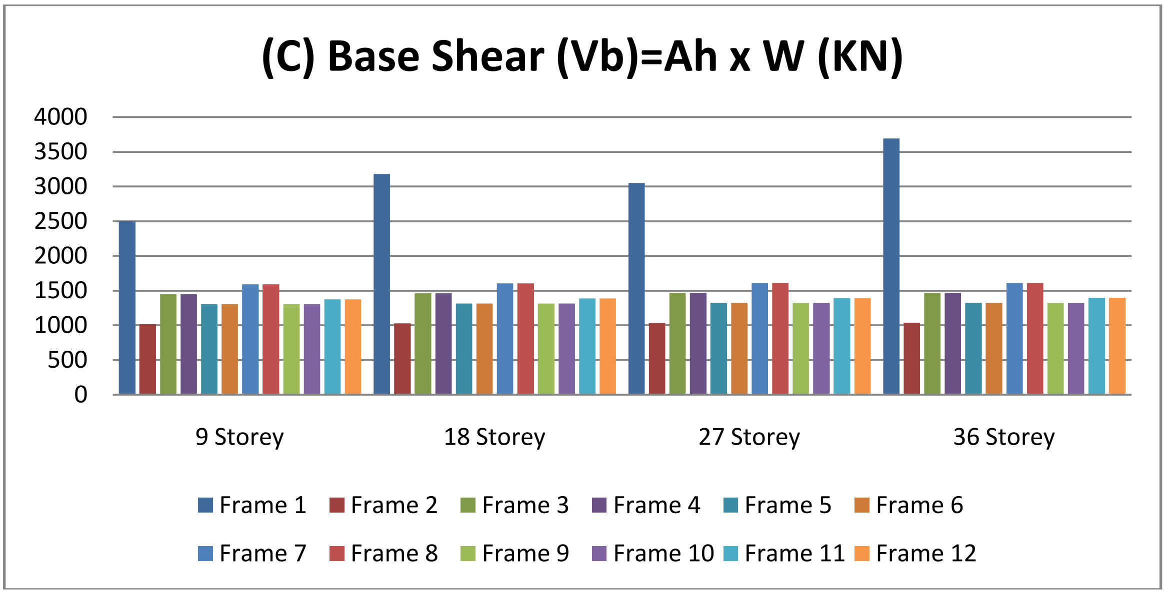


**(C).Base Shear:-** The total design lateral forces or design seismic base shear (Vb) along any principal direction to maximum values in comparison of different height of building with different frames shall be determined by the following expression :-

***Vb= AhW***

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 2497.909 | 1015.123 | 1445.547 | 1445.5 |
| 2 | 58.6 | 18 | 3181.785 | 1028.689 | 1458.602 | 1458.602 |
| 3 | 87.4 | 27 | 3050.62 | 1033.718 | 1463.629 | 1463.629 |
| 4 | 116.2 | 36 | 3688.97 | 1036.254 | 1466.163 | 1466.163 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 1302.073 | 1302.073 | 1589.022 | 1589.022 |
| 2 | 58.6 | 18 | 1315.298 | 1315.298 | 1601.907 | 1601.907 |
| 3 | 87.4 | 27 | 1320.325 | 1320.325 | 1606.932 | 1606.932 |
| 4 | 116.2 | 36 | 1322.86 | 1322.86 | 1609.466 | 1609.466 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 1302.073 | 1302.073 | 1373.81 | 1373.81 |
| 2 | 58.6 | 18 | 1315.298 | 1315.298 | 1386.95 | 1386.95 |
| 3 | 87.4 | 27 | 1320.325 | 1320.325 | 1391.977 | 1391.977 |
| 4 | 116.2 | 36 | 1322.86 | 1322.86 | 1394.512 | 1394.512 |

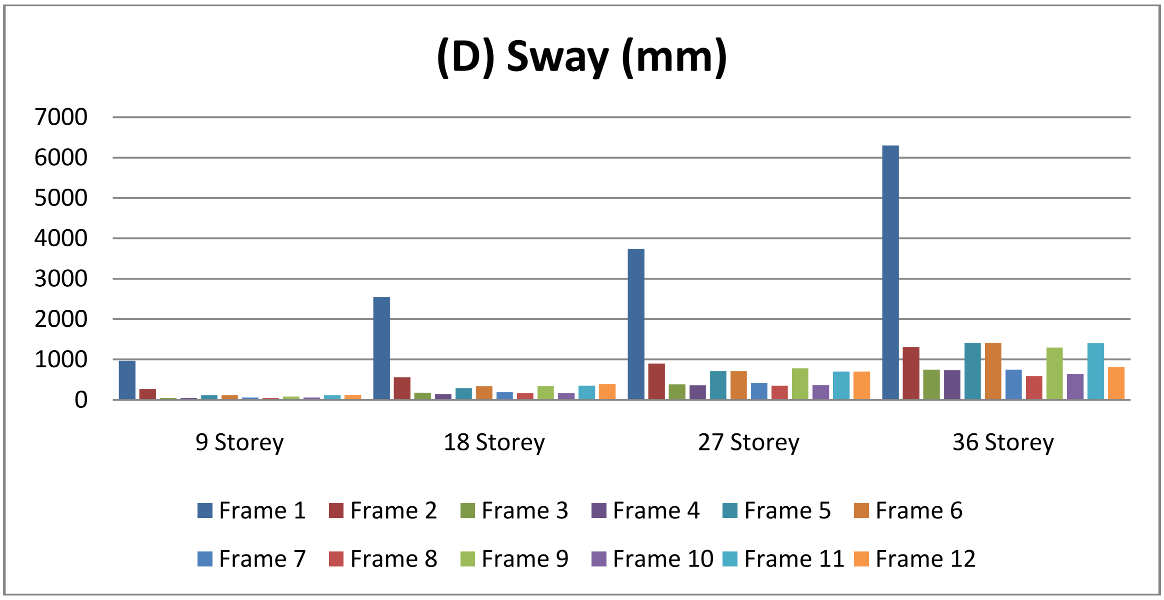




**(D).Sway (mm):-** Storey is the space between two adjacent floor and sway is the displacement of one level relative to the other level above or belowaccording to maximum values in comparison of different height of building with different frames is computed as :-

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 969.117 | 269.665 | 51.063 | 45.468 |
| 2 | 58.6 | 18 | 2551 | 558.223 | 171.984 | 145.822 |
| 3 | 87.4 | 27 | 3740.156 | 899.449 | 380.564 | 353.549 |
| 4 | 116.2 | 36 | 6303.658 | 1306.101 | 749.87 | 732.193 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 107.785 | 107.785 | 52.674 | 50.13 |
| 2 | 58.6 | 18 | 284.661 | 335.081 | 191.481 | 168.205 |
| 3 | 87.4 | 27 | 710.428 | 710.428 | 421.848 | 347.498 |
| 4 | 116.2 | 36 | 1413.971 | 1413.971 | 749.947 | 588.376 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 78.164 | 52.602 | 108.763 | 120.121 |
| 2 | 58.6 | 18 | 339.499 | 169.427 | 350.573 | 391.01 |
| 3 | 87.4 | 27 | 773.819 | 361.885 | 697.144 | 701.344 |
| 4 | 116.2 | 36 | 1295.04 | 643.848 | 1407.691 | 807.018 |

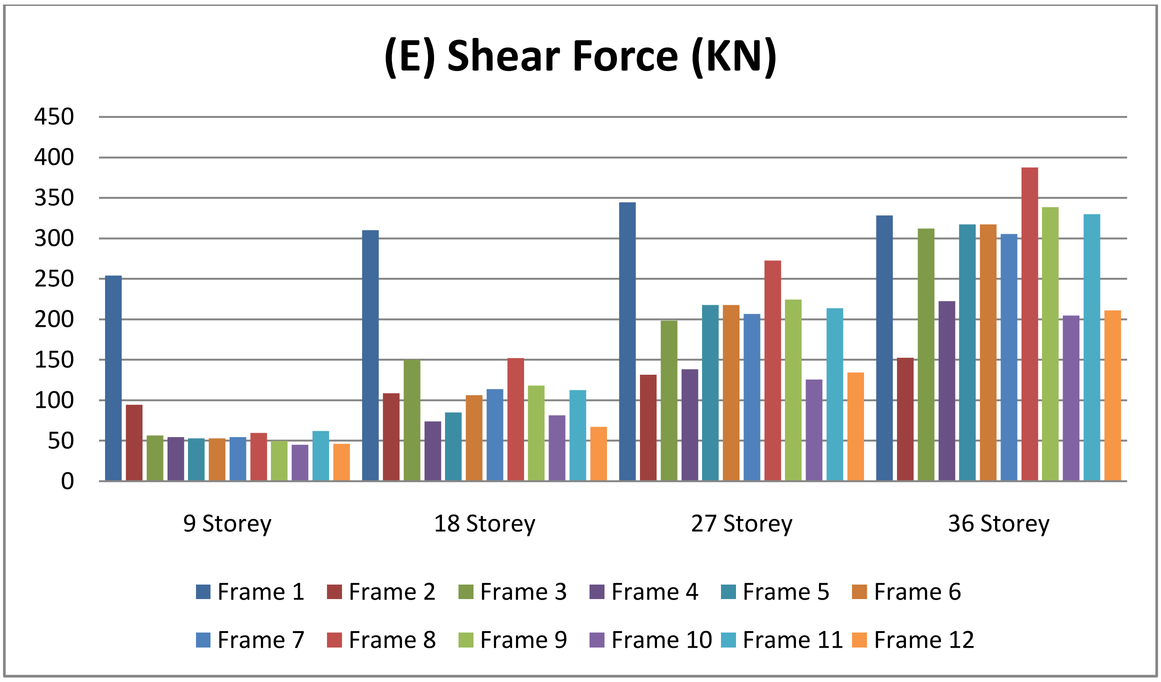




**(E). Shear Force (KN) :-**Shear force at a section of a beam is defined as algebraic sum of all the forces acting on one side of the section. Calculated value of shearing forces according to different variations in storey height with different frames is computed as:-

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 254.013 | 94.512 | 56.408 | 54.564 |
| 2 | 58.6 | 18 | 310.311 | 108.573 | 150.081 | 74.039 |
| 3 | 87.4 | 27 | 344.688 | 131.487 | 198.143 | 138.468 |
| 4 | 116.2 | 36 | 328.392 | 152.674 | 312.216 | 222.337 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 52.954 | 52.954 | 54.34 | 59.586 |
| 2 | 58.6 | 18 | 84.922 | 106.132 | 113.821 | 152.01 |
| 3 | 87.4 | 27 | 217.78 | -217.78 | 206.693 | 272.78 |
| 4 | 116.2 | 36 | -317.431 | 317.431 | 305.396 | 387.594 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 49.939 | 44.944 | 62.001 | 46.393 |
| 2 | 58.6 | 18 | 118.317 | 81.338 | 112.426 | 67.257 |
| 3 | 87.4 | 27 | 224.402 | 125.738 | 213.636 | 134.209 |
| 4 | 116.2 | 36 | 338.717 | 204.499 | 329.981 | 210.785 |

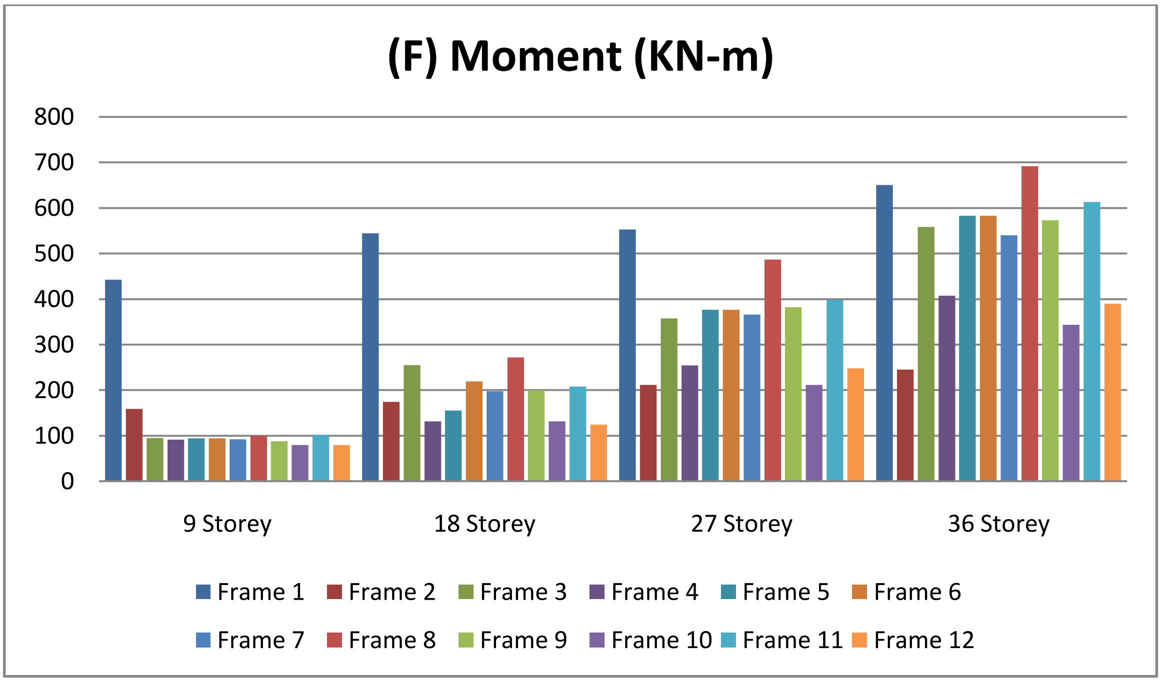




**(F). Moment (KN-m) :-**Bending Moment at a section of a beam is defined as algebraic sum of the moment of all the forces acting on one side of the section. Calculated value of Bending Moment according to different variations in storey height with different frames is computed as:-

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 442.807 | 158.625 | 94.505 | 91.464 |
| 2 | 58.6 | 18 | 544.546 | 174.539 | 255.285 | 131.355 |
| 3 | 87.4 | 27 | 552.783 | 211.171 | 357.167 | 254.303 |
| 4 | 116.2 | 36 | 650.348 | 244.955 | 558.557 | 407.479 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 93.849 | 93.849 | 91.686 | 100.05 |
| 2 | 58.6 | 18 | -155.21 | 218.851 | -197.566 | -271.523 |
| 3 | 87.4 | 27 | 376.815 | -376.815 | -365.796 | -486.797 |
| 4 | 116.2 | 36 | 583.193 | -583.193 | 540.386 | 691.78 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 88.023 | 79.166 | 101.735 | 79.337 |
| 2 | 58.6 | 18 | 199.219 | -131.045 | -207.66 | 124.343 |
| 3 | 87.4 | 27 | -382.425 | -211.67 | -398.124 | 247.654 |
| 4 | 116.2 | 36 | 573.379 | -343.31 | -613.069 | -389.67 |

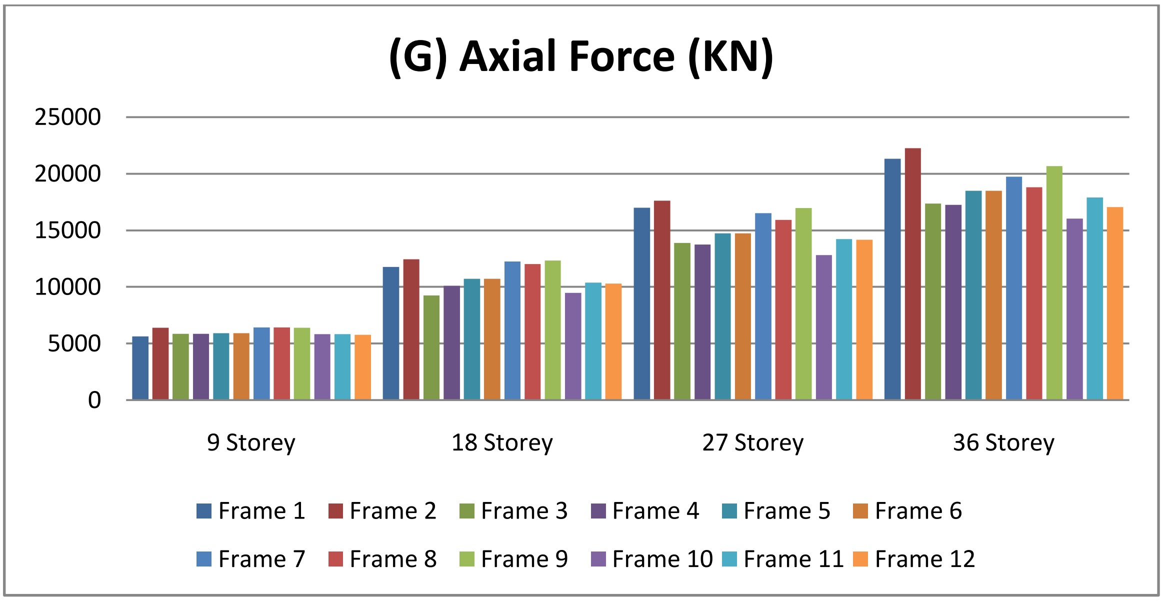




**(G). Axial Force (KN) :-**In an axial-force member, the stresses and strains are uniformly distributed over the cross section. Hence for the calculation of the axial forces in member we have to consider forces in x-z plane when upward global direction is y.Calculated value of axial-force according to different variations in storey height with different frames is computed as:-

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 5641.608 | 6383.943 | 5866.235 | 5858.292 |
| 2 | 58.6 | 18 | 11766.95 | 12434.68 | 9238.988 | 10083.79 |
| 3 | 87.4 | 27 | 16995.92 | 17607.23 | 13883.65 | 13757.37 |
| 4 | 116.2 | 36 | 21316.53 | 22244.14 | 17363.09 | 17258.35 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 5906.765 | 5906.765 | 6418.13 | 6411.928 |
| 2 | 58.6 | 18 | 10722.23 | 10722 | 12233.93 | 12014.82 |
| 3 | 87.4 | 27 | 14737.04 | 14737.04 | 16519.44 | 15919 |
| 4 | 116.2 | 36 | 18484.07 | 18484.07 | 19728.84 | 18792.54 |
| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 6403.597 | 5830.959 | 5814.039 | 5770.324 |
| 2 | 58.6 | 18 | 12330.15 | 9474.261 | 10384.13 | 10293.29 |
| 3 | 87.4 | 27 | 16972.31 | 12804.09 | 14234.22 | 14179.22 |
| 4 | 116.2 | 36 | 20674.63 | 16045.6 | 17893.83 | 17043.28 |





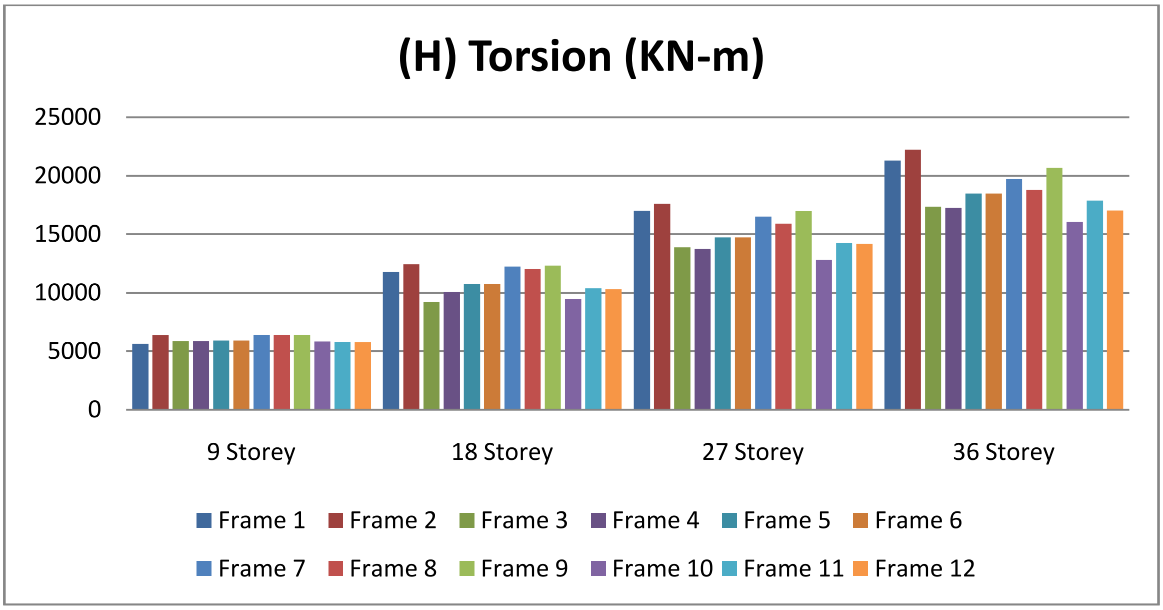
**(H). Torsion (KN-m) :-**Torsion, also known as torque, describes a moment that is acting upon an object around the same axis in which the object lies. A moment is a measurement of the propensity of a force to create motion around either a point or an axis, and is calculated as the force upon the object multiplied by the distance of the force from the chosen origin. Calculated value of torqueaccording to different variations in storey height with different frames is computed as:-

| Sno. | Height Of Building (m) | No. Of Storey | Conventional Bare Frame Structure | Flat Slab Structures | Flat Slab With Different Shear Wall Placings | |
|---|---|---|---|---|---|---|
| | | | (Frame 1) | (Frame 2) | (Frame 3) | (Frame 4) |
| 1 | 29.8 | 9 | 5.298 | 0.152 | 0.238 | 0.234 |
| 2 | 58.6 | 18 | 8.319 | 0.154 | 0.173 | 0.184 |
| 3 | 87.4 | 27 | 9.265 | 0.155 | 0.204 | 0.23 |
| 4 | 116.2 | 36 | 10.616 | 0.172 | 0.267 | 0.386 |

| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
|---|---|---|---|---|---|---|
| | | | (Frame 5) | (Frame 6) | (Frame 7) | (Frame 8) |
| 1 | 29.8 | 9 | 1.736 | 1.736 | 0.345 | 0.185 |
| 2 | 58.6 | 18 | 2.68 | 2.37 | 0.309 | 0.14 |
| 3 | 87.4 | 27 | 2.462 | 2.462 | 0.302 | 0.238 |
| 4 | 116.2 | 36 | 2.341 | 2.341 | 0.375 | 0.336 |

| Sno. | Height Of Building (m) | No. Of Storey | Flat Slab With Different Shear Wall Placings | | | |
|---|---|---|---|---|---|---|
| | | | (Frame 9) | (Frame 10) | (Frame 11) | (Frame 12) |
| 1 | 29.8 | 9 | 0.568 | 0.197 | 1.722 | 1.929 |
| 2 | 58.6 | 18 | 1.43 | 0.19 | 2.512 | 2.887 |
| 3 | 87.4 | 27 | 2.334 | 0.238 | 2.594 | 2.989 |
| 4 | 116.2 | 36 | 3.015 | 0.303 | 2.429 | 1.764 |





## Conclusion

This paper presents a summary of the study, for conventional R.C.C. building, R.C.C. flat slab building and R.C.C. flat slab building with differentvariations in storey height with different frames. The effect of seismic load has been studied for the two types of building with different height. On the basis of the results following conclusions have been drawn:

(A) The natural time period increases as the height of the building increases, since the values are represented by the help of tabular graphs, concluding that all the frames are having same values for different storey computations, it increases according to height though the major change is increased value of Frame 1 only.

(B) Average Response Acceleration Coefficient (Sa/g)decreases as the height of the building increases, since the values are represented by the help of tabular graphs, concluding that all the frames are having same values for different storey computations; it decreases according to height though the major change is decreased value of Frame 1 only.

(C) Design seismic base shear (Vb) is high in Frame 1 onlyand low in Frame-2 though there is a slight change in the values of different storey. The high base shear case is of 36 storey Frame 1 and the low base shear is of 9 storey frame 2.

(D) The values of Sway is clearly said that if moving towards the high storey buildings there is always sway though this paper concludes that if we are providing a structure according to frame 1 there is a lot of sway. Contrasting to this value having a minimum value from all the results in a particular storey is of sway in Frame 4.

(E) Shear force is increasing according to the height of the structure. Hence the maximum value is seen in 36 storey frame 8 and the minimum value is of 36 storey Frame 2.

(F) The Bending Moment seems to bemaximum in 36 storey building. Frame 8 having the maximum values and frame 2 is having the minimum values of Moment.

(G) Axial force is also increasing on comparing the storey of different height. The maximum value is seems overall to be frame 2 and its minimum value seems to be frame 10.

(H) Last but not the least the important value used in the analysis is the value of Torsion i.e. the applied torque. Values also conclude that if moving towards more floors, there is always a greater value of torsion.Maximum value seems to be in Frame 2 and the minimum value seems to be in Frame 10.



## REFRENCES

1. Apostolska R P, Necevska-Cvetanovska G S, Cvetanovska J P and Mircic N (2008), “Seismic performance of flat-slab building structural systems”, The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.

2. Bothara S D and Varghese V (2012), “Dynamic analysis of special moment resisting frame Building with flat slab and grid slab”, *International Journal of Engineering Research and Applications*, Vol. 2, No. 4, pp. 275-280.

3. Erberik M A and Elnashai S A (2004), “Fragility analysis of flat-slab structures”, *ELSEVIER, Engineering Structures*, Vol. 26, pp. 937–948.

4. Makode R K, Akhtar S and Batham G (2014), “Dynamic analysis of multi-storey RCC building frame With flat slab and grid slab”, *Al Int. Journal of Engineering Research and Applications*, Vol. 4, No. 2, Version 1, pp. 416-420.

5. Mohamed A A El-shaer (2013), “Seismic Load Analysis of different RC Slab Systems for Tall Building”, INPRESSCO, Vol. 3, No. 5.

6. Navyashree K and Sahana T S (2014), "Use of flat slabs in multi-storey commercial building situated in high seismic zone",Vol. 03, No. 08, *IJRET: International Journal of Research in Engineering and Technology*.

7. Sable K S, Ghodechor V A and Khandekar S B (2012), "Comparative Study of Seismic Behaviour of multi-storey flat slab and conventional reinforced concrete framed structures", International Journal of Computer Technology and Electronics Engineering, Vol. 2, No. 3