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# Seismic Analysis of G+5 Framed Structures with and Without Floating Columns Using ETABS-2013 Software

Umesh P. Patil[1], Shivanand S Hallur[2]

*1. Associate Professor, Dept. of Civil Engg, KLE Dr .MSSCET, Belagavi – 590008 (Karnataka).*
*2. M-Tech Student in Dept. of Civil Engg, KLE Dr. MSSCET, Belagavi – 590008(Karnataka).*

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*ABSTRACT*

*In order to have more area for parking space and for other amities, concept of floating columns in multi-storey framed structure is becoming popular stability used structural integrity of such structures while resisting earthquake becomes critical. In the paper G+5 storey RCC structure in considered for earthquake analysis. For comparison of three models are used, one with normal structure, second with shear walls and third with masonry infill walls. All the three methods Equivalent static method, response spectrum and time history method were used for analysis ETABS-2013 Software was used and structure was assumed to be situated in earthquake Zone III on a medium soil(type II). The parameters evaluated were Base shear, Storey drift and Displacement. The multi-storey building with shear walls which had performed better than other models(normal building and multi-storey building with masonry infill walls) in resisting earthquake as per IS 1893:2002.*

*Key words: Floating columns, Shear wall, Masonry infill wall, Equivalent static method, Response spectrum and Time history.*

## 1. INTRODUCTION

### Floating Columns

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which ends at its termination level rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it. Such columns where the load was considered as point load.

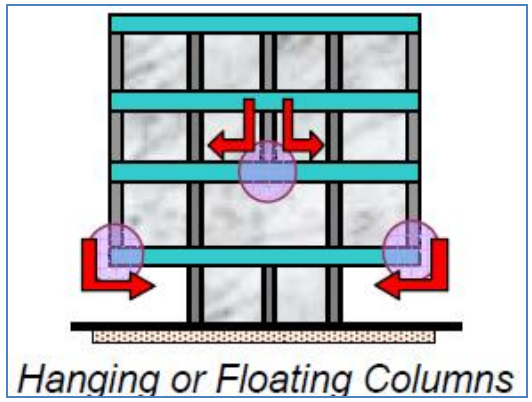


Fig 1: Floating Columns

The floating columns will be provided above the ground floor, there will be more space is available for parking purpose, auditorium purposes and assembly hall. The column is assumed pinned at the base and it will be acting as point load on the beams or girders and all loads will transfer to beam to foundation.

### Shear Wall

A shear wall is vertical structural element that will resist lateral forces in the plane of the wall through shear and bending. Such a wall acts as with a beam part of its strength derives from its depth. The shear wall provides large strength and stiffness to buildings in the direction of their orientation, which way to reduced lateral swing (sway) of the building and there by reduces damage to structure. Shear walls carry large horizontal earthquake force; the overturning effects on them are large. The opening will be provided in shear walls, but their size must be small to ensure least time interval (interruption) to force flow through walls.

 

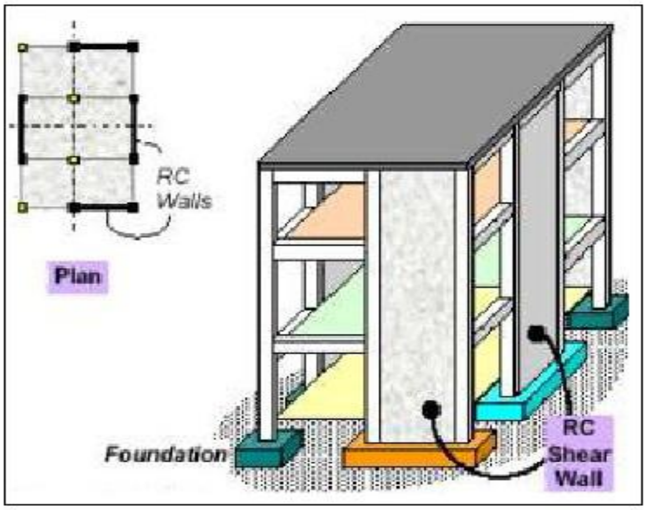


Fig 2: RC Shear wall

Masonry infill wall

The infill wall is the supported wall that closes the perimeter of the building constructed. The infill wall will be provided at inner and outer frames. It will bear its own weight, infill wall also acts as a non load bearing wall and also load bearing wall.

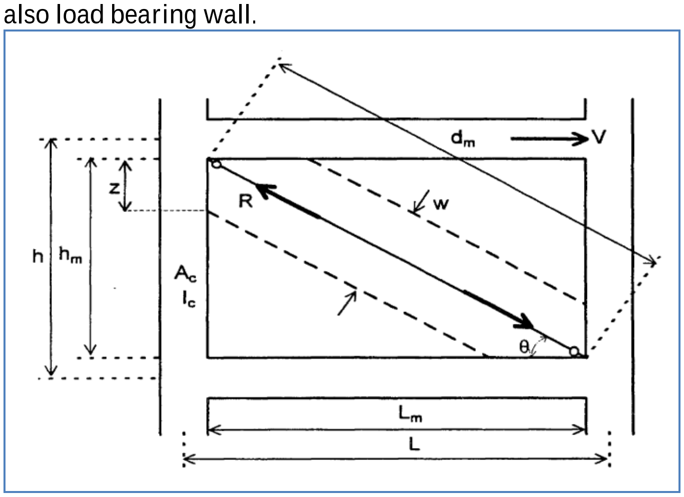


Fig 3: RC Effective width of masonry infill wall

The below formulas are used for the masonry infill wall width calculation.

Calculation of infill width:

$$W=0.175\ ((\lambda * H)^{-0.4} * \sqrt{H^2 + L^2}$$

$$d= \sqrt{H^2 + L^2}$$

$$\lambda= \sqrt[4]{(E_m * t * \sin 2\theta)/(4 * E_c * I_c * h)}$$

Where,

W= Width of masonry infill wall.

$\lambda$= Co-efficient to determined equivalent width of infill.

t= Thickness of masonry infill wall.

h= Height of masonry infill wall.

H= Height of RC frame.

l= Length of infill.

d= diagonal length of the masonry infill.

$E_m$ = Modulus of elasticity of masonry infill.

$(E_m = 500 * f_m)$

$E_c$= Modulus of elasticity of concrete.

$(E_c = 5000 * \sqrt{f_{ck}})$

$I_c$= Moment of inertia of the column.

$I_B$= Moment of inertia of the beam.

## 2. MODELING AND BUILDING DATA

2.1 Without floating columns

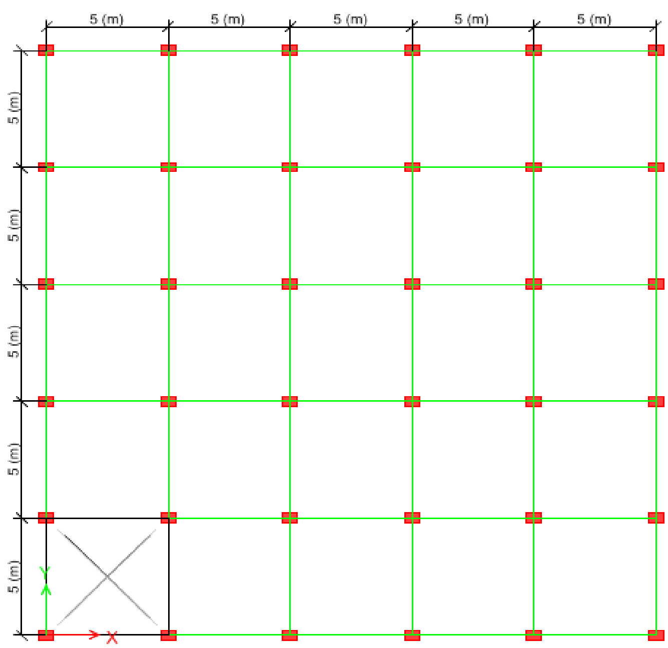


Fig 4: Plan of the building Without floating columns

 

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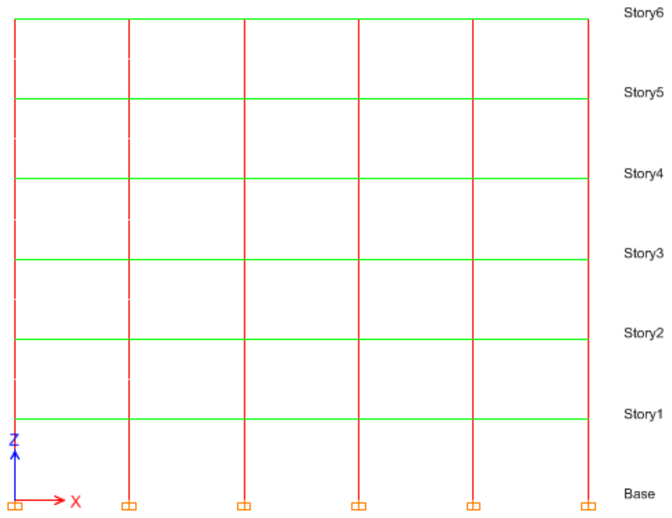


Fig 5: Elevation of the building Without floating columns.

2.2 With floating columns

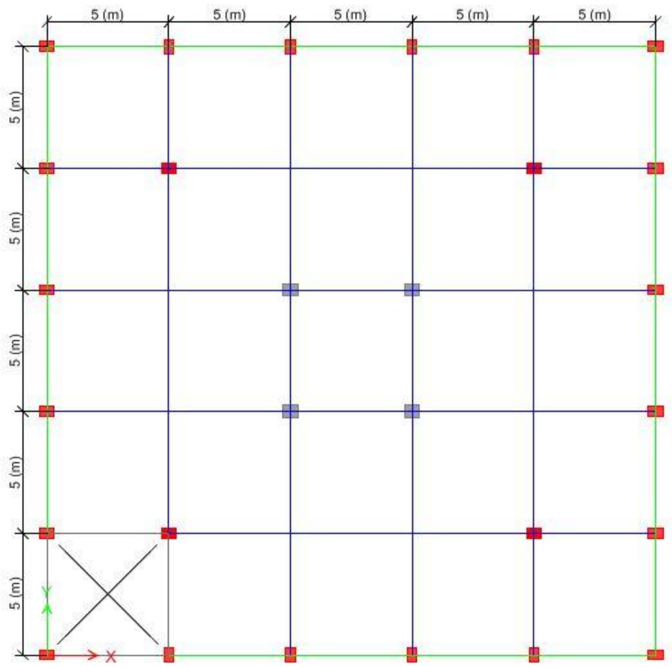


Fig 6: Plan of the building with floating columns.

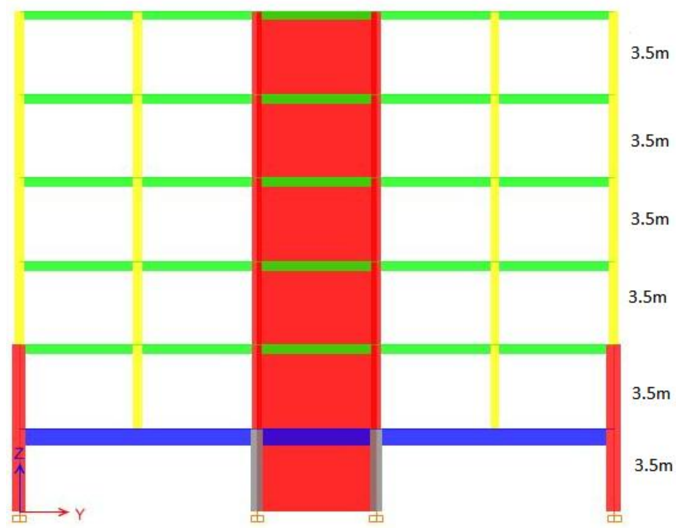


Fig 7: Elevation of the building With floating columns and shear walls.

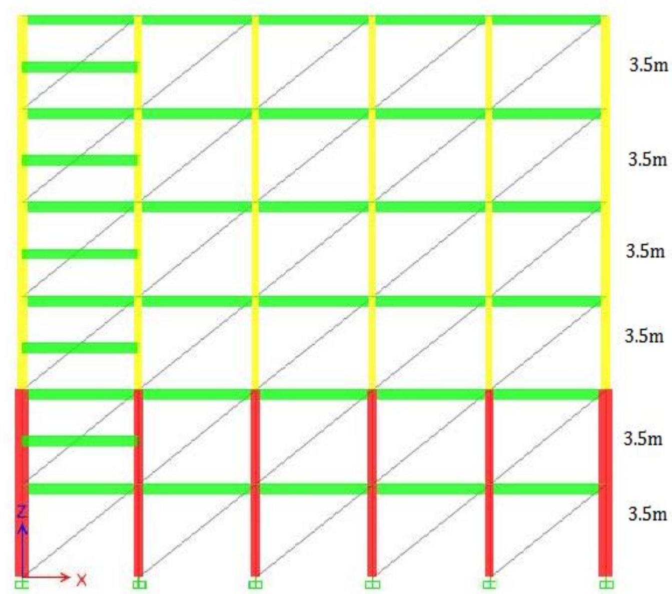


Fig 8: Elevation of the building With floating columns and masonry infill walls.

 

2.3 Building Data

| | | |
|---|---|---|
| Plan dimension | | 25m x 25m |
| No of storey's | | G+15 |
| Each storey height | | 3.5m |
| Thickness of external wall | | 250mm |
| Thickness of internal wall | | 150mm |
| Thickness of parapet wall | | 150mm |
| Thickness of slab | | 150mm |
| Floor finish | | $1kN/m^2$ |
| Live load on floors | | $3kN/m^2$ |
| Live load on roof | | $2kN/m^2$ |
| Density of concrete | | $25kN/m^3$ |
| Density of brick | | $20kN/m^3$ |
| Grade of concrete($f_{ck}$) | | M25 |
| Grade of steel($f_y$) | | Fe 415 |
| Without floating columns | Beam | 300mmx400mm |
| | Column | 400mmx600mm |
| With floating columns | Beam | 400mmx750mm |
| | | 300mmx400mm |
| | Column | 400mmx600mm |
| | | 300mmx400mm |

Table 1: Building data and Dimensions

## 2.4 Analysis of Building

Equivalent static and response spectrum method and time history are used for the analysis of with and without floating columns having shear walls and masonry infill walls. In equivalent static analysis single mode of vibrations are considered. Base shear can be determined by multiplying total seismic weight of building to coefficient of acceleration spectrum value. In response spectrum method, dynamic characteristics are considered for analysis. In this method multiple modes of vibrations are considered where base shear of each mode can be calculated separately. It can be calculated by determining the modal mass and modal mass participation factor for each mode.

EQX- Equivalent static in X direction
EQY- Equivalent static in Y direction
RSX- Response spectrum in X direction
RSY- Response spectrum in Y direction
THX-Time history in X direction
THY- Time history in Y direction

3. RESULTS AND DISCUSSION

3.1(Without floating columns)

3.1.1Base shear

| MODEL | Normal multi-storey building | multi-storey building with shear walls | multi-storey building with masonry infill walls |
|---|---|---|---|
| Base shear in kN (EQ) | 1456.818 | 1525.49 | 1479.844 |
| Base shear in kN (RS) | 1469.770 | 1525.490 | 1482.210 |
| Base shear in kN (TH) | 5029.45 | 10012.55 | 7404.02 |

Table 2: Base shear

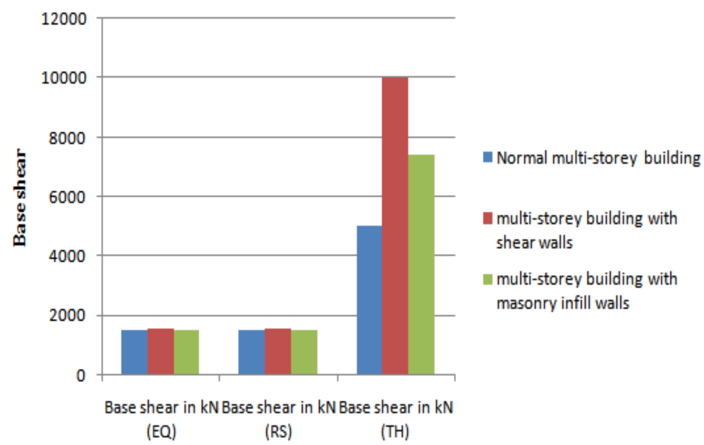


Chart 1: Base shear without floating column

Compared to Equivalent static, response spectrum and time history methods, the base shear is reduced in equivalent static analysis at 60% and in response spectrum analysis at 60%.

**3.1.2 Storey drift**(Without floating columns)

| MODEL | Normal multi-storey building | multi-storey building with shear | multi-storey building with masonry |
|---|---|---|---|

| | | walls | infill walls |
|---|---|---|---|
| Storey drift in mm (EQ) | 2.27 | 0.27 | 0.16 |
| Storey drift in mm (RS) | 2.5 | 0.22 | 0.15 |
| Storey drift in mm (TH) | 6 | 1.50 | 0.57 |

Table 3: Storey drift

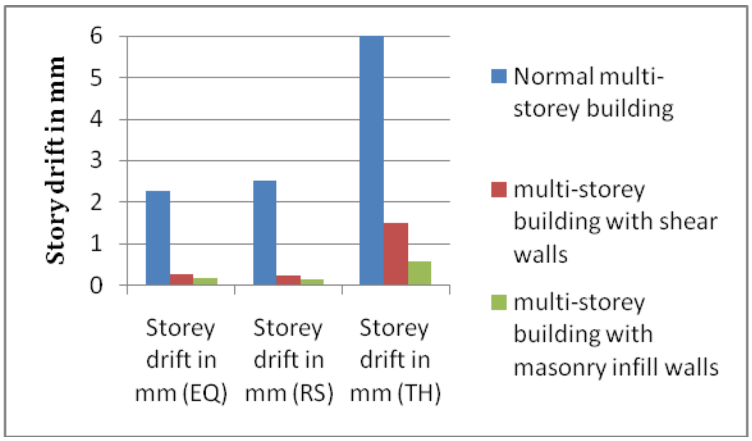


Chart 2: Storey drift without floating column

Compared to Equivalent static, response spectrum and time history methods, the storey drift is reduced in equivalent static analysis and response spectrum analysis.

### 3.1.3 Displacement(Without floating columns)

| MODEL | Normal multi-storey building | multi-storey building with shear walls | multi-storey building with masonry infill walls |
|---|---|---|---|
| Displacement in mm (EQ) | 31.2 | 4.7 | 2.6 |
| Displacement in mm (RS) | 36.1 | 4.1 | 2.2 |
| Displacement in mm (TH) | 93 | 27 | 8.6 |

Table 4: Displacement

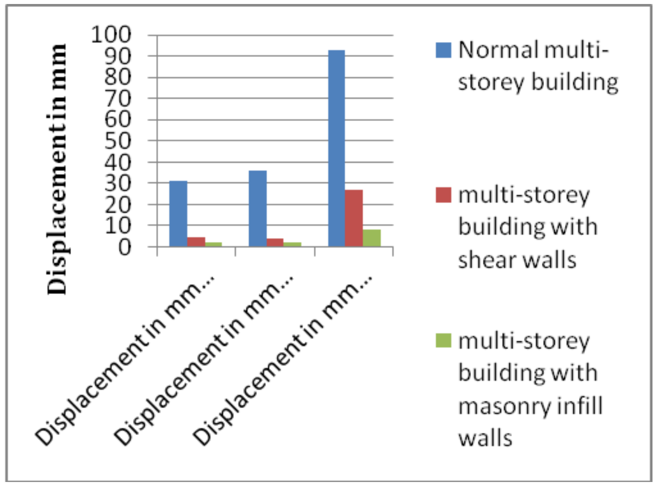


Chart 3: Displacement without floating column

Compared to Equivalent static, a response spectrum and time history method, the displacement is reduced in equivalent static analysis and response spectrum analysis.

## 3.2 With floating column

### 3.2.1 Base shear

| MODEL | Normal multi-storey building | multi-storey building with shear walls | multi-storey building with masonry infill walls |
|---|---|---|---|
| Base shear in kN (EQ) | 1446.45 | 1502.179 | 1454.583 |
| Base shear in kN (RS) | 1446.45 | 1502.168 | 1602.4362 |
| Base shear in kN (TH) | 3121.5948 | 9632.7283 | 7091.4605 |

Table 5: Base shear

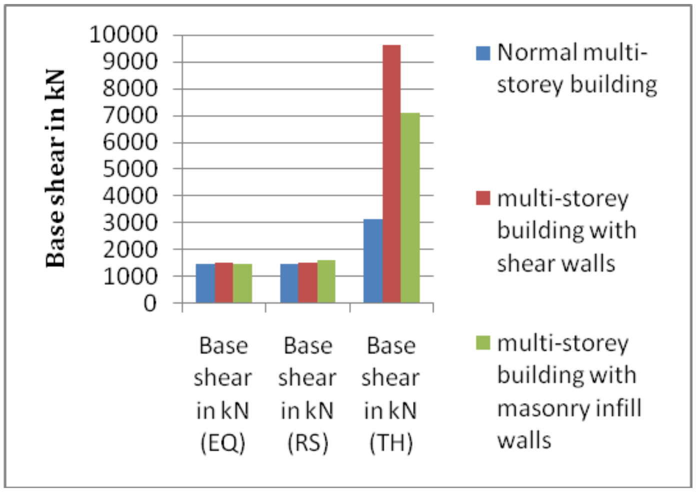


Chart 4: Base shear

Compared to Equivalent static, a response spectrum and time history method, the base shear is reduced in equivalent static analysis and response spectrum analysis.

### 3.2.2 Story drift

| MODEL | Normal multi-storey building | multi-storey building with shear walls | multi-storey building with masonry infill walls |
|---|---|---|---|
| Story drift in mm(EQ) | 2.6 | 0.273 | 0.569 |
| Story drift in mm(RS) | 2.756 | 0.23 | 0.654 |
| Story drift in mm(TH) | 6.97 | 1.473 | 2.28 |

Table 6: Story drift

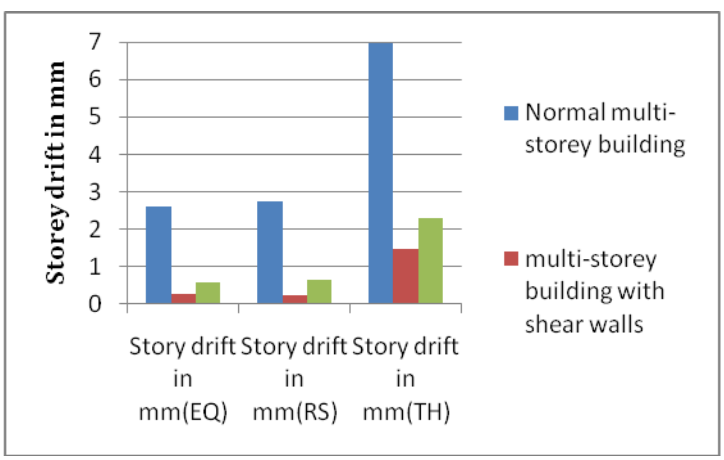


Chart 5: Storey drift

Compared to Equivalent static, response spectrum and time history methods, the storey drift is reduced in equivalent static analysis and response spectrum analysis.

### 3.2.3 Displacement

| MODEL | Normal multi-storey building | multi-storey building with shear walls | multi-storey building with masonry infill walls |
|---|---|---|---|
| Displacement in mm(EQ) | 35.9 | 7.6 | 4.7 |
| Displacement in mm(RS) | 34.6 | 10.9 | 8.2 |
| Displacement in mm(TH) | 93 | 42.5 | 29.3 |

Table 7: Displacement

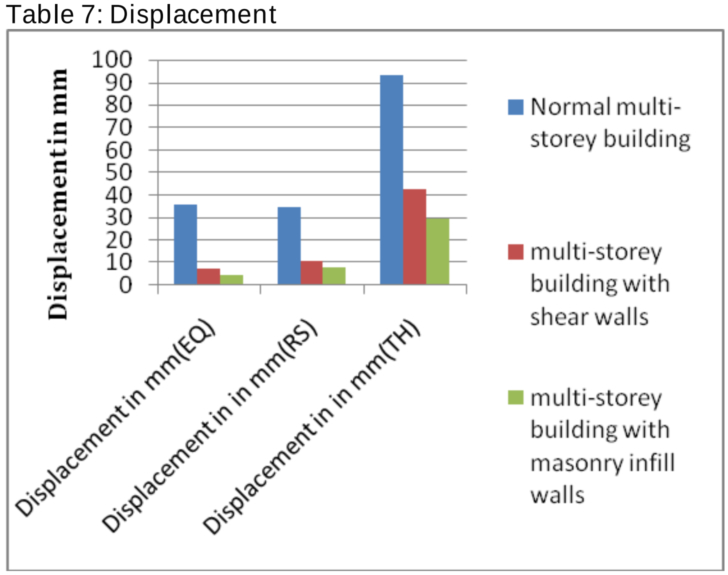


Chart 6: Displacement

Compared to Equivalent static, a response spectrum and time history method, the displacement is reduced in equivalent static analysis and response spectrum analysis.

## 4. CONCLUSION

Following are the broad conclusions in case of seismic analysis of RCC G+5 framed structure with floating columns.

- Out of all the three methods used to evaluate base shear, Multi-storey building with shear walls has performed better compared to normal multi-storey and masonry infill walls.

- Out of all the three methods used to evaluate storey drift, Multi-storey building with shear walls has performed exceedingly well when compared with normal multi-storey and masonry infill walls.
- Out of all the three methods used to evaluate displacement, Multi-storey building with masonry infill walls has performed exceedingly well when compared with normal multi-storey and shear walls.
- Time history analysis presents peak value of base shear for multi-storey building with shear walls.
- Response spectrum analysis presents lowest value of storey drift for multi-storey building with shear walls.
- Equivalent static method of analysis presents lowest value of displacement for multi-storey building with masonry infill walls.
- All the values (Base shear, Storey drift and displacement) are within the permissible limit except the displacement provided by Time history analysis for normal multi-storey building(being more than 84mm).
- Thus for multi-storey building with shear walls pre within the permissible limit except the storey drift has relatively performed normal multi-storey building and masonry infill walls in overall assessment.

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[11] ETABS -2013 software is used to analysis of all models.

 

BIOGRAPHIES

Shri Umesh P. Patil is working as a Associate Professor, Civil Engineering Department in KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belagavi,590 008 Karnataka.
He has work experience of 20 years. He has published 10 papers in international journals and presented 3 papers in international conferences. He has written a text book entitled as "Oil Power Hydraulics and Pneumatics" (1994)

Shivanand S Hallur M-Tech Student Civil Engineering Department in KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belagavi, 590 008 Karnataka

 