# "COMPARATIVE STUDY ON 3D RC FRAME STRUCTURE WITH AND WITHOUT FLOATING COLUMNS FOR STIFFNESS IRREGULARITIES SUBJECTED TO SEISMIC LOADING"

**Mr. Mahesha M[1], Ms. K. Lakshmi[2]**

*[1]Post Graduate student, Department of Civil Engineering, Alpha college of Engineering, Bengaluru, Karnataka, India*
*[2]Assistant professor, Department of Civil Engineering, Alpha college of Engineering, Bengaluru, Karnataka, India*

---***---

**Abstract** – ***The civil engineering structures with floating column is a regular element in the cutting edge multistory construction. Such elements are profoundly undesirable in building implicit seismically dynamic ranges. This study highlights the significance of expressly perceiving the vicinity of the floating columns and significance of explicitly recognizing the presence of with and without floating column in the investigation of building furthermore alongside floating column with a few complexities were considered for G+16 story building at different alternative location, for distinctive zones, for with and without infill and Bracing framework by both equivalent static load method and response spectrum method has been analysed through Etabs finite element package considering the seismic code of IS 1893-2002. Exchange measures, including stiffness equalization of that story where floating column is given and the story above, are proposed to decrease the abnormality presented by the floating columns. The elevated structure is examined for earthquake forces by considering two frames, with and without only floating column and floating column with complexities for reinforced concrete building. At last, examination brings about the high rise building such as Base Shear, Displacement, Overturning minute (Torsion) and Time Period were looked at in this study.***

***Index Terms:*** *Floating columns, Infill wall, Bracing, Stiffness balance, Base Shear, Displacement, Torsion, Time Period, equivalent static load method, response spectrum method etc…*

## 1. INTRODUCTION

A column segment should be vertical part beginning from the establishment level (foundation level) and exchanging the heap to the ground. The term of floating column is additionally a vertical component which at its lower level resting on a part which is a horizontal level member. Building with columns that hang or float over a beams at an in-between storey and try not to go all the way to the establishment, it is have discontinuities in the load transfer path. The pillars thus exchange the heap to different section beneath it, for such segment where heap was considered as a point load.

But such column cannot be implemented easily to construct practically since the true columns below the termination level are not constructed with care and hence finally cause to failure [Sukumar Behera 2012] [1].

There are numerous tasks in which floating columns are already adopted, especially above the ground floor, so that more open space is available on the ground floor. The floating column is used for the purpose of architectural view and site situations and where the open spaces may be needed for assembly hall or parking reason.

While the whole seismic base shear as experienced by a building during an earthquake is reliant on its natural period, the seismic force distribution is subjected to the dispersion of stiffness and mass along the height.

This type of construction does not create any problem under vertical loading conditions. But during an earthquake a clear load path is not available for transferring the lateral forces to the foundation. Lateral forces accumulated at the upper floor during the earthquake have to be transmitted by the projected cantilever beams [2]. Overturning forces thus developed overwhelm the columns of the ground floor. Under this condition the columns start to deform and buckle, resulting in total collapse. This is because of primary deficiency in the strength of ground floor columns, projecting cantilever beams and ductile detailing of beam column joint.

In case of floating column, shear is induced to overturning forces to another resting element of the low level. This imposition of overturning forces overwhelms the columns of lower level through connecting elements. Therefore the most critical region of damage is the connecting element (link between discontinuous columns to lower level column) and lower level columns and the primary concern in load path irregularity is the strength of lower level columns and strength of the connecting beams that support the load of discontinuous frame [3].

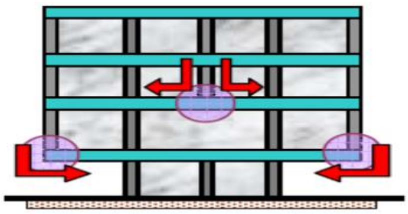
The seismic tremor strength created at diverse floor levels in a very building have to be completed to be brought down on the peak to the bottom by the shortest path, any deviation or separation during this load transfer path leads to poor execution of the building. Structures with vertical setbacks (like the building structures with numerous stories more extensive than the rest) it cause a abrupt jump in earthquake forces at the stage of discontinuity [4]. The buildings that have fewer columns or walls during a specific storey or with outstandingly tall storey tend to wreck or collapse that is initiated in this storey. Analysis needed to provide additional floating columns with infill above soft storey to mitigate earthquake effect. The configuration and points of interest of Float columns, least 25% Earth Quake must be catered notwithstanding gravity powers.

**Research Significance**

Several multistoried buildings in the urban areas that have floating columns may not have been adequately designed for seismic forces. In this current study quantifies the vulnerability in terms of the demands of shear force and bending moment in selected members of a typical building. The forces developed over gravity loads alone and their increments due to earthquake load are compared to show the deficiency in case the building is designed only for gravity loads. The criticality cantilever spans and transfer girders supporting the floating columns. The present research is carried out to create awareness about these issues in earthquake resistant design of multistoried buildings.

## 1.1 Floating column concept

A column should be a vertical part beginning from establishment level and exchanging the heap to the ground level. The term gliding section is additionally a vertical component which (because of engineering outline/ site circumstance) at its lower level (end Level) lays on a shaft which is a flat part. The bars thus exchange the heap to different segments beneath it.



*Hanging or Floating Columns*

Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection.

## 1.2 History

The Provision of floating columns can be stated as most of the buildings in India are covering the maximum possible area on a plot within the available bylaws [5]. Since balconies are not counted in floor space index (FSI), buildings have balconies overhanging in the upper stories beyond the column foot print areas at the ground storey, overhangs up to 1.2 m to 1.5 m in plan are usually provided on each side of the building. In such cases, floating columns are provided along the overhanging perimeter of the building. Most of the time, architect demands for the aesthetic view of the building, in such cases also many of the columns are terminated at certain floors and floating columns are introduced [A.P. Mundada and S.G. Sawdatkar][3].

Sukumar Behera 2012 [1] said that such floating column cannot be implemented easily to construct practically since the true columns below the termination level are not constructed with care and hence finally cause to failure.

## 1.3 Advantages

- Provision of floating column is advantageous in increasing floor space index (FSI) of the building.
- By avoiding closely spaced columns in the ground storey to get large uninterrupted space which is required for the movement of people or vehicles.
- More open space is available in the floor.
- The floating column is used for the purpose of architectural view and site situations.
- Open spaces may be obtained for assembly hall or parking purpose.
- Floating columns are provided for controlling Deflections in Large Cantilevers.

## 2. FORMULATION

The present study is done by using ETABS 9.7.1. It is a fully integrated program that allows model formation, alteration, execution of analysis design optimization and results review from within a single interface. ETABS9.7.1 is a standalone finite element based structural program for the analysis and design of civil structures. Software it offers an intuitive, however powerful user interface with many tools to aid in quick and accurate construction of the models, along with primitive technique needed to do more complex projects.

## 2.1 Building description

In present work is to study the importance of explicitly recognizing the presence of with and without floating column in the analysis of building and also along with floating column some complexities were considered for G+16 storey building at different alternative location, for lower to higher zones (Zone IV and Zone V), for with and without infill (Zone IV and Zone V) and Bracing system (Zone IV and Zone V) by both equivalent static load method and response spectrum method.

Alternate measures, involving stiffness balance of that storey where floating column is provided and the storey over and are proposed to reduce the irregularity introduced by the floating columns. The high rise building is analyzed for earthquake force by considering two type of structural system. Frame with and without only floating column and floating column with complexities for reinforced concrete structures. Finally the analysis results in the high rise building such as storey displacement, overturning moment, time period and base shear were compared in this study.

## 2.2 Building Parameter / Components

**SIESMIC DATA**

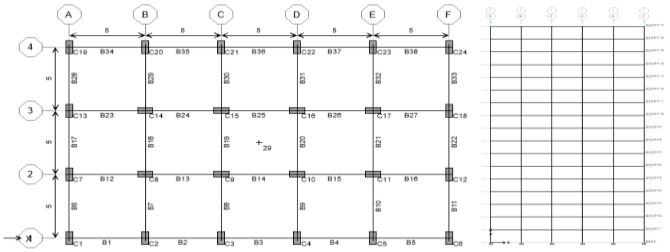


Fig: Plan and Elevation of Building

Building Type : Residential Soil Type : Medium (II)
Stories : G+16 Response Reductions : 5
Zones : IV and V Importance Factor : 1
Bays : 5 X 3 Frame System : SMRF

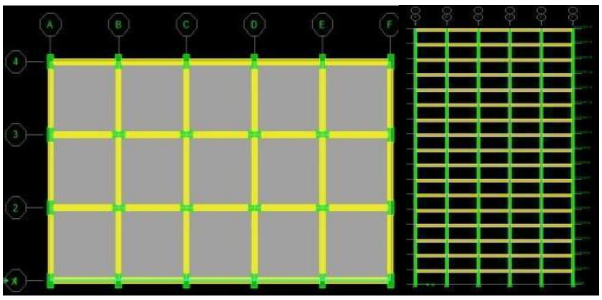
**BUILDING DATA**

Total Height : 51m
Floor Height : 3m
Column : 450mm X 1000mm Cover : 40mm
Beam : 375mm X 600mm Cover : 45mm
Floating Column: 300mm X 300mm Cover : 40mm
Bracing(Concrete):300mm X 300mm Cover : 40mm
Infill(Brick) : 230mm Thick
Density of brick masonry p : 19.2 $kN/m^2$
Poisson's ratio of concrete μ : 0.15
Slab : 150mm Thick
Spacing b/w Columns : 5m
Live Load : 2 $kN/m^2$ (Floors)
1 $kN/m^2$ (Roof)
SDL : 11.26 $kN/m^2$
3.31 $kN/m^2$ (Parapet wall)
Time period Tx:$(0.09h)/\sqrt{dx}$= $(0.09 \times 51)/\sqrt{25}=0.918$sec
Ty:$(0.09h)/\sqrt{dy}$= $(0.09 \times 51)/\sqrt{15}=1.185$sec
Concrete : M25 Grade
Poisson's ratio of concrete μ: 0.2
Steel fy : Fe 415
Grade Characteristic strength of concrete fck : 25Mpa
Modulus elasticity of concrete: Efc $=5000\sqrt{fck}=25X10^6$

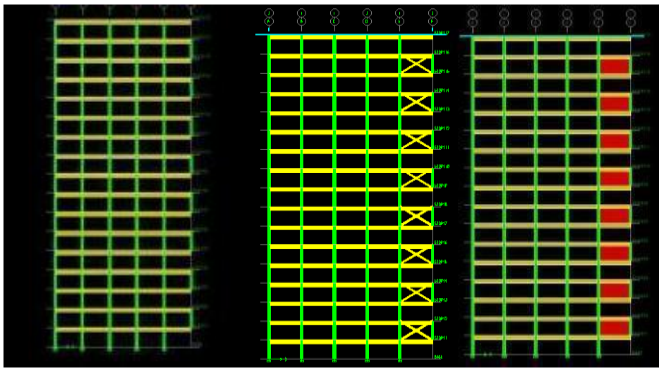
**IS CODES**

IS 456 : 2000 - Plain and reinforced concrete
IS 1893 : 2002 -Earthquake resistant design
IS 875 : 1987 (Part I) - Dead loads
IS 875 : 1987 (Part II) - Imposed loads
IS 13920 : 1993 - Ductile detailing

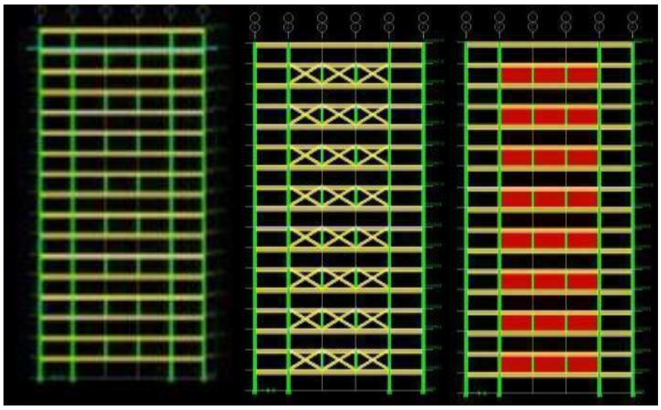
## 2.3 Modelling using Etabs



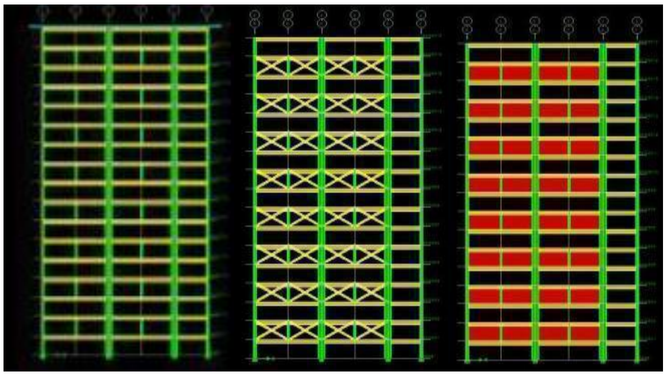
- Model – 1: Structure without Floating Columns.



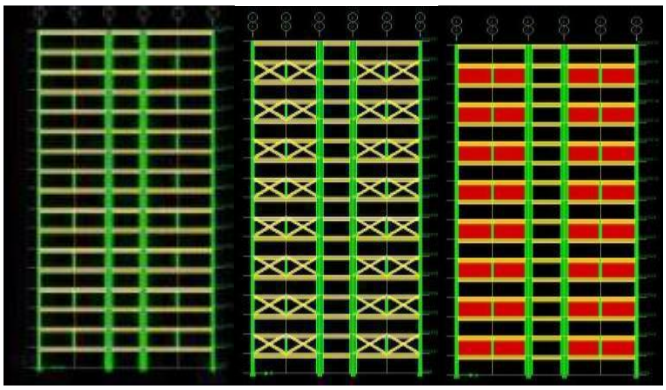
- Model – 2: Alternative Floating Column at Corners.



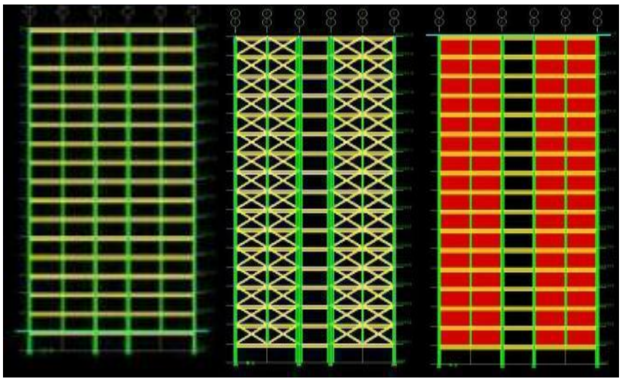
- Model –3: Alternative Floating Columns at middle of Periphery.



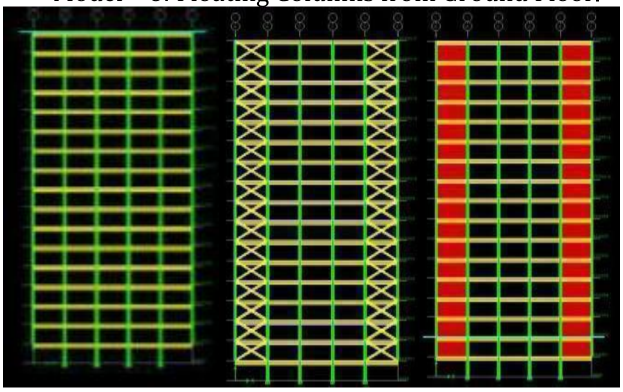
- Model – 4: Alternative Floating Columns at Middle.



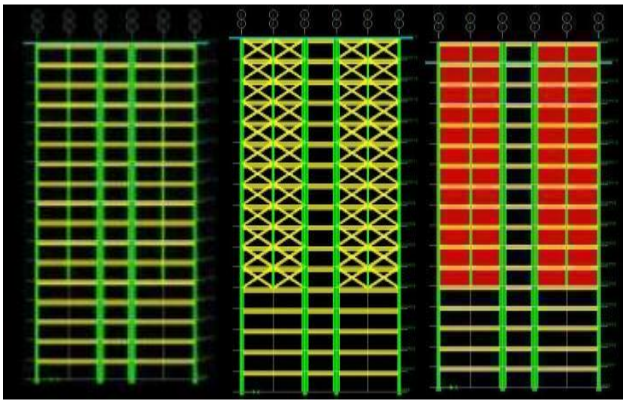
- Model –5: Alternative adjacent Floating columns at middle.



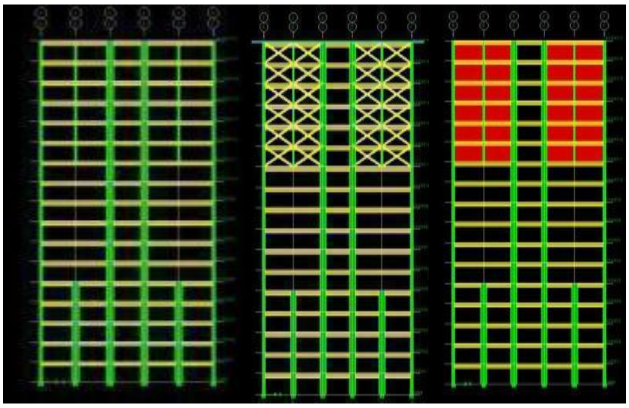
- Model – 6: Floating Columns from Ground Floor.



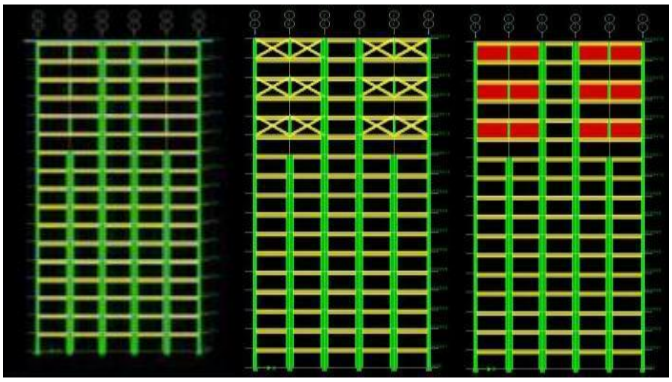
- Model –7: Floating Columns from Ground Floor at Corners.



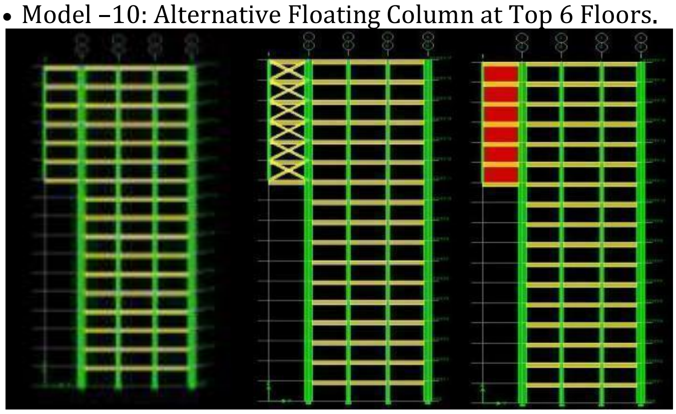
- Model –8: Floating columns From 6th Floor at Middle.



- Model –9: Floating Columns From 11th Floor at Middle.



- Model –10: Alternative Floating Column at Top 6 Floors.



- Model – 11: Over Hanging Floating Columns.

### 2.4 Objective and Scope

- To analyse the effect of floating column by varying locations.
- To compare the effect of floating column of RC supporting members with reference to a buildings with and without concrete bracing system.
- To compare the effect of floating column of RC supporting members with reference to a buildings with and without brick infill.
- To study the dynamic effect of floating column of RC frame by equivalent static load method and response spectrum method under critical Earthquake zones (IV & V) as per IS Codal Provisions.

## 3. RESULTS AND DISCUSSIONS

Analysis of models carried out with the horizontal component of earthquake load as per equivalent static load method and response spectrum method of IS 1893: 2002(part-1).
The results are presented with respect to parameters considered in present study such as base shear, displacement, time period and torsion.
The computational models were developed by using Etabs (Finite element package). The beams and columns were modeled using one dimension frame element. The ground story columns are assigned to be fixed at bottom. Slabs were modeled using membrane element. The gravity loads

acting on the slab are assigned to supporting beam using the method given in clause 24.5 IS 456:2000.
The diaphragm action of the slab under lateral load was accounted for by assigning a rigid diaphragm at each level.
The results and discussions presented in subsequent topics with respect to model considered for analysis.

## 3.1 BASE SHEAR (IS 1893 PART-I: 2002)

**COMPARISON BETWEEN WITH AND WITHOUT FLOATING COLUMNS**

**Table -1:** Base Shear in kN

| Base Shear in kN | | | | |
|---|---|---|---|---|
| **Models** | **EQX** | **EQY** | **SPECX** | **SPECY** |
| **1** | 4823 | 3736 | 2023 | 1927 |
| **2** | 4673 | 3620 | 1881 | 1761 |
| **3** | 4491 | 3479 | 1756 | 1704 |
| **4** | 4361 | 3378 | 1642 | 1644 |
| **5** | 4404 | 3411 | 1427 | 1673 |
| **6** | 4661 | 3610 | 1517 | 1667 |
| **7** | 4790 | 3711 | 1891 | 1735 |
| **8** | 4687 | 3631 | 1837 | 1800 |
| **9** | 4649 | 3601 | 1892 | 1837 |
| **10** | 4737 | 3669 | 1988 | 1900 |
| **11** | 5168 | 4004 | 1839 | 1968 |

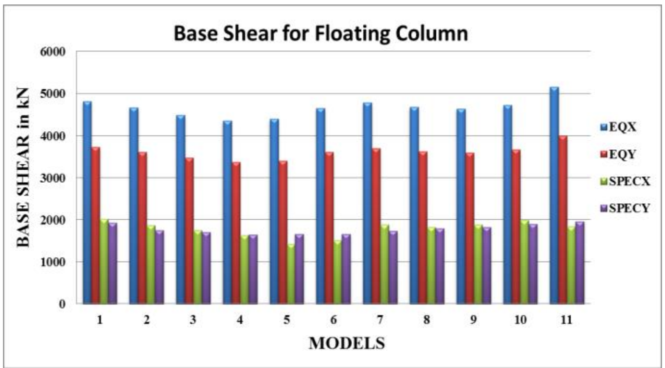



**Chart -1**: Base Shear in kN

- It is observed that Base shear developed in model M1 (i.e M1=4823 kN) is high compred to other models. Reduction in Base Shear observed in models M2, M3, M4, M5 & M6 .
- When floating columns was provided at outer periphery there is marginal decrease in Base Shear that is for model M2 [EQ Static cases].
- There is a decrease in Base Shear in response spectrum cases for model M2, M3, M4 & M5 when compared with M1. This is because the response spectrum takes structural damping into consideration.
- In M6 model, when there is no columns provided at ground floor there is slight decrease in Base Shear compared to model M1.
- Where there are no columns at corners only at ground floor Base Shear is increased marginally when compared with M6.
- When the columns were removed from ground to 5th floor, 5th floor to 11th floor and 11th to top floor Base Shear was decreased. So Model M8, M9 and M10 Base Shear decreased. This is because there is reduction in overall stiffness of structure.
- If the structure is provided with cantilever beam and floating columns from 11th to top floor at Y – direction in model M11, Base Shear was increased by 7 to 10%.
- In response spectrum cases Base Shear in X-direction is decreased and Y-direction is increased.

**COMPARISION USING BRACINGS**

**Table -2:** Base Shear in kN

| Base Shear in kN | | | | |
|---|---|---|---|---|
| **Models** | **EQX** | **EQY** | **SPECX** | **SPECY** |
| **1** | 4823 | 3736 | 2023 | 1927 |
| **2** | 4707 | 3647 | 1818 | 1685 |
| **3** | 4577 | 3546 | 2097 | 1814 |
| **4** | 4511 | 3494 | 2048 | 2043 |
| **5** | 4524 | 3505 | 1827 | 1979 |
| **6** | 3982 | 3085 | 2492 | 1917 |
| **7** | 4490 | 3478 | 2000 | 1868 |
| **8** | 4497 | 3483 | 1980 | 1940 |
| **9** | 4556 | 3529 | 1939 | 1876 |
| **10** | 4690 | 3633 | 2009 | 1919 |
| **11** | 5104 | 3954 | 1984 | 1966 |

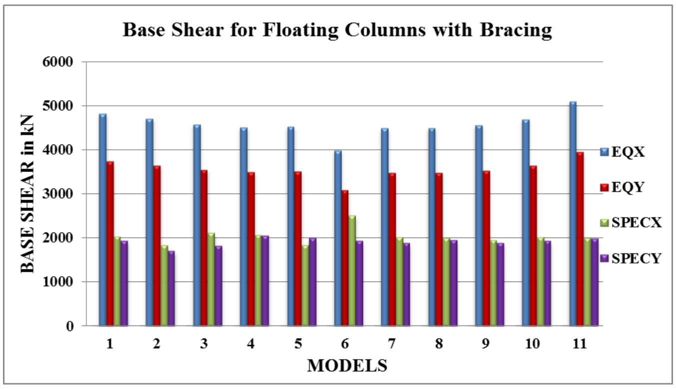



**Chart -2**: Base Shear in kN

- It is noted that when RC Bracing (300mmX300mm thickness) was provided with only floating column there is increase in base shear when compared with model M2 of only floating column.
- It is also seen that there is increase in Base Shear in the models M2 to M5 which is adding lateral stiffness to the structure.
- It is observed in model M6 to M11 there is decrease in base shear when compared to the M1 to M5 as the system tends to be flexible.
- It is observed that model M1 to M10 there is decrease in Base Shear, in model M11 the Base Shear was increased to 5 to 10% as it has overhanging effect in the structure [flexible when compared to other models].

- Similar trends were observed in response spectrum cases also.

**COMPARISION USING BRICK INFILL EFFECTS**

**Table -3:** Base Shear in kN

| Base Shear in kN | | | | |
|---|---|---|---|---|
| **Models** | **EQX** | **EQY** | **SPECX** | **SPECY** |
| **1** | 4823 | 3736 | 2023 | 1927 |
| **2** | 4786 | 3707 | 1718 | 1569 |
| **3** | 4774 | 3698 | 2792 | 2135 |
| **4** | 4825 | 3738 | 2867 | 2760 |
| **5** | 4799 | 3718 | 2595 | 2677 |
| **6** | 4847 | 3755 | 4021 | 3094 |
| **7** | 4804 | 3722 | 2430 | 2337 |
| **8** | 4738 | 3670 | 2234 | 2248 |
| **9** | 4674 | 3621 | 2006 | 1956 |
| **10** | 4749 | 3679 | 2054 | 1972 |
| **11** | 5207 | 4033 | 1987 | 1988 |

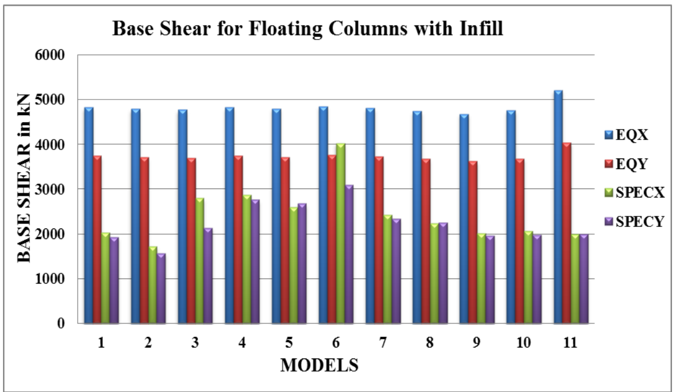



**Chart -3**: Base Shear in kN

- When replacing bracing with brick infill in the structures it was observed that Base Shear was increased when compared to only floating columns and bracing RC frame by increase stiffness of structure.
- In the model M4 by using infill it increase base shear up to 15% compared with both bracing and only floating columns system.
- In the overhanging model shows base is increased than both condition of only floating columns and with Bracing system.
- In the overhanging floating column system, Base Shear is less in Bracing when compared to floating column system and floating column with Infill system.
- This infill effect shows that the floating columns system with Infill in more effective.

  In both Zone V and Zone IV are concluded that infill is more effective than the both only floating columns structure and bracing with floating columns structure.

## 3.2 DISPLACEMENT (IS 456 : 2000)

As per code IS 456 : 2000 clause 20.5 page 33, displacement should not be greater than total height of the structure by 500.

$$D = \frac{H}{500} = \frac{51000}{500} = 102 \text{ mm}$$

**DISPLACEMENT FOR EQX**

**Table -4:** Displacement for EQX in mm

| **Models** | **FC** | **BRACING** | **INFILLS** |
|---|---|---|---|
| **M1** | 96.51 | - | - |
| **M2** | 101.31 | 98.41 | 92.45 |
| **M3** | 114.08 | 80.37 | 48.64 |
| **M4** | 122.46 | 82.43 | 45.92 |
| **M5** | 138.84 | 87.53 | 52.70 |
| **M6** | 161.54 | 44.07 | 26.71 |
| **M7** | 112.54 | 90.70 | 75.99 |
| **M8** | 110.10 | 81.50 | 66.37 |
| **M9** | 105.09 | 93.37 | 88.87 |
| **M10** | 97.97 | 92.06 | 88.01 |
| **M11** | 114.99 | 103.39 | 101.58 |

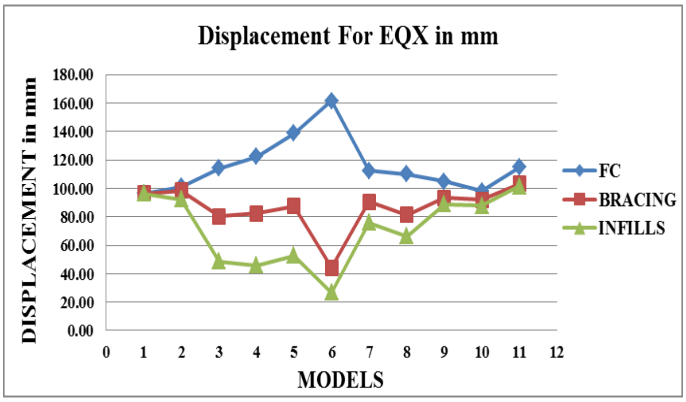



**Chart -4**: Displacement for EQX in mm

- It is seen that provision of floating columns increases the displacement value as compared to models with without floating column. A displacement varies from 2 to 67% as shown in the table 4.
- It is observed that open ground storey M6 model as more displacement that is 67% when compared with model M1. This is because of soft story effect.
- Model M3 M4 M5 M6 M7 M8 M9 and M11 exceed the displacement limit as per IS 456:2000. This is because floating column system tends to be flexible.
- By introducing bracing system, it was observed that stiffness added to the structures resulting in reduction of displacement values.
- It is also seen that by providing bracing is decreases in displacement 3 to 73% when compared with floating columns system.
- In the case over hanging system displacement is marginally greater than the limits due more horizontal forces at the top storey, this due to torsional effect.

- By replacing infill instead of bracing, similar trends were observed. For models infill with floating columns as in for bracing system structure is lot effective.
- The provision of infill walls as reduce the displacement drastically, thus making them desired for displacement control which is a key design criteria for floating as observed in chart 4.

**DISPLACEMENT FOR SPECX**

**Table -5:** Displacement for SPECX in mm

| Models | FC | BRACING | INFILLS |
|---|---|---|---|
| M1 | 31.96 | - | - |
| M2 | 31.70 | 29.26 | 24.45 |
| M3 | 34.99 | 29.18 | 22.89 |
| M4 | 36.47 | 29.58 | 21.89 |
| M5 | 33.24 | 26.02 | 22.75 |
| M6 | 41.37 | 22.14 | 17.78 |
| M7 | 34.82 | 31.38 | 29.18 |
| M8 | 36.14 | 28.56 | 25.34 |
| M9 | 33.84 | 30.80 | 30.18 |
| M10 | 32.11 | 30.47 | 29.69 |
| M11 | 36.07 | 34.38 | 33.75 |

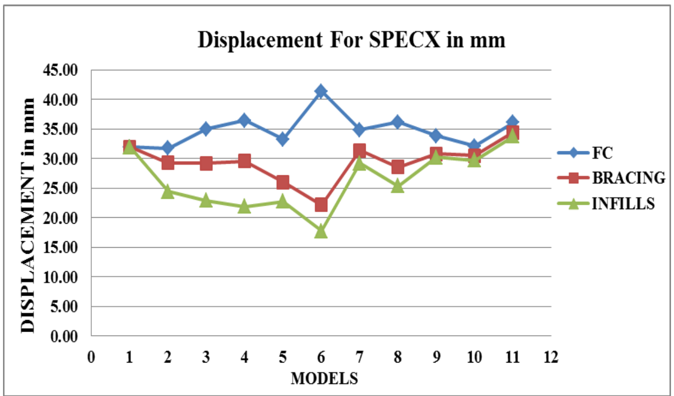



**Chart -5**: Displacement for SPECX in mm

- Above chart 5 and table 5 shows in the response spectrum cases displacement values were within the limits it does not cross the limit. This is because of response spectrum takes structural damping into account.
- By comparing with and without floating columns displacement increases upto 14%.
- And by providing structural complexities like bracing and infills. Displacement value decreases as much as upto 46 to 57% in SPECX direction.

Similar displacement variations were observed in Zone IV same as Zone V.

The displacement in seismic dynamic (RS) case is lesser than seismic static case (ELSM) as seen chart 5 above.

## 3.3 TIME PERIOD (IS 1893 Part-I: 2002)

Natural time period considered based on as per Indian code IS 1893 (Part-1) : 2002 clause 7.6 page 24. In general, time periods vary in the range 0.03-33 sec.

**TIME PERIOD IN MODE 1**

**Table -6:** Time Period in Secs.

| Models | OFC | BRACING | INFILL |
|---|---|---|---|
| 1 | 2.058 | - | - |
| 2 | 2.163 | 2.149 | 2.143 |
| 3 | 2.185 | 2.095 | 1.870 |
| 4 | 2.199 | 1.811 | 1.403 |
| 5 | 2.454 | 1.943 | 1.458 |
| 6 | 2.539 | 1.723 | 1.279 |
| 7 | 2.314 | 2.017 | 1.747 |
| 8 | 2.157 | 1.904 | 1.756 |
| 9 | 2.097 | 2.018 | 2.018 |
| 10 | 2.036 | 2.000 | 1.996 |
| 11 | 2.191 | 2.164 | 2.194 |

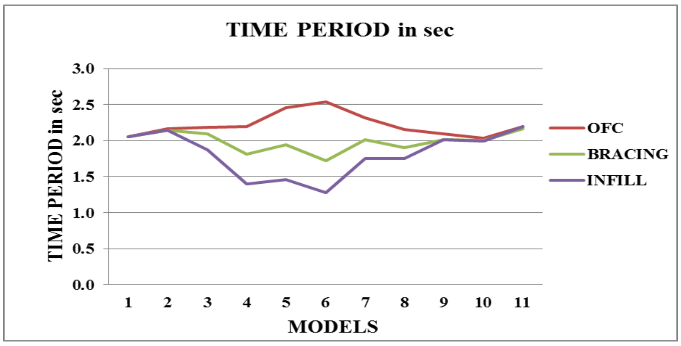



**Chart -6**: Time Period in Secs.

**TIME PERIOD IN MODE 2**

**Table -7:** Time Period in Secs.

| Models | OFC | BRACING | INFILL |
|---|---|---|---|
| 1 | 1.954 | - | - |
| 2 | 1.992 | 1.924 | 1.735 |
| 3 | 2.110 | 1.785 | 1.368 |
| 4 | 2.185 | 1.806 | 1.375 |
| 5 | 2.169 | 1.876 | 1.435 |
| 6 | 2.326 | 1.315 | 0.983 |
| 7 | 2.102 | 1.869 | 1.663 |
| 8 | 2.094 | 1.869 | 1.752 |
| 9 | 2.009 | 1.941 | 1.949 |
| 10 | 1.937 | 1.907 | 1.909 |
| 11 | 2.143 | 2.061 | 2.085 |

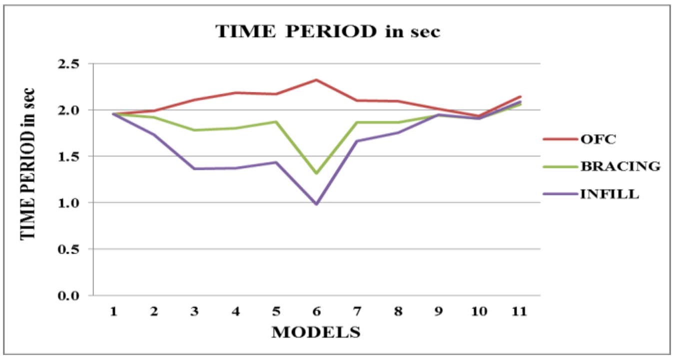



**Chart -7**: Time Period in Secs.

**TIME PERIOD IN MODE 3**

**Table -8:** Time Period in Secs.

| Models | OFC | BRACING | INFILL |
|---|---|---|---|
| 1 | 1.758 | - | - |
| 2 | 1.857 | 1.683 | 1.388 |
| 3 | 1.880 | 1.663 | 1.306 |
| 4 | 1.815 | 1.691 | 1.322 |
| 5 | 1.850 | 1.696 | 1.386 |
| 6 | 1.989 | 1.310 | 0.961 |
| 7 | 2.005 | 1.374 | 1.039 |
| 8 | 1.802 | 1.676 | 1.591 |
| 9 | 1.769 | 1.727 | 1.737 |
| 10 | 1.744 | 1.722 | 1.727 |
| 11 | 1.863 | 1.828 | 1.831 |

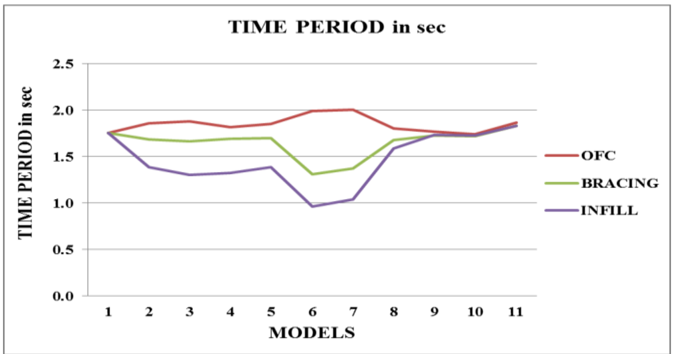



**Chart -8**: Time Period in Secs.

- From all the above tables and graphs, the results obtained from the model time period.
- It is observed that with the introduction of floating columns there is increase in time period compared to model M1 this is due to decrease in stiffness of the structure, it increase 2 to 22% of without floating columns system. Except model M10 because of floating columns provided at top few floors. Floating columns introduce at top floors does not effect to time period, because of less decrease in stiffness. Model M10 decreases time period only 1% when compared with model M1.
- It is observed that model M5 M6 and M7 were more flexible when compared with other models. This is because of introduction of floating columns with soft storey effect.
- Bracing systems, It was noticed that the models of floating columns with bracing has lesser time period when compared to only floating columns system. This is because introduction of bracing with floating columns there is increase in stiffness of the structure.
- In bracing and infills models M11 there was a marginal decrease in time period when compared with without floating columns system.
- Infills, further there is marginal decrease in time period with the introduction of infill with floating columns system. It is observed that model M3 to M8 is stiffer than floating columns with bracing system. Infill reduces the time period value upto 37% due increase of stiffness in the system. It was also noted that floating columns with infill there is increase in time period that model M11 when compared to model M11 of bracing and only floating columns system.
- Similar trends observed in all modes that is Mode 1, Mode 2 and Mode 3.

## 3.4 TORSION (IS 1893 PART-I: 2002)

Torsion effect in the structures was considered based on code IS 1893 (Part-1): 2002 clause 7.9 page 26.

**COMPARISON BETWEEN WITH AND WITHOUT FLOATING COLUMNS**

**Table -9:** Torsion

| Models | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|
| 1 | 0 | 0 | 79.271 |
| 2 | 0 | 0 | 79.078 |
| 3 | 0 | 0 | 78.369 |
| 4 | 0 | 0 | 79.002 |
| 5 | 3.293 | 0 | 75.427 |
| 6 | 0 | 0 | 78.979 |
| 7 | 0 | 0 | 79.092 |
| 8 | 0 | 1.158 | 78.896 |
| 9 | 0 | 0.281 | 77.943 |
| 10 | 0 | 0 | 78.908 |
| 11 | 0 | 17.646 | 62.769 |

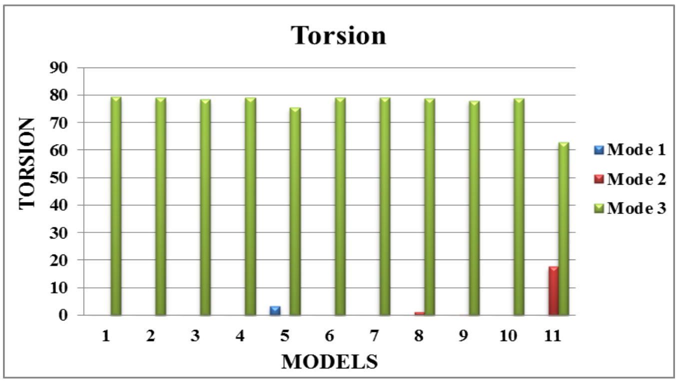



**Chart -9**: Torsion

**COMPARISION USING BRACINGS**

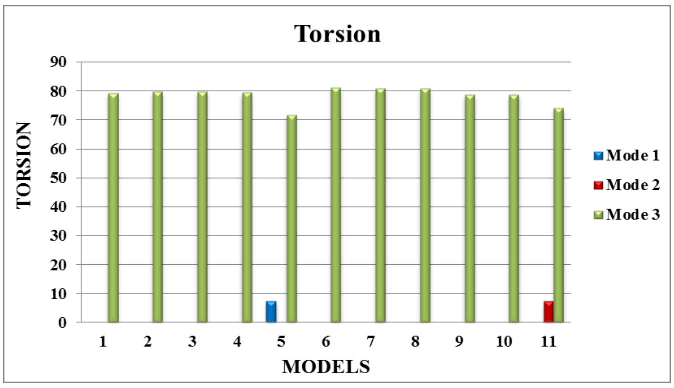



**Chart -10**: Torsion

**Table -10:** Torsion

| Models | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|
| 1 | 0 | 0 | 79.271 |
| 2 | 0 | 0 | 79.66 |
| 3 | 0 | 0 | 79.695 |
| 4 | 0 | 0 | 79.41 |
| 5 | 7.419 | 0 | 71.669 |
| 6 | 0 | 0 | 81.093 |
| 7 | 0 | 0 | 80.952 |
| 8 | 0 | 0.468 | 80.825 |
| 9 | 0 | 0 | 78.57 |
| 10 | 0 | 0.306 | 78.808 |
| 11 | 0 | 7.371 | 74.038 |

**COMPARISION USING BRICK INFILL EFFECT**

**Table -11:** Torsion

| Models | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|
| 1 | 0 | 0 | 79.271 |
| 2 | 0 | 0 | 78.292 |
| 3 | 0 | 0 | 80.007 |
| 4 | 0 | 0 | 79.014 |
| 5 | 22.41 | 0 | 55..465 |
| 6 | 0 | 0 | 81.352 |
| 7 | 0 | 0 | 79.438 |
| 8 | 0 | 2.214 | 81.653 |
| 9 | 0 | 0 | 79.647 |
| 10 | 0 | 0.231 | 79.479 |
| 11 | 0 | 8.607 | 73.985 |

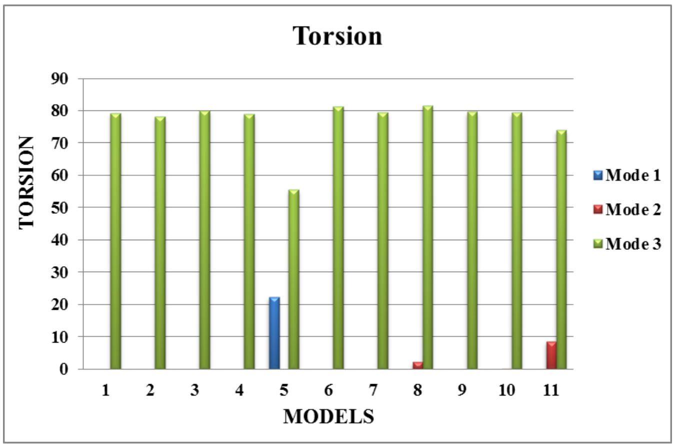



**Chart -11**: Torsion

- All the models with floating columns that Mode 1 and Mode 2 are in translation direction and Mode 3 is torsional direction, which is dominant in nature.
- In Mode 1 case, all models show nil values except model M5. In Model M5 shows translation effect this is due to open ground storey system.
- Bracing and infill complexities are increase the translation direction in structure when compared with without floating columns structure and it increase in translation of structure 125% to 500%, this is due to increase in stiffness of the structure.
- In Mode 2 case, similar trends was observed in Mode 2 and in this also observed model M8.
- By Removing columns floor wise in Model M9 and M10 also shows translation values in Mode 2 due to irregular stiffness in structure.
- In Model M11 over hanging system also shows translation effect.
- By providing bracing and infill in the system decrease the translation values when compared with without floating columns system. It was observed bracing system translation is less than the infill in Mode 2.
- In Mode 3 case, torsions were observed in all models. Floating column models shows is lesser torsion effect when compared with without floating columns structure except model M5. And model M11 over hanging system shows lesser torsion in floating columns system, M11 model decrease 20% torsion of Model M1.
- Function of bracing and infill increase the torsion effect compared with only floating columns structures except model M5.In model M5 observed that it shows inverted value due soft storey effect. In this only floating column shows more torsion than infill and bracing system.

## 4. CONCLUSIONS

The present study compares the difference between without floating columns and with floating columns structures and with structural complexities. Based on the analysis and design following conclusions were drawn based on the investigation.

1. Provision of floating columns into the structural system makes the system flexible there by reducing the base shear for seismic static and seismic dynamic loads.
2. Introduction of floating columns into cantilever structure proved to more efficient with respect to the stiffness.
3. With the provision of RC bracing and brick infills with floating column structures makes it less vulnerable to earthquake.
4. Infill proved to be more effective than the RC bracing system and hence making the floating columns structure more effective.
5. Displacement control is a very important part of design for any structural system. The floating columns structural system only shall not be preferred in zone of high seismicity as it shall resultant excessive of displacement and inter storey drift. Therefore RC bracing and infill walls become an integral part of design for displacement control.
6. The lumped mass idealization for evaluating time period of a floating column type of construction may prove to be inapplicable as basic assumption for a lumped mass is diaphragm rigidity.
7. Provision of bracing and infills into floating columns structure there is reduction in time period, contributing on overall stiffness of the structure.
8. Floating columns structure found to be less vulnerable for torsional stresses.

## REFERENCES


[1] Sukumar Behera, "*Seismic Analysis Of Multistory Building With Floating Column*" A Thesis Of National Institute Of Technology Rourkela, Pp. 21-93.

[2] Sabari S, Mr. Praveen J.V, International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online) Vol. 2, Issue 2, pp: (12-23), Available at: www.researchpublish.com Month: October 2014 - March 2015.

[3] A.P. Mundada and S.G. Sawdatkar, "*Comparative Seismic Analysis of Multistorey Building with and without Floating Column*". International Journal of Current Engineering and Technology E-ISSN 2277 – 4106,P-ISSN 2347 – 5161 Available at http://inpressco.com/category/ijcetVol.4, No.5, Oct 2014.

[4] Sreekanth Gandla Nanabala, Pradeep Kumar Ramancharla and Arunakanthi E, "*Seismic Analysis of A Normal Building and Floating Column Building*" International Journal of Engineering Research & Technology (IJERT) IJERTIJERT ISSN: 2278-0181 IJERTV3IS090685 www.ijert.org Vol. 3 Issue 9, September- 2014.

[5] Srikanth .M K, Yogeendra. R. Holebagilu, "*seismic response of complex buildings with floating column for zone ii and zone v*". International journal of Engineering Research Online http://www.ijoer.in ISSN: 2321-7758 Vol.2. Issue.4, August 2014.

[6] Mr. P.V. Prasad and T. Raja Sekhar, "*Study of Behaviour of Seismic Analysis of Multi Storied Building With and Without Floating Column*". Vol2, 697-710 Carib.j. SciTech, 2014.


## TEXT BOOKS


- Earthquake Resistance Design of Structure, Pankaj Agarwal and Manish Shrikhande.
- Earthquake Resistance Design of Structure, S K Duggal.
- Design of RCC Structural Elements, Bhavikatti.


## BIOGRAPHIES

**MAHESHA M** PG student in Structural Engineering at Alpha College Of Engineering, Bangalore and pursued B.E. in Civil Engineering from Government college of engineering, Mandya.
***Mail id: mp.mahesh07@gmail.com***

**K LAKSHMI** working as assistance professor in Alpha College Of Engineering. Has got 4 years' experience and pursued post PG degree from Visvesvaraya Technological University, Belagavi.
***Mail id: lakshmi1888@gmail.com***