seismic analysis of multistoried rcc building due to mass irregularity

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***Abstract* –**Multistoried buildings are designed as per Earthquake code IS: 1893-1984. Earthquake causes different shaking intensities at different locations and the damage induced in buildings at these locations is also different. There is necessary to construct a structure which is earthquake resistance at a particular level of intensity of shaking a structure. But during Bhuj earthquake, in Ahmedabad two buildings which were designed as per IS:1893-1984 and were found to be seriously damaged due to mass irregularity as a swimming pool was located at the 10^{th} floor. Here excess mass leads to increase in lateral inertia forces, reduced ductility of vertical load resisting elements and increased propensity towards collapse. Excess mass on higher floors produce more unfavourable effects than those at lower floors. Vertical Mass irregularity is an important factor which is to be considered while designing multi-storeyed building. This paper highlights the effect of mass irregularity on different floor in RCC buildings with as Response Spectrum analysis using STAAD-Pro V8i software. In this project work seismic analysis of RCC buildings with mass irregularity at different floor level are carried out. The Model Considered was of G+10 having swimming pool on 3^{rd}, 6^{th} and 9^{th} Floor. Maximum Base Shear along X and Z directions is also calculated. Lateral Displacements and Storey Drift is also evaluated for X and Z directions. Axial Forces, Torsion and Bending Moment are calculated for six different columns.

***Keywords* -** Vertical Irregularity, Storey drift, Storey Shear, Seismic Analysis ,Base Shear, Torsion, Axial Forces, Mass Irregularity, Bending Moment.

INTRODUCTION

The structures having this discontinuity are termed as Irregular structures. These structures contain a large portion of urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the ‘regular’ building.
Analyzing the structure for various Indian seismic zones and checking for multiple criteria at each level has become an essential. This paper shows the effect of different seismic zone on the performance of G+10 residential multi-storeyed RCC building. Maximum Base Shear along X and Z directions is also calculated. Lateral Displacements and Storey Drift is also evaluated for X and Z directions. Axial Forces, Torsion and Bending Moment are calculated for six different columns.

OBJECTIVE

- To analyze the multi storied building with mass irregularity during seismic forces for safety of structure.
- Modeling and analyzing effect of mass irregularity for different stories location of multistoried R.C.C. building.
- To analyze multistoried R.C.C. building by using STAAD PRO software as per IS 1893(Part 1):2002 and IS 456-2000 codes.
- Comparative study of structural parameters like base shear, storey drift, displacement of R.C.C. building.

MASS IRREGULARITY IN STRUCTURES

The irregularity in the structures is due to uneven distribution of mass, strength or stiffness or due to their structural form. The Analysis and design becomes complicated when these structures are constructed in high seismic zones. Hence seismic performance of irregular structures becomes very much important. Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 % of that of its adjacent storey’s. This article is having vertical irregularity in structures i.e. Mass irregularity should be considered. If the mass irregularity should be present at the top or bottom of the storey, there is increase in the average peak drift demand compared to regular structures. If the mass irregularity should be present at the middle of the structures there is lesser demand of drift corresponding to regular structures.

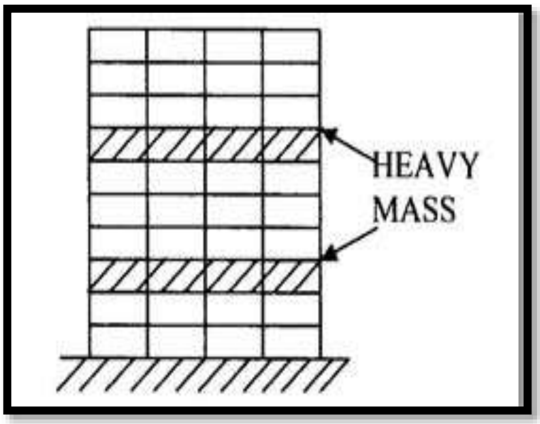

figure 1: mass irregularity in structure

With increase in the mass in one storey, there is increase in the inertia forces generated in that storey. If the percentage difference is small of changes in mass in comparison to the total mass of the building, the effect of mass irregularity is small on the mode shapes in regular buildings.

BUILDING DESCRIPTION

The main intention of modelling the following structures is to study the compare mass irregularity in R.C.C. structures at different floor levels. The structures considered here is a commercial complex building having G+10 storey model located in different seismic zone II, III, IV and V. The plan dimension of the building is 15m X 12m. Height of the storey is kept as 3.5m. Depth of foundation is kept as 3.5 m including 1 m plinth height. The study is carried out on R.C.C structure with one of the important consideration of Mass irregularity in the form of swimming pool at 3th, 6rd and 9th floor. The 3-D elevation of the building is shown in the fig. no. 02.

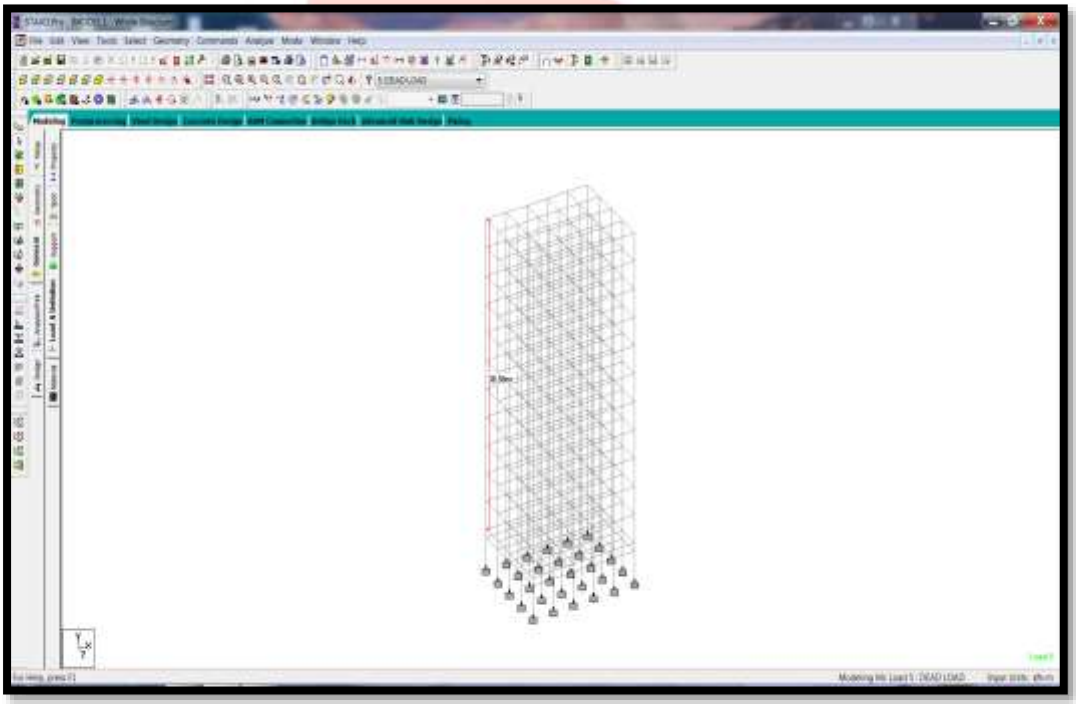

figure 2: 3d view of model

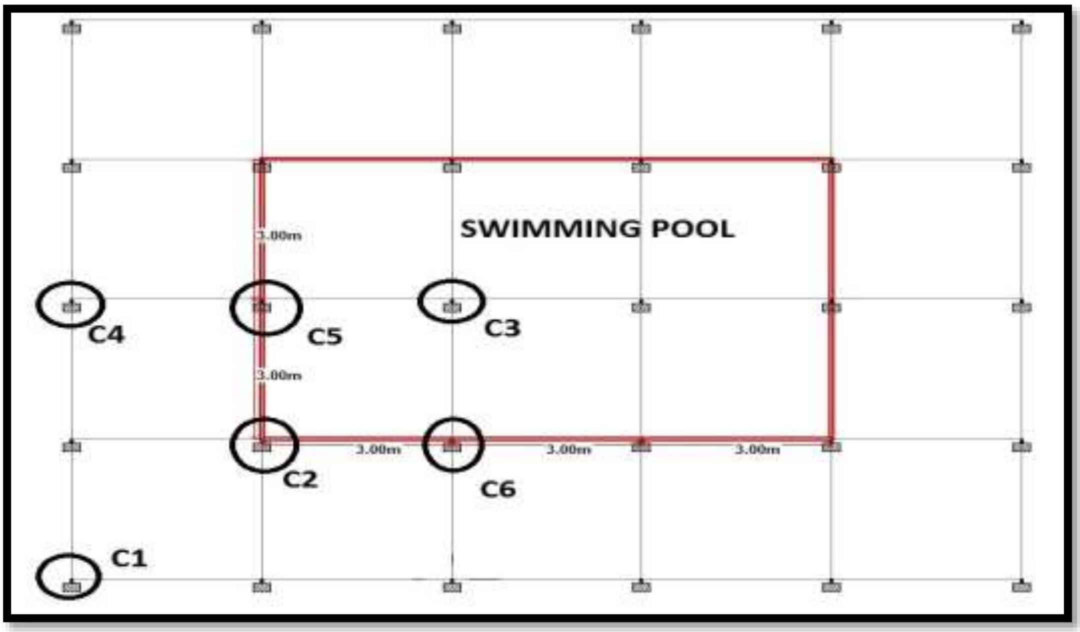

figure 3: overall top view of structure with swimming pool area

table 1: building data

PROPERTY	DIMENSION
SIZE OF COLUMN	800 X 600 MM
SIZE OF BEAM	450 X 300 MM
LIVE LOAD	4 KN/M^2
SLAB	125 MM
BAY ALONG X-DIR.	5
BAY ALONG Z - DIR	4
FLOOR FINISH LOAD	1.5 KN/M^2
PLINTH HT.	1M
STOREY HT.	3.5 M
SPACING OF COL.	3M
DEPTH OF FOUNDATION	3.5 M
DENSITHY OF CONCRETE	25 KN/M^2
DENSITY OF BRICK	20 KN/M2
THICKNESS OF INTERNAL WALL	115MM
THICKNESS OF EX. WALL	230 MM
PARAPET WALL HT.	1M
SWIMMING POOL LOAD	15 KN/M^2
ZONE	ALL SEISMIC ZONES
SOIL TYPE	MEDIUM SOIL
IMPORTANCE FACTOR	1.5
LOAD COMBINATION	1.5 (DL+LL) 1.2(DL+LL+_ EQ) 1.5(DL+_EQ) 0.9DL+_1.5EQ
SUPPORT TYPE	FIXED TYPE
SIZE OF SWIMMING POOL	6 X 9 M
SIZE OF BUILDING	15 X 12 M

RESULTS & DISCUSSIONS

A. BASE SHEAR

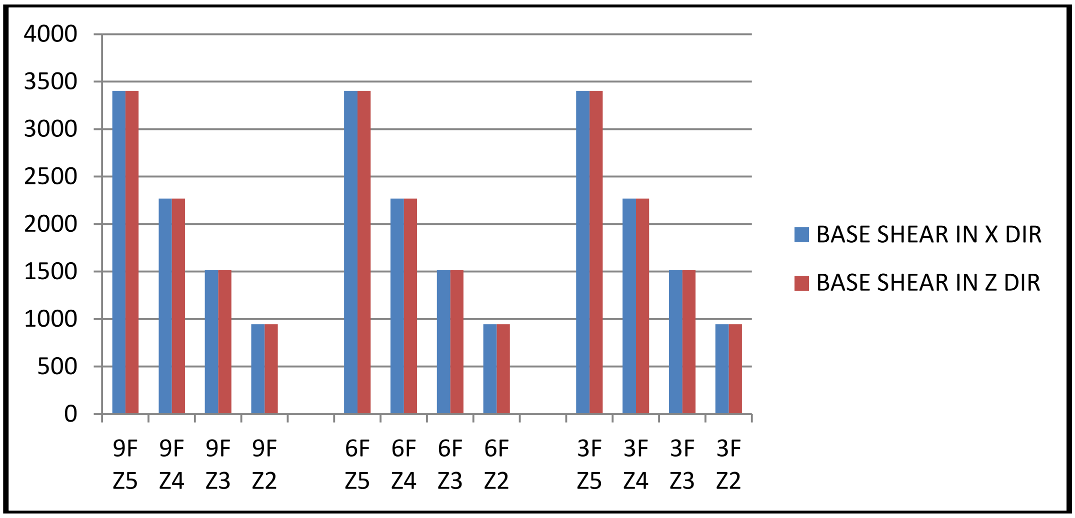

figure 4: base shear in x and z directions.

table 2: base shear in x and z directions.

MODEL	BASE SHEAR IN X DIRECTION (kn)	BASE SHEAR IN Z DIRECTION (kn)
9F Z5	3404	3404
9F Z4	2269	2269
9F Z3	1513	1513
9F Z2	946	946
6F Z5	3404	3404
6F Z4	2269	2269
6F Z3	1513	1513
6F Z2	946	946
3F Z5	3404	3404
3F Z4	2269	2269
3F Z3	1513	1513
3F Z2	946	946

Table 2 and Figure 4 shows Design base shear Values in X-direction & Z-direction. Design base shear obtained for Rcc structures having mass irregularity at 3th, 6rd and 9th floor is same as per their seismic zones.

B. STOREY DRIFT

table 3: storey drift in x direction

FOOTING	9F Z5	6F Z5	3F Z5
GF	6.85	6.85	6.851
1F	11.123	11.121	11.123
2F	13.633	13.631	13.632
3F	14.283	14.468	14.455
4F	14.726	14.532	14.489
5F	14.13	14.119	14.061
6F	13.348	13.289	13.264
7F	12.208	12.077	12.102
8F	10.7	10.523	10.576
9F	8.793	8.664	8.705
10F	6.588	6.565	6.594
TER	4.67	4.682	4.698

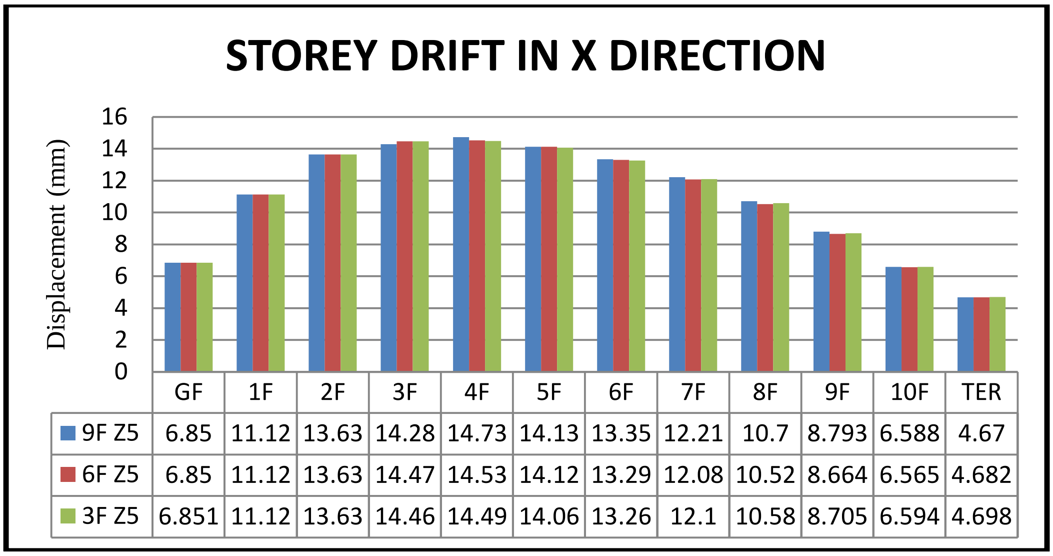

figure 5: storey drift in x direction

table 4: storey drift in z direction

FOOTING	9F Z5	6F Z5	3F Z5
GF	8.53	8.53	8.531
1F	13.239	13.237	13.239
2F	15.909	15.907	15.909
3F	16.617	16.613	16.597
4F	16.572	16.565	16.519
5F	16.087	16.074	16.008
6F	15.224	15.162	15.129
7F	13.972	13.82	13.853
8F	12.293	12.092	12.152
9F	10.122	9.969	10.015
10F	7.498	7.476	7.509
TER	5.079	5.092	5.109

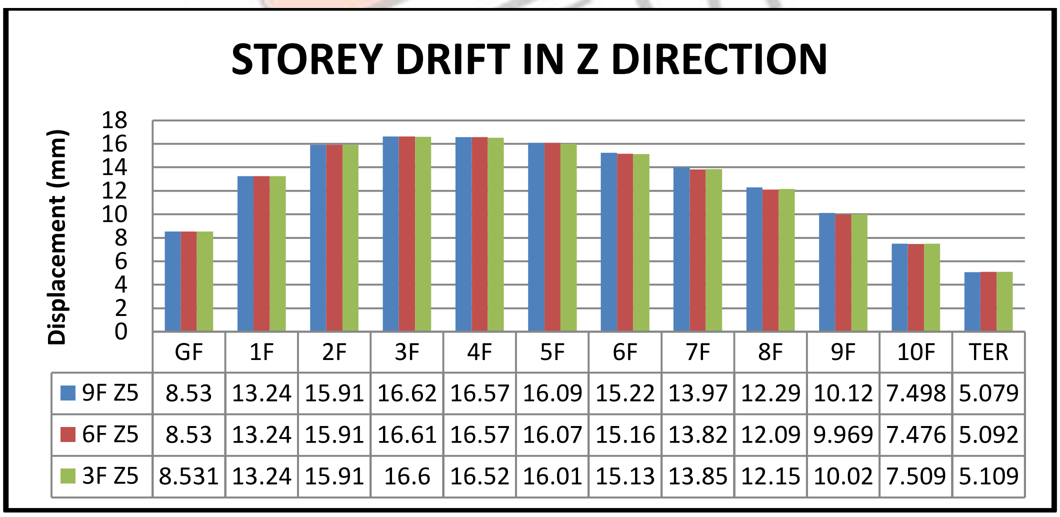

figure 6: storey drift in z direction

In the above Tables and Figures drift values are presented storey wise in X-direction and in Z-direction. Storey drift which is defines as displacement of any storey relative adjacent storey. Permissible limit of storey drift 14 mm as per IS1893 (Part1)-2002. By analysis of G+10 storey structure it is found that maximum storey drift of RCC structure is 14.726 mm and 16.617mm in X and Z direction respectively.Storey Drift is mainly critical in 3,4 and 5 floor.

C. LATERAL DISPLACEMENTS –

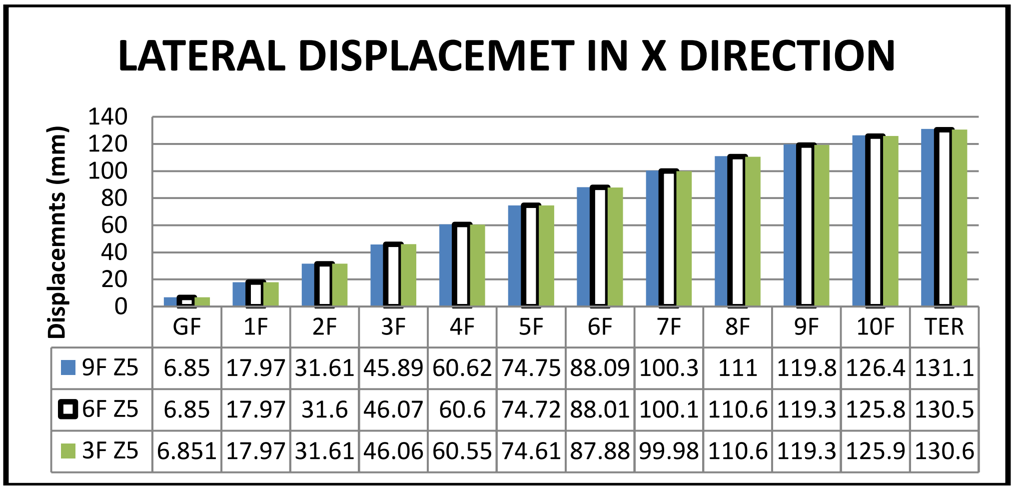

figure 7: lateral displacements in x direction

table 5: lateral displacements in x direction

FOOTING	9F Z5	6F Z5	3F Z5
GF	6.85	6.85	6.851
1F	17.973	17.971	17.974
2F	31.606	31.602	31.606
3F	45.889	46.07	46.061
4F	60.615	60.602	60.55
5F	74.745	74.721	74.611
6F	88.093	88.01	87.875
7F	100.301	100.087	99.977
8F	111.001	110.61	110.553
9F	119.794	119.274	119.258
10F	126.382	125.839	125.852
TER	131.052	130.521	130.55

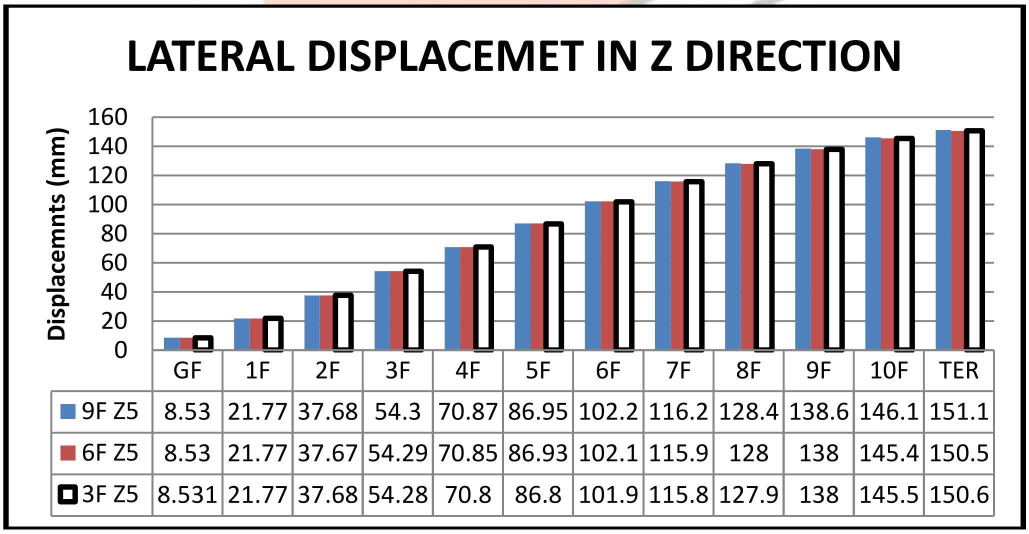

figure 8: lateral displacements in z direction

table 6: lateral displacements in z direction

FOOTING	9F Z5	6F Z5	3F Z5
GF	8.53	8.53	8.531
1F	21.769	21.767	21.77
2F	37.678	37.674	37.679
3F	54.295	54.287	54.276
4F	70.867	70.852	70.795

5F	86.954	86.926	86.803
6F	102.178	102.088	101.932
7F	116.15	115.908	115.785
8F	128.443	128	127.937
9F	138.565	137.969	137.952
10F	146.063	145.445	145.461
TER	151.142	150.537	150.57

The above Tables and Figures show values of joint displacements for structures having mass irregularity at 3^{th}, 6^{rd} and 9^{th} floor. Lateral Displacements increases as per the floor level increases. It is maximum at terrace.

CONCLUSION

In this study Mass irregularity is an important factor to be considered along with other relevant. Joint displacement, base shear and storey drift will help to decide which structure is efficient. Based on analysis and study on previous chapters will draw some conclusions which are presented below.

- The graph of models is compared with each other and behaviour is studied, but not much change is seen, except magnitude is increase in different zones.
- According to RSA results, the storey shear force was found to be maximum for the first storey and it decreased to a minimum in the top storey in all cases.
- Permissible limit of storey drift 14 mm as per IS1893 (Part1)-2002. By analysis of G+10 storey structure it is found that maximum storey drift of RCC structure is 14.726 mm and 16.617mm in X and Z direction respectively. Storey Drift is mainly critical in 3,4 and 5 floor.

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