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Analysis of RC G+10 Structure for Mass Irregularity Subjected to Earthquake Loading

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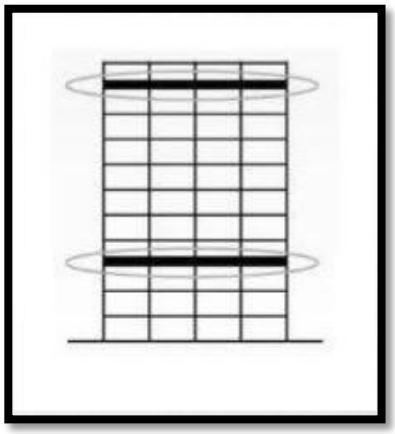
ABSTRACT: The seismic performance of buildings with irregular distribution of mass, stiffness, and strength along the height may be significantly different from that of regular buildings. Design codes prohibit construction or recommend special seismic design of such buildings depending on the level of irregularity and site hazard. It is generally believed that the regular buildings have a dominant fundamental mode participation in their seismic response and as the irregularity increases the contribution of higher mode increases. Accordingly, previous studies have proposed methodologies to quantify the vertical irregularity of the buildings in terms of their fundamental mode properties. This paper checks the adequacy of fundamental mode properties for the quantification of vertical irregularity. Further, this study attempts to check the correlation between existing vertical irregularity indicators and the seismic risk.

KEYWORDS: Shear wall, Response spectrum analysis, story shear ,base reaction ,displacement,auto lateral load

1. INTRODUCTION

In an earthquake, the weakest parts collapse first. Due to space constraints and uneven terrain, multi-storied irregular constructions are need urban infrastructure is irregular. Because earthquake stresses contribute shear and twisting to uneven buildings, they degrade seismic performance. Existing buildings are irregular because exact regularity is uncommon. Multi-story irregular buildings are needed due to space constraints and uneven terrain. As earthquake stresses add shear and twisting to uneven buildings, they drastically impair seismic performance. One of the main causes of a seismic collapse was irregular structural alignments in an elevation or layout. Seismic standards differentiate between plan and vertical irregularities

- **MASS IRREGULARITY :-**Storeys with seismic weights above 200 percent of their neighbours have mass irregularity. Roof irregularity disregarded.



These blueprints provide a height and bay comparison. ETABS examines structural skeletons. Torque, shear, bending moment, drift, and displacement between floors. Regulated by IS

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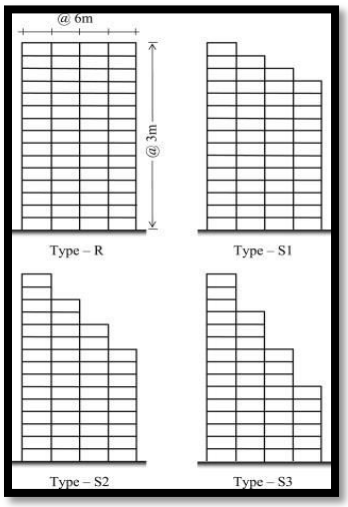
1893:2002, seismic analysis (1). All of the scenarios use medium soil and a seismic zone IV. The intensity of an earthquake is affected by elevation. type R, type S1, type S2, type S3.



II.RELATED WORK

(1) **Prakash Sangamnerkar et. al. has done the comparative study on the static and dynamic[**behavior of reinforced concrete framed regular building. Comparison of static and vibrant behavior of a six storey's structure is considered in this paper and it is analyzed by using computerized solution available in all four seismic zones i.e. II, III, IV and V. It is observed that parameters like base shear, nodal displacements and beam ends forces varies in the same ratio as described above, hence it is very important conclusion derived in the analysis.(1)

(2) Mohit Sharma et. al. considered a G+30 storied regular reinforced concrete framed building. Dynamic analysis of multistoried Building was carried out. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parametersfor the design as per the IS-1893- 2002-Part-1 for the zones- 2 and 3. It was concluded that not much difference in the values of Axial Forces as obtained by Static and Dynamic Analysis. (2)

(3) M. S. Aainawala et. al. done the comparative study of multistoried R.C.C. Buildings with and without Shear Walls. They applied the earthquake load to a building for G+12, G+25, G+38 located in zone II, zone III, zone IV and zone V for different cases of shear wall position. They calculated the lateral displacement and story drift in all the cases. It was observed that Multistoried R.C.C. Buildings with shear wall is economical as compared to without shear wall. As per analysis, it was concluded that displacement at different level in multistoried building with shear wall is comparatively lesser as compared to R.C.C. building without shear wall.(3)

(4) Anwaruddin M. et. al. carried out the study on non linear Static Pushover Analysis of G plus 3 medium rise reinforced cement concrete structure with and without vertical irregularity. It was seen that irregularity in height of the

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building reduces the performance point of structure. There was reduction in displacement or deformation of the RCC building also. They concluded seeing that the no of bays reduces upright, the lateral load carrying capacity increases with decline in lateral displacement. (4)

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(5)Rui Pinho et.al. revised eurocode 8 formulae for periods of vibration and their employment in linear seismic analysis. This paper takes a critical look at the way in which seismic design codes around the world have allowed the designer to estimate the period of vibration for use in both linear static and dynamic analysis. Based on this review, some preliminary suggestions are made for updating the clauses related to the estimation of the periods of vibration in Eurocode 8. (5)

(6)Rakesh K. Goel and Anil K. (1997) studied the period formulas for moment-resisting frame buildings. Based on analysis of the available data for the fundamental vibration period of 27 RC MRF buildings and 42 steel MRF buildings, measured from their motions recorded during earthquakes different formulas were used for estimating, conservatively, the period of RC and steel buildings; respectively .Regression analysis was done to obtain the coefficient of empirical formula for fundamental period. (6)

(7)Sarkar et. al. proposed a new method of quantifying irregularity in vertical geometric irregular building frames, which deals with the dynamic characteristics i.e. stiffness and mass. This paper discusses some of the important issues regarding analysis and design of stepped buildings. They proposed a fresh method for quantifying the irregularity in stepped building. This approach is found to execute better than the existing procedures toquantify the irregularity. The total 78 stepped frames with varying irregularity and height were taken in this study. They proposed a correction factor to the empirical code formula for fundamental period, to provide it applicable for vertical geometric stepped buildings. (7)

(8)Sujit Kumar et. al (2014) studied the effect of sloping ground on structural performance of rccbuilding under seismic load. The seismic analysis of a G+4 storey RCC building on varying slope angles i.e., 7.50 and 150 is carried and compared with the same existing on the flat ground. The seismic loadings are as per IS: 1893-2002. STAAD Pro v8i is used in this study to see the effect of sloping ground on building performance during earthquake. Seismic analysis has been done using equivalent Linear Static method. The analysis is carried out to estimate the effect of sloping ground on structural forces. The bending moment, horizontal reaction in footings and axial force in columns are critically analysed to enumerate the effects of various sloping ground(8)

(9)Mahesh N.Patil, Yogesh N. Sonawane et al (2015)In this paper, the earthquake response of symmetric multistoried building is studied by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The responses obtained bymanual analysis as well as by soft computing are compared. This paper provides complete guide line for manual as well as software analysis of seismic coefficient method.(9)

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(10)Mohammed yousuf, P.M. shimpale et al (2013) The main objective of earthquake engineering is to design and build a structure in such a way that the damage to the structure and its structural component during an earthquake is minimized. This paper aims towards the dynamic analysis of reinforced concrete building with plan irregularity. Four models of G+5 building with one symmetric plan and remaining irregular plan have been taken for the investigation. (10)

(11)Ni Ni Win, Kyaw Lin HtaT et al (2014)This paper presents comparative study of static and dynamic analysis of irregular reinforced concrete building due to earthquake. In present study, computer aided analysis of twelve-storied reinforced concrete building is carried out for static and dynamic analysis by using ETABS (Extended Three dimensional Analysis of Building System) software. Load consideration is based on Uniformed Building Code (UBC-1997). The structure is designed in accordance with American Concrete Institute (ACI-318-99) design code. (11)

III. METHODOLOGY

1.DEAD LOAD

Building design assumes dead weight as material unit weight. Load calculation includes various building component unit weights. IS 875 part 1 has dead loads.

2 .LIVE LOAD

Buildings consider live load. It helps move people, furniture, and other items. Air ,earthquake,snow,and other loads are excluded from this load. IS 875 part

3. LOADS AND COMBINATION

Limit state reinforced concrete structure design considers the following seismic forces. IS 1893-2002

Live load : 2 KN/m

Dead load :1 KN/m

LOAD COMBINATION:

1 1.5(DL+Ll)

2 1.2(DL+Ll+EL)

3 1.5(DL+EL)

4 0.9DL+1.5EQX

5 0.9DL+1.5EQY

6 0.9DL-1.5EQX

7 0.9DL-1.5EQY

8 1.5DL+EQX

9 1.5DL+EQY

10 1.5DL-EQX

11 1.5DL-EQY

12 1.2DL+1.2LL+1.2EQY

13 1.2DL+1.2LL-1.2EQX

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14 1.2DL+1.2LL-1.2EQY

Where DL, LL, and EL respresent dead load, imposed load , and intended seismic load response quantities.

Type R, Type S1 is terms used in seismic design and classify different types of building based on their seismic performance

Type R structures are possess a regular and uniform distribution of mass and stiffness along both vertical and horizontal axes. This regularity in mass and stiffness helps ensure a more predictable and consistent response to seismic forces.

Type S1 structures are a category of irregular buildings that have certain irregularities in their mass or stiffness distribution the irregularities are considered moderate.

While Type S1 structures exhibit performance is still expected to be reasonably predictable and compared to type R structures.

3.1 SEISMIC ANALYSIS

1. MODEL1: MODELING AND ANALYSIS TYPE R STRUCTURE

2. MODEL2: MODELING AND ANALYSIS TYPE S1 STRUCTURE

3. MODEL3: TYPE S1 WITH SHEAR WALL STRUCTURE

IV. RESULT AND COMPARISON

The requirement for base reaction values is that they must be greater than 84%, and the RCC model demonstrates good values meeting or exceeding this criterion, it indicates that the RCC model is performing well in terms of base reactions. This implies that the foundation of the RCC structure can effectively support the applied loads and distribute them evenly to the underlying soil.

Comparatively, the Type S1 and Type S1 with shear wall models should also be evaluated to determine if their base reaction values meet or exceed the minimum requirement of 84%. If either of these models fails to meet the criterion, it suggests that their foundation design or lateral load distribution may be less efficient than the RCC model.

The requirement for response reduction factor values is that they must be greater than 90%, and all the models, including the RCC model, have passed this criterion, it suggests that all the models have acceptable response reduction factors. While the RCC model may exhibit a marginal difference in its response reduction factor compared to the other models, it is still within the acceptable range. This implies that the RCC model provides an adequate level of energy dissipation and structural damping to resist seismic forces.

If the mass irregularity considerable for the analysis in displacement with x &y direction. the comparisons of the result will give the proper analysis of final model.

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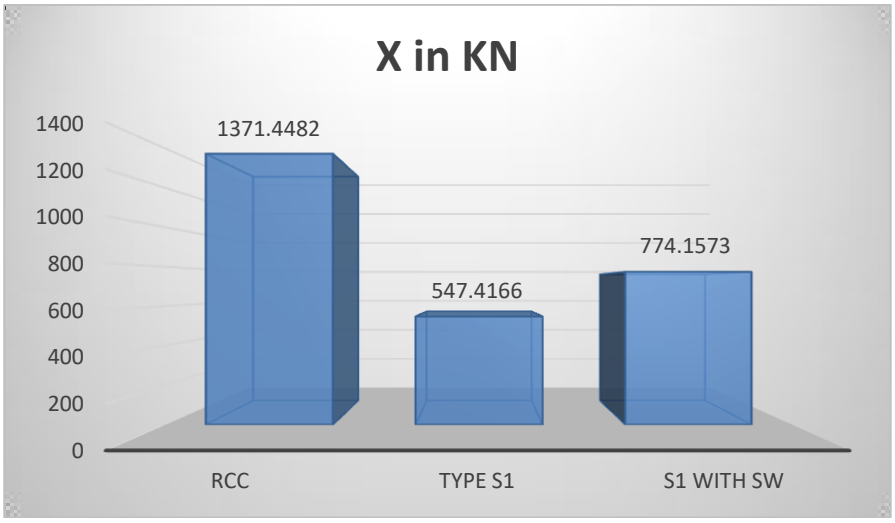
TABLE 1: BASE REACTION

BASE REACTION	MODEL	RSMAX	EQX	BS>84%
	RCC	4321.1463	5643.2581	76.5718
	TYPE S1	4281.723	5004.6803	85.5544
	S1 WITH SW	6166.3243	8857.6432	69.6159



RESPONSE REDUCTION	MODEL	SUM UX	SUM UY	UX %	UY %
	RCC	0.994	0.9943	99.4	99.43
	TYPE S1	0.9932	0.9937	99.32	99.37
	S1 WITH SW	0.9769	0.9869	97.69	98.69

TABLE 2; RESPONSE REDUCTION

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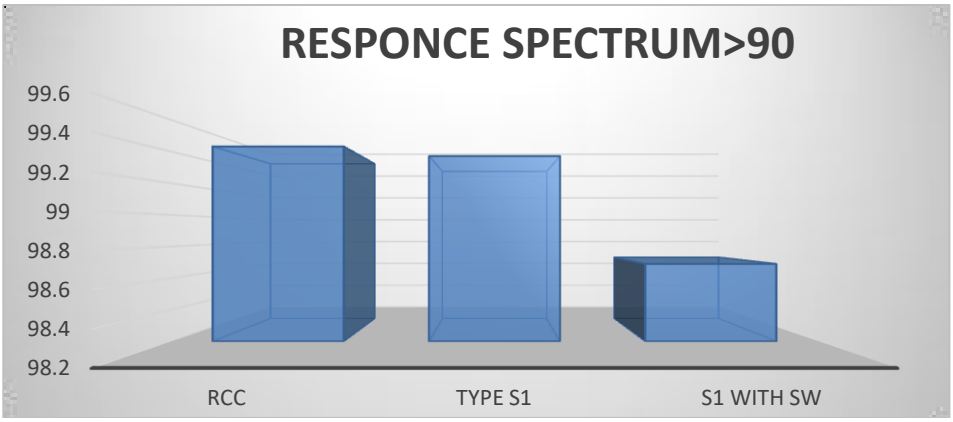
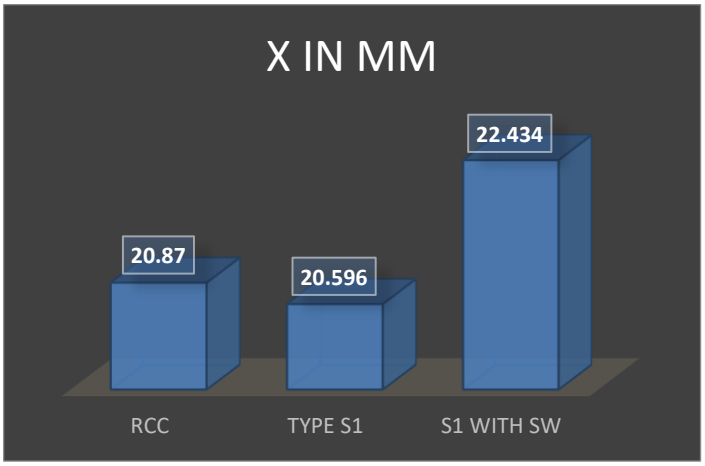


DISPLACEMENT

X-Direction

TABLE 3 ; DISPLACEMENT

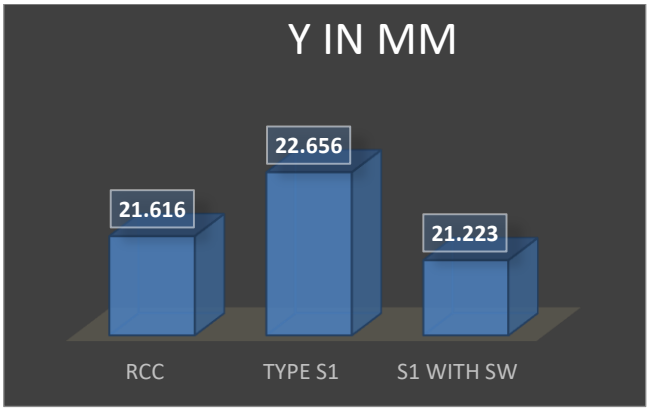
MODEL	X in mm
RCC	20.87
TYPE S1	20.596
S1 WITH SW	22.434



Y-Direction

TABLE 4; DISPLACEMENT

MODEL	Y in mm
RCC	21.616
TYPE S1	22.656
S1 WITH SW	21.223



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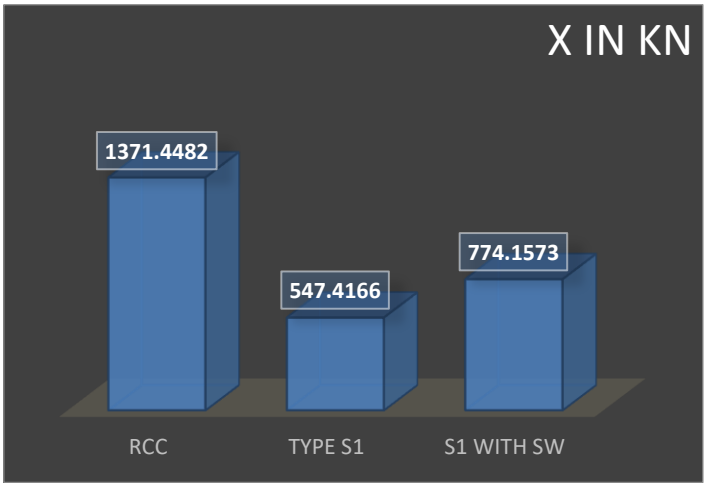
AUTOLATERAL LOADS

X-Direction

Table 5 ; Auto lateral load

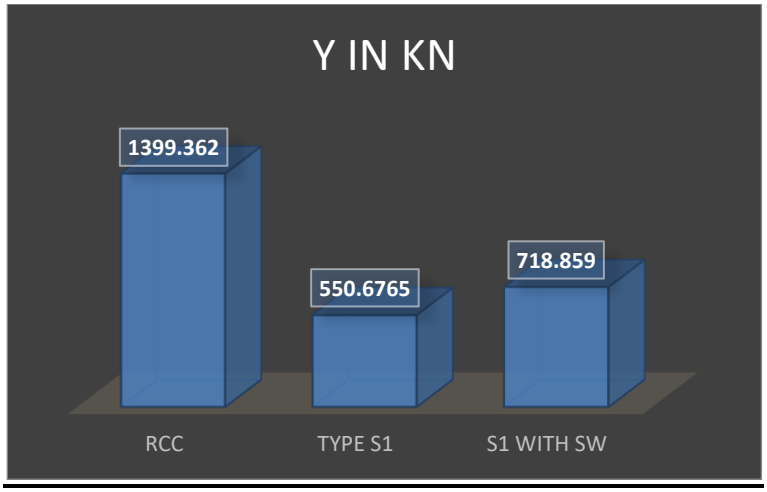
MODEL	X in mm
RCC	1371.448
TYPE S1	547.4166
S1 WITH SW	774.1573



Y-Direction

Table 6; Autolateral loads

MODEL	Y in mm
RCC	1399.36
TYPE S1	550.677
S1 WITH SW	718.859



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V. CONCLUSION AND FUTURE WORK

1. The simulation In both the X and Y dimensions, the Displacement of Type S1 form performs somewhat better than the RCC model.
2. When compared to the RCC model, the Type S1 model's lower storey shear values indicate more resistance to lateral pressures.
3. When comparing the RCC model with the Type S1 model, we can see that the Type S1 model has greater resistance to lateral forces and hence lower auto lateral load values.
4. Considering the results in terms of displacement, narrative shear, and auto lateral load, the Type S1 model is preferable to the RCC model.
5. In terms of displacement, narrative shear, and auto lateral load, the Type S1 model outperforms the RCC form in the study and comparison. These characterstics are not noticeably better in the Type S1 model with shear walls than in the Type S1 model without shear walls.
6. it is recommended to center on the Type S1 model without shear walls, as it demonstrates better performance compared to the RCC model while potentially being more cost-effective and easier to construct.

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