PARAMETRIC STUDY OF RESPONSE OF AN ASYMMETRIC BUILDING FOR VARIOUS EARTHQUAKE RESISTANCE FACTORS

Sundareson A[1], Ganesh Baravkar[2], Vijaya Sarathy R[3]

[1]*PG Student, Applied Mechanics Department, S.V.National Institute of Technology, Surat, Gujarat, India*
[2]*PG Student, Applied Mechanics Department, S.V.National Institute of Technology, Surat, Gujarat, India*
[3]*Asst.Professor, Civil Engineering Department, Prist University, Thanjavur, Tamilnadu, India*

Abstract

Earthquake is a major concern in high seismic prone areas. The structure which lies in seismic zones are to be specially designed. The goal of earthquake-resistant design is to construct structures that fare better during seismic activity than their conventional counterparts. In this paper a study is conducted on the performance of a asymmetric structure, with plan irregularity, strength and stiffness irregularities. The factors which influence the earthquake resistance in a structure are Shear wall, Strong column, Base isolation, Brick infill and use of dampers. Out of above parameters, some of the above parameters are considered for the current study, like Shear wall, Strong column, Brick infill. A time history analysis is performed using SAP 2000 software, a comparative discussion is made on the response of structure between normal building and building which is designed for earthquake resistant. The results showed that it was important to select a suitable parameter, for the type of resistance that the building must offer. This parametric study clears the importance of each earthquake resistance factors.

Keywords: *Asymmetric building, Strong column, Shear wall, Brick infill*

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1. INTRODUCTON

There are many earth quake resistant factors which can be considered while designing a structure. Some of the factors are Strong column, weak beam, Shear wall, Base isolation. The behaviors of each of these factors are unique. The performance of a structure for these factors can be studied analytically and experimentally. Behavior of a simple structure for these factors will give a good vision about the importance of these factors. This paper will give a brief idea about Strong column, Shear wall and Brick infill placed in a simple structure (Fig: 1.1)

2. ANALYSIS

The building configuration is simple G+3 floors and staircase is assumed to be placed separate. All the columns are assumed as fixed in its base. It is a residential building, live load is taken from IS 875 (Part 2). Analysis is made in SAP 2000 software. The analytical model of the structure is shown in fig 2.2. Time history of Buij(26th Jan 2001) is used for dynamic analysis. Fig 2.1 shows the structure model of all types compared. The first model Fig 2.2a shows Normal structure and referred to as N. This normal structure has a beam size of 230mm X 450mm and column 230mm X 300mm. Fig 2.2b shows the structure with strong column, and referred as ST. The sizes of ST are for beam 230mm X 450mm and column 300mm X 500mm. The third is presented in Fig. 2.2c is denoted by SW, which represents shear wall structure. Size of shear wall is 100mm thick and 1000mm width, beams of 230mm X 450mm & column 230mm X 300mm. The last model is a Brick infill model, for this the structure is covered with the masonry 230mm brick infill and represented by BI.

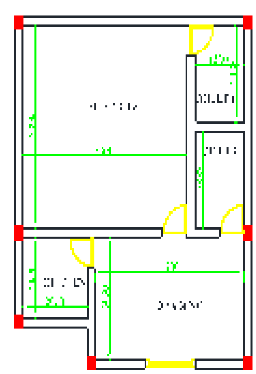


Fig: 1.1 Plan view of the Building

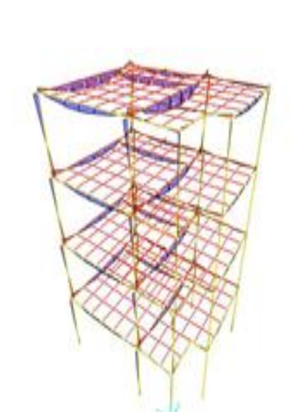
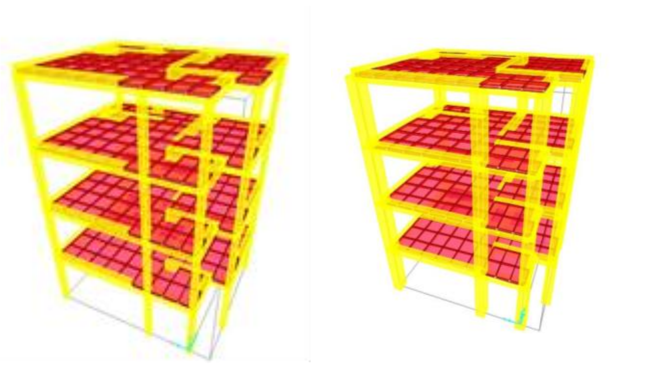
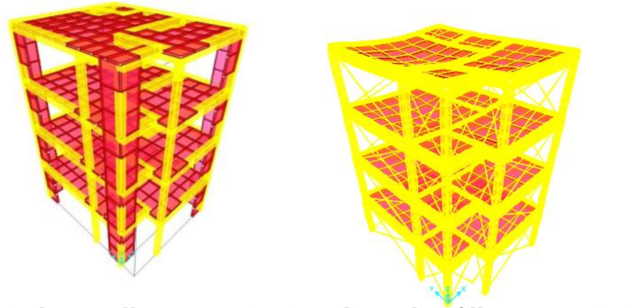


Fig: 2.1 Bending moment of Normal building



a) Normal Structure (N) **b)** Strong column structure (ST)



c) Shear wall structure (SW) **d)** Brick Infill structure (BI)

Fig: 2.2 Model of Structures compared

In the first 3 models, input is given in SAP 2000. But for the 4th model, brick infills are modeled as equivalent diagonal strut model. In fig 2.3, the thickness of strut is given. By equation 1[1], 2[1] and table2.1, the width of the strut is calculated.

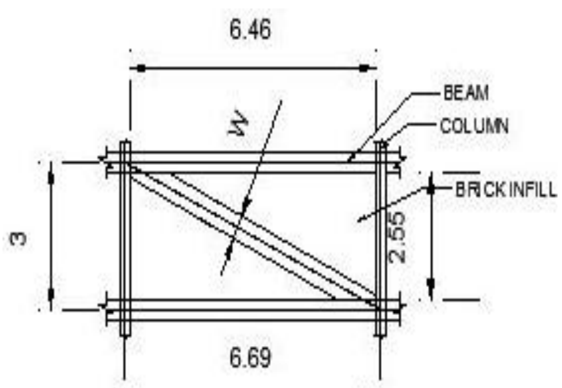


Fig: 2.3 Brick infill model

Width of strut $W = 0.175\,(\lambda H)^{-0.4}\sqrt{H^2 + L^2}$…… Eq 1

Where,

$\lambda = (E_t t \sin 2\theta / 4 E_c I_c H_i)^{1/4}$……………………Eq 2

Table – 2.1: Brick Infill strut width

t	Wall thickness in mm	230
L'	Column centre to centre length in mm	6690
L	Wall length in mm	6460
H	Height of column in mm	3000
Hi	Height of wall in mm	2550
d	Length of strut in mm = $\sqrt{(H^2 + L'^2)}$	7331.86
Icol	Inertia of column in mm^4	517500000
Eme	Young's modulus of wall[1] in N/mm^2	5000
Efe	Young's modulus of frame[1] in N/mm^2	28500
θ	$\tan^{-1}(Hi/L')$	24.15
2θ		48.31
λ		0.00155
W	Width of wall strut in mm	23.25

3. RESULTS AND COMPARISION

Outputs are tabulated and compared for maximum magnitude of response for time history in 'x' and 'y' axis . Comparative graphs are also shown, from which the behavior of each structure is clearly seen.

3.1 Comparison of Base Shear

Base shear, is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. Table 3.1, shows the comparison of base shear of the three models in maximum time history in 'x' axis. From the table 3.1 and graph (fig 3.1), the base shear of ST is greater than N. In first mode ST takes 6.77% more shear than N. SW resists 5.27 % less than ST and 1.14% more than N. BI takes 6.17% less than SW, 12.11% less than SW and 7.23% less than N.

Table – 3.1: Base Shear

Mode	Normal	ST	SW	BI
	GlobalFX in KN			
THx	24016.772	25642.395	24291.036	22534.954
THx	-25345.15	-22654.04	-26696.55	-18842.45
THy	1109.02	2227.825	6429.53	1956.165
THy	-1183.362	-2798.901	-6577.276	-1842.168

3.2 Comparison of Joint Displacement

Displacement is studied in joint 57 (Joint at roof level). Roof level joint will give maximum displacement due to its cantilever action. Table 3.2, shows the displacement comparison between time history modes. When the structure is flexible, then it undergoes many displacements. Comparison shows N must be flexible then ST, SW & BI.

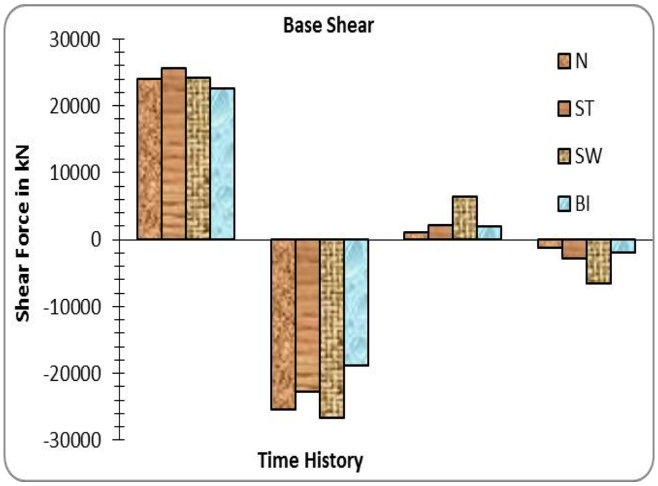


Fig: 3.1 Comparison of Base shear force

Table - 3.2: Displacements of Joint 57 in m

Mode	Normal	ST	SW	BI
	GlobalFX in KN			
THx	2.501622	0.677162	0.799879	0.6269
THx	-2.08726	-0.70574	-0.69793	-0.74185
THy	0.695146	0.20538	0.357715	0.052074
THy	-0.57381	-0.24406	-0.35571	-0.07518

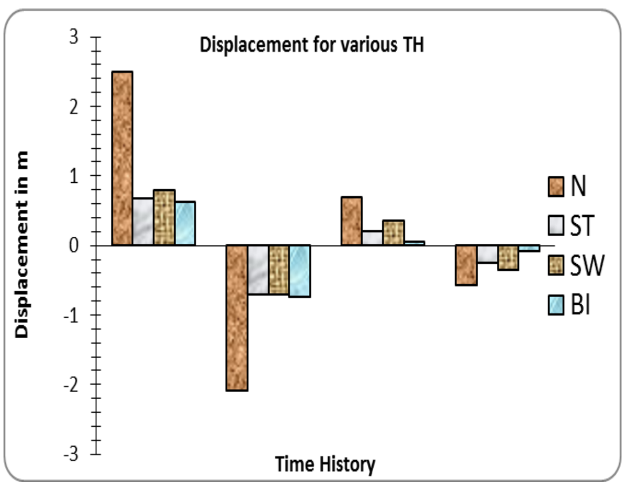


Fig: 3.2 Comparison of Displacement of Joint 57

3.3 Comparison of Floor Displacement

While seeing the floor displacement, N undergoes more displacement, when compared to ST, SW &BI. Due to the brick infill, the floor displacement is less in roof level.

Table - 3.3: Floor Displacement For Thx

Floor	Normal	ST	SW	BI
	GlobalFX in KN			
4	2.50162	0.67716	0.79987	0.626
3	2.14367	0.52310	0.61232	0.54100
2	1.50995	0.31786	0.37299	0.39532
1	0.70201	0.11006	0.13365	0.20360
0	0	0	0	0

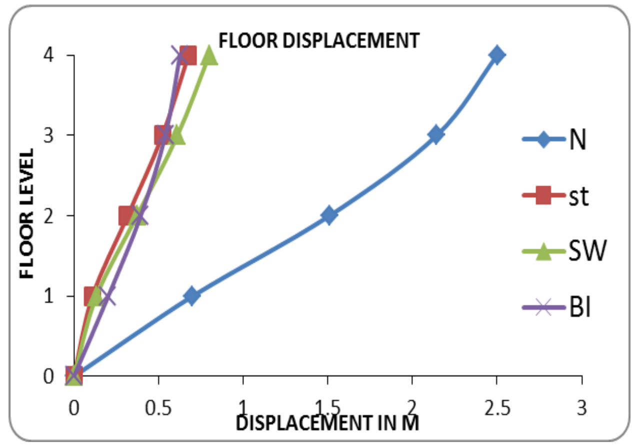


Fig: 3.3 Floor displacements for THX

3.4 Comparison of Time Period

Time period is decreasing, when the mass of the structure gets increased. That can be seen by the table 3.4. But while comparing BI, the time period for 1st mode is more than other models & less in the other 3 modes.

Table - 3.4: Modal Periods in Seconds

Mode	Normal	ST	SW	BI
	GlobalFX in KN			
1	0.802793	0.427437	0.401211	0.937461
2	0.726349	0.38719	0.370544	0.429596
3	0.511689	0.278201	0.243452	0.367461
4	0.27263	0.118884	0.105881	0.259773

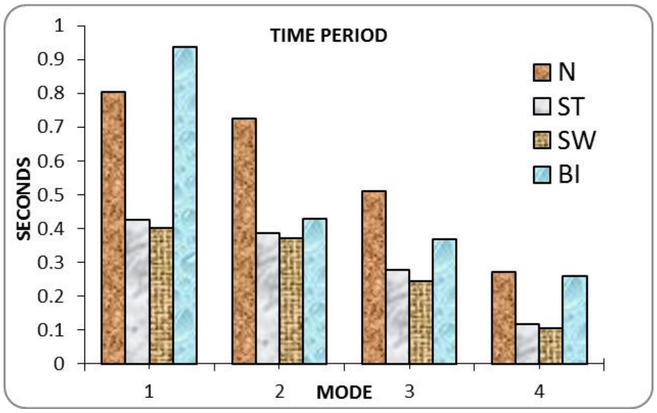


Fig: 3.4 Comparison of Time periods for 4 modes

4. CONCLUSIONS

In this paper comparison of Normal structure with Strong column, Shear wall and Brick infill structures for same configuration is carried out. From this study it is clear that as the stiffness of building increases due to inclusion of Strong column, Shear wall and Brick infill, the maximum base shear force increases while story displacement decreases. Also the fundamental time period of the structure decreases in Strong column, Shear wall and Brick infill as compare to Normal structure. Though Strong column, Shear wall are good while compared to normal structure, Brick infill structure undergoes less displacement and more time period than those ST & SW models. Therefore it is recommended to go for brick infill in a simple structure.

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BIOGRAPHIES

Sundareson A, is an MTech student in SVNIT. His Currently research area is Space frame connectors and Earthquake analysis.

Ganesh Baravkar, is an MTech student in SVNIT. His Currently research area is Earthquake analysis and load transfer path analysis in structures

Prof.Vijaya Sarathy R is Asst.Prof in Civil Engineering Department at Prist University. His research field is Concrete technology and Steel structure connections