STUDY OF SEISMIC BEHAVIOR OF CONVENTIONAL AND RC WALL BUILDING

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Abstract

In multi storey buildings earthquake forces will have a very high impact on any form of the structure. In recent years the construction industry had developed many new technologies. MIVAN construction technology is also one of them. It has been adopted all over the world because the construction is speedy. This work is conducted to come up with the realistic conventional and RC wall building models to study the seismic behavior under fixed base. The main objective of the work is to study the seismic behavior of the conventional and RC wall building and to study the performance of both the buildings under earthquake generated forces. In this work a G+7 storey conventional (beam, column, slab) building and RC Wall Building (mivan construction) of same plan is considered. The models of both buildings are created using ETABS version 15.2.0. To study the seismic behavior of the both conventional and RC Wall buildings the response spectrum analysis was performed on both models as per the Indian Standard Code IS 1893:2002 Part1. From the analysis results it was found that the RC Wall Building performs better compared to the Conventional Building.

***Keywords**: Mivan Construction, RC Wall Building, Conventional Building, ETABS Version 15.2.0.*

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1. INTRODUCTION

In recent years the development in urbanization is showing rapid growth all over the world. This has initiated the concept of multi-storey buildings. The construction technology is improving day by day, one of such recent construction technologies is mivan construction technology. The conventional buildings are the ones which are built with the conventional construction practice that is beam-column and slab concept. In the recent past mivan construction technology has developed and widely used all around the world and even in India this technology has been adopted in may major cities. The buildings built with this technology consist of the RC wall with the slab resting on them. This technology is widely adopted because of the speedy construction. These multi-storey buildings are highly susceptible to the lateral forces induced by the strong earthquake ground motion.

2. OBJECTIVE OF THE WORK

The main objective of this work is to study the seismic behavior of the RC Wall Building in comparison with the conventional one. For this, in the present work the behaviors of the buildings are compared in all the four earthquake zones as per the Indian Standard Code IS 1893 : 2002.

3. METHEDOLOGY

In the present project work two different types of reinforced concrete buildings with G+7 storeys are being considered to study the seismic responses in fixed condition. The two different models considered are beam-column, slab type conventional RC building and the other one is RC wall type building. Both the type of the buildings were modeled using the software package ETABS version 15.2.0. The full description of both models generated in ETABS with figures is as given.

Conventional Building	
Number of floors	G+7
Height of each floor	3.15 m
Size of the column	600 mm X 200
Size of the beam	200 mm X 450
Thickness of the slab	150 mm
Thickness of the concrete block	200 mm
Thickness of the concrete block	150 mm
Height of the plinth above the	1.5 m
Height of the parapet	1 m
Thickness of the parapet wall	150 mm
Number of lift cores	2
Size of the lift core	2.05 m X 2.15 m
Thickness of the lift core wall	200 mm
RC Wall Building	
Number of floors	G+7
Height of each floor	3.15 m
Thickness of the RC Wall	160 mm
Thickness of the slab	150 mm
Height above the foundation	1.5 m
Number of lift cores	2
Size of the lift core	2.05 m X 2.15 m

Thickness of the lift core wall	200 mm
Material Properties	
Grade of concrete	M25
Grade of reinforcing steel	Fe415
Density of the concrete blocks	17.65 kN/m^3
Loading	
Floor finish	1.5 kN/m^2
Load on all rooms	2 kN/m^2
Load on Staircases	3 kN/m^2
Load on the Roof Slab	2 kN/m^2

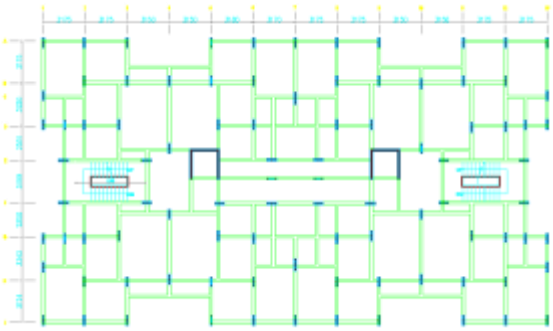

Fig-1: Plan of the building

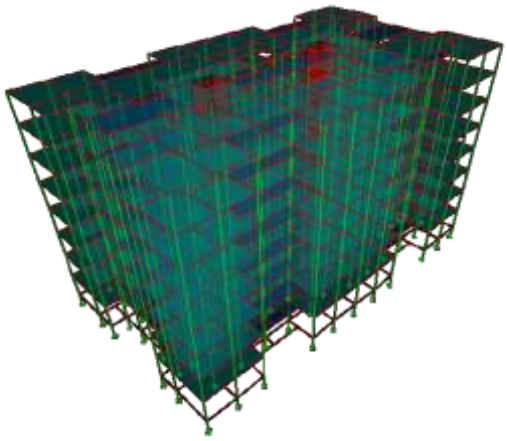

Fig-2: Conventional Building

Fig-3: RC Wall Building

All the loads applied are as per Indian Standard Code IS875:1987 Part 1 and Part 2. The Study was conducted considering all the four earthquake zones as per the Code IS1893:2002 Part 1.Both types of the building are studied in earthquake zones Zone II, Zone III, Zone IV and Zone V considering the medium soil that is soil type II.

The design horizontal seismic coefficient Ah for a structure shall be determined by the following expression:

$$A_h = \frac{ZIS_a}{2Rg}$$

The total design lateral force or design seismic base shear (Vb) along any principal direction shall be determined by the following expression:

$$V_B = A_h W$$

4. RESULTS

From the analysis results some of the parameters such as Displacements, Drifts and Base Shear are compared for the Conventional Building and RC Wall Building. The analysis results, tabulated and represented in the form of plots are given below.

Table-1: Storey Displacement, Conventional v/s RC Wall Building, Zone II (X-direction)

Storey Displacement, Zone II (X-direction)	
Conventional Building, Zone II	RC wall Building, Zone II
0	0
6.37	0.0404
13.50	0.0714
21.02	0.1023
28.27	0.1317
34.87	0.1582
40.58	0.1809
45.27	0.1991
50.00	0.2168

Table-2: Storey Displacement, Conventional v/s RC Wall Building, Zone III (X-direction)

Storey Displacement, Zone III (X-direction)	
Conventional Building, Zone III	RC wall Building, Zone III
0	0
10.20	0.0647
21.61	0.1142
33.63	0.1637
45.23	0.2106
55.79	0.2531
64.93	0.2895
72.43	0.3185
78.40	0.3468

Table-3: Storey Displacement, Conventional v/s RC Wall Building, Zone IV (X-direction)

Storey Displacement, Zone IV (X-direction)	
Conventional Building, Zone IV	RC wall Building, Zone IV
0	0
15.30	0.0971
32.41	0.1713
50.45	0.2455
67.85	0.3160
83.69	0.3797
97.40	0.4342
108.66	0.4778
117.61	0.5203

Table-4: Storey Displacement, Conventional v/s RC Wall Building, Zone V (X-direction)

Storey Displacement, Zone V (X-direction)	
Conventional Building, Zone V	RC wall Building, Zone V
0	0
22.95	0.1456
48.61	0.2569
75.67	0.3683
101.78	0.4739
125.54	0.5695
146.10	0.6513
162.98	0.7167
176.41	0.7804

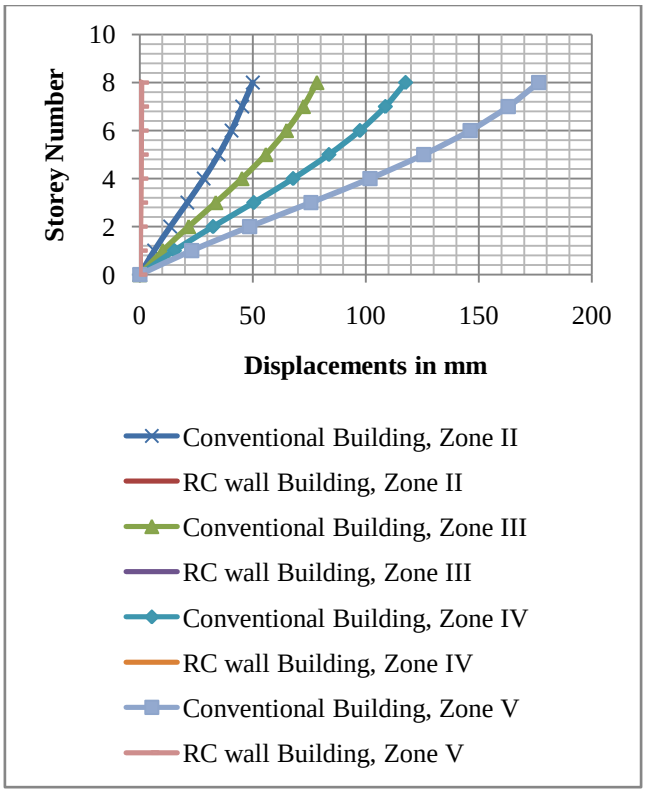

Fig-4: Storey Displacement, Conventional v/s RC Wall Building, Zone II, III, IV, V (X-direction)

Table-5: Storey Displacement, Conventional v/s RC Wall Building, Zone II (Y-direction)

Storey Displacement, Zone II (Y-direction)	
Conventional Building	RC wall Building
0	0
3.48	0.0655
7.72	0.1281
12.31	0.1981
16.76	0.2711
20.80	0.3435
24.26	0.4125
27.09	0.4760
29.34	0.5443

Table-6: Storey Displacement, Conventional v/s RC Wall Building, Zone III (Y-direction)

Storey Displacement, Zone III (Y-direction)	
Conventional Building	RC wall Building
0	0
5.57	0.1047
12.35	0.2049
19.70	0.3168
26.82	0.4336
33.28	0.5495
38.82	0.6599
43.34	0.7615
46.95	0.8707

Table-7: Storey Displacement, Conventional v/s RC Wall Building, Zone IV (Y-direction)

Storey Displacement, Zone IV (Y-direction)	
Conventional Building	RC wall Building
0	0
8.36	0.1571
18.52	0.3074
29.54	0.4752
40.23	0.6504
49.93	0.8243
58.24	0.9900
65.01	1.1423
70.43	1.3061

Table-8: Storey Displacement, Conventional v/s RC Wall Building, Zone V (Y-direction)

Storey Displacement, Zone V (Y-direction)	
Conventional Building	RC wall Building
0	0
12.54	0.2357
27.78	0.4611
44.31	0.7128
60.34	0.9756
74.89	1.2364
87.36	1.4849
97.52	1.7134
105.65	1.9595

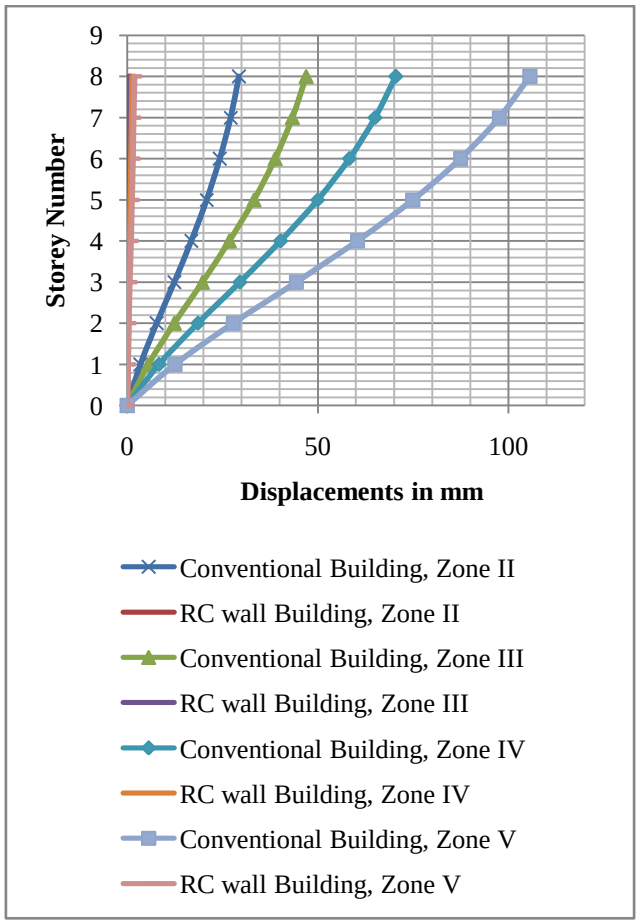

Fig-5: Storey Displacement, Conventional v/s RC Wall Building, Zone II, III, IV, V (Y-direction)

From the above tables and the graphs it can be seen that the RC wall type of building has produced much lesser displacements than the conventional building. This shows that the RC wall type of building offers more resistance to the lateral forces such as seismic forces than the conventional building.

Table-9: Storey Drift, Conventional v/s RC Wall Building, Zone II (X-direction)

Storey Drift, Zone II (X-direction)	
Conventional Building, Zone II	RC wall Building, Zone II
0	0
0.00179	0.000010
0.00227	0.000010
0.00241	0.000010
0.00236	0.000009
0.00219	0.000008
0.00194	0.000007
0.00162	0.000006
0.00128	0.000006

Table-10: Storey Drift, Conventional v/s RC Wall Building, Zone III (X-direction)

Storey Drift, Zone III (X-direction)	
Conventional Building, Zone III	RC wall Building, Zone III
0	0
0.00286	0.000016
0.00363	0.000016
0.00386	0.000016
0.00378	0.000015
0.00351	0.000014
0.00310	0.000012
0.00256	0.000009
0.00205	0.000009

Table-11: Storey Drift, Conventional v/s RC Wall Building, Zone IV (X-direction)

Storey Drift, Zone IV (X-direction)	
Conventional Building, Zone IV	RC wall Building, Zone IV
0	0
0.00429	0.000024
0.00545	0.000024
0.00579	0.000024
0.00566	0.000022
0.00526	0.000020
0.00465	0.000017
0.00388	0.000014
0.00307	0.000014

Table-12: Storey Drift, Conventional v/s RC Wall Building, Zone V (X-direction)

Storey Drift, Zone V (X-direction)	
Conventional Building, Zone V	RC wall Building, Zone V
0	0
0.00644	0.000036
0.00817	0.000035
0.00868	0.000035
0.00850	0.000034
0.00789	0.000030
0.00698	0.000026
0.00582	0.000021
0.00461	0.000021

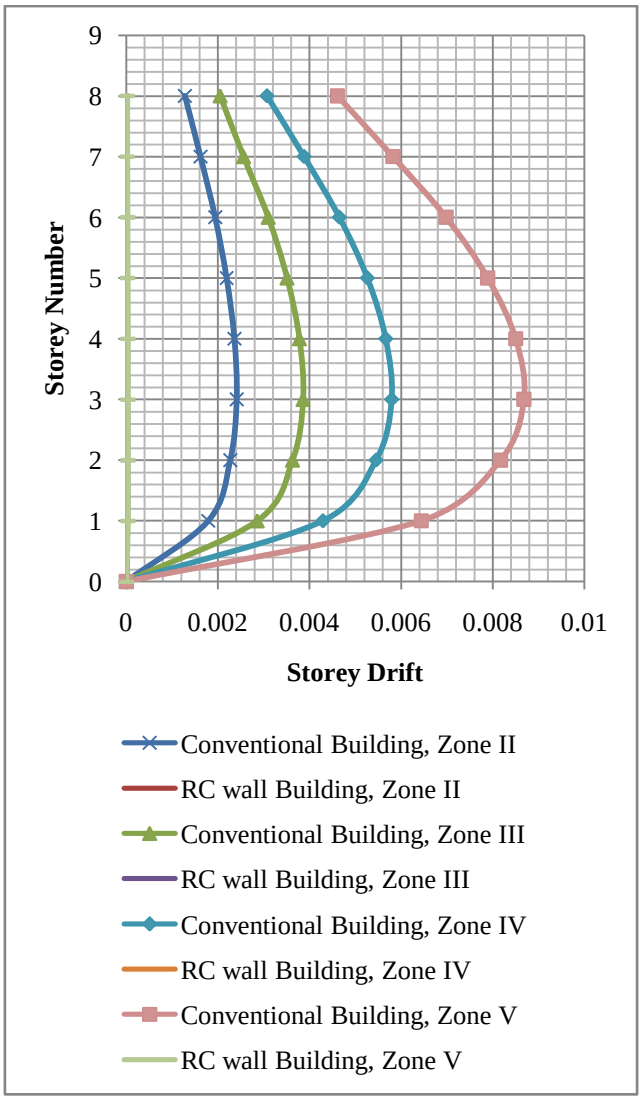

Fig-6: Storey Drift, Conventional v/s RC Wall Building, Zone II, III, IV, V (X-direction)

Table-13: Storey Drift, Conventional v/s RC Wall Building, Zone II (Y-direction)

Storey Drift, Zone II (Y-direction)	
Conventional Building	RC wall Building
0	0
0.00097	0.000017
0.00135	0.000020
0.00147	0.000022
0.00144	0.000023
0.00132	0.000023
0.00116	0.000022
0.00096	0.000020
0.00077	0.000022

Table-14: Storey Drift, Conventional v/s RC Wall Building, Zone III (Y-direction)

Storey Drift, Zone III (Y-direction)	
Conventional Building	RC wall Building
0	0
0.00155	0.000028
0.00216	0.000032
0.00235	0.000036
0.00230	0.000037
0.00212	0.000037
0.00185	0.000035
0.00153	0.000032
0.00123	0.000035

Table-15: Storey Drift, Conventional v/s RC Wall Building, Zone IV (Y-direction)

Storey Drift, Zone IV (Y-direction)	
Conventional Building	RC wall Building
0	0
0.00233	0.000042
0.00323	0.000048
0.00352	0.000053
0.00345	0.000056
0.00318	0.000055
0.00278	0.000053
0.00230	0.000049
0.00184	0.000053

Table-16: Storey Drift, Conventional v/s RC Wall Building, Zone V (Y-direction)

Storey Drift, Zone V (Y-direction)	
Conventional Building	RC wall Building
0	0
0.00349	0.000063
0.00485	0.000072
0.00528	0.000080
0.00518	0.000084
0.00477	0.000083
0.00416	0.000079
0.00344	0.000073
0.00276	0.000079

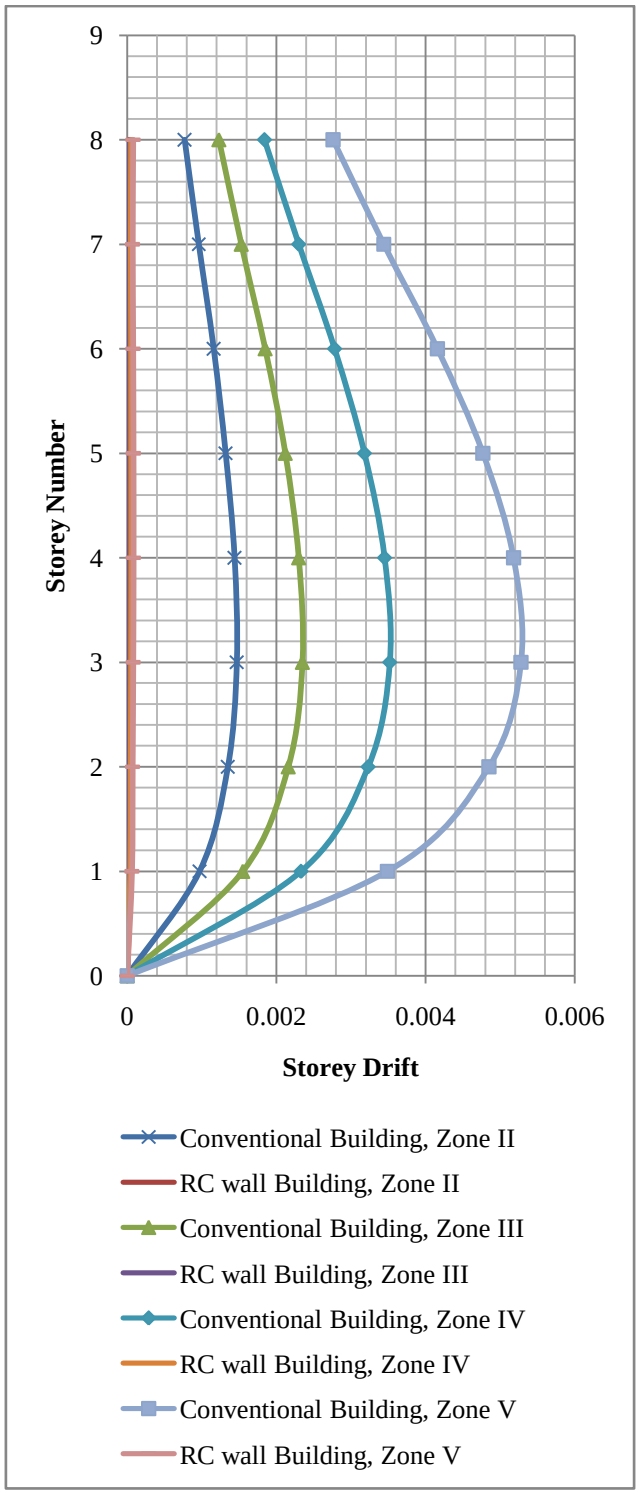

Fig-7: Storey Drift, Conventional v/s RC Wall Building, Zone II, III, IV, V (Y-direction)

As seen in the previous section in case of displacements, here it can be seen from the tables and the plots that the storey drift in the RC wall building is very much less compared to the conventional building. This result shows that the RC Wall building is safer against drift caused by the seismic forces as it produces less storey drift compared that of the conventional building in the same seismic zone.

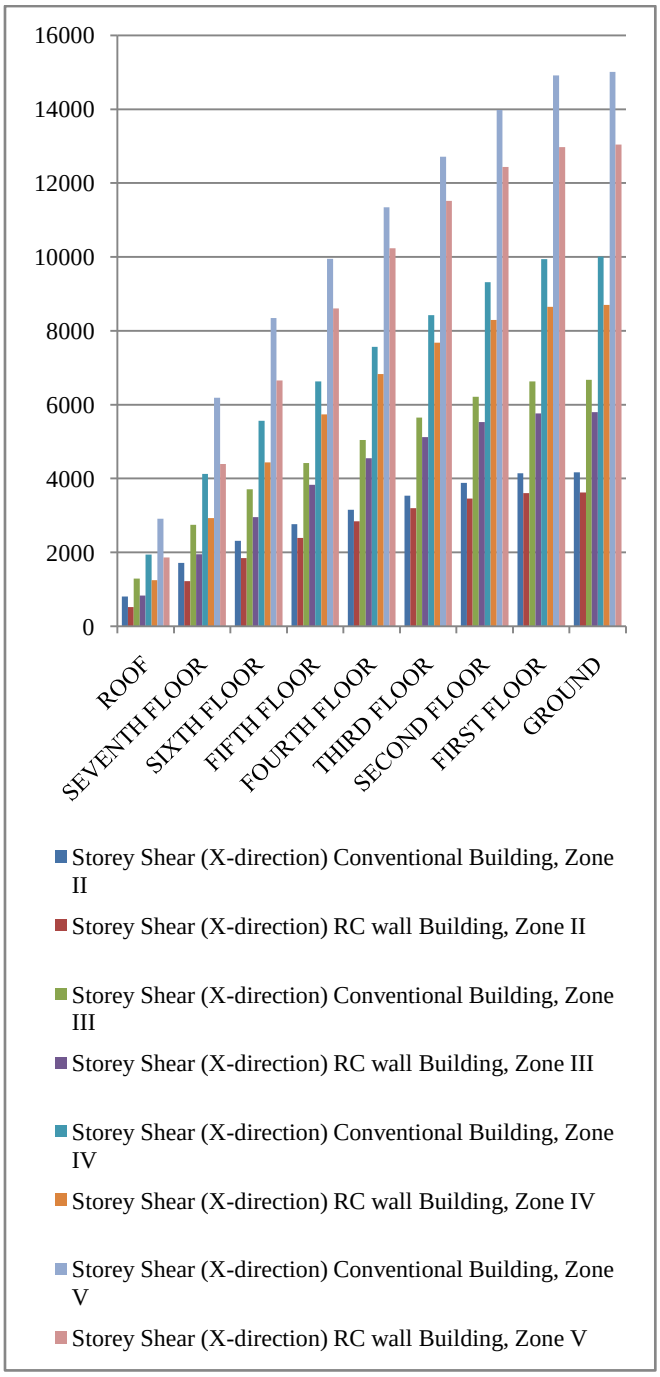

Fig-8: Storey Shear in kN v/s Storey height in X-direction

Table-17: Base Shear, Conventional v/s RC Wall Building

Base Shear in kN		
Zone	Conventional Building	RC Wall Building
Zone II	4170	3625
Zone III	6672	5799
Zone IV	10009	8699
Zone V	15013	13048

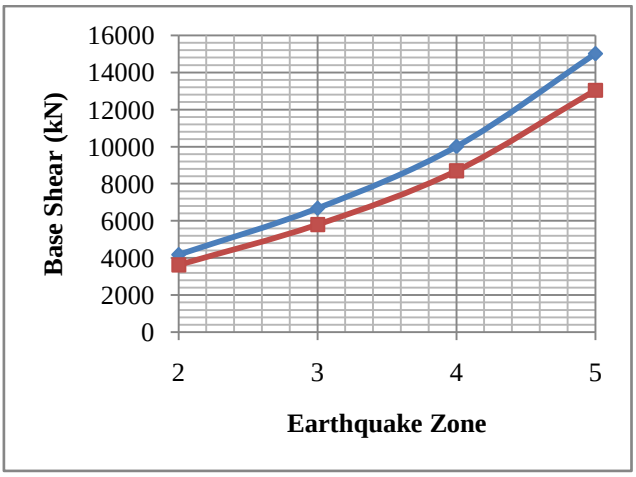

Fig-9: Base Shear, Conventional v/s RC Wall Building

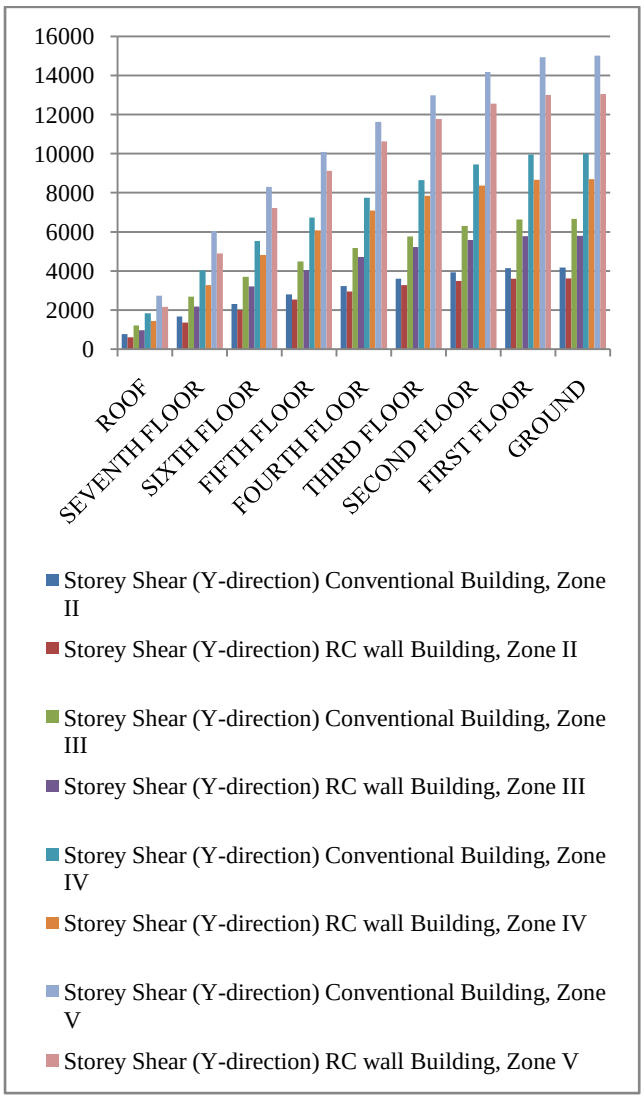

Fig-10: Storey Shear in kN v/s Storey height in Y-direction

The tables 1-8 and figures 4&5 show the variation in the storey displacements for conventional building and RC wall building. The tables 9-16 and figures 6&7 show the variation in the storey drift for conventional building and RC wall building. Table 17 & figure 9 show the variation of base shear against earthquake zones.

Table-18: Modal time periods and frequencies Conventional Building v/s RC Wall Building

Conventional Building			RC Wall Building	
Modes	Modal Time Period (in sec)	Modal Frequency (cyc/sec)	Modal Time Period (in sec)	Modal Frequency (cyc/sec)
1	1.418	0.705	0.165	6.071
2	1.275	0.784	0.112	8.926
3	1.167	0.857	0.111	9.017
4	0.426	2.348	0.048	20.843
5	0.374	2.672	0.037	27.07
6	0.339	2.947	0.036	27.761
7	0.224	4.454	0.028	36.179
8	0.187	5.343	0.028	36.19
9	0.168	5.962	0.025	40.259
10	0.144	6.932	0.022	46.453
11	0.118	8.453	0.02	49.088
12	0.103	9.737	0.017	57.947

5. CONCLUSIONS

From the analysis results of the fixed base buildings it can be concluded that,

1. From the tables and the plots of storey displacements it can be seen that the RC Wall Building produced much lesser displacements when considered in a particular zone and soil type. In Seismic Zone V and Soil Type II maximum displacement in Y-direction was found to be 105.65mm for Conventional Building and 1.9595mm for the RC Wall Building at the roof level. Thus RC Wall Building being much safer against deflections caused by earthquake.
2. It is seen from the tabulations and plots of storey drifts that the storey drift also showed much lesser values for the RC Wall Building than that of the Conventional one. This proves that the RC Wall Building is safe against the storey drifts caused by earthquake forces.
3. It can be seen from the tables and the plots that, the base shear in the RC Wall building is lesser than the conventional building. The Base Shear for Conventional Building in Zone V and Soil Type II was found to be 15013kN and for RC Wall Building it was 13048kN.
4. It can be seen that the modal time period for RC Wall Building is lesser than the Conventional Building.

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