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EFFECT OF SITE SPECIFIC RESPONSE SPECTRA ON SHEAR WALL BUILDING

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Abstract-*Earthquakes are natural hazards which cause destruction to life and property. The surface ground shaking causes severe damage to the structures, which depends on characteristic of subsurface soil. In this study attempt is made to understand the effect of site specific response spectra and site specific acceleration time history analysis with different sites by providing different locations of the shear wall. Present study includes ground response analysis of six sites around Surat city using one dimensional equivalent linear analysis based software deepsoil. Bhuj earthquake data is used as an input motion for different sites to get an acceleration time history of ground as well as response spectra. ETABS was used to perform site specific response spectra and time history analysis. Total 16 models were analyzed like 'c' shape inner shear wall building, outer plane shear wall building, irregular building & 'L' shape outer plane shear wall building for each 7,14,21 & 28 storey. Base shear obtained by site specific response spectra & time history analysis were compared.*

Keywords*- Site specific response spectra, Shear wall, Base shear, ETABS*

I. INTRODUCTION

Natural hazard like earthquake is one of the most devastating of all hazards and unavoidable. It mainly causes damage to buildings or collapse of buildings and other manmade structures. Earthquake damage depends upon many parameters such as intensity, duration and frequency content of ground motion, geologic and soil condition, quality of construction etc; therefore it is essential to perform site specific ground response analysis. The estimation of strong motion characteristics is important for engineering design. Such characteristic includes peak ground acceleration and spectral ordinates. Experience has shown that for new constructions, establishing earthquake resistant regulations and their implementation is the critical safeguard against earthquake induced damage. As regards existing structures, it is necessary to evaluate and strengthen them based on evaluation criteria before an earthquake.

Reinforced concrete shear walls have long been recognized as efficient structural elements for resisting lateral forces due to winds and earthquakes in buildings. In general, shear walls tend to be laterally much stiffer that the moment resisting frames. Ductile response of these elements under strong seismic ground motion can be achieved through the development of a flexural plastic hinge at the base and by resisting the anticipated horizontal shear force over the height of the wall. Thin walled hollow RC shafts around the elevator core of buildings also act as shear walls, and should be taken advantage of to resist earthquake forces.

II. MODELLING

2.1 Problem definition

A 7, 14, 21 & 28 storey reinforced concrete building with different location and shape of shear wall has been considered for the present study. The plan area of building is 25 m X 15 m with 3 m height for all storey.

Total 16 models are considered for the analysis like 'C' shape inner plane shear wall building, outer plane shear wall building, irregular building & 'L' shape outer plane shear wall building.

2.2 Different models of shear wall position

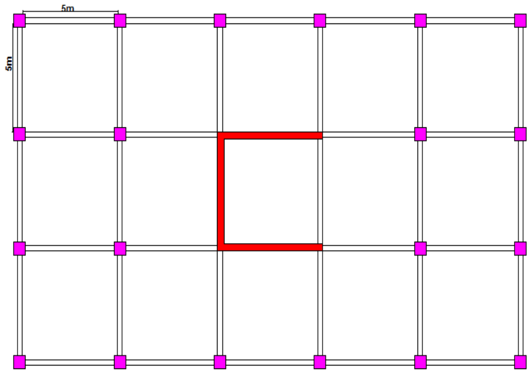


Figure 1. 'C' Shape inner plane shear wall

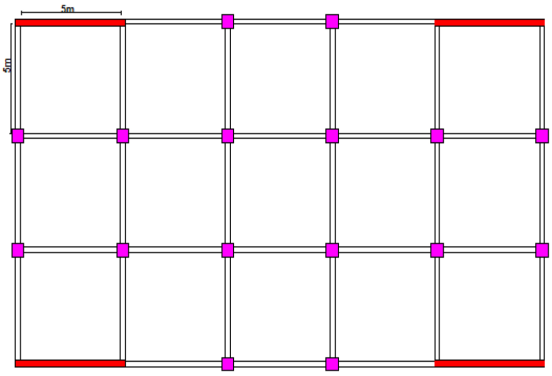


Figure 2. Outer plane shear wall

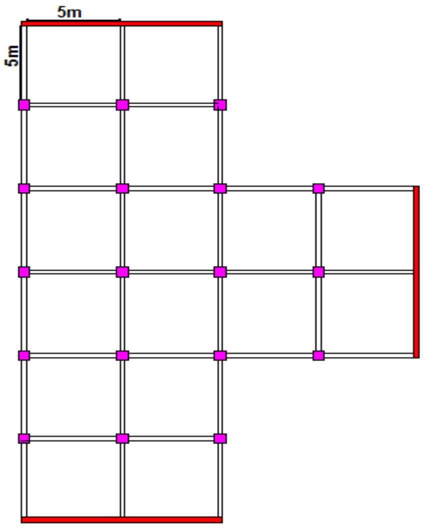


Figure 3. Irregular building

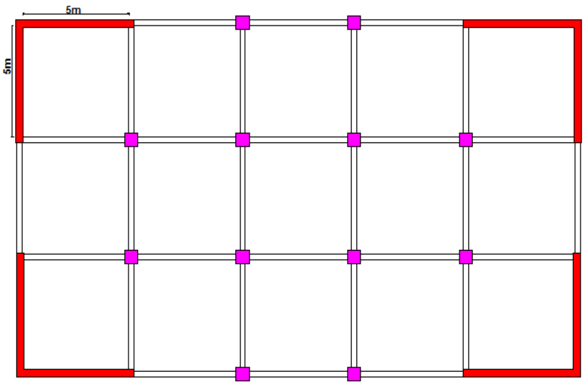


Figure 4. 'L' Shape outer plane shear wall

Table 1: Building Description

Storey	Bay size(m)	Height(m)	Beam size(m)	Column size(m)	Slab thickness(m)	Shear wall thickness(m)
7	5x5	3	0.4x0.6	0.55x0.55	0.15	0.16
14	5x5	3	0.4x0.6	0.65x0.65	0.15	0.20
21	5x5	3	0.4x0.6	0.75x0.75	0.15	0.24
28	5x5	3	0.4x0.6	1x1	0.15	0.28

Table 2: Material Specifications

Grade of Concrete	Fck = 25 N/mm²
Grade of Steel	Fy = 500 N/mm²
Density of Concrete	γc = 25 kN/m³
Density of Brick wall	γ = 20 kN/m³

Table 3: Loading

Earthquake zone	III
Importance factor	1
Response reduction factor	5
Wall load	11.04 kN/m
Parapet wall load	4.6 kN/m
Typical floor live load	3 kN/m
Terrace love load	1.5 kN/m
Typical floor Super dead	2 kN/m
Floor finish	1 kN/m

2.3 Load combination

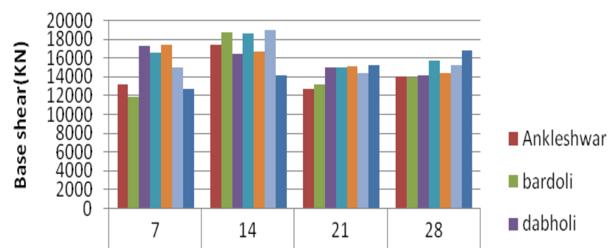
For the analysis, All load combinations are taken as per IS1893 (Part 1):2002, Clause 6.3.1.2

1) 1.5(DL+LL)
2) 1.2(DL+LL+EQX)
3) 1.2(DL+LL-EQX)
4) 1.2(DL+LL+EQY)
5) 1.2(DL+LL-EQY)
6) 1.5(DL+EQX)
7) 1.5(DL-EQX)
8) 1.5(DL+EQY)
9) 1.5(DL-EQY)
10) 0.9DL+1.5EQX
11) 0.9DL-1.5EQX
12) 0.9DL+1.5EQY
13) 0.9DL-1.5EQY

DL= Dead Load
LL= Live Load
EQX= Earthquake in X-direction
EQY= Earthquake in Y-direction

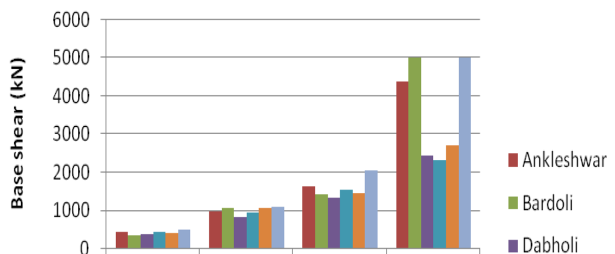
III. RESULTS & DISCUSSION

3.1 Base shear ('C' shape inner plane shear wall building)



	7	14	21	28
Ankleshwar	13074.884	17341.960	12705.877	13990.186
bardoli	11756.266	18671.071	13090.440	13905.151
dabholi	17215.913	16386.720	14936.996	14151.766
dindoli	16496.751	18546.679	14932.039	15701.352
Kamrej	17333.261	16615.001	15008.007	14277.875
kosad	14891.599	18971.832	14379.783	15214.329
IS 1893	12650.388	14101.006	15133.246	16708.805

Figure 5. Base shear using site specific response spectra

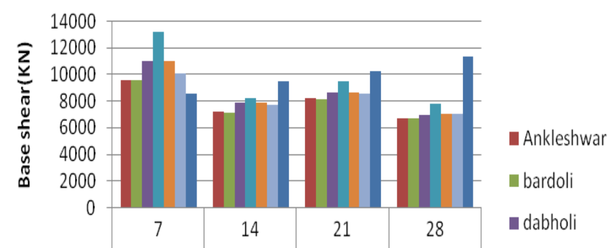


	7	14	21	28
Ankleshwar	405.49	945.1624	1611.6083	4365.8069
Bardoli	341.9816	1051.9237	1408.3761	4996.9088
Dabholi	362.4746	815.7402	1330.1187	2421.8602
Dindoli	416.7038	929.7246	1536.3482	2311.3334
Kamrej	377.4243	1042.973	1454.6263	2713.1626
kosad	469.8505	1070.4139	2041.9948	4997.1573

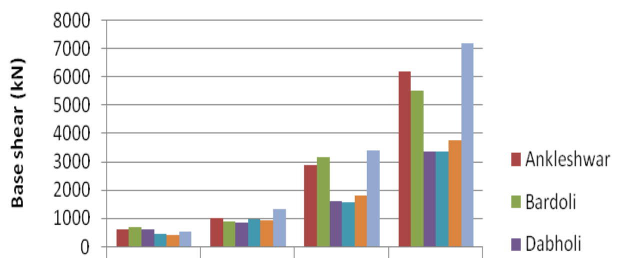
Figure 6. Base shear using time history analysis

From the ***Figure 5& 6***, for site specific response spectra, Kamrej for 7 storey, kosad for 14 storey& IS1893 for 21 & 28 storey shows maximum value of base shear. For time history analysis kosad shows maximum value for all storey.

3.2 Base shear (Outer plane shear wall building)



	7	14	21	28
Ankleshwar	9544.2607	7198.2876	8148.0683	6663.0181
bardoli	9540.9152	7100.9852	8087.0417	6675.494
dabholi	10971.248	7814.4139	8618.1983	6946.7071
dindoli	13184.365	8155.9792	9424.6858	7717.4657
Kamrej	10922.649	7842.2012	8638.5315	6958.0766
kosad	10075.748	7635.3453	8526.9361	7029.6582
IS 1893	8489.91	9448.6011	10216.664	11301.791

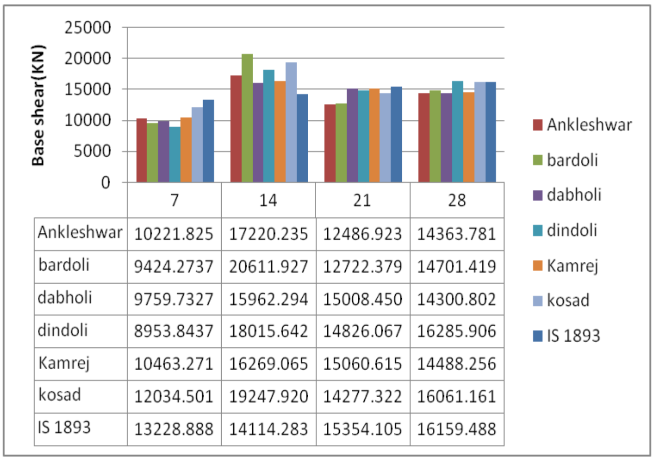


	7	14	21	28
Ankleshwar	608.5774	987.9677	2885.8461	6199.598
Bardoli	676.1593	865.4706	3146.116	5522.658
Dabholi	580.6838	842.883	1614.3004	3343.5843
Dindoli	435.3952	966.9441	1556.5404	3350.457
Kamrej	399.8291	915.0453	1815.5527	3771.7694
kosad	503.0567	1335.883	3394.5238	7184.9234

Figure 7. Base shear using site specific response spectra ***Figure 8. Base shear using time history analysis***

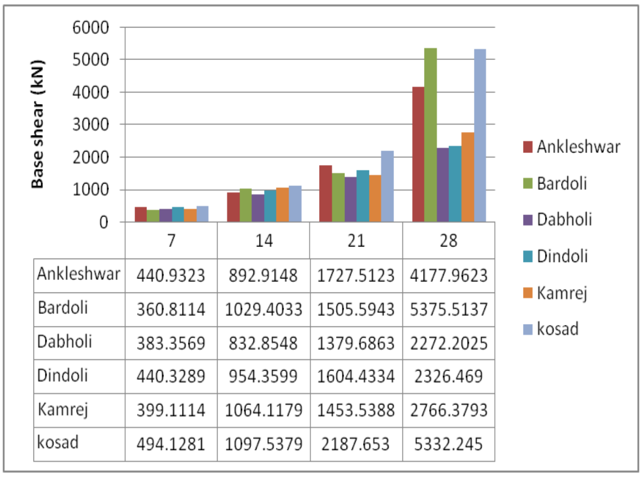
As shown in ***Figure 7&8***, for site specific response spectra, dindoli for 7 storey, & IS1893 for 14, 21 and 28 storey shows maximum value of base shear. In case of time history analysis, bardoli for 7 storey & kosad for 14, 21&28 storey shows maximum value.

3.3 Base shear (Irregular building)



	7	14	21	28
Ankleshwar	10221.825	17220.235	12486.923	14363.781
bardoli	9424.2737	20611.927	12722.379	14701.419
dabholi	9759.7327	15962.294	15008.450	14300.802
dindoli	8953.8437	18015.642	14826.067	16285.906
Kamrej	10463.271	16269.065	15060.615	14488.256
kosad	12034.501	19247.920	14277.322	16061.161
IS 1893	13228.888	14114.283	15354.105	16159.488

Figure 9.Base shear using site specific response spectra

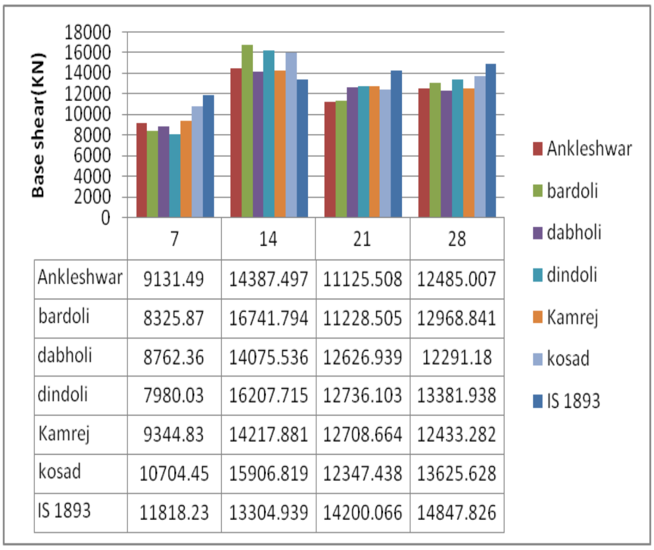


	7	14	21	28
Ankleshwar	440.9323	892.9148	1727.5123	4177.9623
Bardoli	360.8114	1029.4033	1505.5943	5375.5137
Dabholi	383.3569	832.8548	1379.6863	2272.2025
Dindoli	440.3289	954.3599	1604.4334	2326.469
Kamrej	399.1114	1064.1179	1453.5388	2766.3793
kosad	494.1281	1097.5379	2187.653	5332.245

Figure 10.Base shear using time history analysis

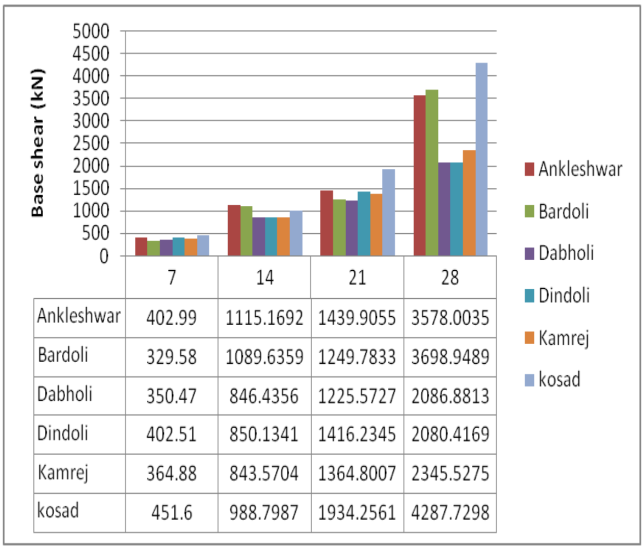
From the ***Figure 9&10***, for site specific response spectra, bardoli for 14 storey & IS1893 for 7, 21 and dindoli for 28 storey shows maximum value of base shear. For time history analysis kosad shows maximum value for 7, 14, 21 storey & bardoli for 28 storey.

3.4 Base shear ('L' Shape outer plane shear wall building)



	7	14	21	28
Ankleshwar	9131.49	14387.497	11125.508	12485.007
bardoli	8325.87	16741.794	11228.505	12968.841
dabholi	8762.36	14075.536	12626.939	12291.18
dindoli	7980.03	16207.715	12736.103	13381.938
Kamrej	9344.83	14217.881	12708.664	12433.282
kosad	10704.45	15906.819	12347.438	13625.628
IS 1893	11818.23	13304.939	14200.066	14847.826

Figure 11. Base shear using site specific response spectra



	7	14	21	28
Ankleshwar	402.99	1115.1692	1439.9055	3578.0035
Bardoli	329.58	1089.6359	1249.7833	3698.9489
Dabholi	350.47	846.4356	1225.5727	2086.8813
Dindoli	402.51	850.1341	1416.2345	2080.4169
Kamrej	364.88	843.5704	1364.8007	2345.5275
kosad	451.6	988.7987	1934.2561	4287.7298

Figure 12. Base shear using time history analysis

From the ***Figure 11&12***, for site specific response spectra, bardoli for 14 storey& IS1893 for 7, 21 and 28 storey shows maximum value of base shear. For time history analysis, ankleshwar for 14 storey & kosad shows maximum value for 7, 21 & 28 storey.

IV. CONCLUSION

1. Response spectra and time history for specific site are affected by sub soil characteristics of that particular site.
2. From the base shear graph it is observed that overall site specific response spectra gives maximum base shear for 7 & 14 storey building while in case of 21 & 28 storey building IS1893 response spectra shows maximum results.
3. Generally, Site specific response spectra shows maximum force results in comparison with site specific acceleration time history.
4. From the site specific response spectra & Site specific acceleration time history analysis 'L' shape, shear wall building gives a lower value of base shear and design force in comparison with the 'C' shape inner shear wall building.

5. In site specific response spectra, there are 20% to 25% reduction in base shear results for 'L' shape, shear wall building in comparison with 'C' shape inner shear wall building while in case of acceleration time history analysis there is 10 % to 15% reduction in Base shear results for 'L' shape shear wall building.
6. It is observed that 'L' shape shear wall at corner & the outer plane shear wall in x direction is desirable location to provide a shear wall in building.

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