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Response Spectra Study of High Rise Structure with RC Shear Wall by Considering Lateral Loads and Storey Stiffness

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Abstract- The present study aims at evaluation of the behavior of a high rise structure with dual system for estimation of structural response lateral loads and storey stiffness has been studied. To meet this objective, G+29 storey building with C shape, Box shape, E shape, I shape and plus shape of RC shear wall, at the center in concrete frame structure with fixed support conditions under different types of soil for high earthquake zone are analyzed by dynamic analysis in ETABS software. It was found that the building with box shape shear walls provided at the center core showed very significant performance in terms of lateral loads and storey stiffness. It was found that the behavior of new shape (plus shape) of shear wall is similar to I and box shape.

For severe lateral loads caused by wind load and or earthquake load, the RC shear wall is obvious.

Keywords: dynamic analysis, structural response, soil conditions, high earthquake zone, ETABS software.

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RESPONSESPECTRASTUDYOFHIGHRISESTRUCTUREWITHRCSHEARWALLBYCONSIDERINGLATERALLOADSANDSTOREYSTIFFNESS

Strictly as per the compliance and regulations of:

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I. Introduction

Shear wall is a structural element used to resist lateral/horizontal/shear forces parallel to the plane of the wall by:

- Cantilever action for slender walls where the bending deformation is dominant.
- Truss action for squat/short walls where the shear deformation is dominant.

Shear walls resist two types of forces: shear forces and uplift forces. Connections to the Structure above transfer horizontal forces to the shear wall. This transfer creates shear forces throughout the height of the wall between the top and bottom shear wall connections. The strength of the lumber, sheathing and fasteners must resist these shear forces or the wall will tear or "shear" apart uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Uplift forces are greater on tall short walls and less on low long walls. Bearing walls have less uplift than non-bearing walls because gravity loads on shear walls help them resist uplift. Shear walls need holdown devices at each End when the gravity loads cannot resist all of the uplift. The holdown device then provides the necessary uplift resistance.

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a) *Site Selection*

The seismic motion that reaches a structure on the surface of the earth is influenced by local soil conditions. The subsurface soil layers underlying the building foundation may amplify the response of the building to earthquake motions originating in the bedrock.

For soft soils the earthquake vibrations can be significantly amplified and hence the shaking of structures sited on soft soils can be much greater than for structures sited on hard soils. Hence the appropriate soil investigation should be carried out to establish the allowable bearing capacity and nature of soil. The choice of a site for a building from the failure prevention point of view is mainly concerned with the stability of the ground. The very loose sands or sensitive clays are liable to be destroyed by the earthquake, so much as to lose their original structure and thereby undergo compaction. This would result in large unequal settlements and damage the building. If the loose cohesion less soils are saturated with water they are likely to lose their shear resistance altogether during ground shaking. This leads to liquefaction. Although such soils can be compacted, for small buildings the operation may be too costly and the sites having these soils are better avoided.

For large building complexes, such as housing developments, new colonies, etc. this factor should be thoroughly investigated and the site has to be selected appropriately. Therefore a site with sufficient bearing capacity and free from the above defects should be chosen and its drainage condition improved so that no water accumulates and saturates the ground especially close to the footing level.

b) *Bearing Capacity of Foundation Soil*

Three soil types are considered here:

I. *Hard* - Those soils, which have an allowable bearing capacity of more than 10t/m2.
II. *Medium* - Those soils, which have an allowable bearing capacity less than or equal to 10t/m2.

III. *Soft* - Those soils, which are liable to large differential settlement or liquefaction during an earthquake.

II. Methodology

a) Dynamic Analysis

Dynamic analysis shall be performed to obtain the design seismic force, and its distribution in different levels along the height of the building, and in the various lateral load resisting element, for the following buildings:
Regular buildings: Those greater than 40m in height in zones IV and V, those greater than 90m in height in zone II and III.

Irregular Buildings: All framed buildings higher than 12m in zones IV and V, and those greater than 40m in height in zones II and III.

The analysis of model for dynamic analysis of buildings with unusual configuration should be such that it adequately models the types of irregularities present in the building configuration. Buildings with plan irregularities, as defined in IS code: 1893-2002 cannot be modeled for dynamic analysis.

Dynamic analysis may be performed either by the TIME HISTORY METHOD or by the RESPONSE SPECTRUM METHOD.

b) Response Spectrum Method

The word spectrum in engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. This method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic of steel and reinforce concrete buildings, respectively. For most buildings, inelastic response can be expected to occur during a major earthquake, implying that an inelastic analysis is more proper for design. However, in spite of the availability of nonlinear inelastic programs, they are not used in typical design practice because:

1. Their proper use requires knowledge of their inner workings and theories. design criteria, and
2. Result produced are difficult to interpret and apply to traditional design criteria, and
3. The necessary computations are expensive.

Therefore, analysis in practice typically use linear elastic procedures based on the response spectrum method. The response spectrum analysis is the preferred method because it is easier to use.

c) Response Spectrum Analysis

This method is also known as modal method or mode superposition method. It is based on the idea that the response of a building is the superposition of the responses of individual modes of vibration, each mode responding with its own particular deformed shape, its own frequency, and with its own modal damping.

According to IS-1893(Part-I):2002, high rise and irregular buildings must be analyzed by response spectrum method using design spectra. There are significant computational advantages using response spectra method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves only the calculation of the maximum values of the displacements and member forces in each mode using smooth spectra that are the average of several earthquake motions. Sufficient modes to capture such that at least 90% of the participating mass of the building (in each of two orthogonal principle horizontal directions) have to be considered for the analysis. The analysis is performed to determine the base shear for each mode using given building characteristics and ground motion spectra. And then the storey forces, accelerations, and displacements are calculated for each mode, and are combined statistically using the SRSS combination. However, in this method, the design base shear (V_B) shall be compared with a base shear (V_b) calculated using a fundamental period T. If is less than response quantities are (for example member forces, displacements, storey forces, storey shears and base reactions) multiplied by V_B/ Response spectrum method of analysis shall be performed using design spectrum. In case design spectrum is specifically prepared for a structure at a particular project site, the same may be used for design at the discretion of the project authorities.

III. Modeling of Building

a) Details of the Building

A symmetrical building of plan 38.5m X 35.5m located with location in zone V, India is considered. Four bays of length 7.5m & one bays of length 8.5m along X - direction and Four bays of length 7.5m & one bays of length 5.5m along Y - direction are provided. Shear Wall is provided at the center core of building model.

Structure 1: G+29 storey building with plus shape shear wall at the center of structure.
Structure 2: G+29 storey building with box shape shear wall at the center of structure.
Structure 3: G+29 storey building with C-shape shear wall at the center of structure.
Structure 4: G+29 storey building with E-shape shear wall at the center of structure.
Structure 5: G+29 storey building with I-shape shear wall at the center of structure.

b) Load Combinations

As per IS 1893 (Part 1): 2002 Clause no. 6.3.1.2, the following load cases have to be considered for analysis:

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1.5 (DL + IL)
1.2 (DL + IL ± EL)
1.5 (DL ± EL)
0.9 DL ± 1.5 EL

Earthquake load must be considered for +X, -X, +Y and –Y directions.

Table 1: Details of the Building

Building Parameters	Details
Type of frame	Special RC moment resisting frame fixed at the base
Building plan	38.5m X 35.5m
Number of storeys	30
Floor height	3.5 m
Depth of Slab	225 mm
Size of beam	(300 × 600) mm
Size of column (exterior)	(1250×1250) mm up to story five
Size of column (exterior)	(900×900) mm Above story five
Size of column (interior)	(1250×1250) mm up to story ten
Size of column (interior)	(900×900) mm Above story ten
Spacing between frames	7.5-8.5 m along x - direction 7.5-5.5 m along y - direction
Live load on floor	4 KN/m2
Floor finish	2.5 KN/m2
Wall load	25 KN/m
Grade of Concrete	M 50 concrete
Grade of Steel	Fe 500
Thickness of shear wall	450 mm
Seismic zone	V
Important Factor	1.5
Density of concrete	25 KN/m3
Type of soil	Soft, Medium, Hard Soil Type I=Soft Soil Soil Type II=Medium Soil Soil Type III=Hard Soil
Response spectra	As per IS 1893(Part-1):2002
Damping of structure	5 percent

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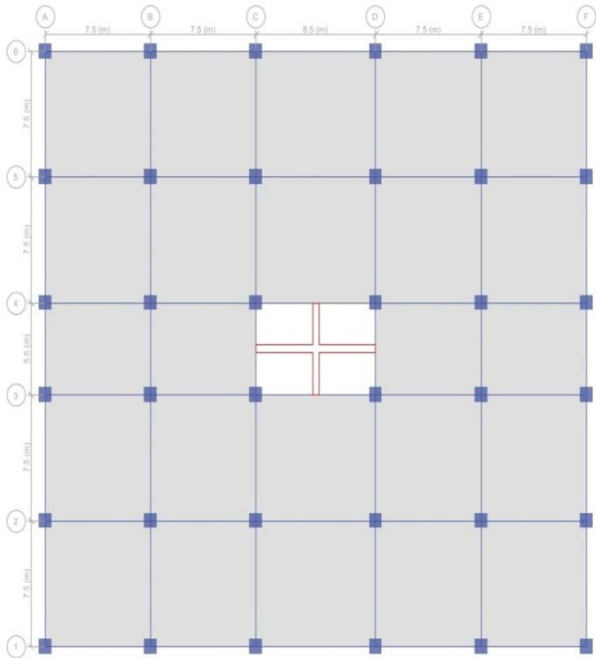


Figure 1: Plan of the Structure 1

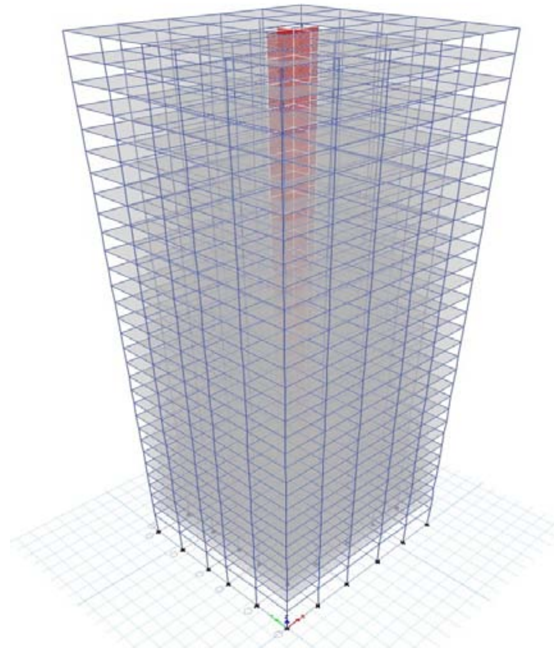


Figure 2: 3D view showing shear wall location for Structure 1

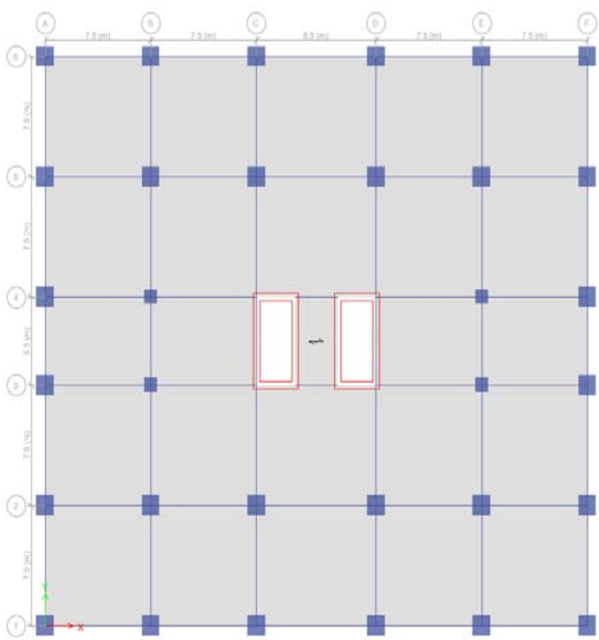


Figure 3: Plan of the Structure 2

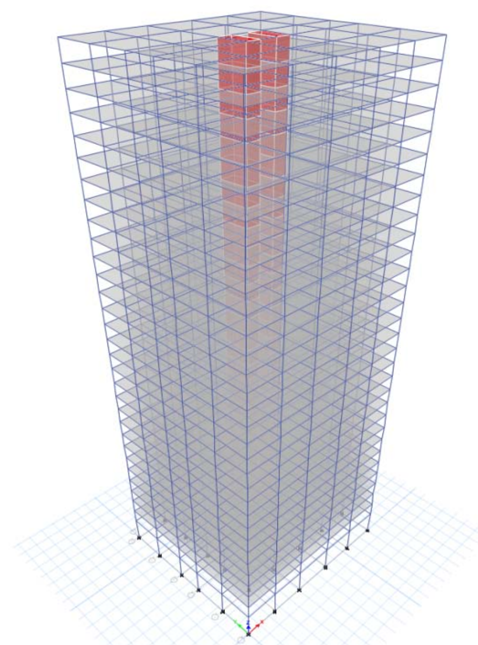


Figure 4: 3D view showing shear wall location for Structure 2

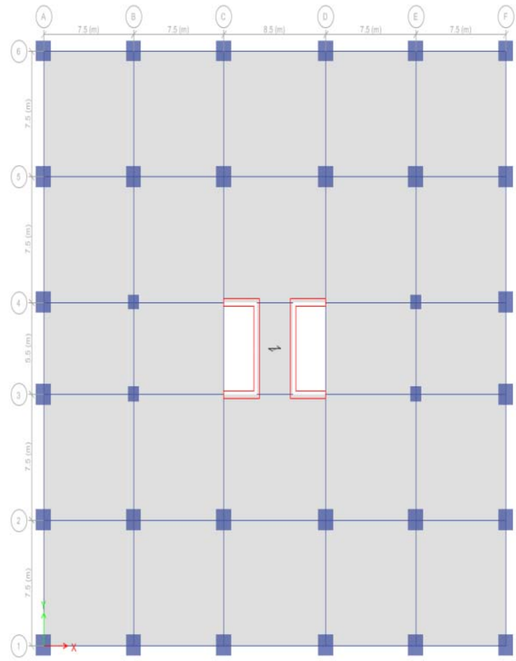


Figure 5: Plan of the Structure 3

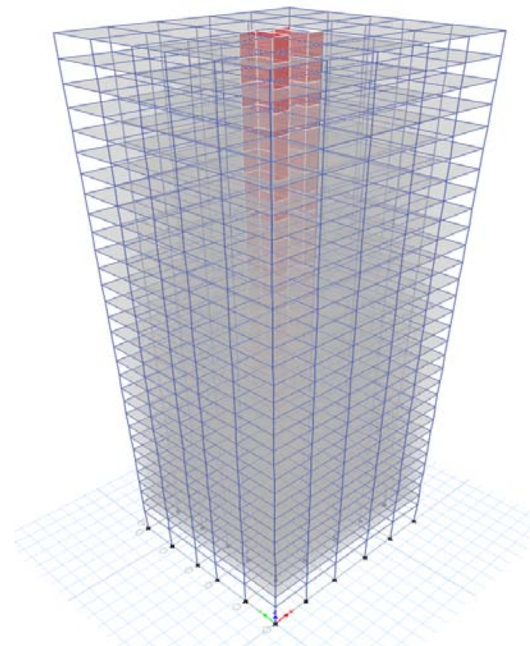


Figure 6: 3D view showing shear wall location for Structure 3

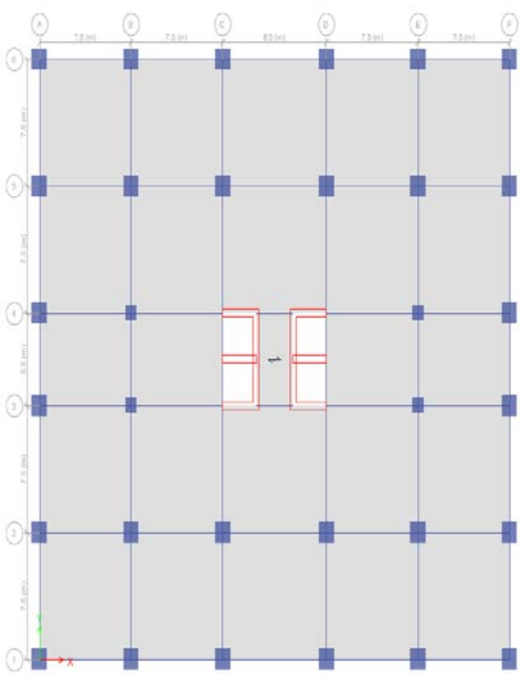


Figure 7: Plan of the Structure 4

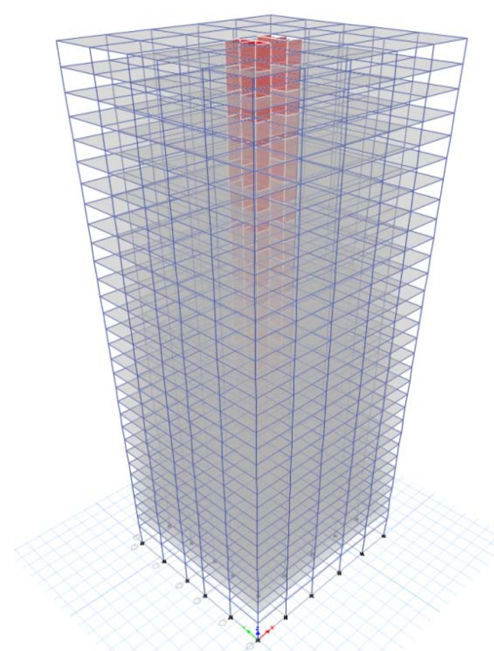


Figure 8: 3D view showing shear wall location for Structure 4

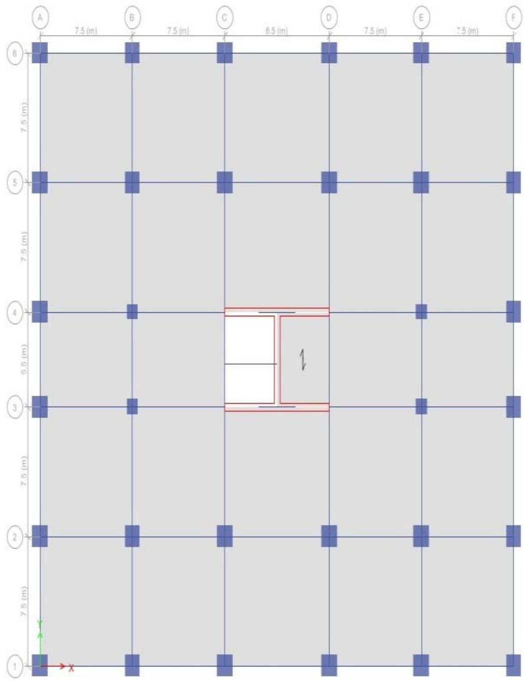


Figure 9: Plan of the Structure 5

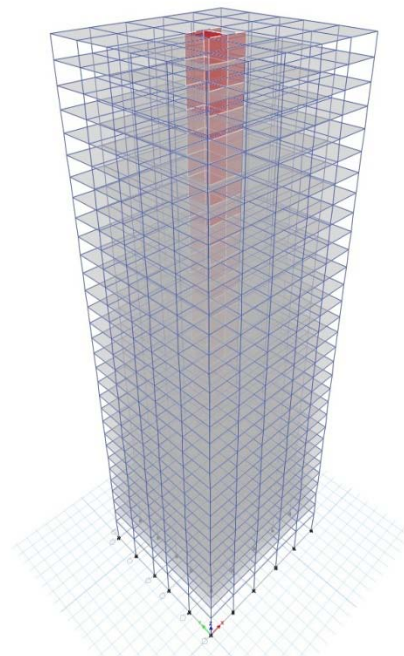


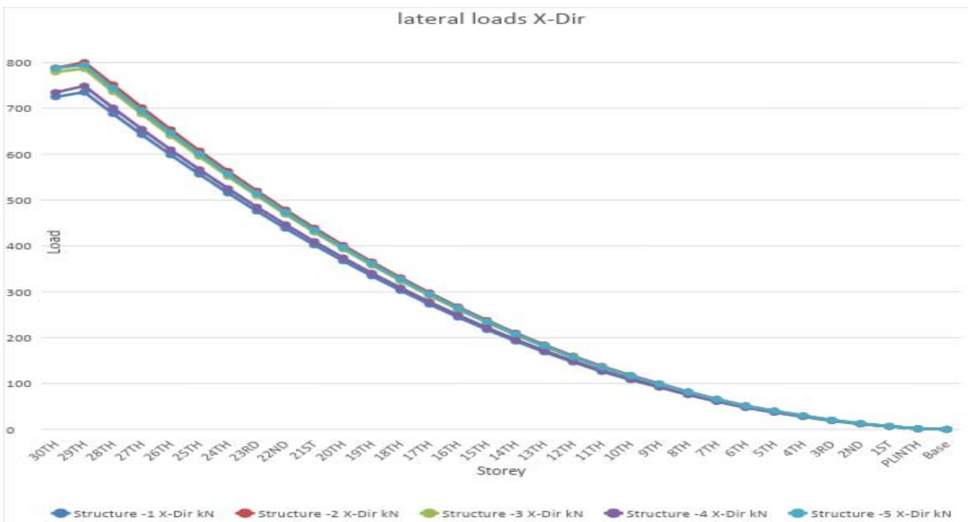
Figure 10: 3D view showing shear wall location for Structure 5

IV. Results and Discussions

Table 2: Lateral loads of structures in soft soil in X - direction with load cases EQXP"kN"

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	725.0746	788.0822	779.3094	734.6607	787.3047
29TH	107.5	Top	735.3706	802.651	786.6752	748.8055	794.5243
28TH	104	Top	688.2655	751.2361	736.2837	700.8398	743.6301
27TH	100.5	Top	642.7194	701.523	687.5601	654.4617	694.4203
26TH	97	Top	598.7324	653.5115	640.5042	609.671	646.8949
25TH	93.5	Top	556.3045	607.2018	595.1161	566.4679	601.054
24TH	90	Top	515.4355	562.5936	551.3959	524.8523	556.8975
23RD	86.5	Top	476.1256	519.6872	509.3435	484.8242	514.4255
22ND	83	Top	438.3747	478.4824	468.9588	446.3836	473.6379
21ST	79.5	Top	402.1829	438.9793	430.242	409.5306	434.5348
20TH	76	Top	367.5501	401.1779	393.1929	374.265	397.1161
19TH	72.5	Top	334.4763	365.0781	357.8117	340.587	361.3818
18TH	69	Top	302.9615	330.68	324.0983	308.4965	327.332
17TH	65.5	Top	273.0058	297.9836	292.0526	277.9935	294.9666
16TH	62	Top	244.6091	266.9889	261.6748	249.0781	264.2857
15TH	58.5	Top	217.7715	237.6958	232.9648	221.7501	235.2892
14TH	55	Top	192.4929	210.1044	205.9225	196.0097	207.9772
13TH	51.5	Top	168.7733	184.2147	180.5481	171.8567	182.3496
12TH	48	Top	146.6128	160.0266	156.8415	149.2913	158.4064
11TH	44.5	Top	126.0113	137.5403	134.8027	128.3134	136.1477
10TH	41	Top	108.2038	117.9886	115.6639	110.1585	116.8056

9TH	37.5	Top	91.6609	99.8447	97.8991	93.2966	98.8543
8TH	34	Top	75.3493	82.0768	80.4774	76.6939	81.2626
7TH	30.5	Top	60.6347	66.0484	64.7614	61.7167	65.3932
6TH	27	Top	47.517	51.7595	50.7509	48.3649	51.2461
5TH	23.5	Top	37.0427	40.255	39.4902	37.6855	39.8653
4TH	20	Top	27.6428	29.9683	29.4137	28.1087	29.6854
3RD	16.5	Top	18.8144	20.3971	20.0197	19.1315	20.2046
2ND	13	Top	11.6791	12.6616	12.4273	11.8759	12.5421
1ST	9.5	Top	6.2369	6.7616	6.6365	6.342	6.6978
PLINTH	6	Top	1.3465	1.4296	1.3634	1.3978	1.3887
Base	0	Top	0	0	0	0	0



Graph 1: Lateral loads of structures in soft soil in X - direction with load cases EQXP

Table 3: Lateral loads of Structures in Medium Soil in X - Direction with load cases EQXP"kN"

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	986.1014	1071.7918	1059.8608	1065.8278	1070.7344
29TH	107.5	Top	1000.104	1091.6053	1069.8782	1080.7416	1080.5531
28TH	104	Top	936.0411	1021.6812	1001.3458	1011.5134	1011.3369
27TH	100.5	Top	874.0984	954.0713	935.0817	944.5763	944.4116
26TH	97	Top	814.2761	888.7757	871.0857	879.9306	879.7771
25TH	93.5	Top	756.5741	825.7944	809.358	817.5761	817.4335
24TH	90	Top	700.9923	765.1273	749.8984	757.5128	757.3806
23RD	86.5	Top	647.5308	706.7746	692.7071	699.7407	699.6187
22ND	83	Top	596.1896	650.7361	637.784	644.2599	644.1476
21ST	79.5	Top	546.9687	597.0119	585.1291	591.0704	590.9673
20TH	76	Top	499.8681	545.6019	534.7424	540.1721	540.0779
19TH	72.5	Top	454.8877	496.5062	486.6239	491.565	491.4793
18TH	69	Top	412.0277	449.7248	440.7736	445.2492	445.1715
17TH	65.5	Top	371.2879	405.2577	397.1916	401.2246	401.1546
16TH	62	Top	332.6684	363.1049	355.8777	359.4912	359.4285

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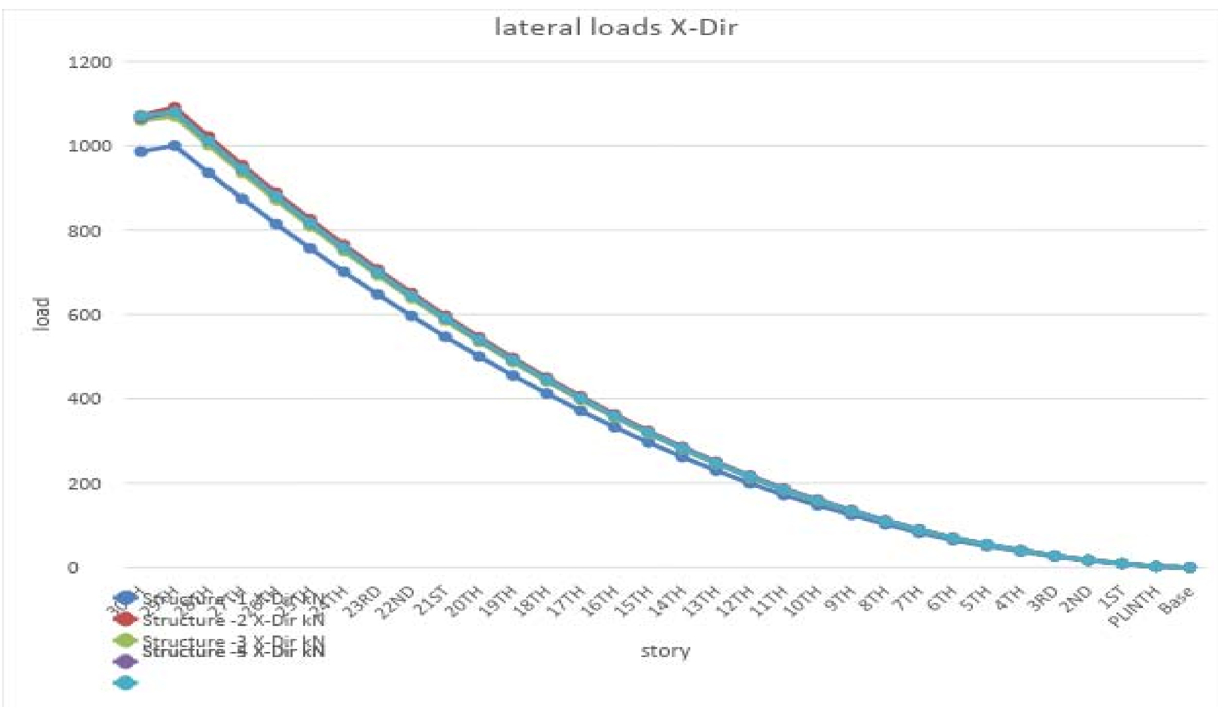
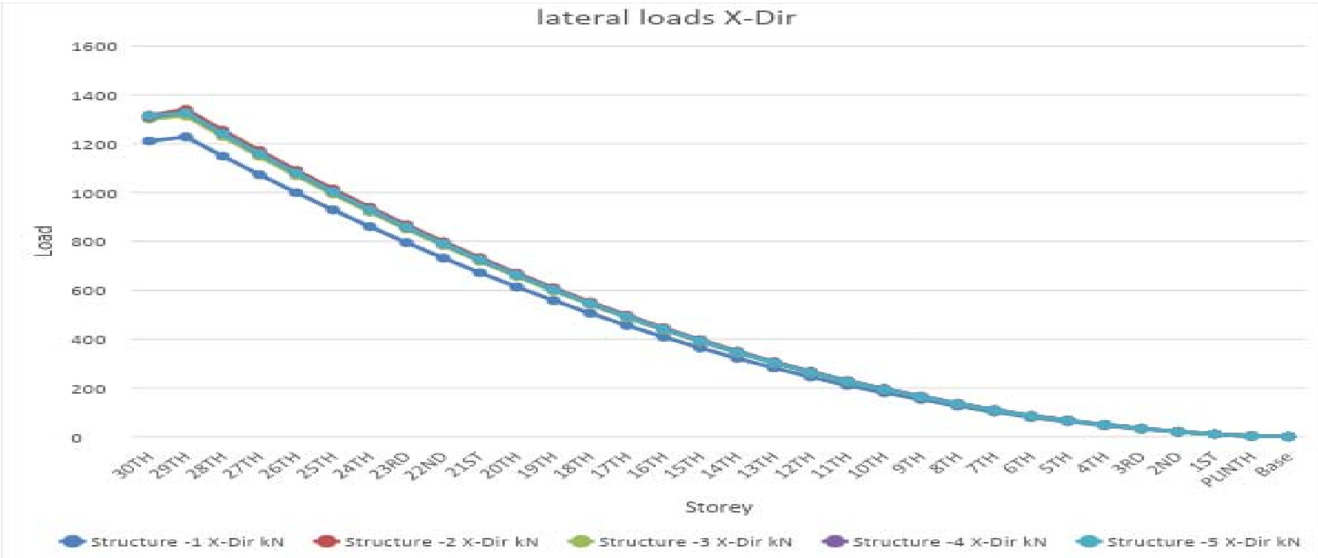
15TH	58.5	Top	296.1692	323.2663	316.8321	320.0491	319.9933
14TH	55	Top	261.7903	285.742	280.0547	282.8983	282.8489
13TH	51.5	Top	229.5317	250.532	245.5454	248.0387	247.9954
12TH	48	Top	199.3934	217.6362	213.3044	215.4703	215.4327
11TH	44.5	Top	171.3753	187.0547	183.3316	185.1932	185.1609
10TH	41	Top	147.1571	160.4645	157.3029	158.8837	158.8557
9TH	37.5	Top	124.6588	135.7888	133.1428	134.4658	134.4418
8TH	34	Top	102.4751	111.6245	109.4493	110.5369	110.5172
7TH	30.5	Top	82.4632	89.8258	88.0755	88.9506	88.9348
6TH	27	Top	64.6231	70.3929	69.0212	69.7071	69.6946
5TH	23.5	Top	50.3781	54.7468	53.7067	54.2268	54.2168
4TH	20	Top	37.5942	40.7568	40.0027	40.3798	40.3722
3RD	16.5	Top	25.5876	27.7401	27.2268	27.4835	27.4783
2ND	13	Top	15.8836	17.2198	16.9011	17.0604	17.0572
1ST	9.5	Top	8.4822	9.1958	9.0256	9.1107	9.109
PLINTH	6	Top	1.8312	1.9442	1.8543	1.8992	1.8886
Base	0	Top	0	0	0	0	0



Graph 2: Lateral loads of structures in medium soil in X - direction with load cases EQXP

Table 4: Lateral loads of structures in hard soil in X- direction with load cases EQXP"kN"

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	1210.8746	1316.0973	1301.4467	1308.7739	1314.7989
29TH	107.5	Top	1228.0688	1340.4271	1313.7475	1327.0871	1326.8556
28TH	104	Top	1149.4034	1254.5644	1229.5938	1242.0789	1241.8623
27TH	100.5	Top	1073.3415	1171.5434	1148.2253	1159.8842	1159.6819
26TH	97	Top	999.8832	1091.3643	1069.642	1080.503	1080.3145
25TH	93.5	Top	929.0284	1014.0269	993.844	1003.9353	1003.7602
24TH	90	Top	860.7773	939.5314	920.8311	930.1811	930.0189
23RD	86.5	Top	795.1297	867.8776	850.6036	859.2405	859.0906
22ND	83	Top	732.0858	799.0656	783.1612	791.1133	790.9753
21ST	79.5	Top	671.6454	733.0955	718.5041	725.7997	725.6731
20TH	76	Top	613.8086	669.9671	656.6322	663.2995	663.1838
19TH	72.5	Top	558.5754	609.6805	597.5455	603.6129	603.5076
18TH	69	Top	505.9458	552.2357	541.2441	546.7398	546.6444
17TH	65.5	Top	455.9197	497.6326	487.7279	492.6802	492.5943
16TH	62	Top	408.4973	445.8714	436.9969	441.4341	441.3571
15TH	58.5	Top	363.6784	396.952	389.0512	393.0015	392.933
14TH	55	Top	321.4631	350.8744	343.8906	347.3825	347.3219
13TH	51.5	Top	281.8514	307.6385	301.5154	304.5769	304.5238
12TH	48	Top	244.8433	267.2445	261.9253	264.5849	264.5387
11TH	44.5	Top	210.4388	229.6922	225.1205	227.4063	227.3667
10TH	41	Top	180.7003	197.041	193.1587	195.0998	195.0654
9TH	37.5	Top	153.0737	166.7407	163.4916	165.1161	165.0867
8TH	34	Top	125.8334	137.0683	134.3973	135.7328	135.7086
7TH	30.5	Top	101.26	110.3008	108.1515	109.2262	109.2067
6TH	27	Top	79.3534	86.4384	84.754	85.5962	85.5809
5TH	23.5	Top	61.8614	67.2259	65.9487	66.5873	66.5751
4TH	20	Top	46.1635	50.047	49.1209	49.584	49.5746
3RD	16.5	Top	31.42	34.0632	33.4329	33.7481	33.7417
2ND	13	Top	19.5041	21.1449	20.7536	20.9492	20.9453
1ST	9.5	Top	10.4156	11.2919	11.0829	11.1874	11.1853
PLINTH	6	Top	2.2486	2.3874	2.2769	2.3321	2.3191
Base	0	Top	0	0	0	0	0

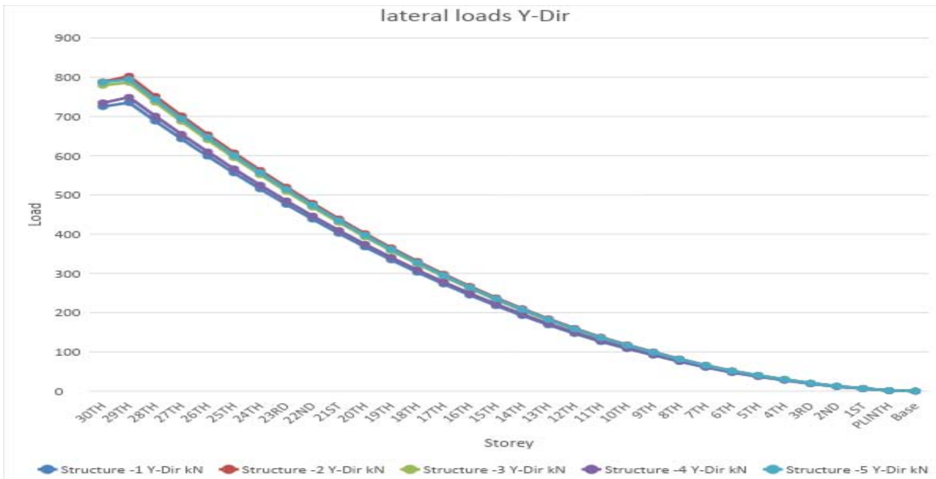


Graph 3: Lateral loads of structures in hard soil in X - direction with load cases EQXP

Table 5: Lateral loads of structures in soft soil in Y - direction with load cases EQYP“kN”

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	725.0746	788.0822	779.3094	734.6607	787.3047
29TH	107.5	Top	735.3706	802.651	786.6752	748.8055	794.5243
28TH	104	Top	688.2655	751.2361	736.2837	700.8398	743.6301
27TH	100.5	Top	642.7194	701.523	687.5601	654.4617	694.4203
26TH	97	Top	598.7324	653.5115	640.5042	609.671	646.8949
25TH	93.5	Top	556.3045	607.2018	595.1161	566.4679	601.054
24TH	90	Top	515.4355	562.5936	551.3959	524.8523	556.8975
23RD	86.5	Top	476.1256	519.6872	509.3435	484.8242	514.4255
22ND	83	Top	438.3747	478.4824	468.9588	446.3836	473.6379
21ST	79.5	Top	402.1829	438.9793	430.242	409.5306	434.5348
20TH	76	Top	367.5501	401.1779	393.1929	374.265	397.1161
19TH	72.5	Top	334.4763	365.0781	357.8117	340.587	361.3818
18TH	69	Top	302.9615	330.68	324.0983	308.4965	327.332
17TH	65.5	Top	273.0058	297.9836	292.0526	277.9935	294.9666
16TH	62	Top	244.6091	266.9889	261.6748	249.0781	264.2857
15TH	58.5	Top	217.7715	237.6958	232.9648	221.7501	235.2892
14TH	55	Top	192.4929	210.1044	205.9225	196.0097	207.9772
13TH	51.5	Top	168.7733	184.2147	180.5481	171.8567	182.3496
12TH	48	Top	146.6128	160.0266	156.8415	149.2913	158.4064
11TH	44.5	Top	126.0113	137.5403	134.8027	128.3134	136.1477
10TH	41	Top	108.2038	117.9886	115.6639	110.1585	116.8056
9TH	37.5	Top	91.6609	99.8447	97.8991	93.2966	98.8543
8TH	34	Top	75.3493	82.0768	80.4774	76.6939	81.2626
7TH	30.5	Top	60.6347	66.0484	64.7614	61.7167	65.3932
6TH	27	Top	47.517	51.7595	50.7509	48.3649	51.2461
5TH	23.5	Top	37.0427	40.255	39.4902	37.6855	39.8653

4TH	20	Top	27.6428	29.9683	29.4137	28.1087	29.6854
3RD	16.5	Top	18.8144	20.3971	20.0197	19.1315	20.2046
2ND	13	Top	11.6791	12.6616	12.4273	11.8759	12.5421
1ST	9.5	Top	6.2369	6.7616	6.6365	6.342	6.6978
PLINT H	6	Top	1.3465	1.4296	1.3634	1.3978	1.3887
Base	0	Top	0	0	0	0	0

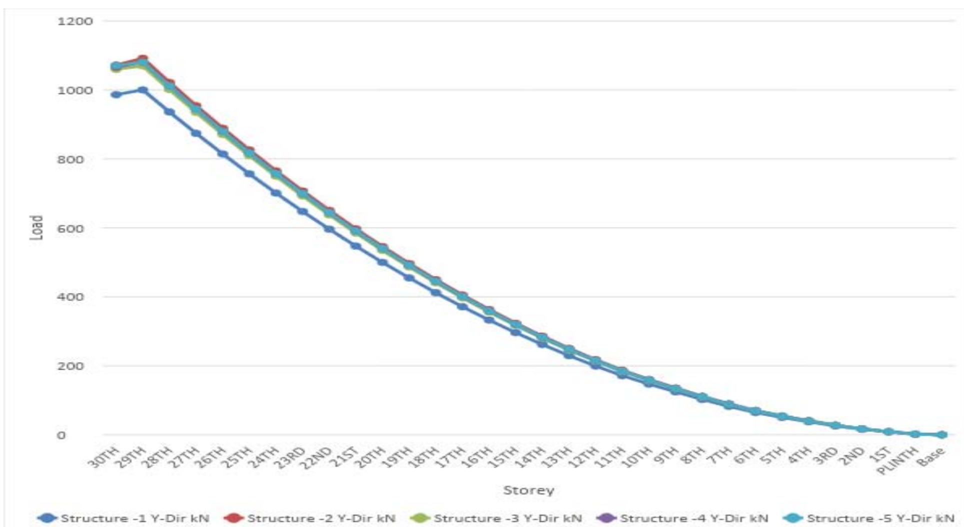


Graph 4: Lateral loads of structures in soft soil in Y - direction with load cases EQYP

Table 6: Lateral loads of structures in medium soil in Y - direction with load cases EQYP"kN"

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	986.1014	1071.7918	1059.8608	1065.8278	1070.7344
29TH	107.5	Top	1000.104	1091.6053	1069.8782	1080.7416	1080.5531
28TH	104	Top	936.0411	1021.6812	1001.3458	1011.5134	1011.3369
27TH	100.5	Top	874.0984	954.0713	935.0817	944.5763	944.4116
26TH	97	Top	814.2761	888.7757	871.0857	879.9306	879.7771
25TH	93.5	Top	756.5741	825.7944	809.358	817.5761	817.4335
24TH	90	Top	700.9923	765.1273	749.8984	757.5128	757.3806
23RD	86.5	Top	647.5308	706.7746	692.7071	699.7407	699.6187
22ND	83	Top	596.1896	650.7361	637.784	644.2599	644.1476
21ST	79.5	Top	546.9687	597.0119	585.1291	591.0704	590.9673
20TH	76	Top	499.8681	545.6019	534.7424	540.1721	540.0779
19TH	72.5	Top	454.8877	496.5062	486.6239	491.565	491.4793
18TH	69	Top	412.0277	449.7248	440.7736	445.2492	445.1715
17TH	65.5	Top	371.2879	405.2577	397.1916	401.2246	401.1546
16TH	62	Top	332.6684	363.1049	355.8777	359.4912	359.4285
15TH	58.5	Top	296.1692	323.2663	316.8321	320.0491	319.9933
14TH	55	Top	261.7903	285.742	280.0547	282.8983	282.8489
13TH	51.5	Top	229.5317	250.532	245.5454	248.0387	247.9954
12TH	48	Top	199.3934	217.6362	213.3044	215.4703	215.4327

11TH	44.5	Top	171.3753	187.0547	183.3316	185.1932	185.1609
10TH	41	Top	147.1571	160.4645	157.3029	158.8837	158.8557
9TH	37.5	Top	124.6588	135.7888	133.1428	134.4658	134.4418
8TH	34	Top	102.4751	111.6245	109.4493	110.5369	110.5172
7TH	30.5	Top	82.4632	89.8258	88.0755	88.9506	88.9348
6TH	27	Top	64.6231	70.3929	69.0212	69.7071	69.6946
5TH	23.5	Top	50.3781	54.7468	53.7067	54.2268	54.2168
4TH	20	Top	37.5942	40.7568	40.0027	40.3798	40.3722
3RD	16.5	Top	25.5876	27.7401	27.2268	27.4835	27.4783
2ND	13	Top	15.8836	17.2198	16.9011	17.0604	17.0572
1ST	9.5	Top	8.4822	9.1958	9.0256	9.1107	9.109
PLINTH	6	Top	1.8312	1.9442	1.8543	1.8992	1.8886
Base	0	Top	0	0	0	0	0

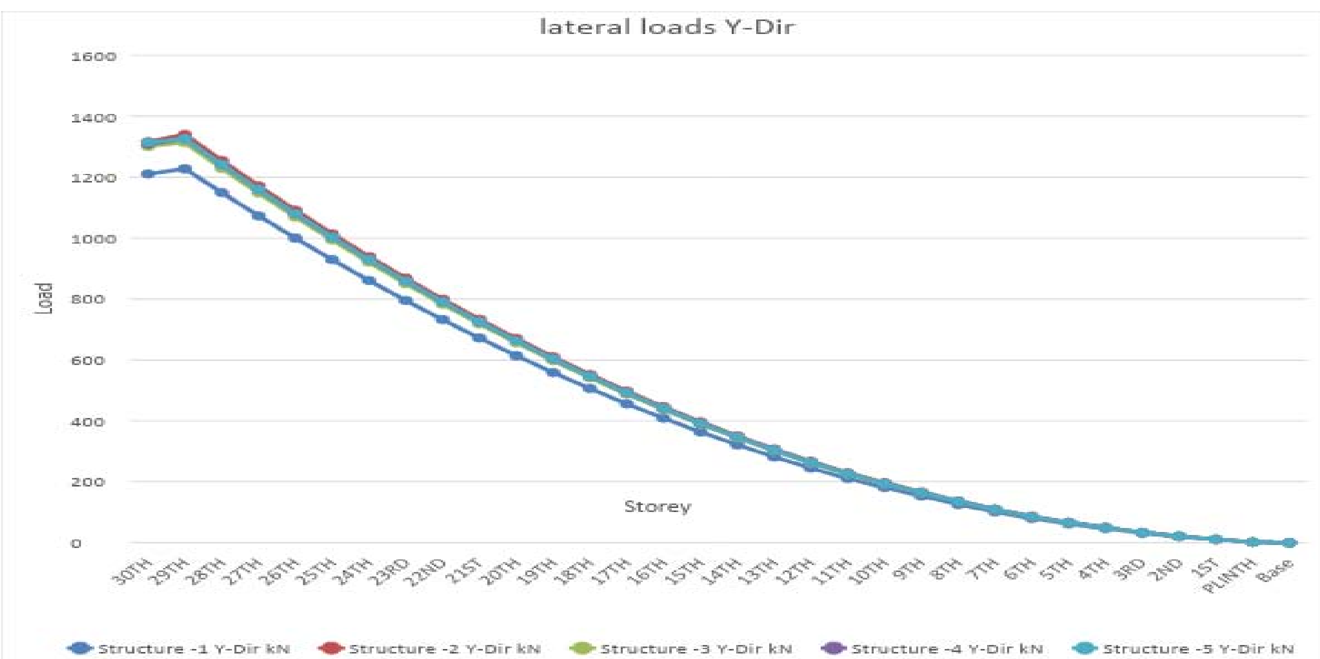


Graph 5: Lateral loads of structures in medium soil in Y - direction with load cases EQYP

Table 7: Lateral loads of structures in hard soil in Y - direction with load cases EQYP“kN”

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	1210.8746	1316.0973	1301.4467	1308.7739	1314.7989
29TH	107.5	Top	1228.0688	1340.4271	1313.7475	1327.0871	1326.8556
28TH	104	Top	1149.4034	1254.5644	1229.5938	1242.0789	1241.8623
27TH	100.5	Top	1073.3415	1171.5434	1148.2253	1159.8842	1159.6819
26TH	97	Top	999.8832	1091.3643	1069.642	1080.503	1080.3145
25TH	93.5	Top	929.0284	1014.0269	993.844	1003.9353	1003.7602
24TH	90	Top	860.7773	939.5314	920.8311	930.1811	930.0189
23RD	86.5	Top	795.1297	867.8776	850.6036	859.2405	859.0906
22ND	83	Top	732.0858	799.0656	783.1612	791.1133	790.9753
21ST	79.5	Top	671.6454	733.0955	718.5041	725.7997	725.6731
20TH	76	Top	613.8086	669.9671	656.6322	663.2995	663.1838

19TH	72.5	Top	558.5754	609.6805	597.5455	603.6129	603.5076
18TH	69	Top	505.9458	552.2357	541.2441	546.7398	546.6444
17TH	65.5	Top	455.9197	497.6326	487.7279	492.6802	492.5943
16TH	62	Top	408.4973	445.8714	436.9969	441.4341	441.3571
15TH	58.5	Top	363.6784	396.952	389.0512	393.0015	392.933
14TH	55	Top	321.4631	350.8744	343.8906	347.3825	347.3219
13TH	51.5	Top	281.8514	307.6385	301.5154	304.5769	304.5238
12TH	48	Top	244.8433	267.2445	261.9253	264.5849	264.5387
11TH	44.5	Top	210.4388	229.6922	225.1205	227.4063	227.3667
10TH	41	Top	180.7003	197.041	193.1587	195.0998	195.0654
9TH	37.5	Top	153.0737	166.7407	163.4916	165.1161	165.0867
8TH	34	Top	125.8334	137.0683	134.3973	135.7328	135.7086
7TH	30.5	Top	101.26	110.3008	108.1515	109.2262	109.2067
6TH	27	Top	79.3534	86.4384	84.754	85.5962	85.5809
5TH	23.5	Top	61.8614	67.2259	65.9487	66.5873	66.5751
4TH	20	Top	46.1635	50.047	49.1209	49.584	49.5746
3RD	16.5	Top	31.42	34.0632	33.4329	33.7481	33.7417
2ND	13	Top	19.5041	21.1449	20.7536	20.9492	20.9453
1ST	9.5	Top	10.4156	11.2919	11.0829	11.1874	11.1853
PLINT H	6	Top	2.2486	2.3874	2.2769	2.3321	2.3191
Base	0	Top	0	0	0	0	0



Graph 6: Lateral loads of structures in hard soil in Y - direction with load cases EQYP

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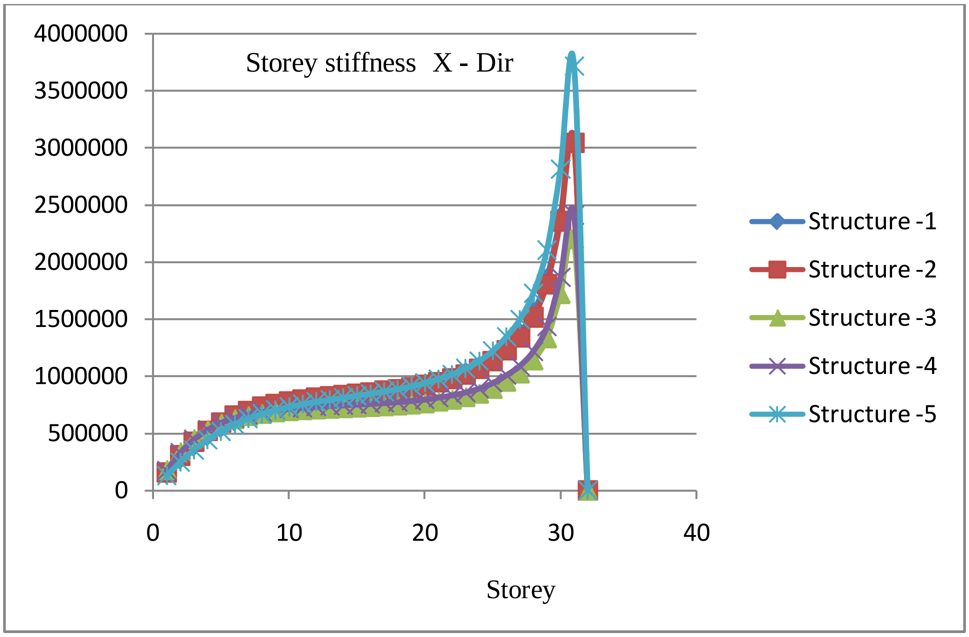
Table 8: Storey stiffness of structures in X - direction with load cases EQXP “kN/m”

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	143022.831	158381.126	181178.624	172953.339	127169.993
29TH	107.5	Top	270359.127	304820.61	337174.461	327254.392	248172.464
28TH	104	Top	381794.982	426099.529	452428.891	444924.118	354071.082
27TH	100.5	Top	472732.209	521829.67	532910.668	530105.692	443372.828
26TH	97	Top	545503.246	596139.507	588332.598	590667.978	517614.83
25TH	93.5	Top	603792.812	653296.417	626524.22	633562.623	578646.371
24TH	90	Top	650454.136	697244.731	653166.633	664160.849	628581.824
23RD	86.5	Top	688057.119	731243.736	672113.127	686302.445	669461.512
22ND	83	Top	718725.486	757866.004	685929.768	702657.154	703133.112
21ST	79.5	Top	744162.046	779096.613	696324.49	715067.826	731206.128
20TH	76	Top	765727.986	796459.142	704448.847	724816.109	755057.429
19TH	72.5	Top	784518.418	811132.376	711098.396	732811.079	775860.721
18TH	69	Top	801430.979	824047.802	716844.342	739719.634	794626.165
17TH	65.5	Top	817225.311	835968.22	722121.338	746057.058	812242.984
16TH	62	Top	832574.637	847551.522	727288.787	752252.191	829522.4
15TH	58.5	Top	848111.52	859404.644	732677.128	758697.633	847240.753
14TH	55	Top	864462.491	872134.49	738629.876	765794.668	866186.754
13TH	51.5	Top	882365.473	886388.491	745533.46	773989.455	887202.279
12TH	48	Top	902632.028	903005.62	753948.505	783882.482	911331.37
11TH	44.5	Top	925075.51	922254.804	764089.67	795870.555	939235.164
10TH	41	Top	956816.406	948997.572	779932.279	813399.858	975316.477
9TH	37.5	Top	988643.743	977803.611	796504.379	832552.458	1015663.136
8TH	34	Top	1030418.09	1015463.943	818704.224	857870.998	1067325.405
7TH	30.5	Top	1083371.397	1064358.095	848785.417	891839.923	1133147.012
6TH	27	Top	1154692.733	1130715.464	891201.329	939154.717	1220632.072
5TH	23.5	Top	1258596.787	1226013.876	953467.383	1007354.759	1343308.893
4TH	20	Top	1375721.385	1339481.13	1025949.531	1089305.176	1494603.693
3RD	16.5	Top	1560244.267	1516467.16	1140460.746	1217443.451	1727466.79
2ND	13	Top	1857338.108	1806840.251	1334049.241	1432837.445	2105070.037
1ST	9.5	Top	2395459.119	2358089.455	1721543.629	1866169.209	2813604.443
PLINT H	6	Top	3052958.805	3044220.373	2202808.66	2409798.589	3716538.982
Base	0	Top	0	0	0	0	0

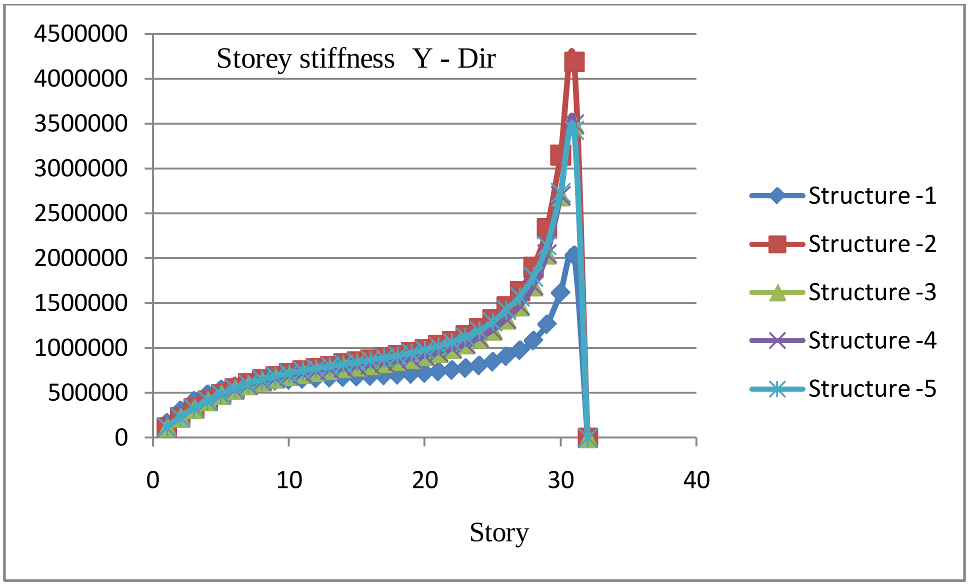


Graph 7: Storey stiffness of structures in X - direction with load cases EQXP

Table 9: Storey stiffness of structures in Y - direction with load cases EQYP "kN/m"

Story	Elevation (m)	Location	Structure -1	Structure -2	Structure -3	Structure -4	Structure -5
30TH	111	Top	164522.123	114244.812	117056.012	116081.044	119164.119
29TH	107.5	Top	302993.412	225651.248	227824.991	227134.567	229810.931
28TH	104	Top	408677.202	325183.311	325767.682	325289.284	328402.199
27TH	100.5	Top	483340.501	411537.184	409355.2	409057.523	413473.499
26TH	97	Top	535680.552	485686.066	479807.335	479661.571	486134.555
25TH	93.5	Top	572640.814	548807.058	538651.644	538628.011	547831.972
24TH	90	Top	599109.141	602365.639	587629.396	587701.998	600146.012
23RD	86.5	Top	618482.871	647862.407	628449.358	628596.387	644624.109
22ND	83	Top	633043.22	686736.82	662687.248	662891.088	682702.979
21ST	79.5	Top	644330.251	720312.671	691743.325	691990.14	715677.877
20TH	76	Top	653399.721	749782.672	716840.128	717119.319	744700.513
19TH	72.5	Top	660994.311	776214.996	739041.147	739344.806	770793.357
18TH	69	Top	667657.281	800572.833	759279.767	759602.203	794872.745
17TH	65.5	Top	673808.885	823741.302	778392.658	778730.008	817776.659
16TH	62	Top	679800.36	846559.21	797155.23	797505.172	840295.4
15TH	58.5	Top	685957.017	869854.874	816318.844	816680.403	863205.201
14TH	55	Top	692607.423	894490.095	836652.716	837026.241	887306.209
13TH	51.5	Top	700142.534	921398.569	858984.397	859371.155	913466.212
12TH	48	Top	709147.826	951743.906	884315.986	884720.614	942691.624
11TH	44.5	Top	719304.159	986339.518	913212.154	913640.643	975623.28
10TH	41	Top	736444.19	1029690.263	951180.036	951607.325	1019626.35
9TH	37.5	Top	752520.322	1078251.194	991814.364	992308.273	1064004.896
8TH	34	Top	774346.165	1139475.911	1043844.75	1044407.058	1120733.923
7TH	30.5	Top	803524.748	1216576.372	1109749.81	1110394.829	1192207.735
6TH	27	Top	844489.543	1317689.178	1197560.369	1198282.023	1287976.983
5TH	23.5	Top	906254.456	1457780.887	1321130.921	1321932.941	1422330.025
4TH	20	Top	973343.501	1633059.784	1466950.928	1468099.344	1570334.519

3RD	16.5	Top	1080765.084	1900437.015	1690646.807	1692303.93	1794350.918
2ND	13	Top	1262128.804	2332077.853	2046043.726	2048530.453	2138462.884
1ST	9.5	Top	1611231.402	3148215.488	2694593.565	2698550.737	2728249.129
PLINTH	6	Top	2029896.11	4184894.988	3491010.809	3496978.337	3423591.625
Base	0	Top	0	0	0	0	0



Graph 8: Storey stiffness of structures in Y - direction with load cases EQYP

Table 10: Comparation percentage of story lateral loads in soft soil of structures 2,3,4,5 with structure -1

Story lateral loads		Structure -2	Structure -3	Structure -4	Structure -5
Load Case	Direction	Percentage	Percentage	Percentage	Percentage
EQXP	X	8%	6%	2%	7%
EQYP	Y	8%	6%	2%	7%

Table 11: Comparation percentage of story lateral loads in medium soil of structures 2,3,4,5 with structure -1

Story lateral loads		Structure -2	Structure -3	Structure -4	Structure -5
Load Case	Direction	Percentage	Percentage	Percentage	Percentage
EQXP	X	8%	6%	7%	7%
EQYP	Y	8%	6%	7%	7%

Table 12: Comparation percentage of story lateral loads in hard soil of structures 2,3,4,5 with structure -1

Story lateral loads		Structure -2	Structure -3	Structure -4	Structure -5
Load Case	Direction	Percentage	Percentage	Percentage	Percentage
EQXP	X	8%	6%	7%	7%
EQYP	Y	8%	6%	7%	7%

a) Discussion on Results

When a structure is subjected to earthquake, it responds by vibrating. An example force can be resolved into three mutually perpendicular directions- two horizontal directions (X and Y directions) and the vertical direction (Z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. All the structures are primarily designed for gravity loads-force equal to mass time's gravity in the vertical direction. Because of the inherent factor used in the design specifications, most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans those in which stability for design, or for overall stability analysis of structures. The basic intent of design theory for earthquake resistant structures is that buildings should be able to resist minor earthquakes without damage, resist moderate earthquakes without structural damage but with some non-structural damage. To avoid collapse during a major earthquake, Members must be ductile enough to absorb and dissipate energy by post elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements. When the primary element or system yields or fails, the lateral force can be redistributed to a secondary system to prevent progressive failure. The structures are supported on soil, most of the designers do not consider the soil structure interaction and its subsequent effect on structures during an earthquake. When a structure is subjected to an earthquake excitation, it interacts with the foundation and the soil, and thus changes the motion of the ground. This means that the movement of the whole ground-structure system is influenced by the type of soil as well as by the type of structure. Understanding of soil structure interaction will enable the designer to design structures that will behave better during an earthquake.

V. Conclusions

In this paper, reinforced concrete shear wall buildings were analyzed with the procedures laid out in IS codes. Seismic performance of building model is evaluated. In this study, regular shaped structures have been considered. Estimation of structural response was carried out for Dual frame system with shear wall structure.

From the above results and discussions, following conclusions can be drawn:

- Building with box shape shear walls provided at the center core showed better performance in term of storey stiffness and lateral loads.
- Provision of the shear wall, generally results in reducing the displacement because the shear wall increases the stiffness of the building.
- It is observed that the value of stiffness in X & Y-direction is same for all models with a different type of soil.
- The value of the lateral loads in x-direction for all models decreases with increase in storey level and also The value of the lateral loads in x-direction for all models in soft soil is less compared with the structure in medium soil and hard soil, lateral loads in X-direction for all models in soft soil <Medium soil < hard soil.
- Percentage of lateral load for all three type of soil is same.
- For severe lateral loads caused by wind load and or earthquake load, the reinforced shear wall is obvious. Because, it produces less deflection and less bending moment in connecting beams under lateral loads than all others structural system.
- It is evident that shear walls which are provided from the foundation to the rooftop, are one of the excellent mean for providing earthquake resistant to multistory reinforced building with different type of soil.
- ETABS is the advanced software which is used for analysing any kind of building structures. By its fast and accuracy it can easily analyses buildings up to 40 floors, ETABS can analyse any building structure with pre-determined load conditions and load combinations for shear walls regarding IS codes.

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Conflict of Interest

The author declare no conflict of interest.

Data Availability Statement

All data generated or analysed during this study are included in this article.

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