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Seismic Analysis of Multi-StoreyBuildingwithPlus ShapeRCShear Wallsat The CenterinConcrete Frame Structure WithDifferentType of SoilCondition

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ABSTRACT: Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Shear walls should be provided along preferably both length and width. Shear walls are analyzed to resist two types of forces: shear forces and uplift forces. Shear forces are created throughout the height of the wall between the top and bottom shear wall connections. 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.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. Three types soil are considered here:Hard soil ,Medium soil,softsoil.In this study 30 story building with plus (+) Shape RC Shear wall at the center in Concrete Frame Structure with fixed support conditions under different type of soil for earthquake zone V as per IS 1893 (part 1) : 2002 in India are analyzed using software ETABS by Dynamic analysis (Response Spectrum method). All the analyses has been carried out as per the Indian Standard code books. This paper aims to Study the behaviour of high rise structure with dual system withPlus ShapeRC Shear Walls under different type of soil conditionwith seismic loading. Estimation of structural response such as; ,stiffness , lateral loads ,storey displacements, storey moment ,storey shear, storey drift , Pier Forces, column forces andMode shapes of shear wall is carried out.

Keywords: Response Spectrum method, Soft ,Medium&Hard Soil, Structural Response , Plus Shape Shear Wall, ETABS software

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I. INTRODUCTION

1.1 Background

Shear walls in high seismic regions require special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements (like glass windows and building contents). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Shear walls should be provided along preferably both length and width. Shear walls in buildings must be symmetrically located in plan to reduce ill-effects of twist in buildings. They could be placed symmetrically along one or both directions in plan. Buildings are designed primarily to serve the needs of an intended occupancy. One of the dominant design requirements is therefore the provision of an appropriate internal layout of buildings. Once the functional layout is established, one must develop a structural system that will satisfy the established design criteria as efficiently and economically as possible, while fitting into the architectural layout. The vital structural criteria are an adequate reserve of strength against failure, adequate lateral stiffness and an efficient performance during the service life of the buildings. In modern tall buildings, shear walls are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquakes. Shear walls of varying cross sections i.e. rectangular shapes to more irregular cores such as channel, T, L, barbell shape, box etc. can be used. Provision of walls helps to divide an enclose space, whereas of cores to contain and convey services such as elevator.

1.2 Literature Review

Prajapati R.J. et al., (2013) carried out study on deflection in high rise buildings for different position of shear walls. It was observed that deflection for building with shear walls provided at the corners in both the directions was drastically less when compared with other models.Chandurkar P.P. et al., (2013) conducted a study on seismic analysis of RCC building with and without shear walls. They have selected a ten storied building located in zone II, zone III, zone IV and zone V. Parameters like Lateral displacement, story drift and total cost required for ground floor were calculated in both the cases.Bhat S.M. et al., (2013) carried out study on Eathquakebehaviour of buildings with and without shear walls. Parameters like Lateral displacement, story drift etc were found and compared with the bare frame model.Sardar S.J. et al., (2013) studied lateral displacement and inter-story drift on a square symmetric structure with walls at the centre and at the edges, and found that the presence of shear wall can affect the seismic behaviour of frame structure to large extent, and the shear wall increases the strength and stiffness of the structure.

Sagar K.et al., (2012) carried out linear dynamic analysis on two sixteen storey high buildings.It was concluded that shear walls are one of the most effective building elements in resisting lateral forces during earthquake. Providin shear walls in proper position minimizes effect and damages due to earthquake and winds.

Kumbhare P.S. et al., (2012) carried out a study on shear wall frame interaction systems and member forces. It was found that shear wall frame interaction systems are very effective in resisting lateral forces induced by earthquake. Placing shear wall away from center of gravity resulted in increase in the most of the members forces. It follows that shear walls should be coinciding with the centroid of the building.Rahman A. et al., (2012) studied on drift analysis due to earthquake load on tall structures. In this study regular shaped structures have been considered. Estimation of drift was carried out for rigid frame structure, coupled shear wall structure and wall frame structure.

Anshuman et al., (2011) conducted a research on solution of shear wall location in multi storey building. An earthquake load was calculated and applied to a fifteen storied building located in zone IV. It was observed that the top deflection was reduced and reached within the permissible deflection after providing the shear wall.Kameshwari B. et al., (2011) analyzed the effect of various configurations of shear walls on high-rise structure. The drift and inter-storey drift of the structure in the following configurations of shear wall panels was studied and was compared with that of bare frame. Diagonal shear wall configuration was found to be effective for structures in the earthquake prone areas.

Based on the literature review, the salient objective of the present study have been identified as

follows:

- behaviour of high rise structure with dual system with Plus shape RC Shear Wallswith seismic loading.
- To examine the effect of different types of soil (Hard, medium and Soft) on the overall interactive behaviour of the shear wall foundation soil system.
- The variation of maximum storey shear, storey moment of the models has been studied.
- The variation of storey drifts of the models has been studied
- The variation of displacement of the models has been studied
- The variation of Time period and frequency has been studied.
- The variation of maximum column axial force, maximum column shear force, maximum column moment and maximum column torsion of the model have been studied.
- The variation of Pier axial force, Pier shear force, Pier moment and Pier torsion of the models have been studied.

1.3Shear Wall Structure

The usefulness of shear walls in framing of buildings has long been recognized. Walls situated in advantageous positions in a building can form an efficient lateral-force-resisting system, simultaneously fulfilling other functional requirements. When a permanent and similar subdivision of floor areas in all stories is required as in the case of hotels or apartment buildings, numerous shear walls can be utilized not only for lateral force resistance but also to carry gravity loads. In such case, the floor by floor repetitive planning allows the walls to be vertically continuous which may serve simultaneously as excellent acoustic and fire insulators between the apartments. Shear walls may be planar but are often of L-, T-, I-, or U- shaped section to better suit the planning and to increase their flexural stiffness.The positions of shear walls within a building are usually dictated by functional requirements. These may or may not suit structural planning. The purpose of a building and consequent allocation of floor space may dictate required arrangements of walls that can often be readily utilized for lateral force resistance. Building sites, architectural interests or client's desire may lead the positions of walls that are undesirable from a structural point of view. However, structural designers are often in the position to advice as to the most desirable locations for shear walls in order to optimize seismic resistance. The major structural considerations for individual shear walls will be aspects of symmetry in stiffness, torsional stability and available overturning capacity of the foundations (Paulay and Priestley, 1992).

1.4 Essentials Of Structural Systems For Seismic Resistance

The primary purpose of all structural members used in buildings is to support gravity loads. However, buildings may also be subjected to lateral forces due to wind and earthquakes. The effects of lateral forces in buildings will be more significant as the building height increases. All structural systems will not behave equally under seismic excitation. Aspects of structural configuration, symmetry, mass distribution and vertical regularity must be considered. In addition to that, the importance of strength, stiffness and ductility in relation to acceptable response must be evaluated in structural system (Paulay and Priestley, 1992).

The first task of the structural designer is to select the appropriate structural system for the satisfactory seismic performance of the building within the constraints dictated by architectural requirements. It is better where possible to discuss architect and structural engineer for alternative structural configuration at the earliest stage of concept development. Thus, undesirable geometry is not locked into the system before structural design is started.

Irregularities in buildings contribute to complexity of structural behavior. When not recognized, they may result in unexpected damage and even collapse of the structures. There are many possible sources of structural irregularities. Drastic changes in geometry, interruptions in load path, discontinuities in both strength and stiffness, disruption in critical region by openings and unusual proportion of members are few of the possibilities. The recognition of many of these irregularities and of conceptions for remedial measures for the mitigation of their undesired effects relies on sound understanding of structural behavior.

II. METHODOLOGY

Earthquake motion causes vibration of the structure leading to inertia forces. Thus a structure must be able to safely transmit the horizontal and the vertical inertia forces generated in the super structure through the foundation to the ground. Hence, for most of the ordinary structures, earthquake-resistant design requires ensuring that the structure has adequate lateral load carrying capacity. Seismic codes will guide a designer to safely design the structure for its intended purpose.

1. Dynamic analysis.
2. Response spectrum method.
3. Time history method.

2.1 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:

2.1.1 Regular buildings: Those greater than 40m in height in zones IV and V, those greater than 90m in height in zone II and III.

2.1.2 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 Table 4 of 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 .However in either method, the design base shear V_B shall be compared with a base shear V_B calculated using a fundamental period *Ta*. When V_B is less than V_B all the response quantities shall be multiplied by V_B /*Vb*The values of damping for a building may be taken as 2 and 5 percent of the critical, for the purpose of dynamic analysis of steel and reinforced concrete buildings, respectively.

2.2 Time History Method

The usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics. In this method, the mathematical model of the building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure.

2.3 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.

2.4 Modes to be Considered

The number of modes to be considered in the analysis should be such that the sum of the total modal masses of all modes considered is at least 90% of the total seismic mass and the missing mass correction beyond 33%.If modes with natural frequency beyond 33 Hz are to be considered, modal combination shall be carried out only for modes up to 33 Hz.

2.5 Computation of Dynamic Quantities

Buildings with regular ,or nominally irregular plan configuration may be modeled as a system of masses lumped at the floor levels with each mass having one degree of freedom, that of lateral displacement in the direction of consideration

2.6 Response Analysis of MDOF System

Multi degree of freedom (MDOF) systems are usually analyzed using Modal Analysis. This system when subjected to ground motion undergoes deformations in number of possible ways. These deformed shapes are known as modes of vibration or mode shapes. Each shape is vibrating with a particular natural frequency. Total unique modes for each MDOF system are equal to the possible degree of freedom of system.

2.7 Design Of Earthquake Resistant Structure Based On Codal Provisions

General principles and design philosophy for design of earthquake-resistant structure are as follows:

a) The characteristics of seismic ground vibrations at any location depends upon the magnitude of earth quake, its depth of focus, distance from epicenter, characteristic of the path through which the waves travel, and the soil strata on which the structure stands. Ground motions are predominant in horizontal direction.
b) Earthquake generated vertical forces, if significant, as in large spans where differential settlement is not allowed, must be considered.
c) The response of a structure to the ground motions is a function of the nature of foundation soil, materials size and mode of construction of structures, and the duration and characteristic of ground motion.
d) The design approach is to ensure that structures possess at least a minimum strength to withstand minor earthquake (DBE), which occur frequently, without damage; resist moderate earthquake without significant damage though some nonstructural damage may occur, and aims that structures withstand major earthquake (MCE) without collapse. Actual forces that appeared on structures are much greater then the design forces specified here, but ductility, arising due to inelastic material behavior and detailing, and over strength, arising from the additional reserve strength in structures over and above the design strength are relied upon to account for this difference in actual and design lateral forces.
e) Reinforced and pre-stressed members shall be suitably designed to ensure that premature failure due to shear or bond does not occur, as per IS:456 and IS:1343.
f) In steel structures, members and their connections should be so proportioned that high ductility is obtained.
g) The soil structure interaction refers to the effect of the supporting foundation medium on the motion of structure. The structure interaction may not be considered in the seismic analysis for structures supporting on the rocks.
h) The design lateral forces shall be considered in two orthogonal horizontal directions of the structures. For structures, which have lateral force resisting elements in two orthogonal directions only, design lateral force must be considered in one direction at a time. Structures having lateral resisting elements in two directions other than orthogonal shall be analyzed according to clause 2.3.2 IS 1893 (part 1) : 2002. Where both horizontal and vertical forces are taken into account, load combinations must be according to clause2.3.3 IS

1893 (part 1) : 2002.

i) When a change in occupancy results in a structure being re-classified to a higher importance factor (I), the structure shall be confirm to the seismic requirements of the new structure with high importance factor.

III . MODELING OF BUILDING

3.1 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.

3.2 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:
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
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

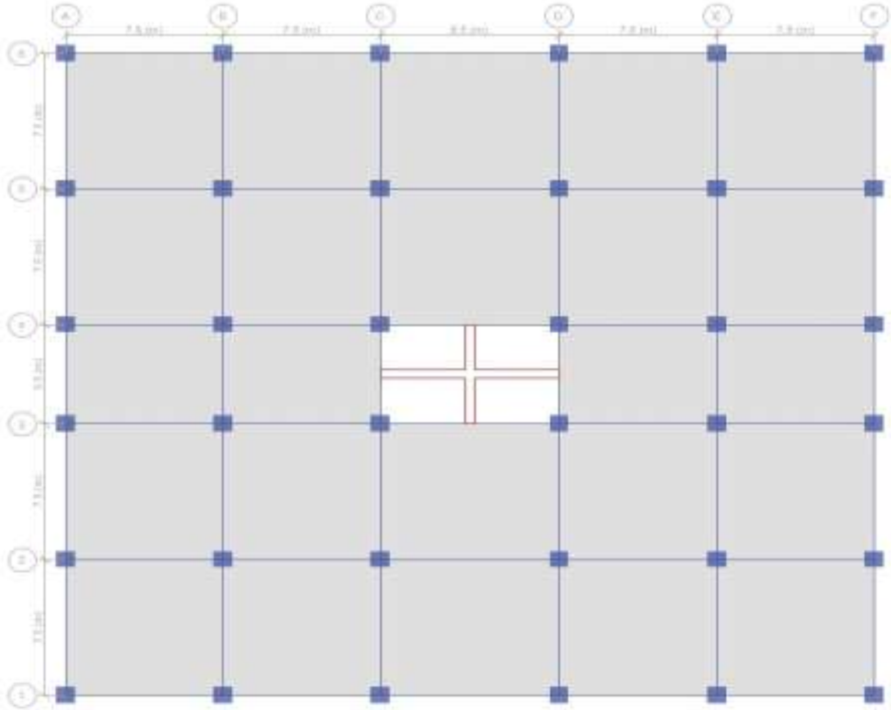


Figure 1. Plan of the building

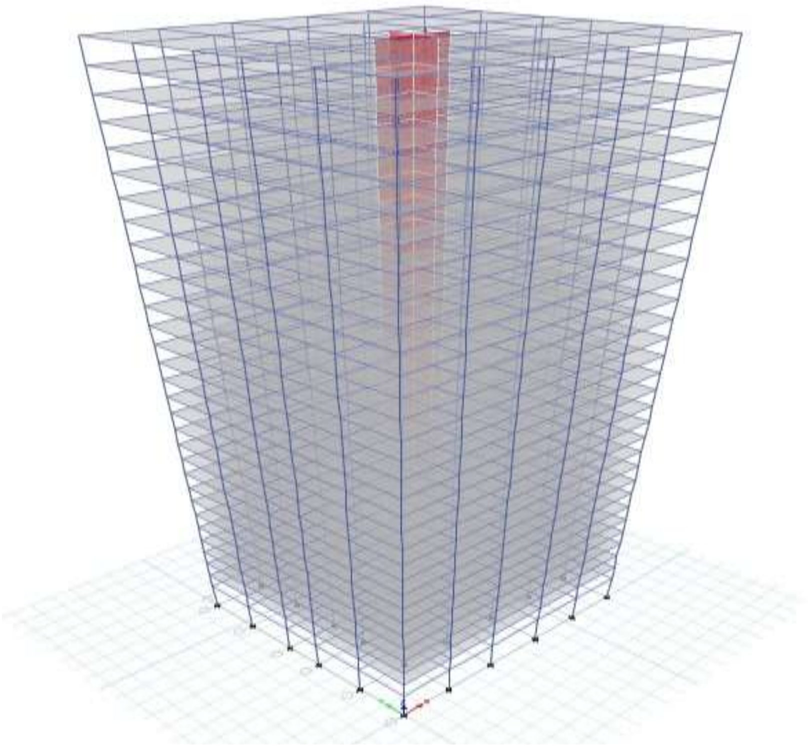


Figure 2.3D view showing shear wall location

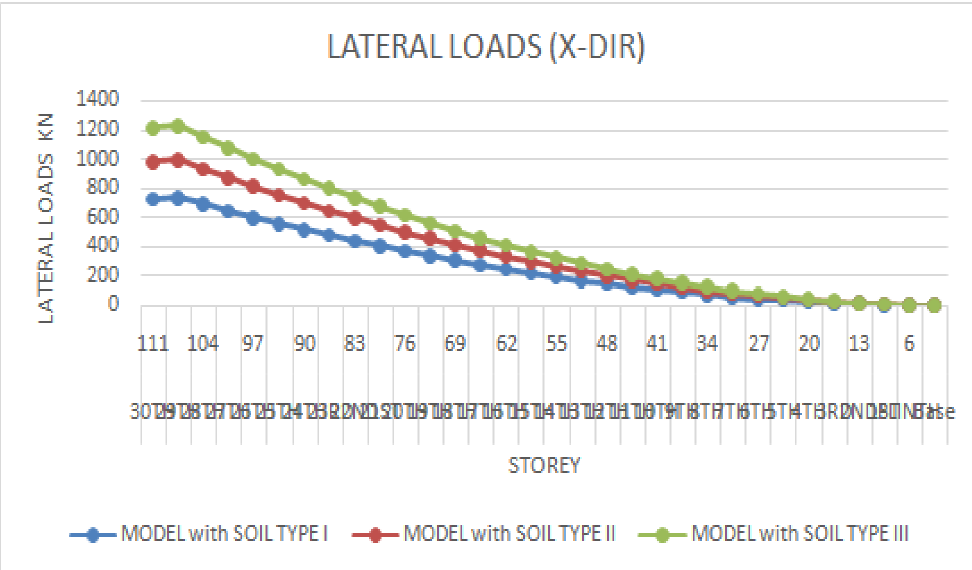
IV. RESULTS AND DISCUSSIONS

Table 2: Lateral Loads of Structure in Soft Soil , Medium Soil and Hard Soil in X –Direction for load cases EQXP

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	X-Dir	X-Dir	X-Dir
	m		kN	kN	kN
30TH	111	Top	725.0746	986.1014	1210.8746
29TH	107.5	Top	735.3706	1000.104	1228.0688
28TH	104	Top	688.2655	936.0411	1149.4034

27TH	100.5	Top	642.7194	874.0984	1073.3415
26TH	97	Top	598.7324	814.2761	999.8832
25TH	93.5	Top	556.3045	756.5741	929.0284
24TH	90	Top	515.4355	700.9923	860.7773
23RD	86.5	Top	476.1256	647.5308	795.1297
22ND	83	Top	438.3747	596.1896	732.0858
21ST	79.5	Top	402.1829	546.9687	671.6454
20TH	76	Top	367.5501	499.8681	613.8086
19TH	72.5	Top	334.4763	454.8877	558.5754
18TH	69	Top	302.9615	412.0277	505.9458
17TH	65.5	Top	273.0058	371.2879	455.9197
16TH	62	Top	244.6091	332.6684	408.4973
15TH	58.5	Top	217.7715	296.1692	363.6784
14TH	55	Top	192.4929	261.7903	321.4631
13TH	51.5	Top	168.7733	229.5317	281.8514
12TH	48	Top	146.6128	199.3934	244.8433
11TH	44.5	Top	126.0113	171.3753	210.4388
10TH	41	Top	108.2038	147.1571	180.7003
9TH	37.5	Top	91.6609	124.6588	153.0737
8TH	34	Top	75.3493	102.4751	125.8334
7TH	30.5	Top	60.6347	82.4632	101.26
6TH	27	Top	47.517	64.6231	79.3534
5TH	23.5	Top	37.0427	50.3781	61.8614
4TH	20	Top	27.6428	37.5942	46.1635
3RD	16.5	Top	18.8144	25.5876	31.42
2ND	13	Top	11.6791	15.8836	19.5041
1ST	9.5	Top	6.2369	8.4822	10.4156
PLINTH	6	Top	1.3465	1.8312	2.2486
Base	0	Top	0	0	0

A plot for Lateral Loads of Structure in Soft Soil , Medium Soil and Hard Soil in X –Direction for load cases EQXP has been shown here



Graph 1: Lateral Loads of Structure in Soft Soil , Medium Soil and Hard Soil in X –Direction

Table 3: Stiffness of Structure in Soft Soil , Medium Soil and Hard Soil in X – Direction for load cases EQXP

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	X-Dir	X-Dir	X-Dir
	m		kN/m	kN/m	kN/m
30TH	111	Top	143022.831	143022.831	143022.831
29TH	107.5	Top	270359.127	270359.127	270359.127
28TH	104	Top	381794.982	381794.982	381794.982
27TH	100.5	Top	472732.209	472732.209	472732.209
26TH	97	Top	545503.246	545503.246	545503.246
25TH	93.5	Top	603792.812	603792.812	603792.812
24TH	90	Top	650454.136	650454.136	650454.136
23RD	86.5	Top	688057.119	688057.119	688057.119

22ND	83	Top	718725.486	718725.486	718725.486
21ST	79.5	Top	744162.046	744162.046	744162.046
20TH	76	Top	765727.986	765727.986	765727.986
19TH	72.5	Top	784518.418	784518.418	784518.418
18TH	69	Top	801430.979	801430.979	801430.979
17TH	65.5	Top	817225.311	817225.311	817225.311
16TH	62	Top	832574.637	832574.637	832574.637
15TH	58.5	Top	848111.52	848111.52	848111.52
14TH	55	Top	864462.491	864462.491	864462.491
13TH	51.5	Top	882365.473	882365.473	882365.473
12TH	48	Top	902632.028	902632.028	902632.028
11TH	44.5	Top	925075.51	925075.51	925075.51
10TH	41	Top	956816.406	956816.406	956816.406
9TH	37.5	Top	988643.743	988643.743	988643.743
8TH	34	Top	1030418.09	1030418.09	1030418.09
7TH	30.5	Top	1083371.397	1083371.397	1083371.397
6TH	27	Top	1154692.733	1154692.733	1154692.733
5TH	23.5	Top	1258596.787	1258596.787	1258596.787
4TH	20	Top	1375721.385	1375721.385	1375721.385
3RD	16.5	Top	1560244.267	1560244.267	1560244.267
2ND	13	Top	1857338.108	1857338.108	1857338.108
1ST	9.5	Top	2395459.119	2395459.119	2395459.119
PLINTH	6	Top	3052958.805	3052958.805	3052958.805
Base	0	Top	0	0	0

Table 4: Stiffness of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction for load cases EQYP

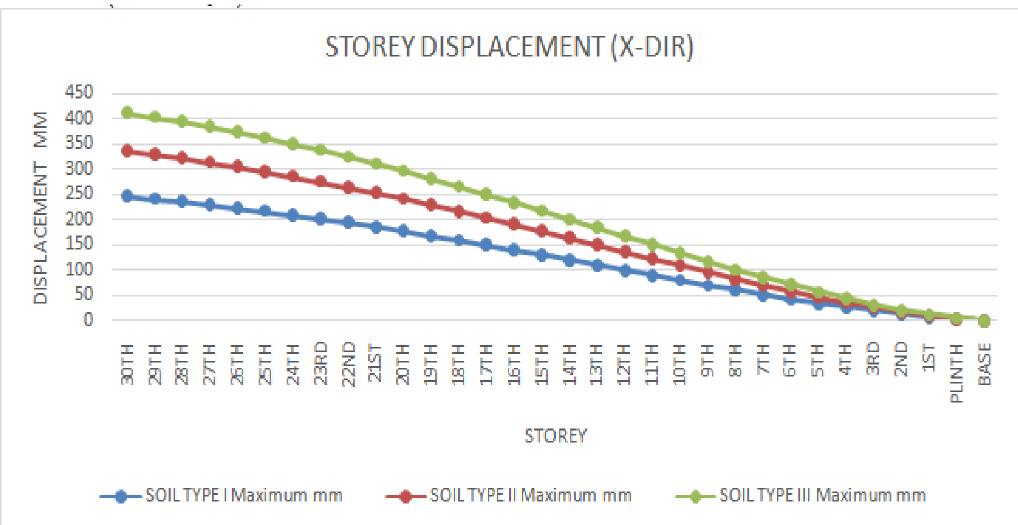
			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	Y-Dir	Y-Dir	Y-Dir
	m		kN/m	kN/m	kN/m
30TH	111	Top	164522.123	164522.123	164522.123
29TH	107.5	Top	302993.412	302993.412	302993.412
28TH	104	Top	408677.202	408677.202	408677.202
27TH	100.5	Top	483340.501	483340.501	483340.501
26TH	97	Top	535680.552	535680.552	535680.552
25TH	93.5	Top	572640.814	572640.814	572640.814
24TH	90	Top	599109.141	599109.141	599109.141
23RD	86.5	Top	618482.871	618482.871	618482.871
22ND	83	Top	633043.22	633043.22	633043.22
21ST	79.5	Top	644330.251	644330.251	644330.251
20TH	76	Top	653399.721	653399.721	653399.721
19TH	72.5	Top	660994.311	660994.311	660994.311
18TH	69	Top	667657.281	667657.281	667657.281
17TH	65.5	Top	673808.885	673808.885	673808.885
16TH	62	Top	679800.36	679800.36	679800.36
15TH	58.5	Top	685957.017	685957.017	685957.017
14TH	55	Top	692607.423	692607.423	692607.423
13TH	51.5	Top	700142.534	700142.534	700142.534
12TH	48	Top	709147.826	709147.826	709147.826
11TH	44.5	Top	719304.159	719304.159	719304.159
10TH	41	Top	736444.19	736444.19	736444.19
9TH	37.5	Top	752520.322	752520.322	752520.322
8TH	34	Top	774346.165	774346.165	774346.165
7TH	30.5	Top	803524.748	803524.748	803524.748
6TH	27	Top	844489.543	844489.543	844489.543
5TH	23.5	Top	906254.456	906254.456	906254.456
4TH	20	Top	973343.501	973343.501	973343.501
3RD	16.5	Top	1080765.084	1080765.084	1080765.084
2ND	13	Top	1262128.804	1262128.804	1262128.804
1ST	9.5	Top	1611231.402	1611231.402	1611231.402
PLINTH	6	Top	2029896.11	2029896.11	2029896.11
Base	0	Top	0	0	0

Table 5: StoreyDisplacement of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination (DL+LL+EQXP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III

Story	Load Case/Combo	Direction	Story Maximum Displacements	Story Maximum Displacements	Story Maximum Displacements
			mm	mm	mm
30TH	DLLLEQXP	X	247.583	336.596	413.247
29TH	DLLLEQXP	X	242.298	329.414	404.43
28TH	DLLLEQXP	X	236.611	321.685	394.942
27TH	DLLLEQXP	X	230.622	313.544	384.95
26TH	DLLLEQXP	X	224.275	304.917	374.358
25TH	DLLLEQXP	X	217.536	295.757	363.114
24TH	DLLLEQXP	X	210.398	286.054	351.202
23RD	DLLLEQXP	X	202.862	275.81	338.626
22ND	DLLLEQXP	X	194.94	265.041	325.405
21ST	DLLLEQXP	X	186.65	253.771	311.57
20TH	DLLLEQXP	X	178.016	242.034	297.161
19TH	DLLLEQXP	X	169.068	229.869	282.226
18TH	DLLLEQXP	X	159.836	217.319	266.818
17TH	DLLLEQXP	X	150.356	204.431	250.996
16TH	DLLLEQXP	X	140.667	191.258	234.823
15TH	DLLLEQXP	X	130.807	177.854	218.366
14TH	DLLLEQXP	X	120.821	164.277	201.697
13TH	DLLLEQXP	X	110.754	150.59	184.893
12TH	DLLLEQXP	X	100.656	136.861	168.037
11TH	DLLLEQXP	X	90.581	123.163	151.219
10TH	DLLLEQXP	X	80.58	109.565	134.524
9TH	DLLLEQXP	X	70.768	96.224	118.145
8TH	DLLLEQXP	X	61.148	83.144	102.085
7TH	DLLLEQXP	X	51.811	70.449	86.498
6TH	DLLLEQXP	X	42.845	58.259	71.531
5TH	DLLLEQXP	X	34.377	46.744	57.393
4TH	DLLLEQXP	X	26.571	36.13	44.362
3RD	DLLLEQXP	X	19.376	26.348	32.351
2ND	DLLLEQXP	X	12.981	17.651	21.673
1ST	DLLLEQXP	X	7.564	10.286	12.63
PLINTH	DLLLEQXP	X	3.951	4.831	5.241
BASE	DLLLEQXP	X	0	0	0

A plot for StoreyDisplacement of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination (DL+LL+EQXP) has been shown here



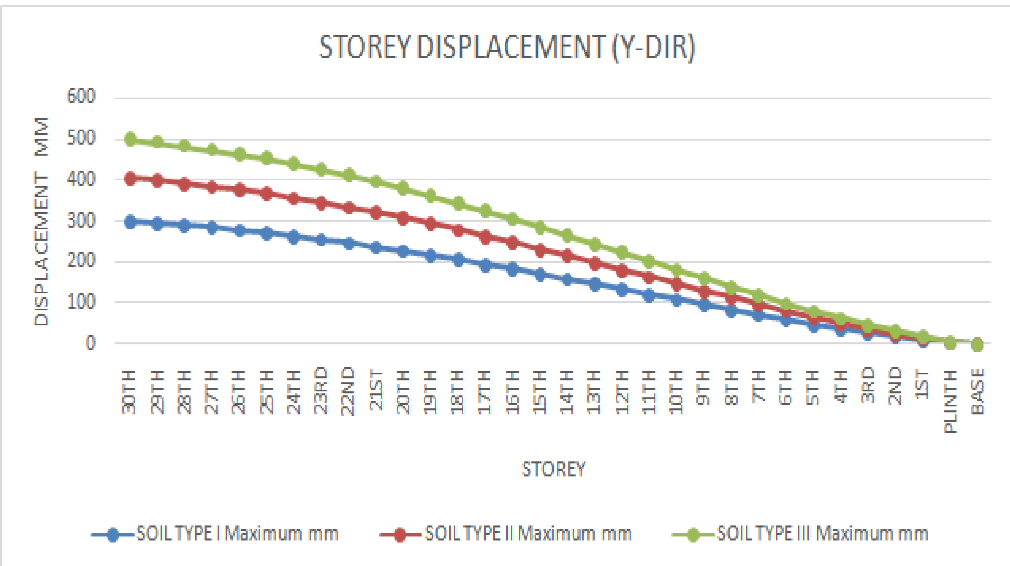
Graph 2: StoreyDisplacement of Structure in Soft Soil , Medium Soil and Hard Soil in X – Direction

Table 6: StoreyDisplacement of Structure in Soft Soil , Medium Soil and Hard Soil in Y – Direction with load combination (DL+LL+EQYP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Load Case/Combo	Direction	Story Maximum Displacements	Story Maximum Displacements	Story Maximum Displacements
			mm	mm	mm

30TH	DLLLEQYP	Y	298.758	407.017	500.24
29TH	DLLLEQYP	Y	294.166	400.75	492.53
28TH	DLLLEQYP	Y	289.096	393.829	484.016
27TH	DLLLEQYP	Y	283.5	386.194	474.624
26TH	DLLLEQYP	Y	277.293	377.726	464.21
25TH	DLLLEQYP	Y	270.439	368.377	452.712
24TH	DLLLEQYP	Y	262.93	358.137	440.122
23RD	DLLLEQYP	Y	254.778	347.024	426.459
22ND	DLLLEQYP	Y	246.009	335.071	411.763
21ST	DLLLEQYP	Y	236.656	322.324	396.093
20TH	DLLLEQYP	Y	226.758	308.835	379.512
19TH	DLLLEQYP	Y	216.358	294.664	362.094
18TH	DLLLEQYP	Y	205.503	279.874	343.915
17TH	DLLLEQYP	Y	194.239	264.527	325.054
16TH	DLLLEQYP	Y	182.615	248.692	305.592
15TH	DLLLEQYP	Y	170.681	232.436	285.613
14TH	DLLLEQYP	Y	158.489	215.828	265.204
13TH	DLLLEQYP	Y	146.092	198.943	244.453
12TH	DLLLEQYP	Y	133.548	181.858	223.457
11TH	DLLLEQYP	Y	120.921	164.66	202.324
10TH	DLLLEQYP	Y	108.27	147.429	181.15
9TH	DLLLEQYP	Y	95.744	130.371	160.188
8TH	DLLLEQYP	Y	83.342	113.481	139.433
7TH	DLLLEQYP	Y	71.167	96.901	119.061
6TH	DLLLEQYP	Y	59.342	80.798	99.273
5TH	DLLLEQYP	Y	48.031	65.395	80.347
4TH	DLLLEQYP	Y	37.459	50.999	62.659
3RD	DLLLEQYP	Y	27.565	37.527	46.106
2ND	DLLLEQYP	Y	18.609	25.333	31.123
1ST	DLLLEQYP	Y	10.901	14.839	18.23
PLINTH	DLLLEQXP	Y	2.443	3.614	4.39
BASE	DLLLEQXP	Y	0	0	0

A plot for StoreyDisplacement of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction with load combination (DL+LL+EQYP) has been shown here



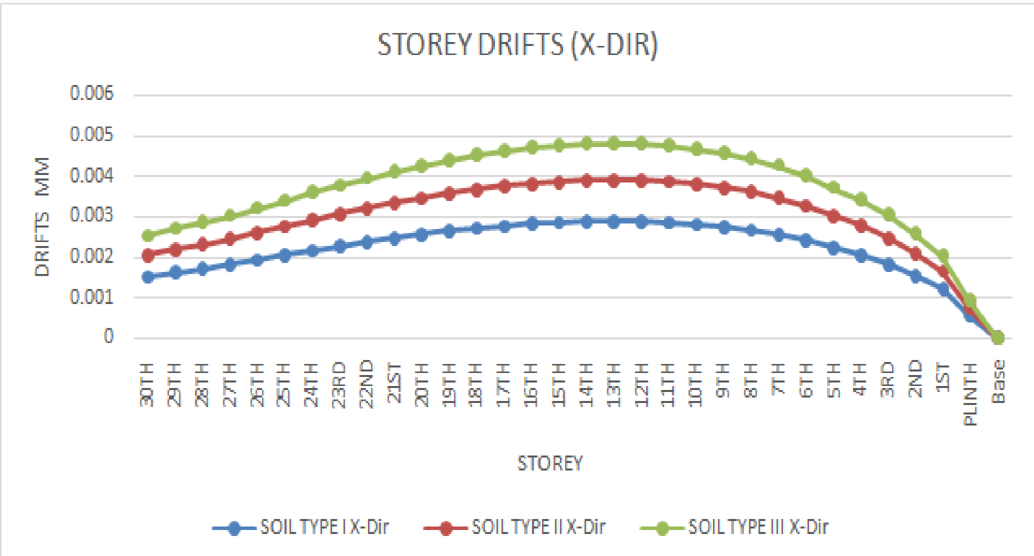
Graph 3: StoreyDisplacement of Structure in Soft Soil , Medium Soil and Hard Soil in Y – DirectionFor both X and Y directions, the behaviour of the graph is similar for model in Soft Soil , Medium Soil and Hard Soil as shown. The order of maximum storey displacement in both the directions for the models is same.

Table 7: StoreyDrifts of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination (DL+LL+EQXP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	X-Dir	X-Dir	X-Dir
30TH	111	Top	0.001515	0.002059	0.002527
29TH	107.5	Top	0.001625	0.002208	0.002711

28TH	104	Top	0.001711	0.002326	0.002855
27TH	100.5	Top	0.001814	0.002465	0.003026
26TH	97	Top	0.001925	0.002617	0.003213
25TH	93.5	Top	0.00204	0.002772	0.003403
24TH	90	Top	0.002153	0.002927	0.003593
23RD	86.5	Top	0.002263	0.003077	0.003777
22ND	83	Top	0.002369	0.00322	0.003953
21ST	79.5	Top	0.002467	0.003353	0.004117
20TH	76	Top	0.002557	0.003476	0.004267
19TH	72.5	Top	0.002638	0.003586	0.004402
18TH	69	Top	0.002708	0.003682	0.004521
17TH	65.5	Top	0.002768	0.003764	0.004621
16TH	62	Top	0.002817	0.00383	0.004702
15TH	58.5	Top	0.002853	0.003879	0.004762
14TH	55	Top	0.002876	0.003911	0.004801
13TH	51.5	Top	0.002885	0.003923	0.004816
12TH	48	Top	0.002879	0.003914	0.004805
11TH	44.5	Top	0.002858	0.003885	0.00477
10TH	41	Top	0.002803	0.003812	0.00468
9TH	37.5	Top	0.002749	0.003737	0.004588
8TH	34	Top	0.002668	0.003627	0.004454
7TH	30.5	Top	0.002562	0.003483	0.004276
6TH	27	Top	0.00242	0.00329	0.004039
5TH	23.5	Top	0.00223	0.003032	0.003723
4TH	20	Top	0.002056	0.002795	0.003432
3RD	16.5	Top	0.001827	0.002485	0.003051
2ND	13	Top	0.001548	0.002104	0.002584
1ST	9.5	Top	0.00122	0.001656	0.002031
PLINTH	6	Top	0.00056	0.00076	0.000932
Base	0	Top	0	0	0

A plot for StoreyDrifts of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination (DL+LL+EQXP) has been shown here



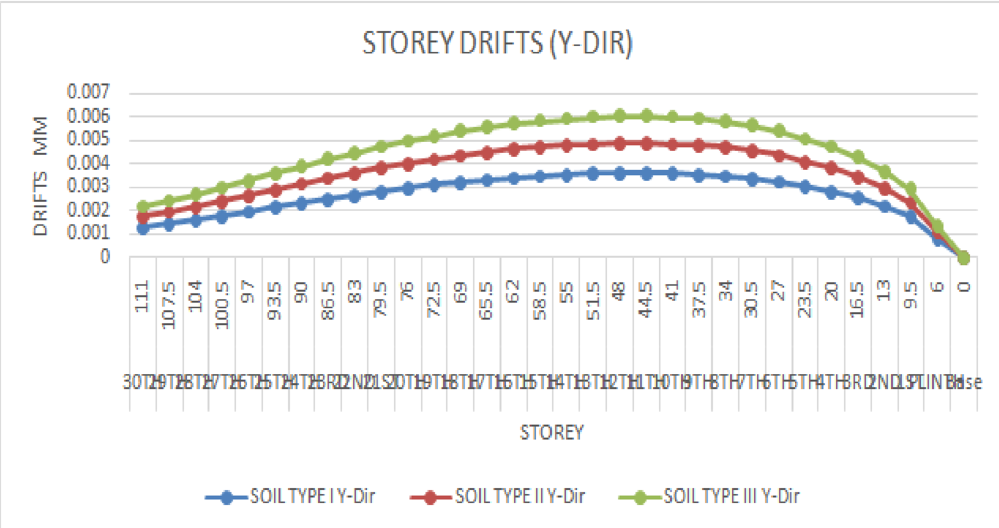
Graph 4: StoreyDrifts of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction

Table 8: StoreyDrifts of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction with load combination (DL+LL+EQYP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	Y-Dir	Y-Dir	Y-Dir
30TH	111	Top	0.001312	0.001791	0.002203
29TH	107.5	Top	0.001449	0.001977	0.002433
28TH	104	Top	0.001599	0.002182	0.002683
27TH	100.5	Top	0.001773	0.002419	0.002976
26TH	97	Top	0.001958	0.002671	0.003285
25TH	93.5	Top	0.002145	0.002926	0.003597
24TH	90	Top	0.002329	0.003175	0.003904
23RD	86.5	Top	0.002505	0.003415	0.004199

22ND	83	Top	0.002672	0.003642	0.004477
21ST	79.5	Top	0.002828	0.003854	0.004737
20TH	76	Top	0.002971	0.004049	0.004977
19TH	72.5	Top	0.003102	0.004226	0.005194
18TH	69	Top	0.003218	0.004385	0.005389
17TH	65.5	Top	0.003321	0.004524	0.005561
16TH	62	Top	0.00341	0.004645	0.005708
15TH	58.5	Top	0.003483	0.004745	0.005831
14TH	55	Top	0.003542	0.004824	0.005929
13TH	51.5	Top	0.003584	0.004882	0.005999
12TH	48	Top	0.003608	0.004914	0.006038
11TH	44.5	Top	0.003615	0.004923	0.00605
10TH	41	Top	0.003579	0.004874	0.005989
9TH	37.5	Top	0.003544	0.004826	0.00593
8TH	34	Top	0.003478	0.004737	0.005821
7TH	30.5	Top	0.003379	0.004601	0.005654
6TH	27	Top	0.003232	0.004401	0.005407
5TH	23.5	Top	0.003021	0.004113	0.005054
4TH	20	Top	0.002827	0.003849	0.004729
3RD	16.5	Top	0.002559	0.003484	0.004281
2ND	13	Top	0.002202	0.002998	0.003684
1ST	9.5	Top	0.001748	0.002376	0.002917
PLINTH	6	Top	0.00081	0.001102	0.001354
Base	0	Top	0	0	0

A plot for StoreyDrifts of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction with load combination (DL+LL+EQYP) has been shown here



Graph 5: StoreyDrifts of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction

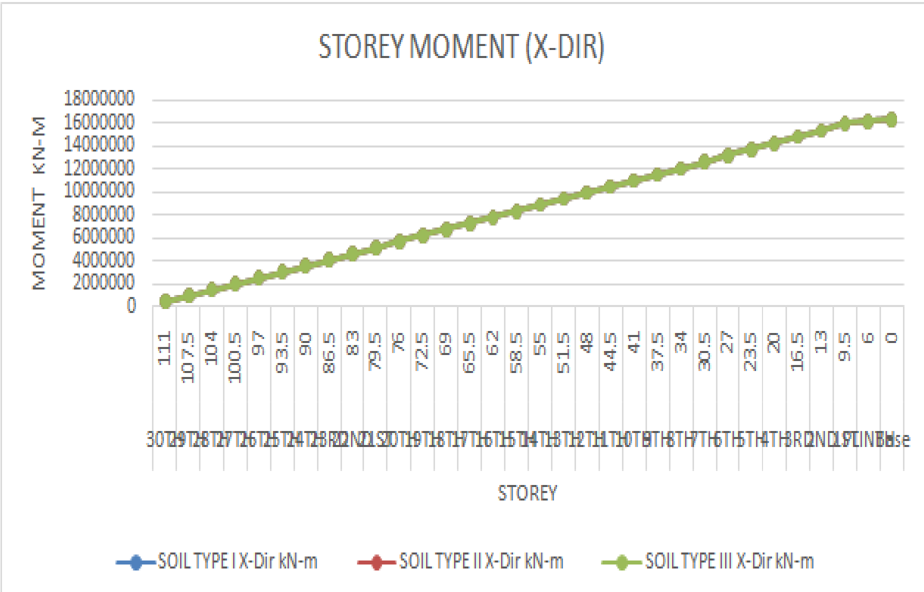
As per Indian standard, Criteria for earthquake resistant design of structures, IS 1893 (Part 1) : 2002, the story drift in any story due to service load shall not exceed 0.004 times the story height. The height of the each storey is 3.5 m. So, the drift limitation as per IS 1893 (part 1) : 2002 is 0.004 X 3.5 m = 14 mm. The model show a similar behaviour for storey drifts as shown in graph.

Table 9: Storey Moment of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination 1.2(DL+LL+EQXP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	X-Dir	X-Dir	X-Dir
	m		kN-m	kN-m	kN-m
30TH	111	Top	465614.6719	465614.6719	465614.6719
29TH	107.5	Top	995789.2594	995789.2594	995789.2594
28TH	104	Top	1525964	1525964	1525964
27TH	100.5	Top	2056138	2056138	2056138
26TH	97	Top	2586313	2586313	2586313
25TH	93.5	Top	3116488	3116488	3116488
24TH	90	Top	3646662	3646662	3646662

23RD	86.5	Top	4176837	4176837	4176837
22ND	83	Top	4707011	4707011	4707011
21ST	79.5	Top	5237186	5237186	5237186
20TH	76	Top	5767361	5767361	5767361
19TH	72.5	Top	6297535	6297535	6297535
18TH	69	Top	6827710	6827710	6827710
17TH	65.5	Top	7357884	7357884	7357884
16TH	62	Top	7888059	7888059	7888059
15TH	58.5	Top	8418233	8418233	8418233
14TH	55	Top	8948408	8948408	8948408
13TH	51.5	Top	9478583	9478583	9478583
12TH	48	Top	10008757	10008757	10008757
11TH	44.5	Top	10538932	10538932	10538932
10TH	41	Top	11068570	11068570	11068570
9TH	37.5	Top	11609427	11609427	11609427
8TH	34	Top	12150285	12150285	12150285
7TH	30.5	Top	12691142	12691142	12691142
6TH	27	Top	13232000	13232000	13232000
5TH	23.5	Top	13771918	13771918	13771918
4TH	20	Top	14339886	14339886	14339886
3RD	16.5	Top	14907854	14907854	14907854
2ND	13	Top	15475821	15475821	15475821
1ST	9.5	Top	16043789	16043789	16043789
PLINTH	6	Top	16264437	16264437	16264437
Base	0	Top	16445051	16445051	16445051

A plot for Storey Moment of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination 1.2(DL+LL+EXP) has been shown here



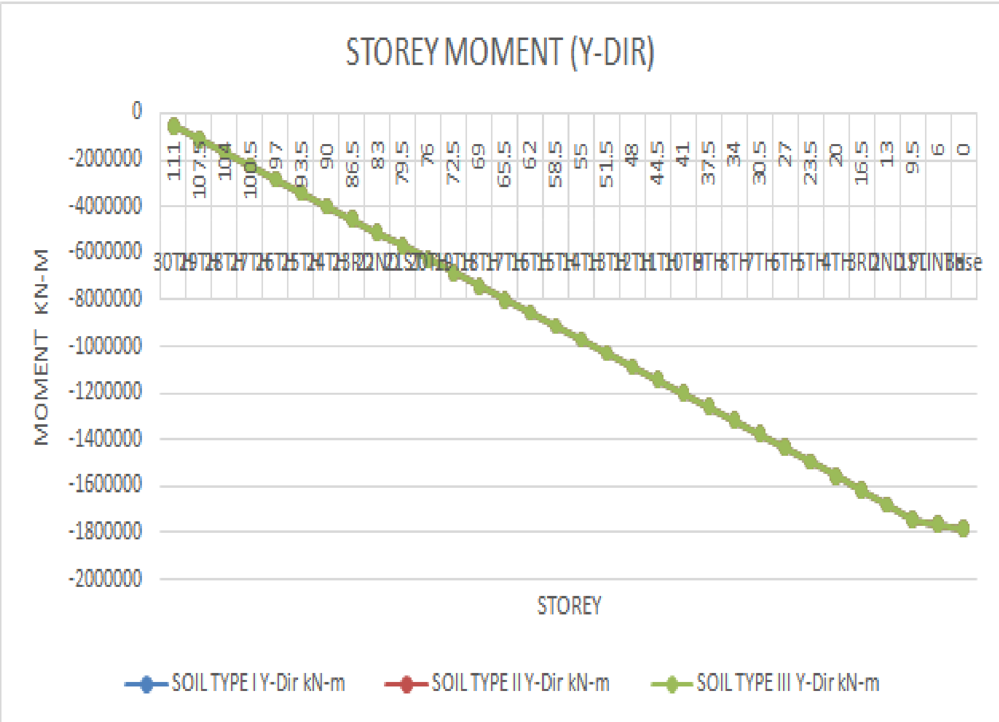
Graph 6: StoreyMoment of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction

Table 10: StoreyMoment of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction with load combination 1.2(DL+LL+EQYP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	Y-Dir	Y-Dir	Y-Dir
	m		kN-m	kN-m	kN-m
30TH	111	Top	-504851	-504851	-504851
29TH	107.5	Top	-1080107	-1080107	-1080107
28TH	104	Top	-1655363	-1655363	-1655363
27TH	100.5	Top	-2230620	-2230620	-2230620
26TH	97	Top	-2805876	-2805876	-2805876
25TH	93.5	Top	-3381133	-3381133	-3381133
24TH	90	Top	-3956389	-3956389	-3956389
23RD	86.5	Top	-4531645	-4531645	-4531645

22ND	83	Top	-5106902	-5106902	-5106902
21ST	79.5	Top	-5682158	-5682158	-5682158
20TH	76	Top	-6257414	-6257414	-6257414
19TH	72.5	Top	-6832671	-6832671	-6832671
18TH	69	Top	-7407927	-7407927	-7407927
17TH	65.5	Top	-7983184	-7983184	-7983184
16TH	62	Top	-8558440	-8558440	-8558440
15TH	58.5	Top	-9133696	-9133696	-9133696
14TH	55	Top	-9708953	-9708953	-9708953
13TH	51.5	Top	-10284209	-10284209	-10284209
12TH	48	Top	-10859466	-10859466	-10859466
11TH	44.5	Top	-11434722	-11434722	-11434722
10TH	41	Top	-12009396	-12009396	-12009396
9TH	37.5	Top	-12596238	-12596238	-12596238
8TH	34	Top	-13183081	-13183081	-13183081
7TH	30.5	Top	-13769923	-13769923	-13769923
6TH	27	Top	-14356765	-14356765	-14356765
5TH	23.5	Top	-14942589	-14942589	-14942589
4TH	20	Top	-15558832	-15558832	-15558832
3RD	16.5	Top	-16175075	-16175075	-16175075
2ND	13	Top	-16791318	-16791318	-16791318
1ST	9.5	Top	-17407562	-17407562	-17407562
PLINTH	6	Top	-17646856	-17646856	-17646856
Base	0	Top	-17842733	-17842733	-17842733

A plot for Storey Moment of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction with load combination 1.2(DL+LL+EYP)has been shown here



Graph 7: StoreyMoment of Structure in Soft Soil , Medium Soil and Hard Soil in Y - Direction

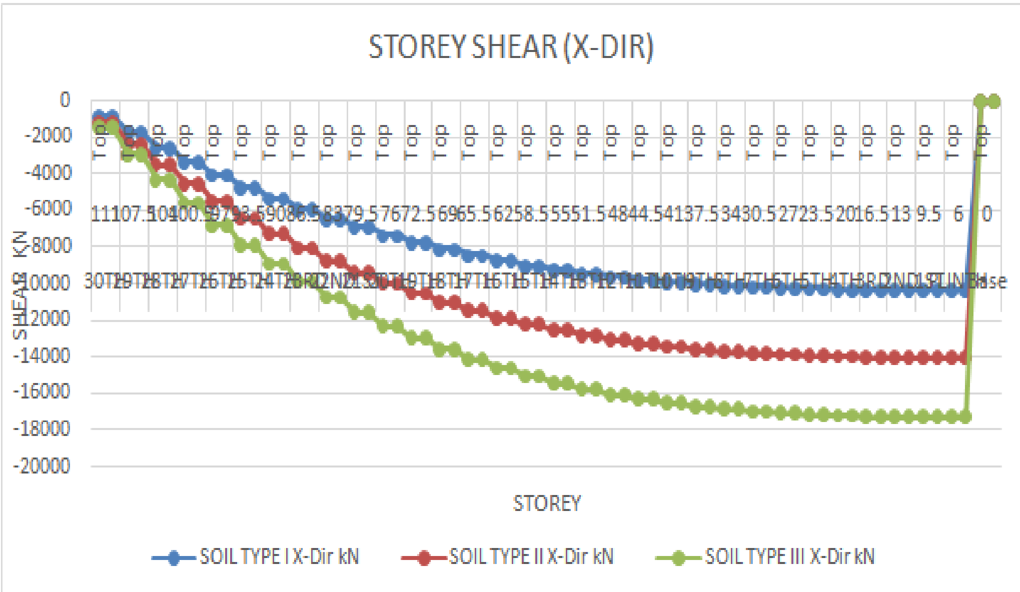
Table 11: StoreyShear of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination1.2 (DL+LL+EQXP)

			SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Elevation	Location	X-Dir	X-Dir	X-Dir
	m		kN	kN	kN
30TH	111	Top	-870.0895	-1183.3217	-1453.0495
		Bottom	-870.0895	-1183.3217	-1453.0495
29TH	107.5	Top	-1752.5342	-2383.4465	-2926.7321
		Bottom	-1752.5342	-2383.4465	-2926.7321

28TH	104	Top	-2578.4528	-3506.6958	-4306.0161
		Bottom	-2578.4528	-3506.6958	-4306.0161
27TH	100.5	Top	-3349.7161	-4555.6139	-5594.0259
		Bottom	-3349.7161	-4555.6139	-5594.0259
26TH	97	Top	-4068.195	-5532.7452	-6793.8857
		Bottom	-4068.195	-5532.7452	-6793.8857
25TH	93.5	Top	-4735.7604	-6440.6341	-7908.7198
		Bottom	-4735.7604	-6440.6341	-7908.7198
24TH	90	Top	-5354.283	-7281.8248	-8941.6526
		Bottom	-5354.283	-7281.8248	-8941.6526
23RD	86.5	Top	-5925.6337	-8058.8618	-9895.8083
		Bottom	-5925.6337	-8058.8618	-9895.8083
22ND	83	Top	-6451.6833	-8774.2894	-10774.3112
		Bottom	-6451.6833	-8774.2894	-10774.3112
21ST	79.5	Top	-6934.3028	-9430.6518	-11580.2857
		Bottom	-6934.3028	-9430.6518	-11580.2857
20TH	76	Top	-7375.3629	-10030.4935	-12316.856
		Bottom	-7375.3629	-10030.4935	-12316.856
19TH	72.5	Top	-7776.7344	-10576.3588	-12987.1465
		Bottom	-7776.7344	-10576.3588	-12987.1465
18TH	69	Top	-8140.2883	-11070.792	-13594.2814
		Bottom	-8140.2883	-11070.792	-13594.2814
17TH	65.5	Top	-8467.8952	-11516.3375	-14141.3851
		Bottom	-8467.8952	-11516.3375	-14141.3851
16TH	62	Top	-8761.4262	-11915.5397	-14631.5818
		Bottom	-8761.4262	-11915.5397	-14631.5818
15TH	58.5	Top	-9022.752	-12270.9427	-15067.9959
		Bottom	-9022.752	-12270.9427	-15067.9959
14TH	55	Top	-9253.7435	-12585.0911	-15453.7516
		Bottom	-9253.7435	-12585.0911	-15453.7516
13TH	51.5	Top	-9456.2715	-12860.5292	-15791.9733
		Bottom	-9456.2715	-12860.5292	-15791.9733
12TH	48	Top	-9632.2068	-13099.8012	-16085.7853
		Bottom	-9632.2068	-13099.8012	-16085.7853
11TH	44.5	Top	-9783.4203	-13305.4516	-16338.3119
		Bottom	-9783.4203	-13305.4516	-16338.3119
10TH	41	Top	-9913.2648	-13482.0401	-16555.1522
		Bottom	-9913.2648	-13482.0401	-16555.1522
9TH	37.5	Top	-10023.2579	-13631.6307	-16738.8406
		Bottom	-10023.2579	-13631.6307	-16738.8406
8TH	34	Top	-10113.6771	-13754.6008	-16889.8407
		Bottom	-10113.6771	-13754.6008	-16889.8407
7TH	30.5	Top	-10186.4387	-13853.5566	-17011.3526
		Bottom	-10186.4387	-13853.5566	-17011.3526
6TH	27	Top	-10243.4591	-13931.1044	-17106.5767

		Bottom	-10243.4591	-13931.1044	-17106.5767
5TH	23.5	Top	-10287.9104	-13991.5582	-17180.8104
		Bottom	-10287.9104	-13991.5582	-17180.8104
4TH	20	Top	-10321.0818	-14036.6713	-17236.2066
		Bottom	-10321.0818	-14036.6713	-17236.2066
3RD	16.5	Top	-10343.6591	-14067.3763	-17273.9107
		Bottom	-10343.6591	-14067.3763	-17273.9107
2ND	13	Top	-10357.674	-14086.4366	-17297.3156
		Bottom	-10357.674	-14086.4366	-17297.3156
1ST	9.5	Top	-10365.1583	-14096.6153	-17309.8143
		Bottom	-10365.1583	-14096.6153	-17309.8143
PLINTH	6	Top	-10366.7741	-14098.8127	-17312.5127
		Bottom	-10366.7741	-14098.8127	-17312.5127
Base	0	Top	0	0	0
		Bottom	0	0	0

A plot for Storey Shear of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction with load combination 1.2(DL+LL+EXP) has been shown here



Graph 8: Storey Shear of Structure in Soft Soil , Medium Soil and Hard Soil in X - Direction

Column Forces

Table 12: column axial force, P for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium &hard soil

TABLE: Column Forces					SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Column	Unique Name	Load Case/Combo	Station	P	P	P
				m	kN	kN	kN
1ST	C34	67	12DLRLLEQXP	0	-24171.1	-24937.5	-25597.5
1ST	C34	67	12DLRLLEQXP	1.45	-24103.1	-24869.5	-25529.5
1ST	C34	67	12DLRLLEQXP	2.9	-24035.1	-24801.6	-25461.5
1ST	C34	67	12DLRLLEQYP	0	-23630.6	-24202.5	-24695
1ST	C34	67	12DLRLLEQYP	1.45	-23562.7	-24134.6	-24627
1ST	C34	67	12DLRLLEQYP	2.9	-23494.7	-24066.6	-24559

Table 13:column Moment, M for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium&hard soil

TABLE: Column Forces					SOIL TYPE I	SOIL TYPE II	SOIL TYPE III	SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Column	Unique Name	Load Case/Combo	Station	M2	M3	M2	M3	M2	M3
				m	kN-m	kN-m	kN-m	kN-m	kN-m	kN-m
1ST	C34	67	12DLRLLEQXP	0	-244.012	979.4715	-312.524	1329.527	-371.521	1630.963
1ST	C34	67	12DLRLLEQXP	1.45	-146.268	805.6993	-197.671	1112.772	-241.934	1377.196
1ST	C34	67	12DLRLLEQXP	2.9	-48.5251	631.9271	-82.8175	896.0172	-112.347	1123.428
1ST	C34	67	12DLRLLEQYP	0	1727.573	-24.7075	2368.832	-36.1568	2921.026	-46.0159
1ST	C34	67	12DLRLLEQYP	1.45	1393.642	-70.5194	1896.607	-78.8855	2329.716	-86.0897
1ST	C34	67	12DLRLLEQYP	2.9	1059.71	-116.331	1424.382	-121.614	1738.406	-126.163

Table 14:column Shear , V for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium &hard soil

TABLE: Column Forces					SOIL TYPE I	SOIL TYPE II	SOIL TYPE III	SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Column	Unique Name	Load Case/Combo	Station	V2	V3	V2	V3	V2	V3
				m	kN	kN	kN	kN	kN	kN
1ST	C34	67	12DLRLLEQXP	0	119.8429	-67.4092	149.486	-79.2092	175.012	-89.3703
1ST	C34	67	12DLRLLEQXP	1.45	119.8429	-67.4092	149.486	-79.2092	175.012	-89.3703
1ST	C34	67	12DLRLLEQXP	2.9	119.8429	-67.4092	149.486	-79.2092	175.012	-89.3703
1ST	C34	67	12DLRLLEQYP	0	31.5944	230.2977	29.4681	325.6722	27.6371	407.8002
1ST	C34	67	12DLRLLEQYP	1.45	31.5944	230.2977	29.4681	325.6722	27.6371	407.8002
1ST	C34	67	12DLRLLEQYP	2.9	31.5944	230.2977	29.4681	325.6722	27.6371	407.8002

Table 15:column Torsion , T for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium &hard soil

TABLE: Column Forces					SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Column	Unique Name	Load Case/Combo	Station	T	T	T
				m	kN-m	kN-m	kN-m
1ST	C34	67	12DLRLLEQXP	0	-41.6175	-56.5981	-69.4981
1ST	C34	67	12DLRLLEQXP	1.45	-41.6175	-56.5981	-69.4981
1ST	C34	67	12DLRLLEQXP	2.9	-41.6175	-56.5981	-69.4981
1ST	C34	67	12DLRLLEQYP	0	45.3145	61.6294	75.6784
1ST	C34	67	12DLRLLEQYP	1.45	45.3145	61.6294	75.6784
1ST	C34	67	12DLRLLEQYP	2.9	45.3145	61.6294	75.6784

Pier Forces

Table 16: Pier Axial Force, P for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium&hard soil

TABLE: Pier Forces				SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Pier	Load Case/Combo	Location	P	P	P
				kN	kN	kN
1ST	P3	12DLRLLEQXP	Top	-31716.3887	-31716.3887	-31716.3887
1ST	P3	12DLRLLEQXP	Bottom	-31976.2637	-31976.2637	-31976.2637
1ST	P3	12DLRLLEQYP	Top	-31716.3887	-31716.3887	-31716.3887
1ST	P3	12DLRLLEQYP	Bottom	-31976.2637	-31976.2637	-31976.2637

Table 17: Pier Moment, M for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium &hard soil

TABLE: Pier Forces				SOIL TYPE I	SOIL TYPE I	SOIL TYPE II	SOIL TYPE II	SOIL TYPE III	SOIL TYPE III
Story	Pier	Load Case/Combo	Location	M2	M3	M2	M3	M2	M3
				kN-m	kN-m	kN-m	kN-m	kN-m	kN-m
1ST	P3	12DLRLLEQXP	Top	429.3134	-285.376	587.5838	-285.376	723.8721	-285.376
1ST	P3	12DLRLLEQXP	Bottom	-796.6308	-244.1397	-1084.8797	-244.1397	-1333.0941	-244.1397
1ST	P3	12DLRLLEQYP	Top	-10.3264	29494.5797	-10.3264	40215.3638	-10.3264	49447.15
1ST	P3	12DLRLLEQYP	Bottom	4.0607	41193.3422	4.0607	56110.8357	4.0607	68956.455

Table 18: Pier Shear Force, V for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium&hard soil

TABLE: Pier Forces				SOIL TYPE I	SOIL TYPE I	SOIL TYPE II	SOIL TYPE II	SOIL TYPE III	SOIL TYPE III
Story	Pier	Load Case/Combo	Location	V2	V3	V2	V3	V2	V3
				kN	kN	kN	kN	kN	kN
1ST	P3	12DLRLLEQXP	Top	11.7818	-350.2698	11.7818	-477.8467	11.7818	-587.7046
1ST	P3	12DLRLLEQXP	Bottom	11.7818	-350.2698	11.7818	-477.8467	11.7818	-587.7046
1ST	P3	12DLRLLEQYP	Top	3342.5036	4.1106	4541.5634	4.1106	5574.0871	4.1106
1ST	P3	12DLRLLEQYP	Bottom	3342.5036	4.1106	4541.5634	4.1106	5574.0871	4.1106

Table 19: Pier Torsion, T for structure with the load combination 1.2 (DL+LL+EQXP) &1.2 (DL+LL+EQYP) in soft ,medium&hard soil

TABLE: Pier Forces				SOIL TYPE I	SOIL TYPE II	SOIL TYPE III
Story	Pier	Load Case/Combo	Location	T	T	T
				kN-m	kN-m	kN-m
1ST	P3	12DLRLLEQXP	Top	-57.8883	-75.9256	-91.4578
1ST	P3	12DLRLLEQXP	Bottom	-57.8883	-75.9256	-91.4578
1ST	P3	12DLRLLEQYP	Top	46.5531	66.1147	82.9594
1ST	P3	12DLRLLEQYP	Bottom	46.5531	66.1147	82.9594

Table 20: Modal Load Participation Ratios

TABLE: Modal Load Participation Ratios				
Case	**Item Type**	**Item**	**Static**	**Dynamic**
			%	%
Modal	Acceleration	UX	99.82	86.71
Modal	Acceleration	UY	99.79	87.46
Modal	Acceleration	UZ	0	0

According to IS-1893:2002 the number of modes to be used in the analysis should be such that the total sum of modal masses of all modes considered is at least 90 percent of the total seismic mass. Here the minimum modal mass is 86.71 percent.

Table 21: Modal Participating Mass Ratios

Case	**Mode**	**Period** sec	**UX**	**UY**	**UZ**	**RX**	**RY**	**RZ**
Modal	1	6.298	0	0.7575	0	0.2499	0	0
Modal	2	6.248	0	0	0	0	0	0.7702
Modal	3	5.545	0.7329	0	0	0	0.2768	0
Modal	4	2.062	0	0	0	0	0	0.1046
Modal	5	1.952	0	0.1171	0	0.4414	0	0
Modal	6	1.603	0.1343	0	0	0	0.3985	0
Modal	7	1.191	0	0	0	0	0	0.0422
Modal	8	1.027	0	0.046	0	0.0794	0	0
Modal	9	0.803	0	0	0	0	0	0.0227
Modal	10	0.782	0.0528	0	0	0	0.0991	0
Modal	11	0.645	0	0.0255	0	0.0769	0	0
Modal	12	0.581	0	0	0	0	0	0.0141

Here the minimum modal mass for accelerations Ux and Uy is 86.71% and 87.46% respectively.

Table 22: Modal Periods and Frequencies

TABLE: Modal Periods and Frequencies SOIL TYPE I				SOIL TYPE II	SOIL TYPE II	SOIL TYPE III	SOIL TYPE III
Case	Mode	Period	Frequency	Period	Frequency	Period	Frequency
		sec	cyc/sec	sec	cyc/sec	sec	cyc/sec
Modal	1	6.298	0.159	6.298	0.159	6.298	0.159
Modal	2	6.248	0.16	6.248	0.16	6.248	0.16
Modal	3	5.545	0.18	5.545	0.18	5.545	0.18
Modal	4	2.062	0.485	2.062	0.485	2.062	0.485
Modal	5	1.952	0.512	1.952	0.512	1.952	0.512
Modal	6	1.603	0.624	1.603	0.624	1.603	0.624

Modal	7	1.191	0.84	1.191	0.84	1.191	0.84
Modal	8	1.027	0.974	1.027	0.974	1.027	0.974
Modal	9	0.803	1.245	0.803	1.245	0.803	1.245
Modal	10	0.782	1.279	0.782	1.279	0.782	1.279
Modal	11	0.645	1.55	0.645	1.55	0.645	1.55
Modal	12	0.581	1.72	0.581	1.72	0.581	1.72

Mode 1 is having maximum time period of 6.298sec and 0.159 cyc/sec Frequency which is same for all three type of soils.

Mode shapes of shear wall

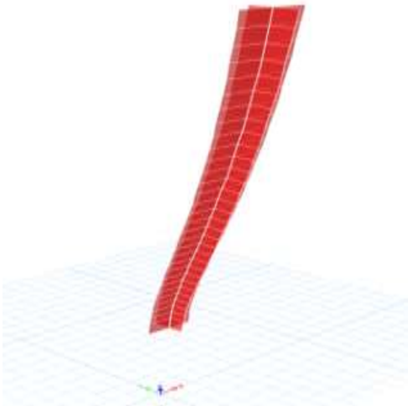


Figure 3: Mode shape 1 for shear wall

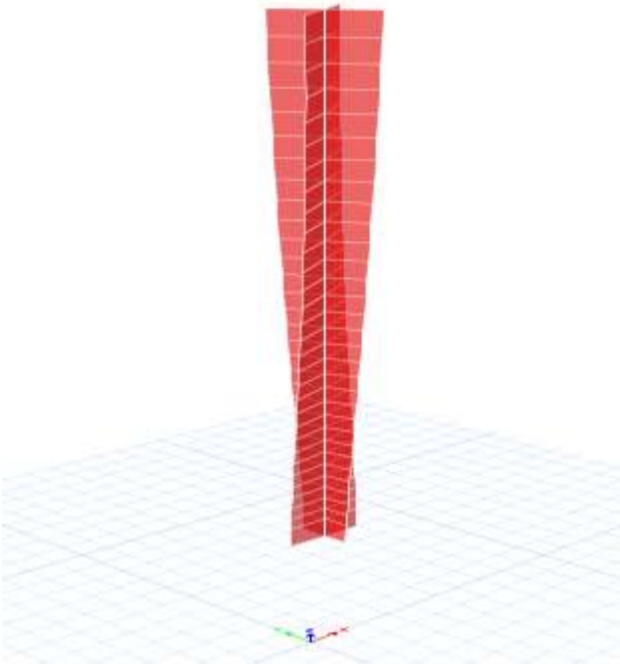


Figure 4: Mode shape 2 for shear wall

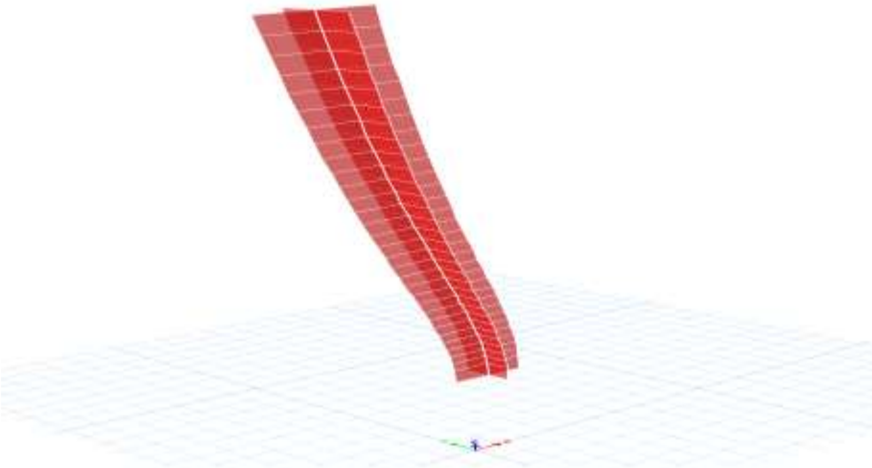


Figure 5: Mode shape 3 for shear wall

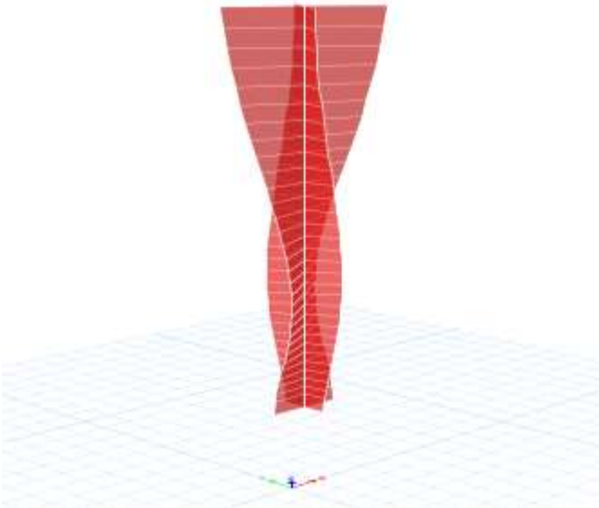


Figure 6: Mode shape 4 for shear wall

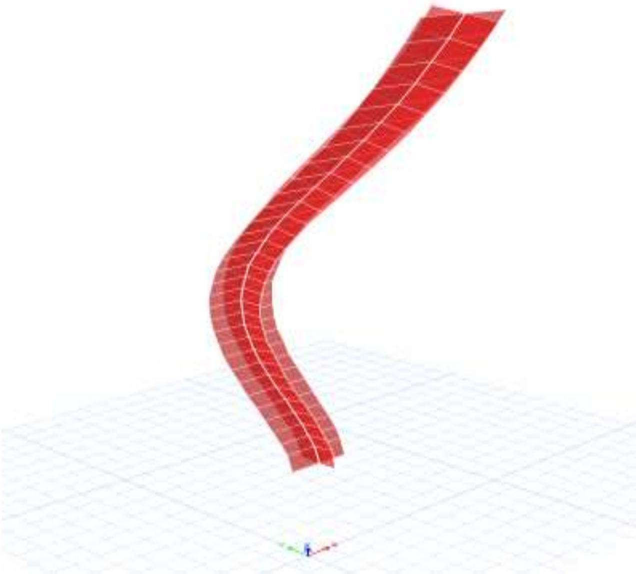


Figure 7: Mode shape 5 for shear wall

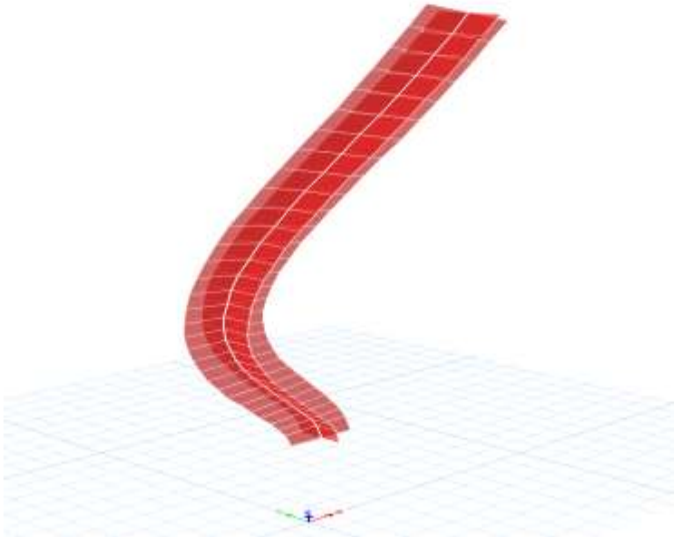


Figure 8: Mode shape6 for shear wall

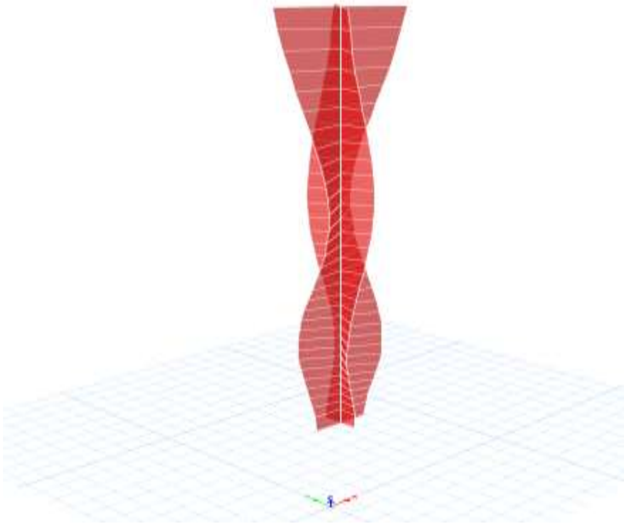


Figure 9: Mode shape 7 for shear wall

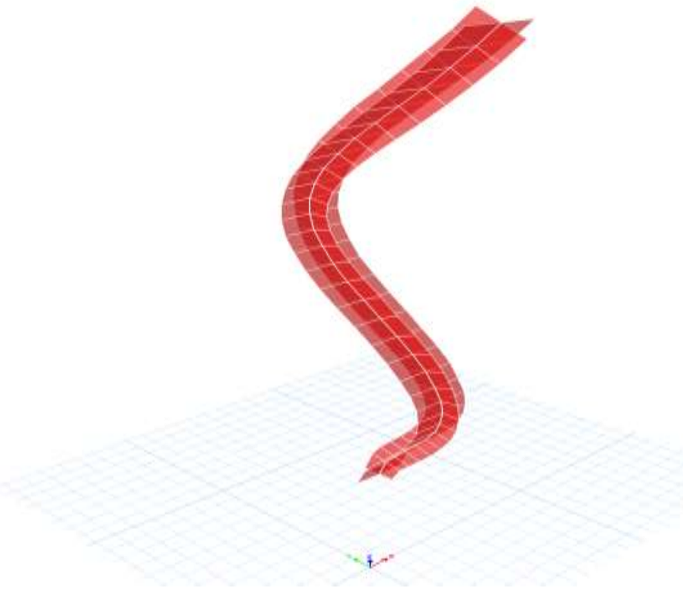


Figure 10: Mode shape 8 for shear wall

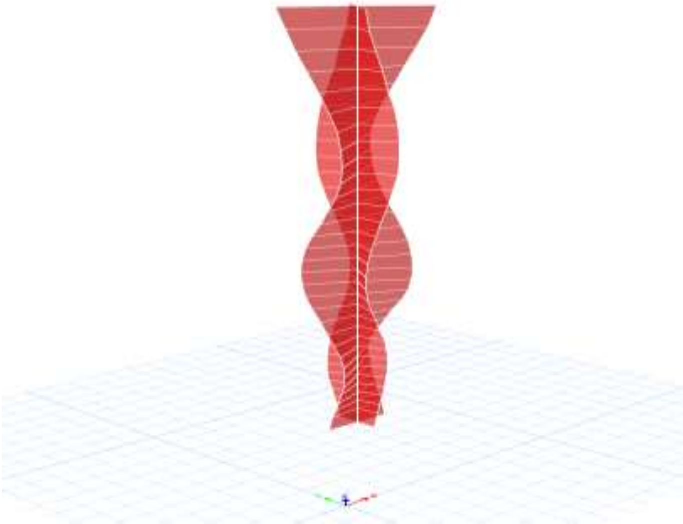


Figure 11: Mode shape 9 for shear wall

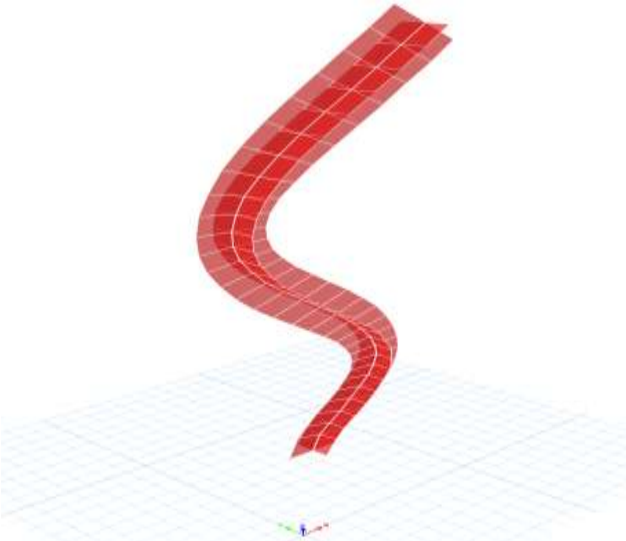


Figure 12: Mode shape 10 for shear wall

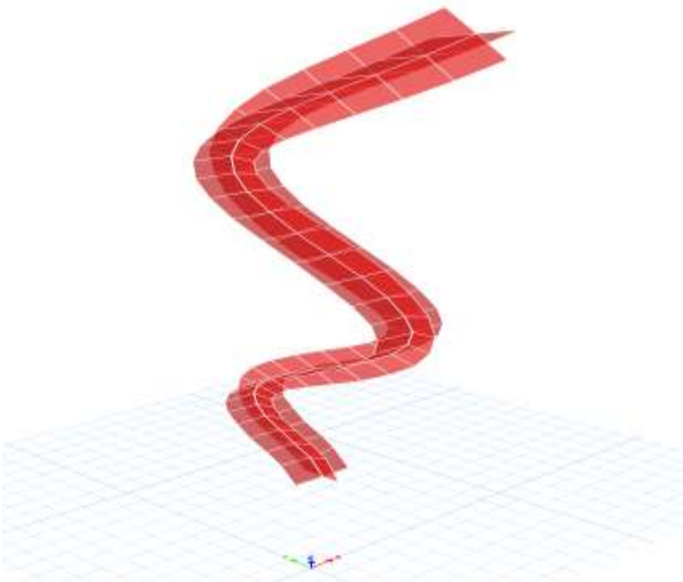


Figure 13: Mode shape 11 for shear wall

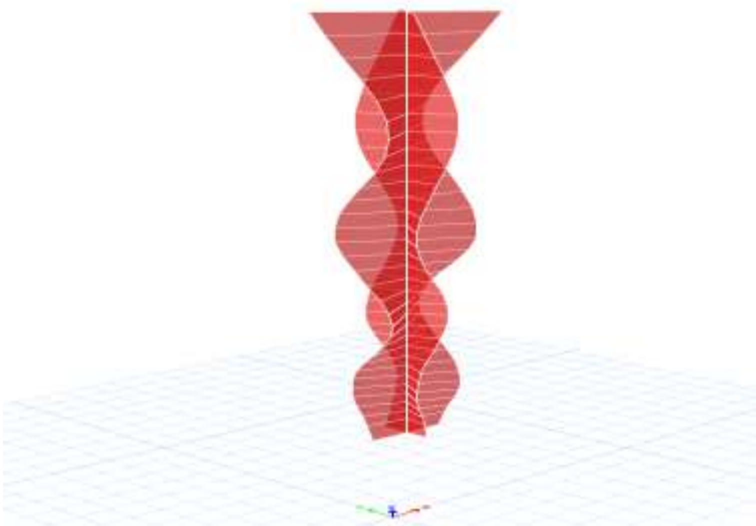


Figure 14: Mode shape 12 for shear wall

III. DISCUSSION ON RESULTS

The result obtained from the analysis models will be discussed and compared as follows:

It is observed that

- The time period is 6.298Sec for structure and it is same for different type of soil.
- The Frequency is 0.159cyc/sec and it is same for different type of soil.

It is observed that

- The percentage of displacement in X& Y direction is more by 35.94 % of the model in medium soil and 66.90 % of model in hard soil compared with model in soft soil.

It is observed that

- The maximum storey drift in X-direction occurred at storey 13th for the model in hard ,medium and soft soil.
- The percentage of storey drift in X- direction is decreased by placing shear wall as shown below :-
- 35.90 % of model in medium soil compared with model in soft soil.
- 66.79% of model in hard soil compared with model in soft soil.

It is observed that

- The maximum column axial force is various with type of soil and placing of the shear wall.column axial force in soft soil>medium soil>hard soil.

It is observed that

- The maximum column moment in Y-direction is influenced by the type of soil and placing of shear wall.
- The maximum column moment M2 in X-direction for soft Soil >Medium soil > Hard soil.
- The maximum column moment M3 in X-direction for soft Soil <Medium soil < Hard soil.
- The maximum column moment M2 in Y-direction for soft Soil <Medium soil < Hard soil.
- The maximum column moment M3in Y-direction for soft Soil >Medium soil > Hard soil.

It is observed that

- The maximum column Shear V2 in X-direction for soft Soil <Medium soil < Hard soil.
- The maximum column Shear V3 in X-direction for soft Soil >Medium soil > Hard soil.
- The maximum column Shear V2 in Y-direction for soft Soil>Medium soil > Hard soil.
- The maximum column Shear V3 in Y-direction for soft Soil <Medium soil < Hard soil.

It is observed that

- The maximum column Torsion , T in X-direction for soft Soil >Medium soil > Hard soil.
- The maximum column Torsion , T in Y-direction for soft Soil <Medium soil < Hard soil.

It is observed that

Shear Wall forces (Pier Forces)

- For the Pier axial forces in X direction There is not considerable difference for soft Soil ,Medium soil & Hard soil.
- Pier Moment M2 in X direction for soft soil <medium soil < hard soil .
- Pier Moment M3 in X direction for soft soil =medium soil = hard soil .
- Pier Moment M2 in Y direction for soft soil =Medium soil = hard soil .
- Pier Moment M3 in Y direction for soft soil <Medium soil < hard soil .
- Pier Shear Forces V2 in X direction for soft soil =Medium soil = hard soil.
- Pier Shear Forces V3 in X direction for soft soil >Medium soil > hard soil.
- Pier Torsion in X direction for soft soil >Medium soil > hard soil.
- Pier Torsion in Y direction for soft soil <Medium soil < hard soil.

It is observed that

- There is considerable difference in storey shear force in x-direction with a type of soils.
- The value of the storey shear force in x-direction decreases with increase in storey level.
- The value of the storey shear force in x-direction for the structure in soft soil is more compared with the structure in hard and medium soil.

It is observed that

- The value of the lateral loads in x-direction decreases with increase in storey level.
- The value of the lateral loads in x-direction for the structure in soft soil is less compared with the structure in medium soil and hard soil.
- lateral loads in X-direction for the structure in soft soil <Medium soil < hard soil.

It is observed that

- There is not difference in a storey moment in x-direction with a different type of soils.
- There is not difference in a storey moment in y-direction with a different type of soils.

It is observed that

- The value of the Stiffness of Structure in Soft Soil , Medium Soil and Hard Soil in X – direction for load cases EQXP is same .
- The value of the Stiffness of Structure in Soft Soil , Medium Soil and Hard Soil in Y – direction for load cases EQYP is same .

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.

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

- Shear Walls must be coinciding with the centroid of the building for better performance. It follows that a centre core Shear wall should be provided.
- The shear wall and it is position has a significant influenced on the time period. The time period is not influenced by the type of soil..
- shear is effected marginally by placing of the shear wall, grouping of shear wall and type of soil. The shear is increased by adding shear wall due to increase the seismic weight of the building.
- Provision of the shear wall, generally results in reducing the displacement because the shear wall increases the stiffness of the building. The displacement is influenced by type and location of the shear wall and also by changing soil condition. The better performance for model with soft soil because it has low displacement.
- For both X and Y directions, the behaviour of the displacement graph is similar for model in Soft Soil , Medium Soil and Hard Soil. The order of maximum storey displacement in both the directions for the models is same.
- The shear force resisted by the column frame is decreasing by placing the shear wall and the shear force resisted by the shear wall is increasing. This can be concluded indirectly by observing the maximum column shear force and moment in both directions.

- As per code, the actual drift is less than permissible drift. The parallel arrangement of shear wall in the center core and outer periphery is giving very good result in controlling drift in both the direction. The better performance for model with soft soil because it has low storey drift.
- The moment resisting frame with shear walls are very good in lateral force such as earthquake and wind force. The shear walls provide lateral load distribution by transferring the wind and earthquake loads to the foundation. And also impact on the lateral stiffness of the system and also carries gravity loads.
- 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.
- For the columns located away from the shear wall the Bending Moment is high and shear force is less when compared with the columns connected to the shear wall.
- Based on the analysis and discussion ,shear wall are very much suitable for resisting earthquake induced lateral forces in multistoried structural systems when compared to multistoried structural systems whit out shear walls. They can be made to behave in a ductile manner by adopting proper detailing techniques.
- The vertical reinforcement that is uniformly distributed in the shear wall shall not be less than the horizontal reinforcement .This provision is particularly for squat walls (i.e. Height-to-width ratio is about 1.0).However ,for walls whit height-to-width ratio less than 1.0, a major part of the shear force is resisted by the vertical reinforcement. Hence ,adequate vertical reinforcement should be provided for such walls.
- According to IS-1893:2002 the number of modes to be used in the analysis should be such that the total sum of modal masses of all modes considered is at least 90 percent of the total seismic mass. Here the minimum modal mass is 86.71 percent.
- It is observed that the column axial force is various with type of soil and placing of the shear wall.
- It is observed that the column shear force in x&ydirection is influenced by the type of soil and placing of the shear wall.
- It is observed that the column torsion is influenced by the type of soil and placing shear wall.
- It is observed that the column moment is influenced by the type of soil and placing of shear wall.
- It is observed that the Pier shear force is various with type of soil and placing of the shear wall.
- It is observed that the pier Torsion is various with type of soil and placing of the shear wall.
- It is observed that the There is not difference in a storey moment with a different type of soils.
- It is observed that the pier Moment is various with type of soil and placing of the shear wall
- It is observed that the There is not considerable difference in Pier Axial Force is various with type of soil and placing of the shear wall.
- It is observed that the value of stiffness in x& y-direction is same for the model with a different type of soil and placing shear wall.

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