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COMPARATIVE STUDY OF ZONE 2 AND ZONE 3 FOR EQUIVALENT STATIC METHOD, RESPONSE SPECTRUM METHOD AND TIME HISTORY METHOD OF ANALYSIS FOR SINGLE MULTI-STOREY BUILDING

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Abstract - *Reinforced concrete frames are the most commonly used method of construction in India. With the economic growth, the unavailability of urbanization and horizontal space has increased the cost of land and the demand for agricultural land. High-rise buildings are more popular in Indian architectural scenes, especially in cities. For high-rise buildings, not only must the building bear a gravity load, but it must also withstand lateral forces. Many important Indian cities are high-risk seismic belts. Therefore, strengthening the lateral force construction is a prerequisite*

In this study the aim is to analyze the response of a high-rise structure to lateral loads using static and dynamic seismic loads and static wind loads. This analysis procedure is based on IS codes for Design analysis of Structures.

The results of analysis are used to verify the structure fitness for use, finally the comparison of all lateral stability checks as been carried a for zone 2 and zone 3. Design and detailing of one critical element as been shown in this study

1. INTRODUCTION

Structural analysis mainly involves the act of discovering a structure when something happens. Such behavior may be due to the weight of objects such as people, furniture, wind and snow, or other forms of excitation such as earthquakes, ground shaking caused by nearby explosions, and the like. In essence, all of these loads are dynamic, including the weight of the structure, since at some point these loads do not exist. The distinction between dynamic and static analysis is based on whether the applied motion has sufficient acceleration compared to the natural frequency of the structure. If the load is applied slowly enough, the inertial force (Newton's second law of motion) can be neglected and the analysis can be simplified to static analysis.

Therefore, structural dynamics is a structural analysis that covers the behavior of structures that are loaded dynamically (with high acceleration). Dynamic loads include people, wind, waves, traffic, earthquakes and explosions. Any structure can withstand dynamic loads. Dynamic analysis can be used to find dynamic displacement, time history and modal analysis

Since earthquake forces are random in nature and unpredictable, the static and dynamic analysis of the structures have become the primary concern of civil engineers. The main parameters of the seismic analysis of structures are load carrying capacity, ductility, stiffness, damping and mass. The type of structural model selected is based on external action, the behavior of structure or structural materials, type of structural model selected.

High Rise Building-A building having height more then15m As per National Building Code 2005 of India is called High Rise Building. The materials used for the structural system of high- rise buildings are reinforced concrete and steel. Most North American style skyscrapers have a steel frame, while residential blocks are usually constructed of concrete. There is no clear definition of any difference between a tower block and a skyscraper, although a building with fifty or more stores is generally considered a skyscraper. High-rise structures pose particular design challenges for structural and geotechnical engineers, particularly if situated in a seismically active region or if the underlying soils have geotechnical risk factors such as high compressibility.

1.1 OBJECTIVES

- Numerical modelling of conventional beam slab system high rise building using relevant design software suite.
- Choosing of required materials as per exposure conditions and fire rating as per Indian Code and assigning of gravity loads (dead load, live load, super dead load) as per Indian standard provisions.

- Definition of the seismic (static and dynamic) and wind parameters for Bangalore locations according to specification of Indian code

- To carry out equivalent static and dynamic analysis (Response spectrum and time history analysis) for the proposed building

- Lateral stability checks for both the methods are carried out and compared.

1. Base shear
2. Storey drift
3. Storey displacement
4. Storey stiffness
5. Soft storey
6. Weak storey
7. Modes

Comparison of both zone 2 and zone 3.

2. LITERATURE REVIEW

Vinayak B Kulkarni, Mahesh V Tatikonda 2016 IJARSE: Dynamic analysis is carried out using STAAD Pro software. The Loads on structure were considered as per IS standards. The dynamic analysis may be Response spectrum method or time history analysis method. Response spectrum method uses rules laid down in IS 1893 (part 1) 2002 and time history analysis can be carried out using previous Earthquake data. In this paper El Centro earthquake occurred in 1940, data is used. The results in terms of lateral displacements with respect to each story are determined and compared story wise.

Mr. Chetan A. Timande 2017 (ICRTEST 2017) Right from the evolution of the earth, Earthquakes have been cause great disasters in the form of destruction of property, injury and loss of life to the population. The effective design and construction of earthquake resistant structures has much greater importance in this country due to rapid industrial development and concentration of population in cities. In this project, the earthquake response of symmetric multi-storied building by two methods will be studied. The methods include seismic coefficient method and response spectrum method as recommended by IS Code 1893-2002 part I, where natural frequencies, period, base shear, lateral forces are calculated by STAAD-PRO software as well as manually by seismic coefficient method.

3. MATERIALS

3.1 CONCRETE

SL.NO	Property	Specification
1	Grade of concrete	M 30 & M40
2	Grade of steel/ rebar	HYSD 500
3	Density of brick	20 KN/m^3
4	Density of RCC	25 KN/m^3
5	Poissons ratio	0.2

3.2 FRAME SECTION PROPERTY

Sl no	Section	Details (mm)
1	Beam	230 X600
2	Column	300 X900
3	Slab	150 , 175
4	Shear wall	300
5	Masonry wall	200

3 .3 LOADS DETAILING

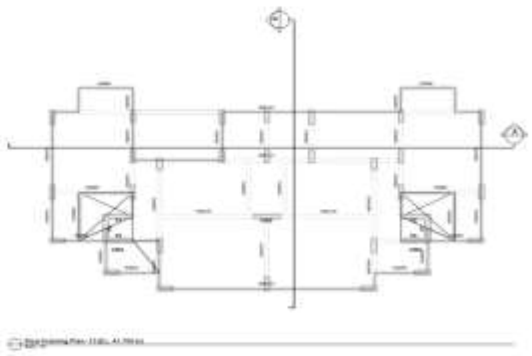
Property	Intensity of load(KN/m)
Live load	2 , 3(for balcony & corridors)
Floor finish	1.5
Wall load	16.5
OHT Load	2.64

4. MODEL GEOMETRY

G+15 High rise building

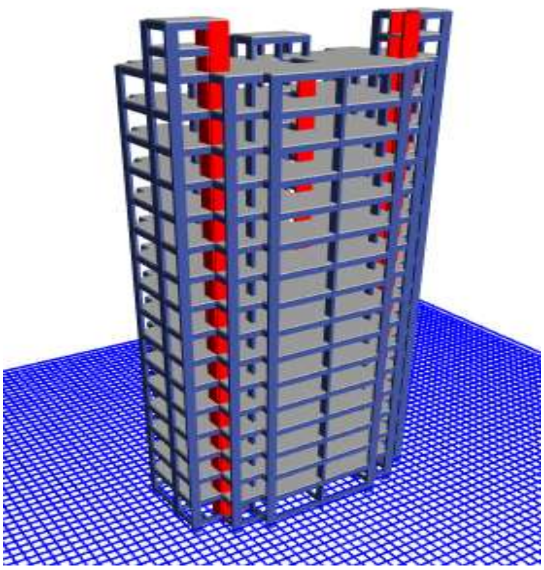
Floor to Floor Height - 3m ground floor height 5m

Plan View:



Plan view of building

3D View of G+15



4.1 WIND LOADS

Parameters	Zone 2	Zone 3
Wind speed , Vb	33 km/ph	50 km/ph
Terrain category	2	2
Structure class	B	B
Risk coefficient	1	1
Topography	1	1

4.2 STATIC EARTHQUAKE

Parameters	Zone 2	Zone 3
Seismic zone factor	0.1	0.16
Site type	2	2
Importance factor	1	1
Response reduction factor	3	3
Damping ratio	0.05	0.05
Time period	0.075 h^0.75 =1.43	1.43

4.3 Analysis

As per IS 1893 2002

There different types of analysis are considered in the project

- Equivalent static analysis.
- Response spectrum.
- Time history analysis.

4.3.1 EQUIVALENT STATIC ANALYSIS:

It is one of the methods for calculating the seismic loads. The high rise structures are not considered for the design simple static method. In practical as it does not take into account all the factors that are the importance of the foundation condition. The equivalent static analysis is used to design only for the small structures. In this method only one mode is considered for each direction. The earthquake resistant designing for the low rise structures the equivalent static method is enough. Tall structures are needed more than two modes and mass weight of each story to design earthquake resistant loads. This is not suitable to design those structures and dynamic analysis method to be used for high rise structures.

4.3.2 RESPONSE SPECTRUM ANALYSIS:

Response-spectrum analysis (RSA) method is the linear-dynamic method which measures the contribution from each natural mode of vibration to indicate the likely maximum seismic response of an essentially elastic structure.

Response-spectrum analysis provides insight into dynamic behavior by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping. It is practical to envelope response spectra such that a smooth curve represents the peak response for each realization of structural period. Response-spectrum analysis is useful for design decision-making because it relates structural type-selection to dynamic performance. Structures of shorter period experience greater acceleration, whereas those of longer period experience greater displacement. Structural performance objectives should be taken into account during preliminary design and response-spectrum analysis

Response Spectrum Method

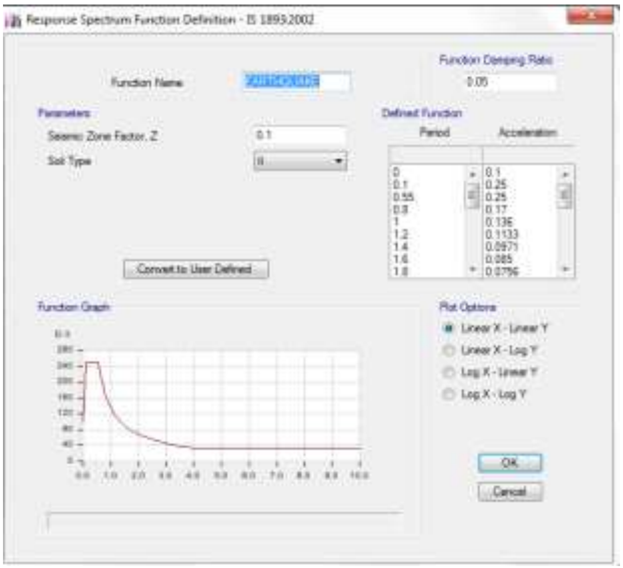


Chart 1 Response reduction function

4.3.3 TIME HISTORY DATA

Historical data includes the opening, high, low, and closing values of an asset or index over a specific period of time. Historic data is often used to forecast future forex rate movements. The time history data provides structure response under various loading cases to the specified time function.

In this project study, the time history data of Bhuj earthquake is considered

Location: Gujarat
Date : 26th January 2001
Time : 8:40 am
Area affected : India & Pakistan

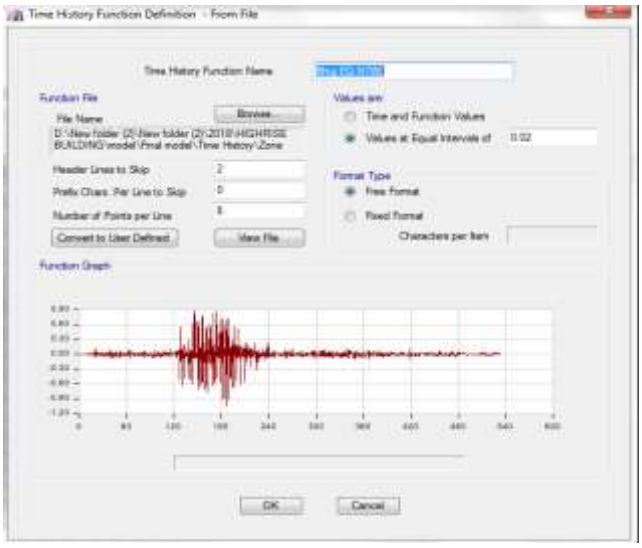


Chart 2 Time history function

5. RESULT AND DISCUSSION

INTERPRETATION OF ZONE 3

5.1 BASE SHEAR:

5.1.1 EQUIVALENT STATIC METHOD

Base shear value for Ex: Max 1.096 E -08

Min -1388.4633

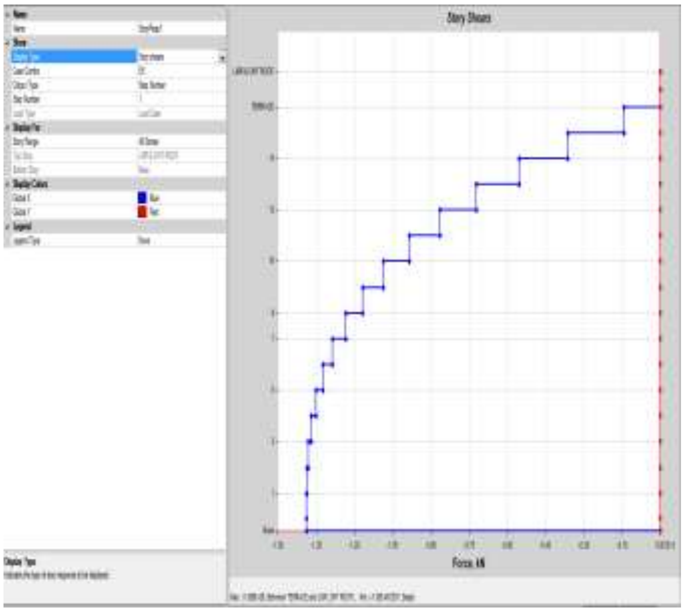


Fig 5.1.1(a) Shows the value of Base Shear Ex 1.096 E -08

Base shear value for Ey: Max 1.683 E -08

Min -1388.4633

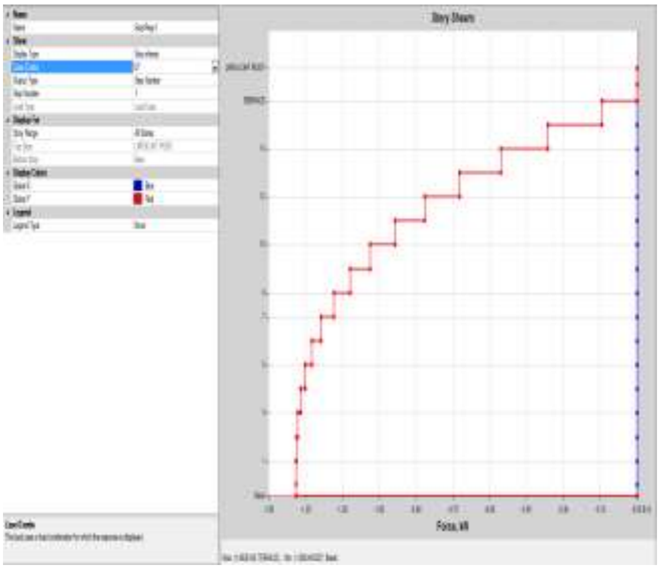


Fig 5.1.1(b) Shows the value of Base Shear Ey 1.683 E -08

5.1.2 RESPONSE SPECTRUM METHOD

Base shear value for SpecX: Max 472.0688

Min 0

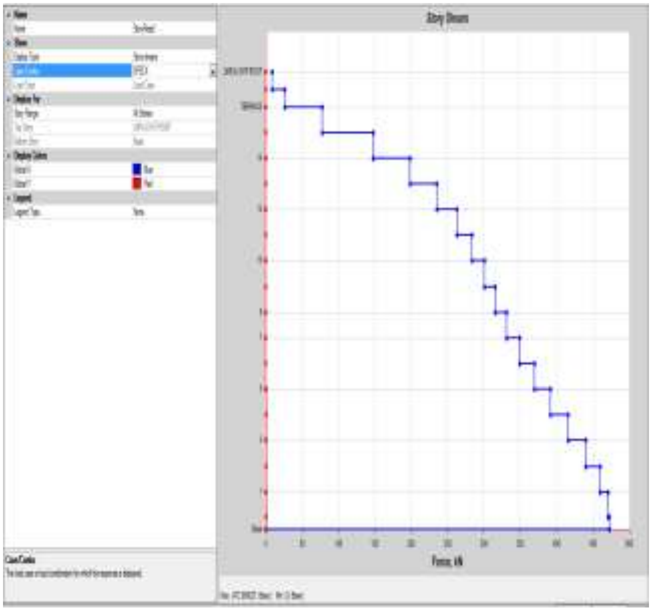


Fig 5.1.2(a) Shows the value of Base Shear SpecX 472.0688

Base shear value for SpecY: Max 572.486

Min 0

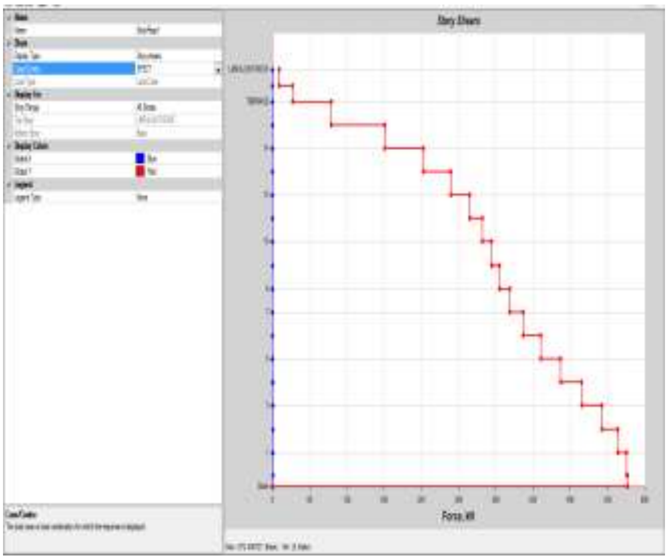


Fig 5.1.2(b) Shows the value of Base Shear SpecY 572.486

5.1.3 TIME HISTORY METHOD

Base shear value for TimeX: Max 74.38057

Min 0

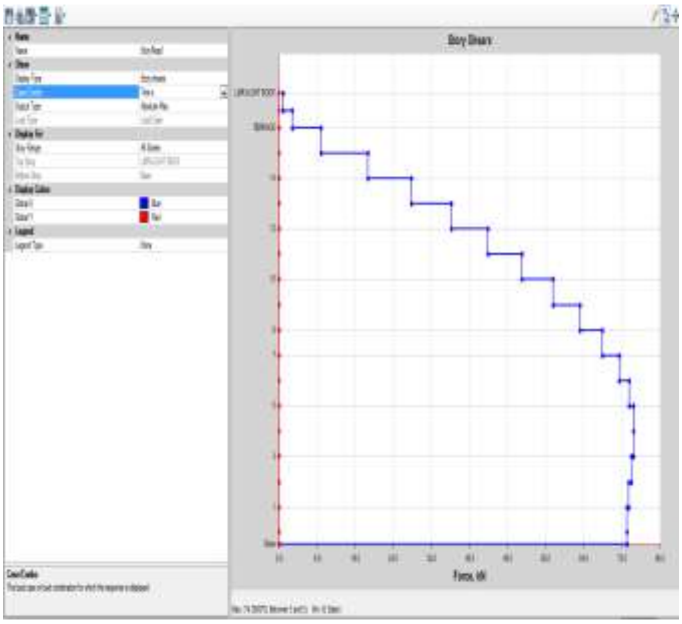


Fig 5.1.3(a) Shows the value of Base Shear TimeX74.38057

Base shear value for Time Y: Max 64.433

Min 0

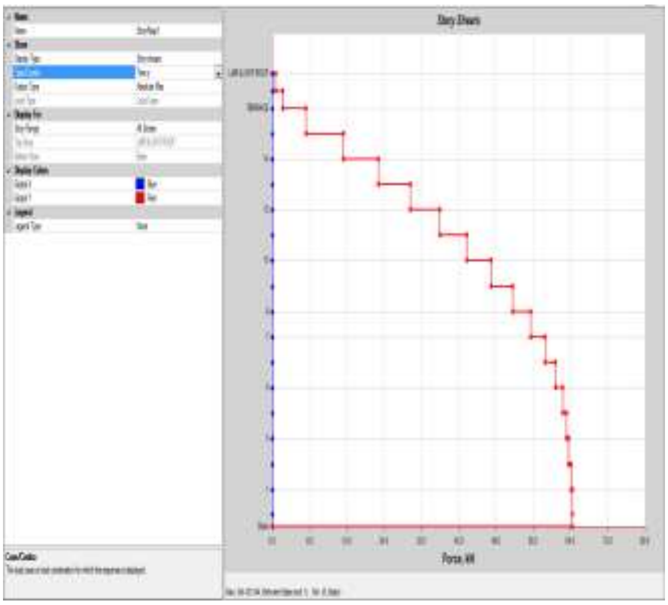


Fig 5.1.3(b) Shows the value of Base Shear TimeY64.433

5.2 STOREY DRIFT:

5.2.1 EQUIVALENT STATIC METHOD:

Storey drift value for Ex: Max 0.000992

Min 0

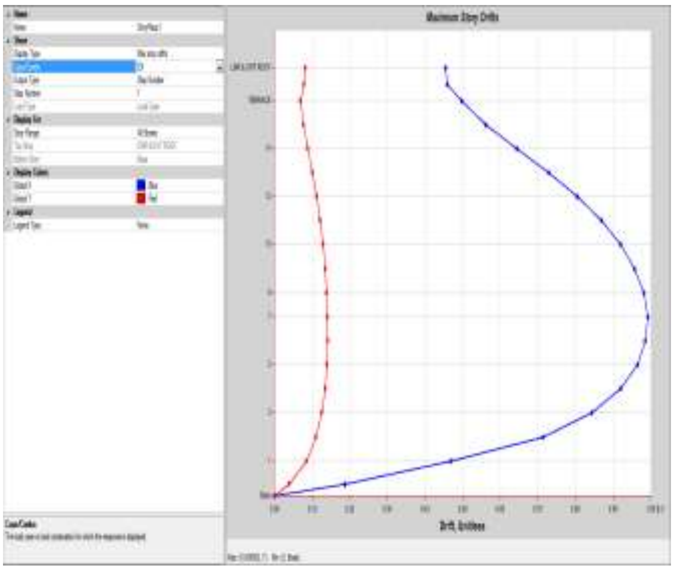


Fig 5.2.1(a) Shows the value of Storey drift Ex 0.00092

Base shear value for Ey: Max 0.000758

Min 0

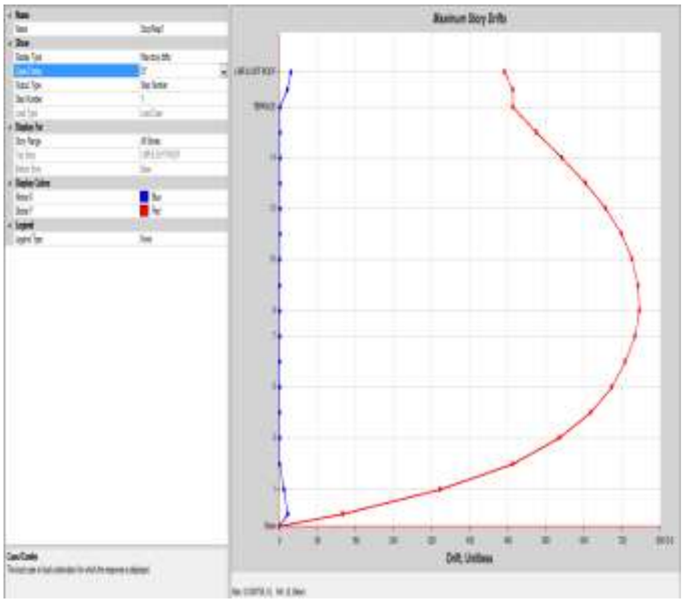


Fig 5.2.1(b) Shows the value of Storey Drift Ey0.000758

5.2.2 RESPONSE SPECTRUM METHOD:

Storey drift value for SpecX: Max 0.000291

Min 0

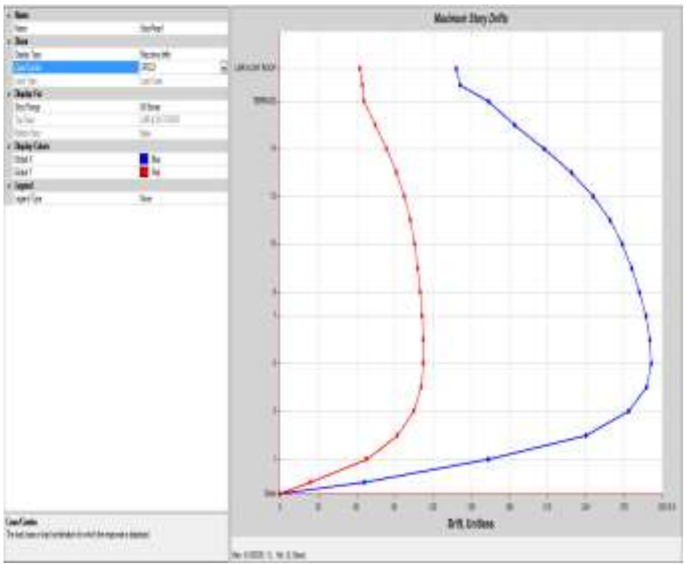


Fig 5.2.2(a) Shows the value of Storey Drift SpecX0.00029

Storey drift value for SpecY : Max 0.00023

Min 0

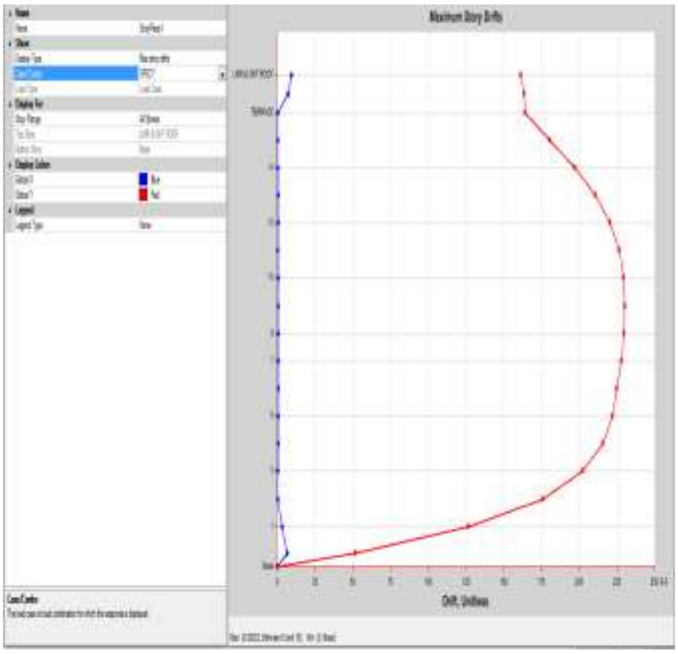


Fig 5.2.2(b) Shows value of Storey Drift SpecY 0.00023

5.2.3 TIME HISTORY METHOD:

Storey drift value for Time X: Max 0.000068

Min 0

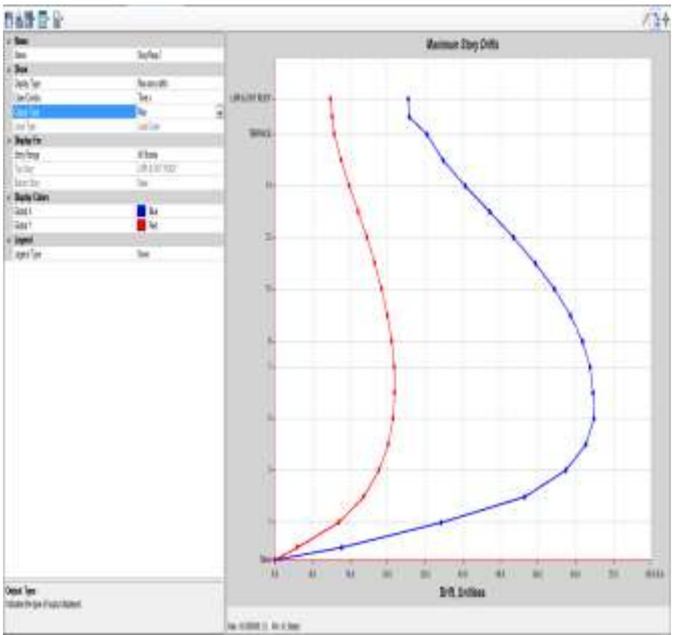


Fig 5.2.3(a) Shows value of Storey Drift TimeX 0.000068

Storey drift value for Time Y: Max 0.000051

Min 0

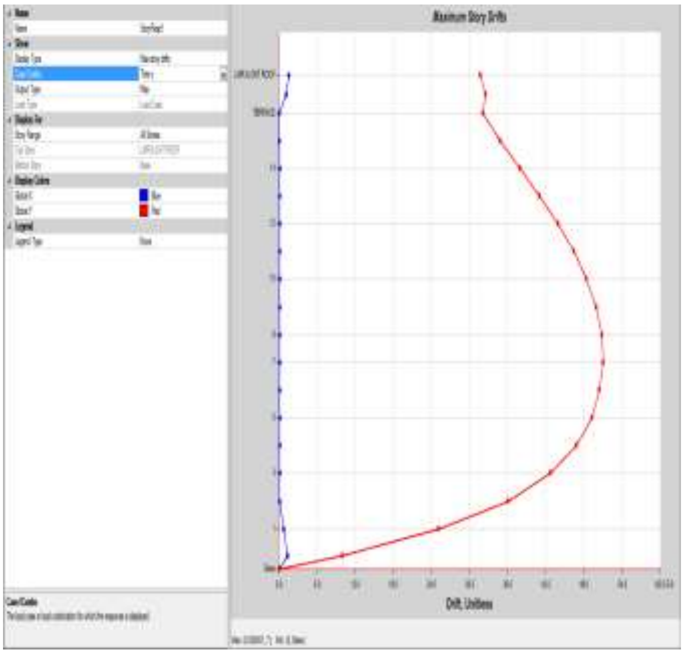


Fig 5.2.3(b) Shows value of Storey Drift TimeY 0.000051

5.3 STOREY DISPLACEMENT

5.3.1 EQUIVALENT STATIC METHOD:

Storey displacement value for Ex: Max 40.7841

Min 0

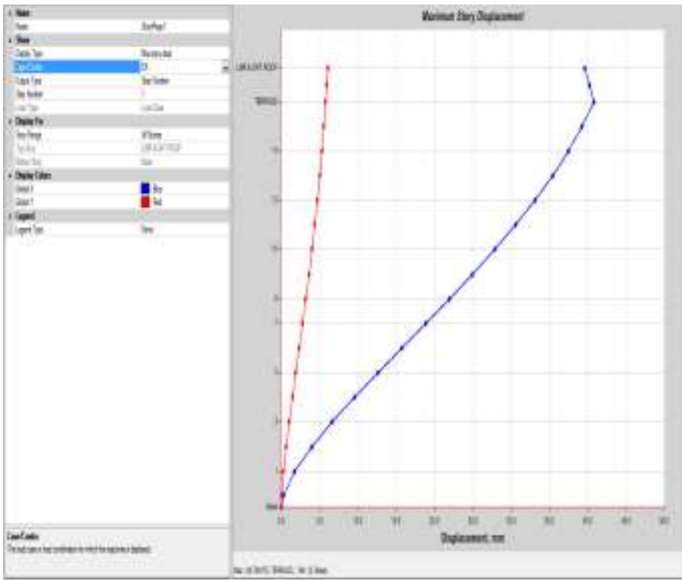


Fig 5.3.1(a) Shows value of Storey Displacement Ex 40.784

Storey displacement value for Ey: Max 33.619306

Min 0

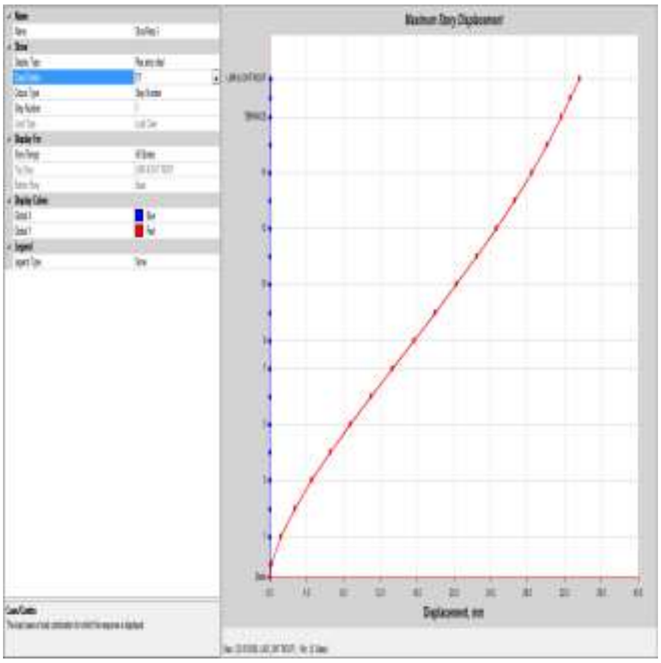


Fig 5.3.1(b) Shows the value of Storey Displacement Ey 33.61930

5.3.2 RESPONSE SPECTRUM METHOD

Storey displacement value for SpecX: Max 11.891408

Min 0

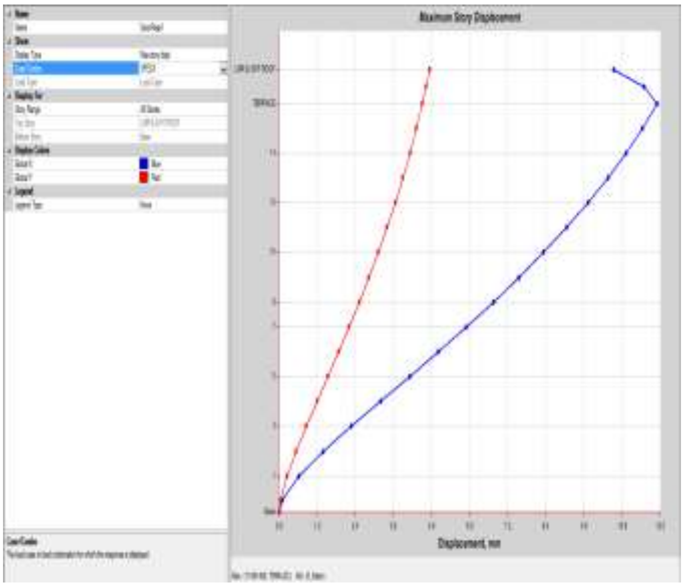


Fig 5.3.2(a) Shows value of Storey Displacement SpecX 11.89140

Storey displacement value for SpecY: Max 10.193262

Min 0

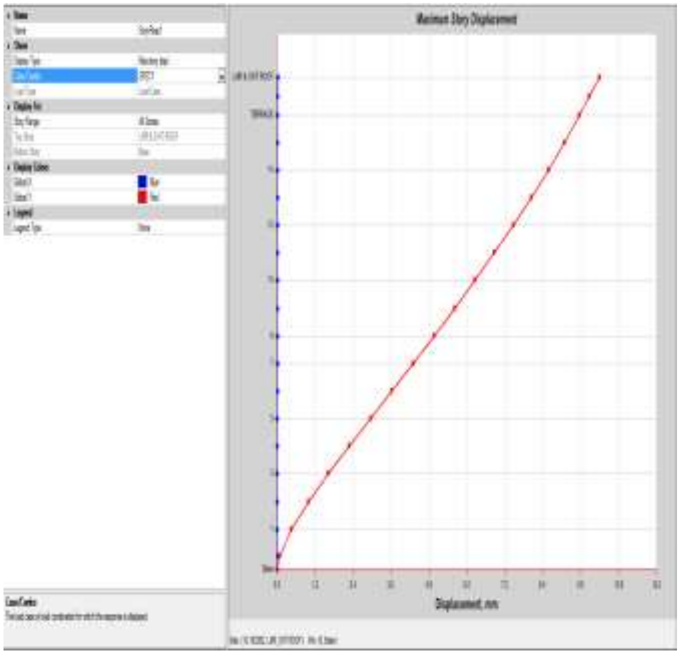


Fig 5.3.2(b) Shows value of Storey Displacement SpecY 10.19326

5.3.3 TIME HISTORY METHOD:

Storey displacement value for TimeX: Max 2.776399

Min 0

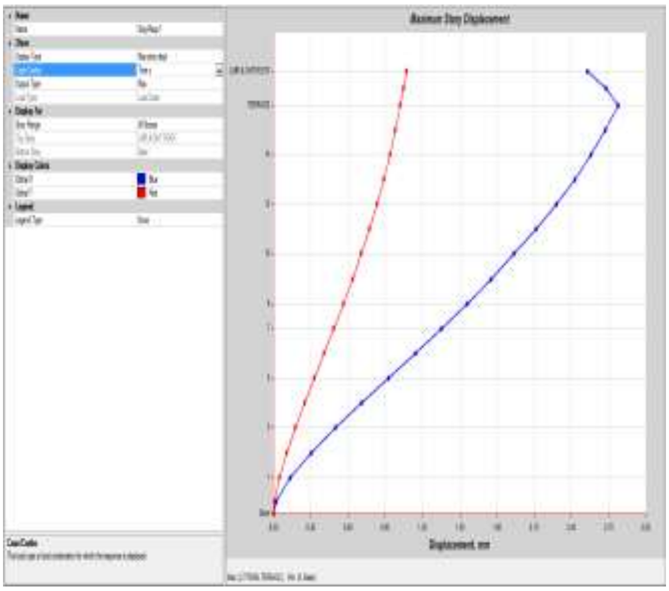


Fig 5.3.3(a) Shows value of Storey Displacement TimeX 2.77639

Storey displacement value for Time Y: Max 2.268821

Min: 0

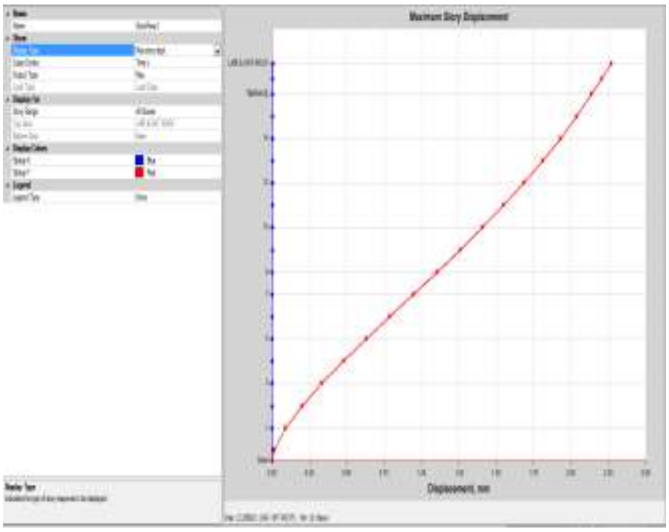


Fig 5.3.3(b) Shows value of Storey Displacement TimeY 2.268821

5.4 STOREY STIFFNESS

5.4.1 EQUIVALENT STATIC METHOD

Storey stiffness value for Ex: Max 5766168

Min 0

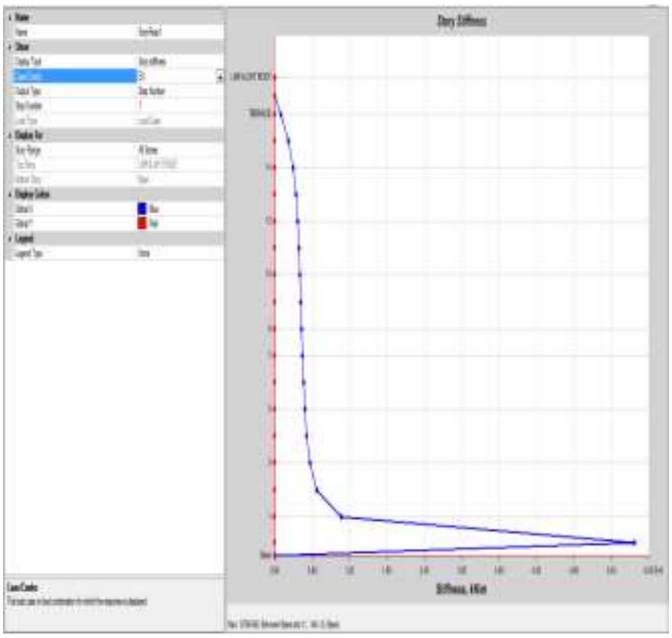


Fig 5.4.1(a) Shows the value of Storey Stiffness Ex 576616

Storey stiffness value for Ey: Max 7524731

Min 0

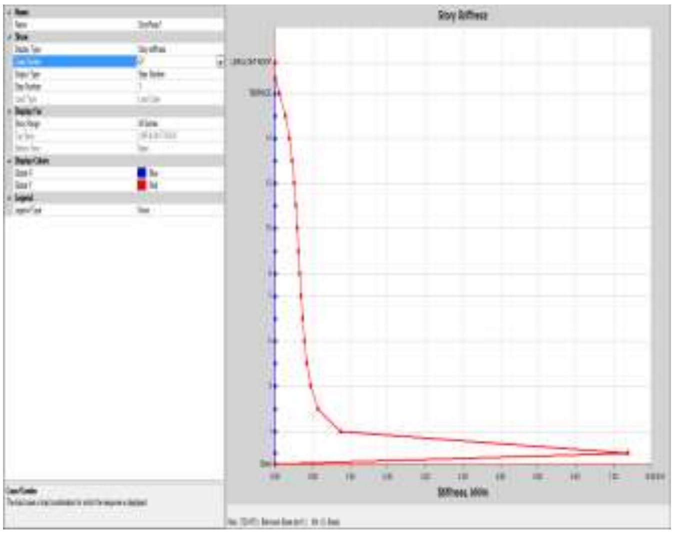


Fig 5.4.(b) Shows value of Storey Stiffness Ey 7524731

5.4.2 RESPONSE SPECTRUM

Storey stiffness value for SpecX: Max 5914678

Min 0

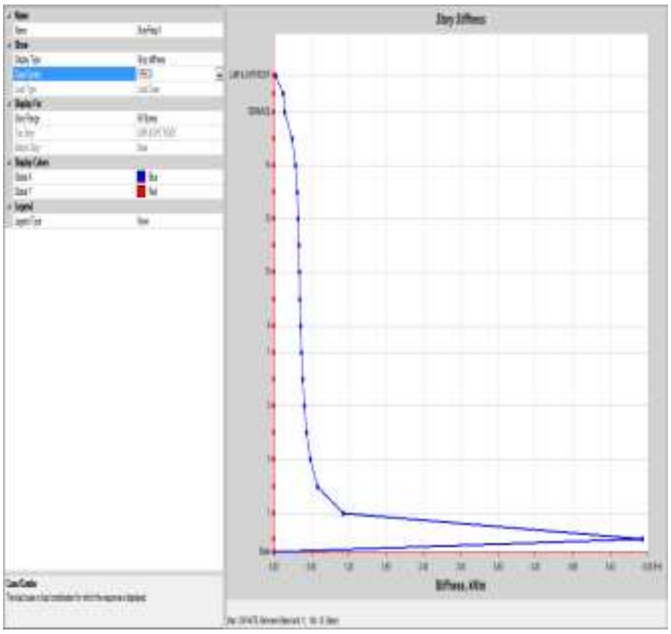


Fig 5.4.2(a) Shows value of Storey stiffness SpecX 5914678

Storey stiffness value for SpecY:Max 8028212

Min 0

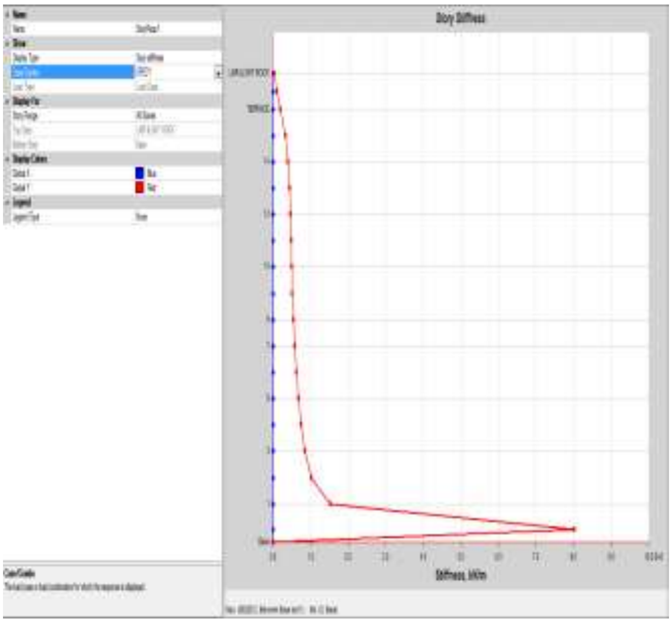


Fig 5.4.2(b) Shows the value of Storey Stiffness SpecY 802821

5.4.3 TIME HISTORY METHOD:

Storey stiffness value for Time X: Max 0.00

Min 0

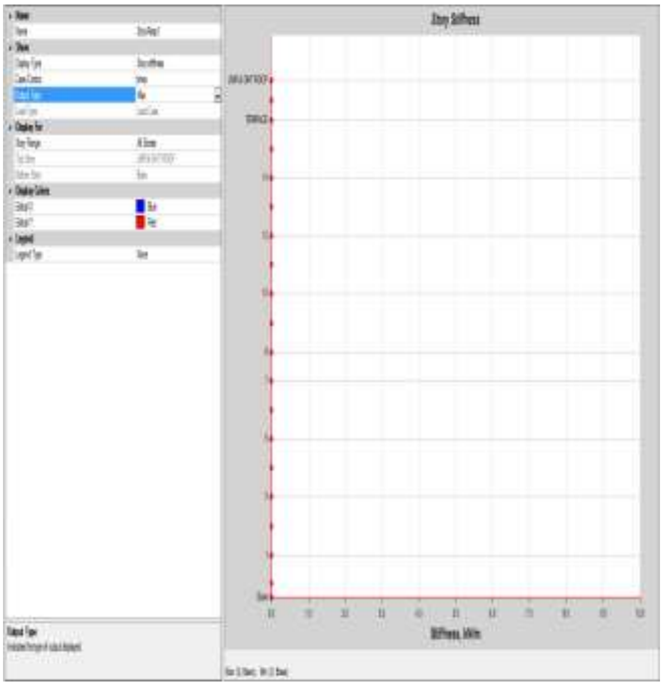


Fig 5.4.3(a) Shows the value of Storey Stiffness TimeX 0.00

Storey stiffness value for Time Y: Max 0.00

Min 0

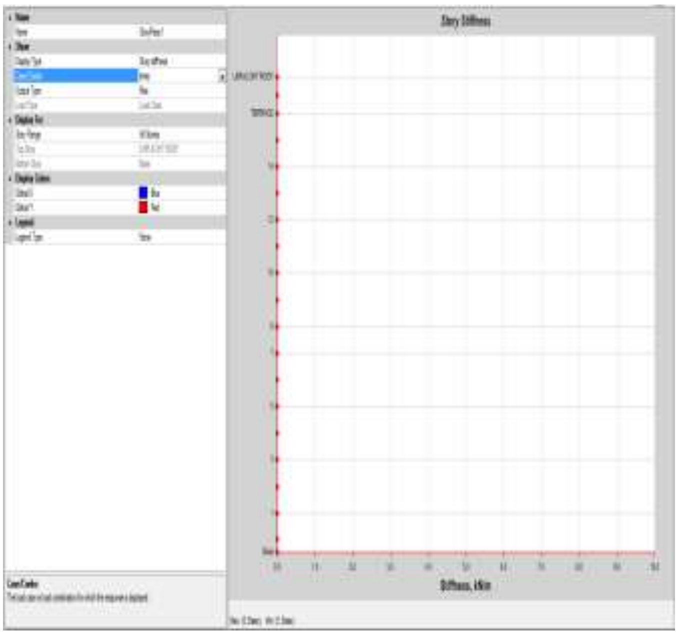


Fig 5.4.3(b) Shows the value of Storey Stiffness TimeY 0.0

5.5 SOFT STOREY

A delicate story building is a muitistory building n which at least one stories have windows, wide entryways, vast unhindered business spaces, or oher opening in places where a shear divider would regularly be required for solidness as an issue of quake designing outline.

5.5.1 EQUIVALENT STATIC METHOD:

Table 5.5.1 Storey Stiffness for Ex

TABLE: Story Stiffness				
Story	Load Case	Stiffness X	Stiffness Y	Soft Story Check
		kN/m	kN/m	
LMR & OHT ROOF	EX	0	0.0001068	ok
LMR & OHT FLOOR	EX	0.00001991	0.0001571	ok
TERRACE	EX	97843.203	0	ok
15	EX	220308.853	0	ok
14	EX	293761.626	0	ok
13	EX	338058.832	0	ok
12	EX	366702.168	0	ok
11	EX	387018.211	0	ok
10	EX	403300.47	0	ok
9	EX	416839.056	0	ok
8	EX	429588.682	0	Ok
7	EX	442973.568	0	Ok
6	EX	459426.051	0	Ok
5	EX	479343.302	0	Ok
4	EX	509789.171	0	Ok
3	EX	560793.319	0	Ok
2	EX	667835.985	0	Ok
1	EX	1064808.804	0	Ok
GL	EX	5766168.159	0	Ok
LMR & OHT ROOF	EY	0	0.000006076	Ok
LMR & OHT FLOOR	EY	0	0.00001682	Ok
TERRACE	EY	0	93896.536	Ok
15	EY	0	217290.516	Ok
14	EY	0	302867.785	Ok
13	EY	0	363423.941	Ok
12	EY	0	408296.747	Ok
11	EY	0	443593.263	Ok
10	EY	0	473806.844	Ok
9	EY	0	500675.877	Ok
8	EY	0	526932.631	Ok
7	EY	0	555164.944	Ok
6	EY	0	588433.663	Ok
5	EY	0	624614.654	Ok
4	EY	0	675757.242	Ok
3	EY	0	757606.566	Ok
2	EY	0	912889.511	Ok
1	EY	0	1392691.351	Ok
GL	EY	0	7524730.728	Ok

5.5.2 RESPONSE SPECTRUM METHOD:

Table 5.5.2 Storey Stiffness for specX

TABLE: Story Stiffness				
Story	Load Case	Stiffness X	Stiffness Y	Soft Story Check
		kN/m	kN/m	
LMR & OHT ROOF	SPECX	29800.606	0	Ok
LMR & OHT FLOOR	SPECX	149490.979	0	Ok
TERRACE	SPECX	171613.054	0	Ok
15	SPECX	290658.43	0	Ok
14	SPECX	347081.887	0	Ok
13	SPECX	372971.415	0	Ok
12	SPECX	387009.308	0	Ok
11	SPECX	396787.059	0	Ok
10	SPECX	405207.085	0	Ok
9	SPECX	413488.862	0	Ok
8	SPECX	424700.508	0	Ok
7	SPECX	440186.007	0	Ok
6	SPECX	461007.992	0	Ok
5	SPECX	486695.276	0	Ok
4	SPECX	523744.42	0	Ok
3	SPECX	582625.58	0	Ok
2	SPECX	696219.925	0	Ok
1	SPECX	1109733.884	0	Ok
GL	SPECX	5914677.972	0	ok
LMR & OHT ROOF	SPECY	0	32084.055	Ok
LMR & OHT FLOOR	SPECY	0	97692.25	Ok
TERRACE	SPECY	0	187182.055	Ok
15	SPECY	0	323628.959	Ok
14	SPECY	0	399609.735	Ok
13	SPECY	0	441010.072	Ok
12	SPECY	0	465513.355	Ok
11	SPECY	0	482432.522	Ok
10	SPECY	0	497217.542	Ok
9	SPECY	0	513659.869	Ok
8	SPECY	0	537860.271	Ok
7	SPECY	0	573595.162	Ok
6	SPECY	0	621656.825	Ok
5	SPECY	0	676024.286	Ok
4	SPECY	0	746748.462	Ok
3	SPECY	0	848305.036	Ok
2	SPECY	0	1021787.109	Ok
1	SPECY	0	1529914.56	Ok
GL	SPECY	0	8028211.877	Ok

5.5.3 TIME HISTORY METHOD

Storey Stifnees is zero hence soft storey checck is ok

5.6 WEAK STOREY CHECK:

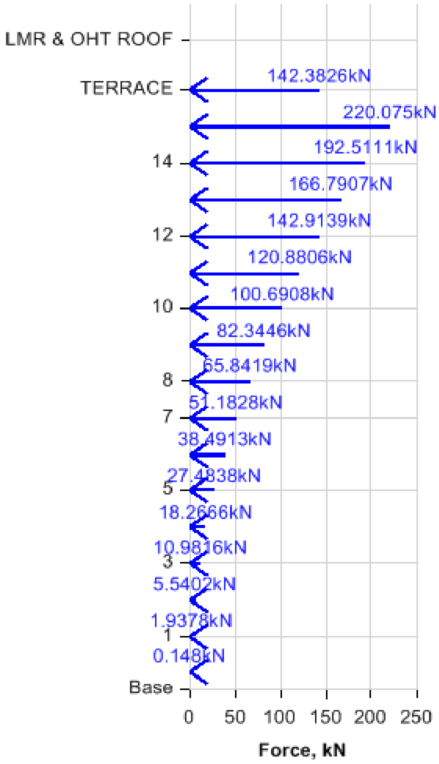


Fig 5.6.1 Shows Weak storey in X –Direction

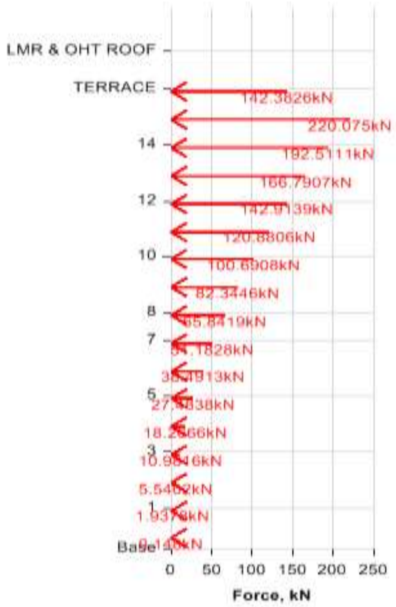


Fig 5.6.2 Shows weak storey in Y –Direction

5.7 MODE SHAPES:

5.7.1 1st Mode: Time period : 2.196

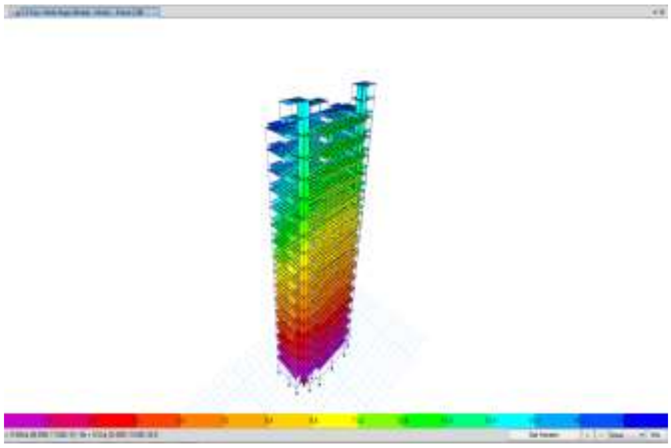


Fig 5.7.1 Shows 1st Mode of Time period 2.196

5.7.2 2nd Mode : Time period : 1.943

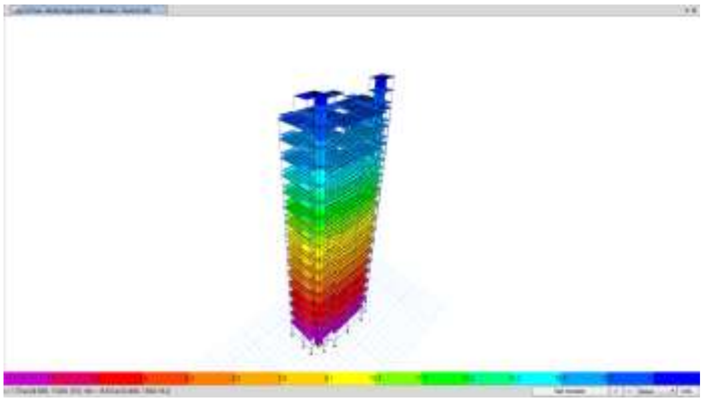


Fig 5.7.2 Shows 2nd Mode of Time period 1.943

5.7.3 3rd Mode : Time period : 1.69

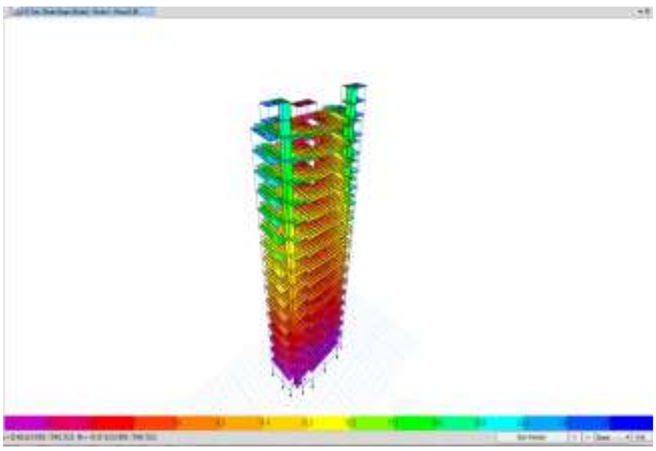


Fig 5.7.3 Shows 3rd Mode of Time period 1.69

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INTERPRETATION OF ZONE 3

5.8 BASE SHEAR

5.8.1 EQUIVALENT STATIC METHOD

Base shear value for Ex: Max 1.739 E -08

Min -2221.54129

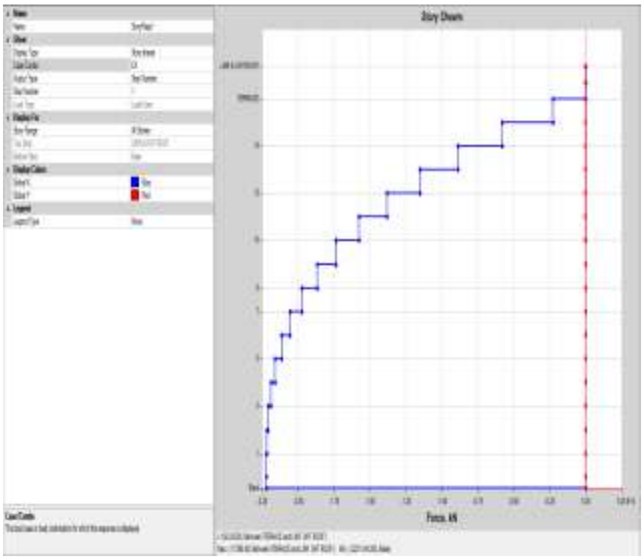


Fig 5.8.1(a) Shows value the of base shear Ex 1.739 E -08

Base shear value for Ey : Max 2.691 E -08

Min -2221.541

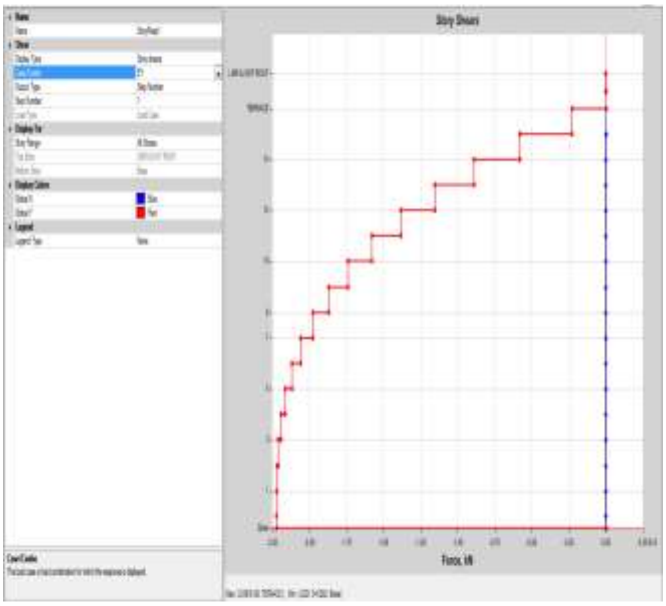


Fig 5.8.1(b) Shows the value of base shear Ey 2.691 E -08

5.8.2 RESPONSE SPECTRUM

Base shear value for SpecX : Max 755.3088

Min 0

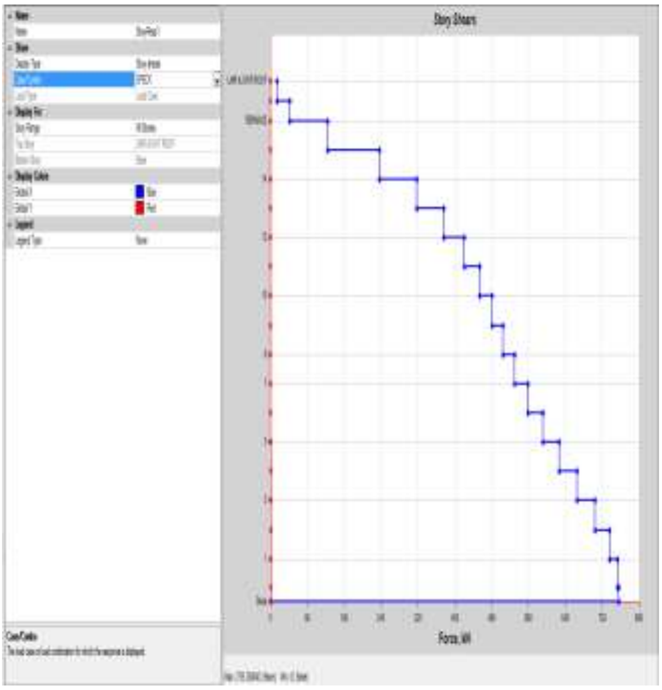


Fig 5.8.2(a) Shows the value of base shear SpecX 755.3088

Base shear value for SpecY : Max 915.9787

Min 0

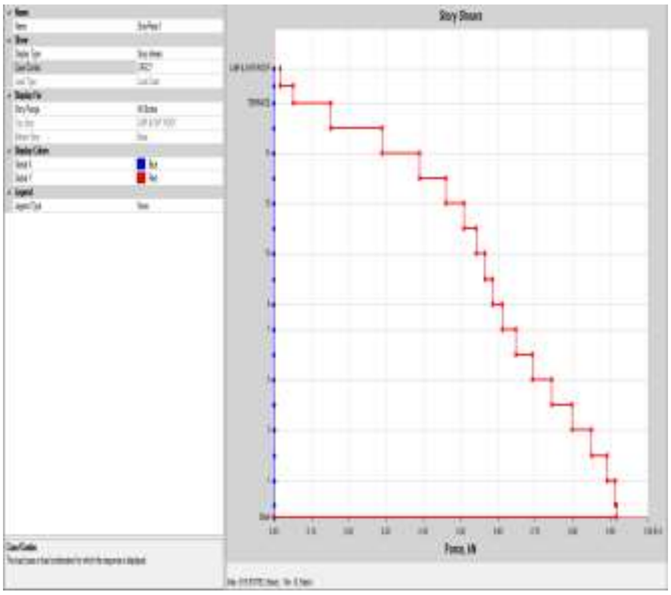
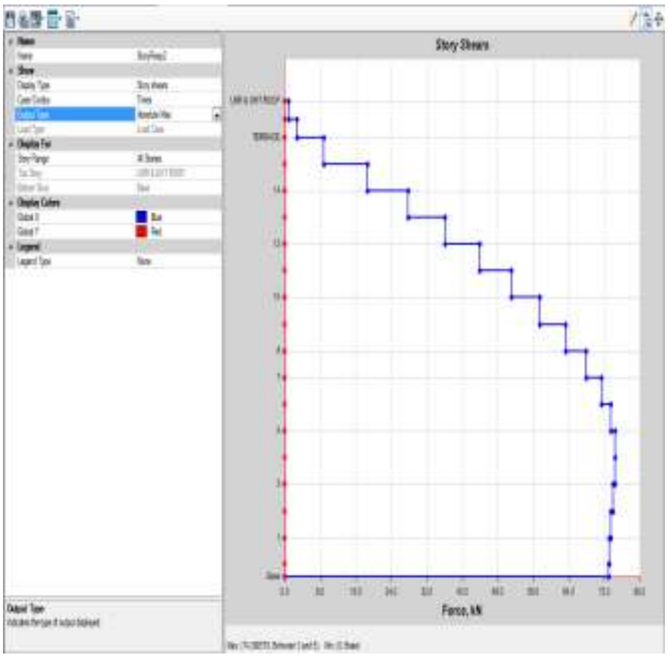


Fig 5.8.2(b) Shows value of base shear SpecY 915.978763

5.8.3 TIME HISTORY

Base shear value for Time X: Max 74.38057

Min 0



5.8.3(a) Shows the value of base shear Time X 74.380579

Base shear value for Time Y: Max 11828.8702

Min 0

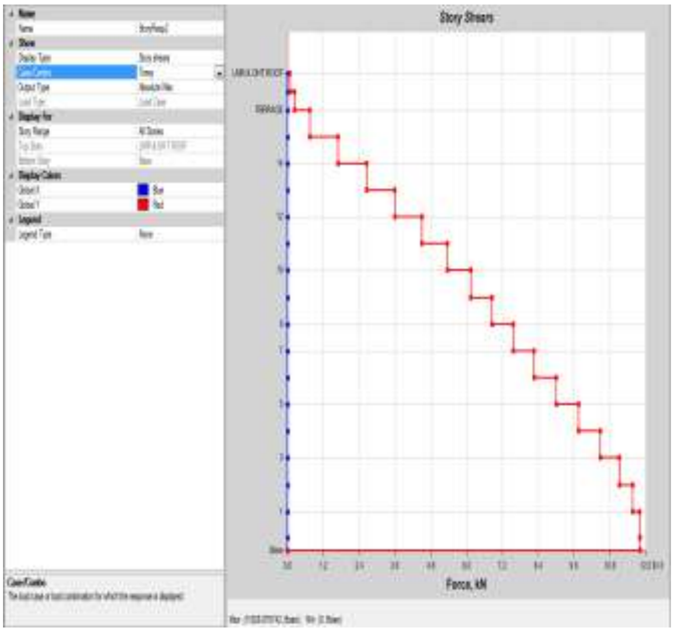


Fig 5.8.3(b) Shows value of Base shear TimeY 11828.870

5.9 STOREY DRIFT:

5.9.1 EQUIVALENT STATIC METHOD:

Storey drift value for Ex: Max 0.001587

Min 0

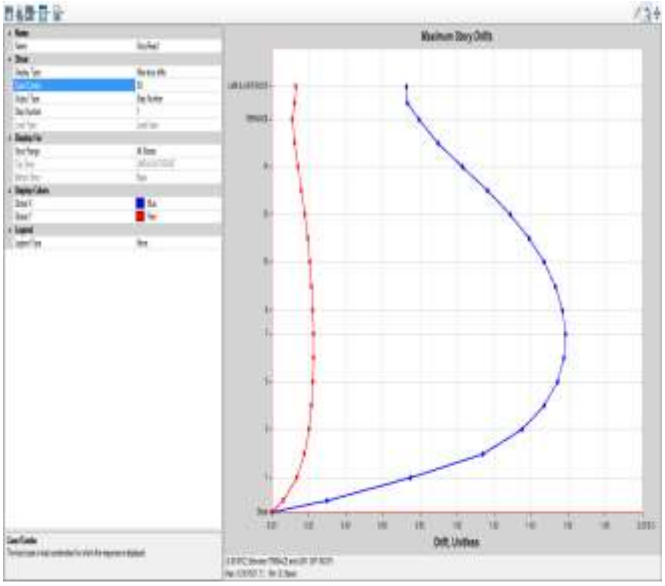


Fig 5.9.1(a) Shows the value of storey drift Ex 0.001587

Base shear value for Ey: Max 0.001209

Min 0

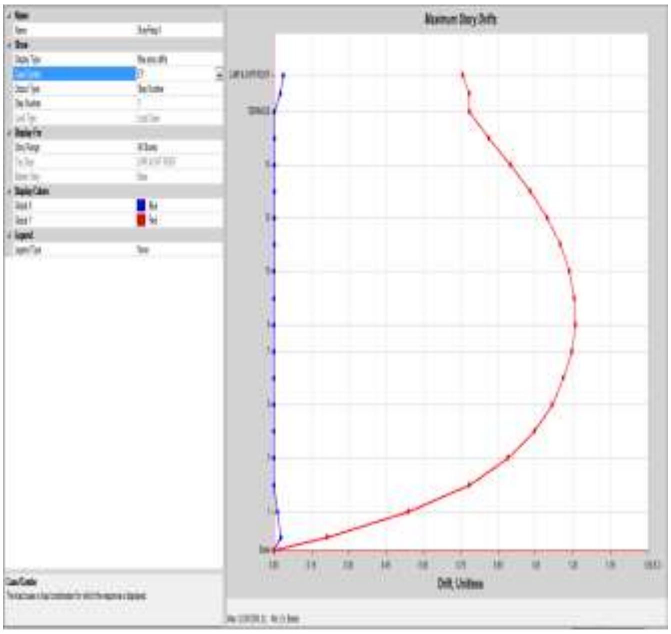


Fig 5.9.1(b) Shows the value of storey drift Ey 0.001209

5.9.2 RESPONSE SPECTRUM METHOD:

Storey drift value for SpecX: Max 0.000465

Min 0

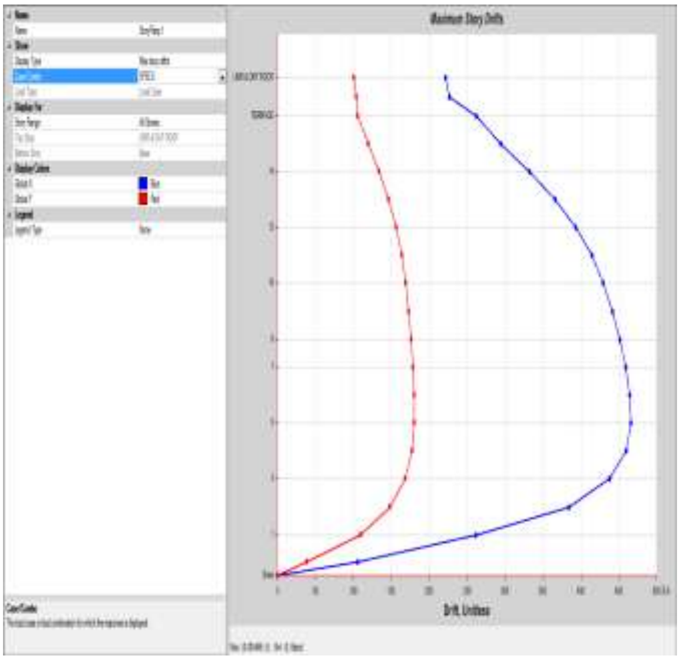


Fig 5.9.2(a) Shows value of storey drift SpecX 0.000465

Storey drift value for SpecY : Max 0.000368

Min: 0

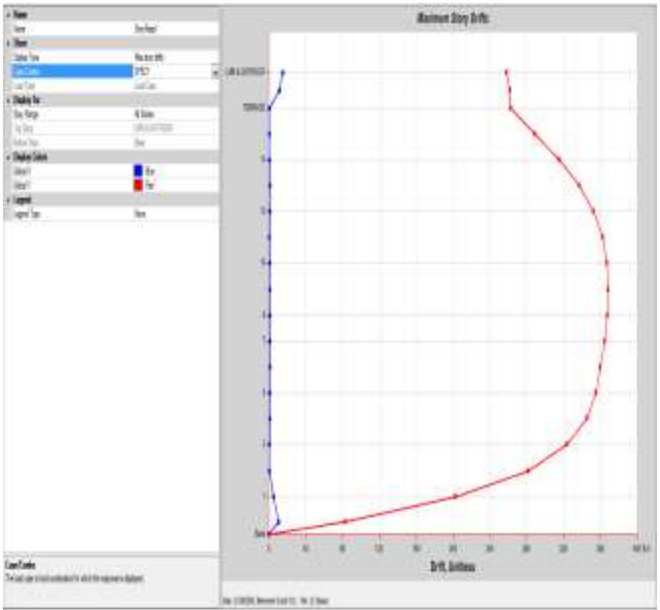


Fig 5.9.2(b) Shows value of storey drift SpecY 0.000368

5.9.3 TIME HISTORY METHOD

Storey drift value for Time X: Max 0.000068

Min 0

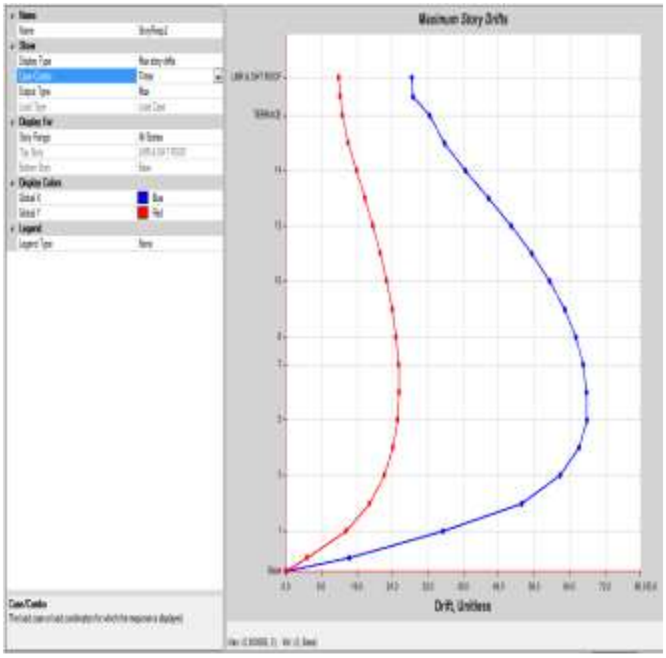


Fig 5.9.3(a) Shows value of storey drift TimeX 0.000068

Storey drift value for Time Y: Max 0.000141

Min: 0

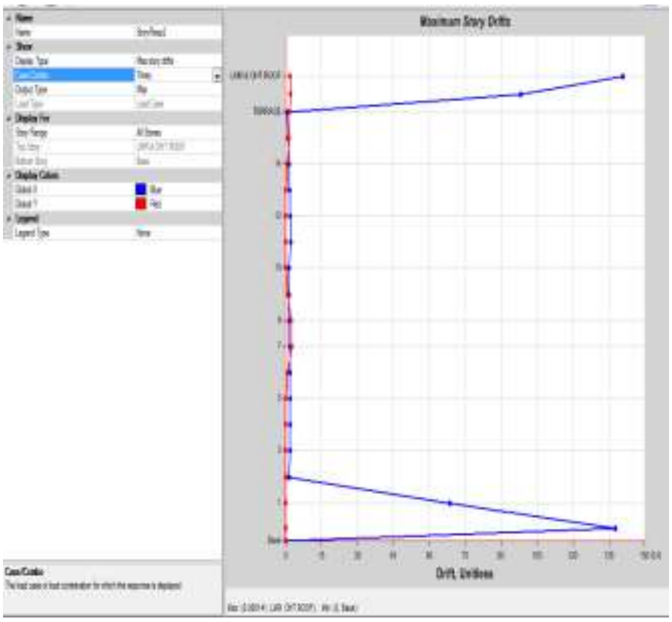


Fig 5.9.3(b) Shows value of storey drift TimeY 0.000068

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5.10 STOREY DISPLACEMENTS:

5.10.1 EQUIVALENT STATIC METHOD:

Storey displacement value for Ex: Max 65.254679

Min 0

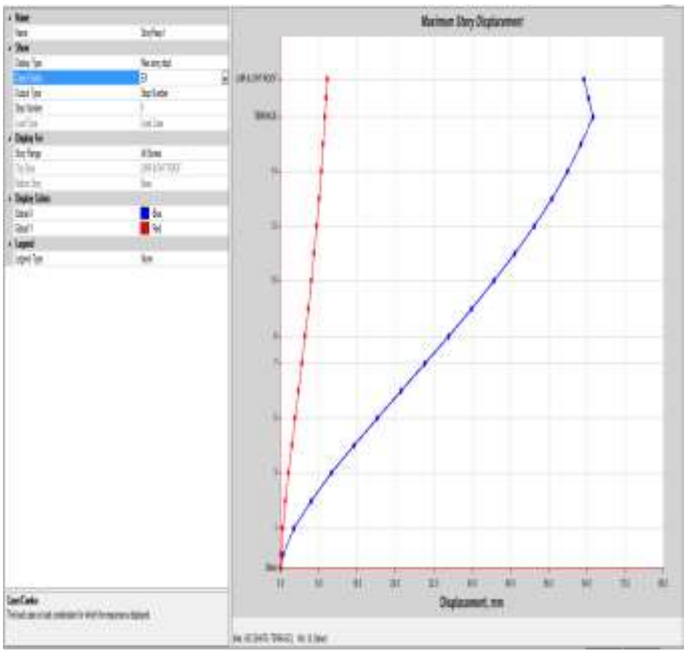

Fig 5.10.1(a) Shows value of storey displacement Ex 65.254679

Storey displacement value for Ey: Max 53.79089

Min 0

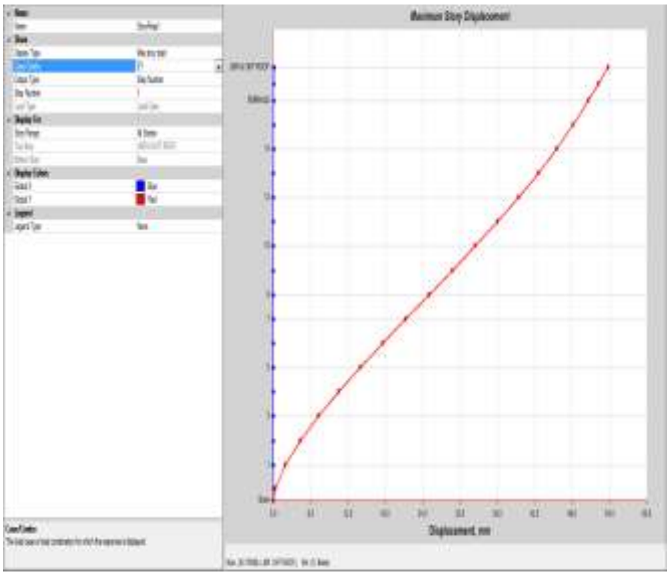

Fig 5.10.1(b) Shows value of storey displacement Ey 53.79089

5.10.2 RESPONSE SPECTRUM METHOD

Storey displacement value for SpecX : Max 19.0265

Min 0

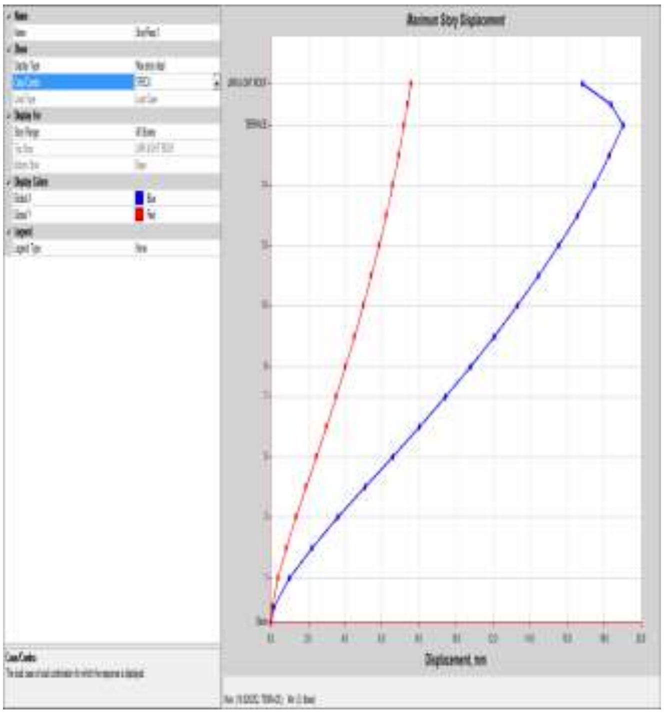

Fig 5.10.2(a) Shows value of storey displacement SpecX 19.0265

Storey displacement value for SpecY : Max 16.30922

Min 0

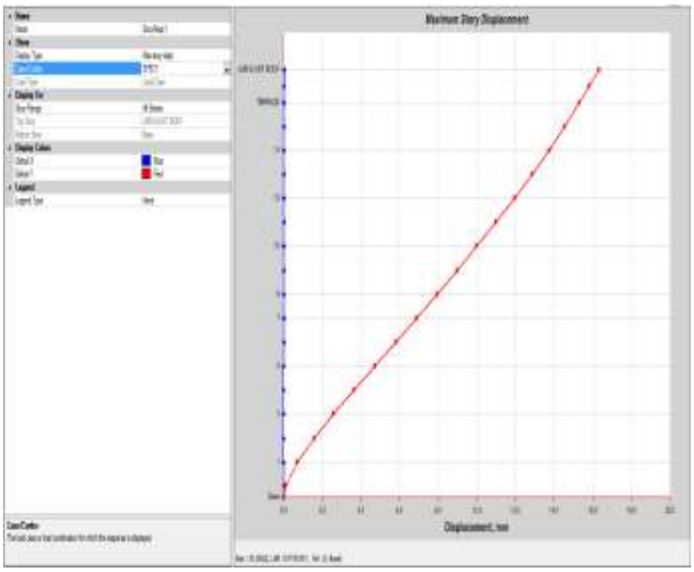

fig 5.10.2(b) Shows value of storey displacement spec y 16.30922

5.10.3 TIME HISTORY METHOD:

Storey displacement value for Time X: Max 2.776399

Min 0

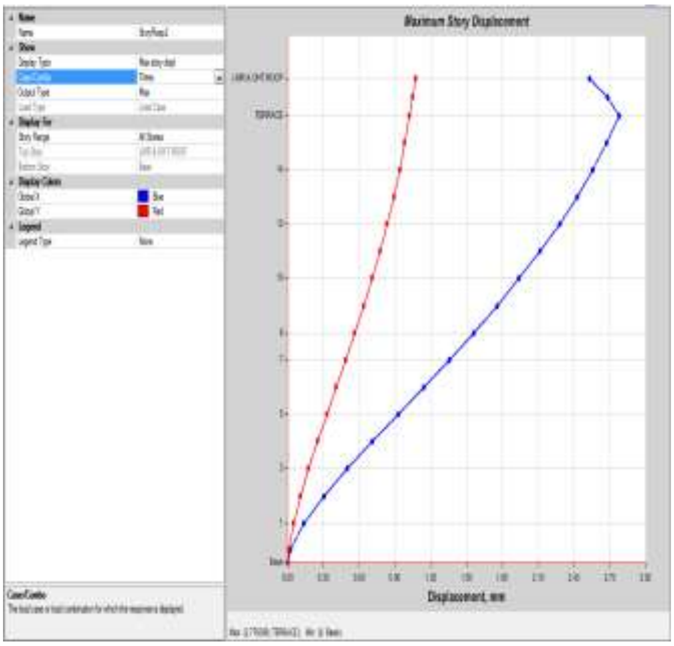

Fig 5.10.3(a) Shows value of storey displacement TimeX 2.77639

Storey displacement value for Time Y: Max 0.459962

Min: 0

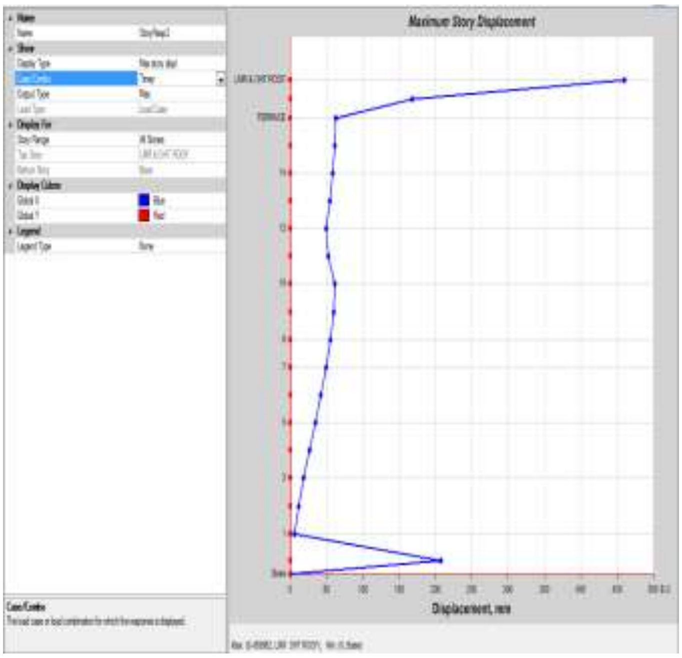

Fig 5.10.3(b) Shows value of storey displacement TimY 0.459962

5.11 STORY STIFFNESS

5.11.1 EQUIVALENT STATIC METHOD

Storey stiffness value for Ex: Max 5766168

Min 0

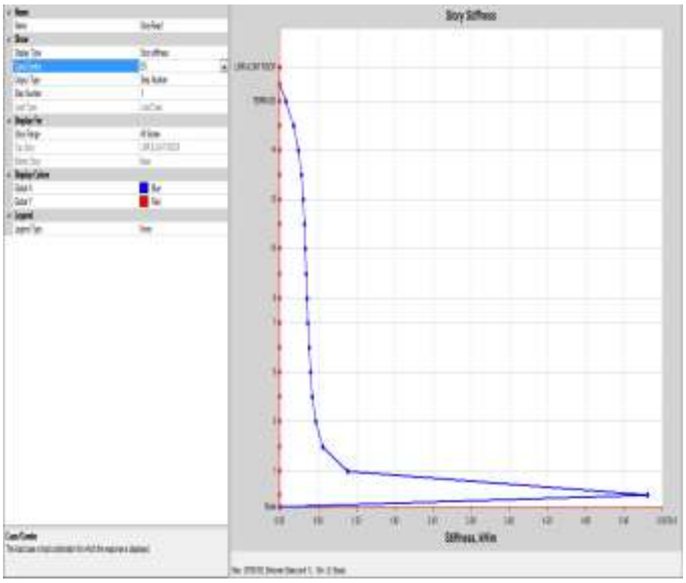

Fig 5.11.1(a) Shows value of storey stiffness Ex 576616

Storey stiffness value for Ey: Max 7524731

Min 0

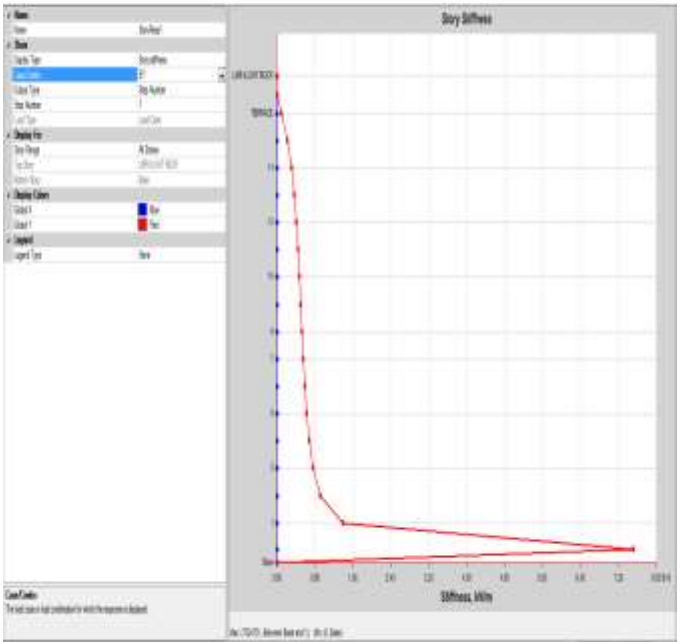

Fig 5.11.1(b) Shows value of storey stiffness Ey 7524731

5.11.2 RESPONSE SPECTRUM

Storey stiffness value for SpecX : Max 5914678

Min 0

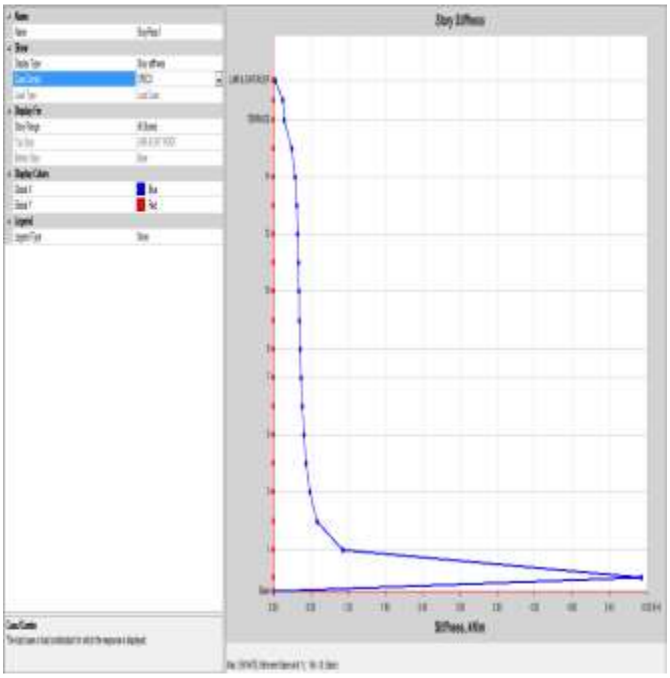

Fig 5.11.2(a) Shows value of storey stiffness SpecX 5914678

Storey stiffness value for SpecY : Max 8028212

Min 0

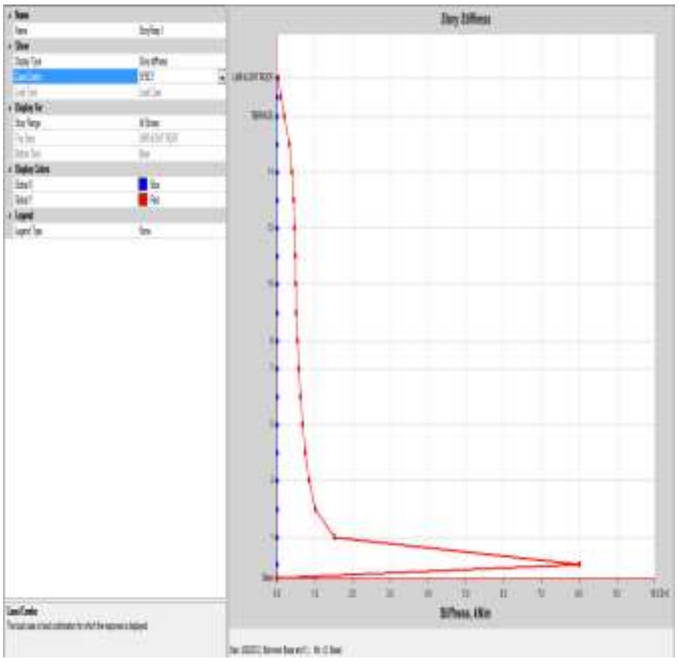

Fig 5.11.2(b) Storey stiffness value for SpecY 8028212

5.11.3 TIME HISTORY METHOD:

Storey stiffness value for Time Y: Max 0.00

Min 0

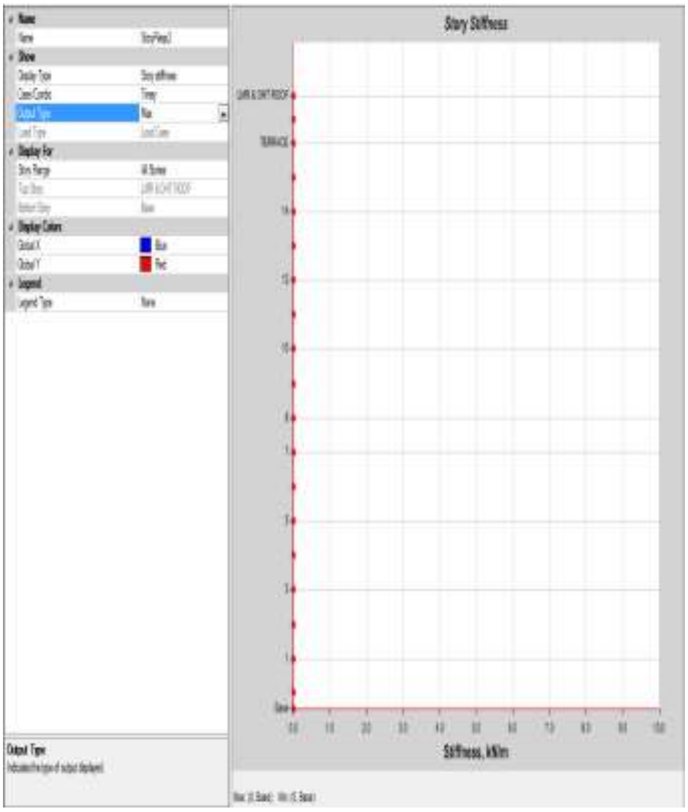

Fig 5.11.3(a) Shows value of storey stiffness Time Y 0.0

5.12 SOFT STOREY

5.12.1 EQUIVALENT STATIC METHOD:

Table 5.12.1 Storey Stiffness for Ex and Ey

Story	Load Case	Stiffness X	Stiffness Y	Soft Story Check
		kN/m	kN/m	
LMR & OHT ROOF	EX	0	0.0001068	ok
LMR & OHT FLOOR	EX	0.00001978	0.0001571	ok
TERRACE	EX	97843.203	0	ok
15	EX	220308.853	0	ok
14	EX	293761.626	0	ok
13	EX	338058.832	0	ok
12	EX	366702.168	0	ok
11	EX	387018.211	0	ok
10	EX	403300.47	0	ok
9	EX	416839.056	0	ok
8	EX	429588.682	0	ok
7	EX	442973.568	0	ok
6	EX	459426.051	0	ok
5	EX	479343.302	0	ok
4	EX	509789.171	0	ok
3	EX	560793.319	0	ok
2	EX	667835.985	0	ok
1	EX	1064808.804	0	ok
GL	EX	5766168.159	0	ok
LMR & OHT ROOF	EY	0	0.000006063	ok
LMR & OHT FLOOR	EY	0	0.00001681	ok
TERRACE	EY	0	93896.536	ok
15	EY	0	217290.516	ok
14	EY	0	302867.785	ok
13	EY	0	363423.941	ok
12	EY	0	408296.747	ok
11	EY	0	443593.263	ok
10	EY	0	473806.844	ok
9	EY	0	500675.877	ok
8	EY	0	526932.631	ok
7	EY	0	555164.944	ok
6	EY	0	588433.663	ok
5	EY	0	624614.654	ok
4	EY	0	675757.242	ok
3	EY	0	757606.566	ok
2	EY	0	912889.511	ok
1	EY	0	1392691.351	ok

5.12.2 RESPONSE SPECTRUM METHOD:

Table 15.2.2 Shows Storey Stiffness for specX & specY

Story	Load Case	Stiffness X	Stiffness Y	Soft Story Check
LMR & OHT ROOF	SPECX	29800.606	0	ok
LMR & OHT FLOOR	SPECX	149490.979	0	ok
TERRACE	SPECX	171613.054	0	ok
15	SPECX	290658.43	0	ok
14	SPECX	347081.887	0	ok
13	SPECX	372971.415	0	ok
12	SPECX	387009.308	0	ok
11	SPECX	396787.059	0	ok
10	SPECX	405207.085	0	ok
9	SPECX	413488.862	0	ok
8	SPECX	424700.508	0	ok
7	SPECX	440186.007	0	ok
6	SPECX	461007.992	0	ok
5	SPECX	486695.276	0	ok
4	SPECX	523744.42	0	ok
3	SPECX	582625.58	0	ok
2	SPECX	696219.925	0	ok
1	SPECX	1109733.884	0	ok
GL	SPECX	5914677.972	0	ok
LMR & OHT ROOF	SPECY	0	32084.055	ok
LMR & OHT FLOOR	SPECY	0	97692.25	ok
TERRACE	SPECY	0	187182.055	ok
15	SPECY	0	323628.959	ok
14	SPECY	0	399609.735	ok
13	SPECY	0	441010.072	ok
12	SPECY	0	465513.355	ok
11	SPECY	0	482432.522	ok
10	SPECY	0	497217.542	ok
9	SPECY	0	513659.869	ok
8	SPECY	0	537860.271	ok
7	SPECY	0	573595.162	ok
6	SPECY	0	621656.825	ok
5	SPECY	0	676024.286	ok
4	SPECY	0	746748.462	ok
3	SPECY	0	848305.036	ok
2	SPECY	0	1021787.109	ok
1	SPECY	0	1529914.56	ok
GL	SPECY	0	8028211.877	ok

5.12.3 TIME HISTORY METHOD

Storey Stifnees is zero hence soft storey checck is ok

5.13 WEAK STOREY CHECK:

Fig 5.13.1 Shows weak storey in X-direction

Fig 5.13.2 Shows wak storey in y direction

From the figure it can be observed that story lateral strength is less than that of the story above hence the building is safe for weak storey effect in x and y direction.

5.14 MODE SHAPES:

5.14.1 1st mode: Time period : 2.196

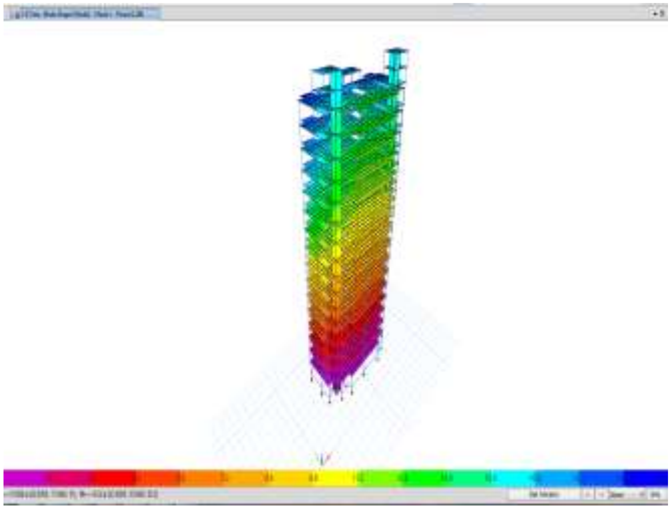

Fig 5.14.1 Shows 1st Mode of Time period 2.196

5.14.2: 2nd mode: Time period : 1.943

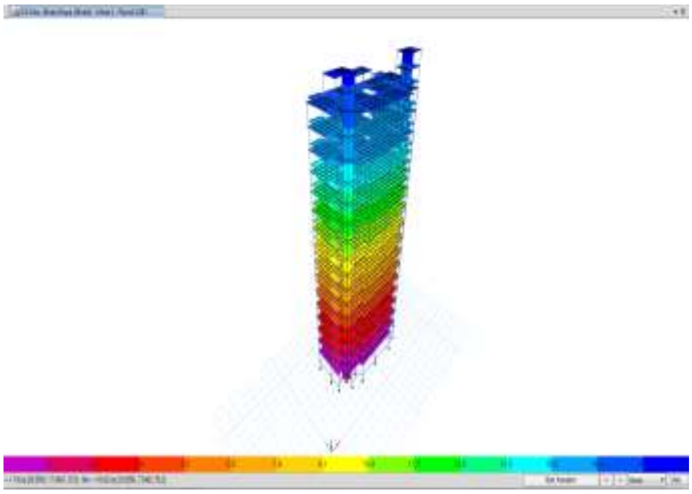

Fig 5.14.2 Shows 2nd Mode of Time period 1.943

5.14.3: 3rd mode: Time period : 1.69

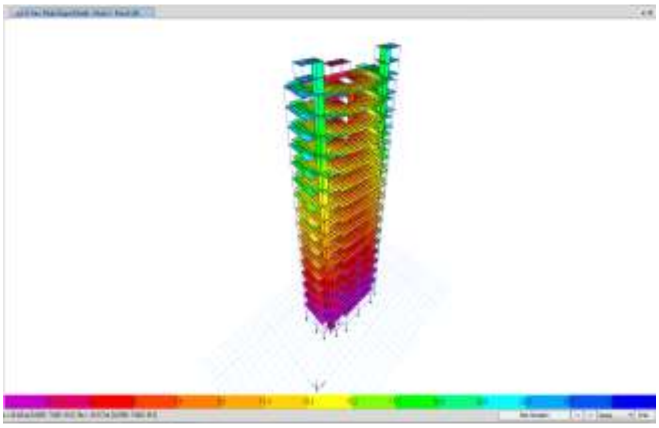

Fig 5.14.3 Shows 3rd Mode of Time period 1.69

5.15 COMPARATIVE ANALYSIS OF ZONE 2 AND ZONE 3:

5.15.1 BASE SHEAR

Table 5.15.1: Base Shear

BASE SHEAR							
Zone		Equivalent static		Response spectrum		Time history	
		X	Y	X	Y	X	Y
Zone 2	Max	1.096E-08	1.683E-08	472.0688	572.48	74.38	64.43
	Min	-1388.46	-1388.4	0	0	0	0
Zone 3	Max	1.739E-08	2.691E-08	755.3088	915.9787	74.38057	11828.87
	Min	-2221.5419	-2221.54	0	0	0	0

Conclusion:

- From the above obtained results, it is observed that the Base shear values of zone 2 are lesser compare to zone 3 for Equivalent static and response spectrum method but in the case of Time history analysis the response is similar pattern for both zone 2 and zone 3. Also the base shear is maximum for Dynamic analysis methods compare to Equivalent static case, hence it is as per IS1893:2002 (Part 1).
- Base shear is an estimate of maximum expected lateral force that will occur due seismic ground motion at the base of structure. Lower the base shear, safer will be the structure. Hence it is concluded that **zone 2** is low damage risk zone as compare to **zone3**.

5.15.2 STOREY DRIFT

Table 5.15.2: Storey Drift

STORY DRIFT							
Zone		Equivalent static		Response spectrum		Time history	
		X	Y	X	Y	X	Y
Zone 2	Max	0.000992	0.000758	0.000291	0.00023	0.000068	0.000141
	Min	0	0	0	0	0	0
Zone 3	Max	0.001587	0.001209	0.000465	0.000368	0.000068	0.000141
	Min	0	0	0	0	0	0

Conclusion:

- Maximum drift due to static earthquake load is 0.000992 and due to response spectrum is 0.000291, time history is 0.000068 for **zone 2** in this case static earthquake is more compared to dynamic earthquake. Hence the results are in good agreement within the permissible limit of IS 1893:2000 clause 7.11.1.
- Maximum drift due to static earthquake load is 0.001587 and due to response spectrum is 0.000465, time history is 0.000068 for **zone 3** in this case static earthquake is more compared to dynamic earthquake. Hence the results are in good agreement within the permissible limit of IS 1893:2000 clause 7.11.1.
- From the above obtained results, it is observed that the storey Drift values of zone 2 are lesser compare to zone 3 for Equivalent static and response spectrum method but in the case of Time history analysis the response is similar pattern for both zone 2 and zone 3. The storey drift should be low for stable building, hence it is concluded that **zone 2** is low damage risk zone as compare to **zone3.**

5.15.3 STOREY DISPLACEMENT

Table 5.15.3: Storey Displacement

STOREY DISPLACEMENT							
Zone		Equivalent static		Response spectrum		Time history	
		X	Y	X	Y	X	Y
Zone 2	Max	40.781	33.6193	11.891408	10.1932	2.776	2.268
	Min	0	0	0	0	0	0
Zone 3	Max	65.254	53.79089	19.0265	16.30922	2.7763	0.45996
	Min	0	0	0	0	0	0

Conclusion:

- If the structure is stiff then it will displace less but if a structure is flexible it will displace much more. From above obtained results from analysis, it concludes that zone 2 has lower storey displacement in both static and dynamic analysis, as compared to zone 3. Hence zone 2 is stiff and zone 3 is flexible in behaviour.
- Maximum displacement due to static earthquake load is 40.78mm and due to response spectrum is 11.891mm in this case static earthquake is more compared to dynamic earthquake for **zone 2**. Hence the high rise building is safe from displacement criterion for a period of 50 years.

5.15.4 STOREY STIFFNESS

Table 5.15.4: Storey Stiffness

STOREY STIFFNESS							
Zone		Equivalent static		Response spectrum		Time history	
		X	Y	X	Y	X	Y
Zone 2	Max	5766168	7524731	5914678	802821	0.00	0.00
	Min	0	0	0	0	0	0
Zone 3	Max	5766168	7524731	5914678	8028212	0.00	0.00
	Min	0	0	0	0	0	0

Conclusion:

- Stiffness is a measure of how much force is required to displace a building by certain amount. From above results, Story stiffness is more for the dynamic earthquake loads compared to static earthquake loads; hence building is stiffer for dynamic loads.
- Also from above results the Story Stiffness is same for both zone 2 and zone 3.

6. CONCLUSION:

- In the present study of comparative analysis is carried out for seismic (static & dynamic) loadings for zone 2 and zone 3. Wind load static analysis is only limited and dynamic analysis is not in a scope of work.
- Maximum deflection for zone2 and zone3 due to equivalent static load is more compared to dynamic earthquake loads, hence the dynamic effects due to earthquake loads shall be considered. The obtained deflection results are within permissible limit according to IS 456:2000 clause 23.2
- Base Shear is for zone2 and zone3 maximum for static earthquake case compared to dynamic earthquake; According to IS 1893: 2000 clause 7.8.2 Dynamic analyses may be performed either by the (Time History Method or by the Response Spectrum Method). However, in either method, the dynamic design base shear shall be compared with a static base shear calculated using a fundamental period T, Before doing dynamic analysis base shear shall be matched.
- Maximum drift due to static earthquake load is 0.000992 and due to response spectrum is 0.000291, time history is 0.000068 for zone 2 in this case static earthquake is more compared to dynamic earthquake. Hence the results are in good agreement within the permissible limit of IS 1893:2000 clause 7.11.1.
- Maximum drift due to static earthquake load is 0.001587 and due to response spectrum is 0.000465, time history is 0.000068 for zone 3 in this case static earthquake is more compared to dynamic earthquake. Hence the results are in good agreement within the permissible limit of IS 1893:2000 clause 7.11.1.
- Maximum displacement due to static earthquake load is 40.78mm and due to response spectrum is 11.89mm in this case static earthquake is more compared to dynamic earthquake. Hence the high rise building is safe from displacement criterion for a period of 50 years

- Storey stiffness is more for the dynamic earthquake loads compared to static earthquake loads; hence building is stiffer for dynamic loads.
- As Time History is realistic method, used for seismic analysis, it provides a better check to the safety of structures analyzed and designed by method specified by IS code. In our study time history is not governing.
- Soft storey and weak storey check are in good agreement with is 1893:2002 hence there is no soft storey and weak storey in our building.
- Mode shapes are in good agreement with the standard mode shapes.

It is beneficial if design and analysis is carried out for dynamic earthquake loads so meet the serviceable life of the structure.

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