COMPARATIVE ANALYSIS AND DESIGN OF SEISMIC BEHAVIOUR OF SYMMETRIC AND UNSYMMETRIC STRUCTURE FIXED WITH RUBBER BASE ISOLATED SYSTEM

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***ABSTARCT**: Base isolation has become one of the reliable tools for earthquake resistant design of thestructure. Researchers have done various important researches on the base isolation system, which has been fully accepted in the engineering field. Nowadays, a full-scale test is being done on the shake table to test the different features of different isolators. The present review essence literature and theoretical aspect available on base isolation system. Some of the research papers also deal with the effectiveness of variously available isolator and their applicability. It is stated in this review paper that its main objective is to focus on the background of different isolators and also to provide the useful guideline for making suitable choices between a large numbers of available isolators. The main objective of the present paper is isolated buildings, the design for base isolation system is regarded as the dominant factor of the success of isolated buildings In this thesis totally eight models (8) models and are compared with symmetrical(i.e rectangle building) and unsymmetrical buildings (i.e I shaped buildings, L shaped buildings and S shaped buildings) with fixed supports at base and with rubber isolator at the base by using commercial software by ETABS and compared for the storey displacement, storey shear, story moments, storey over turning moments, are compared .*

Keywords : storey drifts, storey shear , storey moments , storey moments , ETABS etc

I.INTRODUCTION

The earthquake resistant structures can be categorized into rigid structures and flexible structures. In rigid structures, the control methods that are applied to withstand extreme loads are basically reducing the interstory displacement with the help of diagonal bracing, the installation of shear walls and the use of composite materials. In flexible structures, such as base-isolated buildings, the key control approach is to reduce the excitation input with the use of dampers and isolators. The control strategies of rigid structures were preferred to be earthquake hazard mitigation alternatives due to long-lasting established knowledge and the maturity of technologies pertinent to structural stiffening. However, significant interstory drift and floor accelerations of highly stiffening structures raise risks of severe devastation of the building, especially under large scale of earthquake. Flexible structures such as high-rise buildings can avoid resonant condition and effectively reduce structural responses.In the last few years, using base isolation systems as a mean of a seismic design of structures has attracted considerable attention. Different designs for base isolators have special features in common, the most important of which are the horizontal flexibility and the energy dissipation capacity. Base isolation can greatly reduce earthquake intensity and losses, which directly reduces the shaking intensity and damage that permanent equipment and building contents experience during earthquake ground shaking. Base Isolation is one of the passive energy dissipation techniques for earthquake resistant designs of a structure. It is useful to controlling energy, which is passing from foundation or ground to the upper stories. Base isolation is an anti-seismic design strategy that can reduce the effect of earthquake ground motion by uncoupling the superstructure from the foundation. The structure can be decoupled from the horizontal components of the ground motion by interposing structural elements with low horizontal stiffness between the foundation and superstructure. the performance of base-isolated buildings, subjected to a large scale earthquake has proven to be excellent as predicted. Hence, engineers have devoted tome and research to this topic and the isolation system technologies have been well developed and established in terms of theory, design and construction phases

BASE ISOLATIONS

Base isolation has to be the most effective device and primary option to reduce ductility demand of structural subjected to earthquake in seismic zones The base isolation system is considerably effective to employ on structural building that located on relatively firm soil that the structural building typically have short natural period and make the building vulnerable to seismic excitation

There are two major types of base isolation, namely, elastomeric and sliding. Both systems are designed to take the weight of the building and let the foundations move sideways during an earthquake. This paper deals with the laminated rubber bearing isolator, which falls under the first category. . A layer of rubber with much lower horizontal stiffness is introduced between superstructure and the foundation. After the isolation, the system has a natural period much longer than the fixed base natural period. A typical low damping natural rubber bearing isolator.

Principle of Base Isolation

The basic principle behind base isolation is that the response of the structure or a building is modified such that the ground below is capable of moving without transmitting minimal or no motion to the structure above. A complete separation is possible only in an ideal system. In a real world scenario, it is necessary to have a vertical support to transfer the vertical loads to the base.

The relative displacement of ground and the structure is zero for a perfectly rigid, zero period structure, since the acceleration induced in the structure is same as that of ground motion. Whereas in an ideal flexible structure, there is no acceleration induced in the structure, thus relative displacement of the structure will be equal to the ground displacement.

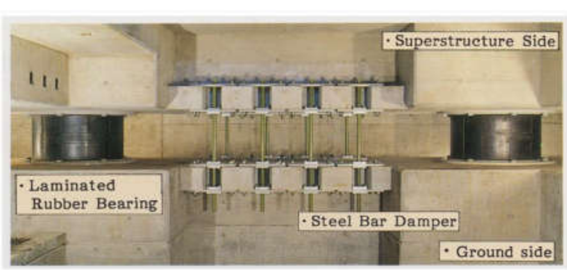
Basic requirements of an isolation system are

- Flexibility
- Damping
- Resistance to Vertical or other service loads.

Type of Base Isolation Systems

Elastomeric Rubber Bearings

Bearings formed of horizontal layers of synthetic or natural rubber in thin layers bound between steel plates. These bearings are capable of supporting high vertical loads with very small deformations. These bearings are flexible under lateral loads. Steel plates prevent the rubber layers from bulging.



Elastomeric Rubber Bearings

Roller and Ball Bearings

For isolation applications in machinery isolation, roller and ball bearing are used. It includes cylindrical rollers and balls. It is sufficient to resist service movements and damping depending on the material used.

Springs

Steel springs are most likely used in mechanical applications as in roller bearings. It is not adopted in structural applications because it is flexible in both vertical and horizontal directions. This will increase service deflections.

Sliding Bearing

Sliding systems with a predefined coefficient of friction can provide isolation by limiting acceleration and forces that are transferred. Sliders are capable of providing resistance under service conditions, flexibility and force-displacements by sliding movement. Shaped or spherical sliders are often preferred over flat sliding systems because of their restoring effect. Flat sliders provide no restoring force and there are possibilities of displacement with aftershocks.

OBJECTIVE OF THE STUDY

- The material is stiff under low service loads like¬ wind and small tremors.
- Period of vibration of the system is increased sufficiently so as to reduce the seismic force response.
- It should have the ability to with stand the large displacement and pulse-type base motions from near fault earthquakes.
- It should have a parallel damping mechanism such¬ that the relative deflection between the building and the ground is reduced
- Dynamic analysis was performed for the moment resisting frame with base isolation and the results were compared with the results obtained for moment resisting frame without base isolation
- The isolating elastomer is a rubber and its total stiffness is calculated to be 3169 kN/m. The spectral displacement for the first mode suffered by the isolated building was calculated using the response spectrum curve, and found to be 0.121 m/sec2 . The thickness of required rubber material is calculated to be 0.121 m, assuming 100% maximum shear strain.

SUMMARY

High seismicity at many locations in the world causes the application of massive structures which induce large inertial forces. This results in severe damage, partial or total demolition of all types of structures. Conventional aseismic design is based on the concept of increasing capacity of resistance of ductile structures using vertical elements and other stiffeners. By applying the base isolation in combination with a system for dissipation of energy, seismic protection of building is enabled without using an optional external energy, with relatively long service life of the system. The paper presents the basic concepts of the base isolation system, a description of the method of designing mentioned system in order to reduce the damage and ensure adequate performance of the structure. In addition it provides a wide review of the literature in the field of base isolation of buildings.

II.LITERATURE REVIEW

Kelly (1990) illustrated through a linearised theory of base isolation the effect of superstructure flexibility using two degrees of freedom system.Fan and Ahmadi (1990) observed that use of base-isolation system eliminates the resonance peak of the floor spectra, which occurs at the natural frequency of the fixed base system for earthquake' ground excitation. In their study they had modeled the superstructure as a shear type building.

Koh and Kelly (1990) presented a fraction Kelvin model to define the force-deformation relation of elastomeric bearings: An efficient numerical integration scheme is presented for the solution of the equation of motion for a base isolated system. The numerical examples reveal a good performance of the algorithm developed. In addition, a shaking table test indicated that the fractional derivative model agrees well with the experimental model.

Lin Su et al (1991) In this paper Lin Su, Goodarz Ahmadi and Iradj G. Tadjbakhsh, discussed the analysis on a new combination of base isolator obtained after combining the properties of electricity de France (EDF) base isolator and resilient base isolator(R-FB1) device, and new isolator formed which named sliding resilient base isolation system (SR-F). For these isolator response spectra, a curve is generated and compared with that which is finding by EDF and R-FB1 isolator system. Whatever results are received, they are compared with fixed base system. For various conditions and various earthquake records, we found Base shear, spectral acceleration, and spectral displacement. Different results obtained from this different earthquake records were then compared with SR-F new proposed isolator. Peak response of all earthquakes for EDF and R-FB1 were recorded and obtained results are compared to the SRF system. Therefore, maximum responses almost ended without large base displacement and the peak response of this isolator was also not too much serious in frequency and amplitude content.

III.METHODOLOGY

Statement of the Project

L No	Anatomical details	Type of location
1	Utility of Edifices	Office Building
2	No of Storey	G+21
3	Area	2308 sq.mts
4	Height of Building	63.5 mts
5	Shape of the Building	Rectangle, I shaped, S shaped, L shaped, building
6	Types of Walls	SHEAR Wall -230 mm thickness Masonry wall – 230 mm thickness
7	Story to story height	3.0 mts
	Beam	0.230X0.450 mts
	Columns (Inner)	0.45X0.55 mts
	Slab	0.150 mts
8	**Material Details** Concrete Grade All Steel Grades	M40 (All structural elements) FE 415 (All structural elements)
9	Type Of Construction	R.C.C FRAMED STRUCTURE
10	Place of construction	Bhuj - Gujurat.
11	Load s considered in building	Dead load , Live load , Earthquake ,Wind load
12	Wind Speed	50 m/s (Bhuj wind speed)
13	Seismic Zone	Zone – V (Bhuj)
14	Method of Analysis	RESPONSE SPECTRUM ANALYSIS EQUIVALENT STATIC ANALYSIS
15	NON Ductile properties	5 (Response reduction factor)
16	STATIC COMBINATION	1.2(Dead load + Live load + Earthquake in X direction)
17	IS codes used	IS456 :2000,IS1893:2002,IS 16700:2017,IS 875:1987 (Part 1, Part 2, Part 3)

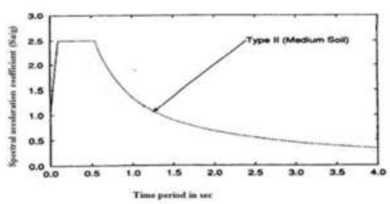
Rubber isolater	
Effective stiffness LINEAR U1	800
Effective stiffness NON LINEAR	2500
YEILD STRENGHT NON LINEAR	80
POST YEILD STIFFNESS RATIO	0.1

Fundamentals of isolation

The fundamental principle of base isolation is to modify the response of the building so that the ground can move below the building without transmitting these motions into the building[1].The building must behave like a rigid body such that all the points in the building move in the same direction and by same amount as the ground. This method of base isolation works by interposing structural elements with low horizontal stiffness between the structure and the foundation. This gives a fundamental frequency that is much less than both its fixed base frequency and the predominant frequencies of the ground motion. . The first dynamic mode of the isolated structure involves deformation only in the isolation system, the structure above being to be rigid. The higher modes that are orthogonal to the first mode, do not participate the motion and thus ground motion cannot be transmitted into the structure[3].The natural period of the fixed-base structure undergo a jump and the new base-isolation structure has a new natural period.

RESPONSE SPECTRUM ANALYSIS

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002 (part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 9.7.4 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).



Response Spectrum Analysis Graph for Medium type of soil

LOADS ON THE STRUCTURE

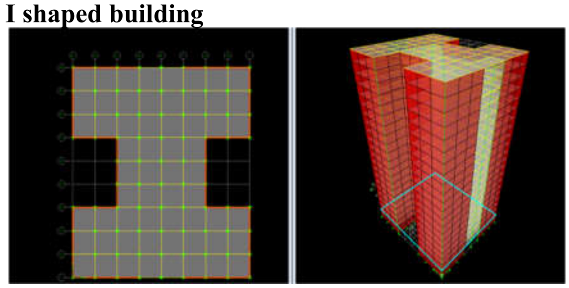
The types of loads acting on structures for buildings and other structures can be broadly classified as vertical loads, horizontal loads and longitudinal loads. The vertical loads consist of dead loads, live load and impact load. The horizontal loads comprises of wind load and earthquake load. The longitudinal loads i.e. tractive and braking forces are considered in special case of design of bridges, gantry girders etc.In a construction of building two major factors considered are safety and economy. If the loads are adjusted and taken higher then economy is affected. If economy is considered and loads are taken lesser then the safety is compromised.So the estimation of various loads acting is too calculated precisely. Indian Standard code IS: 875-1987 and American Standard Code ASCE 7: Minimum Design Loads for Buildings and Other Structures specifies various design loads for buildings and structures.

Types of loads acting on the structure are:

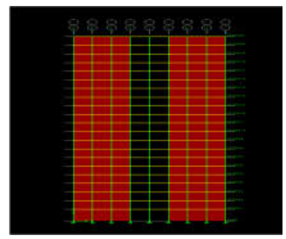
- Dead loads
- Imposed loads
- Wind loads
- Snow loads
- Earthquake loads
- Special loads

MODELS IN ETABS

I shaped building



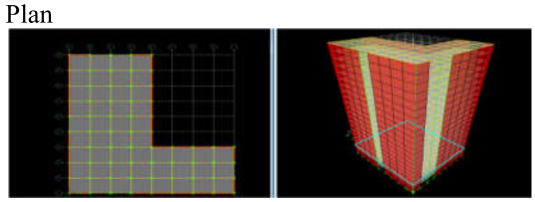
Elevation



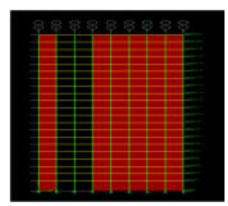
I-Shaped Plan and Elevation Fitted with rubber isolator

L shaped building

Plan



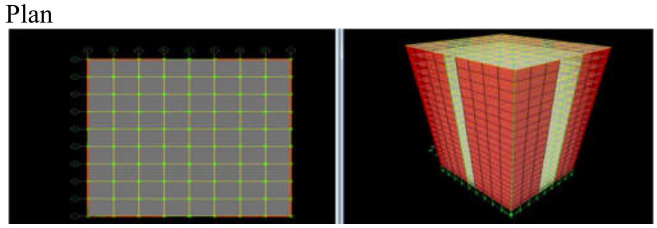
Elevation



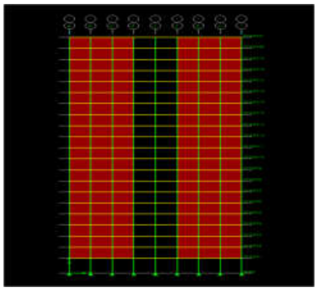
L-Shaped Plan and Elevation Fitted with rubber isolator

Rectangle shaped building

Plan



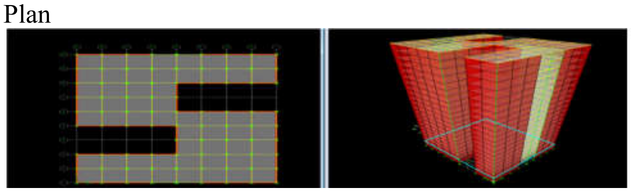
Elevation



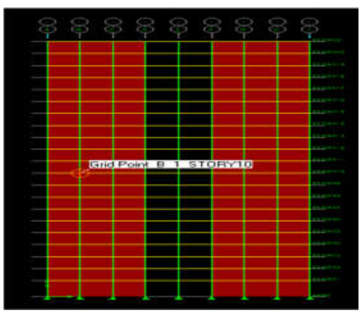
Rectangular-Shaped Plan and Elevation Fitted with rubber isolator

S shaped building

Plan



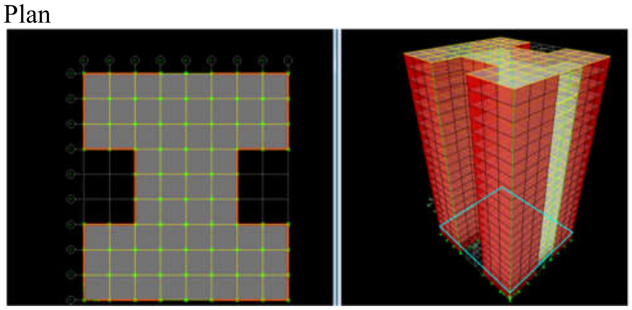
Plan



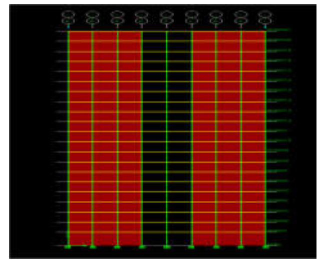
S-Shaped Plan and Elevation Fitted with rubber isolator

I shaped builidIng

Plan



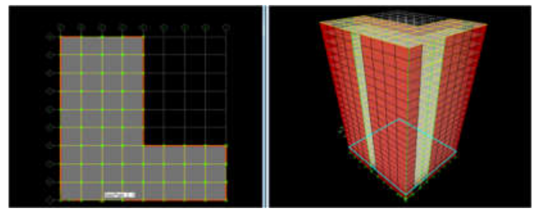
Elevation



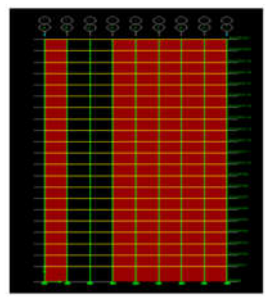
I-Shaped Plan and Elevation Fitted without rubber isolator

L shaped building

Plan



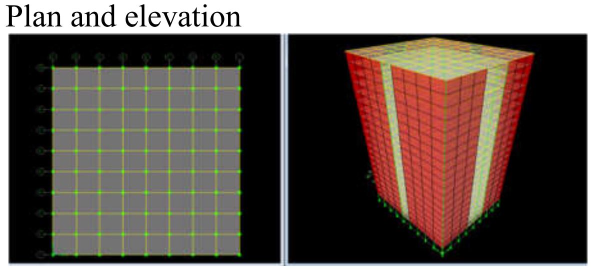
Elevation

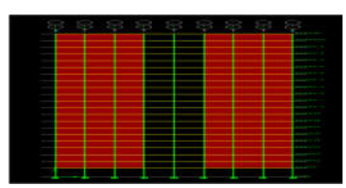


L-Shaped Plan and Elevation Fitted without rubber isolator

Rectangle shaped building

Plan and elevation

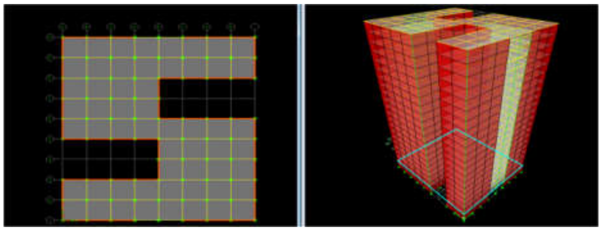




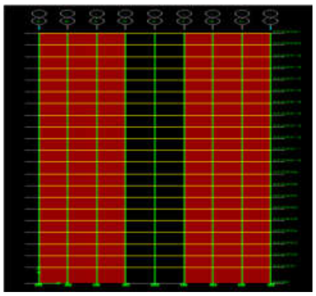
Rectangular-Shaped Plan and Elevation Fitted without rubber isolator

S shaped building

Plan



Elevation



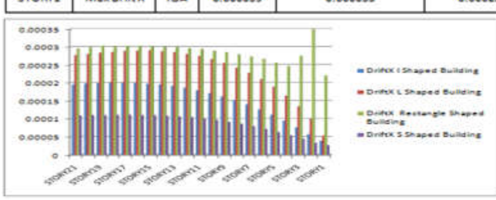
S-Shaped Plan and Elevation Fitted without rubber isolator

IV.RESSULTS AND ANLYSIS

A. STRUCTURE WITH FIXED SUPPORTS AT BASE

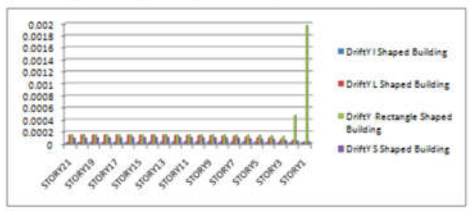
DRIFT IN X DIRECTION

Story	Item	Load	Drift X I Shaped Building	Drift X L Shaped Building	Drift X Rectangle Shaped Building	Drift X S Shaped Building
STORY21	Max Drift X	RSA	0.000195	0.000277	0.000295	0.000109
STORY20	Max Drift X	RSA	0.000198	0.00028	0.000299	0.00011
STORY19	Max Drift X	RSA	0.000199	0.000283	0.000302	0.00011
STORY18	Max Drift X	RSA	0.0002	0.000286	0.000301	0.000111
STORY17	Max Drift X	RSA	0.0002	0.000288	0.000302	0.000111
STORY16	Max Drift X	RSA	0.000199	0.000289	0.000302	0.00011
STORY15	Max Drift X	RSA	0.000197	0.00029	0.000301	0.00011
STORY14	Max Drift X	RSA	0.000195	0.000288	0.0003	0.000108
STORY13	Max Drift X	RSA	0.000191	0.000285	0.000299	0.000106
STORY12	Max Drift X	RSA	0.000186	0.00028	0.000296	0.000104
STORY11	Max Drift X	RSA	0.000179	0.000274	0.000293	0.0001
STORY10	Max Drift X	RSA	0.000171	0.000266	0.000289	0.000096
STORY9	Max Drift X	RSA	0.000162	0.000255	0.000285	0.000091
STORY8	Max Drift X	RSA	0.000152	0.000242	0.000279	0.000086
STORY7	Max Drift X	RSA	0.00014	0.000227	0.000273	0.000079
STORY6	Max Drift X	RSA	0.000126	0.00021	0.000266	0.000072
STORY5	Max Drift X	RSA	0.000111	0.000189	0.000255	0.000063
STORY4	Max Drift X	RSA	0.000094	0.000164	0.000246	0.000054
STORY3	Max Drift X	RSA	0.000076	0.000134	0.000275	0.000044
STORY2	Max Drift X	RSA	0.000057	0.0001	0.000349	0.000033
STORY1	Max Drift X	RSA	0.000039	0.000053	0.00022	0.000026



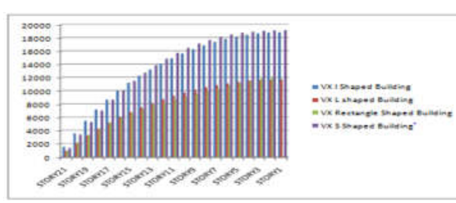
DRIFT IN Y DITRECTION

Story	Item	Load	Drifty I Shaped Building	Drifty L Shaped Building	Drifty Rectangle Shaped Building	Drifty S Shaped Building
STORY21	Max Drift Y	RSA	0.000024	0.00015	0.000154	0.000097
STORY20	Max Drift Y	RSA	0.000028	0.000151	0.000156	0.000099
STORY19	Max Drift Y	RSA	0.00003	0.000152	0.000156	0.000101
STORY18	Max Drift Y	RSA	0.000031	0.000152	0.000157	0.000103
STORY17	Max Drift Y	RSA	0.000033	0.000152	0.000157	0.000105
STORY16	Max Drift Y	RSA	0.000035	0.000152	0.000157	0.000107
STORY15	Max Drift Y	RSA	0.000036	0.000151	0.000158	0.000108
STORY14	Max Drift Y	RSA	0.000037	0.000149	0.000158	0.000109
STORY13	Max Drift Y	RSA	0.000039	0.000149	0.000157	0.000109
STORY12	Max Drift Y	RSA	0.00004	0.000147	0.000157	0.000108
STORY11	Max Drift Y	RSA	0.00004	0.000145	0.000156	0.000107
STORY10	Max Drift Y	RSA	0.000041	0.000142	0.000155	0.000104
STORY9	Max Drift Y	RSA	0.000041	0.000138	0.000154	0.000101
STORY8	Max Drift Y	RSA	0.000041	0.000133	0.000152	0.000098
STORY7	Max Drift Y	RSA	0.000041	0.000126	0.00015	0.000093
STORY6	Max Drift Y	RSA	0.00004	0.000119	0.000149	0.000087
STORY5	Max Drift Y	RSA	0.000038	0.000109	0.000147	0.00008
STORY4	Max Drift Y	RSA	0.000036	0.000096	0.000135	0.000072
STORY3	Max Drift Y	RSA	0.000032	0.00008	0.000129	0.000062
STORY2	Max Drift Y	RSA	0.000027	0.000062	0.000475	0.000051
STORY1	Max Drift Y	RSA	0.000025	0.000037	0.001968	0.000035



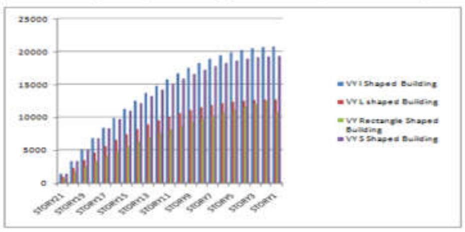
SHEAR FORCE IN X DIRECTION

Story	Load	Loc	VX I Shaped Building	VX L shaped Building	VX Rectangle Shaped Building	VX S Shaped Building
STORY21	RSA	Bottom	1526.24	885.46	991.72	1381.77
STORY20	RSA	Bottom	3594.32	2094.23	2236.88	3383.22
STORY19	RSA	Bottom	5467.49	3210.63	3353.21	5259.62
STORY18	RSA	Bottom	7151.88	4235.11	4343.95	7009.86
STORY17	RSA	Bottom	8658.18	5171.1	5216.58	8633.26
STORY16	RSA	Bottom	10000.81	6023.42	5981.05	10129.48
STORY15	RSA	Bottom	11197.17	6797.95	6649.71	11498.67
STORY14	RSA	Bottom	12266.2	7501.23	7237.05	12741.57
STORY13	RSA	Bottom	13226.67	8139.8	7759.11	13859.57
STORY12	RSA	Bottom	14095.39	8719.6	8232.34	14854.78
STORY11	RSA	Bottom	14885.66	9245.34	8672.46	15730.05
STORY10	RSA	Bottom	15606.21	9720.15	9093.07	16489.07
STORY9	RSA	Bottom	16260.88	10145.43	9504.45	17136.38
STORY8	RSA	Bottom	16849.15	10521.06	9912.71	17677.45
STORY7	RSA	Bottom	17367.26	10845.81	10319.41	18118.67
STORY6	RSA	Bottom	17809.92	11118.06	10721.79	18467.4
STORY5	RSA	Bottom	18172.16	11336.6	11113.66	18732.02
STORY4	RSA	Bottom	18451.22	11501.54	11487.37	18921.92
STORY3	RSA	Bottom	18648.09	11615.2	11833.64	19047.54
STORY2	RSA	Bottom	18768.8	11682.78	12120.69	19120.42
STORY1	RSA	Bottom	18830.84	11715.54	130.99	19156.61



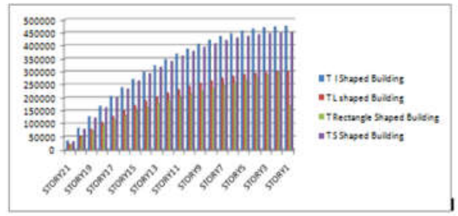
SHEAR FORCE IN Y DIRECTION

Story	Load	Loc	VY I Shaped Building	VY L shaped Building	VY Rectangle Shaped Building	VY Bu
STORY21	RSA	Bottom	1364.59	942.88	688.13	
STORY20	RSA	Bottom	3277.99	2237.11	1598.34	
STORY19	RSA	Bottom	5087.14	3442.14	2467.12	
STORY18	RSA	Bottom	6787.57	4557.53	3295.27	
STORY17	RSA	Bottom	8378.3	5584.74	4083.91	
STORY16	RSA	Bottom	9860.23	6526.33	4834.34	
STORY15	RSA	Bottom	11236.06	7385.89	5548.08	
STORY14	RSA	Bottom	12509.86	8167.74	6226.88	
STORY13	RSA	Bottom	13686.42	8876.56	6872.74	
STORY12	RSA	Bottom	14770.39	9516.92	7487.81	
STORY11	RSA	Bottom	15765.57	10092.86	8074.45	
STORY10	RSA	Bottom	16674.21	10607.55	8635.11	
STORY9	RSA	Bottom	17496.73	11063.14	9172.33	
STORY8	RSA	Bottom	18231.7	11460.79	9688.7	
STORY7	RSA	Bottom	18876.25	11800.93	10186.75	
STORY6	RSA	Bottom	19426.84	12083.74	10668.96	
STORY5	RSA	Bottom	19880.32	12309.66	11137.64	
STORY4	RSA	Bottom	20235.16	12480.15	11594.98	
STORY3	RSA	Bottom	20492.65	12598.37	12044.03	
STORY2	RSA	Bottom	20658.3	12669.81	12487.97	
STORY1	RSA	Bottom	20749.67	12705.79	10741.23	



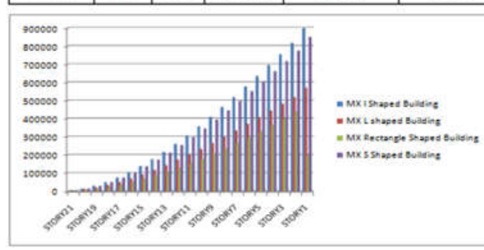
BUILDING TORSION

Story	Load	Loc	T I Shaped Building	T L shaped Building	T Rectangle Shaped Building
STORY21	RSA	Bottom	35091.36	21520.38	20973.21
STORY20	RSA	Bottom	83285.37	51750.59	47698.61
STORY19	RSA	Bottom	127711.6	79703.39	72119.62
STORY18	RSA	Bottom	168422.9	105368.6	94306.32
STORY17	RSA	Bottom	205568	128822.9	114396.5
STORY16	RSA	Bottom	239362.5	150187.3	132564.5
STORY15	RSA	Bottom	270077.1	169622	149019.4
STORY14	RSA	Bottom	298013.5	187314.9	163998.9
STORY13	RSA	Bottom	323474.2	203463	177758.4
STORY12	RSA	Bottom	346731.2	218249.8	190554.9
STORY11	RSA	Bottom	367998	231823.7	202630
STORY10	RSA	Bottom	387410.4	244278.6	214192.1
STORY9	RSA	Bottom	405020.4	255645	225402.1
STORY8	RSA	Bottom	420802.3	265891.5	236363.6
STORY7	RSA	Bottom	434673.9	274938	247119.2
STORY6	RSA	Bottom	446525.9	282676.7	257654.1
STORY5	RSA	Bottom	456258.6	289003.3	267907.5
STORY4	RSA	Bottom	463818.3	293850.9	277799.4
STORY3	RSA	Bottom	469232	297226	287239.3
STORY2	RSA	Bottom	472638.5	299238.2	295841.6
STORY1	RSA	Bottom	474459.5	300208	171875.9



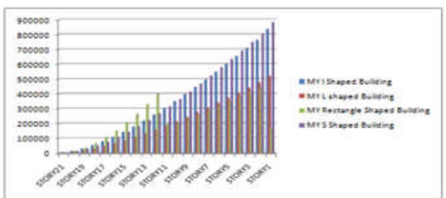
BUILDING MOMENT IN X DIRECTION

Story	Load	Loc	MX I Shaped Building	MX L shaped Building	MX Rectangle Shaped Building	MX S Shaped Building
STORY21	RSA	Bottom	4093.764	2828.649	2064.394	4075.345
STORY20	RSA	Bottom	13926.68	9539.528	6859.08	14000.57
STORY19	RSA	Bottom	29184.11	19863.9	14259.17	29343.56
STORY18	RSA	Bottom	49535.73	33530.25	24141.61	49668.73
STORY17	RSA	Bottom	74645.53	50269.83	36386.13	74551
STORY16	RSA	Bottom	104176.9	69819.7	50875.63	103582.5
STORY15	RSA	Bottom	137798	91925.73	67496.79	136378.6
STORY14	RSA	Bottom	175186.4	116345.2	86140.65	172582
STORY13	RSA	Bottom	216032.1	142848.6	106703.2	211864.8
STORY12	RSA	Bottom	260039.4	171220.1	129086	253927.6
STORY11	RSA	Bottom	306926.3	201257.9	153196.4	298496.4
STORY10	RSA	Bottom	356422.4	232772.2	178948.5	345317.9
STORY9	RSA	Bottom	408266	265584.4	206262.9	394153.6
STORY8	RSA	Bottom	462199.8	299524.4	235067.1	444773.8
STORY7	RSA	Bottom	517967.9	334429.2	265295.7	496952.7
STORY6	RSA	Bottom	575312.4	370141.3	296890.4	550465.4
STORY5	RSA	Bottom	633973.6	406509	329799.7	605086.9
STORY4	RSA	Bottom	693691	443386.9	363978.9	660594.7
STORY3	RSA	Bottom	754208.8	480639.2	399392	716773.6
STORY2	RSA	Bottom	815283.6	518143.5	436013	773423.2
STORY1	RSA	Bottom	897215.8	568371.3	197887.2	849396.4



BUILDING MOMENT IN Y DIRECTION

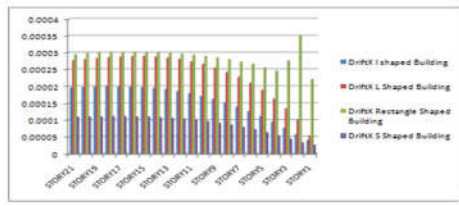
Story	Load	Loc	MY I Shaped Building	MY L shaped Building	MY Rectangle Shaped Building	MY S Shaped Building
STORY21	RSA	Bottom	4578.735	2656.376	2064.394	4145.324
STORY20	RSA	Bottom	15359.83	8938.32	14259.17	14294.96
STORY19	RSA	Bottom	31754.1	18566.81	36386.13	30073.74
STORY18	RSA	Bottom	53185.94	31262.22	67496.79	51103.15
STORY17	RSA	Bottom	79105.7	46752.8	106703.2	77002.57
STORY16	RSA	Bottom	108999.9	64778.57	153196.4	107390.3
STORY15	RSA	Bottom	142400	85094.63	206262.9	141885.3
STORY14	RSA	Bottom	178888.3	107473.6	265295.7	180108.4
STORY13	RSA	Bottom	218100.7	131706.9	329799.7	221684.9
STORY12	RSA	Bottom	259724.4	157604.5	399392	266246.2
STORY11	RSA	Bottom	303493.7	184993.2	197887.2	313432.5
STORY10	RSA	Bottom	349180.8	213713.9	206045.2	362895
STORY9	RSA	Bottom	396586.6	243618.3	233178.6	414298.6
STORY8	RSA	Bottom	445529.6	274564.8	261182.1	467324.7
STORY7	RSA	Bottom	495836.3	306415.7	290036.5	521673.9
STORY6	RSA	Bottom	547334.5	339035	319734.3	577068.9
STORY5	RSA	Bottom	599848.7	372287.7	350270	633257.6
STORY4	RSA	Bottom	653200.5	406040.7	381631.1	690016.1
STORY3	RSA	Bottom	707212.3	440167	413791.7	747151.8
STORY2	RSA	Bottom	761715.5	474550.3	446697.1	804506.6
STORY1	RSA	Bottom	834903.9	520632.6	171921.3	881125.3



B.STRUCTURE WITH RUBBER BASE ISOLATION

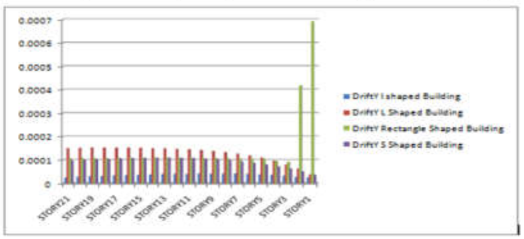
DRIFT IN X DIRECTION

Story	Item	Load	Drift X I shaped Building	Drift X L Shaped Building	Drift X Rectangle Shaped Building	Drift X S Shaped Building
STORY21	Max Drift X	RSA	0.000196	0.000277	0.000295	0.000109
STORY20	Max Drift X	RSA	0.000198	0.00028	0.000299	0.00011
STORY19	Max Drift X	RSA	0.000199	0.000283	0.000301	0.00011
STORY18	Max Drift X	RSA	0.0002	0.000286	0.000301	0.000111
STORY17	Max Drift X	RSA	0.0002	0.000288	0.000302	0.000111
STORY16	Max Drift X	RSA	0.000199	0.000289	0.000302	0.00011
STORY15	Max Drift X	RSA	0.000197	0.00029	0.000301	0.00011
STORY14	Max Drift X	RSA	0.000195	0.000288	0.0003	0.000108
STORY13	Max Drift X	RSA	0.000191	0.000285	0.000299	0.000106
STORY12	Max Drift X	RSA	0.000186	0.000281	0.000296	0.000104
STORY11	Max Drift X	RSA	0.000179	0.000274	0.000293	0.0001
STORY10	Max Drift X	RSA	0.000171	0.000266	0.000289	0.000096
STORY9	Max Drift X	RSA	0.000162	0.000255	0.000285	0.000091
STORY8	Max Drift X	RSA	0.000152	0.000242	0.000279	0.000086
STORY7	Max Drift X	RSA	0.00014	0.000227	0.000273	0.000079
STORY6	Max Drift X	RSA	0.000126	0.00021	0.000266	0.000072
STORY5	Max Drift X	RSA	0.000111	0.000189	0.000255	0.000063
STORY4	Max Drift X	RSA	0.000094	0.000164	0.000246	0.000054
STORY3	Max Drift X	RSA	0.000076	0.000134	0.000276	0.000044
STORY2	Max Drift X	RSA	0.000058	0.000101	0.000352	0.000033
STORY1	Max Drift X	RSA	0.00004	0.000054	0.000221	0.000026



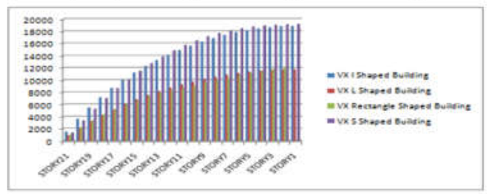
DRIFT IN Y DIRECTION

Story	Item	Load	Drift Y I shaped Building	Drift Y L Shaped Building	Drift Y Rectangle Shaped Building
STORY21	Max Drift Y	RSA	0.000024	0.00015	0.000106
STORY20	Max Drift Y	RSA	0.000028	0.000151	0.000107
STORY19	Max Drift Y	RSA	0.00003	0.000152	0.000107
STORY18	Max Drift Y	RSA	0.000031	0.000152	0.000107
STORY17	Max Drift Y	RSA	0.000033	0.000152	0.000108
STORY16	Max Drift Y	RSA	0.000035	0.000152	0.000108
STORY15	Max Drift Y	RSA	0.000036	0.000151	0.000108
STORY14	Max Drift Y	RSA	0.000037	0.000149	0.000108
STORY13	Max Drift Y	RSA	0.000039	0.000149	0.000108
STORY12	Max Drift Y	RSA	0.00004	0.000147	0.000108
STORY11	Max Drift Y	RSA	0.00004	0.000145	0.000108
STORY10	Max Drift Y	RSA	0.000041	0.000142	0.000107
STORY9	Max Drift Y	RSA	0.000041	0.000138	0.000107
STORY8	Max Drift Y	RSA	0.000041	0.000133	0.000106
STORY7	Max Drift Y	RSA	0.000041	0.000127	0.000105
STORY6	Max Drift Y	RSA	0.00004	0.000119	0.000105
STORY5	Max Drift Y	RSA	0.000038	0.000109	0.000104
STORY4	Max Drift Y	RSA	0.000036	0.000096	0.000095
STORY3	Max Drift Y	RSA	0.000032	0.00008	0.000092
STORY2	Max Drift Y	RSA	0.000027	0.000062	0.000417
STORY1	Max Drift Y	RSA	0.000025	0.000038	0.000692



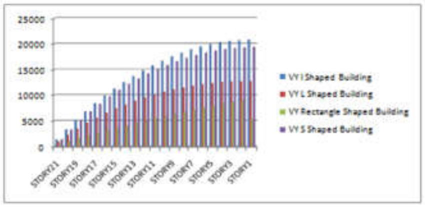
SHEAR FORCE IN X DIRECTION

Story	Item	Loc	VX I Shaped Building	VX L Shaped Building	VX Rectangle Shaped Building	VX S Shaped Building
STORY21	RSA	Bottom	1526.79	885.64	990.95	1382.02
STORY20	RSA	Bottom	3595.53	2094.63	2235.34	3383.86
STORY19	RSA	Bottom	5469.23	3211.19	3351.22	5260.67
STORY18	RSA	Bottom	7154.01	4235.79	4341.81	7011.36
STORY17	RSA	Bottom	8660.58	5171.87	5214.56	8635.22
STORY16	RSA	Bottom	10003.39	6024.27	5979.32	10131.91
STORY15	RSA	Bottom	11199.84	6798.86	6648.36	11501.6
STORY14	RSA	Bottom	12268.91	7502.19	7236.11	12745.02
STORY13	RSA	Bottom	13229.42	8140.83	7758.46	13863.56
STORY12	RSA	Bottom	14098.22	8720.74	8231.83	14859.32
STORY11	RSA	Bottom	14888.63	9246.66	8671.86	15735.16
STORY10	RSA	Bottom	15609.44	9721.72	9092.18	16494.77
STORY9	RSA	Bottom	16264.53	10147.38	9503.13	17142.69
STORY8	RSA	Bottom	16853.39	10523.5	9910.93	17684.37
STORY7	RSA	Bottom	17372.28	10848.88	10317.3	18126.21
STORY6	RSA	Bottom	17815.9	11121.88	10719.65	18475.56
STORY5	RSA	Bottom	18179.28	11341.28	11111.95	18740.81
STORY4	RSA	Bottom	18459.61	11507.15	11486.7	18931.34
STORY3	RSA	Bottom	18657.82	11621.71	11834.71	19057.58
STORY2	RSA	Bottom	18779.73	11690.26	12123.9	19131.01
STORY1	RSA	Bottom	18844.34	11725.6	145.93	19168.43



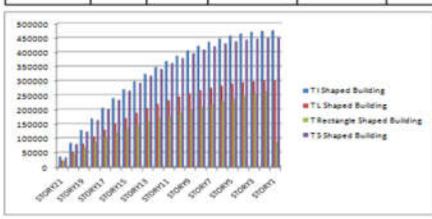
SHEAR FORCE IN Y DIRECTION

Story	Item	Loc	VY I Shaped Building	VY L Shaped Building	VY Rectangle Shaped Building	VY S Shaped Building
STORY21	RSA	Bottom	1364.97	943.15	419.14	1358.95
STORY20	RSA	Bottom	3278.95	2237.72	982.94	3310.24
STORY19	RSA	Bottom	5088.69	3443.06	1531.06	5118.53
STORY18	RSA	Bottom	6789.73	4558.69	2063.9	6783.88
STORY17	RSA	Bottom	8381.1	5586.09	2581.99	8311.13
STORY16	RSA	Bottom	9863.67	6527.85	3085.89	9707.54
STORY15	RSA	Bottom	11240.16	7387.55	3576.22	10982.23
STORY14	RSA	Bottom	12514.65	8169.55	4053.69	12145.39
STORY13	RSA	Bottom	13691.92	8878.54	4519.04	13207.14
STORY12	RSA	Bottom	14776.67	9519.11	4973.07	14176.42
STORY11	RSA	Bottom	15772.7	10095.33	5416.62	15060.05
STORY10	RSA	Bottom	16682.31	10610.38	5850.56	15862.21
STORY9	RSA	Bottom	17505.94	11066.44	6275.77	16584.3
STORY8	RSA	Bottom	18242.19	11464.67	6693.13	17225.33
STORY7	RSA	Bottom	18888.21	11805.51	7103.49	17782.73
STORY6	RSA	Bottom	19440.48	12089.11	7507.67	18253.52
STORY5	RSA	Bottom	19895.82	12315.89	7906.44	18635.55
STORY4	RSA	Bottom	20252.67	12487.3	8300.52	18928.82
STORY3	RSA	Bottom	20512.23	12606.41	8691.1	19136.5
STORY2	RSA	Bottom	20679.74	12678.69	9080.05	19265.89
STORY1	RSA	Bottom	20775.8	12716.63	5319.63	19337.49



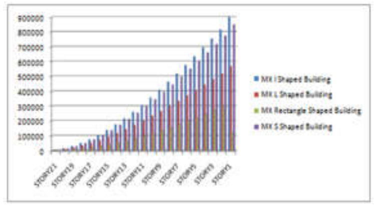
BUILDINING TORSION

Story	Item	Loc	T I Shaped Building	T L Shaped Building	T Rectangle Shaped Building	T S Shaped Builc
STORY21	RSA	Bottom	35102.77	21523.33	19056.04	32421.05
STORY20	RSA	Bottom	83311.91	51757.49	43200.37	79115.21
STORY19	RSA	Bottom	127751.5	79713.21	65106.24	122536.6
STORY18	RSA	Bottom	168474.5	105380.5	84842.72	162689
STORY17	RSA	Bottom	205630	128836.3	102551.1	199636
STORY16	RSA	Bottom	239433.8	150202	118412.5	233475.5
STORY15	RSA	Bottom	270156.9	169637.5	132646.5	264333.6
STORY14	RSA	Bottom	298101.4	187330.7	145505.1	292355.1
STORY13	RSA	Bottom	323570.5	203479.2	157260.1	317690.8
STORY12	RSA	Bottom	346837.1	218267.2	168185.7	340484.6
STORY11	RSA	Bottom	368115.3	231843.8	178539	360863.7
STORY10	RSA	Bottom	387542	244304	188539.2	378931.6
STORY9	RSA	Bottom	405169.7	255679.6	198350.6	394767.5
STORY8	RSA	Bottom	420973.7	265940	208071.5	408430.7
STORY7	RSA	Bottom	434872	275004.8	217730.1	419970.3
STORY6	RSA	Bottom	446755.3	282766.2	227289.7	429439.3
STORY5	RSA	Bottom	456523.5	289119.4	236662.5	436910.3
STORY4	RSA	Bottom	464122.2	293996.1	245739.7	442492.2
STORY3	RSA	Bottom	469576.3	297399.6	254394.5	446343.2
STORY2	RSA	Bottom	473019.3	299441.8	262165.8	448682.9
STORY1	RSA	Bottom	474925.7	300489.4	85154.57	449942.3



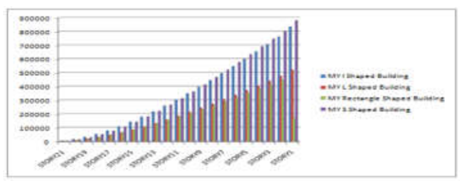
STOREY MOMNT IN X DIRECTION

Story	Item	Loc	MX I Shaped Building	MX L Shaped Building	MX Rectangle Shaped Building	MX S Shaped Building
STORY21	RSA	Bottom	4094.896	2829.439	1257.416	4076.846
STORY20	RSA	Bottom	13930.68	9542.167	4206.072	14005.87
STORY19	RSA	Bottom	29192.75	19869.28	8798.629	29354.97
STORY18	RSA	Bottom	49550.84	33539.08	14988.76	49688.57
STORY17	RSA	Bottom	74669.03	50282.68	22731.43	74581.57
STORY16	RSA	Bottom	104210.7	69837.01	31983.05	103626.1
STORY15	RSA	Bottom	137844.2	91947.88	42701.62	136437.5
STORY14	RSA	Bottom	175246.8	116372.5	54846.93	172658.5
STORY13	RSA	Bottom	216109	142881.5	68380.7	211961.1
STORY12	RSA	Bottom	260135	171259	83266.78	254045.7
STORY11	RSA	Bottom	307042.8	201303.2	99471.21	298638.6
STORY10	RSA	Bottom	356562.6	232824.8	116962.4	345486.3
STORY9	RSA	Bottom	408432.7	265645.2	135711.2	394350.4
STORY8	RSA	Bottom	462396.3	299594.6	155690.9	445001.5
STORY7	RSA	Bottom	518197.9	334510.4	176877.3	497214.1
STORY6	RSA	Bottom	575580.2	370235.3	199248.5	550763.5
STORY5	RSA	Bottom	634283.9	406617.9	222785.2	605425.2
STORY4	RSA	Bottom	694049.1	443513.1	247470.1	660976.9
STORY3	RSA	Bottom	754620.1	480785.2	273289.8	717203.6
STORY2	RSA	Bottom	815753.4	518311.7	300236.4	773904.9
STORY1	RSA	Bottom	897779.8	568576.1	123459.4	849961.6



STOREY MOMNT IN Y DIRECTION

Story	Item	Loc	MY I Shaped Building	MY L Shaped Building	MY Rectangle Shaped Building	MY S Shaped Building
STORY21	RSA	Bottom	4580.376	2656.922	2972.843	4146.059
STORY20	RSA	Bottom	15365.11	8940.064	9677.611	14297.62
STORY19	RSA	Bottom	31764.58	18570.24	19725.74	30079.57
STORY18	RSA	Bottom	53202.78	31267.67	32734.97	51113.47
STORY17	RSA	Bottom	79129.68	46760.52	48340.91	77018.75
STORY16	RSA	Bottom	109031.5	64788.77	66202.97	107413.8
STORY15	RSA	Bottom	142439.3	85107.41	86010.23	141917.6
STORY14	RSA	Bottom	178935.4	107489	107487.2	180151
STORY13	RSA	Bottom	218155.2	131725	130398.1	221739.5
STORY12	RSA	Bottom	259786.3	157625.4	154549.9	266314.4
STORY11	RSA	Bottom	303562.8	185017.2	179792.7	313516.1
STORY10	RSA	Bottom	349257.2	213741.4	206017.5	362995.7
STORY9	RSA	Bottom	396670.6	243649.8	233152.8	414418.2
STORY8	RSA	Bottom	445621.9	274601.3	261157	467465.1
STORY7	RSA	Bottom	495938.3	306458.6	290010.4	521836.9
STORY6	RSA	Bottom	547447.7	339085.8	319705.4	577256.4
STORY5	RSA	Bottom	599975.3	372348.5	350236.9	633471.4
STORY4	RSA	Bottom	653343.2	406113.9	381593.1	690258.2
STORY3	RSA	Bottom	707374.2	440254.9	413749.2	747423.9
STORY2	RSA	Bottom	761899.6	474655.5	446652	804810.4
STORY1	RSA	Bottom	835125.3	520769.3	171417.8	881476.4



V.CONCLUSIONS

- The characteristics and type of base isolation system plays a vital role on the performance of structure during the effect of earthquake.
- So there arises a need to design a system that puts this concept into practice. Along with many other engineers doing independent work in other countries, have produced a wealth of information about base isolators and have become common knowledge to structural engineers.
- The other factors like mass asymmetry, interlaying ground condition, geometry of structure and height of super structure also defines the response of structure during

shocks. The effect of soil structure interaction is the widest area of research.

- Based on the above literature survey it is clear that the performance of fixed base and isolated base structure is depends on the type of underlying soil on which the structure rests.
- By introducing base isolators the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure is considerably reduced. This concept has created a breakthrough in structural design and as years go by will prove to be a life-saving innovation of historic proportions
- All the design procedures are related directly to different types of structural control. In order to reach the optimal design, it is crucial to understand all possible control schemes and they can further be implemented to the design.
- Based on the above study it is clear that the performance of fixed base and isolated base structure depends on the type of underlying soil on which the structure rests.
- the efficiency of isolators is good. The response of the structure is different because of the different types of changes due to the changes in physical properties of an isolator.
- By comparing the with and without base isolators the base iasolators shows less deflection and shear momnts\\

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