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Comparative analysis and Design of Seismic behaviour of Symmetric and Unsymmetric structure fixed with Rubber base isolated system

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KEYWORDS

Base isolation, Seismic analysis, Rubber Bearing Isolator, ETABS, Response spectrum analysis, Storey drift, Storey shear, Symmetric and Unsymmetric buildings.

ABSTRACT

Base isolation has become one of the most effective seismic protection techniques for enhancing the earthquake resistance of structures. By introducing flexible isolation devices between the foundation and the superstructure, seismic energy transmitted from the ground to the building can be significantly reduced. Over the past few decades, extensive experimental and analytical research has demonstrated the effectiveness of various base isolation systems, particularly elastometric rubber bearings, in minimizing structural damage and improving the overall seismic performance of buildings. Continuous advancements in shake-table testing and numerical simulation have further contributed to the development and optimization of these isolation systems for practical engineering applications.

The structural models are developed and analysed using ETABS software by adopting Response spectrum analysis in accordance with the relevant IS codes. Important seismic response parameters, including storey displacement, storey drift, storey shear, base shear, torsional response, and storey moments, are evaluated and compared for all models.

I. INTRODUCTION

Earthquakes are one of the most hazardous natural events, often causing extensive destruction to buildings, infrastructure, and human life. The ability of a structure to with stand seismic forces determines its overall earthquake performance. Based on their structural behaviour during seismic excitation, buildings are generally classified into two categories i.e., conventional fixed-base structures and base-isolated structures. Conventional buildings resist earthquake loads by increasing their strength and stiffness through components such as shear walls, bracing systems, and reinforced structural members. These elements improve the building's capacity to resist lateral forces and reduce excessive deformation.Base isolation is a passive structural control technique developed to reduce the adverse effects of earthquake forces on buildings. The principal objective of this method is to isolate the superstructure from ground motion through specially designed bearings installed between the foundation and the building. This technique is particularly beneficial in regions with high seismic activity where conventional strengthening methods may not provide sufficient protection.Earthquake and wind loads are the primary lateral forces considered in structural engineering design. Unlike wind forces, earthquake loading is highly unpredictable and cannot be controlled, making seismic design one of the most challenging aspects of civil engineering. The intensity of earthquake-induced inertia forces mainly depends on the structural mass and the ground acceleration generated during seismic events.

A perfectly rigid structure, having an extremely short natural period, responds almost identically to ground motion. Such behaviour results in very small relative displacement but generates large acceleration forces, which may cause severe structural damage. In contrast, a highly flexible structure experiences much lower acceleration because it is less influenced by ground motion. However, this flexibility leads to greater relative displacement between the structure and the ground. Since actual buildings possess a combination of stiffness and flexibility, their seismic behaviour lies between these two theoretical conditions.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss related work. In Section 3 shares information about the flexible ETABS software work and its results. Section 4 tells us about the methodology and the process description. Section 5 tells us about the future scope and concludes the paper with acknowledgement and references.

OBJECTIVES

To evaluate the seismic behaviour of buildings with conventional fixed-base supports and compare it with buildings provided with rubber base isolation systems.

To study the influence of base isolation on important structural response parameters such as storey displacement, storey drift, storey shear, base shear, and storey moments.

To investigate the seismic performance of both symmetric and unsymmetric building configurations under earthquake loading.

II.LITERATURE REVIEW

The introduction of the isolation layer increases the natural period of vibration of the structure, shifting it away from the predominant frequencies of earthquake ground motion. As a result, the seismic forces transferred to the superstructure are considerably reduced. During an earthquake, most of the deformation occurs within the isolation system, while the superstructure behaves almost like a rigid body with significantly lower storey drift, floor acceleration, and internal structural forces. Higher vibration modes have only a minor influence on the structural response because the isolation system effectively filters out high-frequency ground motion.

The concept of a **flexible first storey** was later introduced by **Martel (1929)** and further investigated by **Green (1935)** and **Jacobsen (1938)**. Their studies proposed reducing the lateral stiffness of the first storey so that earthquake-induced deformation would be concentrated at the lower level, thereby protecting the upper portion of the structure. Although this concept demonstrated potential, practical implementation presented several engineering challenges.

Y. Li and J. Li (2014) developed an innovative smart base isolation system featuring variable stiffness and controllable damping characteristics. Recognizing the limitations of conventional passive rubber bearings under extreme earthquakes, the researchers proposed an adaptive isolation device capable of modifying its mechanical properties according to the intensity of seismic excitation. Experimental testing and dynamic analysis confirmed that the smart isolator significantly improved structural performance under varying earthquake conditions.

M. K. Shrimali et al. (2015) reviewed the growing application of seismic control devices for reducing earthquake vulnerability, particularly in adjacent buildings susceptible to pounding effects. Their study compared passive damping devices with conventional base isolation systems and concluded that hybrid seismic control strategies generally provide superior performance compared with semi-active control techniques. The research also emphasized the importance of selecting appropriate control devices based on structural characteristics and seismic demand.

There are numerous works that have been done related to image processing machine learning algorithms.

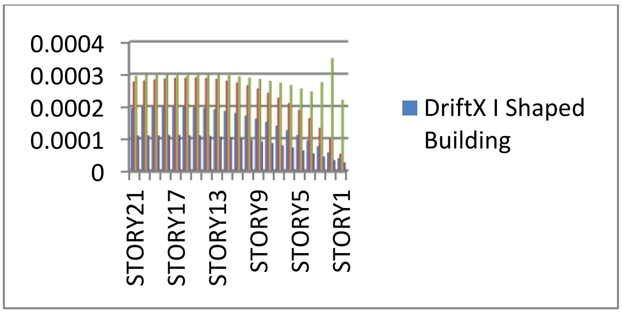
III. RESULTS AND ANALYSIS

STRUCTURE WITH FIXED SUPPORTS AT BASE

Table No. 3.1:DRIFT IN X DIRECTION

Story	Item	Load	DriftX I Shaped Building	DriftX L Shaped Building	DriftX Rectangle Shaped Building	DriftX 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	Ma	RS	0.00014	0.000227	0.000273	0.000079

	Max Drift X	RSA				
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

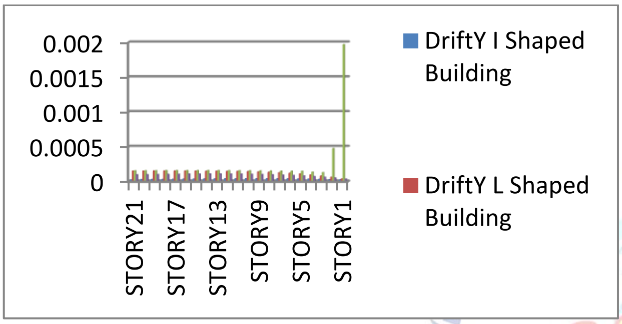


Graph No. 3.1: Drift In X Direction

Table No. 3.2:DRIFT IN Y DIRECTION

Story	Item	Load	Drift Y 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

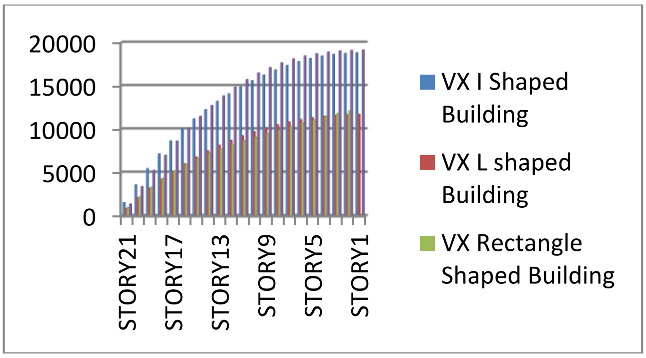


Graph No. 3.2: Drift In Y Direction

Table No. 3.3.: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	Botto	18768.8	11682.78	12120.69	19120.42

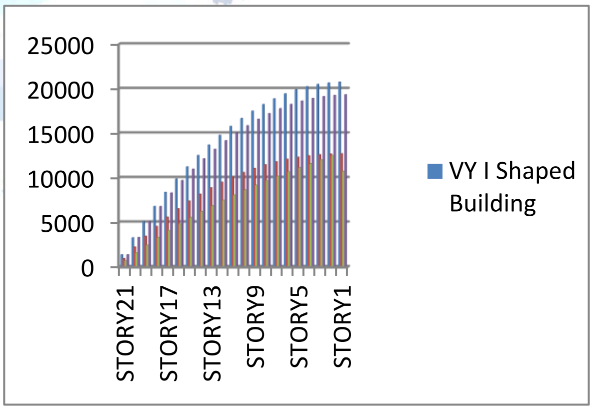
Story1	RSA	Bottom	18830.84	11715.54	130.99	19156.61



Graph No. 3.3: Shear Force In X Direction

Table No. 3.4:SHEAR FORCE IN Y DIRECTION

Story	Load	Loc	VY I Shaped Building	VY L shaped Building	VY Rectangle Shaped Building	VY S Shaped Building
Story21	RSA	Bottom	1364.59	942.88	688.13	1358.45
Story20	RSA	Bottom	3277.99	2237.11	1598.34	3308.97
Story19	RSA	Bottom	5087.14	3442.14	2467.12	5116.49
Story18	RSA	Bottom	6787.57	4557.53	3295.27	6781.07
Story17	RSA	Bottom	8378.3	5584.74	4083.91	8307.56
Story16	RSA	Bottom	9860.23	6526.33	4834.34	9703.2
Story15	RSA	Bottom	11236.06	7385.89	5548.08	10977.14
Story14	RSA	Bottom	12509.86	8167.74	6226.88	12139.55
Story13	RSA	Bottom	13686.42	8876.56	6872.74	13200.57
Story12	RSA	Bottom	14770.39	9516.92	7487.81	14169.1
Story11	RSA	Bottom	15765.57	10092.86	8074.45	15051.97
Story10	RSA	Bottom	16674.21	10607.55	8635.11	15853.32
Story9	RSA	Bottom	17496.73	11063.14	9172.33	16574.52
Story8	RSA	Bottom	18231.7	11460.79	9688.7	17214.55
Story7	RSA	Bottom	18876.25	11800.93	10186.75	17770.84
Story6	RSA	Bottom	19426.84	12083.74	10668.96	18240.35
Story5	RSA	Bottom	19880.32	12309.66	11137.64	18620.98
Story4	RSA	Bottom	20235.16	12480.15	11594.98	18912.73
Story3	RSA	Bottom	20492.65	12598.37	12044.03	19118.92
Story2	RSA	Bottom	20658.3	12669.81	12487.97	19246.83
Story1	RSA	Bottom	20749.67	12705.79	10741.23	19313.99

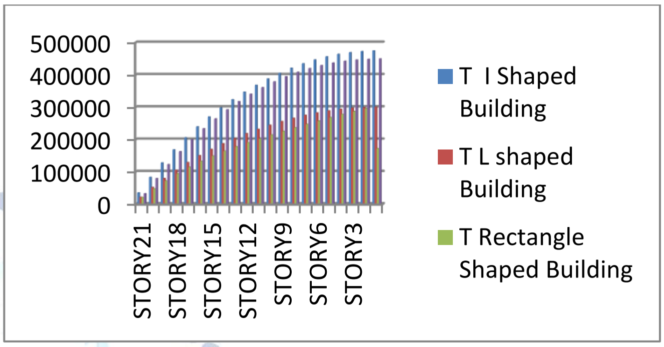


Graph No. 3.4: Shear Force InY Direction

Table No.3.5:BUILDING TORSION

Story	Load	Loc	T I Shaped Building	T L Shaped Building	T Rectangle Shaped Building	T S Shaped Building
Story21	RSA	Bottom	35091.36	21520.38	20973.21	32414.74

Story20	RSA	Bottom	83285.37	51750.59	47698.61	79098.98
Story19	RSA	Bottom	127711.6	79703.39	72119.62	122510.1
Story18	RSA	Bottom	168422.9	105368.6	94306.32	162651.6
Story17	RSA	Bottom	205568	128822.9	114396.5	199587.4
Story16	RSA	Bottom	239362.5	150187.3	132564.5	233415.3
Story15	RSA	Bottom	270077.1	169622	149019.4	264261.5
Story14	RSA	Bottom	298013.5	187314.9	163998.9	292270.9
Story13	RSA	Bottom	323474.2	203463	177758.4	317594.3
Story12	RSA	Bottom	346731.2	218249.8	190554.9	340375.5
Story11	RSA	Bottom	367998	231823.7	202630	360741.4
Story10	RSA	Bottom	387410.4	244278.6	214192.1	378795.4
Story9	RSA	Bottom	405020.4	255645	225402.1	394616.2
Story8	RSA	Bottom	420802.3	265891.5	236363.6	408262.9
Story7	RSA	Bottom	434673.9	274938	247119.2	419784.2
Story6	RSA	Bottom	446525.9	282676.7	257654.1	429233
Story5	RSA	Bottom	456258.6	289003.3	267907.5	436682
Story4	RSA	Bottom	463818.3	293850.9	277799.4	442240.3
Story3	RSA	Bottom	469232	297226	287239.3	446067.9
Story2	RSA	Bottom	472638.5	299238.2	295841.6	448385.2
Story1	RSA	Bottom	474459.5	300208	171875.9	449580.1



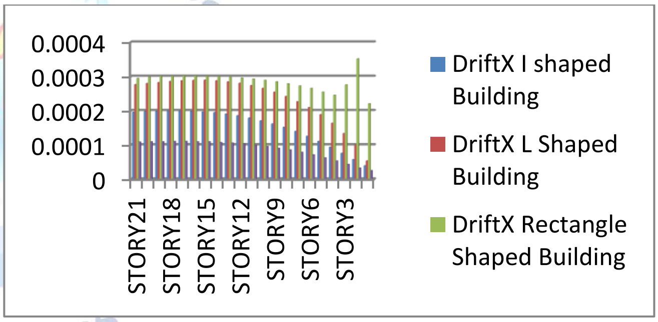
Graph No. 3.5: Building Torsion

STRUCTURE WITH RUBBER BASE ISOLATION

Table No. 3.6:DRIFT IN X DIRECTION

Story	Item	Load	DriftX I shaped Building	DriftX L Shaped Building	DriftX Rectangle Shaped Building	DriftX 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 Dr	RSA	0.0002	0.000288	0.000302	0.000111

	ift X				
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

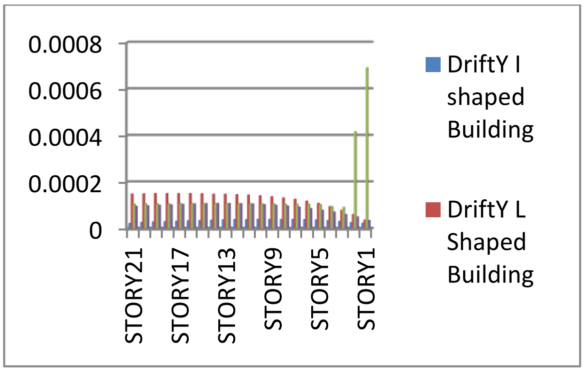


Graph No. 3.6: Drift In X Direction

Table No. 3.7:DRIFT IN Y DIRECTION

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	0.000106	0.000097
Story20	Max Dr	RSA	0.000028	0.000151	0.000107	0.000099

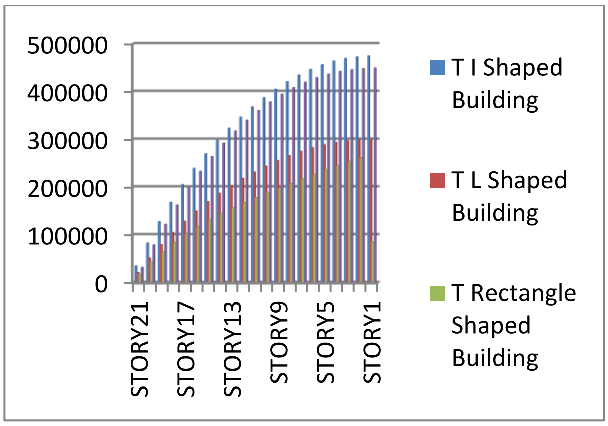
	ift Y					
Story19	Max Drift Y	RSA	0.00003	0.000152	0.000107	0.000101
Story18	Max Drift Y	RSA	0.000031	0.000152	0.000107	0.000103
Story17	Max Drift Y	RSA	0.000033	0.000152	0.000108	0.000105
Story16	Max Drift Y	RSA	0.000035	0.000152	0.000108	0.000107
Story15	Max Drift Y	RSA	0.000036	0.000151	0.000108	0.000108
Story14	Max Drift Y	RSA	0.000037	0.000149	0.000108	0.000109
Story13	Max Drift Y	RSA	0.000039	0.000149	0.000108	0.000109
Story12	Max Drift Y	RSA	0.00004	0.000147	0.000108	0.000108
Story11	Max Drift Y	RSA	0.00004	0.000145	0.000108	0.000107
Story10	Max Drift Y	RSA	0.000041	0.000142	0.000107	0.000104
Story9	Max Drift Y	RSA	0.000041	0.000138	0.000107	0.000101
Story8	Max Drift Y	RSA	0.000041	0.000133	0.000106	0.000098
Story7	Max Drift Y	RSA	0.000041	0.000127	0.000105	0.000093
Story6	Max Drift Y	RSA	0.00004	0.000119	0.000105	0.000087
Story5	Max Drift Y	RSA	0.000038	0.000109	0.000104	0.00008
Story4	Max Drift Y	RSA	0.000036	0.000096	0.000095	0.000072
Story3	Max Drift Y	RSA	0.000032	0.00008	0.000092	0.000062
Story2	Max Drift Y	RSA	0.000027	0.000062	0.000417	0.000051
Story1	Max Drift Y	RSA	0.000025	0.000038	0.000692	0.000036



Graph No. 3.7: Drift In Y Direction

Table No.3.8:BUILDING TORSION

Story	Item	Loc	T I Shaped Building	T L Shaped Building	T Rectangle Shaped Building	T S Shaped Building
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



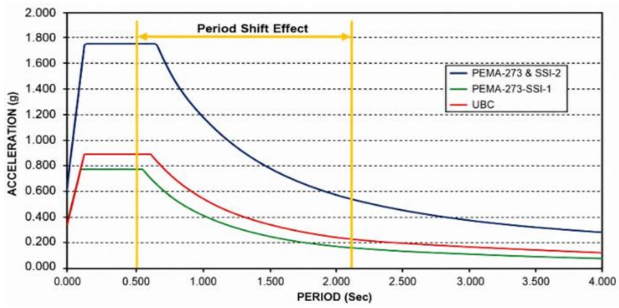
Graph No.4.8: Building Torsion

IV. METHODOLOGY

Seismic base isolation is an advanced earthquake-resistant design technique that minimizes the transmission of ground motion from the foundation to the superstructure. The primary objective of this method is to protect buildings from earthquake-induced damage by installing specially designed isolation devices between the foundation and the structural frame. These isolators possess high vertical stiffness to support gravity loads while providing low horizontal stiffness, allowing controlled lateral movement during seismic events.

CONCEPT AND DYNAMICS OF BASE ISOLATION

The basic principle of base isolation is to modify the dynamic response of a building so that earthquake induced ground motion is not directly transmitted to the superstructure. This is accomplished by introducing flexible isolation devices between the foundation and the building. During an earthquake, these devices allow the foundation to move with the ground while significantly reducing the motion transferred to the structure above.



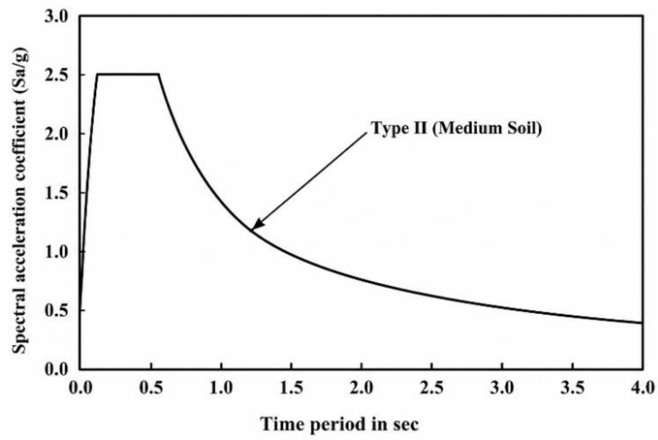
Response Spectrum Showing the Period Shift Effect

RESPONSE SPECTRUM ANALYSIS

In the present study, seismic analysis has been carried out in accordance with the recommendations of IS 1893

(Part 1):2002-Criteria for ERDS. The required seismic parameters, including the seismic zone factor, importance factor, response reduction factor, damping ratio, and soil classification, were selected as specified in the code. The standard design response spectrum corresponding to medium soil conditions was adopted for all analytical models developed in ETABS9.7.4.

Illustrates the standard design response spectrum for medium soil as prescribed in **IS 1893 (Part 1): 2002**, where the variation of spectral acceleration coefficient (**Sa/g**) with respect to the natural period (**T**) is presented.



Response Spectrum Analysis Graph for Medium type of soil

LOADS ON THE STRUCTURE

The major types of loads considered in structural design are:

Dead Loads (DL), Imposed or Live Loads (LL), Wind Loads (WL), Snow Loads, Earthquake Loads(EL), Special Loads.

INTRODUCTION TO ETABS

ETABS (Extended Three-Dimensional Analysis of Building Systems) is one of the most widely used structural engineering software packages for the analysis and design of buildings. Developed by computers and structures, Inc.(CSI), ETABS provides an integrated environment for modelling, analysis, design, and detailing of reinforced concrete, steel, and composite building structures.

The software combines advanced finite element analysis with user-friendly modelling tools, enabling engineers to perform comprehensive structural analysis efficiently. It supports both linear and nonlinear analysis methods and is capable of handling simple low-rise buildings as well as complex high-rise structures.

ETABS incorporates powerful analysis engines capable of performing:

1. Linear static analysis
2. Response spectrum analysis
3. Time-History analysis
4. Pushover analysis
5. Nonlinear statis and dynamic analysis
6. Buckling analysis
7. Construction sequence analysis
8. Creep and shrinkage analysis

Statement of the Project

SL 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	**Geometric Details** Ground Floor	3.5 mts
	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	Loads 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 Used	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)

MODELING DETAILS

Modeling Steps in ETABS

1) Open ETABS program.

2) Check the units of the model in the drop-down box in the lower right-hand corner of the ETABS window tap the drop-down box to set units to KN-m.

Fig.No.4.1:Units selection bar

1) Click the File menu > New model command

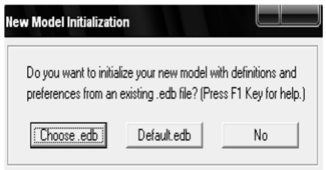


Fig.No. 4.2:New model Initialization Command

2) The next form of Building Plan Grid System and Story Data Definition will be displayed after you select NO button.

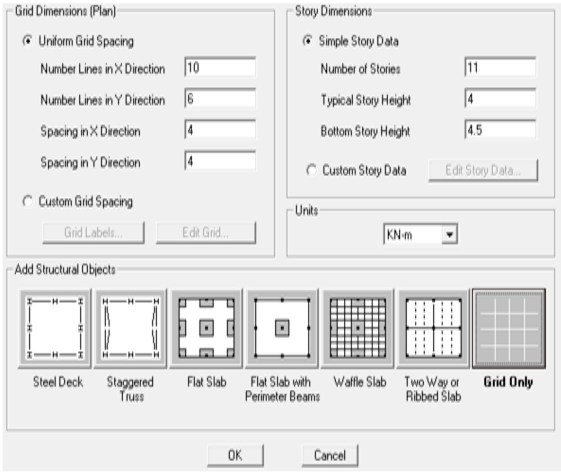
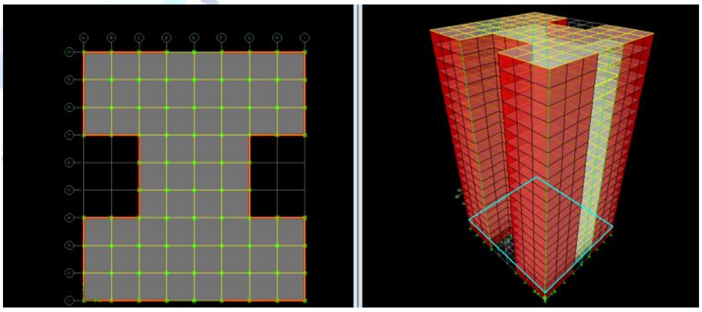


Fig.No. 4.3: Selection of Building plan Grid system & storey data

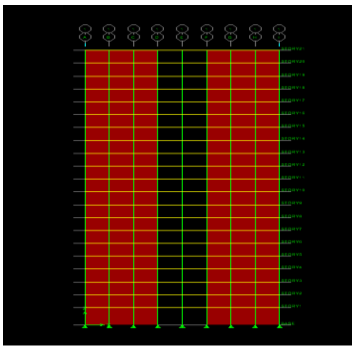
Models In ETABS

I shaped building

Plan



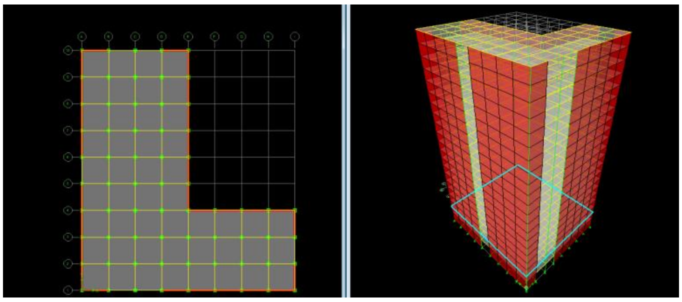
Elevation



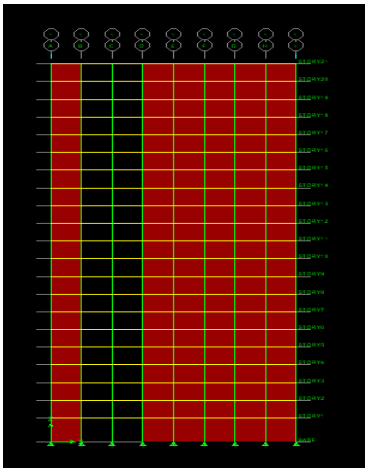
I-Shaped Plan and Elevation Fitted with rubber isolator

L shaped building

Plan



Elevation

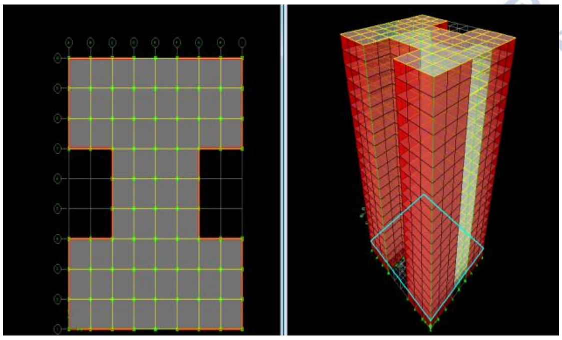


L-Shaped Plan and Elevation Fitted with rubber isolator

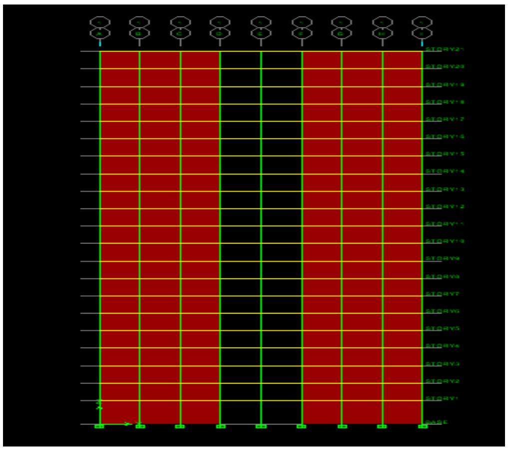
Without rubber isolator

I shaped building

Plan



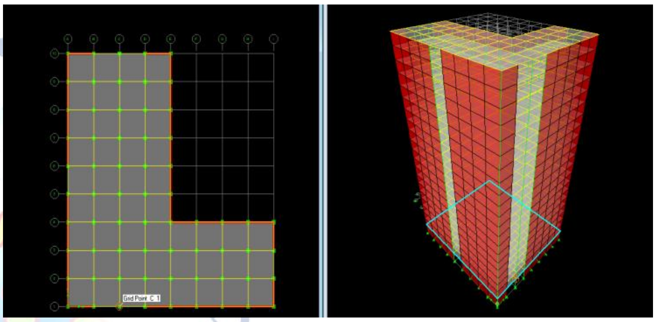
Elevation



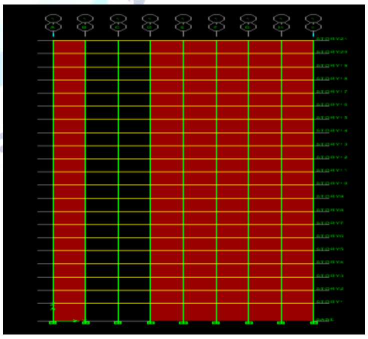
I-Shaped Plan and Elevation Fitted without rubber isolator

L shaped building

Plan



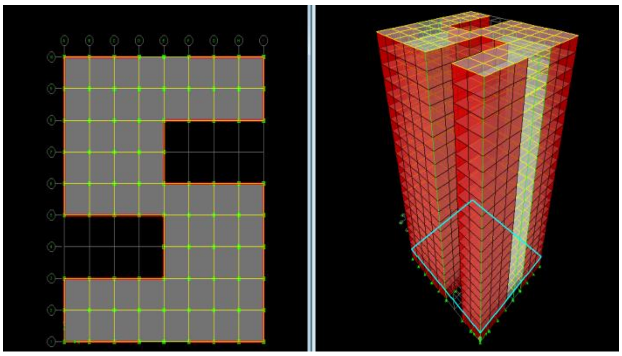
Elevation



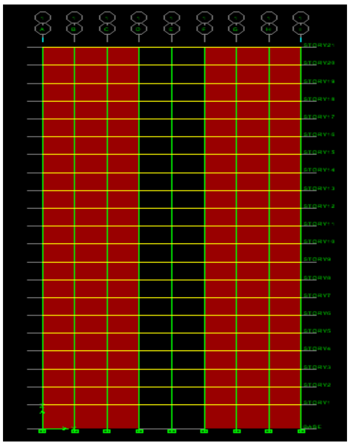
L-Shaped Plan and Elevation Fitted without rubber isolator

S shaped building

Plan



Elevation



S-Shaped Plan and Elevation Fitted without rubber isolator

V. FUTURE SCOPE AND CONCLUSION

This study presents a comparative seismic performance evaluation of symmetric and unsymmetric reinforced concrete buildings with fixed-base supports and rubber base isolation systems using ETABS. Based on the analytical results obtained from response spectrum analysis, the following conclusions are drawn:

1. The seismic behaviour of a building is significantly influenced by the type and characteristics of the base isolation system. Properly designed rubber base isolators effectively reduce the transmission of earthquake forces from the ground to the superstructure.
2. Base isolation technology has emerged as an efficient seismic protection technique that enhances the overall safety and serviceability of structures. Continuous research and advancements in isolation devices have made this technology increasingly reliable for earthquake-resistant construction.
3. Structural parameters such as plan irregularity, mass distribution, building geometry, height, and soil conditions have a considerable influence on the seismic response of buildings. These factors should be carefully considered during the structural design process.
4. The study confirms that the seismic performance of both fixed-base and base-isolated structures is strongly affected by the supporting soil conditions. Appropriate consideration of soil structure interaction can further improve the accuracy of seismic performance assessment.
5. The incorporation of rubber base isolators considerably reduces the seismic forces transferred to the structure. As a result, lateral displacements, storey shear, and bending moments are significantly lower compared to conventional fixed-base structures.

Overall, the study concludes that rubber base isolation systems provide superior seismic performance compared to conventional fixed-base structures. The adoption of base isolation technology offers an efficient and reliable approach for designing earthquake-resistant buildings, particularly in high seismic zones.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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