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International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

COMPARATIVE ANALYSIS OF DIA GRID STRUCTURAL SYSTEM WITH AND WITHOUT BASE ISOLATION

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ABSTRACT

In the present period, high-rise building construction is rapidly expanding around the globe. Architects and engineers have started building cities vertically because to the lack of easily available free land and the expansion of urban regions. Because of the system's triangulation's aesthetic potential and structural efficiency, the dia grid structural system has gained popularity lately for tall buildings. Dia grid architecture is more resistant to lateral loads than standard frame constructions with external vertical columns because it has slanted columns. In the dia grid system, lateral loads are resisted by the axial motion of the inclined columns positioned at the exterior edges of the buildings. An economical method of enhancing the seismic performance of buildings constructed in accordance with industry standards is to install seismic isolation and energy dissipation systems. By adjusting structural stiffness and damping, these strategies lessen seismic forces, while traditional seismic design requires more strength and ductility to resist seismic forces.

The current research uses ETABS software to analyse a 15-story dia grid building with varying dia grid member angles for both friction pendulum and rubber base isolation systems. Results for rubber base and friction pendulum models are compared, including time period, tale drift, story shear, story bending, and model stiffness.

Key words: time period, model stiffness, dia grid, ETABS, seismic isolation, tale drift, shear, and bending.

I. INTRODUCTION

General

The cutting-edge architectural layout movement was used to build a variety of intricately structured tall systems, such as twisted, slanted, tapering, and freeform towers. The structural device that resists gravity loads is subordinated to the lateral load-resisting device as the apex of a building rises. The most often used lateral load-resisting constructions are the inflexible frame, shear wall, wall-frame, braced tube device, outrigger device, and tubular device. The diagrid structural device is now well-known for tall metal structures due to its structural performance and the aesthetic options it provides via its unique geometric pattern. Another kind of area truss is called a digrid. It is constructed with triangulated truss structures that form a fringe grid.

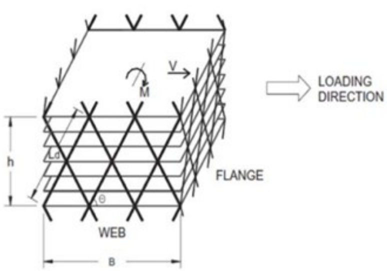
The diagonal and horizontal additions are crossed to create a digrid. The greatest examples of diagrid systems include the Capital Gate Tower in Abu Dhabi, the Hearst Tower in New York, the Cyclone Tower in Asan, South Korea, the Swiss Re in London, and the Jinling Tower in China. The new Central China Television (CCTV) headquarters in Beijing is one example of how a diagrid structural mechanism is used to maintain a traumatic form. Diagrid is easily recognisable and has a pleasant look. Seismic isolators and power dissipating devices are evidently effective solutions in this context. They can be placed inside the building as they should be to reduce seismic power, or they can be placed between the muse and

International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

vertical structural structures to reduce seismic power below the building's floor, thereby reducing the effects of lateral hundreds on pinnacle floors. The cost of such technologies will rise if earthquake safety features are included in systems that are being built or were built, especially in older structures.

Dia grid Structure

The Diagrid (diagonal grids) design is a structural solution for skyscrapers composed of a horizontal ring and straight or curved triangulated beams (Tall Building). In summary, it is composed of horizontal and diagonal elements that cross. Compared to a chosen metallic frame, it needs a lot less structural metallic. Diagrid is easily recognisable and has a pleasant look. The design and functionality of a diagrid system reduce the number of structural elements that are significant on a building's facade, resulting in much less obstruction of the outside view. Because of the diagrid system's structural effectiveness, interior and corner columns may be avoided, giving floor designers a lot of creative flexibility. The perimeter "diagrid" approach reduces the weight of structural steel by almost 20% as compared to a conventional moment-frame structure.



Diagrid structure

As can be seen in the photographs below, diagrid constructions may be found all over the world.


Hearst Tower, New York


SwissRe, London, UK

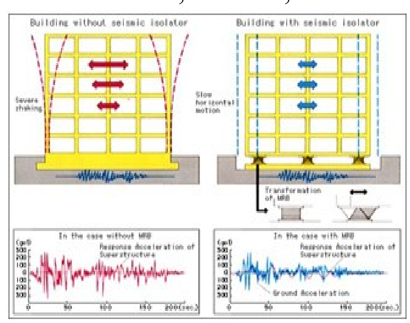


Fig 1. 1 : Building with and without seismic isolators

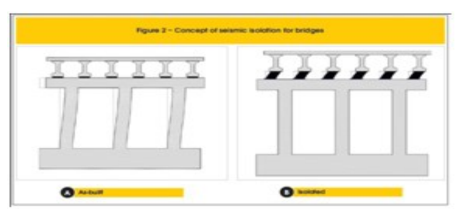
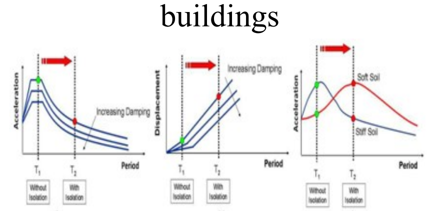


Fig 1. 2 : Concept of seismic isolation for buildings



Rubber Bearings:

International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

In addition to rubber and neoprene, those structures also provide steel laminated rubber and metal laminated rubber with a lead nucleus. Synthetic and natural rubber bearings that were formerly used in bridge bearings were converted into elastomeric bearings. Typically, seismic isolators—including those bearings—are used. Rubber laminated isolators are created by vulcanising thin metal plates to rubber plates (Fig.6). The most sophisticated are laminated rubber variants with a lead nucleus. Rubber Laminated with Lead Bearing structures are highly advanced seismic isolators made of layers of rubber and metal bonded together, with a lead nucleus within the middle.

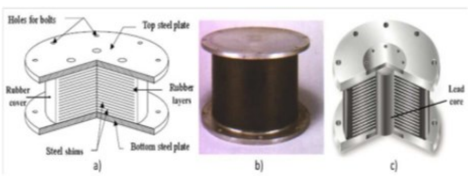


Fig 1. 6 : Elastomeric bearings

Friction pendulum bearings:

Friction pendulum systems are the most often used kinematic systems, particularly in base isolation. In a pendulum system, a metal globe with concave curved surfaces or a cylindrical problem with global touch surfaces is fitted. In certain parts, special metals are employed.

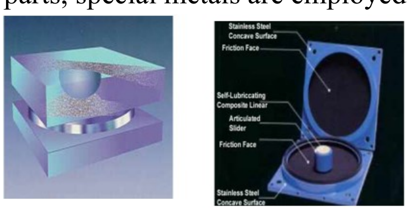


Fig 1. 7 : Cross section of a friction pendulum bearing

These bearings, which have all the advantages of rubber bearings, significantly reduce the effect of earthquakes and hose down strength by taking on a function that raises the form during a lateral motion. Because of the mechanical properties of certain metals that make up their form, these bearings may be used in buildings, spans, and heavy roof systems. They can also be effectively used in cold locations where freezing is a possibility.

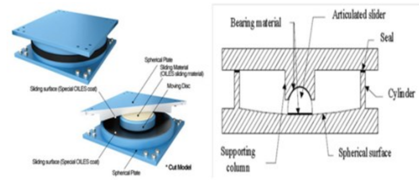


Fig 1. 8 : Flat Friction pendulum section cut and Curved / spherical Friction pendulum

Objectives of the study

The project's primary goals are as follows:

1. Examine the seismic behaviour of dia grid structures with isolation devices using IS 1893:2002.
2. To inspect a grid building with a 15-story diameter that is situated in a high seismic zone.
3. To evaluate and contrast the results of constructing torsion, shear force, bending moment, and tale drift.
4. To look at the multi-story buildings' response spectrum analysis in ETABS

II. LITERATURE REVIEW

Sun Moon Kyoung et al. The lateral overall performance of dia grids, braced tubes, and outrigger systems is investigated in tall dwellings that are twisted, inclined, tapering, and loose in shape. The effects of improving several fundamental geometric configurations of intricately designed tall dwellings, such as the degree of twist, tilt, taper, and loose form fluctuation, are investigated using parametric structural designs. For analysis, design, and comparative research, the parametric fashions are exported to a structural engineering software package. The tilt attitude used in this investigation, which ranges from zero to thirteen degrees, has no effect on the lateral stiffness of tilted diagrid and braced tubes. While dia grids, braced tubes, and outrigger systems may be used to curve tall houses, their lateral stiffness is reduced. The charge of stiffness loss increases in tandem with the cost of twist.

International Journal of Engineering Research and Science & Technology
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Vol. 21, Issue 1, 2025

Because the braced core, mega-columns, outrigger trusses, and other essential components of the lateral load-resisting device are triangulated, the lateral stiffness of outrigger systems increases dramatically as they may be tilted. In addition to an eccentric distribution of gravity pressures, wind hundreds are causing lateral deformation in tilted tall houses. With proper form design, lateral displacements caused by gravity may be significantly decreased. Tall building systems often adopt a tapering shape. The lateral stiffness of the structural device improves as the taper attitude increases, while the wind hundreds added to the form diminish. Consequently, tapered tall houses have lots that reduce lateral displacements as compared to prismatic tall systems. For tall systems with domestic capabilities at the top and corporate office sports at the lower floors, a tapering design works well. Since triangular structural geometric devices clearly described with the aid of dia grids can specify any abnormal freeform tower extra as it should be with no distortion, the dia grid structural device has many potentials to become one of the most appropriate structural solutions for freeform tall homes. Di grid structural systems utilised for freeform tall dwellings have less lateral rigidity.

Jani Khushbu et al. The assessment impacts were compared in terms of inter-story drift, pinnacle storey displacement, and time period. Structural components are examined and versioned using the ETABS tool. All load combinations are taken into account, and all structural elements are developed in accordance with IS 800:2007. The form's layout and study take wind dynamics into consideration both within and outside the shape. The load distribution of a 36-story skyscraper in a dia grid machine is also investigated. Grid systems with a diameter of 50, 60, 70, and 80 stories are being examined and developed.

Deshpande, Raghunath D., et al. A comparison was made between the structural systems of the conventional and dia grids. The structural components are modelled and analysed using the ETABS program. Wind dynamics along and across the structure are taken into account in the research and design. Diagrid outperforms the competition in all performance metrics, such as expressiveness, efficiency, and long-term viability. The structure is better able to withstand lateral stresses since it deflects less and its weight is reduced more. Diarid uses just 11247 tonnes of steel, as opposed to 15255 tonnes for a conventional orthogonal design, making it both economical and environmentally friendly. Compared to conventional structures, the Diagrid Structure uses 28% less steel, has a larger opening area, and experiences less deflection.

Maria Femy Thomas, et al. After reviewing the literature, the most advantageous structural arrangement and diagrid most efficient viewpoint were obtained by using ETABS software to evaluate round, square, and rectangular systems with the same plan region. Both round and rectangular Diagrid houses perform almost as well as square diagrid homes, however circular Diagrid homes outperform rectangular ones.

Singh, Rohit Kumar, et al. Storey flow, node-to-node displacement, bending moment, shear pressures, reinforcing area, and cost are used to compare the study's results. Diagrid construction has about half as much flow as traditional construction. It is found that the amount of metallic reinforcing used in Diagrid constructions is 33% lower than that of stylish buildings. The Diagrid form has greater lateral load resistance because to the diagonal columns that run the length of the structures. They discovered that diagrid constructions are more resistant to lateral stresses, have superior

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Vol. 21, Issue 1, 2025

structural performance, store a lot of material, and look fantastic.

III. METHODOLOGY USED AND TYPES OF LOADS USED

3.1 EARTHQUAKE LOADING

Earthquake stacking is the term used to describe the interior forces of a building mass that arise from the shaking of its foundation caused by a seismic disturbing effect. The key focus of earthquake-safe design is the translational inertial powers. A structure is more impacted by these translational inertial pushing elements than by vertical or rotating shaking components. For example, liquefaction of the surrounding subgrade due to vibration, subsidence, and land sliding are all primarily solid earthquake forces. On the contrary, the frequency of earthquakes is proportional to their magnitude. Even if a building is built to survive the worst earthquakes without suffering significant damage, the need for such strength throughout the course of the project would not justify the huge additional cost.

Seismic stacking is surveyed using two basic methods. These tactics take into account the characteristics of the building as well as the history of earthquakes in the area. The primary approach is the comparable parallel power measure. An important calculation of the design's critical period and the typical maximum ground speed increase, together with other suitable limits, are used to establish the maximum base shear.

The next step is a modular analysis, which determines the maximum modular response by breaking down the construction's modular frequencies and combining them with earthquake design spectra.

3.2 IMPORTANCE OF SEISMIC DESIGN CODES

Ground vibrations caused by seismic movement are what cause building misshapenings and powers. Buildings should thus be designed to resist these fears and deformities. Seismic regulations assist in ensuring that buildings are constructed to withstand the effects of earthquakes with minimal loss of life and property. Every country has seismic code measures to assist design engineers in planning, creating, counting, and building structures.

A) AN EARTHQUAKE RESISTANT STRUCTURE HAS FOUR VIRTUES IN IT, NAMELY

i. Excellent Structural Configuration: As a result of its size, structure, and main framework for carrying weights, inactivity powers go to the ground quickly and smoothly.

ii. Sidelong Strength: Its maximum parallel (even) strength prevents it from breaking down no matter what damage it sustains.

iii. Sufficient Stiffness: When the structure is rocked gently to moderately, its parallel weight opposing framework is made to prevent damage from earthquakes and, of course, any misshapenings.

iv. Great Ductility: Effective itemising techniques and design increase its ability to tolerate significant deformations, even after yielding during strong seismic shaking.

B) INDIAN SEISMIC CODES

a. Seismic codes are particular to a nation or area. They include building types, construction materials and techniques, the perceived degree of seismic threat, and the local seismology. The following are the seismic codes provided by the Bureau of Indian Standards (BIS):
b. IS 1893 (PART 1) 2002 (fifth correction), Indian Standard Criteria for Earthquake Resistant Design Structures.
c. The 1993 Indian Standard Code of Practice for Designing and Constructing Buildings That Resist Earthquakes (IS 4326). (second redesign).

International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

d. Indian Standard Guidelines for Enhancing Earthquake Resistance in Earthen Structures (IS 13827, 1993).
e. The Indian Standard Guidelines for Improving Low-Strength Masonry Buildings' Earthquake Resistance (IS 13828) were disseminated in 1993.
f. In 1993, IS 13920, which stands for Indian Standard Code for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, was made available.

If everything else is equal, these regulations do not guarantee that designs will not be impacted by earthquakes. However, to the extent that it is practical, they ensure that designs can endure solid earthquake shaking without catastrophic failure and moderate earthquake shaking without causing underlying damage.

3.3 ARCHITECTURAL FEATURES

Engineers design beautiful and innovative structures to produce a construction that is both aesthetically pleasing and practical. The condition of the building sometimes attracts the attention of visitors, while on other instances, the underlying structure comes together to create a marvel. Therefore, the buildings and structures chosen have a big impact on how the design is presented. Previous earthquakes across the globe have provided a wealth of information on identifying major settings that are desirable and those that should be avoided.

3.4 SIZE OF BUILDINGS

In elevated constructions with a significant tallness to base size relation, the level uprooting of the floors during ground shaking is astonishing. In structures that are short yet extremely lengthy, the destructive effects of earthquake shaking are more noticeable. Additionally, the flat seismic stacking may be too much for columns and dividers to support in buildings with large arrangement areas, such as stockrooms.

3.5 VERTICAL LAYOUT OF BUILDINGS

An unexpected increase in earthquake power at the degree of intermittence is caused by buildings with a few stores larger than the others; any deviation or irregularity in this heap movement way results in a terrible display of buildings with a few stores larger than the others that cause an abrupt increase in earthquake power at the degree of brokenness. In a given story, buildings with fewer columns or dividers or very tall stories are more likely to collapse or cause damage. A few structures with an open ground story or basement that were intended to resist the 2001 Bhuj earthquake in Gujarat either collapsed or suffered significant damage. Different height columns along the tilt of buildings dependent on untidy territory might cause problems like curvature and damage to more limited columns.

3.6 ADJACENT BUILDINGS

In the event of a significant earthquake, two buildings that are too near to one another may collide. This accident can become more of a concern as building heights increase. When the buildings' heights don't line up, the top of the smaller structure may bang into the middle of the higher one's column, which could be quite dangerous.

3.7 DESIGN ASPECT

Anywhere there is a critical shortage on the surface of the earth, earthquakes may happen both onshore and offshore. When an earthquake occurs on land, it damages the environment around its source and causes fatalities. When a strong earthquake happens under the sea or ocean, it has a negative impact on nearby structures, but it also creates massive tsunamis, or torrents, that affect areas far away from the source. All structures are constructed for the combined impacts of gravity and seismic stresses in order to ensure that enough vertical and sidelong strength and solidity are achieved, as well as to meet the fundamental requirements and allowable deformation levels stated in the

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com

Vol. 21, Issue 1, 2025

supervising building code. Because of the inherent security element used in design standards, the majority of structures are successfully obtained from vertical shaking. In buildings with broad ranges, vertical speed growth should be taken into account, similar to fundamental layout and generally steadyness analysis.

3.8 SERVICEABILITY LIMIT STATE

This time, there is hardly no underlying damage supported by the design. Important structures that affect the general population, such as emergency rooms, nuclear power plants, gathering places, etc., should be designed to withstand expected seismic stresses. These structures should be able to function in the event of an earthquake or a storm.

3.9 DAMAGE CONTROLLED LIMIT STATE

Therefore, the structure may be damaged in the event of an earthquake or tornado, but it may be restored even after the disaster has occurred. Since this class should include the majority of eternal designs, the construction should only be worked for limited malleability response.

3.10 SURVIVAL LIMIT STATE

In this instance, a catastrophic event such as an earthquake or hurricane is permitted to do damage to the design. In any event, the backings should be able to support and endure the constant loads placed on them in order to prevent the design from collapsing and dying. By preventing people' fragile dissatisfaction and ensuring that supportive elements, like columns, don't collapse, we may carry out the aforementioned behaviour. The "full" flexible conduct response of the structure should also be designed to disperse earthquake energy.

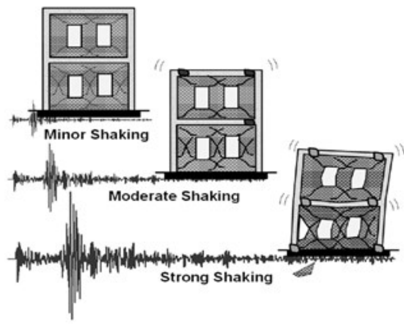


Figure 3. 1 Earthquake resistant design philosophy for different levels shaking.

Earthquake loads (EL)

Both vertical and level earthquake effects might affect the structure. Three generally opposing tomahawks—often referred to as vertical and flat—can be distinguished from the broader vibration caused by an earthquake.

Significant powers are not delivered to the superstructure by developments in the upward hub. Nevertheless, while planning, the design's simultaneous displacement in the event of an earthquake should be taken into account. There are 'whipping' effects on both sides of a building caused by level earthquake forces (to and fro shaking). It is necessary to transfer these forces from the design to the base.

The way a structure reacts to ground vibration depends on a number of factors, including the synthesis of the foundation soil, the size and method of construction, and the duration and intensity of ground movement. The specifics of such predictions for structures built on standing soils that would not settle or incline completely due to an earthquake are indicated by IS 1893-2016.

Lateral loads acting on the building

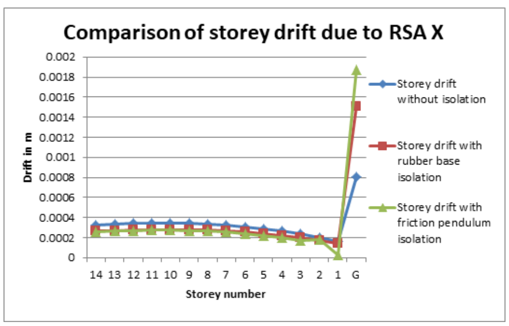
IV. RESULTS AND ANALYSIS

International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

RSA X Load type

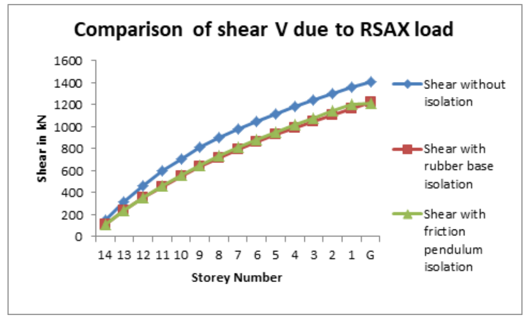
Storey drift

Storey Number	Load case	Storey drift without isolation	Storey drift with rubber base isolation	Storey drift with friction pendulum isolation
14	RSA X	0.000327	0.000266	0.000261
13	RSA X	0.000334	0.000271	0.000267
12	RSA X	0.00034	0.000276	0.000271
11	RSA X	0.000344	0.000279	0.000273
10	RSA X	0.000345	0.000281	0.000273
9	RSA X	0.000342	0.000279	0.000269
8	RSA X	0.000336	0.000275	0.000263
7	RSA X	0.000325	0.000267	0.000253
6	RSA X	0.00031	0.000256	0.000239
5	RSA X	0.00029	0.000241	0.00022
4	RSA X	0.000265	0.000222	0.000198
3	RSA X	0.000235	0.000198	0.000172
2	RSA X	0.000198	0.000169	0.000184
1	RSA X	0.000162	0.000142	3.10E-05
G	RSA X	0.000807	0.001507	0.00187



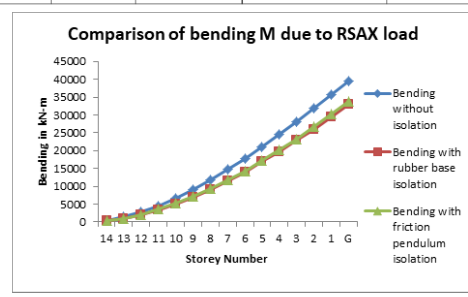
Comparison of shear

Storey Number	Load case	Shear without isolation	Shear with rubber base isolation	Shear with friction pendulum isolation
14	RSA X	151.6406	111.5894	113.4555
13	RSA X	317.3607	236.4568	240.4577
12	RSA X	465.222	351.1298	357.1558
11	RSA X	595.9877	456.0281	464.026
10	RSA X	710.9655	551.8043	561.8009
9	RSA X	811.8752	639.2868	651.4172
8	RSA X	900.7275	719.4441	733.9508
7	RSA X	979.712	793.3603	810.5547
6	RSA X	1051.0761	862.1972	882.4066
5	RSA X	1116.9707	927.1276	950.6666
4	RSA X	1179.3054	989.2606	1016.416
3	RSA X	1239.6388	1049.5831	1080.6004
2	RSA X	1299.1283	1108.9333	1143.9983
1	RSA X	1358.5329	1167.9995	1200.3629
G	RSA X	1412.0184	1221.3674	1217.2091



Comparison of Bending

Storey Number	Load case	Bending without isolation	Bending with rubber base isolation	Bending with friction pendulum isolation
14	RSA X	454.9218	334.7681	340.3664
13	RSA X	1406.7569	1043.99	1061.5826
12	RSA X	2801.284	2096.7234	2132.3621
11	RSA X	4585.9318	3462.9688	3522.5145
10	RSA X	6711.292	5114.3344	5203.661
9	RSA X	9132.3087	7024.5568	7149.8452
8	RSA X	11809.1539	9169.9147	9337.999
7	RSA X	14707.8273	11529.5758	11748.2613
6	RSA X	17800.5146	14085.8845	14364.1718
5	RSA X	21065.6712	16824.5463	17172.7701
4	RSA X	24487.8258	19734.6777	20164.5645
3	RSA X	28057.1208	22808.7102	23333.4
2	RSA X	31768.697	26042.204	26676.2228
1	RSA X	35621.9925	29433.6288	30176.3764
G	RSA X	39609.9283	32970.773	33739.0023

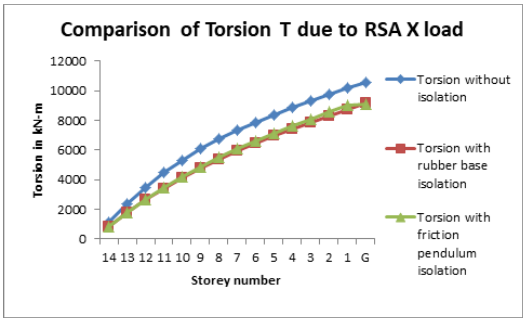


Comparison of torsion

Storey Number	Load case	Torsion without isolation	Torsion with rubber base isolation	Torsion with friction pendulum isolation
14	RSA X	1137.3045	836.9203	850.9158
13	RSA X	2380.2049	1773.4262	1803.4332
12	RSA X	3489.1651	2633.4736	2678.669
11	RSA X	4469.9079	3420.2107	3480.1954
10	RSA X	5332.241	4138.5322	4213.5064
9	RSA X	6089.0643	4794.6509	4885.6292
8	RSA X	6755.456	5395.831	5504.6317
7	RSA X	7347.8403	5950.2021	6079.1594
6	RSA X	7883.0704	6466.4789	6618.0487
5	RSA X	8377.2801	6953.4569	7129.9996
4	RSA X	8844.7909	7419.4544	7623.1203
3	RSA X	9297.2909	7871.8734	8104.5034
2	RSA X	9743.4621	8316.9996	8579.9876
1	RSA X	10188.9967	8759.996	9002.7215
G	RSA X	10590.1382	9160.2558	9129.0683

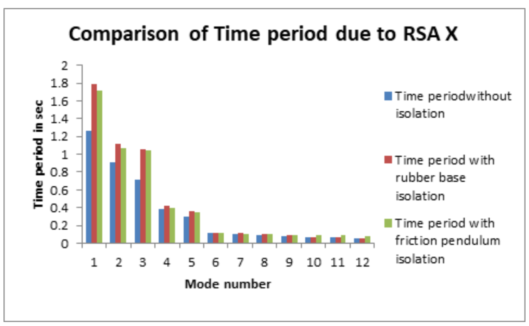
ISSN 2319-5991 www.ijerst.com

Vol. 21, Issue 1, 2025



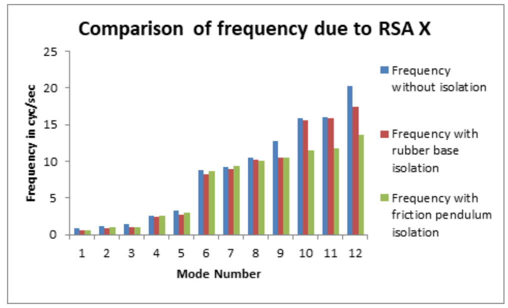
Time period

Mode number	Time period without isolation	Time period with rubber base isolation	Time period with friction pendulum isolation
1	1.261	1.785	1.716
2	0.908	1.117	1.064
3	0.712	1.061	1.043
4	0.386	0.421	0.394
5	0.302	0.363	0.343
6	0.115	0.121	0.116
7	0.108	0.112	0.106
8	0.096	0.098	0.1
9	0.079	0.096	0.095
10	0.063	0.064	0.087
11	0.062	0.063	0.086
12	0.05	0.058	0.074



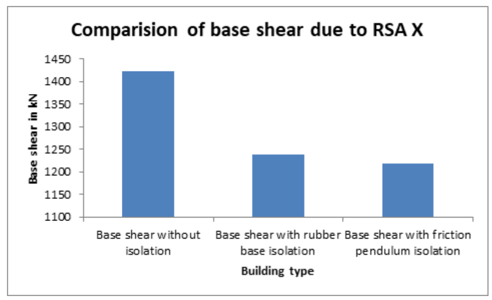
Frequency

Mode number	Frequency without isolation	Frequency with rubber base isolation	Frequency with friction pendulum isolation
1	0.793	0.56	0.583
2	1.101	0.895	0.94
3	1.405	0.942	0.959
4	2.592	2.374	2.536
5	3.314	2.756	2.918
6	8.73	8.284	8.61
7	9.219	8.89	9.411
8	10.437	10.201	10
9	12.721	10.42	10.551
10	15.93	15.603	11.45
11	16.001	15.874	11.69
12	20.183	17.358	13.541



Base shear

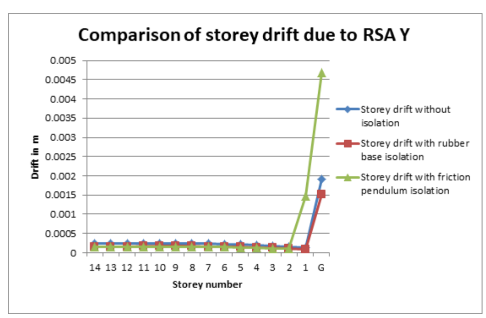
S. No	Base shear without isolation	Base shear with rubber base isolation	Base shear with friction pendulum isolation
1	1422.5593	1237.3956	1217.2091



RSA Y Load type

Storey drift

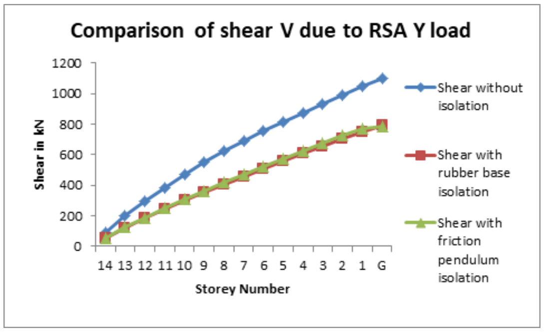
Storey Number	Load case	Storey drift without isolation	Storey drift with rubber base isolation	Storey drift with friction pendulum isolation
14	RSA Y	0.000234	0.000157	0.000154
13	RSA Y	0.000239	0.00016	0.000156
12	RSA Y	0.000243	0.000163	0.000159
11	RSA Y	0.000246	0.000165	0.00016
10	RSA Y	0.000247	0.000166	0.000161
9	RSA Y	0.000246	0.000165	0.000159
8	RSA Y	0.000243	0.000164	0.000156
7	RSA Y	0.000237	0.00016	0.000151
6	RSA Y	0.000227	0.000154	0.000144
5	RSA Y	0.000214	0.000147	0.000133
4	RSA Y	0.000197	0.000136	0.000121
3	RSA Y	0.000176	0.000123	0.000107
2	RSA Y	0.000151	0.000106	0.000107
1	RSA Y	0.00012	8.60E-05	0.001482
G	RSA Y	0.001904	0.001507	0.004677



Comparison of shear

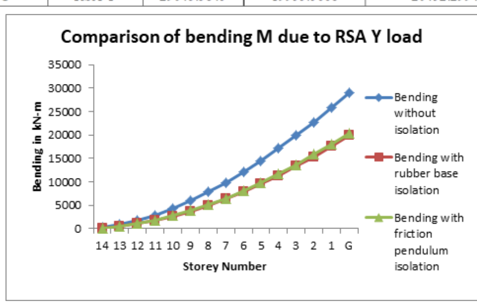
International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

Storey Number	Load case	Shear without isolation	Shear with rubber base isolation	Shear with friction pendulum isolation
14	RSA Y	93.3771	56.554	57.6263
13	RSA Y	198.746	121.9628	124.3397
12	RSA Y	296.5113	184.3678	188.089
11	RSA Y	387.0685	243.9774	249.1253
10	RSA Y	470.9912	301.0712	307.766
9	RSA Y	548.9492	355.9584	364.3422
8	RSA Y	621.6581	408.9433	419.1614
7	RSA Y	689.8644	460.3074	472.497
6	RSA Y	754.3511	510.313	524.6009
5	RSA Y	815.9286	559.2155	575.7239
4	RSA Y	875.3994	607.2739	626.1222
3	RSA Y	933.5062	654.7489	676.0485
2	RSA Y	990.8868	701.888	725.7207
1	RSA Y	1048.0468	748.9046	770.4781
G	RSA Y	1099.8321	791.4589	785.4293



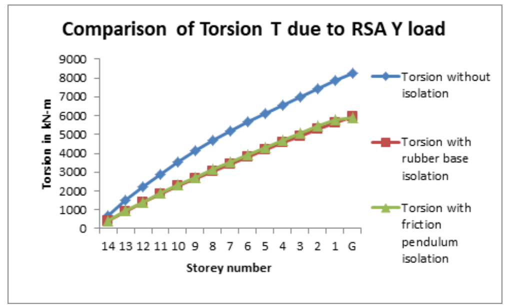
Comparison of Bending

Storey Number	Load case	Bending without isolation	Bending with rubber base isolation	Bending with friction pendulum isolation
14	RSA Y	280.1314	169.6619	172.8788
13	RSA Y	876.2379	535.4808	545.8195
12	RSA Y	1765.1924	1088.2889	1109.7552
11	RSA Y	2924.7883	1819.4222	1856.2453
10	RSA Y	4334.277	2720.9453	2777.699
9	RSA Y	5974.7039	3785.7783	3867.471
8	RSA Y	7829.0922	5007.731	5119.8518
7	RSA Y	9882.5529	6381.4738	6530.0001
6	RSA Y	12122.392	7902.4917	8093.8777
5	RSA Y	14538.222	9567.0539	9808.2221
4	RSA Y	17122.0477	11372.2131	11670.5512
3	RSA Y	19868.2723	13315.8224	13679.1816
2	RSA Y	22773.6185	15396.5493	15833.1942
1	RSA Y	25836.9513	17613.8588	18118.8448
G	RSA Y	29045.5845	19955.5668	20452.2994



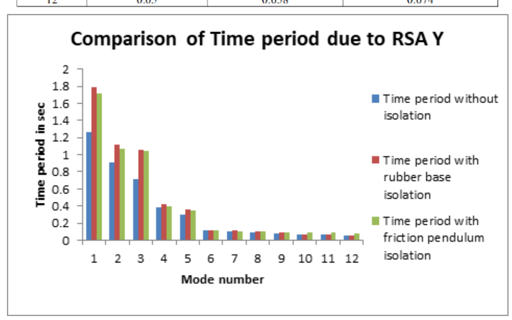
Comparison of torsion

Storey Number	Load case	Torsion without isolation	Torsion with rubber base isolation	Torsion with friction pendulum isolation
14	RSA Y	700.3284	424.1547	432.1969
13	RSA Y	1490.5955	914.7207	932.5475
12	RSA Y	2223.8347	1382.7588	1410.6673
11	RSA Y	2903.0141	1829.8303	1868.4399
10	RSA Y	3532.4338	2258.0336	2308.2451
9	RSA Y	4117.1193	2669.6882	2732.5663
8	RSA Y	4662.4355	3067.0747	3143.7103
7	RSA Y	5173.9826	3452.3058	3543.7277
6	RSA Y	5657.6336	3827.3477	3934.5071
5	RSA Y	6119.4646	4194.1161	4317.9291
4	RSA Y	6565.4958	4554.5542	4695.9162
3	RSA Y	7001.2965	4910.6166	5070.3637
2	RSA Y	7431.6511	5264.1596	5442.9054
1	RSA Y	7860.3506	5616.7845	5778.5856
G	RSA Y	8248.7411	5935.9417	5890.7199



Time period

Mode number	Time period without isolation	Time period with rubber base isolation	Time period with friction pendulum isolation
1	1.261	1.785	1.716
2	0.908	1.117	1.064
3	0.712	1.061	1.043
4	0.386	0.421	0.394
5	0.302	0.363	0.343
6	0.115	0.121	0.116
7	0.108	0.112	0.106
8	0.096	0.098	0.1
9	0.079	0.096	0.095
10	0.063	0.064	0.087
11	0.062	0.063	0.086
12	0.05	0.058	0.074

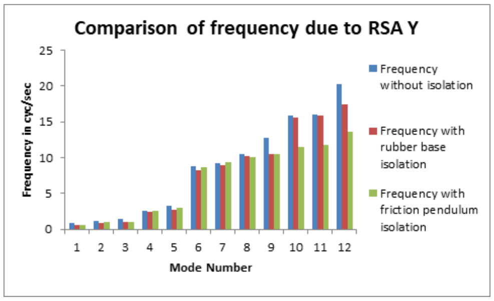


Frequency

Mode number	Frequency without isolation	Frequency with rubber base isolation	Frequency with friction pendulum isolation
1	0.793	0.56	0.583
2	1.101	0.895	0.94
3	1.405	0.942	0.959
4	2.592	2.374	2.539
5	3.314	2.756	2.918
6	8.73	8.284	8.61
7	9.216	8.89	9.411
8	10.437	10.201	10
9	12.721	10.42	10.551
10	15.93	15.603	11.45
11	16.001	15.874	11.69
12	20.183	17.328	13.541

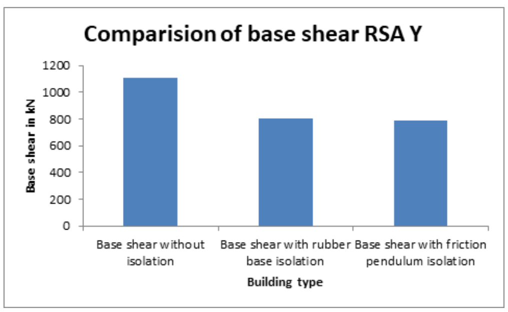
ISSN 2319-5991 www.ijerst.com

Vol. 21, Issue 1, 2025



Base shear

S. No	Base shear without isolation	Base shear with rubber base isolation	Base shear with friction pendulum isolation
1	1110.9102	805.6742	785.4293



V. CONCLUSION

According to the results, it is clear that using a base isolation technique is crucial for reducing the seismic response of a structure with an isolator in comparison to a fixed base structure and managing damage to the form during an earthquake. The rise or decrease of end outcomes parameters with respect to narrative is examined below in comparison to a predetermined base model.

1. According to the study, the bulk of lateral load is supported by dia grid columns at the perimeter, whilst the gravity load is supported by both internal and outside diagonal columns.
2. Consequently, interior columns should be constructed only for vertical stresses. The expanded lever arm of the periphery diagonal columns gives the diagrid structural device more strength in lateral load resistance.
3. The device is more strong because axial pressure in diagonal components at the shape's perimeter resists lateral and gravity loads. The Diagrid structural device allows for more flexibility in the layout of the building's façade and interior space.
4. When compared to a typical building, the story drift values are shown to be lower for the friction pendulum system and rubber base isolation.
5. When the building is damped by friction pendulum isolation and lead rubber isolation, storey shear values are reduced.
6. When the building is examined using a friction pendulum and a lead rubber isolation system, the storey moment is reduced.
7. When isolation systems are used to represent the building, torsion values are reduced.
8. The tale lateral loads pendulum model significantly decreased as a consequence of base isolation.

REFERENCES

1. ATC 17-1 (1993). "Proceedings of Seminar on Seismic Isolation, Passive Energy Dissipation, and Active Control," Applied Technology Council, Redwood City, California.
2. Aiken, I.D. and Kelly, J.M. (1990). "Earthquake Simulator Testing and Analytical Studies of Two Energy-Absorbing System for Multi-storey Structures," Report No. UCB/EERC-90/03, University of California at Berkeley.
3. Architectural Institute of Japan (1995). "Preliminary Reconnaissance Report of the 1995 Hyogoken Nanbu Earthquake. "
4. Bergman, D.M. and Hansen, R.D. (1993). "Viscoelastic Mechanical Damping Devices Tested at Real Earthquake

International Journal of Engineering Research and Science & Technology
ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 1, 2025

Displacements," Earthquake Spectra, Vol. 9, No. 3, pp. 389417.

5. Chang, K.c., Soong, T.T., Oh, S.T. and Lai, ML. (1992). "Effect of Ambient Temperature on Viscoelastically Structures," Journal of Structural Engineering, ASCE, Vol. 1 18, No. 7, pp. 19551973.
6. Agarwal Pankaj, Shrikhande Manish (2009), "Earthquake resistant design of structures", PHI learning private limited, New Delhi.
7. Arlekar Jaswant N, Jain Sudhir K. and Murty C.V.R, (1997), "Seismic Response of RC Frame Buildings with Soft First Storeys". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.
8. Awkar J. C. and Lui E.M, "Seismic analysis and response of multistory semirigid frames", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425-442, 1997.
9. Balsamoa A, Colombo A, Manfredi G, Negro P & Prota P (2005), "Seismic behavior of a full-scale RC frame repaired using CFRP laminates". Engineering Structures 27 (2005) 769–780.
10. Bardakis V.G., Dritsos S.E. (2007), "Evaluating assumptions for seismic assessment of existing buildings ".Soil Dynamics and Earthquake Engineering 27 (2007) 223–233.
11. Brodericka B.M., Elghazouli A.Y. and Goggins J, "Earthquake testing and response analysis of concentrically-braced sub-frames", Journal of Constructional Steel Research ,Volume 64, Issue 9, Page no: 997-1007,2008.
12. Chopra, Anil k. (1995), "Dynamics of structures", Prentice Hall.
13. Daryl L. Logan (2007), "A First Course in the Finite Element Method", Thomson, USA
14. Fall H.G (2006), "Direct Stiffness Method For 2D Frames-Theory of structure"
15. Garcia Reyes, Hajirasouliha Iman, Pilakoutas Kypros, (2010),"Seismic behaviour of deficient RC frames strengthened with CFRP composites". Engineering Structures 32 (2010) 3075-3085.