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SEISMIC BEHAVIOUR OF MULTI-STORE BUILDING USING VARIOUS ENERGY DISSIPATION SYSTEM

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Abstract - *In this paper we study that multi-story building with underground story for parking space and storage are very common in practice. Now a day, seismic energy dissipating devices are being used for various types of structures and located in basements which are difficult to maintain. The main objective is to evaluate the effectiveness of horizontal dampers in the ground floor level of the multi-story building above basement. Among different types of dampers, viscous- dampers are used for this numerical study. Comparing with other types of passive energy dissipating devices, viscous dampers are considered most suitable. For the better understanding of the effectiveness of horizontal dampers, stiff foundation system is considered thus soil-structure interaction is omit-ted. In this numerical study, seismic response of different hypothetical structures analyzed having different underground stories and horizontal dampers only in the ground level. Modeling and analysis of the structures and installation of the dampers are done by using [ETABS]. Different dynamics parameters such as time period, story displacement, story stiffness and story drift were evaluated. Changes in the results among the structures demonstrated the efficiency of horizontal dampers. Optimum locations of the horizontal dampers were also revealed in this study in the basis of the analysis results.*

Key Words: Viscous damper, Lead rubber bearing, Time history method, Etabs, Analysis.

1. INTRODUCTION

In multistory building, various energy dissipation systems has been widely used for vibration control in mechanical engineering system. It is useful to reduced vibrations in tall building and make safe and economical. This paper presents we use various energy dissipation system namely viscous damper and Lead rubber bearing damper for vibration control.

1.1. Viscous damper

Viscous dampers are hydraulic devices that dissipate the kinetic energy of seismic events and cushion the impact between structures. They are versatile and can be designed to allow free movement as well as controlled damping of a structure to protect from wind load, thermal motion or seismic-events.

Available in ratings up to 1,000 KIP, seismic dampers are well suited for large displacement and/or large load applications such as bridges, buildings, and large structures. Viscous damping force is a formulation of the damping phenomena, in which the source of damping force is modelled as a function of the volume, shape, and velocity of an object traversing through a real fluid with viscosity.

1.2. Lead rubber bearings

LRB is a type of base isolation employing a heavy damping. It was invented by William Robinson, a New Zealander. Heavy damping mechanism incorporated in vibration control technologies and, particularly, in base isolation devices, is often considered a valuable source of suppressing vibrations thus enhancing a building's seismic performance. However, for the rather pliant systems such as base isolated structures, with a relatively low bearing stiffness but with a high damping, the so-called "damping force" may turn out the main pushing force at a strong earthquake. The bearing is made of rubber with a lead core. It was a uniaxial test in which the bearing was also under a full structure load. Many buildings and bridges, both in New Zealand and elsewhere, are protected with lead dampers and lead and rubber bearings.

2. STUCTURAL PROPERTIES AND MODELLING:

2.1. Material and geometrical property:-

In this research paper we have analyzed and designed the multi-storeyed building by using ETABS 2016 software. A G+20 storey building under the lateral loading effect of wind and earthquake was considered for this study and analysis is done by using ETABS. To achieve the objectives of the study that is to analyze and design residential building using ETABS. All the parameters which has been used in plan are given below.

Table.1: Material and Section Properties

S.NO.	MATERIAL PROPERTIES	
1.	Plan	(20*20)mm
2.	Building type	Residential Building
3.	No. of storey	G+20
4.	Floor height	3m
5.	Bottom storey height	3.5m

6.	Total height	63.5m
7.	No.of grid lines in X&Y direction	6
8.	Spacing of grid lines in X&Y direction	4m
9.	Size of column	(600*400)mm
10.	Size of beam	(450*300)mm
11.	Thickness of slab	150mm
12.	Grade of concrete	M25
13.	Grade of steel	HYSD415
14.	Wall load	15 KN/m
15.	Parapit wall	7.5 KN/m
16.	Slab load	3 KN/m^2
17.	Roof load	1.5 KN/m^2

2.2. Earthquake Parameters:-

Table.2: Seismic Data (IS 1893:2002)

S.No.	**Earthquake Parameters**	
1.	Seismic Zone	III
2.	Zone Factor	0.16
3.	Soil Type	II
4.	Importance Factor	1
5.	Response Reduction Factor	5
6.	Effective Stiffness	1175418.57 kN/m
7.	Effective Damping	0.05
8.	Yield Strength	34.7 kN
9.	Mass	44kg
10.	Weight	250 kN
11.	Scale Factor	254

2.3. Modeling:-

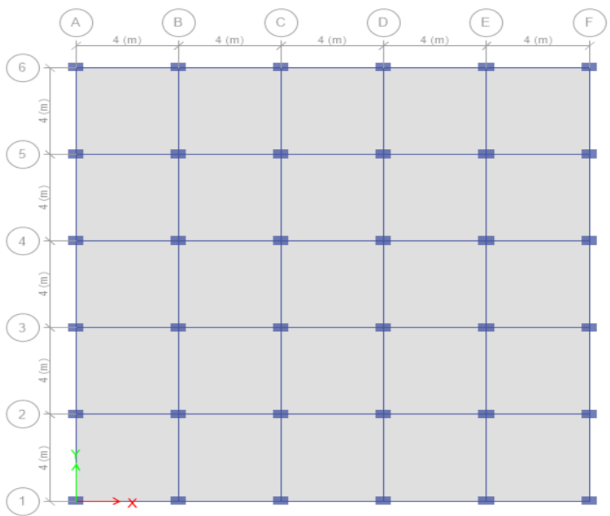


fig.(a).Building Without Damper

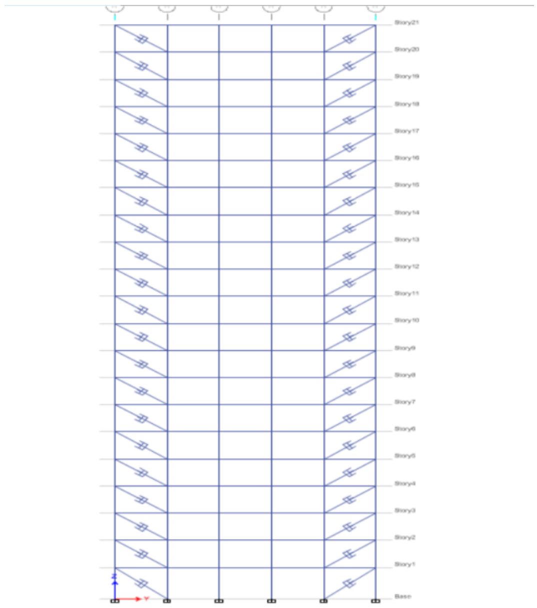


fig.(b).Building With Viscous Damper

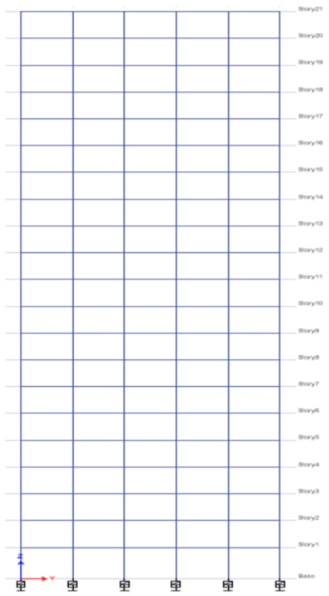


fig.(c).Building With Lead Rubber Bearing

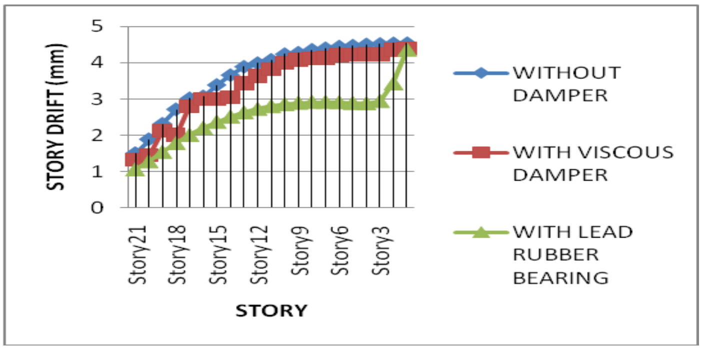
3. Method of Analysis

Time History Method:- Time History Analysis of Structures is carried out when the input is in the form of specified time history of ground motion. Time History Analysis is performed using Direct Integration Methods or by using Fourier Transformation Technique. The time history analysis of the base isolated building is carried out using the computer program ETABS. A full three-dimensional representation of the structure is used in time history analysis of the base isolated buildings.

4. RESULTS AND DISCUSSION

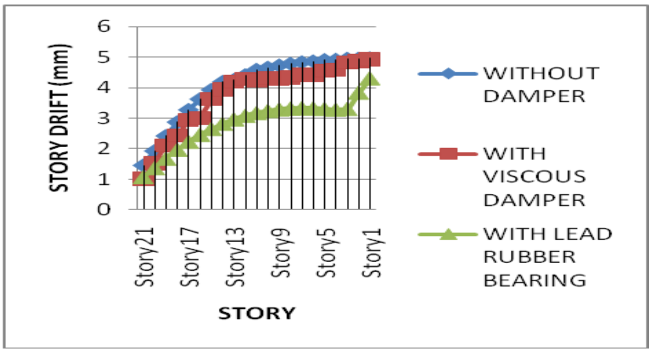
4.1 STORY DRIFT-Story drift is calculated only at top of the building. The value of max. story drift with damper is less than without damper.

STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Story21	1.501	1.326	1.074
Story20	1.883	1.442	1.296
Story19	2.311	2.12	1.555
Story18	2.71	2.004	1.799
Story17	3.014	2.8	2.019
Story16	3.068	2.996	2.212
Story15	3.383	3.004	2.379
Story14	3.655	3.055	2.521
Story13	3.886	3.44	2.64
Story12	3.985	3.645	2.736
Story11	4.078	3.821	2.811
Story10	4.234	4.002	2.867
Story9	4.273	4.086	2.903
Story8	4.355	4.122	2.923
Story7	4.397	4.14	2.927
Story6	4.443	4.22	2.917
Story5	4.468	4.224	2.898
Story4	4.501	4.236	2.887
Story3	4.513	4.24	2.952
Story2	4.531	4.361	3.435
Story1	4.534	4.398	4.359



Max. *Story drift in x direction*

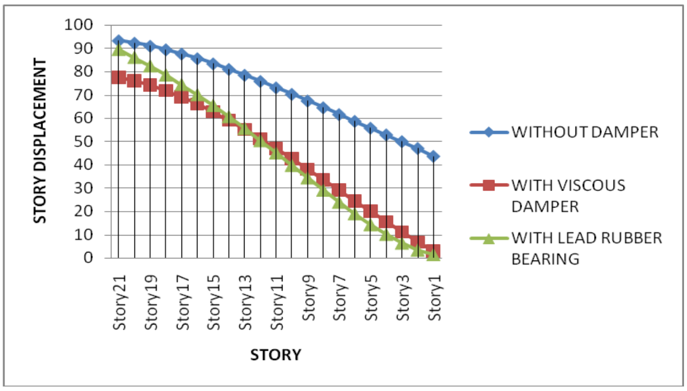
STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Story21	1.45	1	1.079
Story20	1.922	1.522	1.372
Story19	2.417	2.108	1.689
Story18	2.867	2.426	1.979
Story17	3.269	2.943	2.238
Story16	3.622	3.008	2.466
Story15	3.928	3.636	2.663
Story14	4.189	3.942	2.833
Story13	4.251	4.2	2.974
Story12	4.408	4.293	3.091
Story11	4.587	4.243	3.183
Story10	4.656	4.323	3.252
Story9	4.728	4.314	3.301
Story8	4.783	4.341	3.329
Story7	4.834	4.422	3.341
Story6	4.863	4.432	3.336
Story5	4.907	4.561	3.317
Story4	4.918	4.591	3.293
Story3	4.949	4.832	3.315
Story2	4.952	4.88	3.851
Story1	4.964	4.944	4.321



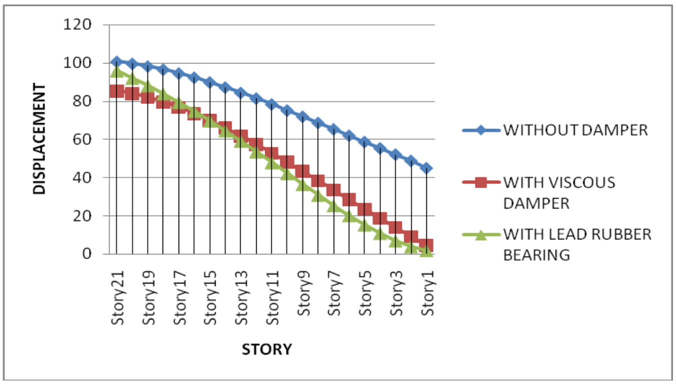
Max. Story drift in y direction

4.2 STORY DISPLACEMENT- Story displacement is calculated only at top of the building. The value of max. story displacement with damper is less than without damper.

STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Story21	93.368	77.678	89.458
Story20	92.323	76.198	85.999
Story19	91.033	74.317	82.361
Story18	89.479	72.007	78.492
Story17	87.68	69.296	74.385
Story16	85.661	66.228	70.033
Story15	83.449	62.846	65.434
Story14	81.071	59.191	60.611
Story13	78.549	55.306	55.596
Story12	75.91	51.227	50.428
Story11	73.174	46.993	45.152
Story10	70.362	42.638	39.818
Story9	67.496	38.195	34.483
Story8	64.593	33.694	29.209
Story7	61.67	29.163	24.065
Story6	58.744	24.63	19.13
Story5	55.827	20.117	14.493
Story4	52.929	15.65	10.257
Story3	50.044	11.253	6.554
Story2	47.102	6.981	3.574
Story1	43.7	3.014	1.64



Max. Story displacement in x direction

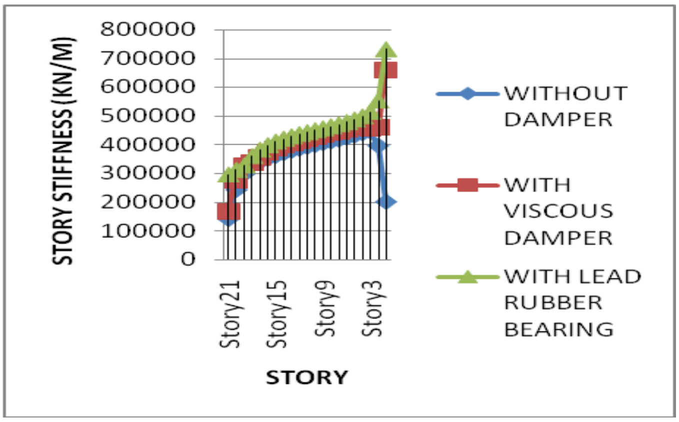


Max. Story displacement in y direction

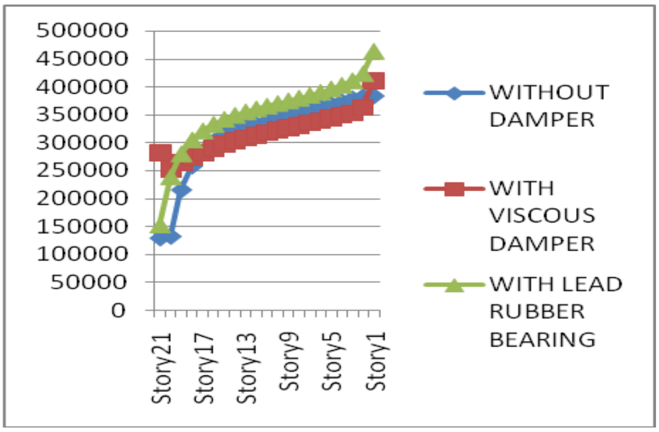
STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Story21	100.691	85.425	95.929
Story20	99.627	83.991	92.097
Story19	98.257	82.071	88.09
Story18	96.568	79.655	83.85
Story17	94.589	76.788	79.369
Story16	92.351	73.519	74.638
Story15	89.886	69.898	69.653
Story14	87.222	65.97	64.439
Story13	84.39	61.782	59.029
Story12	81.415	57.374	53.464
Story11	78.325	52.787	47.794
Story10	75.142	48.058	42.071
Story9	71.89	43.224	36.358
Story8	68.59	38.318	30.722
Story7	65.261	33.369	25.24
Story6	61.92	28.405	19.995
Story5	58.585	23.453	15.086
Story4	55.268	18.535	10.621
Story3	51.976	13.673	6.737
Story2	48.668	8.891	3.634
Story1	44.844	4.251	1.64

4.3 STORY STIFFNESS- Story stiffness is calculated only at top of the building. The value of max. story stiffness with damper is greater than without damper.

STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Story21	142337.4	164458.9	295666.9
Story20	243159.3	272492.3	311851.6
Story19	297875.9	326764.5	327063.2
Story18	332044.4	335628.2	359817.8
Story17	339318.4	355501.4	381833.2
Story16	350904.8	372716.2	397836.4
Story15	360818.9	386000.7	410172.3
Story14	369599.4	396702.5	420171.3
Story13	377471.8	405671.5	428658.4
Story12	384647.8	413480.2	436185
Story11	391316.1	420537.2	443144.1
Story10	397660.5	427150.4	449834.6
Story9	403836.5	433564.4	456498.4
Story8	409983.1	439981.5	463345.6
Story7	416258.5	446564.4	470573.9
Story6	422858.5	453380.8	478397.9
Story5	429927.1	460116.1	487148.2
Story4	438227.9	464514.9	497695
Story3	444619	456247.3	513701.7
Story2	395201.8	460039.6	552997.7
Story1	201916	661327.8	731760.8



Max. Story stiffness in x direction

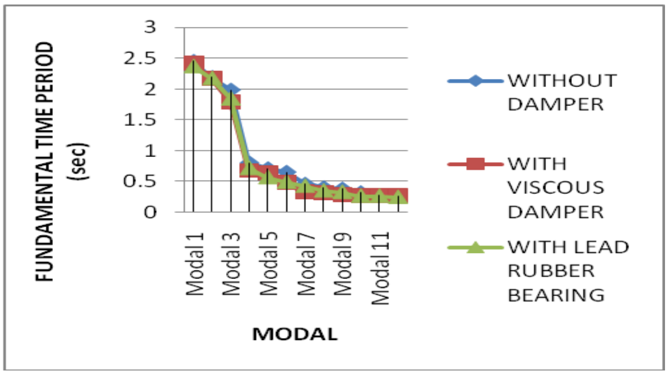


Max. Story stiffness in y direction

STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Story21	129397	281485.8	151647.1
Story20	132344.2	251593.3	238424.3
Story19	215337.3	263416.1	279694
Story18	257745.7	273146.9	304248.5
Story17	283839.8	281757.4	320603.2
Story16	301528.9	289430.1	332383.2
Story15	314366.4	296238.6	341387.2
Story14	324177.5	302315.1	348633
Story13	330573.5	307790.5	354745.7
Story12	332017.7	312791.7	360138.3
Story11	338544.5	317435.3	365101.7
Story10	344194.9	321826.2	369854.5
Story9	349276.9	326078	374571.1
Story8	354019.7	330267.7	379400
Story7	358604.1	334483.1	384475.6
Story6	363179.7	338825.9	389926.2
Story5	367877.7	343356.8	395887.8
Story4	372808.1	348368.1	402528.1
Story3	378018.7	352542.1	410536.3
Story2	381809.2	362326.3	423119.9
Story1	382810.5	410186.8	463482.3

4.4 TIME PERIOD- Time period is calculated only at top storey of the building. The value of time period with damper is less than without damper.

STORY	WITHOUT DAMPER	WITH VISCOUS DAMPER	WITH LEAD RUBBER BEARING
Modal 1	2.453	2.418	2.375
Modal 2	2.194	2.172	2.18
Modal 3	1.988	1.785	1.85
Modal 4	0.807	0.676	0.721
Modal 5	0.716	0.642	0.573
Modal 6	0.658	0.485	0.5
Modal 7	0.464	0.329	0.432
Modal 8	0.406	0.317	0.356
Modal 9	0.387	0.284	0.335
Modal 10	0.327	0.273	0.273
Modal 11	0.282	0.268	0.272
Modal 12	0.272	0.267	0.251



Time period

5. CONCLUSION

After applying viscous damper and lead rubber bearing in G+20 multi storey building. We conclude that the building with dampers is more safe than the building without damper. Viscous damper is more economical and safe for the G+20 multi storey building. We use viscous damper and lead rubber bearing damper. The value of storey drift, displacement and time period at top of the building is reduced by using viscous damper and lead rubber bearing. And the value of storey stiffness is maximum at the bottom storey.

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