Experimental Investigation of (G+7) Building Using Viscous Dampers

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Sairam Baikhan¹, K. Lakshmi Shiva Priya², N. V. N. Santhoshi Srija³,
CH. Nikhil Kumar⁴, G. Sri Nath⁵
^{1,2,3,4} Student, ⁵ Assistant Professor, Vidya Jyothi Institute of technology, Hyderabad

Abstract

Seismic development is a whimsical in nature coming about an essential damage and breakdown in the end an uncommon incident to human life in the pieces of property. With these concerns, much perception has been begun by creative work of essential control strategies, for instance, disengaged and dynamic system are connected in the sorts of Tuned Mass Damper (TMD), Fluid Viscous Dampers (FVD), Base Isolation, etc. In the current assessment an examination has made by considering (G+7) structure with the multiplication of seismic examination using SAP-2000. The plan is bankrupt down with the foundation of fluid gooey damper (FVD) arranged at various patterns, of complete 12 Types have embraced being researched based. The suitability of the researched particular is obviously seen as the resultant essential lead, similar to Time Period, Base Reactions, Displacement, story buoy and story shear, etc The best ideal approach of dampers proposed for essential response of vibrating system.

Keywords— Seismic Activity, Tuned Mass Damper, Fluid Viscous Damper, Base Isolation, Base Reaction, Story Drift, Story Shear, SAP-2000.

I. INTRODUCTION

Strong seismic quakes can occur at inconsistent ranges, often segregated from each other by extended lengths. This is the explanation the seismic quakes in an enormous number of the undermined countries is oftentimes put down and seen as a to some degree speculative thing. The proportion of mischief achieved by shakes could augment later on. This will not be a direct result of a rising in the number and earnestness of quakes, yet rather to the extension in absolute people, associated with the creating number of amassed metropolitan regions and the extending assessment of property and material in these zones. More than three-quarter of the excessively metropolitan zones on the planet (metropolitan networks with a general population of more than 10 million) are arranged in risked zones. All through the latest fifty years, the seismic quakes are masterminded into two social occasions of close field shakes and far-field seismic quakes subject to the distance of the spot of recording the quake from the defect. Thereafter, this definition was adjusted and various factors moreover influenced this course of action. Over the new years, the investigation thinks about zeroed in on the examination of impacts of ground development in the nearby field seismic quake on the essential execution. The mind-boggling effects of the new quakes like the Northridge shudder (1994), Kobe quake (1995), and Taiwan tremors (1999) on the constructions of the metropolitan zones close by a deficiency, and concerning the close by territory of countless the metropolitan zones of India to the unique imperfections show the significance of the investigation.

Over the new year's profound cost have been paid for accurate affirmation of the force of a shake in the assessment associations of the world to decrease its damage, the growing requirement for more investigation focuses on the effects came about on account of the seismic quake is felt in the speculative and exploration office scales. The best way to deal with avoid a disaster achieved by quakes is using tremor safe arrangement in seismically powerful regions.

II. LITERATURE REVIEW

- A. General
- The composing audits of a couple of remarkable hidden resources amassed are showed up in the predictable posting of investigation. Further, a couple of kinds of dampers and base Isolators are inspected in the past area, basically centered around this assessment; gooey dampers were significantly enlightened with its importance, need, places where it will in general be used and its specifics.
- Y.G. Zhao et.al (2001) referred to about "Second methods for basic steady quality" in which they said, to play out an exact examination an essential engineer ought to choose such information as essential weights, math, maintain conditions, and material properties. The delayed consequences of such an examination consistently consolidate help reactions, stresses and migrations. This information is then diverged from measures that exhibit

the conditions of disillusionment. Advanced essential examination may investigate dynamic response, unfaltering quality and non-straight lead.

- Dr.H.J.Shah et.al (2009) they had developed an arrangement representation of working as indicated by seismic weights IS 1893 part I - 2002. A six-story working for a business complex. The construction is arranged in seismic zone III on a site with medium soil. He explained immediately about the gravity load assessment and seismic weight figuring genuinely.
- Shaik Qamaruddin et.al (2016) analyzed a 10 story model using a gooey damper by square and rectangular plans with respect square and rectangular portions. The well known story Displacements are restricted by 90% with usage of FVD. The addition of 60% to 70% are found in Eigen Values shows the feasible increase in the robustness of the development when FVD250 used for outside corners. It is seen that structures with square segments are performing honorably to the extent response of the plan when diverged from the rectangular portions paying little heed to the floor plan. In surveying the seismic display of plans the gauge of mischief in developments is difficult to assess by using the push-over examination when differentiated and the Time history assessment.
- Lakshmi Shireen Banu et.al (2019) examined the story responses from the time history examination to the extent PSA, PSV and SD have been diminished with the usage of fluid gooey dampers. The response range twists of PSA, PSV and SD shows the diminishing after some time-frame with the usage of dampers stood out from the constructions without dampers. 90% mass help is cultivated in seventh and eighth strategies for a wide scope of designs. It might be seen that 75% lessening in base shear due to time history examination. There is an amazing abatement in most prominent story migration, most extraordinary story buoys and story shears when the damper is used in constructions. The responses can be moreover lessened by the assurance of damper, position of damper and shape and sort of improvement of the construction being referred to.

Fluid Viscous Damping Applications:

V. Umachagi et.al "Usages of Dampers for Vibration Control of Structures: A layout" has immediately explained that Viscous dampers works reliant on fluid course through openings.

Feng Qian et al., 2012 included thick divider, chamber with different little openings, cover stacked up with a silicon or some liquid material like oil, through which the fluid pass starting with one side of the chamber then onto the next.

Stefano et al., 2010 have created the gooey damper and it was completed in 3 story building structure for seismic control of plan with additional thick damper.

Attar et al., 2007 have proposed ideal thick damper to reduce the bury story migration of steel building

Fig 2.1: Fluid Viscous Damper Cross-section.

CONTROL SYSTEMS & DAMPERS

Control Systems

Different kinds of seismic control structures are used in quake safe arrangement that successfully lessens the movement of shudder powers on the central basic system. All around, there are four sorts of seismic control systems - to be explicit.

- Active control
- Passive control
- Semi-powerful control and
- Hybrid control

➤ Active Seismic Control Systems

This technique remembers the route toward constraining force for the development to counterbalance the seismic quake powers circling back to the design. This system requires additional fuel source is stunning differentiated and the inactive seismic control structures.

➤ Passive Control System

A detached control system is a shock balance procedure that uses latent methodologies. These needn't bother with additional fuel source to fill the alleviation need. Taking everything into account, it uses the quake input development to impel seismic control.

Fig 3.1: Passive response control systems, (a) Base seismic isolation, (b) energy dissipation devices, (c) dynamic vibration absorbers

➤ Semi-Active Seismic Control System

Semi-unique contraptions require essentially less energy than dynamic devices and the energy can much of the time be taken care of locally, in a battery, appropriately conveying the semi-powerful device liberated from any external power supply.

➤ Hybrid Seismic Control System

As the name states, it is a cross variety seismic control structure that joins both the dynamic and reserved seismic system. A hybrid seismic control structure has the going with inclinations over the dynamic and dormant system: Improved resolute quality, Reduced Cost, Power Demand is less.

Energy Dissipation Devices: These are mechanical systems attached to the design that experiences misshapening and yielding by charming a gigantic piece of seismic quake input energy, therefore guaranteeing the construction. Exceptional contrasted with other model for energy dissipating contraptions are dampers.

DAMPERS: are the contraptions which are used to ingest or scatter the vibration achieved by the tremor to the plan and to assemble the damping and solidness of the development.

➤ Classification Of Dampers

Dampers are described reliant on their presentation of pounding, metal (Flowing), Viscous, Viscoelastic, shape memory composites (SMA) and mass dampers. About the advantages of using dampers we can induce to high energy absorbance, easy to present and replace them similarly as coordination to other essential people.

- Viscous Damper
- Viscoelastic Damper
- Friction Damper
- Tuned Mass Damper
- Yielding Damper
- Magnetic Damper
- Mass Damper
-

Viscous Dampers: In thick dampers, seismic energy is devoured by silicone-based fluid passing between chamber blueprints. Thick dampers are used in raised constructions in seismic regions. It can work over an encompassing temperature going from 40°C to 70°C. Goopy damper reduces the vibrations impelled by both strong breeze and quake.

Fig 3.2 Schematic Detailing of Viscous Damper Components

Viscoelastic Dampers: such a damper is viscoelastic dampers that stretch an elastomer in blend in with metal parts. This sort of damper disperses the construction's mechanical energy by changing over it into heat.

Fig 3.3 Viscoelastic Damper

Friction Dampers: Generally, a contact damper contraption involves a couple of steel plates sliding against each other contrarily. The steel plates are disengaged by shims of grinding pad material. The damper scatters energy by techniques for disintegration between the surfaces which are scouring against each other. It is in like manner possible to make surfaces from materials other than steel.

Tuned Mass Damper (TMD): Tuned Mass Damper (TMD), in any case called vibration shields or vibration dampers, is an unapproachable control device mounted to a specific zone in a development to diminish the ampleness of vibration to a commendable level at whatever point a strong equal force, for instance, a seismic quake or high breezes hit.

Fig 3.4 Friction Damper

Fig 3.5 Tuned Mass Damper

Yielding Dampers: Yielding damper or metallic yielding energy dispersal device or unapproachable energy dissipating contraption is created from helpfully yielded metal or composite material. It spreads energy through its plastic disfigurement (yielding of the metallic contraption) which changes over vibratory energy and accordingly diminishes the mischief to the fundamental hidden parts. Yielding dampers are traditionalist, incredible, and wind up being a good energy dissipates.

Fig 3.6 Metallic Yielding Damper Installed in Multistory Building

Magnetic Damper: Magnetic Damper involves two racks, two pinions, a copper circle and extraordinary earth magnets. Such a damper is neither expensive nor subject to temperature. Alluring damping isn't strength that is the explanation it is fruitful in one of a kind vibration shields which require less damping.

Fig 3.7 Magnetic Damper

Mass Damper: Mass is put on a help which goes probably as a roller. Also, it licenses to mass with move as a trade sidelong improvement to the floor. Springs and dampers are set among mass and anchor people to the floor and the packaging and they are set relative in "converse stage" and a portion of the time are adjoining vertical. Likewise, these anchor people send essential even force. Bidirectional trade dampers are made as a spring-damper in two vertical manners.

Fig 3.8 Mass Damping System in the Building

III. MODELLING & ANALYSIS

In this paper a 8 story reinforced strong construction with supreme height of 24m, and plan size of 16.45x11m, with 3 river with isolating of 4.15m,2.36m,4.15m along y-rotate and 3 sound with separating of 6.725m, 2.7m and 7.025m along x-center is shown in SAP 2000. This construction is explored by indistinguishable static and direct response range procedure (in Zone v). In this a total of 12 sorts of plans of slanting bracings of fluid thick dampers are used for a comparable construction is shown, load mix and all design portion sizes are same for all models. All models are analyzed by equivalent static and straight response range examination.

Table I Sectional Details

Site Area	254 sqm
Carpet area	180sqm (16.45mx11m)
Structural details:	
Slab thickness	200 mm (8")
Beam (primary beams)	380mm x 230mm
Column	650mm x 400mm
	Exterior 230mm
	Interior 110mm
Material details:	
Concrete	M30
Steel	Fe 415
Brick	AI Grade (standard size)

Table 2 Considerable Loads

Load Types	Value
Dead load	1.5 KN/m
Live load	3 KN/m
Floor finish	1 KN/m

Seismic loads are optimized in both the directions (i.e., EQ - X and EQ - Y) Load patterns directly using Code IS 1893:2002. (i.e., Z - Zone V, Importance factor, Reduction factor, spectral acceleration S_a/g). The structure is idealized to IS:456 for concrete & IS:800 for steel, with sustainable parameters for modelling.

Table 3. Load Patterns

Name	Type	Self-Weight Multiplier	Auto Load	Static Type
Dead	Dead load	1	-	Linear static
Live	Live load	0	-	Linear static
EQ X	Seismic load	0	IS 1893-2002	Linear static
EQ Y	Seismic load	0	IS 1893-2002	Linear static

Fig 4.1 Plan view

Fig 4.2 3D view

Installation of Damper In Various Patterns

All things considered fluid gooeey dampers are planned in a Chevron Bracing system and Diagonal Bracing structure, before long we have gotten slanting supporting system. Pondering the experimentation approach strategies, various instances of corner to corner propping structures are arranged as inspected following.

- Alternate Patterns Arrangements Of Dampers:
- Zig zoom Cross Bracing (Type-1)
- Cross Corner Sequence Bracing (Type-2)
- Center Cross Bracing (Type-3)
- Counter Cross Bracing (Type-4)
- Zig Zag Cross All Frames (Type-5)
- Counter Cross Sequence of All Frame (Type-6)
- Cross Sequence of All Bracing (Type-7)
- Counter by Floor Bracing (Type-8)
- Cross Center Bracing of Alternate Floor (Type-9)
- Counter Cross Sequence Bracing of Alternate Floor (Type-10)
- Sequence by Floor Bracing-1 (Type-11)
- Sequence by Floor Bracing-2 (Type-12)

Fig 4.3 Patterns of arranging the bracing

In these models dampers are coordinated in (45°) awry piece of the external straights in both (x and y) headings. The dampers are arranged in various models, for instance, jumble setup and others w.r.t center point at the external corners of floors to check the forces on account of seismic event on development and spread of energy can be concentrated by such extraordinary strategies and helps with picking most ideal strategy.

IV. RESULTS AND DISCUSSION

The examination did on two significant strategies of model plans (i.e., standard design and with damper presented gathering), considering damper we have overhauled experimentation system for 12 assorted propping sorts of models with various arranged. The results got from the examination are dissected for the better upgrade approaches which are

mulled over reliant on the purpose of the assessment.

Fundamental Time Period

Measured assessment is the past pattern of eliminating the immediate response (like regular frequencies, damping mishap components and particular constants) of developments to various sort loadings. This model response acknowledges the amount of DoF's of the plan, its damping type and maybe the amount of vibration modes inside the purposeful repeat range.

In SAP - 2000 examination, we will all things considered concentrate the secluded limit like time frame, measured help factor with mass distributes, frequencies, etc, which help in smoothing out of essential response.

Table 4. Fundamental Time Period from SAP-2000

Types of Structure	Modes											
	1	2	3	4	5	6	7	8	9	10	11	12
Regular (without damper)	1.26	1.25	1.24	0.41	0.41	0.39	0.24	0.23	0.21	0.17	0.16	0.14
With damper models												
Type - 1	1.71	1.23	1.22	0.64	0.59	0.59	0.51	0.43	0.31	0.31	0.24	0.24
Type - 2	1.35	1.10	0.98	0.45	0.36	0.30	0.28	0.23	0.22	0.21	0.18	0.14
Type - 3	1.70	1.66	1.59	0.52	0.49	0.49	0.26	0.24	0.23	0.20	0.19	0.19
Type - 4	1.35	1.07	0.97	0.45	0.35	0.29	0.26	0.22	0.21	0.20	0.18	0.15
Type - 5	1.50	1.08	1.06	0.59	0.55	0.49	0.23	0.20	0.19	0.18	0.18	0.16
Type - 6	1.39	1.11	1.02	0.46	0.37	0.27	0.20	0.17	0.16	0.14	0.14	0.12
Type - 7	1.43	1.12	0.79	0.48	0.32	0.25	0.22	0.17	0.16	0.15	0.14	0.13
Type - 8	1.39	1.19	1.01	0.47	0.42	0.35	0.29	0.28	0.24	0.23	0.22	0.21
Type - 9	1.51	1.50	1.46	0.49	0.47	0.45	0.28	0.27	0.24	0.22	0.21	0.18
Type - 10	1.54	1.32	1.13	0.52	0.47	0.39	0.32	0.31	0.27	0.26	0.25	0.23
Type - 11	1.44	1.38	1.14	0.47	0.42	0.37	0.26	0.26	0.21	0.20	0.20	0.19
Type - 12	1.39	1.20	1.02	0.47	0.43	0.36	0.29	0.28	0.24	0.23	0.23	0.22

Graph 5.1 Fundamental time period for various types of Model

Differentiating the manual and programming interpretations, the time period is generally extraordinary in sort 1 and type 3 and restricted for type 2 and type 4. Respecting the different models, in sort on various occasions period is reliable through starting three modes later-on dynamically restricted to least regard.

Base Reactions

Generally, base shear is evaluated as the best expected equal force that may happen as a result of seismic ground development through the base of the plan.

➤ **Manual Approach**

Considering the seismic static procedure we have obtained the base shear (VB) in both the (x and y) course.

$$VB = 16643.5 \text{ Kn}$$

➤ **Software Approach**

Researching the plan with all the data blends we have procured the assessment of VB as proceeds in table 5.

Table 5. Base Reactions

Types of Structural Models	Global FX	Global FY	Global FZ
	KN	KN	KN
Regular / Normal (without damper)	2177.8	-3742.9	41327.3
With damper models			
Type -1	16054.9	-3742.9	83327.3
Type -2	8888.6	-3742.9	83327.3
Type -3	3366.2	-3742.9	62327.3
Type -4	9043.4	-3742.9	83327.3
Type -5	10917.4	-3742.9	104327.3
Type -6	11552.6	-3742.9	104327.3
Type -7	9617.0	-2337.4	103795.2
Type -8	6096.3	-3742.9	65327.3
Type -9	2942.6	-3742.9	53327.3
Type -10	6944.6	-3742.9	77327.3
Type -11	4638.4	-3742.9	59327.3
Type -12	6060.5	-3742.9	65327.3

Story Displacements

It is dislodging achieved by the Lateral Force on the each Story level of development. Even evacuating will be more on well known story (coast range from $h/50 - h/2000$). From this time forward, in the wake of inspecting the development with different supporting system, the results gained for 13 models in both without and with damper foundation and their assessment are showed up in after plain construction

**Table 6. Lateral Displacements of Buildings
(13 Model Approaches)**

Floors	With Out Damper (mm)	With Damper											
		Type -1 (mm)	Type -2 (mm)	Type -3 (mm)	Type -4 (mm)	Type -5 (mm)	Type -6 (mm)	Type -7 (mm)	Type -8 (mm)	Type -9 (mm)	Type -10 (mm)	Type -11 (mm)	Type -12 (mm)
7	430	365	220	465	258	164	253	146	298	436	303	278	282
6	393	328	198	403	232	151	232	133	283	381	291	260	266
5	345	291	177	335	204	140	209	120	232	319	236	250	219
4	287	252	154	265	174	127	183	109	214	257	223	207	205
3	223	217	131	196	143	120	157	100	146	187	150	198	139
2	157	182	110	132	115	108	130	93	130	131	139	146	128
1	91	155	95	80	87	106	105	90	60	70	65	140	58
G	40	123	79	40	72	87	88	88	49	53	56	61	54

Seeing the various types of building we can summarize that after foundation of dampers the dislodging is diminished consistently, with least reduction of 15.6 % and 66% as the best.

Graph 5.2 Displacement of storey's with and without dampers.

5.4 Comparative Result

Table 7. Maximum Displacement Reduction (%) for Different trail approaches

Types of structural models	Maximum displacement
	% reduction comparing with Regular building
Type-1	15.6
Type-2	49.0
Type-3	15.9
Type-4	41.0
Type-5	61.8
Type-6	41.0
Type-7	66.0
Type-8	34.5
Type-9	23.0
Type-10	32.7
Type-11	34.4
Type-12	36.5

To help the introduction of dampers, upstream improvement focus on the zone of to one side supporting part positions was driven on twelve different alternatives w.r.t. Typical design. The results show that the elective Type – 2, Type – 5 and type – 7 are the great vibration's time period and mass collaboration, they were differentiated and non-upheld and damped models. The results are summarized in Table 6., in like manner the condition of 90% of mass speculation required by (seismic code), has been satisfied for the present circumstance of upheld other alternative. Exactly as expected, the significant season of vibration of the upheld configuration decreases due to the extended immovability. In most the starter

cases, the time period decreases due to the extra strength coming about in light of the usage of dampers.

In the end differentiating every one of the 12 kinds of plan effective reduction in sidelong story evacuation have been seen in after three systems.

- Cross Corner Sequence Bracing (Type – 2)
- Zig Zag Cross inside and out Frames (Type – 5)
- Cross Sequence overall Frames (Type – 7)

It is obviously seen from the previously mentioned, structure has an adaptable force movement relationship; thusly, its lead is like a fundamentally slanting help. One could see that most noteworthy rate (%) reduction of apex evacuations would be requested under the optimistic one. This result shows that the customary circumstance of dampers in the plan, may be difficult to predict, and higher than envisioned, paying little mind to the straightforwardness of the development, model and assessment.

- Cross Corner Sequence Bracing (Type-2)

The approach of dampers in such model in a development have been diminished the 49% of dislodging with that of non-upheld edge building.

Fig 5.3 Cross Corner Sequence bracing arrangement

Graph 5.3 Comparison Displacements for Regular and Type -2 Buildings

Graph 5.4 Type 2 building Storey drift

➤ Zigzag Cross All Frame (Type 5)

Considering these arrangements of dampers in such pattern in a structure have been reduced the 62% of displacement with that of non-braced frame building.

Fig 5.4 Arrangement of Zigzag Cross in All Frames

Graph 5.5 Comparison Displacements for Regular and Type -5 Buildings

Graph 5.6 Type 5 building Storey drift

➤ Cross Sequence in All Frames (Type 7)

In general, intrusion of fluid viscous damper in the frame structure results in reduction of the relative floor displacement of 66% in the storey of the structure. Hence, the dampers arrangement in such pattern is considered as more optimistic.

Fig 4.3 Cross Sequence arrangement in All Frames

Graph 5.7 Comparison Displacements for Regular and Type -7 Buildings

Graph 5.8 Type 7 Building Storey Drift

V. CONCLUSION

This assessment permitted to separate the essential direct, with and without thick fluid damper for a seismic weight. Numerical assessment with SAP - 2000 writing computer programs was used for the assessment of a G+7 building. The results show that the use of the inactive control contraption FVD in designs delivers a basic lessening of the essential response appeared differently in relation to the unbraced ones. Regardless, because of primer approachs of the design, the essential closures are summarized under:

- The focal period logically lessened diverged from the un-upheld plan.
- The most extraordinary movements reducing of the FVD models are in the arrive at 15.6 % to 66% appeared differently in relation to the standard plan.
- Reduction of the most outrageous story skim is 68%, which lessens the assessments of story shear forces and its response.
- The restoring power actuated by the damper makes visco-adaptable lead which gives more noticeable capacity to spread the special stacking energies.
- The benefits of essential propping types (12 elective models) were obviously displayed by the relationship data and improving execution of the development, by which the unique 3 kinds of plan are embraced and suggested a confident strategies for foundation of arranged of dampers.
- Cross Corner Sequence Bracing (Type – 2)
- Zig Zag Cross all in all Frames (Type – 5)
- Cross Sequence all in all Frames (Type – 7)

{Among the above three types of arrangements, “Cross Sequence in All frames” is observed to be preferable in all the aspects}

VI. REFERENCE

1. Limit State of Analysis” – IS 456 : 2000
2. “Recommendations for Earthquake Resistant Design of Structures”, Code of Practice – IS 1893 – 2016.
3. S.K.Jain et al; “Explanatory Example on Indian Seismic Code IS 1893 (Part – I)” – IIT Kanpur,
4. D.Bandyopadhyay, S.K. Bhattacharyya “Structural vulnerability assessment of old metropolitan cities in earthquake disaster mitigation” The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, Chaining 2008.
5. Mauro Filipe Santos Monteiro “Energy dissipation systems for buildings” in 2011.
6. Vajreshwari Umachagi, Katta Venkataramana, G. R. Reddy, Rajeev Verma, “Applications of Dampers for Vibration Control of Structures: An Overview” International Journal of Research in Engineering and Technology, Nov-2013.
7. Liya Mathew & C.Prabha, “Effect of Fluid Viscous Dampers in Multi- Storeyed Buildings”, International Journal of Research in Engineering & Technology, Vol. 2, Issue 9, Sep 2014, 55-60.
8. Sumyat Aye, Dr. Kyaw Moe Aung, “Comparative Study on Seismic Response of RC Structure Using Viscous Dampers and Viscoelastic Dampers”, International Journal of Scientific Engineering and Technology Research, Vol.03, Issue.08, May-2014, Pages:1468-1478.
9. IJRET: International Journal of Research in Engineering and Technology eISSN: 2319- 1163 | pISSN: 2321-7308.
10. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-7 May, 2019.
11. V. Umachagi, K. Venkataramana, G.R.Reddy, and R. Verma, “Applications of Dampers for Vibration Control of Structures: An Overview,” *Int. J. Res. Eng. Technol.*, pp. 6–11, 2013.
12. M.R.Arefi, “A study on the damping ratio of the viscous fluid dampers in the braced frames,” vol. 3, no. 4, pp. 1223–1235, 2014..

13. J.Marti, M.Crespo, and F. Martinez, "Seismic Isolation and Protection Systems," *Seism. Isol. Prot. Syst.*, vol. 1, no. 1, pp. 125–140, 2010.
14. M.K.Muthukumar G, "Analytical modeling of damping," *Indian Concr. J.*, vol. 88, no. 4, 2014.
15. I.López, J.M.Busturia, and H.Nijmeijer, "Energy dissipation of a friction damper," *J. Sound Vib.*, vol. 278, no. 3, pp. 539–561, 2004.
16. J.A.Inaudi and J. M. Kelly, "Mass Damper Using Friction-Dissipating Devices," *J. of Eng. Mech.*, vol. 121, no. 1, pp. 142–149, 1995.
17. W.J.William H. Robinson, "Lead Damper for base isolation.pdf." Proceedings of 9th world conference on Earthquake, 1998.
18. D.Demetriou, N. Nikitas, and K. D. Tsavdaridis, "Semi active tuned mass dampers of buildings: A simple control option," *Am. J. Eng. Appl. Sci.*, vol. 8, no. 4, pp. 620–632, 2015.
19. E.L.Anderson, "Performance-Based Design of Seismically Isolated Bridges," p. 494, 2003.