IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 2, April 2022
Impact Factor: 6.252

Review on Analysis of Multistoried RCC Structure with and Without Viscous Dampers in Seismic Zone

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Abstract: *This paper presents a literature review on viscous dampers. Civil constructions such as high-rise skyscrapers, towers, and long-span bridges are created with more flexibility as a result of fast economic development and modern technology increase in their susceptibility to external excitation. Therefore, these flexible structures are susceptible to be exposed to excessive levels of vibration under the action of strong wind or earthquake. The viscous damper is one of the devices used to minimize the seismic forces.*

Keywords: RCC Structure

I. INTRODUCTION

From historical and recent records, the globe has seen a number of devastating earthquakes, resulting in a rise in the number of human deaths due to structural collapse and significant structural damage. Because of such structural damage during earthquakes, it is apparent that structures such as residential buildings, public life-line structures, historical structures, and industrial structures should be constructed to seismic force design and carefully to avoid earthquake dangers. The use of a seismic response control device in structural design is now broadly acknowledged and widely employed in the civil engineering sector. The structural control idea has been developed into a feasible technology, and such devices have been put in structures. Three approaches are often used to classify structural control systems. Active energy dissipation, semi-active energy dissipation, and passive energy dissipation are the three types of structural control systems. Devices that are utilized to diffuse the seismic effect are known as passive energy systems. Passive devices are designed to absorb a portion of seismic energy, minimize earthquake energy or force on structural materials, and limit the amount of structural damage. Passive control systems, unlike semi-active or active systems, do not require external power. The active control system is programmable and requires some external power to operate. The active control system will employ the sensor linked to the structure. The energy dissipation devices known as semi-active systems are a blend of active and passive control systems.

II. LITERATURE REVIEW

1. Analysis of Building using Viscous Dampers in Seismic Zone - V

Abhishek Kumar Maurya & V.K. Singh

This research investigates the vibration characteristics of multi-story conventional reinforced buildings. It also compares the seismic behavior of a fixed base building without dampers to the proposed building, which has dampers linked at multiple locations, such as the Middle and Corners. The G+10 structure is located in zone V, and a study is carried out on them in order to determine the difference in structural response of the fixed RC building without viscous dampers were inserted into the damper and the structure at various spots. ETABS 2016 is used to do time history analysis. After considering the earthquake occurrence at the India-Nepal border, taking the region into account some of the characteristics under dynamic loading of the story include story drift, story displacement, and mode periods have been studied in this paper. When compared to a fixed foundation structure without damper building, the viscous damper significantly reduces the time period for buildings by more than 50%. When compared to a structure without a damper at the corner, the building with a damper at the corner reduces the maximum drift value by 85%, putting the corner damped building on the safer side. The use of a damper at the corner decreases the displacement by around 60%.

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2. Effect of Fluid Viscous Dampers in Multi-Storeyed Buildings

Liya Mathew & C.Prabha

The analysis of reinforced concrete buildings with and without fluid viscous dampers is the subject of this research. A parametric research was carried out to determine the best damper characteristics for reinforced concrete frames. On a symmetrical square building, a nonlinear time history analysis is performed. The analysis is done with SAP2000 software, and the results are presented in a graphical style. The reactions of structures have been studied using nonlinear dynamic analysis, and the following findings have been drawn. A structure with FVD should be constructed with a damping ratio of 20% and a velocity exponent of 0.5 for best efficacy in decreasing dynamic reactions. Based on the dynamic floor reactions of the structures, it can be determined that for square layouts, installing FVD at the exterior corners on all four sides is effective.

3. Study on the Effect of Viscous Damper for RCC Frame Structure

Puneeth Sajjan, Praveen Biradar

The research investigates how the ETABs 2015 software is used to model and evaluate an 8-story symmetrical construction. The seismic loads are defined in accordance with IS1893-2002 (Part 1). The static and dynamic analysis methods are used to analyse the structure. To do dynamic analysis, the response spectrum function is defined. Viscoseismic dampers are installed in the structure to regulate seismic reaction and boost structural stiffness. With the same characteristics, a structure with a viscous damper is modelled and examined. The damping coefficient Cd= 810 kN-s/m and exponent of 0.3 are the mechanical parameters of the viscous damper employed in this investigation. The acquired and contrasted findings in the form of displacement, tale drift, and story shear. When viscous dampers are applied to a structure, the displacement value of the structure is lowered by 60 to 85 percent. When compared to the basic model, tale drift at mid-stories is decreased by 70%. The drift value at the top and bottom stories is reduced by around 60% to 80% when a viscous damper is applied to the structure.

4. Optimal Placement of Supplemental Dampers in Seismic Design of Structures

Ajeet S. Kokil and Manish Shrikhande

A generic method for determining the best location for supplementary dampers in structural systems with any degree of design complexity has been developed. The goal function used to find the best site for dampers was a linear combination of maximum inter-storey drift and maximum base shear of the damped structure normalised by their respective undamped counterparts. For varying degrees of soil compliance, the influence of soil-structure interaction on maximum response reduction and also on the best placement of dampers is investigated. Supplementary dampers are shown to be more successful in decreasing the seismic response of a symmetric building, but their efficiency decreases when either plan irregularity or soil compliance rises. Moreover, it is discovered that additional damping is more successful in decreasing the seismic response of a symmetric building than it is in reducing the seismic response of an asymmetric building, and its efficacy decreases as plan irregularity grows. In the case of compliant soils, the reduction in seismic response with the installation of dampers is not as dramatic as in the fixed base situation, and damper efficacy improves as soil stiffness increases. An increase in the number of dampers beyond a certain point does not result in a further reduction in the building's reaction. The structural structure and soil flexibility, however, have a role in determining the maximum number of dampers.

5. A Methodology of Design for Seismic Performance Enhancement of Buildings using Viscous Fluid Dampers

K. Rama Raju, M. Ansu and Nagesh R. Iyer

The use of linear VFDs to improve building seismic performance is recommended as a design technique. It is based on the idea of placing the dampers where the inter-storey velocities and drifts are at their maximum. It also explains how to arrive at an effective VFD distribution in the building. For achieving the UBC 1997 defined goal performance requirements for base shear and inter-storey drifts, the peak base shear and inter-storey drifts obtained from the time history analysis of the building subjected to DBE are employed. The suggested technique is utilised to construct linear VFDs with chevron, upper toggle, and scissor jack mechanisms to maximise effective damping in a 20-story benchmark building subjected to DBE to fulfil performance standards. The N–S components of El Centro, Kobe, Northridge, and Taft scaled to a PGA of 0.2 g is believed to be indicative of DBE for the place, that is, where the 20-story benchmark building is located. The ground

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level or the first few stories from the ground floor appears to be the best place for dampers with various mechanisms in the building. The toggle brace mechanism is shown to be the most efficient for the distribution of VFDs in buildings among the systems evaluated. The scissor jack mechanism is the second best arrangement for damper distribution in a structure. The suggested approach may be used to determine the capacity and distribution of VFDs installed in various mechanisms in any building. To do so, an ensemble of earthquakes is needed to prescribe a DBE that is reflective of the building's location.

6. Application of Viscous Dampers for Super Tall Residential Buildings in High-Wind Strong-Seismic Area
Kun Ding, Xin Zhao, Yue Yang and Liwei Ye

This study used a super tall residential building project in Xiamen, China, to examine viscous damping system selection, optimal damper placement, highly effective deformation amplification devices, damping parameter optimization, and extra damping ratio computation. It can be seen that using a very effective viscous damping system not only improves the human comfort performance of super tall residential structures in low-wind conditions, but also reduces lateral deformation in high-wind and large earthquakes, resulting in more efficient structural design. By adding a viscous dampening system to the top level, the maximum acceleration response under wind loads may be significantly lowered. Adding a viscous dampening system can significantly minimize story drifts under both wind and seismic stresses. The large energy dissipation capability of viscous damping is shown by the plump hysteresis curve.

7. Placement of Fluid Viscous Dampers to Improve Total Building Seismic Performance
Giuseppe Marcantonio Del Gobbo

The effectiveness of three key damper placement methods was studied and compared in this article, with structural and nonstructural performance quantified in repair costs. Linear FVDs in regular, CBF architectures were the only ones studied. The overall damping coefficient had to be kept within a certain range. The following conclusions can be derived within this scope, but they should be cautiously applied to other sorts of structures. Repair costs were generally lower with the SEM and consistent dampening than with other damper installation methods. The iterative strategies did not improve the overall seismic performance of the structure. Optimizing for one parameter may exacerbate a problem with another factor that affects post-earthquake repair costs. The SSSA, FSDA, and ESEM encourage the concentration of dampers in a small number of storeys, which has a detrimental impact on seismic performance. It appears that pursuing optimum linear FVD placement for low- and mid-rise structures will not result in substantial reductions in post-earthquake maintenance costs. The SEM or uniform damping should be employed with a large target total damping ratio to improve the total-building seismic performance of low- and mid-rise buildings utilising linear FVDs. High-rise constructions may benefit from better damper location optimization. Practical concerns, such as structural flaws in the un-retrofitted structure, may limit the location of dampers even more.

8. Comparison between Seismic Performance of G+5 Building With and Without Fluid Viscous Dampers
Pranita Tamanga and Guru Prasad Sharma

The primary goal of this research is to examine the seismic performance of G+5 structures with and without dampers. Because the maximum number of floors allowed in Sikkim is six, the modelling and analysis in this study were done using "ETABs" software for G+5 story buildings. Using FVDs, the suggested model revealed a significant reduction in the building's displacement. In comparison to the model without FVDs, the suggested model in this study was able to reduce displacement by 64 percent, 53 percent, 42 percent, 31 percent, and 18 percent in story6, Story5, Story4, Story3, and Story2.

9. Applications of Dampers for Vibration Control of Structures: An Overview
Vajreshwari Umachagi, Katta Venkataramana, G. R. Reddy & Rajeev Verma

Different types of dampers are discussed, such as metallic dampers, viscoelastic dampers, frictional dampers, and so on. The usage of seismic control devices has grown in recent years, but selecting the proper damper and placing it in a structure is critical for decreasing vibration in structures susceptible to seismic pressure. The regulating mechanisms greatly decrease damage by improving structural safety and serviceability, as well as preventing the structure from collapsing during an earthquake. As a result, several studies are being conducted in order to determine the optimum answer. This study aims to offer an overview of several types of seismic response control devices while also highlighting some recent advancement.

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The results of numerous researchers' experimental and analytical studies clearly show that the seismic control approach has the ability to improve the seismic performance of structures.

10. A Study on the Damping Ratio of the Viscous Fluid Dampers in the Braced Frames

Mohammad Reza Arefi

The goal of this research is to determine the best damping ratio for viscous fluid dampers (VFD) in braced frames. The library research, as well as appropriate tools, were utilised to evaluate data and come to a conclusion in order to achieve the goals of this study. The velocity pulses of near-field earthquakes feature powerful strike waves, extended durations, and lasting ground deformation. The directivity of the fault rupture causes velocity pulses in horizontal components perpendicular to the fault motion's surface. The unusual behaviour of the response spectrum in the Imperial Valley fault can be attributed to pulse features such as the velocity record in near-field earthquakes. The forced energy on the structure by these pulses causes the earthquake energy to be absorbed in the early joints rather than non-linear behaviour and plastic joints in the high section of the structure.

11. Seismic Response Study of Multi-Storied Regular and Irregular Reinforced Concrete Buildings with and Without Fluid Viscous Dampers

K. Ramana Appalanaidu & Bhaskar Singh B

Fluid viscous dampers (FVD 500) were utilised to examine the response of Regular and Irregular RC structures in this study.

The primary goal is to ensure that the structure can sustain lateral loads and transfer them to the foundation. Because lateral stresses placed on a structure are dynamic, they produce vibrations inside the structure. Fluid viscous dampers have been utilised at corners to make constructions earthquake resistant. Buildings with and without FVD are studied, both with and without regular and irregular plans. The programme ETABS 2016 was utilised in this investigation. The response of the four RC structures investigated in this study is analysed and compared with and without FVD at corners using Linear and Non Linear Analyses. For maximal PSA with minimal damping, buildings with FVD have low periodic values, but structures without FVD have lengthy periodic values, which is sensitive. When employed with FVD, these structures exhibit a reduction in periodic values of more than 50% for regular buildings and 70% for irregular buildings. When comparing buildings with and without FVD, it has been discovered that those with FVD perform better in terms of structural reaction.

12. Design of RCC Structure Using Dampers in all the Seismic Zones

Gayatri Kiran Kunta and Manasa Dwarampudi

The study's major goal was to build a reinforced concrete structure in various seismic zones. The findings of this investigation show that adopting a fluid viscous damper helps minimise structural response. The insertion of dampers in the structure at each level minimised maximum storey displacements. Storey drifts have been shown to be decreased to a significantly lower value in buildings employing fluid viscous dampers. When a damper is used, the maximum storey movement in each level is reduced. As a consequence, under earthquake conditions, dampers at each floor provide a suitable outcome. By using a viscous damper on the structure, the drift value at the top and bottom stories is reduced by around 60% to 80%.

13. Dynamic Analysis of RCC Frame Structures with and Without Viscous Damper Having Different Aspect Ratio

Vibha More, Dr. Vikram Patil & Somanagouda Takkalaki

The effects of four distinct damper placements and no FVD on models with three different aspect ratios and two story heights are investigated. In ETABS, an individual model was constructed for damper analysis and to perform various results such as tale displacement, story drift, and modal period. The reactions of the RCC model are evaluated in this study using Response Spectrum Analysis. When FVD are installed till the tenth floor in a zigzag design, storey displacement is reduced by up to 44%, while it is reduced by up to 54% when FVD are installed at all exterior corners in a zigzag pattern. When FVD are given in a zig-zag pattern until the 10th level, storey drift is reduced by up to 78 percent. It also drops by up to 65 percent when FVD is installed in every exterior corner in a zigzag pattern. When FVD was employed, a 40 percent reduction in time period was noticed.

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14. Study on the Performance of Reinforced Concrete Structure with Viscous Damper with Elcentro Earthquake Time History

Kirtikumar K. Prajapati, Prof.Arjun M. Butala

This research looks at different numbers of dampers that will make a structure more earthquake resistant. The dissertation work focuses on a comparison of the number of dampers and the number of dampers without dampers for multi-story RCC. Building. The seismic behaviour of a G+4 storey structure with and without dampers is studied using the time history approach. Etabs 2017 software is utilised to do the analysis. These analyses' results are explained in terms of several parameters such as maximum displacement, storey drift, storey shear, time vs shear, and column forces. The construction is investigated with and without dampers. Maximum displacement, storey drift, storey shear, time vs shear, and column forces values are all higher in RC buildings without dampers than in RC buildings with dampers, according to these comparisons. From the analysis of the elcentro earthquake time history analysis, there is a decree in displacement with increasing the number of damper at different stories as compared to without damper, but damper at all stories(1 to 5 damper) give a less displacement as compared to 1-2 damper, 2-4 damper, 1-3-5 damper, and without damper. From the analysis of elcentro earthquake time history analysis, there is also a reduction in story drift with the number of damper at different stories as compared to without damper, but damper at all stories(1 to 5 damper) give a less story drift as compared to 1-2 damper, 2-4 damper, 1-3-5 damper, and without damper. We discovered that dampers should be installed at all stories to decrease displacement, all story drift ratio, stresses on all story columns, and foundation shear.

15. Seismic Response Study of Multistoried Reinforced Concrete Building with Fluid Viscous Dampers

Amit Kumar

The primary function of a structure is to support and exchange horizontal loads with the establishment. Because the sidelong loads imposed on a structure are dynamic in nature, they create vibrations. Fluid Viscous Dampers were used to create tremor-resistant constructions. The effects of FVD on structures with square and rectangular plans, as well as square and rectangular segment cross-areas, are explored. The product ETABS 2015 was used in the current investigation. The reactivity of the RC building under inquiry is analysed and contrasted with and without FVD using Push over and Time history studies. It has been shown that constructions with square sections perform better in terms of structure reaction as compared to rectangular segments, independent of floor design. When FVD are used in Time History investigations, the timeframe can be reduced by up to 90 percent. The Base Shear of the buildings was reduced by 70% using FVD250. As a result, FVDs may be used in RC multi-story constructions to effectively reduce response rates.

16. Evaluating Effects of Viscous Dampers on Optimizing Seismic Behavior of Structures

V. Sadeghi Balkanloua, M. Reza Bagerzadeh Karimib, B. Bagheri Azarc and Alaeddin Behravesh

The position of dampers and how to optimise their position at the height of the structure are investigated in this research. It looks into viscous damper systems and their impacts on multistory seismic behaviour, as well as the effects of damper system position on structural height, utilising uniform distribution and SSSA approaches. Three 4, 8, and 12-story steel structural frames were used as understudy models in this investigation. The models were created and examined using existing Codes to represent a variety of buildings. To assess the impacts of specific damper system characteristics, two goal values of 15% and 25% for the effective damping ratio of the damper system were studied, with the findings serving as illustrative of the suitable spectrum of typical damper system features. The maximum response of relative displacement of stories was computed for every point of the obtained damper after time history analyses on the models developed under three earthquake recordings that were scaled according to spectrum design of Iran 2800 Code-3rd Ed. The damper system has a considerable impact on the structure's dynamic characteristics. The smaller the seismic reaction, the higher the damping ratio of the damper system. In time history investigations, the results of the SSSA approach are largely dependent on the earthquake record and damping ratio of the selected target.

17. Viscous Dampers for High-Rise Buildings

Samuele Infanti, Jamieson Robinson & Rob Smith

The findings of a large laboratory testing programme aimed at confirming their behaviour during both wind storms and earthquakes are described in this research, as well as the VD technology installed in these high-rise structures. The inclusion

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of VDs to the St Francis Towers, together with the use of performance-based seismic design, allowed for a smaller superstructure, resulting in a net savings of $4 million dollars. Furthermore, earthquakes in March 2005 and May 2008 (Sichuan Earthquake) as well as several powerful typhoons (notably during a particularly active typhoon season in mid-to-late 2005) have previously activated the Taipei 101 TMD. Building performance data was acquired via the on-site monitoring system during some of these occurrences, and the TMD was found to operate as the design planned.

III. Conclusion

From this we conclude that the viscous damper can reduce the seismic load on the structure. When dampers are provided in a structure the displacement value of a structure is lowered upto 60% to 85%. And the storey drift value is reduced at top and bottom stories upto 60% to 80%. Viscous dampers is effectively controlled the effects due to seismic forces and the wind forces. When the dampers are provided in zig-zag pattern the reduction in the lateral deformation have been noticed to have reduced by 40%, due to high wind load and earthquake forces.

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