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A Review on "Analysis and Design of Multi Storied Building for Vertical and Horizontal Loading with and Without Dampers"

Pratiksha Gondane [1], Prof. Harshwardhan Rangari [2], Prof. Girish Sawai [3]

[1] PG Scholar, Civil Engineering Department, V.M. Institute of Engineering and Technology, Dongargaon, Nagpur, Maharashtra, India

[2] Guide, Assistant Professor, Civil Engineering Department, V.M. Institute of Engineering and Technology, Dongargaon, Nagpur, Maharashtra, India

[3] Co-Guide, Head of the Department, Civil Engineering Department, V.M. Institute of Engineering and Technology, Dongargaon, Nagpur, Maharashtra, India

ABSTRACT: Dampers are strategically placed in the building structure to control floor vibrations and building displacement, cater for occupancy comfort and mitigate against major seismic events. The energy generated by floor vibration and building displacement is absorbed by the dampers and dissipated though heat energy.The most crucial factor to take into account while designing any construction is earthquake. The majority of structures experience vibration during an earthquake.. The vibrations may arise from wind forces, earthquake excitation, machine vibrations, ormany other sources. In some cases, especially under strong earthquake excitations, these vibrations can cause structuraldamage or even structural collapse. By using dampers severe damages can be prevented. The concept of the viscous damper isto absorb the shocks and vibrations from the structure.However, the most important is the location of dampers which isthe major consideration. Viscous damper is considered as thepassive control systems used to dissipate and absorb energy induced during the earthquakes due to earthquake. The mainpurpose of application of dampers is to enhance the stiffness and stability of the structure and make the structure earthquakeresistant. The present review is focused on the study of seismic behavior of building with the dampers and to evaluate seismicresponses such as displacement, Storey drift and modal parameters.

KEYWORDS: Seismic Analysis, Earthquake, Dampers, Storey Drift, Displacement, Time History Method

I. INTRODUCTION

The common practice to strengthen existing buildings is to strengthen members and joints with concrete or steel jacketing and to increase the size of the structural members so as to meet the new design requirements. However, it is a time-consuming process and requires demolition of plastering of members, further it may cause pollution to the environment. Considering the above disadvantages, earthquake resistant design and retrofit of structures using energy absorption devices have received desirable attention in recent years (Soong and Dargush 1997). Primary objective of adding energy passive dissipators is to enhance the damping of the structure and to bring down the demand on structural members without the help of external power supply and to minimize structural damage. Number of passive energies dissipators are employed in structural design viz., friction dampers, metallic dampers, viscoelastic dampers and dampers made out of smart materials.The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces.The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. The minimum requirements pertaining to the structural safety of buildings are being covered by way of laying down minimum design loads which have to be assumed for dead loads, imposed loads, and other external loads, the structure would be required to bear. Strict conformity to loading standards recommended in this code, it is hoped, will not only ensure the structural safety of the buildings which are being designed.

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The term "earthquake" refers to the movement of the Earth's surface. It's a sudden trembling of the Earth's surface. Earthquakes are unquestionably a devastating natural calamity. The severity of an earthquake is determined by its magnitude and the distance from its epicenter. A high-rise structure's performance during significant trembling motions is influenced by its stiffness and mass distribution in both vertical and horizontal directions. A building is classified as irregular if there is a discontinuity in stiffness or mass between adjoining storeys. The presence of a vertical uneven frame that is susceptible to earthquakes is cause for concern. Weak or critical points in structures are areas where stiffness, mass, and strength abruptly change. This flaw causes the structure to deteriorate, eventually leading to structural collapse. One of the primary reasons of earthquake failure has been found as irregular structure forms, either in plan or in elevation.

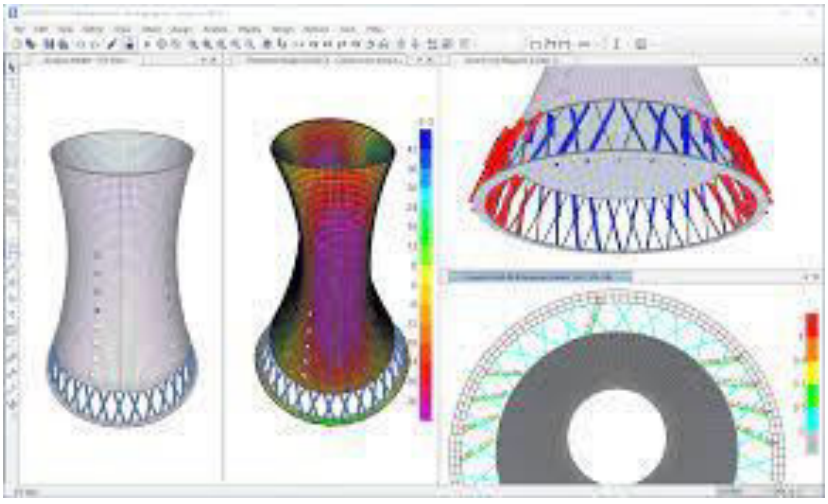
Table 1.1: List of natural and man-made earthquake sources

Natural Source	Man-made Source
• Tectonic Earthquakes • Volcanic Earthquakes • Rock Falls/Collapse of Cavity • Microseism	• Controlled Sources (Explosives) • Reservoir Induced Earthquakes • Mining Induced Earthquakes Cultural • noise (Industry, Traffic, etc)

At the point when the focal point of a vast quake is found seaward, the seabed might be movement adequately to cause a wave. Seismic tremors can likewise trigger destruction of property, landslide, and at times volcanic movement injury of people and even kills. For a gigantic number of years, the powers of tectonic plates have mold the Earth as the enormous plates that structure the Earth's surface move progressively finished. A seismic tremor's purpose of introductory burst is called its focus or hypocenter. The focal point is the point at ground level straightforwardly over the hypocenter. The dynamic response of structure to seismic tremor ground development is the most basic explanation behind shudder incited mischief to structures. The mischief that a structure suffers essentially depends not upon its removing, anyway after accelerating. While dislodging is the genuine detachment the ground and building may move in the midst of a shudder, stimulating is an extent of how quickly they change speed as they move. The standard method to manage seismic tremor safe arrangement of structures depends on outfitting the structure with quality, solidness and inelastic twisting limits which are incredible to withstand a given component of shudder formed drive.

1.1 SAP 2000 PROGRAM

SAP2000 means Structural Analysis Program2000. SAP2000 is a structural analysis and design software produced by Computer and Structures, Incorporated (CSI), a structural and earthquake engineering company. SAP2000 is a structural analysis and design software developed by csiamerica. It is a very powerful software that can design almost any kind of civil engineering structure. SAP2000 is used for the design of beam and columns only. CSI SAP2000 (Structural Analysis Program) is an engineering software that is ideal for analysis and design of structural elements like beams, columns, slabs, trusses, cables, shells, etc. What makes SAP2000 used by most engineers around the world is the fact that it's simple and capable at the same time.



[Fig.1.1: Working Interface of SAP 2000]

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1.2 CODAL PROVISIONS

1) Dead Load – IS 875 Part I
2) Live Load – IS 875 Part II
3) Wind Load - IS 875 Part III
4) Seismic Analysis

a. IS 1893:2002 (Part 1)

Main code that provides the seismic zone and specifies seismic design force. This depends on the mass and seismic coefficient of the structure; the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility.

II. LITERATURE REVIEW

The main purpose of literature survey is to give us an idea about the work conducted world over in the field of our project work. For the seismic analysis of multi-storied structure with shear wall, some of the important literatures were collected. Here are the few literature reviews related to the work carried out. This forms the basis on which we can carry out work and the techniques that can be used for the analysis.

2.1 REVIEW/ RESEARCH ARTICLE

[1] Seismic Design of Multistorey RCC-Building with Dampers Using ETABS (2018)

The basic principles of design for vertical and lateral loads (wind & seismic) are the same for low, medium or high-rise building. But a building gets high both vertical & lateral loads become controlling factors. The vertical loads increase in direct proportion to the floor area and number of floors. In contrast to this, the effect of lateral loads on a building is not linear and increase rapidly with increase in height. Due to these lateral loads, moments on steel components will be very high. By providing viscous dampers these moments can be reduced. In the present analysis, a residential building with 20 floors is analysed with columns, columns with viscous dampers at different locations were for all the 2 cases. The building is analysed in Zone 3 & Zone 5 with three soils in both static Analysis. Displacement was compared for all the cases.

It is observed that the deflection was reduced by providing the Viscous dampers. Displacement is compared for two models i.e,, without dampers & with dampers at top storey of a high rise building in zone-2 & zone -5 in each soil it is observed that 50% displacement is reduced when the dampers are provided at each elevation. By providing the dampers the stiffness of the structure is increased and storey shear is decreased with increase in height of structure.

[2] Analysis and Design of Multi Storied Building For Vertical And Horizontal Loading With And Without Dampers (2018)

Damping plays important feature in format of Earthquake Resistant Structures, which reduces the response of the structure while they are subjected to lateral loads. There are many particular sorts of dampers in use. In the prevailing have a study Fluid Viscous dampers (FVD) are used to evaluate the reaction of RC buildings.

The major task of a shape is to undergo the lateral loads and switch them to the foundation. Since the lateral loads imposed on a structure are dynamic in nature, they motive vibrations in the shape. In order to have earthquake resistant systems, fluid viscous dampers have been used. Buildings having square and rectangular plans, with rectangular and rectangular column pass- sections are analyzed, with and with out FVD. In the prevailing take a look at the software program ETABS 2015 had been used. Using Push over and Time facts analyses the reaction of the RC constructing taken into consideration in the present test is evaluated and as compared with and without FVD.

It has been located that homes with square columns are performing nicely in terms of reaction of the structure whilst in comparison to the rectangular columns no matter the ground plan. In Time History analysis, as tons as 90% decrease within the time Period is obtained whilst FVD are used. FVD250 decreased the Base Shear of the structures with the aid of the usage of 70%. Hence FVD's may be used in RC multistory buildings to lessen the reaction efficiently. Based on the effects and communicate given in financial ruin 5 the following conclusions are drawn. Up to 90% decrease in Time period of maximum PSA in Response spectrum curves even as FVD is used.

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FVD250 reducing the Base Shear of the systems by using 70% in Time history evaluation. The pinnacle tale Displacements are minimized by ninety% with use of FVD. The boom of 60% to 70% are placed in Eigen Values indicates the effective increment inside the stiffness of the shape while FVD250 used for exterior corners.

It is observed that homes with square columns are acting nicely in terms of response of the shape at the same time as compared to the square columns no matter the ground plan. In evaluating the seismic overall performance of structures, the prediction of harm in structures is tough to estimate by using the use of using the push-over assessment while in assessment with the Time data evaluation.

[3] Analysis and Design of Multi Storied Building for Vertical and Horizontal Loading with and Without Dampers using SAP2000 (2016)

The current trend toward buildings of ever increasing heights and the use of lightweight, high strength materials, and advanced construction techniques have led to increasingly flexible and lightly damped structures. Understandably, these structures are very sensitive to environmental excitations such as wind, ocean waves and earthquakes. In this study a Tuned mass damper proposed as energy dissipation devices for buildings subjected to earthquake loads. The springs of the Tuned mass damper are placed between the structure and the mass of the damper to eliminate or minimize the damage due to earthquake loads. To reduce the response of displacement, The Tuned mass damper are introduced as energy dissipation devices. The Tuned mass damper (with spring and dashpot) is sufficiently flexible to reduce the response of acceleration.

The response of displacement due to provided flexibility is effectively controlled by the addition of energy dissipation devices, In this study the Response Spectrum Analysis are used. SAP 2000 is an extremely versatile and powerful program with many features and functions. This manual does not attempt to fully document all of those features and functions. Rather, we briefly show how to work with the program, providing some commentary along the way.

A TMD system using spring units and visco-elastic dampers can reduce vibration in a building, and it is become more safety during the earthquakes. For applying this system in India, it is necessary to confirm the seismic safety. At first static loading tests of the spring units and dynamic loading tests of a visco-elastic damper were carried out.

The analytical models created by SAP 2000 program with and without Tuned mass damper (TMD) to study the behavior of the building and the responses of it after subjected to earthquake load. The dampers in these models are installed on the top storey of the buildings, and the models created as regular and symmetrical models with 15 storey (45m) ,25 storey (75m) and 35 storey (105m).

[4] Design and Analysis of Seismic Forces in Multi-Storey Building with Water Tank as Liquid Damper (2017)

The principle objective of this project is to analyse and design a multi-storeyed building G+10 (3 dimensional frame) using ETABS 2015. The design involves load calculations manually and analyzing the whole structure by ETABS 2015. The design methods used in ETABS 2015 analysis are Limit State Design conforming to Indian Standard Code of Practice. ETABS features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities.

From model generation, analysis and design to visualization and result verification, ETABS 2015 is the professional‟s choice. Initially we started with the analysis of simple 2 dimensional frames and manually checked the accuracy of the software with our results. The results proved to be very accurate. We analyzed and designed a G + 10 storey building [2-D Frame] initially for all possible load combinations [Dead, Live, Wind and Seismic Loads]. Several technologies are available to minimize the vibration of structures, of which, use of Tuned Liquid Damper (TLD) is a recent development. TLD is traditionally made of rigid tank filled with water. Once excited, the water inside the tank experiences sloshing motion as a result of building vibration and dissipates energy through the sloshing and wave-breaking of the liquid. This project aims to study the effectiveness of TLD in reducing seismic vibration of a two-storied building frame when it is subjected to horizontal excitations. Analytical study of the undamped frame was carried out in ANSYS WORK BENCH software. Based on modes and frequencies obtained from analytical study, dimensions of steel building frame were fixed and experimental study was carried out by shake table experiments. Also various parameters that influence the effectiveness of TLD are studied.

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[5] Dynamic Analysis of a Steel Structure for Horizontal and Vertical Loading with and Without Dampers (2018)

Earthquakes are the most capricious and destroying of every single catastrophic event, which are extremely hard to spare over building properties and life, against it. Thus so as to beat these issues we have to recognize the seismic execution of the fabricated condition through the improvement of different explanatory strategies, which guarantee the structures to withstand amid visit minor tremors and create enough alert at whatever point subjected to real quake occasions. So that can spare however many lives as could be expected under the circumstances.

There are a few rules everywhere throughout the world which has been over and again refreshing on this subject. In the present study, Extensive literature review is carried out and few conclusions were drawn and also predicted few out comings. SAP2000 Software is used for the modelling and analysis of different building and damper configurations. The static and dynamic analysis is carried out. Finally, Conclusions are made based on the performance of each system under study.

The conclusions drawn from analysis, from the modal analysis results it can be concluded that presence of damper increase the overall frequency of structure due to stiffness increase. From the displacement results of equivalent static analysis, it can be concluded that, dampers play a very important role in reducing the overall displacement of the structure. From time history analysis it can be concluded that, dampers are effective in reducing the displacements along Y direction compared to X direction.

Hence it is suggested that provision of dampers at re-entrant corner will be advantageous with respect to overall stability of structure. Hence it is suggested that provision of dampers at re-entrant corner will be advantageous with respect to overall stability of structure. Also it is concluded that, damper are very effective in reducing the story drifts particularly at their respective location.

[6] Seismic Analysis and Design of Multi Storey RC Buildings with and without Fluid Viscous Dampers (2021)

Earthquakes are one among the foremost destructive of natural hazards. Earthquake occurs due to sudden transition motion of the ground as a result of release of energy in a matter of few seconds. This recent events remind us of the vulnerability of our society to natural hazards. The protection of civil structures, including material content and human occupants is, doubtless, a worldwide priority. The challenge of structural engineers is to raised withstand these natural hazards. In the present study reinforced concrete moment resisting frame building of G+20 are considered.

The building is taken into account to be located in the seismic zone (v) and intended for commercial purpose. Model-I Building without dampers, Model-II –Building with dampers. The building of G+20 has been modeled by providing with and without damper providing all parameters using S A P 2 0 0 0 software. When the structure is connected to the fluid viscous dampers (FVD), the building's displacements and accelerations may be controlled. Further damper at appropriate locations can significantly decrease the earthquake response.

The Present study is focused on the study of Seismic demands of different R.C buildings high rise buildings using numerous analytical techniques for the buildings located in seismic zone V of India medium soil. The achievement of the building is studied in terms of time period, base shear, lateral displacements, storey drifts in linear static and linear dynamic analysis for with and without fluid viscous dampers building G+20 storey models. The storey drift rises in regular building as compared to building having fluid viscous dampers. The addition of fluid viscous dampers in the building drastically decreases the inter storey drift as compared to that of building without fluid viscous dampers. Compared to the regular building the storey displacement decreases for the buildings having fluid viscous dampers. Addition of fluid viscous dampers in the building will result in drastic depletion of lateral displacement of the building there by in turn assures the safety of the structure. The base shears due to seismic forces for the building with fluid viscous dampers are greater than the base shear achieved for without fluid viscous dampers.

[7] Analysis of irregular multistorey buildings with and without floating columns under seismic loading (2022)

Floating column is a vertical structural member that rests on the beam. Floating column is advantageous to provide large open space in a building, but it is disadvantageous in earthquake conditions. On the other hand, by the advancements in civil engineering knowledge, architects try to adopt irregular shapes of buildings. Providing floating

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columns in irregular buildings is a challenging issue for civil engineers they should deal with. That's why study of application of floating column in irregular buildings is one of the important topics in modern civil engineering. This study focuses on analysing the seismic behaviour of G + 10 irregular buildings considering floating columns and without floating columns to compare with a regular building. The building models are analysed in ETABS V19 software, then analytical findings are explained in terms of (maximum storey drift, maximum storey displacement, and torsional irregularity). From the study it is found that providing floating columns in irregular buildings increase storey drift and storey displacement significantly. Similarly, the torsion increases in buildings when the floating columns are not provided symmetrically. In this paper we will deal with the seismic analysis of G + 10 building with irregular configuration considering floating columns and without floating columns and compare to a regular building without floating column. Response Spectrum analysis method will be used to determine storey drift, storey displacement and torsional irregularity of the buildings using ETABS (V19) in seismic zone IV of India. For the seismic analysis purpose, the Indian Standard code (IS 1893 – 2016) (part 1) is used.

In this study, the seismic response of non-parallel lateral force system irregular building with and without floating columns is examined to compare with a regular building. Response Spectrum analysis method is used by ETABS V19 software to analyse G + 10 building models and got the results of maximum storey drift, maximum storey displacement and torsional irregularity of buildings in seismic zone IV of India.

[8] Seismic Analysis of Multi-Storey Building with Vertical Irregularities in Stiffness and Mass Under Various Soil Conditions (2021)

Earthquakes are a major problem all around the world as they cause catastrophic damage such as building failure and collapse and most importantly loss of human lives and homes. One of the most common causes of failure during earthquakes is irregular configuration, either in plan or in elevation. As a result, irregular structures, especially in seismic zones, becomes the main cause of concern. The current study deals with the performance analysis of a G+6 Storey residential building with Stiffness and Mass irregularity carried out by varying the positions of these irregularities in the building as per IS 1893 (Part 1): 2002 considering seismic zone 4.

Response spectrum analysis has been adopted for analyzing the effect of Stiffness and Mass irregularity using ETABS16 software. Parameters such as Storey displacement, Storey drift, Storey stiffness, Storey shear and overturning moment have been considered for its performance study. With the consideration of all the irregular models and their behavior in dynamic earthquake loading, it is evident that the Model H11 gives the most optimal results and is recommended to be constructed in the earthquake prone areas that includes least Displacement, least Drift and least Shear force among all the other models. Among all the models analyzed under consideration, Model H11 has the least Displacement of 23.41% less than the Model S23 having the highest. Also, the Drift of 24% and Storey shear of 12.40% are less as compared to ModelS23. The problem considered for the current study is taken from IS 1893-part 1: 2002 this 6-storey building frame is considered with two different irregularities as mass and stiffness irregularities are taken from IS-1893-part 1: 2002. A total of 21 models have been modelled of which 3 models are regular models of soft, medium and hard soil and remaining 18 models are Irregular models with 6 models in each soil condition (soft, medium and hard) by varying the positions of Stiffness and Mass Irregularity. With the consideration of all the irregular models and their behavior in dynamic earthquake loading, it is evident that the Model H11 gives the most optimal resultsand is recommended to be constructed in the earthquake prone areas that includes least Displacement, least Drift and least Shear force among all the other models.

[9] Seismic Analysis and Design of RCC Multi Storey Building Considering with and without Slab Diaphragm Effect (2022)

This experimental study encompasses the seismic analysis and design of multi storey RC building frames by considering different types of slab diaphragm. Two different type of slab diaphragm are considered namely without slab diaphragm i.e Flexible slab diaphragm and with slab diaphragm i.e Rigid slab diaphragm. These slab diaphragm systems are very efficient in resisting lateral forces.

STAAD.Pro software has been used for analysis and design purpose. Results are collected in terms of maximum moments in Columns/beams, axial force, shear force, maximum displacement and storey displacement which are critically analyzed to quantify the effects of various parameters. This approach focuses on choosing the suitable slab diaphragm for a particular structure and their effectiveness in reducing the lateral displacement and moment thereby achieving economy in construction with similar structure.

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The role of Diaphragms are to a) resist gravity loads. b) to provide lateral support to vertical elements. c) to resist out-of-plane forces Resist thrust from inclined columns. d) to transfer lateral inertial forces to vertical elements of the seismic force-resisting system. e) to transfer forces through the diaphragm. f) to support soil loads below grade. Internal forces in a diaphragm are computed using approaches that range from simple idealizations to complex computer analysis. The analysis need only be as complex as necessary to represent how lateral forces flow through the building including the diaphragms.

For regular buildings in which lateral resistance is provided by similar vertical elements distributed throughout the floor plan, simple models are often adequate for determining the diaphragm forces. For buildings with irregularities or with dissimilar vertical elements, significant force transfers may occur among the vertical elements at various levels, requiring more complex models to determine the diaphragm design forces. Hence STAAD.Pro software has been used for analysis purpose.

[10] Seismic analysis of Multi storey Building on Sloping Ground and Flat Ground by using ETABS (2022)

Due to urbanization and industrialization, which paved the door for the development of tall, multi-story structures on mountainous terrain, land is scarce in emerging nations like India. Buildings built on hilly terrain differ from those built on flat terrain due of their uneven and asymmetrical vertical and horizontal structures. These buildings are also significantly more vulnerable to earthquake pressures when located in mountainous terrain. The primary goal of the current endeavor is to investigate how structures behave on level and sloping terrain. Hilly places require different construction configurations than level areas.

Hill structures vary from those on lowlands in that they are torsionally linked, highly irregular, and asymmetrical in both the horizontal and vertical planes. As a result, they are vulnerable to severe damage when an earthquake strikes. The behavior of a multi-story structure with two distinct slope angles was attempted to be studied in this paper, and a comparison with flat ground was made. by taking Earthquake Zone II into account. Buildings on level ground and buildings on slanted ground are compared. The models are created with the aid of the structural analysis program ETABS.

Response spectrum analysis is used for analysis. The analysis's findings, including storey shear, storey drifts, moments, and displacement, are tabulated and examined.

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