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Study of effect of damper on high rise structure

Mudbakhe A. A [1] Sanap S. T [2]

1(P.G.Student, Department of Civil Engineering, S P Pune University/SND College of Engineering and Research Center, Yeola)

2 (Assistant Professor, Department of Civil Engineering, S P Pune University/SND College of Engineering and Research Center, Yeola)

Abstract:

In day to day life, it is needed to study the behaviour of every multi-storied building structure subjected to ground motion which is the common problem for construction. The earthquake creates the vibrating forces at the base of structure. These vibrations create the oscillations in building which may damage the structure tremendously. These vibrations created at the ground level gets transferred up to the top of building and because of mass of structure which produces the lateral forces on the frame which finally reduces the moment resistance capacity of building parameters such as columns beams etc. Paper gives the idea about different researches carried out on multi-storeyed building considering various parameters. This study describes the results of a study on the seismic behaviour of a structure (G+20) with and without damper with soft storey. The result from a previous experiment expressed that with the use of dampers, the stiffness and strength of the structure increase considerably..

Keywords **— soft storey, damper, lateral story displacement, base shear.**

I. INTRODUCTION

An earthquake (also known as a quake, tremor or temblor) is the perceptible shaking of the surface of the Earth, which can be violent enough to destroy major buildings and kill thousands of people. The severity of the shaking can range from barely felt to violent enough to toss people around. Earthquakes have destroyed whole cities. They result from the sudden release of energy in the Earth's crust that creates seismic waves. The seismicity or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time.

In addition to the loads due to the effects of gravity, earthquake loading must be considered when designing structures located in seismically active areas. The philosophy in the conventional seismic design is that a structure is designed to resist the lateral loads corresponding to wind and small earthquakes by its elastic action only, and the structure is permitted to damage but not collapse while it is subjected to a lateral load associated with moderate or severe seismic events. As a consequence, plastic hinges in structures must be developed in order to dissipate the seismic energy when the structure is under strong shakings. The design methods based on this philosophy are acceptable to account for the needs for both economic consideration and life safety. However, the development of the plastic hinges relies on the large deformation and high ductility of a structure. The more ductility a structure sustains the more damage it suffers. Besides, some important structures such as hospitals and fire stations have to remain their functions after a major earthquake, the aforementioned design philosophy (life-safety based) may not be appropriate. These structures should be strong enough to prevent from large displacement and acceleration so that they can maintain their functions when excited by a severe ground motion.

II. LITERATURE

Waseem Khan [1], Dr. Saleem Akhtar [2], and Aslam Hussein [3] (Department of Civil Engineering, University Institute of Technology, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal. M.P. India) has describes the results of an extensive study on the seismic behaviour of a structure with damper and without damper under different earthquake acceleration frequency like EQ Altadena, EQ Lucerne, EQ Pomona, EQ Smonica and EQ Yormo. The proposed procedure is placed the dampers on the floors of the ninth-floor and five-floor of a ninth story building frame then compare the different performance of structure with damper up to Ninth-floors, damper up to Fifth-floors and without damper of ninth-story building frame using SAP2000 V15. As per IS-1893 2002 non-linear time-history analyses of frame structure indicate that maximum displacement, maximum base shear and maximum acceleration effectively reduce by providing the damper in building frame from base support to fifth- floor and base support to ninth-floor comparison to as usual frame.

Mohit Sharma [1], and Dr. SavitaMaru [2] (Department of Civil Engineering, U.E.C, Ujjain, Madhya Pradesh, India) has mentioned that analysis and design of buildings for static forces is a routine affair these days because of availability of affordable computers and specialized programs which can be used for the analysis. On the other hand, dynamic analysis is a time consuming process and requires additional input related to mass of the structure, and an understanding of structural dynamics for interpretation of analytical results. Reinforced concrete (RC) frame buildings are most common type of constructions in urban India, which are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forces due to the wind and earthquake. Here the present works (problem taken) are on a G+30 storied regular building. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parameters for the design as per the IS-1893- 2002-Part-1 for the zones- 2 and 3 and the post processing result obtained has summarized.

Wakchaure M.R [1] , and Ped S. P. [2] (Department of Civil Engineering, Amrutvahini, College of Engineering, Sangamner, and Maharashtra.) has studied the effect of masonry infill panel on the response of RC frames subjected to seismic action is widely recognized and has been subject of numerous experimental investigations, while several attempts to model it analytically have been reported. In analytically analysis infill walls are modelled as equivalent strut approach there are various formulae derived by research scholars and scientist for width of strut and modelling. Infill behaves like compression strut between column and beam and compression forces are transferred from one node to another. In this study the effect of masonry walls on high rise building is studied. Linear dynamic analysis on high rise building with different arrangement is carried out. For the analysis G+9 R.C.C. framed building is modelled. Earthquake time history is applied to the models. The width of strut is calculated by using equivalent strut method. Various cases of analysis are taken. All analysis is carried out by software ETABS. Base shear, storey displacement, story drift is calculated and compared for all models. The results show that infill walls reduce displacements, time period and increases base shear. So it is essential to consider the effect of masonry infill for the seismic evaluation of moment resisting reinforced concrete frame.
superposition has several advantages not only for the efficiency of response evaluation but for the understanding of the modal characteristics of the non-proportionally damped structures.

In this study some of efficient analytical procedures are applied to obtain the seismic response of a non-proportionally damped building structure with added visco-elastic dampers; the complex mode superposition method, direct integration method combined with matrix condensation, modal strain energy method, and the method disregarding the off-diagonal terms of a transformed damping matrix. Special attention has been paid for the derivation of the complex modal superposition procedure, and the reliability of the approximate methods is checked by comparing the approximate solutions with those obtained from the complex mode superposition.

Jinkoo KIM [1], And Chang-Yong LEE [2] has stated that in the analysis of a structure installed with visco-elastic dampers the modal strain energy method has been generally applied to predict the equivalent damping ratios of the system [Lai et. al., 1995]. The method derives the equivalent damping ratios based on the assumption that the damping is proportional to mass and/or stiffness of the structure system. However the assumption of proportional damping may no longer be valid when the visco-elastic dampers are added to the structure. In this case the direct integration method provides the correct results, but it requires too much computation time and memory space to be applied in practice. There is, however, a reliable alternative procedure for the analysis of the non-proportionally damped structure; the complex mode superposition method which provides exact solution in less time than needed for the direct integration. Compared with the direct integration method, the complex mode

Timothy Paul Jester [1] (Lehigh University Bethlehem, PA, USA) has stated that there are two types of visco-elastic (VE) seismic dampers for building structures, the VE diagonal damper and the VE passive mass damper which are studied in this thesis. The thesis reviews the relevant theoretical considerations in earthquake engineering and discusses the properties of VE materials important in damper design. It presents analytical equations for determining the damping added for each system. Finite element modeling of each system is used to determine the effectiveness of the dampers at reducing the seismic response of a prototype frame structure. Current design methods are reviewed, where possible. The effects of variation in the important design parameters are studied. For the VE diagonal dampers, these parameters include the stiffness of the supporting brace and the thickness of the VE material, whereas for the VE passive mass dampers, they included the damper mass, the number of dampers and the tuning frequency of the dampers. A method for designing a system of VE diagonal dampers is presented which uses the mass-normalized mode shapes to simplify previous methods. Stability problems in low frequency VE passive mass dampers are discussed and the feasibility of constructing them is considered. Several alternative designs and approaches are presented to deal with the problems.
It is concluded that both VE diagonal dampers and VE passive mass dampers were effective at reducing the seismic response of the prototype. The mass dampers were somewhat better at

reducing the base shear and moment response. Mass dampers also appeared to have some advantages in design, including greater versatility, and better economy in the use of VE material.

Roman Lewandowski [1], and Zdzis"awPawlak [2] has studied frame structures with visco-elastic dampers mounted on them are considered in this paper. Visco-elastic (VE) dampers are modeled using two, three-parameter, fractional rheological models. The structures are treated as elastic linear systems. The equation of motion of the whole system (structure with dampers) is written in terms of state-space variables. The resulting matrix equation of motion is the fractional differential equation. The proposed state space formulation is new and does not require matrices with huge dimensions. The paper is devoted to determine the dynamic properties of the considered structures. The nonlinear eigenvalue problem is formulated from which the dynamic parameters of the system can be determined. The continuation method is used to solve the nonlinear eigenvalue problem. Moreover, results of typical calculations are presented.

[1], L. Rouleau1 [2], V. D´Ortona1 [3], W. Desmet1 [4], and B. Pluymers [5] (Institute of Aeronautics and Space (IAE)/Technological Institute of Aeronautics (ITA) PraçaMarechal Eduardo Gomes, 50, São José dos Campos, São Paulo, Brazil) has studied the effect of the damping addition due to visco-elastic (VE) material on the dynamic behavior of aluminum panels is assessed in this work. Dynamic Mechanical Analysis (DMA) tests are carried out, aiming at characterizing the rheological behavior of a VE compound. The Time-Temperature Superposition Principle (TTSP) is applied and the VE compound master curve is built over a large frequency range. As a result, the parameters for both, Generalized Maxwell Model (GMM) and Fractional Derivative Model (FDM) are determined. Distributed and local coatings of the VE material are applied to aluminum plates and the responses of these sandwich structures are calculated by using finite elements method where the VE behavior is modeled either with a GMM or a FDM. As a second step, tests are done by reproducing the same modeled configurations with the testing facilities of KULeuven. Numerical vs. experimental Frequency Response Functions (FRF) comparisons are done in order to validate the models.

Zhao-Dong Xu (Civil Engineering College, RC & PC Key Laboratory of Education Ministry, Southeast University, Nanjing 210096, China) has stated visco-elastic (VE) dampers are one of the most common earthquake mitigation devices. This paper addresses the mathematical modelling of VE dampers and the dynamic analysis of structures with VE dampers. In this paper, the equivalent standard solid model, a new mathematical model of VE dampers, is used to describe the influence of temperature on the energy absorption features of VE dampers. Elastoplastic time field analysis, frequency field analysis and shaking table tests are used to analyse responses of a 1/5-scale three-story reinforced concrete frame structure with and without VE dampers. Comparisons between the numerical and experimental results show that the VE dampers can be modelled by the equivalent standard solid model and that the VE dampers are effective in reducing the seismic responses of structures.

III. METHODOLOGY

The main object of the project is to determine the seismic response of the high rise structure. There are many research works reported on various damper aspects like linear and nonlinear Static and linear and nonlinear dynamic analysis of buildings frame. In this study we have provided the damper at different story of building frame for seismic analysis as per IS 1893-2002. To analyse the behaviour of structure with applying damper to structure or the behaviour of structure without applying damper to structure with the help of E-tab software. The comparison of equivalent static analysis of structures with damper and without damper has been carried out. The resultant forces are as absolute displacement, absolute story drift, base reactions and base shear.

A) Modelling and Analysis

1. Number of stories - G+21
2. Floor to floor height - 3 m
3. Height of Building - 63m
4. Length in long direction - 38 m
5. Length in short direction - 16 m
6. Size of the columns - 1200X1050 mm
7. Size of the beams - 230X600 mm
8. Thickness of internal wall - 0.15 m
9. Thickness of external wall - 0.23 m
10. Live load on slab - 2 KN per meter
11. Floor finish load - 1.5 KN per meter
12. Grade of concrete - M25
13. Seismic Zone - III
14. Importance factor - 1
15. Soil Type -Medium Soil
16. Density of concrete - 25 KN/m^3
17. Damping - 5 %
18. Time period in x direction - 0.91
19. Time period in y direction - 1.4178

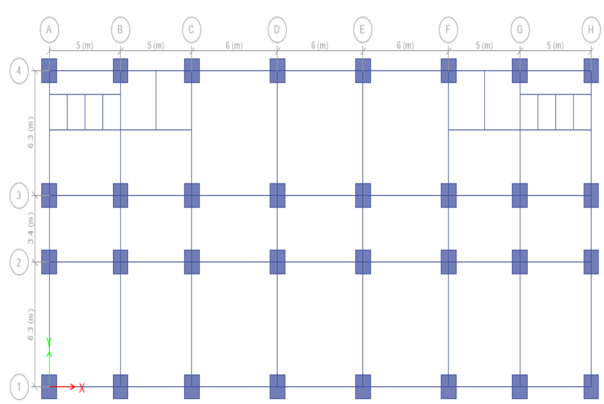


Fig no 1 Plan of Building

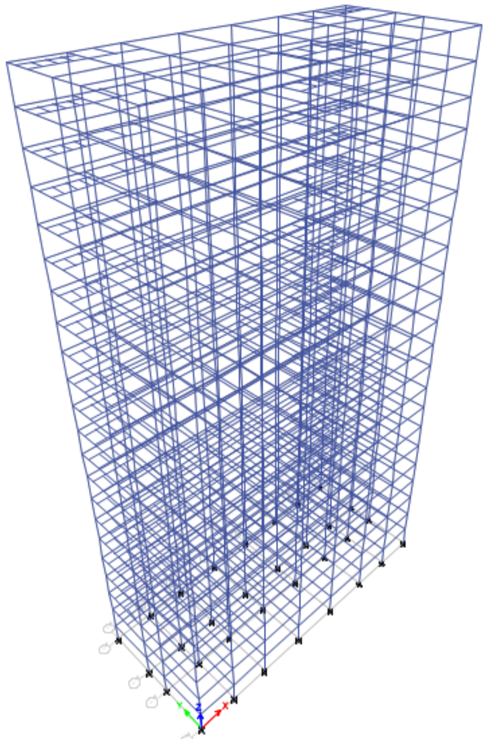
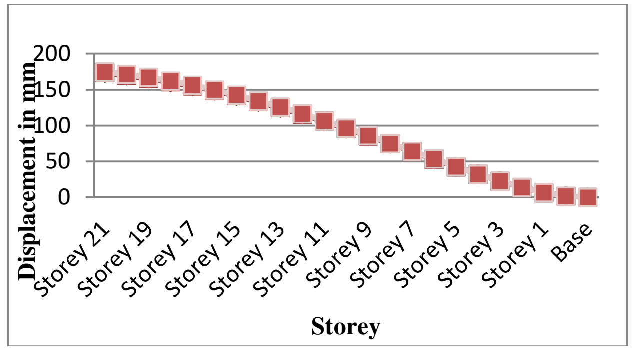
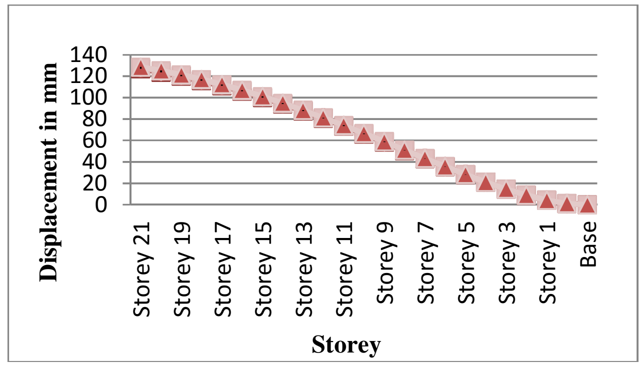


Fig no 2 Elevation of Building

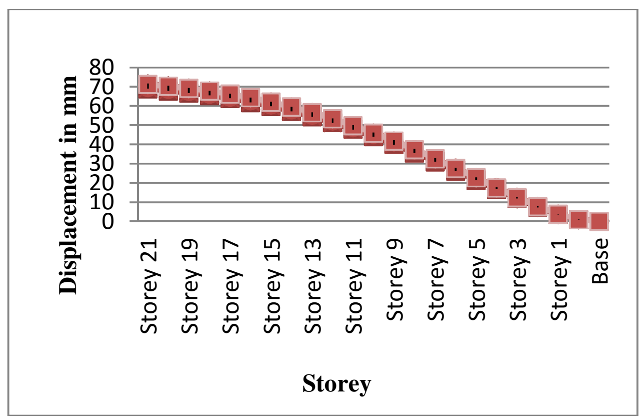
MODEL	DESCRIPTION
M 1	Building without Dampers
M 2	Building with dampers at 1st and 2nd floor
M 3	Building with dampers at 3rd and 4th floor
M 4	Building with dampers at 6th and 7th floor
M 5	Building with dampers at 8th and 9th floor
M6	Building with dampers at 10th and 11th floor
M7	Building with dampers at 12th and 13th floor
M8	Building with dampers at 14th and 15th floor
M9	Building with dampers at 16th and 17th floor
M10	Building with dampers at 18th and 19th floor
M11	Building with dampers at 20th and 21th floor



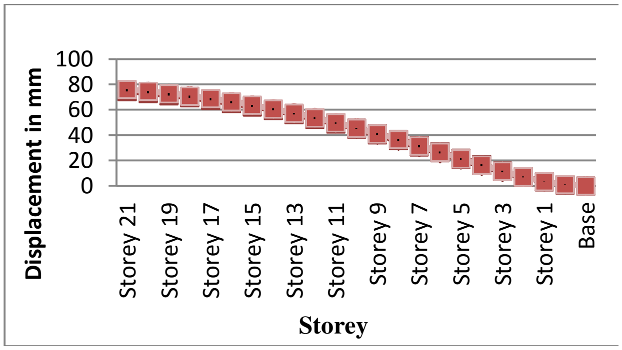
Graph no 1 Displacement of building in X direction (Equivalent Statics)



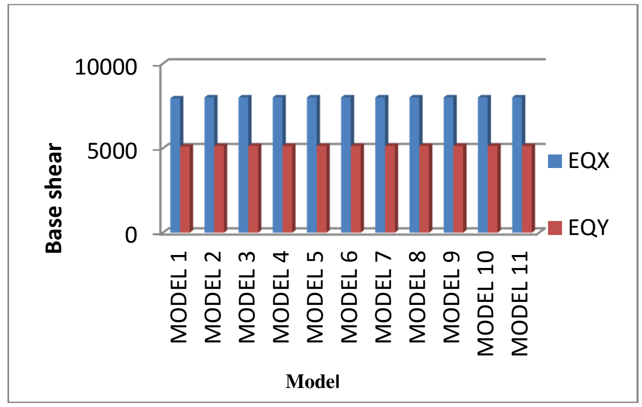
Graph no 2 Displacement of building in Y direction (Equivalent Statics)



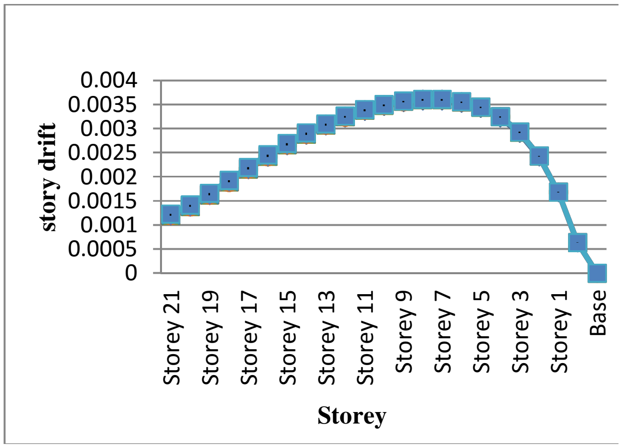
Graph no 3 Displacement of Building in X direction (Time History)



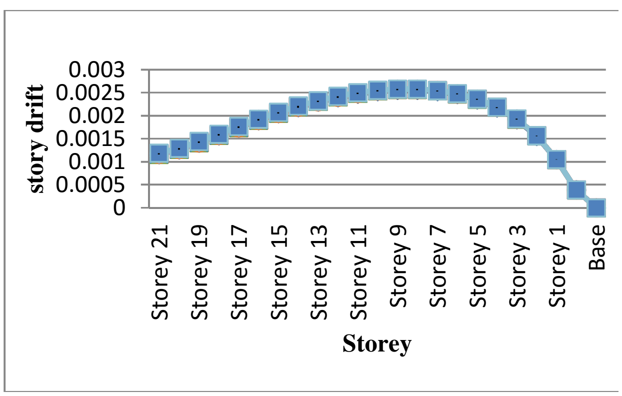
Graph no 4 Displacement of Building in Y direction (Time History)



Graph no 6 Base Shears



Graph no 5 Story Drift of Building in X direction



Graph no 6 Storey Drift of Building in Y Direction

CONCLUSION

After analysing a G+21 storied building by using ETABS software. Responses in the form of displacement, axial force & bending moment are noted. For that we have presented and discussed the Damping system. This is very effective in damping vibration cause by seismic activity or wind forces. It improve the earthquake resistance capacity of the structure and reduced the vibration of the structure. By using the damper for the particular storey the axial forces and bending moments are reduced of that storey. The deduction in drift and storey displacement is formed.

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