SEISMIC PERORMANCE OF BUILDING USING ACCORDION METALLIC DAMPER

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ABSTRACT

In recent years considerable attention has been paid to research and development of structural control devices with particular emphasis on mitigation of wind and seismic response of buildings. Many vibration-control measures like passive, active, semi- active and hybrid vibration control methods have been developed. Passive vibration control keeps the building to remain essentially elastic during large earthquakes and has fundamental frequency lower than both its fixed base frequency and the dominant frequencies of ground motion.

Passive energy dissipation has been used so far to dissipate the unwanted energy due to earthquake and heavy wind actions. The complete failure of the structures that has occurred in the past due to catastrophic earthquakes may be avoided with the use of such devices. The study is concerned with the use of accordion metallic dampers that uses hysteretic energy to dissipate the unwanted energy due to earthquake. It consists of corrugated thin walled tubes installed as a brace connection in the frame. The axial deformation of the accordion damper enhances the lateral buckling capacity and results in maximum reduction of the damaging measures. The study emphasizes the use of such dampers and in-depth analysis is performed by subjecting the building to base excitations in order to assess the nonlinear performance of the dampers installed in thebuilding

Finally, it is concluded that the metallic damper results in dissipation of earthquake energy and reduction in damaging measures such as storey drift, top storey displacement and axial forces by 30-40 %. Further, from the pushover curves, the capacity of the building is found to increase using metallic dampers.

Key Words- Metallic Damper, Lateral Buckling Capacity, Non-Linear Performan

1.INTRODUCTION

1.1 GENERAL :

Earthquake is a natural activity which takes place due to the sudden movement betweenmain tectonic plates beneath the earth surface which releases energy in earth’s crust and generate seismic waves, these radiates away from the source and travels rapidly throughthe earth’s crust. Earthquake may range in size from those that are so weak that they cannot be felt to those violent enough to toss people around and destroy whole cities. These waves reaches on earth‘s surface and it produce shaking which will remain for seconds to minutes and will produce a big disaster on earth surface which can cause structural damage or even structural collapse which results in loss of lives on earth surface and hence earthquake resistant design is considerably needed to minimize the effects of earthquake and can provide seismic retrofitting to important and lifeline existing structures.

In India, large number of existing buildings which are severely deficient against earthquake forces are increasing day by day. The solution for this problem is Seismic retrofitting and it strengthen such existing building but it is a complex task and requiresskill, retrofitting of RC buildings is particularly challenging due to complex behavior

of the RC composite material. The behavior of such buildings during the earthquake depends not only on the size of the members and amount of reinforcement, but to a great extent on the placing and detailing of the reinforcement.

Structures shows the inelastic non-linear behavior under severe cyclic loads associated with natural activities like earthquakes and winds, which imparts the external seismic energy to the them, consuming in the lateral movement of structures such movement may be responsible for the failure or collapse of these structures, in order to prevent such a collapse it is necessary to recognize the non-linear behavior of structure and adopt an suitable mechanism to control the response of them and this is possible by dissipating the input seismic energy which imparts on them. This dissipation of energycan be achieved by providing supplementary energy dissipating devices like metallic dampers, friction dampers, viscous and viscoelastic dampers amount of energy dissipates by these dampers is directly dependent on the material used and geometry of dampers. Amount of energy dissipates by metallic dampers can be evaluated by considering the force-displacement relationship of dampers material, such relationshipknown as hysteresis loop. The dampers may be intruded inside the building in the formof bracing element as shown in figure 1.2

1.2.OBJECTIVES

The objective of the present work is to study the effectiveness of metallic damper.The following are the objectives:

1. To study linear seismic analysis of building.
2. To study design of a structure for seismic forces.
3. To study the effectiveness of metallic damper.
4. To study Non-linear seismic analysis (push over analysis & time history analysis).
5. Investigate the response of structure with and without AMD.
6. To develop mathematical model of building with and without AMD in SAP2000 and perform non-linear time history analysis of the building to studythe seismic response of buildings under real earthquake ground motions.

2.LITERATURE REVIEW

Review of Literature

1.Constantinou and Symans (1993) conducted an experimental as well as analytical study of the response of the structure using viscous damper. One and three storey steel frames were modelled over shake table with and without damper. The test was conducted at different temperature and frequency range. The mechanical properties of the damper depend upon the temperature ranging from 0^0C to 50^0C and found to be independent of theamplitude of the motion. At the frequencies of 1, 2 and 4Hz, the device exhibits insignificant storage stiffness. At frequency above 4 Hz, the device exhibits storage stiffness. A comparison of the analytical and experimental study of various parameters such as force displacement relation, story shear and drift relation were made. Final conclusion made from the tested results were 30-70% reduction in storey drift, 40 – 70 % reduction in the storey shear. The tested damper showed linear viscous behavior for frequencies of motion below cut off frequency. The cut off frequency was 4 Hz and beyondthis frequency, damper showed visco-elastic behavior.

2.Dargush and Soong (1995), proposed a metallic damper as a most effective energy dissipation mechanisms for seismic retrofit as well as for design of new structure. For design of metallic dampers, he considered a microscopic (solid mechanics) approach withthis it is possible to determine fundamental quantities such as stress and strain, they concluded that resulting model permits a better understanding of dampers which help tounderstand aspects of the damper behavior to design implementation.

3.Motamedi and Nateghi (2004) Investigated Accordion thin-walled tube as a hystereticmetallic damper. In this paper, it is tried to introduce a new metallic damper as a supplemental passive energy absorption device for seismic design and seismic retrofitting of structures. Application of this device is in base isolation and chevron bracing in frame stories. A hysteretic system including of accordion thin-walled metallic tube has been suggested for this damper. Finite elements model and nonlinear dynamic analysis have been used in these studies. Analytical behavior of accordion thin-walled tubes like deflections, stress distribution, hysteretic loops, deterioration effects like strength reductionand stiffness degradation, and their capacity of energy absorption due to axial cyclic loadsfor using as a suggested damper have been studied. Analytical results show that the suggested system is suitable and usable as a hysteretic metallic damper because of stable behavior in tension and compression and energy absorption. They concluded that –

i. Most developed metallic dampers are applicable in small deformation range. So metallic dampers which could suffer big deformation in the stable state and absorb the energy, are required.
ii. Numerical studies and nonlinear analysis show that accordion thin-walled tubes canbe used as hysteretic metallic damper.
iii. Accordion metallic damper can be used for retrofitting the existing structures against the earthquake.

4.Khosravian and Hosseini (2005), applied a genetic algorithm (GA) to obtain an optimalnumber of the damper in each story of the building. The effectiveness of Metallic dampersfor seismic response reduction of structures is quite well known in the earthquake engineering community. However, little attention has been paid to evaluating the influenceof the number and placement of this type of dampers on the dynamic response. Using genetic algorithms as an optimization technique will allow for the simultaneous number and design of an effective structural control system. In this paper, the number of blades is cost as an optimization problem in the sense minimum base shear and inter-story drift with a minimum number of dampers. Optimal number of damper in a 10-storey building model is investigated. The proper configuration in this study will satisfy the evaluation condition such as a vibration control effect, an economical effect and a damper performance for arranging the damper in each story. They concluded that –

The paper demonstrates the use of a genetic algorithm approach for optimal design of passive dampers for building structures. The study employs the yielding Metallic dampers for the dissipation of energy. The genetic approach is used to calculate the required number of a given capacity dampers and their optimal numbers in a building to achieve adesired reduction in the response. For a given location of dampers, the approach can findoptimal distribution of blades to achieve the maximum reduction in a desired response. The response reduction performance could be expressed in terms of a reduction in a chosen response quantity such as base shear, inter-storey drift or floor acceleration. It could also be defined in terms of a performance function, depending upon several response quantities. The approach is flexible inasmuch as it can work with any performance function as long as it can be numerically calculated. Numerical results are reported for a shear building model installed with one type of damping devices (TADAS)and one form of performance index.

5.Patro and Sinha (2009) have represented the various energy dissipation systems to control the seismic response of structure. According to them, input seismic energy gets transform into kinetic and potential energy, which must be absorbed or dissipated to reduce the seismic response of structure. Their study concluded that seismic response of the structure can be control with these energy dissipation devices.

3.METHODOLOY

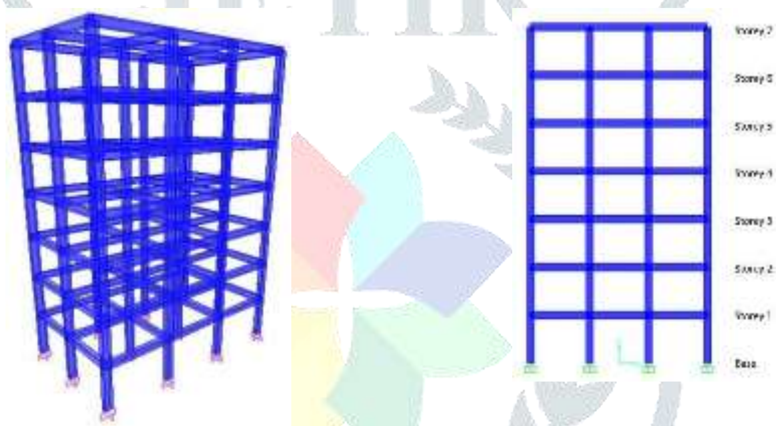
Overview

Earthquake and its occurrence, measurements, and its vibration effect and structural response have been studied for past many years. Since then structural engineers have tried hard to examine the procedure, with an aim to counter the complex dynamic effect of seismically induced forces in structures, for designing of earthquake resistant structures in a refined and easy manner. Various approaches to seismic analysis have been developed to determine the lateral forces. However according to IS 1893(Part1):2002 following methods have been recommended to determine the designlateral loads. Methods of seismic analysis has been given below-

1. Equivalent lateral force method
2. Response spectrum method
3. Pushover Analysis
4. Time history method

4.RESULTS

4.1 Images of SAP Models



3-D View *Front View*

Fig.4.1 Images from SAP (Rectangular Model)

The study presents both theoretical investigation and modelling for buildings with and without dampers using finite element-based software SAP 2000 (NL). From the results, it has been concluded that intrusion of metallic damper reduces the critical response of structure. The unwanted energy due to seismic or heavy wind actions may be reduced by the installation of such dampers. The energy absorbing capacity of a damper depends on its hysteretic actions and the ability to deform under transient loading. Following conclusions are made based on our study –

a. For both buildings, reduction in top storey displacement is up to 40%.
b. Drift reduced by 35%
c. Axial and shear force reduction is observed to be up to 30%.
d. Hysteretic action of dampers results in dissipation of energy.
e. Pushover curves shows the capacity curves of building with and without dampers.
f. With the intrusion of dampers, the base shear capacity is enhanced by 25-30%.

Next chapter illustrates the concluded remarks for the present study based on the resultsobtained.

5.CONCLUSION

In the present study, in-depth analysis has been carried out in order to analyze the structure with and without dampers. The use of dampers has gained momentum from decades. Researchers all over the world are emphasizing on the need of use of dampers inearthquake resistant design of structures. Though the trend has not gained in the developing country such as India, but earthquake sensitive countries such as China, Japan, New-Zealand etc. have used such passive energy dissipation devices for the safety of structure and protection of lives of people. There are many structures such as hospital which has to remain operational even after earthquake loading. The use of such energy dissipation devices ensures formation of plastic hinges of beam and the complete collapse of the structure may be avoided. At the time of earthquake, some non-structural damages are allowed but major damages to structural components are not allowed as per IS 1893:2016. The use of dampers which do not require external energy to actuate itself during seismic event are called passive energy dissipation devices. Various Multi- national companies such as Taylor devices are manufacturing such dampers and isolators, and the demand of such dampers has increased due to eco-friendly and economy and ease application in new and existing structures.

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