Analysis of Blast Loading With And Without Tmd: A Review

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Abstract- *Current trends in construction industry demands taller and lighter structures, which are also more flexible and having quite low damping value. This increases failure possibilities and also problems from serviceability point of view. Now-a-days several techniques are available to minimize the vibration of the structure, out of the several techniques available for vibration control, concept of using TMD is a newer one. This study was made to study the effectiveness of using TMD for controlling vibration of structure. At first a numerical algorithm was developed to investigate the response of a shear building fitted with a TMD. Then another numerical algorithm was developed to investigate the response of a 2D frame model fitted with a TMD. From the study it was found that, Base isolation, shear walls and TMD can be effectively used for vibration control of structures.*

Keywords- TMD, Base isolation, shear walls.

I. INTRODUCTION

Vibration control is having its roots primarily in aerospace related problems such as tracking and pointing, and in flexible space structures, the technology quickly moved into civil engineering and infrastructure-related issues, such as the protection of buildings and bridges from extreme loads of earthquakes and winds.

The number of tall buildings being built is increasing day by day. Today we cannot have account of number of low-rise or medium rise and high rise buildings existing in the world. Mostly these structures are having low natural damping. So increasing damping capacity of a structural system, or considering the need for other mechanical means to increase the damping capacity of a building, has become increasingly common in the new generation of tall and super tall buildings. But, it should be made a routine design practice to design the damping capacity into a structural system while designing the structural system.

The control of structural vibrations produced by earthquake or wind can be done by various means such as modifying rigidities, masses, damping, or shape, and by providing passive or active counter forces. To date, some methods of structural control have been used successfully and newly proposed methods offer the possibility of extending applications and improving efficiency.

The selection of a particular type of vibration control device is governed by a number of factors which include efficiency, compactness and weight, capital cost, operating cost, maintenance requirements and safety.

Tuned mass dampers (TMD) have been widely used for vibration control in mechanical engineering systems. In recent years, TMD theory has been adopted to reduce vibrations of tall buildings and other civil engineering structures. Dynamic absorbers and tuned mass dampers are the realizations of tuned absorbers and tuned dampers for structural vibration control applications. The inertial, resilient, and dissipative elements in such devices are: mass, spring and dashpot (or material damping) for linear applications and their rotary counterparts in rotational applications. Depending on the application, these devices are sized from a few ounces (grams) to many tons. Other configurations such as pendulum absorbers/dampers, and sloshing liquid absorbers/dampers have also been realized for vibration mitigation applications.
TMD is attached to a structure in order to reduce the dynamic response of the structure. The frequency of the damper is tuned to a particular structural frequency so that when that frequency is excited, the damper will resonate out of phase with the structural motion. The mass is usually attached to the building via a spring-dashpot system and energy is dissipated by the dashpot as relative motion develops between the mass and the structure.

II. STATE OF DEVELOPMENT

Introduction

Many papers have been published in the area of structural vibration control system. Now-a-days several techniques are available to minimize the vibration of the structure, out of the several techniques available for vibration control ,concept of using TMD is a newer one. This study was made to study the effectiveness of using TMD for controlling vibration of structure.

The authors and scientists from different countries have been presented their thesis / researches about TMD and their applications and effectiveness.

TUNED LIQUID DAMPERS FOR CONTROL OF EARTHQUAKE RESPONSE, PradiptaBanerji ,13th World Conference on Earthquake Engineering's Vancouver, B.C., Canada, Paper No. 1666, August 1-6, 2004.

Earlier studies have shown that a tuned liquid damper (TLD) is effective in controlling the response of a structure to small amplitude and narrow-banded motions. However, since it is a tuned damper it has been implicitly assumed that a TLD is effective only for such excitations. A preliminary paper co-authored by the present author showed, through a few numerical simulations, that if the TLD is properly designed, it also has the ability to be effective in controlling response of structures to broad-banded excitations, such as ground motions generated by earthquakes. A selection of numerical simulations and experiments, done here over the past couple of years, are presented in this paper to conclusively show that a TLD is effective in controlling the response of a structure to broad-banded, long duration earthquake ground motions. It is shown that a TLD water particle motion formulation based on a shallow-wave theory proposed by earlier researchers is reasonable for predicting the response of a structure with a TLD attached to it and subjected to large amplitude earthquake type motions at its base. It is, however, interesting to note that experiments show that the above theory consistently under-predicts the reduction in structural response for a wide variety of structures and ground motions. This is possibly due to energy being dissipated by breaking waves, which is seen to occur during the excitation phase in the experiments and is only approximately modeled in the numerical simulations. The TLD parameters such as the ratio of water depth to tank length (called the depth ratio) and the ratio of water mass to the structure mass (called the mass ratio) are shown to control the effectiveness of a TLD. The response of a typical single degree-of-freedom (SDOF) structure is typically reduced by about 30% if a TLD has a depth ratio of 0.15 and mass ratio of 4%.

Tuned Liquid Damper,JitadityaMondal, HarshaNimmala, Shameel Abdulla, Reza Tafreshi ,Proceedings of the 3rd International Conference on Mechanical Engineering and Mechatronic , Prague, Czech Republic s,Paper No. 68,August 14-15, 2014.

The aim of this paper is to show the effectiveness of a tuned liquid damper (TLD). TLD can be used in building structures to damp structural vibrations. A Tuned liquid damper is water confined in a container, usually placed on top of a building that uses the sloshing energy of the water to reduce the dynamic response of the system when it is subjected to excitation. The experimental setup models a building using PASCO beams and trusses and uses moveable base, powered by a motor, to simulate an earth quake. The sensor used in the experiment is an accelerometer that measures the acceleration at the top of the structure when subjected to vibrations in the presence and absence of a TLD. Vernier DAQ in conjecton with Lab VIEW was used for data acquisition from the accelerometer. Frequency range around the resonant frequency (first natural frequency) was considered for excitation in both the cases. The outcome of the experiment was that the TLD effectively dampened the vibrations (up to 80% reduction in vibration) when excited and the dampening effect was found to be maximum around the resonance frequency. An attempt has also been made to theoretically model the system in the absence and presence of TLD.

Effectiveness of Spring Mass Dampers in Articulated Platform Supporting Offshore Wind Turbine, Nimmy Lancelot and Vivek Philip, International Journal of Research in IT, Management and Engineering , Volume 06 Issue 08, , Page 37-44,August 2016.

Articulated support structures are those towers which are connected to the sea bed through a universal joint offering position restrain, but no restrain against rotation. These platforms can be used as a deep water support for offshore wind turbine. Responses of the structure to environmental loads like wind and wave can be reduced by using spring mass dampers. This study discusses the effectiveness of spring-mass damper in reducing the responses of a three legged articulated tower suited for sea depth of around 200 m. Previous researches show that articulated platforms are well suited for supporting the offshore wind turbine under environmental loads. Such compliant platforms have been shown to experience much higher fatigue and ultimate loading than onshore or fixed bottom offshore turbines, and could therefore benefit greatly from load reduction techniques.

Earthquake Analysis of Tall Building with Tuned Mass Damper, Mr. Ashish A. Mohite, Prof. G.R. Patil, IOSR Journal of Mechanical and Civil Engineering, PP 113-122,2015.

A Tuned mass damper (TMD) is a device consisting of a mass, and spring that is attached to structure in order to reduce the dynamic response of the structure. The frequency of the damper is tuned to a particular structural frequency so that when that frequency is excited, the damper will resonate out of phase with the structural motion. As tall buildings keep becoming taller, they become more susceptible to dynamic excitations such as wind and blast loadingexcitation. For the structure safety and occupants comfort, the vibrations of the tall buildings are serious concerns for both engineers and architects. In order to mitigate the vibration, different approaches have been proposed, among which Tuned Mass Dampers (TMDs) are one of the most preferable and have been widely used in practice. Tall buildings and observation towers are occasionally vibrated under strong winds and become uncomfortable for occupants. Therefore, various types of dampers are being developed at present to reduce the vibration in those structures. However, there is no sure way to predict the wind-induced response of a structure with a damper system and to estimate the suppressing effects of dampers under earthquake loadings. Analysis of symmetrical moment resistance frame (MRF)

10th,12th,14th,16th,18th, and 21th storey three –dimensional model with tuned mass damper and without tuned mass damper by using software ETABS, moment resistance frames are column and girder plane frames with fixed or semi rigid connections. They can be constructed from concrete, steel or composite material. Moment resistance frames can be sufficient for a building up to 20 storey. A tuned mass damper (TMD) is placed on its top and through it to study its effects on structural response due to time history analysis with and without the tuned mass damper (TMD) in a ETABS. The result obtained from software analysis of 10th, 12th, 14th, 16th, 18th, and 21th storey building with and without tuned mass damper and compare result with each other.

A Method Of Estimating The Parameters Of Tuned Mass Dampers For Blast loadingApplications , Fahim Sadek et.al. , Earthquake engineering and structural dynamics,26,617-635,1997.

The optimum parameters of tuned mass dampers that result in considerable reduction in the response of structures to blast loadingloading are presented. The criterion used to obtain the optimum parameters is to select,for a given modes o vibration. The parameters are used to compute the response of several single and multi-degree-of-freedom structures with TMD's to different earthquake excitations.The results indicate that the use of proposed parameters reduces the displacements and acceleration responses significantly,where substructures serve as vibration absorbers for main structure.

2.6. Effectiveness of Water Tank as Passive TMD for RCC Buildings, Rutuja S. Meshram1, S N. Khante, International Journal of Engineering Research, Volume No.5 Issue: Special 3, pp: 731-736, 27-28 Feb. 2016.

Recent devastating earthquakes around the world have underscored the tremendous importance of understanding the way in which civil engineering structures respond during such dynamic events. Today, one of the main challenges in structural engineering is to develop innovative design concepts to protect civil structures, including their material contents and human occupants from hazards like wind and earthquakes. Among the numerous passive control methods available, the tuned mass damper (TMD) is one of the simplest and most reliable. The common man in a developing country like India may not be in a position to afford for implementing control devices of any sort which may prove uneconomical. Hence an attempt has been made to study the feasibility of utilizing the water tank in the structure to resist blast loadingforces. The present paper deals with the analytical investigation of G+7 and G+30storey symmetric and asymmetric, buildings with and without water tank. The blast loadingperformances of a building with and without tank rovided with different water level were studied using El-centro earthquake record. The buildings were studied under four conditions, namely, without tank, empty tank, half filled and fully filled tank.

III. CONCLUSION

1. TMDs can be successfully used to control vibration of the structure.
2. TMD should be placed at top floor for best control .
3. It is necessary to properly implement and construct a damper in any high rise building situated in earthquake prone areas.
4. Analysis can be done by using ETABS .
5. Displacement can be calculated by response spectrum method.

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