Analytical Investigation of Water Tank as Tuned Mass Damper Using Etabs 2015

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Abstract - *An earthquake is a natural phenomenon. Depending upon the intensity, it may cause damage to life and property.The idea of seismic response control of the structures by using TMD's is considered for this study. A tuned mass damper (TMD) is a device consisting of a mass, a spring, and a damper that is attached to a structure in order to reduce the dynamic response of the structure. Water tanks are integral part of all buildings and they impart large dead load on the structure. This additional mass can be utilized as TMD to absorb the extra energy imparted on the structure during earthquakes. In this project comparative study is done on building without water tank, buildings with water tank at centre, buildings with water tank at corner and comparing its feasibility on empty and full tank conditions.*

This project is based on the analytical investigation carried out to study the feasibility of implementing water tank as a passive Tuned Mass Damper (TMD) using ETABS 2015. Multi-storey concrete structure is taken for the study. The water tank is placed at the roof. The mass and frequency of both were tuned to the optimized values. The behavior of the tank under full and empty tank subjected to earthquake data was studied.

The comparative results show that water tank at centre show the properties of tuned mass damper in full tank condition compared to water tank at centre.

***Key Words*: Water tank, Tuned Mass Damper, Earthquake, feasibility, ETABS 2015**

1. INTRODUCTION

1.1 General

Civil engineering structures located in environments where earthquakes or large wind forces are common will be subjected to serious vibrations during their lifetime. These vibrations can range from harmless to severe with the later resulting in serious structural damage and potential structural failure.

Earthquakes create vibrations on the ground that are translated into dynamic loads which cause the ground and anything attached to it to vibrate in a complex manner and cause damage to buildings and other structures. Civil engineering is continuously improving ways to cope with this inherent phenomenon. Conventional strategies of strengthening the system consume more materials and energy. Moreover, higher masses lead to higher seismic forces. Alternative strategies such as passive control systems are found to be effective in reducing the seismic and other dynamic effects on civil engineering structures.

Today there are 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. New generation high rise building is equipped with artificial damping device for vibration control through energy dissipation. The various vibration control methods include passive, active, semi-active, hybrid. Now a day's TMD theory has been adopted to reduce vibrations of tall buildings and other civil engineering structures. A Tuned mass damper (TMD) is a passive damping system which utilizes a secondary mass attached to a main structure normally through spring and dashpot to reduce the dynamic response of the structure. The secondary mass system is designed to have the natural frequency, which depends on its mass and stiffness, tuned to that of the primary structure. Common man is unable to afford such control devices since they prove to be uneconomical. Hence provisions are to be made to use the existing component of building, to reduce the vibrations induced in the building by earthquake and wind. Since the water storage tanks are built-in component of buildings and mostly these are constructed on the top roof level, hence they add dead burden on the structure. During earthquakes, this extra mass can be employed as damper to take over the surplus energy transmitted to the structure The present work studies effect of water tank fully and partially filled on the response of symmetric buildings using ETABS

1.2 Aim and Objective

- To study the seismic behavior of structures implementing water tank as tuned mass damper using non linear time history analysis to reduce roof displacements, storey drifts and base shear in full tank and half tank condition

2 ANALYTICAL INVESTIGATIONS

2.1 General

The objective of the present work is analyzing the feasibility of implementing water tank and roof top frame as passive TMD and finding the optimum design which would reduce the peak response of the structure subjected to seismic forces using ETABS. Carried out analysis for mitigation of structural response using water tanks as TLD (Tuned Liquid Dampers). And carried out analysis of roof isolation systems and their implementation.

2.2 Comparison Of Base Shear

From the Chart. 2.1 it is observed that in the full tank condition where the effect of sloshing is considered, the values of base reactions in the direction of X is less compared to the base reaction in empty tank condition, which explains the economical behavior of the structure under the liquid damper

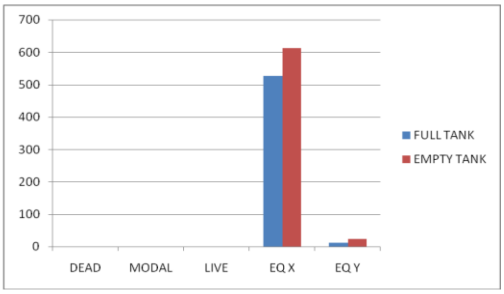

Chart -2.1: Base Shear in the direction of X

It is observed that the base shear value is decreased from 613kN to 526kN which is almost 15% decrease in the base shear value.
Displays the Base shear of the structure in both the cases of Empty and Full Tank, mainly comparing the Base shear values in the earthquake condition in Y direction. The graph clearly displays the change in the structures base shear when a TLD is used

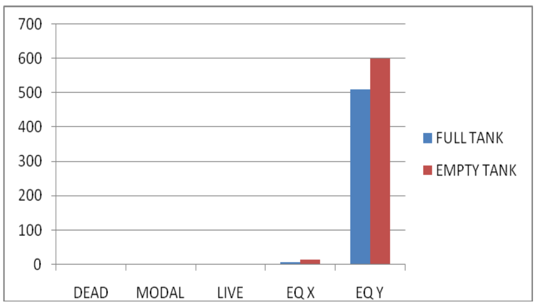

Chart 2.2 Base shear in the direction of y

2.3 Comparison of displacements

Change in the displacement values in seismic conditions in both X and Y directions were found out. Displacements are reduced under damping condition that is in full tank condition compared to empty tank

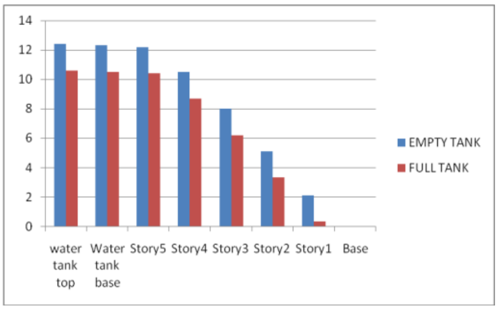

Chart 2.3 Displacements in the direction of X

Similarly, displacements are compared in the Y direction and results are observed. Chart. 2.4 compares the displacement values in Y direction for Damping and without TLD case

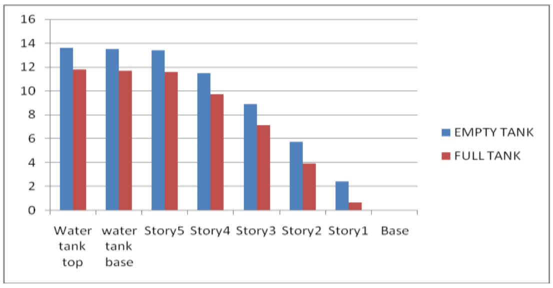

Chart 2.4 Displacements in the direction of Y for EQ Y

From above figures for displacement, it is observed that for every joint there is an average decrease in the displacement value by 14% when a TLD is used.

3. CONCLUSIONS

- It has been found that water tank can be successfully used as passive TMD to control the vibrations of the structure subjected to earthquakes.
- Based on the results it can be concluded that when water tank sloshing load is analyzed and considered as a TLD in application on the structure against the earthquake load it effectively reduces the overall behavior of the structure resulting in economic and safe design.
- From this study, it has been found that TLD can successfully be used to control the response of the structure. Water tank with full tank condition will show

properties of tuned mass damper than compared with empty tank condition.

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