Ain Shams University
Faculty of Engineering
Department of Civil Engineering

Inelastic Analysis of Frames with Tuned Mass Damper

A Thesis submitted in the Partial Fulfillment for the Requirement of the Degree of Master of Science in Structure Engineering

By

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DISCLAIMER

This thesis is submitted as partial fulfillment of M.Sc degree in structure Engineering, Faculty of Engineering, Ain Shams University.

The work included in this thesis was carried out by the author and no part of it has been submitted for a degree or qualification at any other scientific entity.

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Wael Adel Gairgis Oza

Signature

Date June 2016

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ABSTRACT

The advantages of adding a tuned mass damper at the roof of structures to reduce seismic acceleration response is discussed in the following chapters. Different structure frames were analytically studied using a suite of nonlinear static push over analysis and uniform building code UBC 97 regulations regarding response spectrum functions.

The analyses indicate that adding tuned mass dampers has a notable effect on the structure fundamental period as it increases causing decreasing of the seismic acceleration response of the structure when applying time history or response spectra records and comparing the structure behavior with and without using tuned mass dampers.

Appropriate design of the rooftop tuned mass damper can be performed to decrease the structure vibration during earthquakes and reducing the developed internal forces in the structure which can leads to more economic design and can be used as a retrofit measure.

flexible structures having long fundamental periods seismic behavior is considered to be a good behavior as a lower level of internal forces is developed during seismic vibration than stiff structures with short fundamental periods. Base isolation was developed to be used for rigid structures to make it act as a limber structure while keeping the advantage of rigid structures. base isolation increases the fundamental period of a structure causing less respond to lateral seismic acceleration. Any other method that can cause the fundamental period of a structure to be increased can have a similar effect of seismic base isolation.

Passive energy absorbing devices have many types, tuned mass damper (TMD) is one of the familiar types which has been used in many structures.

In this study different steel framing systems are investigated with regards to their lateral load carrying capacity and in this context seismic response modification factors of individual systems are analyzed. Numerous load resisting layouts, such as different bracing systems and un-braced moment resisting frames with various story configurations are designed and evaluated in a parametric fashion. Two types of beam to column connection conditions are incorporated in evaluation process.

The seismic behavior factor (*R*) is evaluated for steel frames portal and X-braced. The *R* factor is composed of three main items including ductility reduction factor and overstrength factor which are calculated based on the inelastic pushover analyses results of each framing system regarding frame geometry (spans and heights) and the used connection type.

Frames, designed according to UBC97 seismic code, are investigated by nonlinear static analysis with the guidance of previous studies and recent provisions of FEMA. Method of analysis, design and evaluation data are presented in details.
Previous studies in literature, history and the theory of response modification phenomenon is presented. Results are summarized, main weaknesses and ambiguities introduced to design by the use of “R” factors are stated depending on the observed behavior.

Key words: Nonlinear analysis, steel frames, pushover analysis, tuned mass dampers

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TMD	Tuned mass damper
HD	High ductility frame
ND	Normal ductility frame
BR	Braced frame
CL	Centerline connection type
PR	Partially restrained connection type
SDOF	Single degree of freedom
MDOF	Multi degree of freedom