SEISMIC RESPONSE CONTROL BY ORB-BOWL (OB) TMD SYSTEM

Mehran AKHAVAN SALMASSI
Ph.D. Student in Structural Engineering, Islamic Azad University, Semnan Branch, Semnan, Iran
m.akhavan.s@stu.semnaniau.ac.ir
Ali KHEYRODDIN
Professor of Structural Engineering, Faculty of Civil Engineering, Semnan University, Iran and Member of Center of Excellence for Engineering and Management of Civil Infrastructures, University of Tehran, Iran
kheyroddin@semnan.ac.ir
Ali HEMMATI
Assistant Professor, Islamic Azad University, Semnan Branch, Semnan, Iran
ali.hemmati@semnaniau.ac.ir

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In recent decades, in order to reduce the damage to the structures, a number of methods have been proposed for seismic control of structures, which has reduced the demand for them. On the other hand, decreasing demands by reduction of displacement and displacement ratio in SDOF system is one of the issues related to the use of active, passive, semi-active and hybrid control systems.

In this paper, a new system called orb-bowl or OB damper has been invented (Figure 1). In this passive TMD system, a combination of orb and bowl with a mass, spring and damper system in the SDOF mood has been considered. Also, a number of records have been applied to orb-bowl and mass, spring, and damper systems to evaluate the performance of the system under a number of seismic vibrations. This system moves freely in vibration and in the opposite direction of the structure of orb in bowl, which causes a phase delay in shifting orb against the mass, spring and damper system; and the mass tendency to move towards the center of bowl causes vibration in the opposite phase, and as a result, an increase in the damping of the system. On the other hand, while the vibration gets close to the end of the record, orb will gradually stop considering the tendency to move towards the center of bowl.

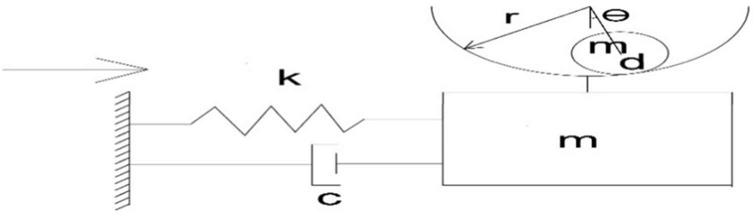

Figure 1. SDOF OB damper system.

The equation of the movement in OB system is as follows:

$$\ddot{u} + 2\zeta\omega_n\dot{u} + \omega_n^2 u \mp \gamma r\,\dot{\theta}^2 sin\theta = -\ddot{u}_g \quad , \quad \gamma = m_d\,/m \qquad (1)$$

Greco and Marano (2013) investigated for stochastic optimum design of linear tuned mass dampers for seismic protection of high towers showed that the effectiveness of the vibration control strategy is evaluated by expressing the objective function in terms of the reduction factors of the structural displacement and absolute acceleration. The mechanical characteristics of the tuned mass damper represent the design variables. Matta (2013) searched for Effectiveness of Tuned Mass Dampers against Ground Motion Pulses. The resulting statistical evaluation, expressed by percentile response spectra, shows the pros and cons of a pulse-oriented TMD design and improves the general understanding of TMD performance under impulsive ground motions. Miranda (2013) studied about a method for tuning tuned mass dampers for seismic applications and realized that significant equal modal damping and average modal damping can be induced by properly tuning highly damped TMDs, obtaining parameters intrinsic to the mechanical systems, and excitation independent. In order to investigate the system, a number of records are applied to the system. After numerical analysis by MATLAB software, a decrease in displacement and average displacement ratio in Figures 2 and 3 in OB system in relation to the mass, spring and damper system has been found, which indicates the proper performance of the system in energy dissipation.

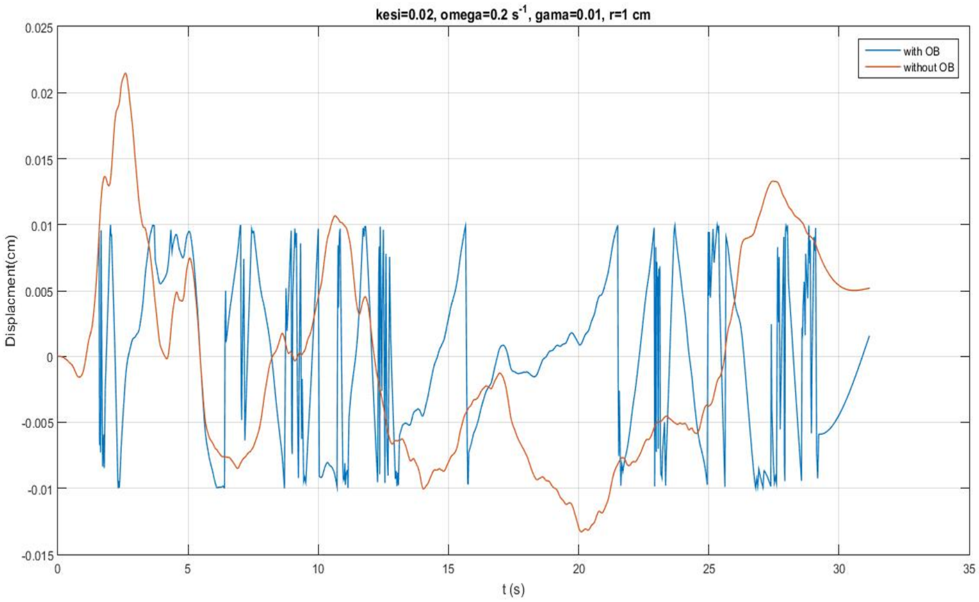

Figure 2. Displacement –time graph (El Centro 1940 Record).

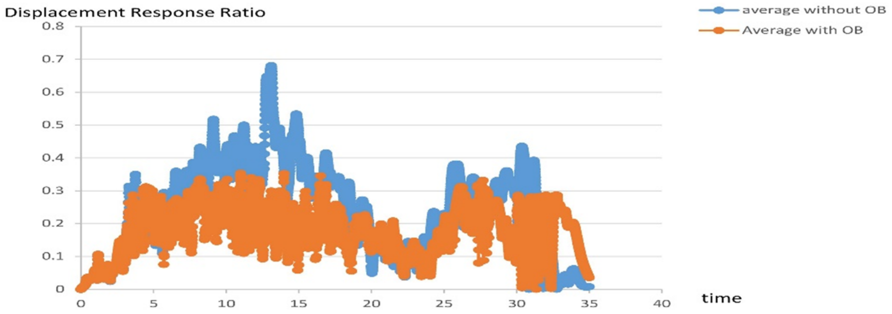

Figure 3. Average displacement ratio OB system.

Briefly, some of advantages are simple to manufacture, low profile, easy to model, low cost, easy repair and maintenance, low space, exposed or hidden element, re-centering specification.

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