Analytical Studies of Impact Damper on SDOF System Vibrations under Harmonic and Impulsive Excitations

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Abstract

Impact damper is a highly sensitive instrument, which belongs to the category of passive vibration devices used to attenuate the vibration of discrete and continuous systems.
In this paper, the effect of single unit impact damper on the single degree of freedom system under two different excitations is investigated. A study is made of the general behavior of a single particle impact damper; with the main emphasis on sinusoidal and impulse excitations. The effects of mass ratio, coefficient of restitution, and gap size are determined by using *MATLAB* program.
It is found that the impact damper is an efficient device for reducing the vibration of structures subjected to impulsive and harmonic excitations. Numerical investigations are compared with each other. Effect of this damper shows that the system under consideration can serve as an efficient damper.
It is observed that the response of the system varies with small changes in the particle's mass, the coefficient of restitution and particle's clearance. There are critical values of the particle's parameters which an increase or a decrease does not contribute significantly toward amplitude reduction of the system.
Keywords: Impact Damper, Harmonic Excitation, Impulsive Excitation, Vibration Reduction.

1. INTRODUCTION

Structural control technology offers many new ways to protect structures from natural and other types of hazards. Semiactive structural control technology, appears to combine the best features of both passive and active control systems and to offer a viable means of protecting civil engineering structural systems against earthquake and wind load.[1]
An impact damper generally consists of a mass which is allowed to travel freely between two defined stops. Under the right conditions, the vibration of the system to which the impact damper is attached will cause the mass of the impact damper to strike the structure. Therefore, there is a need to understand the particle's motion, at varying parameters, as it travels between the container's boundaries to explore the potential of the impact damper.[2] The mass of the damper, the distance of travel, the excitation frequency, the peak values of modal amplitude at the location of the impact damper should be further investigated.
For more than three decades, researchers have studied the possibility of using impact damper to improve approaches to reduce structural responses (In 1973 S. F. Masri studied that chain-type impact dampers offer a simple and reliable method for attenuating wind-induced vibrations of tall flexible structures and also he performed experiments on a class of nonlinear dissipative cantilever and simply supported beams subjected to external sinusoidal excitation. In addition the damper was more effective when located away from the node of the mode shape; Ranjit K. Roy and Richard D. Rocke and J. Eari Foster referred when the impact damper attached to a vibrating mechanical system the collision of the particle with the container boundaries results in a reduction of the vibration amplitude of the primary system through momentum transfer in 1975; Yousef and Akl (1987) performed a study of the free and forced vibration response of a vertical cantilever steel stack; R. Chalmers and S. E. Semercigl were mentioned that a properly designed impact damper, is more effective and less sensitive to the changes in the external load and the system's parameters in 1990; Aamir S. Butt and Fred A. Akl studied that impact damper can reduce the response of a vibrating continuous system if used