Dynamic Analysis of Frame with Tuned Mass Damper by Considering Soil-Structure Interaction

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Abstract

One of the effective way that caused to decrease the response of structures is using of tuned mass damper. The dynamic behavior of these dampers is determined by natural frequency of structures and it is an efficient parameter for the response of structure. So the accurate determination of this frequency is very important. In this paper the effect of soil- structure interaction with cones has been used in dynamic equation of structure with tuned mass damper. This paper presents that the response of structure with modeling of tow frames with different dynamic characteristic and tuned mass damper has been compared by tow method with and without considering of soil-structure interaction. Also response of the frames has been investigated with north-south component of horizontal ground acceleration recorded at the Elcentro during the earthquake of May 18, 1940. The comparison of results indicates that considering of soil-structure interaction in modeling has more efficiency in response of structure.

Keywords: damper, Soil-structure interaction, Cones method, Dynamic Time History nalysis.

1. INTRODUCTION There are many passive control systems of reducing the earthquake demand on structural system. One of the suitable passive controls for structures is tuned mass damper [1]. A Tuned Mass Damper 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 it. The frequency of the damper is tuned to a particular structural frequency so that when the frequency is excited, the damper will resonate out of phase with the structural motion. Energy is dissipated by the damper inertia force acting on the structure. The mass of the damper transmits its inertia force to the building in a direction opposite to the motion of structure itself, thereby reducing the building's oscillations [2]. The mass of TMD is a small fraction 0.25 to 0.7 of total mass of building, which corresponds to about 1 to 2% of first modal mass [3].

The invention of the TMD as an energy dissipative vibration absorber is credited to Frahm, who developed the concept in 1909. The theory was later described by Emeritus and J.Den Hartog, in textbook on mechanical Vibrations in 1940.The initial theory was applicable for an undamped SDOF system subjected to sinusoidal force excitation. Significant contributions were made by Randall et al in 1981, Werburton in 1982, and Tsai and Lin in 1993 [1].

The estimation of natural periods of structures is the most important phase of the design or retrofit of a structure resisting earthquake motions. The large number of simplified assumptions required to determine natural periods of structures, one of them considering soil flexibility or assuming fixed base. The researches mentioned that natural period of structures considering soil flexibility is greater than structures assuming fixed base [4]. For example fundamental natural period of two reinforced of the San Onofre power plant in California was computed to be 0.15 sec assuming the base as fixed, and 0.5 sec considering soil flexibility. Difference in the period indicates the important effect of soil-structure interaction for structures [4]. This lack of accuracy can be improved to different method.

About the effect of soil-structure interaction upon the structural response Chopra and Gutierres, 1974; Clough and Penzien, 1987; Jennings and Bielak, 1973; Meek and Veletsos, 1972; Singh, 1980; Veletsos and Wei, 1971; Veletsos and Verbic, 1974; Wu and Smith, 1995. Most research can be divided into two categories. One uses the finite element method to simulate soil deformation effects on the structural response. This method is effective for complicated soil conditions. The other uses a modal combination method, by assuming that the soil is a half-space continuum, and treating the soil as a spring-damper system to resolve structural responses in the frequency domain for excitations. In such an approach, the modal combination method was adopted for linearly elastic systems. In this paper, a modified structural response in the frequency domain approach was adopted [5].