CONSIDERATION OF SOIL-STRUCTURE INTERACTION IN SEISMIC ANALYZING OF STEEL STRUCTURES BY USING OF HYBRID DAMPER – ACTUATOR BRACING CONTROL (HDABC) SYSTEM

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The traditional dynamic analysis of structures is based on the fixed-base model in which the structure is assumed to be fixed at its base. This model may be well founded where the structure is built on rock and the structural responses could be only influenced from the dynamic characteristic of the structure. In general, the response of structures subjected to earthquake excitations is governed by three continuum components: structure, foundation, and the soil base (Wolf, 1985, 1987). The soil-structure interaction (SSI) evaluates the whole system under input of free field ground motion, which describes the ground motion at site without existence of a structure. Seismic rehabilitation of structural systems is often performed with assuming the fixes-base model, where as suitable case for structures built on the bed rock. If the structure is constructed on soil, both the control algorithm and the structural system shall include the soil–structure interaction (SSI) that covers the flexibility of the soil and the displacement of the foundation. This leads to an increase in the number of the system's degrees of freedom (d.o.f.) that changes the structural response behavior and accordingly controls action and (Cheng, et al., 2008; Takahashi 2004). In this paper a new type of hybrid control is used combining passive and active systems, that is an attractive innovation and an effective protection system. The Hybrid Damper-Actuator Bracing Control (HDABC), consists of a hydraulic actuator and viscous fluid damper mounted on a v-invert chevron bracing between two stories of a structure that it's shown in Figure 1. Closed-loop system identification is employed to identify the structure with hybrid control. An observer–controller identification (OCID) procedure determines the system's parameters, and an eigen system realization algorithm (ERA) obtains the state-space model of the structure with hybrid control (Chang and Spenser, 2013; Ghaffarzadeh and Younespour, 2014; Cheng et al., 2008; Zhang et al., 2006; Lei et al., 2013).

In this study, the effects of soil-structure interaction on the seismic response of the steel structures under strong and dominant earthquakes whose built on shallow foundation and supplied with Hybrid Damper-Actuator–Bracing Control (HDABC) system, as energy absorber elements, is investigated (Cheng et al., 2008; Zhang et al., 2006; Takahashi 2004; Humar, 2002).

For this purpose, several steel structures with 1, 3, 6, and 9 floors are considered and time history analysis, with either considering the soil-structure interaction or without, are obtained. The time history analysis determined by written codes in MATLAB software. The performance seismic levels related to the flexible base vibrations have been determined. The substructuring method and also the flexible volume method accompanied achieved from SASSI 2000 software (Lysmer et al., 2000) has been used to evaluate the soil-structure interaction where the soil under the foundation assumed to be consists with the soil classification in the Iranian standard no. 2800 version 4.

The computer's program System for Analysis of Soil Structure Interaction (SASSI) has ability to comprehensive numerical analysis of full soil structure interaction based on two or three dimensional seismic waves propagation and it's capable to perform a full impedance model of soil field, foundation and superstructure. At this software capability to defined variety of horizontal and vertical accelerograms of earthquakes from the near or far fault with accompany simultaneously definition longitudinal, shear, Rayleigh and Love waves with different directions, frequencies and wave lengths depended to site. Output from this software includes types of horizontal and vertical displacement and acceleration components at the time domain or frequency domain for structures nodes, foundation and soil vibrating. Specific advantage of this software than other softwares is capability to perform full dynamic soil structure interaction analysis with entire nonstatic seismic wave's progressive propagation effects with refractions, passes and waves scattering whether in substructure region or in superstructure region (Computer program SASSI, 1991; Lysmer et al., 2000).

The results show that accounting flexibility of the soil below the foundation has significant effects on the capacity and the structural demand curves with respect to the soil type and the fundamental period of structures.

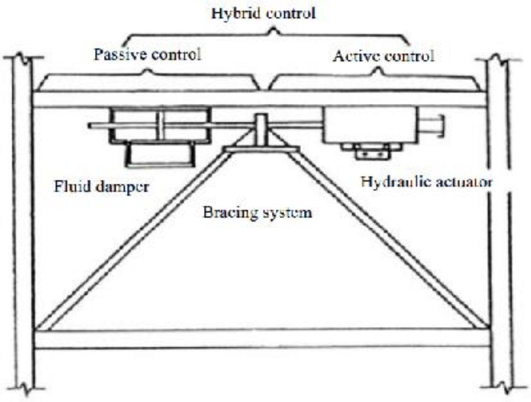

Figure 1. Smart seismic structure with control device HDABC

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