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ACTIVE STRUCTURAL CONTROL BY POLE ASSIGNMENT METHOD CONSIDERING SOIL-STRUCTURE INTERACTION EFFECTS

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In this paper, the effect of soil-structure interaction (SSI) on pole assignment active control method has been investigated. To evaluate the performance of pole assignment control method in mitigating the seismic response of a soil-structure building structure, a base-isolated structure with and without soil structure interaction are considered. For investigating the effect of soil condition, various shear wave velocities (Vs=50,100, 200) are considered. The larger the value of shear wave velocity varies, the relatively stiffer the soil becomes. Damping and stiffness coefficients of the soil (cg and kg), which are calculated according to the Parmelee's relations (1968) based on the exact solution for the circular rigid foundation with an underlying halfspace soil:

$$cg = \frac{6.21}{2.54-\nu}.\rho.V_s.r^2,\ kg = \frac{6.77}{1.79-\nu}.\rho.V_s^{\ 2}.r$$

Since the inputs of control algorithms depend on dynamic characteristics of the structure, the SSI effect significantly changes the control design. A considerable part of control studies is devoted to SSI effect due to its importance on control design. Smith and Wu (1997) studied the effects of SSI on the optimal control. A 5-story shear building supported on rigid foundation in soft soil was introduced as numerical example. Shen and Manzari (2002) used a Linear Quadratic Gaussian (LQG) controller in time domain to control seismic response of a structure with soil structure interaction. Wang and Lin (2005) investigated the control performance of a multiple tuned mass dampers (MTMDs) for soil-irregular building interaction systems. Following their research, Lin, Chang and Wang (2010) applied H∞ control algorithm on a soil-irregular building interaction system. Amini and Shadlou (2011) evaluated the effects of foundation embedment on the control of structures.

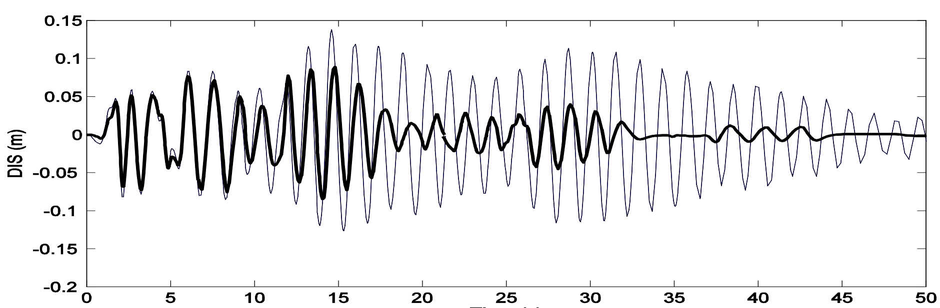
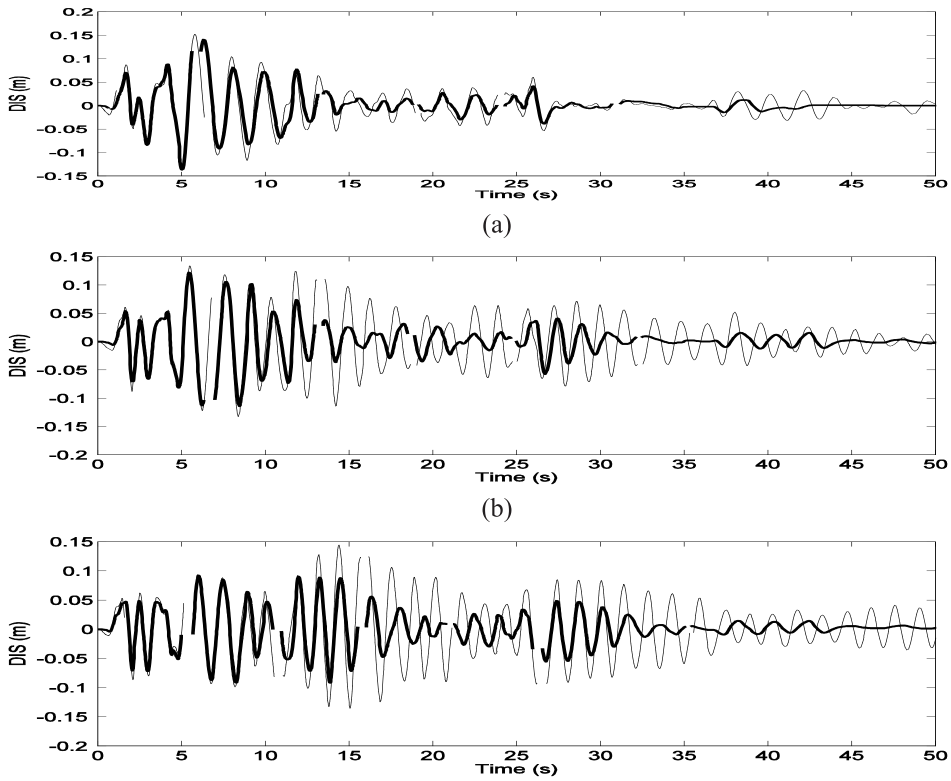


Figure 1. Uncontrolled and controlled displacement response for fixed-base structure



(c)

Figure 2. Uncontrolled and controlled displacement response for SSI system with (a)Vs=50m/s (b)Vs=100m/s (c)Vs=200m/s

As it is shown in Figure 2, pole assignment control design can reduce maximum values of displacement responses for soil-structure interaction system with larger shear wave velocities (Vs=200 m/s). However, for the soil-structure interaction system with softer soil (Vs=100, 200), which has lower shear wave velocity, pole assignment control design is not effective enough in reducing peaks of displacement responses. It can be noted that as the soil becomes stiffer, the behavior of control system is more similar to the fixed-base structure system. The displacement responses of the system with the large shear wave velocity (Vs=200 m/s), is approximately the same as fixed-base structure. Therefore, the effect of soil-structure interaction in control design should be taken into account for the SSI system with very soft soil.

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