Time Delay's effect on Higher Structure's Modes

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Abstract

In active controlling of structures, we can monitor just one or few modes of structure. Applied control force to active control devices which regulated on main vibration mode of structure and it seems that large time delays have deteriorated effects only on the controlled mode. In this paper we evaluate time delay's effect on the other modes that are not controlled. For this reason, used a 2D 8-shear story that subjected to EW Elcentro ground motion. For processing and determining structure's responses, discrete instantaneous optimal control method is used. Structure and control system are analyzed in many different time delay and after that found out time delay in active structural control system loop has not only mortal effect on controlled mode but also has similar effects on the other uncontrolled modes. In the other word, time delay has approximately same effects on all vibration modes of structure.

Keywords: Higher vibration modes, Active control, DIOC algorithm, Time delay effect

1.   INTRODUCTION

Time delay is one of the most important topics in active structural control [1]. Large time delay in control system's loop increase structure's and control system's responses to the point that structure to become unstable during environmental excitations. Time delay is the wreckage time between measuring structure's responses and environmental excitation up to applying calculated control force to structure with control system devices. In the other words, calculated control force should be applied to structure in the time that structure responses and excitation are measured. Time delay is generated in three steps in control loop. First step: sensing responses and environmental excitation and transmission them to main system. Second step: determining control force and third step: exerting control force to structure. Main part of generated time delay occurs in the mechanical devices working. By amelioration of design mechanism of instrument in active control systems, proportion of mechanical time delay is reduced but this problem is one of the inseparable portions of active structural control systems.

Many researchers attempted to reduce sensitivity of control systems to time delay and obviation its bad effects on structure's responses in active structural control systems up to now. Study in evaluation of sensitivity of control algorithm to time delay [2], modifying instantaneous control algorithm with presence of time delay in control loop [3], proposing the relationship between controlled structure systems sensitivity and period of single degree of freedom structure's vibration [4] and comparison positive velocity feedback with negative velocity feedback control [5] had done in the past. First of all in this paper, control system and structure's responses sensitivity was checked to time delay with suggested algorithm [6] and checked its sensitivity to time delay with consideration seismic excitation [7]. Utilized active control system in this paper is Active Mass Damper (AMD) that is installed in the top floor of building. Whereas in this type of structure we can monitor and control just one or a few modes of structure and control devices are adjustable with monitored vibration modes. In this paper we evaluated time delay effects on the higher vibration modes of structure and its effects on the other modes.

2.   CONTROL ALGORITHM

Utilized algorithm in this paper is discrete instantaneous optimal control that uses state-space equation to