International Conference on Contemporary Iran on Civil Engineering
Architecture and Urban Development
Iran Tehran - August 16, 2017

Active Control of Structures Using H Infinity Method

Ariyan Katebi[1]*, Masoud Maleki[2]

1. MSc. Civil Engineering – Earthquake Engineering, University of Tabriz, Ari.katebi.2011@gmail.com
2. MSc. Civil Engineering – Earthquake Engineering, University of Tabriz, m.maleki.civil@gmail.com

Abstract

This paper presents robust H∞ control for civil engineering structures using state feedback, within the H∞ framework controller which lead to desirable performance are obtained, using full degree of sensors. In this paper three story building is considered and a robust controller is designed with mentioned algorithm to mitigate the responses due to strong earthquake excitations. The results indicate that significant reductions in the building responses can be achieved with H∞ method.

Key words: H∞, Civil Engineering Structures, Structural Control, Response Reduction, State Feedback.

1. Introduction

Natural hazards such as earthquakes and strong wind events impose large forces on tall, slender structures and on long-span bridges that inherit numerous uncertainties due to model errors, stress calculations, material properties and load environments. The H∞ control algorithm considers input uncertainty and estimation errors. The equation of motion for systems with multi degree of freedom can be expressed as the following [1]:

$$[M]_{n\times n}\{\ddot{q}\}_{n\times 1}+[C]_{n\times n}\{\dot{q}\}_{n\times 1}+[K]_{n\times n}\{q\}_{n\times 1}=-[M]_{n\times n}\{f\}_{n\times 1}\ddot{x}_g+[\gamma]_{n\times r}\{u\}_{r\times 1}$$

$[M]$, $[C]$ and $[K]$ are mass, damping and stiffness matrices of the structure. Also $\{\ddot{q}\}$, $\{\dot{q}\}$ and $\{q\}$ are relative acceleration, velocity and displacement vectors. The standard H∞ state feedback control problem is formulated by state space model like the following [1]:

$$\{\dot{x}\}=[A]\{x\}+[B_1]\{u\}+\{B_2\}\ddot{x}_g$$
$$\{z\}=[C_1]\{x\}+[D_{11}]\{u\}+\{D_{12}\}\ddot{x}_g$$
$$\{y\}=[C_2]\{x\}+[D_{21}]\{u\}+\{D_{22}\}\ddot{x}_g$$

If $[A]$ equals to $\begin{bmatrix} 0 & I \\ -M/K & -M/c \end{bmatrix}$ the state space formulation of the motion equation is accomplished. The equation of motion is a second order differential equation while the state space system is a first order one and because of this reason solving a state space system is much easier than equation of motion.

In structural control the poles of the system are given by the following complex conjugate pairs [2]: