

OPTIMAL CONTROL OF AN ELASTICALLY CONNECTED RECTANGULAR DOUBLE-PLATE COMPLEX SYSTEM

Ismail Kucuk and Ibrahim Sadek

Department of Mathematics and Statistics
American University of Sharjah
P.O. Box 26666
Sharjah, United Arab Emirates
ikucuk@aus.edu, sadek@aus.edu

Abstract. In this paper, the problem of damping out the vibrations of a system of two rectangular simply supported thin plates connected by a homogeneous Winkler elastic layer is investigated. A method is proposed to damp out actively the undesirable vibrations in the structures by means of point-wise actuators. Plate-type structures are of great importance in many fields of civil and mechanical engineering. The basic control problem is to minimize the deflection and velocity of displacements at a specified time with minimum expenditure of actuation energy. A quadratic performance functional that depends on the deflection and velocity of the structure, and the point-wise actuator forces is chosen. Necessary conditions for optimality in the form of independent integral equations are obtained using a variational approach. These conditions lead to explicit expressions for the point-wise actuator forces. The theoretical analysis is illustrated by a numerical example to demonstrate the effectiveness of the proposed controls for damping the vibrations of a system of two identical plates.

Keywords. Optimal Control, Double-Plate, Integral Equations, Vibration Control

AMS (MOS) subject classification: Optimal Control

1 Introduction

Vibration analysis of mechanical systems consisting of different forms of plate-type structures such as beam-plate, double-beam, and double-plate is of great interest in many engineering applications. Lévy and Navier methods [9] are two analytical methods to determine the free vibrations of a single plate based on the classical Kirchhoff-Love assumptions in plate vibration theory. Developing new systems with control actuators is as equally important as solving plate-type structures so that the structure resists any undesirable resonance situation. In this paper, we study the optimal control of transverse vibrations of an elastically connected double-plate system having three layers, and a Winkler-type foundation joining two isotropic plates. An elastically connected double-plate system can be used as a simple model for a part of complex structures such as bridges, aircraft wings.