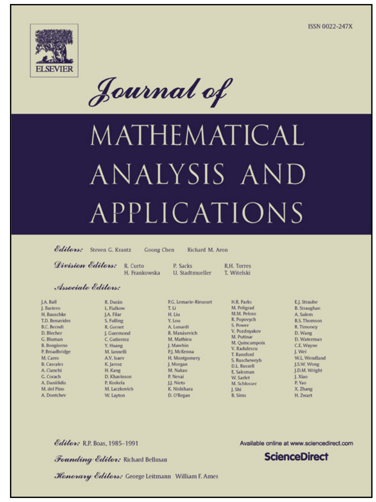

Exponential stability of an active constrained layer beam actuated by a voltage source without magnetic effects

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Exponential stability of an active constrained layer beam actuated by a voltage source without magnetic effects☆

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Abstract

We study the boundary stabilization of an active constrained layer (ACL) beam consisting of a stiff layer, a viscoelastic layer and a piezoelectric layer. The piezoelectric layer is actuated by a voltage source without magnetic effects. The system is modeled as a Rayleigh beam coupled with two wave equations. By using an asymptotic technique, we present the asymptotic expressions for the eigenpairs of the system. We show that the generalized eigenfunctions form a Riesz basis in the state space, and hence the spectrum determined growth condition holds. Finally, the exponential stability of the closed-loop system is established.

Keywords: ACL beam, Rayleigh beam, Riesz basis, exponential stability

1. Introduction

Active constrained layer (ACL) damping treatments have been one of the main research topics in the vibration suppression of various flexible structures due to their reliability, robustness, low weight, adjustability, and high efficiency [1–5]. The ACL damping treatments integrate both active and passive dampings through constrained layer treatments [6]. The ACL beam is composite material, which usually represents a beam treated with an ACL damping treatment. A typical design of an ACL beam is consisting of a viscoelastic shear (passive damping) layer sandwiched between a piezoelectric constraining (active damping) layer and the vibrating structure (e.g. an Euler-Bernoulli beam) [7].

Much research of composite beams systems has been made in the past decade, and many methods, such as Riesz basis approach, multiplier method, Carleman estimates, Lyapunov's energy method, and so on, have been used to analyze the systems. For example, the exponential stability and the exact controllability of a sandwich beam system with a boundary control are considered using the Riesz basis approach in [8]. The exact controllability of a Rao-Nakra sandwich beam with boundary controls is studied by the multiplier method in [9]. The analyticity of the solution and the exponential stability of a sandwich beam system are obtained via the Riesz basis approach in [10]. By the method of Carleman estimates, the exact controllability results of a multilayer plate system with clamped (or hinged) and free boundary conditions are obtained in [11, 12], respectively. The boundary feedback stabilization of a multilayer Rao-Nakra sandwich beam is

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