Vibration Control beam using Piezoelectric-based Smart Materials

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Abstract
Traditionally, the vibrations of bituminous beam are damped by inherent damping properties. In this research, smart materials are used to control and reduce the vibration of such beams. The study focused on the passive piezoelectric vibration shunt control technique. Firstly, the finite element method was used in order to determine optimal design and location of piezoelectric transducers. Based on the results obtained from a simple Euler Bernoulli beam evaluation, up to 42% of bending vibration reduction was gained by using smart beam. Secondly, the analytical study of passive piezoelectric vibration shunt control of cantilever beam was undertaken. The equation of motion of a composite beam (cantilever beam bonded with a PZT patch) using Hamilton's principle and Galerkin's method has been derived.

Key words
Bituminous Beam, Finite Element, Piezoelectric smart structures, Vibration Control.

1. Introduction

Many studieshave been conducted these last ten years in the field of the vibration control of structures. In references [1] and [2] we may find an interesting overview of some works done on this field, especially in sizing and shape optimization. In 2002, Mukherjee & al. [3] proposed a method to optimize piezoelectric structures based on the minimization of the global displacement residual error between the desired and the current structural configuration for a beam in static and dynamic cases. Irschick& al. [4] have conducted a dynamic shape control analysis, for a composite beam type structures by computing the spatial distribution of piezoelectric actuators leading to a determination of a structural displacement field. Then, using an energy optimization based method for static shape control of composite plates, Sun & al. [5] proposed a method to find, within a given error, the optimal control voltages which can actuate a structure close to the desired shape.Nguyen & al. [6] also proposed a design method for static cases. They studied the shape control of plates by using a multi-criteria optimization method. Later, Donoso& al. [7] considered optimal design problems in the context of active damping, more specifically to control the deflection of a structure subjected to static and dynamic loads. The optimal thicknesses or widths of the piezoelectric ceramics minimizing the deflection of cantileverbeam were computed. In reference [8], Donosoet&. [8] extended the same analytical method to rectangular plates. At the same time, Zhang J. & al. [9] computed, in a dynamic study, the optimal location and size of piezoelectric actuator to produce the maximum controllability and observability of modes in smart structures. In this