VIBRATIONS OF A BEAM BETWEEN TWO STOPS

Kenneth L. Kuttler[1] and Meir Shillor[2]

[1]Department of Mathematical Sciences
Michigan Technical University
Houghton, MI 49931
[2]Department of Mathematics and Statistics
Oakland University

Rochester, MI 48309

Abstract. We establish the existence of weak solutions of a model that describes the dynamic vibrations of a beam which has one of its ends constrained between two stops. The contact at the free end is modeled either by the classical Signorini unilateral condition, for rigid stops, or by the normal compliance condition, for flexible stops. The beam is considered either elastic or viscoelastic. We prove the uniqueness of the weak solution for the problem with a viscoelastic beam with normal compliance.

Keywords: Dynamic contact, impact, viscoelastic beam, Signorini's condition, normal compliance, constrained vibrations.
AMS(MOS) classification: 73T05; 35L35, 35L85.

1 Introduction

Currently, there is considerable interest in the automotive industry, as well as in other industries, in dynamic vibrations of mechanical systems, caused by the noise and vibration (NVH) characteristics of cars and car components. Indeed, appreciable effort has been made in the design of automotive components to reduce unwanted or disturbing noise. A portion of the unwanted noise is generated by the dynamic contact of parts and components when periodically forced. For instance, if the mounting of the components on the car engine is not perfect, the motion in the clearances leads to dynamic contact, which in turn may generate unwanted noise.

The main tools used in the investigation of NVH are modal analysis and energy density distribution methods. However, these work well only for simple geometries and settings, and do not take contact into account. Often, in the study and simulations of vibrations of elastic bodies and structures, random or stochastic input is assumed – the source of which is usually unspecified. On the other hand, it is well known, by now, that nonlinear deterministic systems can exhibit behavior which is essentially unpredictable; namely, they can behave chaotically. These chaotic vibrations may cause certain noise characteristics which need to be well understood before any systematic noise control can be designed, or a proper component setting