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Stability Analysis and Resonant Conditions for a Beam Subjected to Moving Particles

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Abstract

In this paper, the dynamic stability analysis of a simply supported beam carrying a sequence of moving masses is investigated. The periodical traverse of masses over the beam results a linear time periodic problem. Floquet theory and Incremental Harmonic Balance Method (IHBM) are used to obtain the boundary of stable and unstable regions in the plane of moving mass parameters. Results of IHBM not only do verify the boundary curve separating the stable and unstable regions generated by Floquet theory, but also determine other curves of instability occurrence conditions, which to the best authors' knowledge have not been addressed before in open literature.

Keywords: Dynamic stability; Moving mass problem; Incremental Harmonic Balance Method, Floquet theory.

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1. Introduction

A wide variety of systems in engineering can be represented as a flexible beam carrying a moving mass. Many practical applications such as motion of vehicles or trains on bridges, cranes carrying moving loads, robotic arms, piping systems, space structures and high speed machining operations are some of these systems. Therefore, determining dynamic behavior of a beam subjected to a moving mass has been an interesting subject for investigation for a long time. Historically the first known attempts to solve a moving load problem arose in the study of the collapse of Chester Railway Bridge by *Willis*[1] and *Stokes*[2]. After that, there have been a lot of efforts in this field, including the investigations done by *Ayre* [3], and two well known monographs by *Inglis* [4] and *Hillerborg* [5]. Recently, two books have been published by *Fryba* [6], and *Yang* et al. [7]. The growing usage of heavy and rapid truck vehicles, and the employment of lighter and more flexible structures in order to minimize costs associated, have drawn engineers' attention [8–21] on terms which have not been considered in most of previous research such as inertia and shear deformations.