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Zuzana Dimitrovová

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New semi-analytical solution for a uniformly moving mass on a beam on a two-parameter visco-elastic foundation

Zuzana Dimitrovová

Departamento de Engenharia Civil, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa and

IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Lisboa, Portugal

zdim@fct.unl.pt

Abstract

In this paper a new semi-analytical solution for the moving mass problem is presented. Firstly, the problem of a mass traversing a finite beam on an elastic foundation is reviewed and some new aspects are added. Then, the new semi-analytical solution is deduced for an infinite beam. The semi-analytical solution of the displacement under the mass is derived with the help of integral transforms and the full deflection shape is obtained by linking together two semi-infinite beams. An iterative procedure is suggested for the determination of the frequency of the oscillation induced by the moving mass. Results deduced for infinite beams are confirmed by analysis of long finite beams, with the help of derivations given in the first part of this paper. Convergence analysis on finite beams is also presented, and, in addition, the effects of the normal force, of the harmonic component of the vertical force and of the foundation damping are discussed.

Keywords: transverse vibrations; moving mass; harmonic load component; normal force; mass-induced frequency; finite, infinite and semi-infinite beams; semi-analytical solution.

1. Introduction

Dynamic analyses of beam structures under moving loads have attracted the engineering and scientific community from the middle of the 19th century, when railway construction began. Building new modern high speed lines and increasing demands on the railway network renewed the need for better understanding of dynamic phenomena related to train-track-soil interactions, and therefore, questions regarding the moving load and moving mass problems are the still important subjects in nowadays investigations. New modelling approaches and