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# Finite element dynamic analysis of beams lying on nonlinear supports under moving loads

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#### Abstract

The vibration of beams on foundations subjected to moving loads is an important engineering problem, specifically in high-speed railway track and infrastructure design. It is well know that constant loads moving with a constant velocity on uniform beams supported by uniform foundations may lead to significantly different dynamic behavior, depending on the velocity magnitude; for some velocity ranges the oscillation amplitudes may become very large, thus endangering the structural and passengers safety.

This presentation is dedicated to the computation by the finite element method of the critical velocities of loads or vehicles moving on Euler-Bernoulli beams supported by uniform or non-uniform, linear or nonlinear viscoelastic foundations. The considered non-uniform foundations are composed by two homogeneous sub-domains. Two types of physical nonlinearity of the foundation are considered: either a cubic law or a bilateral law differentiating between compression and tension. The finite element formulation of the problem is derived and the corresponding mass, damping and stiffness matrices are consistently obtained. The semi-discrete system of the governing dynamic equations is solved by the HHT-alpha method.

In the case of non-uniform linear foundations, a very good agreement is obtained between the results of the model and the analytical results available from the literature. The goal of this study is to generalize, for more realistic foundation behavior and vehicle-beam interaction models, the analyses obtained by other authors so that it may become useful in railway track modelling and design.

#### **BIOGRAPHICAL SKETCH**

Fernando M.F. Simões received his Ph.D. degree in Civil Engineering from the Instituto Superior Técnico of the Technical University of Lisbon, Portugal, in 1997. Currently, he is Assistant Professor at the Department of Civil Engineering, Architecture and GeoResources of the Instituto Superior Técnico (University of Lisbon). His research interests include solid mechanics, dynamics and biomechanics.

Prof. Simões will be hosted at UniBG as ItalyR Visiting Professor in the period 2-16 October 2015.

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