Transition radiation in an infinite beam discretely supported by nonlinear springs and dashpots

Faragau, A.B.; de Oliveira Barbosa, J.M.; Keijdener, C.; Metrikine, A.; van Dalen, K.N.

Publication date
2020

Document Version
Final published version

Citation (APA)
Faragau, A. B., de Oliveira Barbosa, J. M., Keijdener, C., Metrikine, A., & van Dalen, K. N. (2020). *Transition radiation in an infinite beam discretely supported by nonlinear springs and dashpots*. Abstract from EURODYN 2020, Athens, Greece.

Transition radiation in an infinite beam discretely supported by nonlinear springs and dashpots

Andrei B. Fărăgău*, João M. de Oliveira Barbosa, Chris Keijdener, Andrei V. Metrikine, Karel N. van Dalen

Faculty of Civil Engineering and Geosciences
Delft University of Technology
Stevinweg 1, 2628 CN, Delft, the Netherlands
{A.B.Faragau, J.M.deOliveiraBarbosa, C. Keijdener, A. Metrikine, K.N.vanDalen}@tudelft.nl

ABSTRACT

Transition radiation is emitted when a source moves along a straight line with constant velocity and acts on or near an inhomogeneous medium [1]. It occurs, for example, when trains cross areas with substantial variation of track properties (e.g., foundation stiffness) encountered near rigid structures such as bridges; these areas are called *transition zones*. Apart from potentially giving rise to vehicle instability, transition radiation has been addressed as one of the causes of track and foundation degradation due to the often strong amplification of the stress and strain fields. This leads to a high frequency of maintenance required for transition zones in areas with soft soils, which can be 3–8 times higher than for the regular parts of the railway track.

Wave radiation is also generated due to the periodic variation of the support stiffness (i.e., periodically placed sleepers). The periodically supported beam interacting with a vehicle has been addressed in studies on vehicle instability and on the resonant behaviour of the system [2]. Moreover, it has been shown that the periodic supports play a role in the fatigue and corrugation of both wheel and rail [3]. However, most studies consider either the local variation of the foundation stiffness (i.e., transition zones) or the periodic variation of the support stiffness, and not the combination of the two. Furthermore, studies that consider both scales make use of complex supporting structures and vehicle models such that the influence of the discrete supports on the transition radiation is not clear.

This work aims at studying the influence of accounting for the discrete supports on the transition radiation (inside transition zones) and on the plastic deformation that develops in the supporting structure. To this end, a 1-D model is formulated, consisting of an infinite Euler-Bernoulli beam discretely supported by nonlinear springs and dashpots whose characteristics locally vary in space, interacting with a moving loaded oscillator. The solution is obtained using a time-stepping method (i.e., Newmark-β) for the temporal dimension of the system while the finite element method is used to discretise the spatial dimension. The infinite extent of the system is ensured through a set of non-reflective boundary conditions obtained using the Floquet theory.

The model presented here can be used for preliminary designs of transition zones in railway tracks. Given the stiffness dissimilarity, the optimum length of the transition zone and the train's maximum velocity can be obtained such that the damage in the railway track is minimized.

References

[1] V. L. Ginzburg, I. M. Frank, *Radiation arising from a uniformly moving electron as the electron crosses from one medium into another*, 1946. J. Exp. Theoret. Phys. **16**, 15-30.
[2] A. I. Vesnitskii, A. V. Metrikin, *Transient Radiation in a Periodically Nonuniform Elastic Guide*, 1993. Uzv. RAN. Mekhanika Tverdogo Tela **28**, 164-168.
[3] T. Mazilu, *Green's functions for analysis of dynamic response of wheel/rail to vertical excitation*, 2007. J. of Sound and Vibration **306**, 31-58.