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Trees to mitigate induced railway vibration

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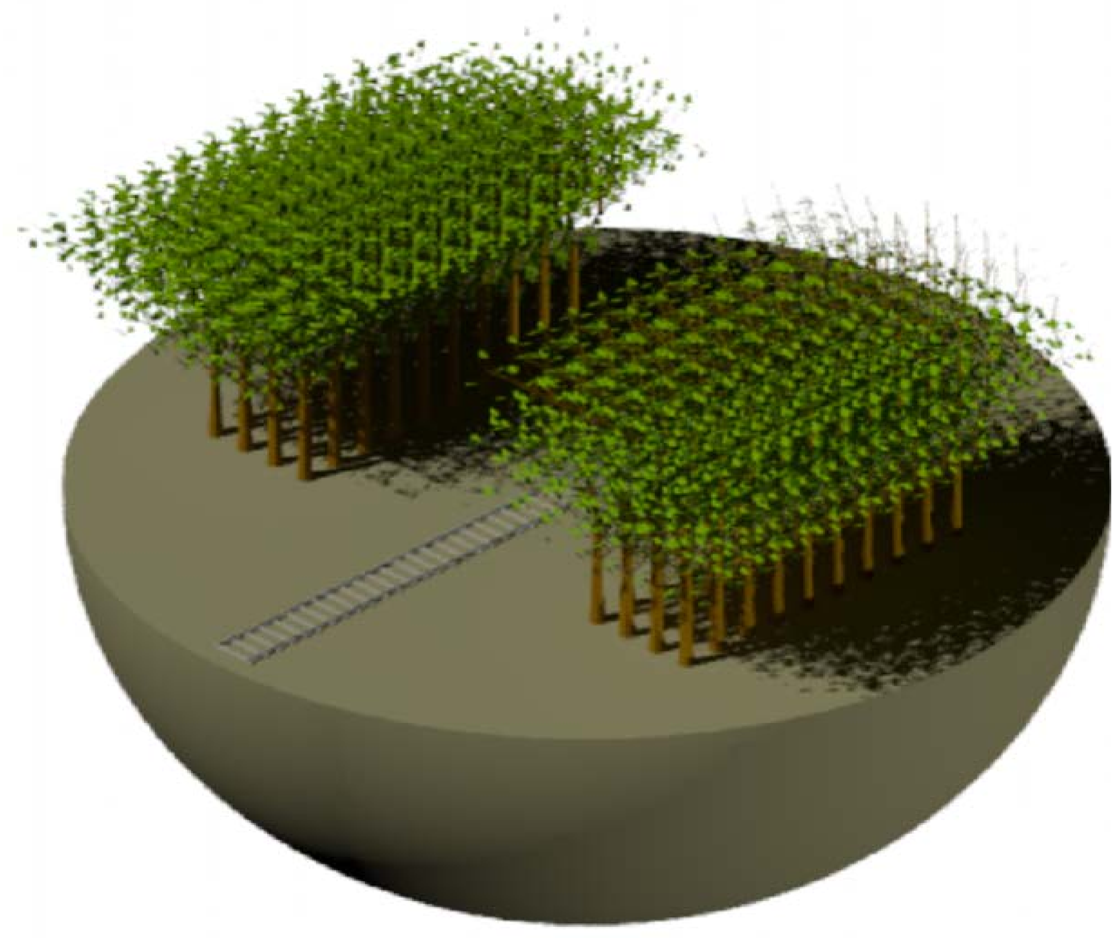
INTRODUCTION

The railway system as means of transportation is experiencing a large growth globally because of its sustainability. One main drawback that could slow down this extension of the railway traffic is the vibration that is generated at wheel-rail interaction and propagates through the transmission path right up to the nearby building's foundations and affecting negatively the daily life of the residents. Different mitigation measure already exists in the field, yet some of them present high costs and others are not in line with the sustainability wanted from this means of transport [1-2]. Therefore, the use of nature could be the right compromise in order to make rail transport even more sustainable and attract new investors. This research focuses on a brief implementation of the so-called natural metamaterials integrated within a validated numerical approach based on the two-step approach in order to mitigate the induced vibration generated at the rail-wheel interaction. Results are shown for the vibration time history in order to have the first outputs of the levels of attenuation which could be reached with the use of trees as mitigation measures within the transmission path.

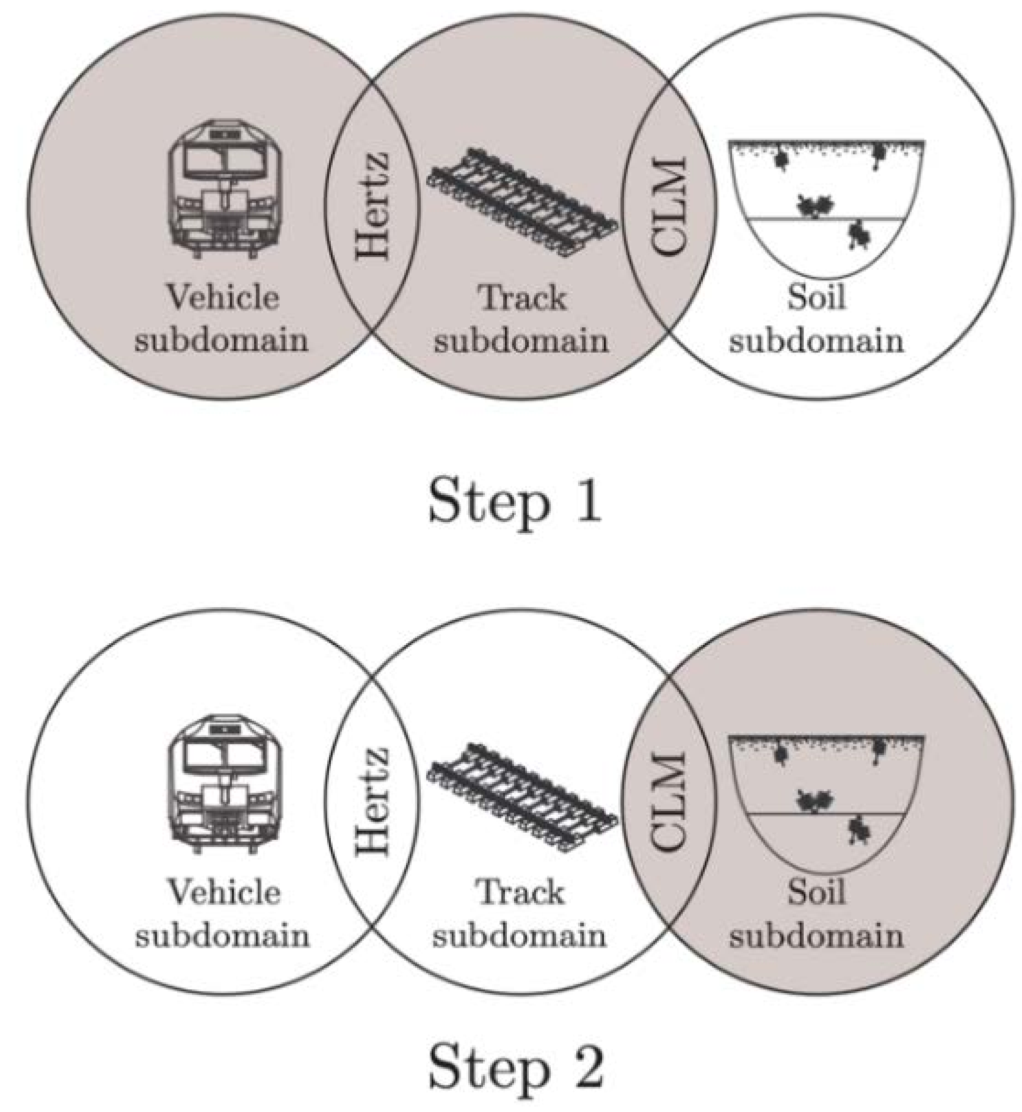


RESEARCH AIMS

The main aims of the research are:

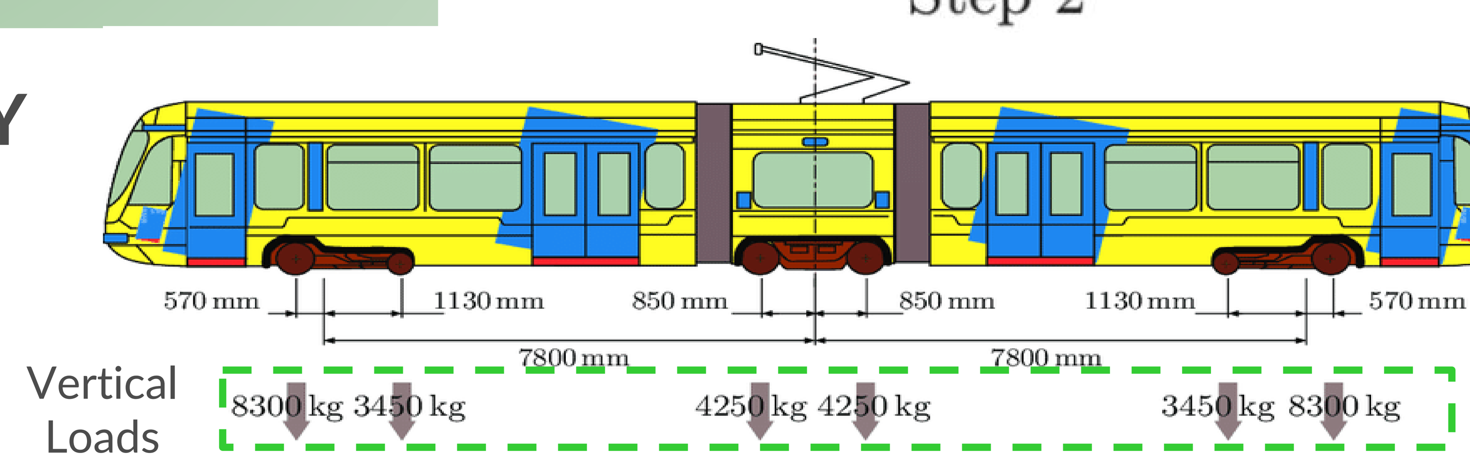
- To develop new types of mitigation measures capable of minimizing the vibrations generated by railways and dropping them to acceptable thresholds.
- To achieve this a two-step method approach will be used, that combines the vehicle, track and soil dynamics [3]. Using in the first step a multibody framework (EasyDyn) to model the vehicle and in the second step a Finite Element software (ABAQUS) to model the soil.

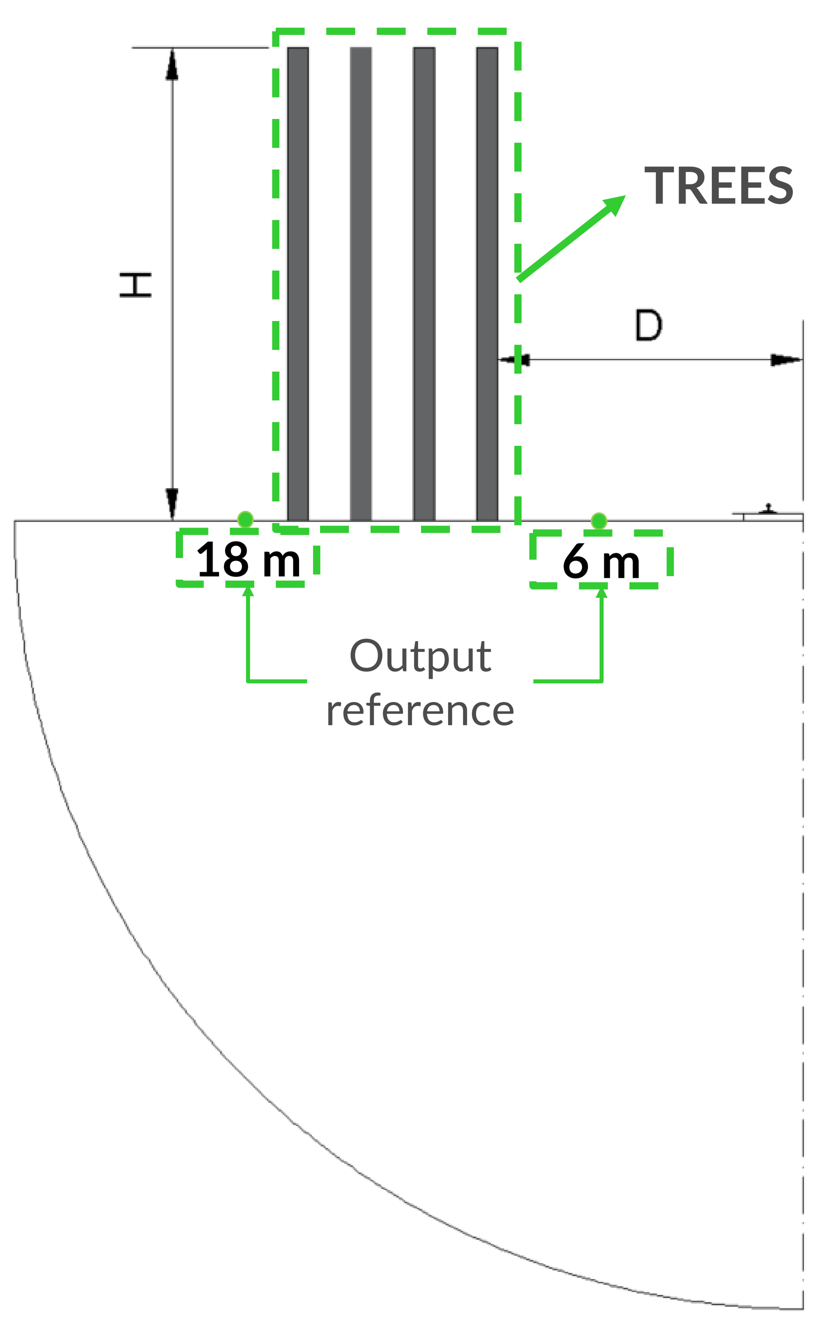
The new methodology of mitigation measures using natural metamaterial will be applied to the vehicle-track-soil model, providing a comprehensive reproduction of the railway environment.



APPLICATIONS OF THE NATURAL METAMATERIAL IN RAILWAY

Examples illustrate the efficacy of the metamaterials [2]:

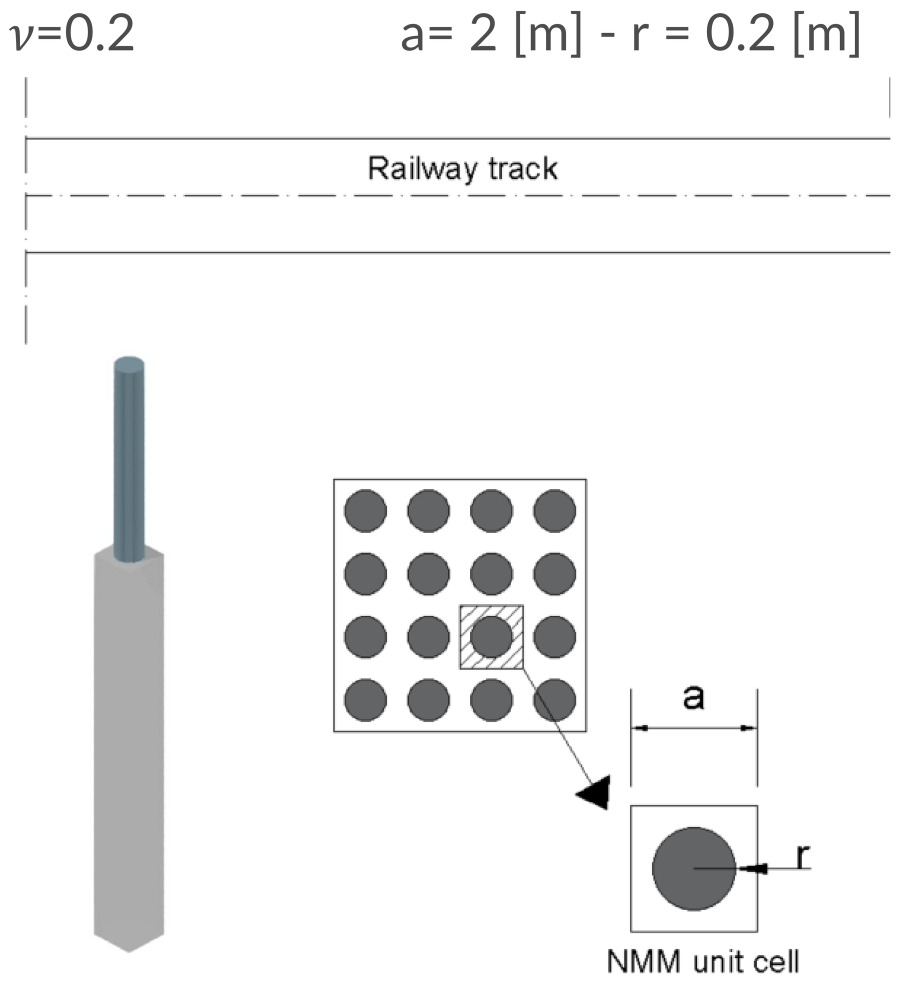


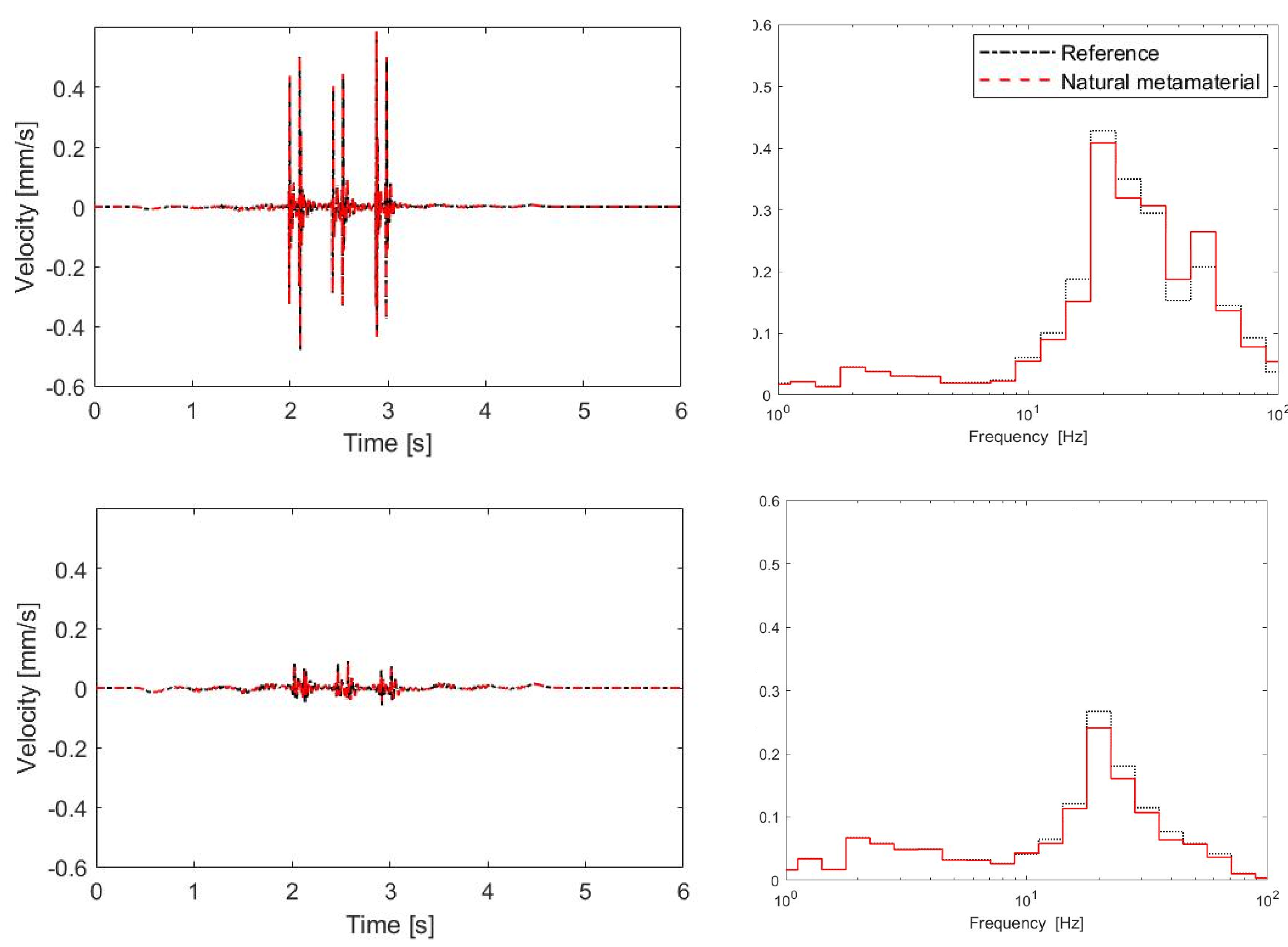


METAMATERIAL CONFIGURATION

The natural metamaterial considered has 4x4 layout with the following characteristic:

E=70000 MPa D = 12 [m]
ρ=2700 kg/m H = 12 [m]
ν=0.2 a= 2 [m] - r = 0.2 [m]





CONCLUSIONS AND DEVELOPMENT

Natural metamaterial has double potential to find their application in the mitigation of railway vibration. First, because the intrinsic characteristics of the metamaterial can be achieved, secondly because the use of trees to mitigate induced vibration will add an extra value in terms of the sustainability of the railway environment.

The array configuration used in this research shows a promising achievement in terms of mitigation vibration, by reducing the peak vibration by 25 % and affecting mostly the most relevant range of frequencies, around 10 to 30 Hz.

Results shown in this presentation need to be investigated in detail with parametric studies to estimate the capacity of the natural metamaterial.

Further, parametric studies will be undertaken to explore the range of possible metamaterial configurations that will stand the best for induced vibration generated by the rail traffic.

REFERENCES

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[3] Kouroussis G & Verlinden O. & Conti C. (2012) A two-step time simulation of ground vibrations induced by the railway traffic, Journal of Mechanical Engineering Science, 226, 454-472.

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