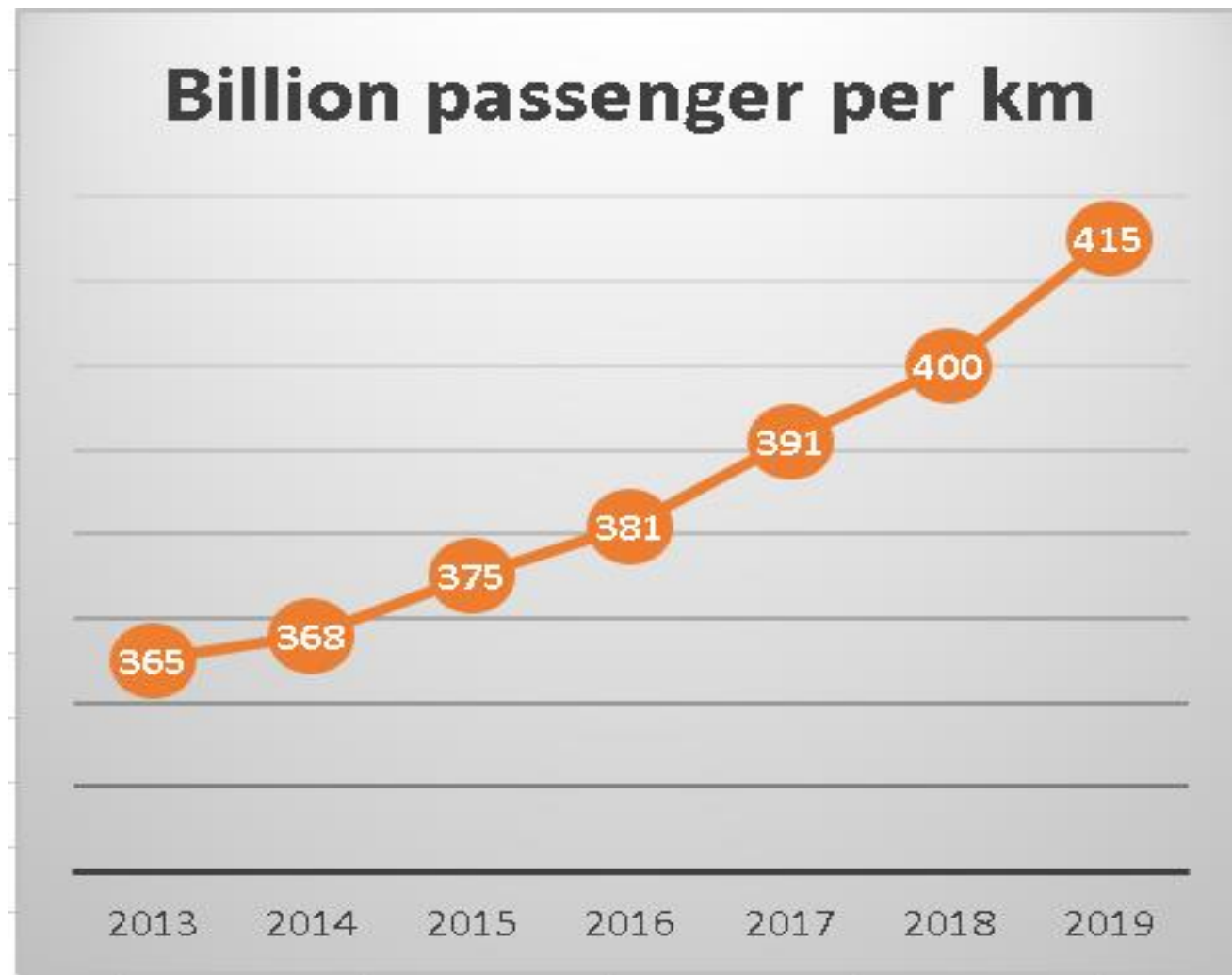


METAMATERIAL CONCEPTS IN RAILWAY AS VIBRATION MITIGATION MEASURES

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INTRODUCTION

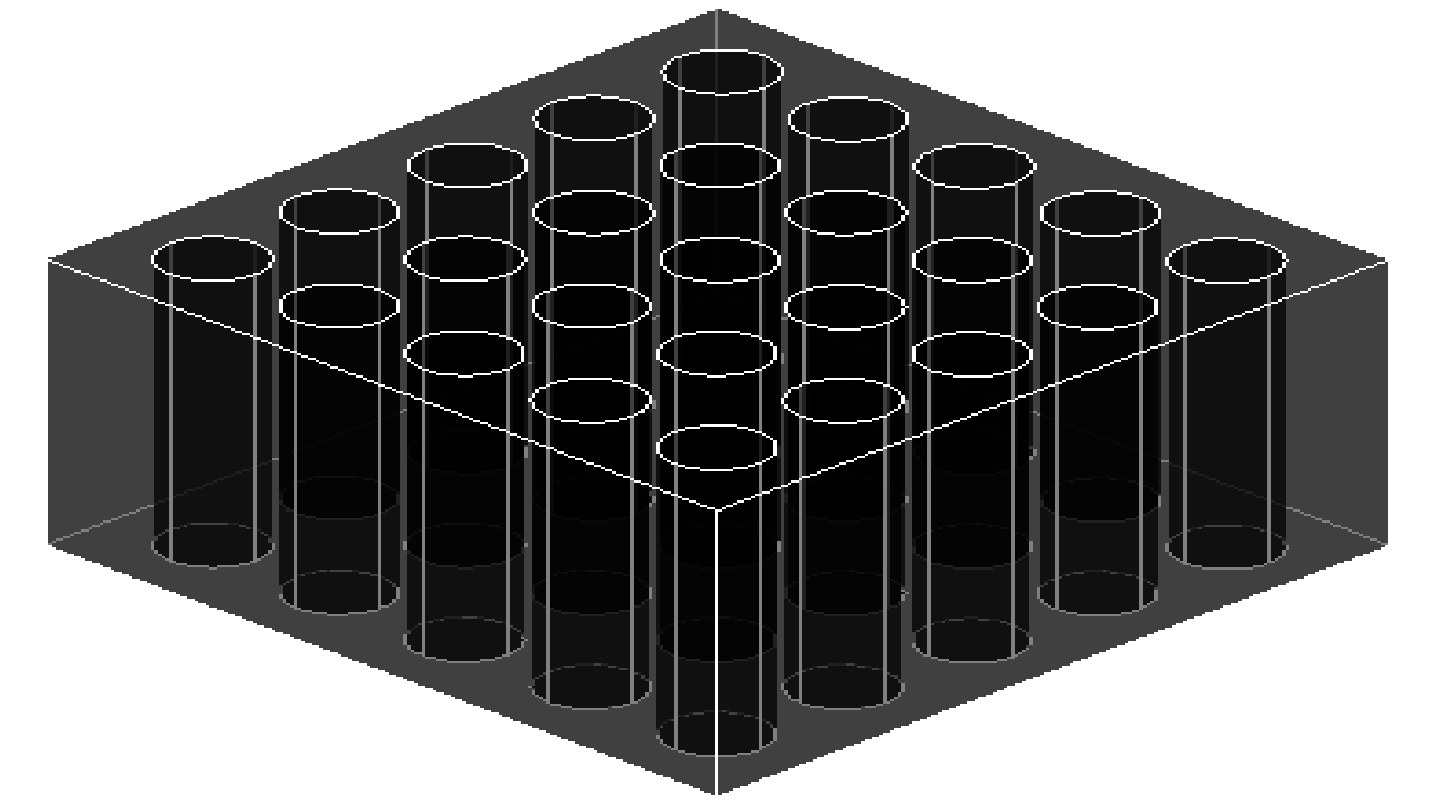
Railway system has been characterized by the exponential growth in the last years in Europe.



A supplemental increase is expected due to the sustainability of this means of transportation, which is in line with the global decarbonization target. As a matter of fact, Europe aims to achieve a 50% coverage of land transportation with rail lines by 2050 [1].

The expansion will inevitably raise the effects generated by the rail traffic and this might be the only limitation for the 2050 aim. Mitigation measures are already present yet to place the railway as the first candidate in transportation new technologies need to be developed.

In this direction the beneficial are characteristics of Metamaterial (MM). Those are materials structured with periodically repeated unit blocks which exhibit extraordinary properties for inhibiting the wave propagation [2].

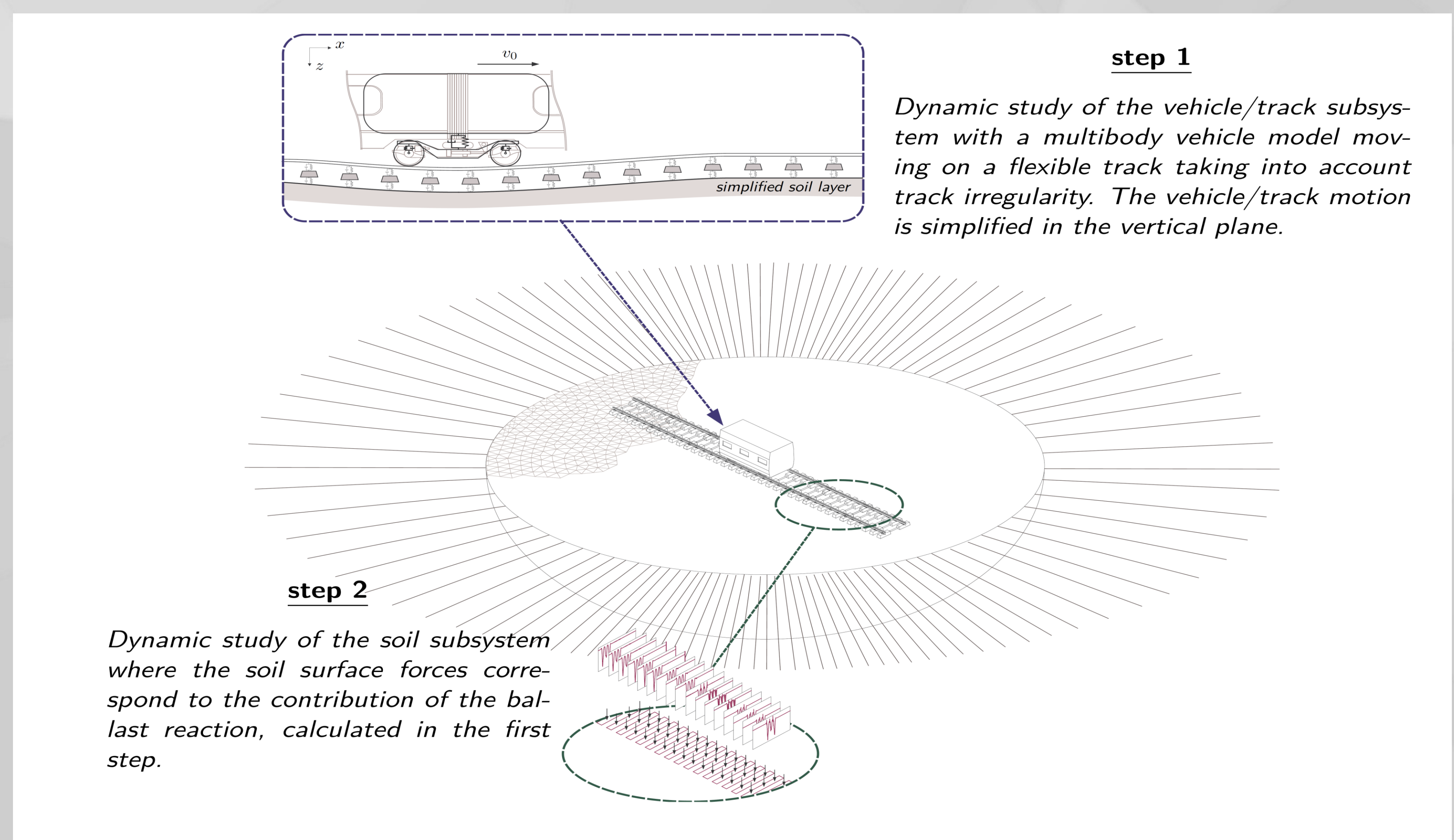


RESEARCH AIMS

The main aims of the research are:

- To develop new types of mitigation measures capable of minimizing the vibrations generated by railway and drop 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.

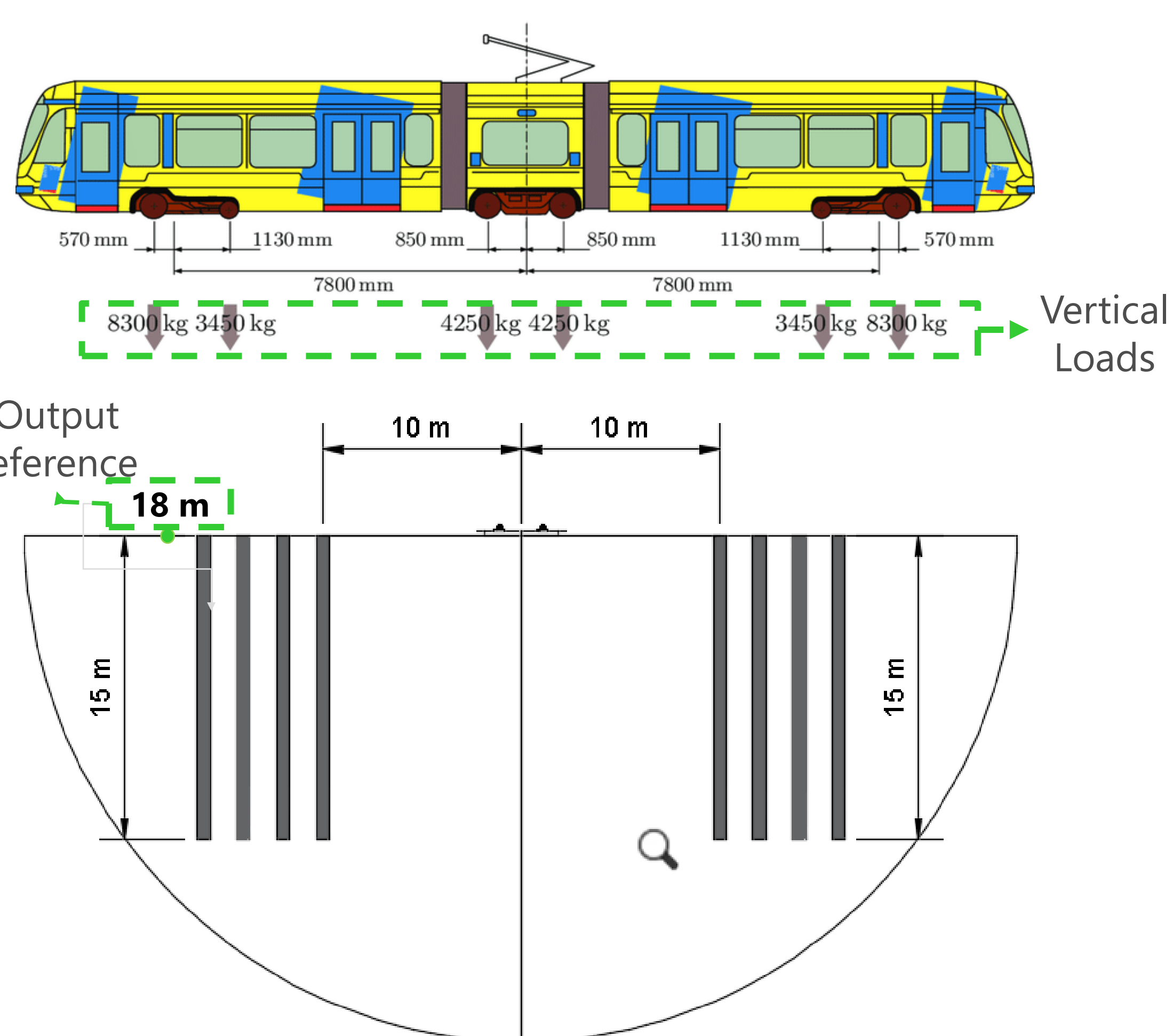
The new methodology of mitigation measures using MM will be applied to the vehicle-track-soil model, providing a comprehensive reproduction of the railway environment .



APPLICATIONS OF THE METAMATERIAL IN RAILWAY

Examples illustrate the efficacy of the metamaterials [2]:

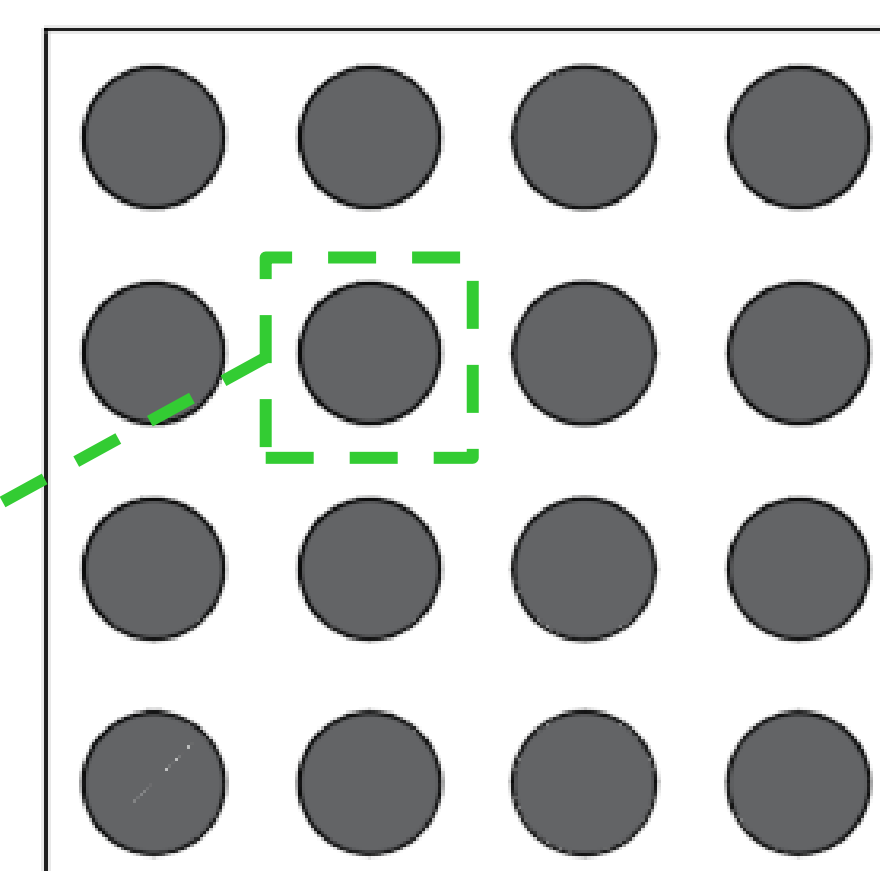
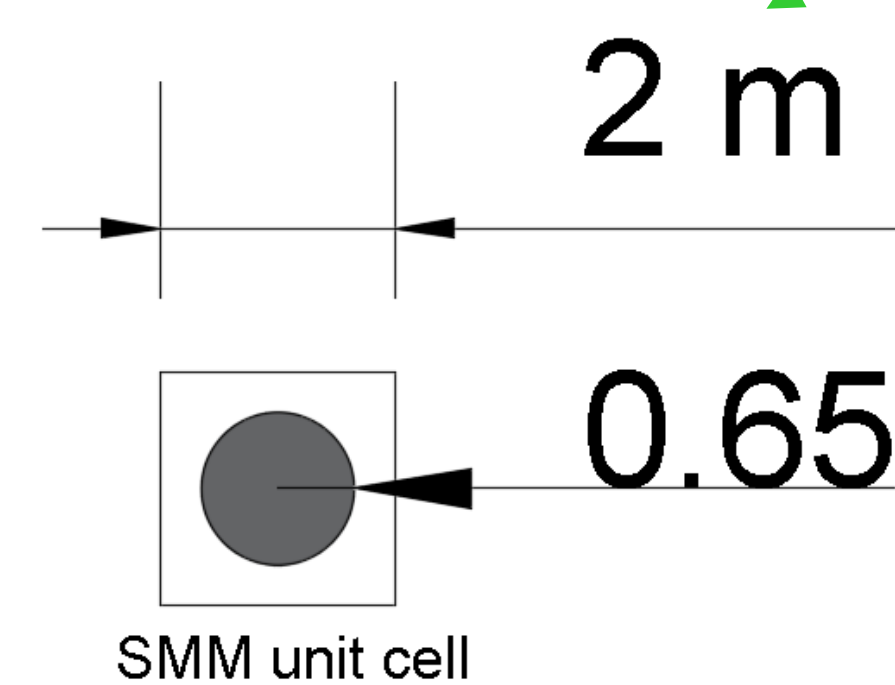
T2000 BRUSSELS' TRAM



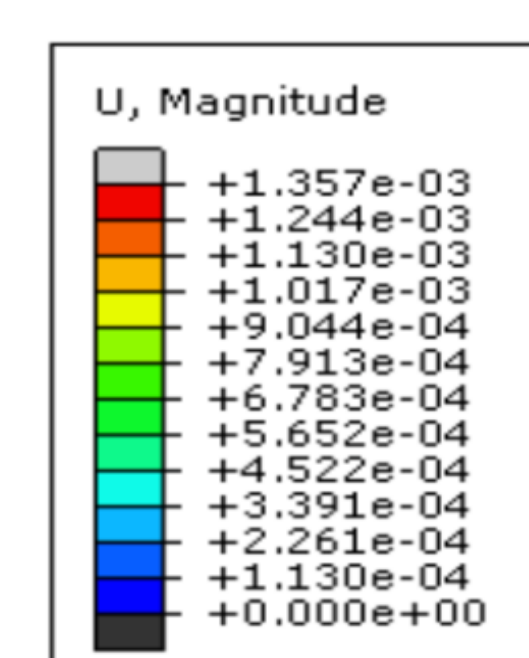
METAMATERIAL CONFIGURATION

The MM considered in the case are composed by a 4x4 layout, with the following characteristic:
 $E=70000 \text{ MPa}$
 $\rho=2700 \text{ kg/m}$
 $\nu=0.2$

UNIT CELL

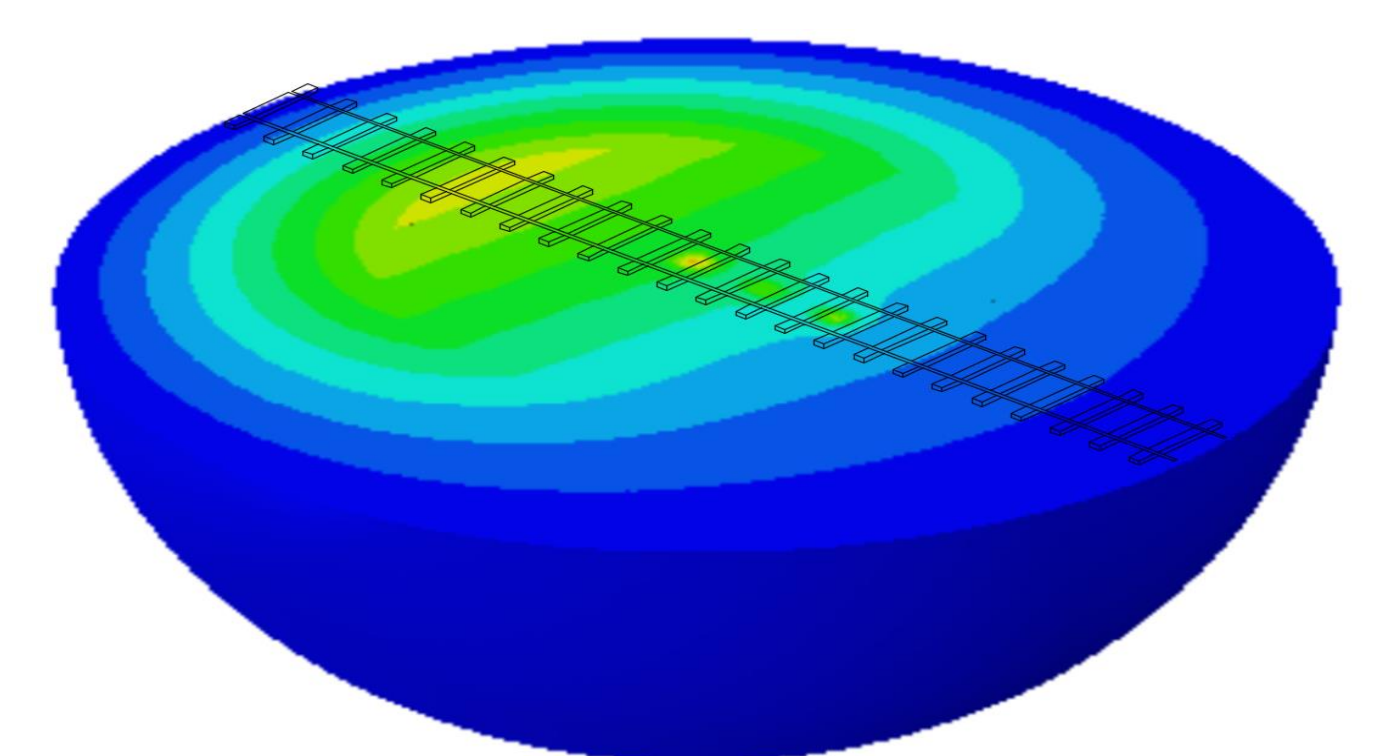
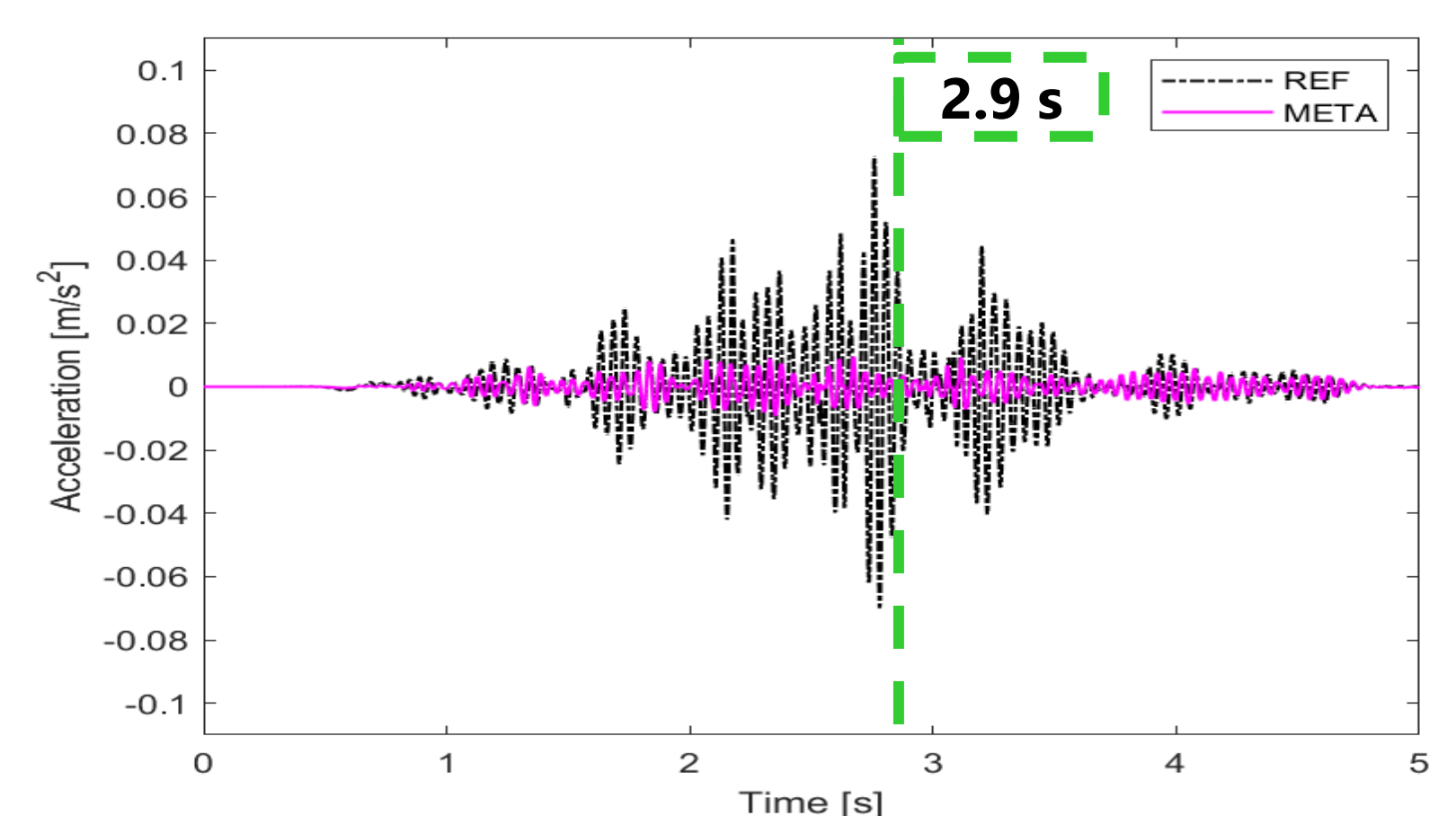


Possible paths



NUMERICAL RESULTS

Numerical analysis shows an important improvement in terms of acceleration.



CONCLUSIONS

Proprieties of metamaterial have the right potential to withstand the new thresholds of the vibration coming from the railway traffic.

The MM configuration used in this research shows a great achievement in terms of mitigation vibration, indeed a reduction of 74% is obtained.

Results shown in this manuscript need to be investigated in detail with parametric studies to estimate the capacity of MM.

FUTURE DEVELOPMENT

Parametric studies will be undertaken to explore the range of possible metamaterial configuration that will stand the best to the induced vibration generated by the rail traffic.

The MM characteristics will be applied also to the other two subsystems (vehicle and track) of the railway environment to achieve the best solution in terms of vibration attenuation.

REFERENCES

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