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Mitigation of high-speed trains vibrations by expanded polystyrene blocks in railway embankments

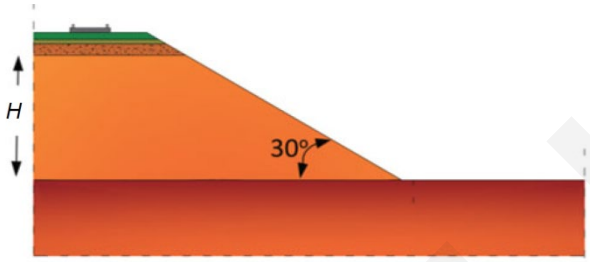
Alexandros Lyratzakis, Yiannis Tsompanakis*, Prodromos N. Psarropoulos

Keywords: High-speed railways (HSR); High-speed trains (HST); Traffic-induced vibrations; Mitigation measures; Expanded polystyrene (EPS)

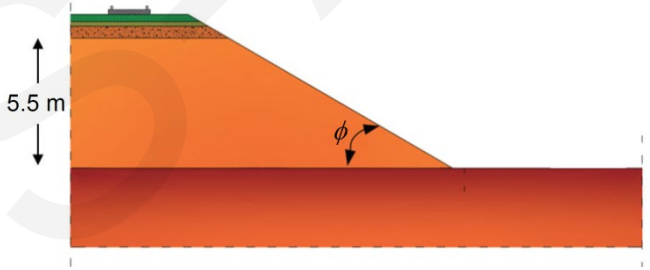
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PURPOSE OF THE STUDY

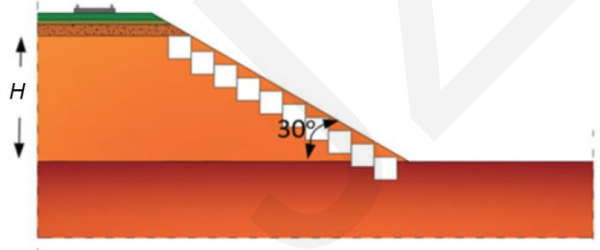
IMPACT OF EMBANKMENT HEIGHT ON HST-INDUCED VIBRATIONS

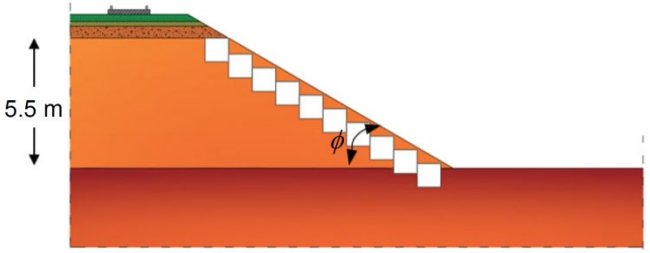


IMPACT OF EMBANKMENT INCLINATION ON HST-INDUCED VIBRATIONS



IMPLEMENTATION OF EPS BLOCKS ON THE EMBANKMENT SLOPE IN ORDER TO REDUCE VIBRATION LEVELS





CASE STUDY

- Examined HST: Thalys
- Passing speed: 284 km/h
- Welded UIC-60 rails
- Classical ballasted track
- Track components: ballast, subballast, subgrade.

Soil profile and embankment

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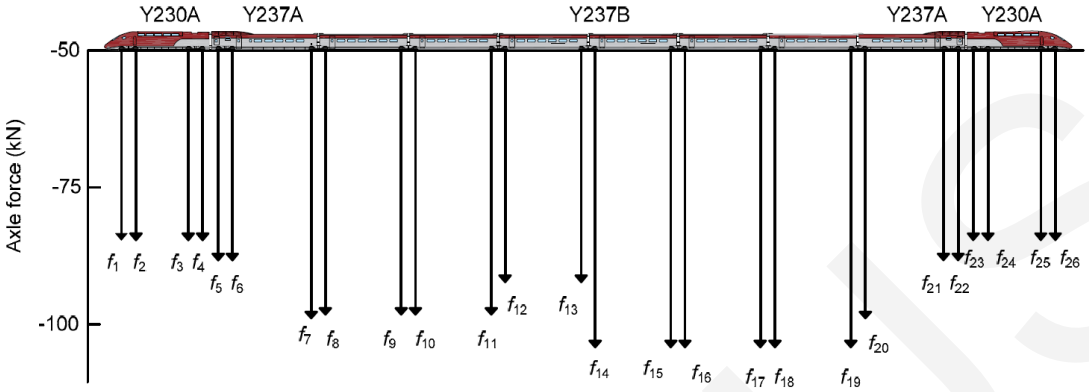
Site north-east of Braffe, Belgium



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FINITE-ELEMENT MODEL

THALYS STATIC AXLE FORCES

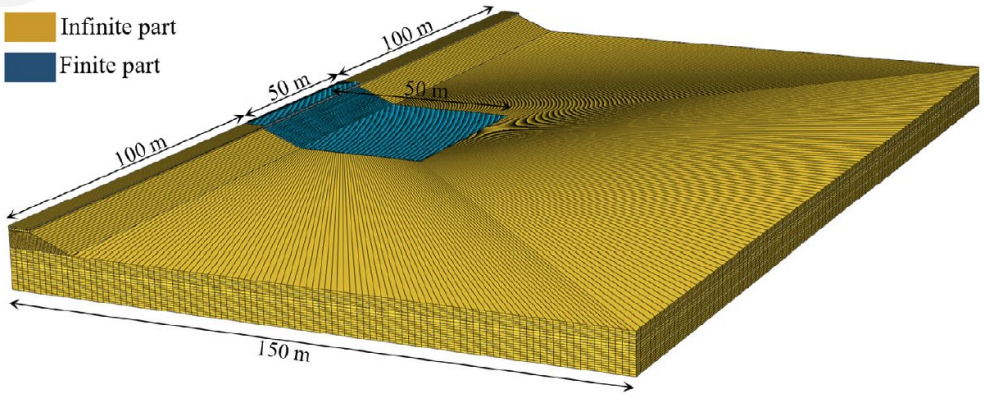


Modeling of HST's axle forces

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Fortran Vdload subroutine

3D FINITE/INFINITE NUMERICAL MODEL



Modeling of the track and soil components

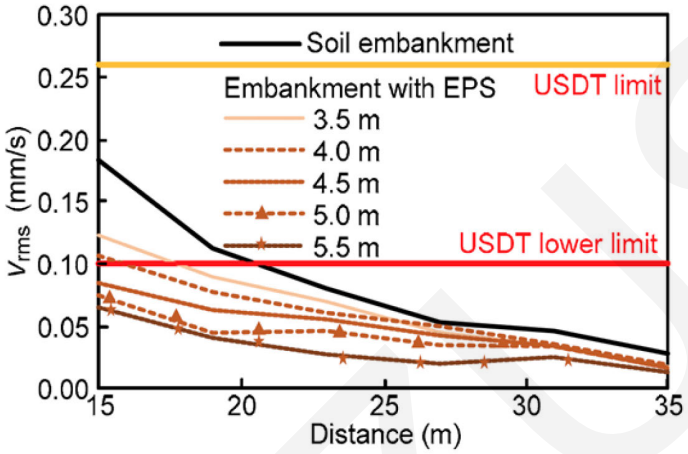
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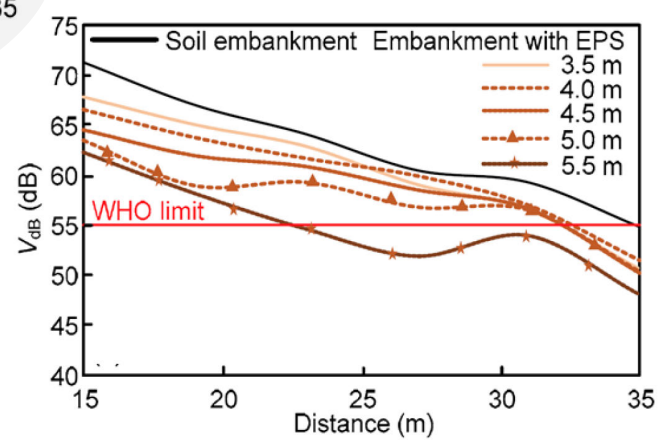
ABAQUS Explicit

RESULTS

SOIL AND EPS-RETROFITTED EMBANKMENTS: VIBRATION LEVELS FOR VARIOUS HEIGHTS

V_{rms} compared to USDT limits



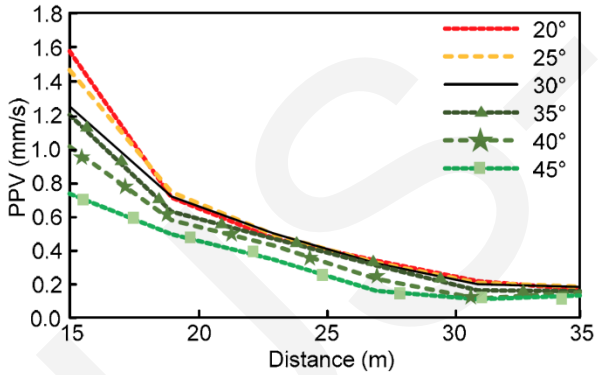


V_{dB} compared to WHO limit

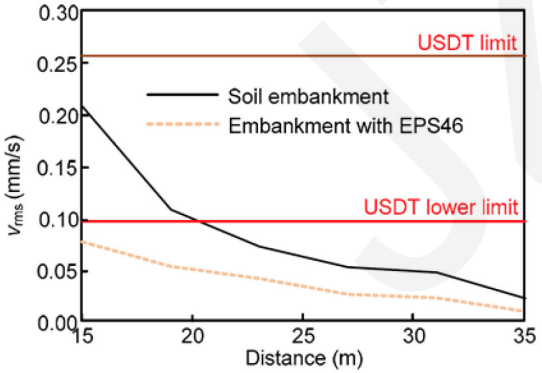
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RESULTS

PPV(=max|v(t))|) OF THE SOIL EMBANKMENT FOR VARIOUS SLOPE INCLINATIONS

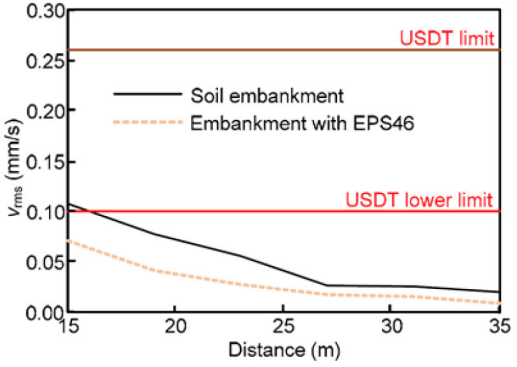


COMPARISON WITH EPS-RETROFITTED EMBANKMENT



20°

45°



CONCLUDING REMARKS

- In general, the implementation of EPS blocks contributes to the mitigation of the HST-induced vibrations.
- The embankment height has a minor impact on the HST-induced vibrations.
- The embankment slope inclination plays a more crucial role on vibration levels. A steeper slope leads to lower vibration levels.
- The application of EPS blocks leads to a reduction of v_{rms} values below the USDT limit for frequent HST passage.
- In addition, PPV values are lower than the DIN limit for the protection of nearby buildings and their residents.

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