Modelling critical velocity effects on high speed railways – a case study.

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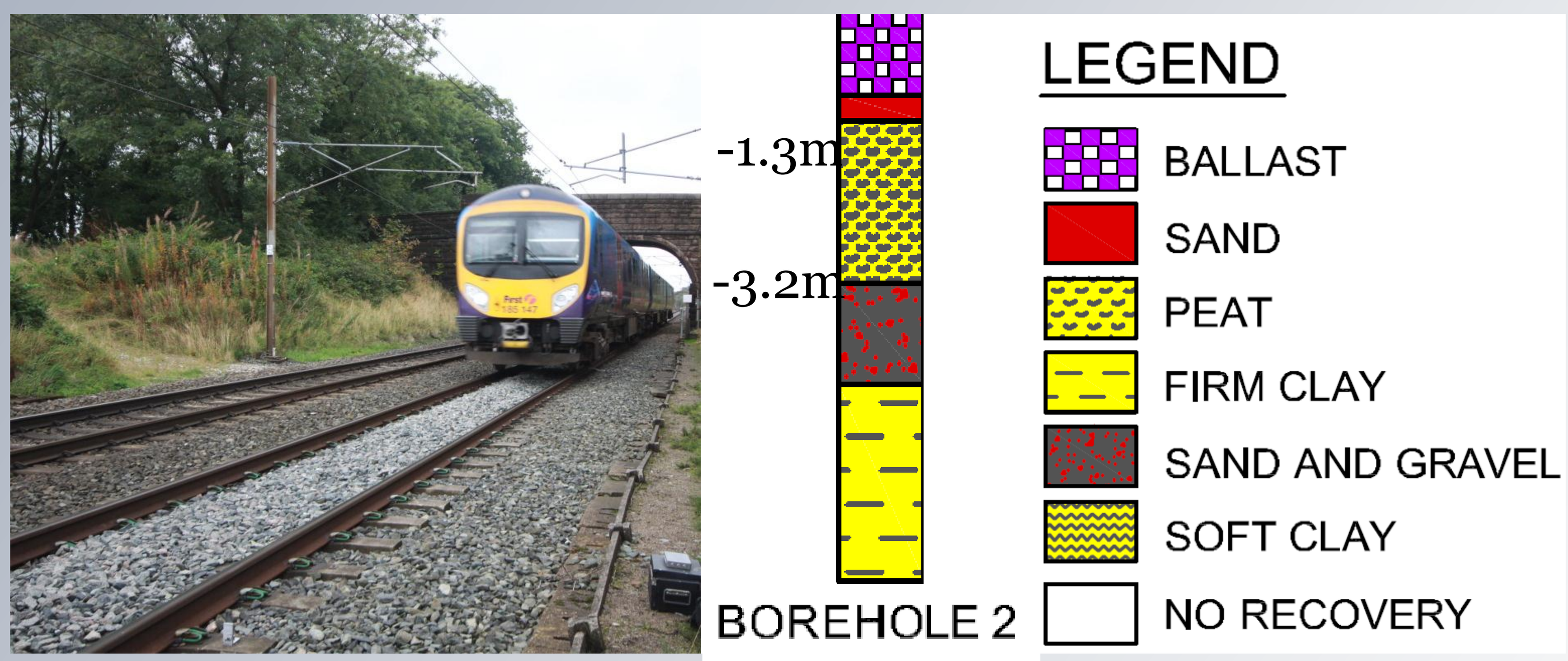


Site: *Stratigraphy, after Aspen Foundations Ltd. (2014) Factual Ground Investigation Report. Preston.*

Modelling Options:

Two potential prediction models:

- TGV – 2.5D semi-analytical
- WANDS – 2.5D Finite/Boundary element.

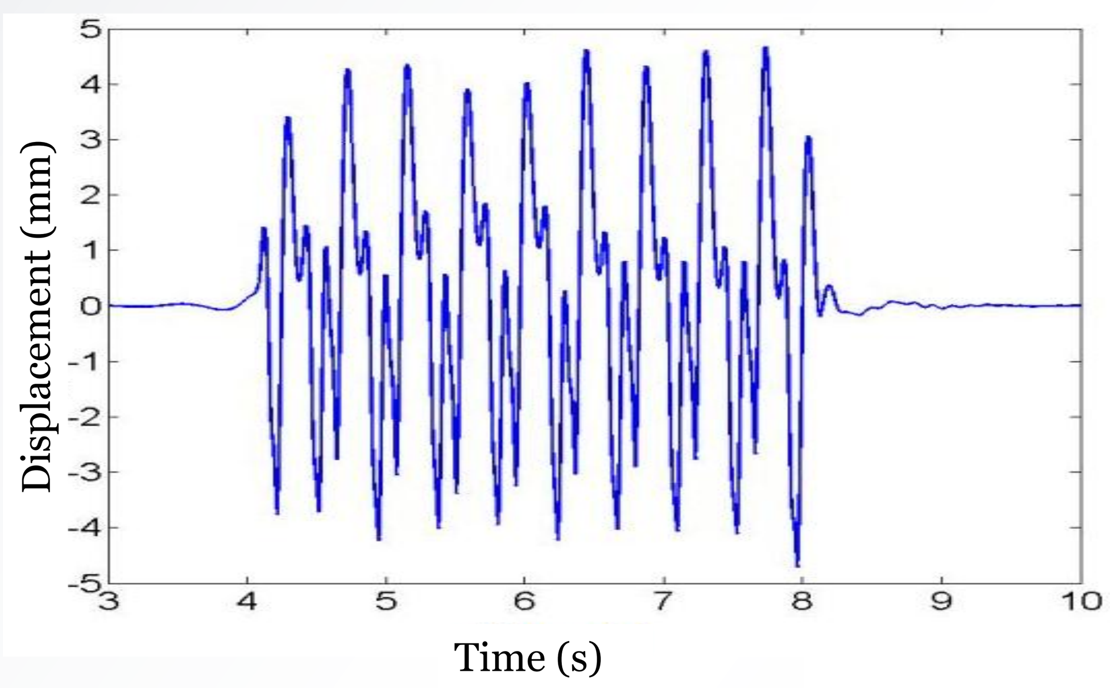
Neither has been used for in–depth critical velocity investigation before, therefore parametric study carried out.

Three ground geometry types:

- Peat halfspace
- Peat layer over rigid foundation
- Peat layer over stiffer halfspace.

Three load situations:

- Single moving load – quasi-static displacement
- Multiple loads-single vehicle– quasi-static displacement
- Full train - quasi-static and dynamic analysis.



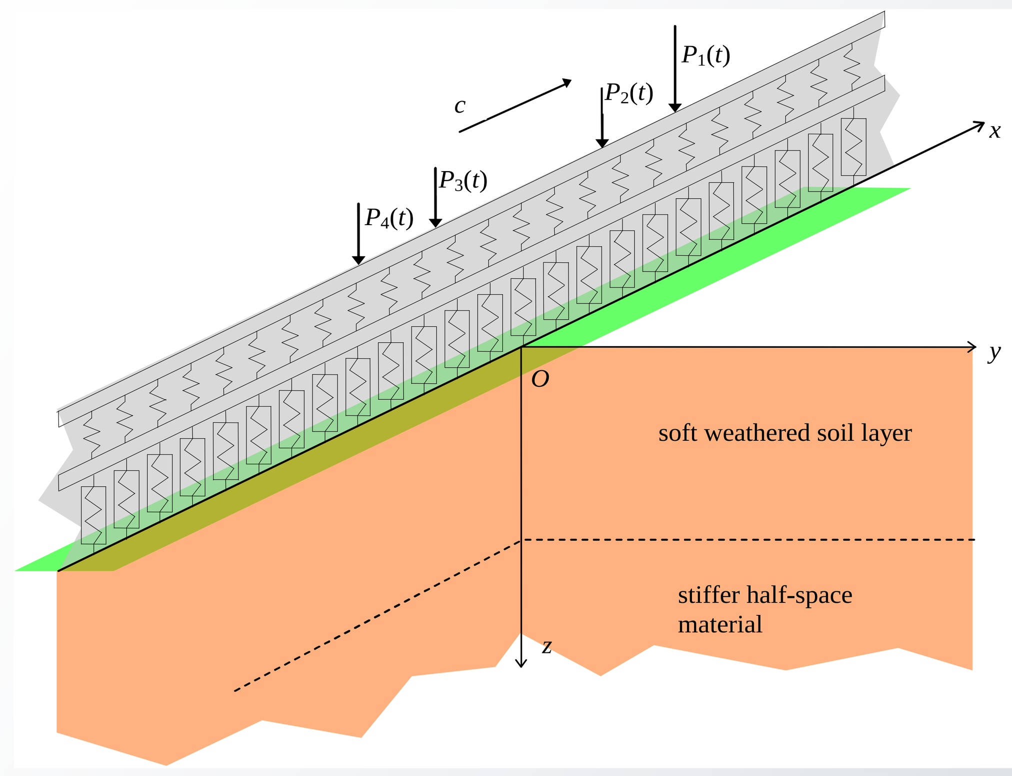
Site - Cause and Effect:

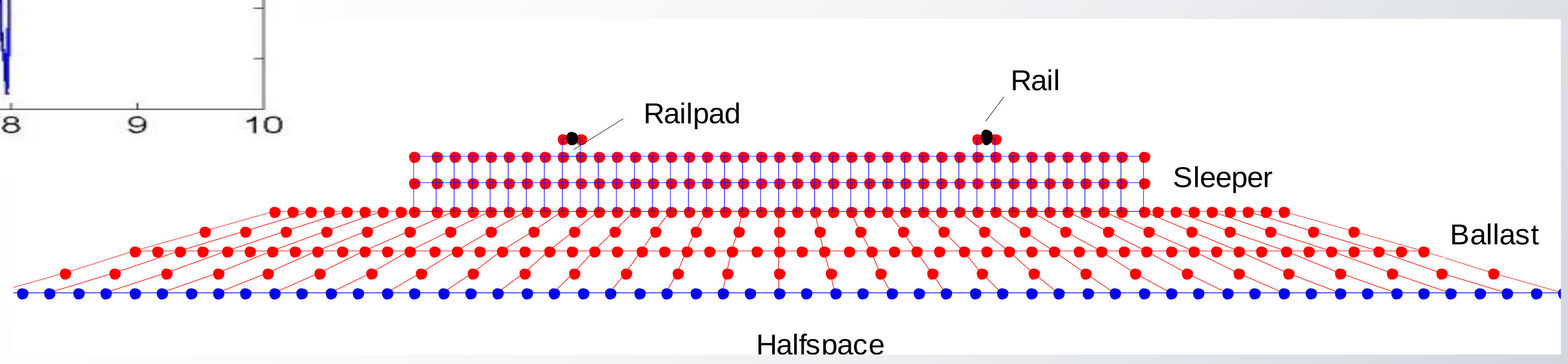
In areas of soft ground there is a much greater likelihood of the high train speed approaching the speed of ground borne waves (Rayleigh waves), potentially resulting in excessive ground borne vibration and movement.

Excessive ground movements monitored using geophones at a site on the existing UK rail network. The maximum speed of trains on the site is 120 mph (53 ms⁻¹).

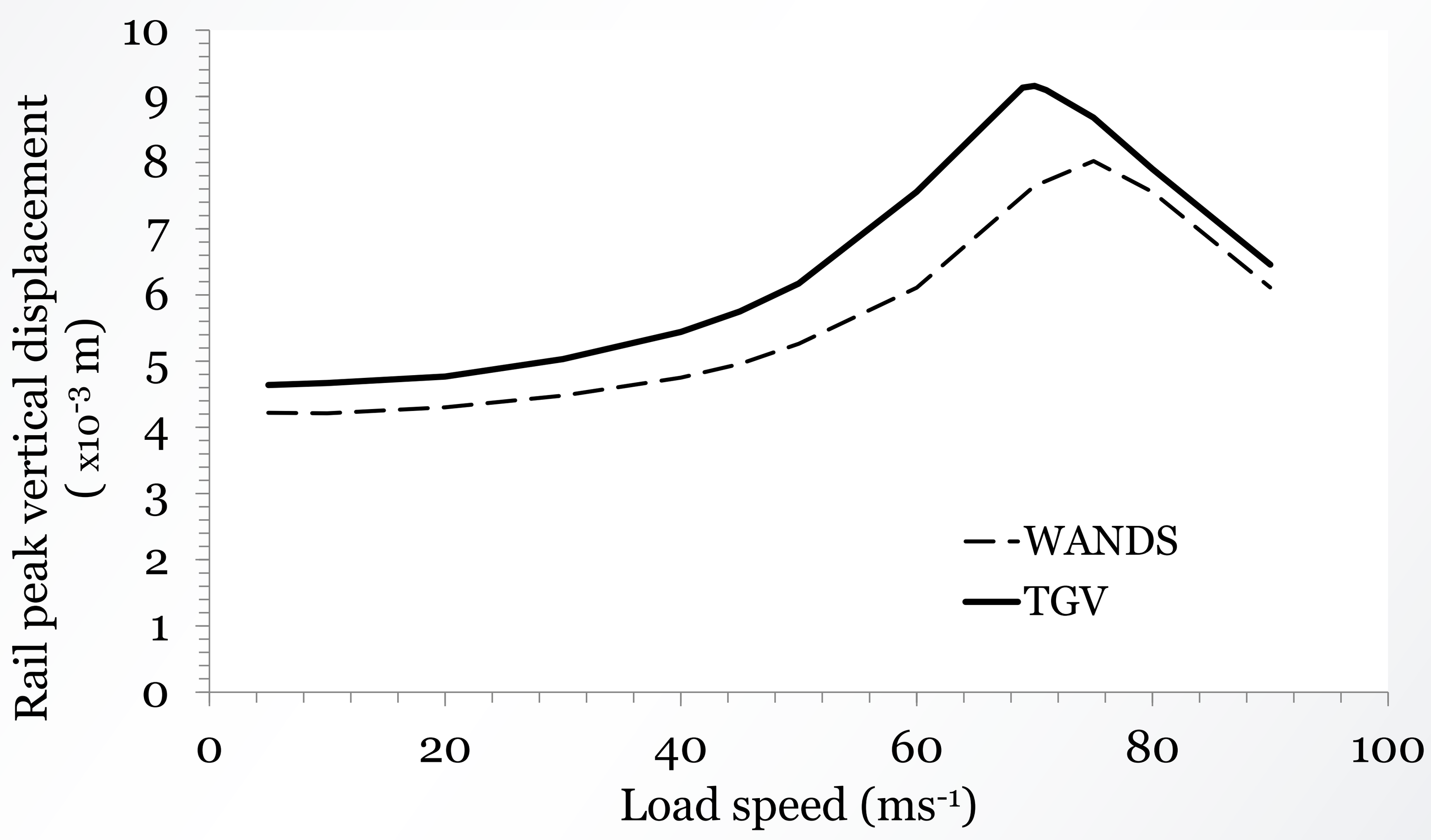
Ground consists of a soft peat layer, ranging in depth from 1.9 to 4 m , overlying stiffer ground. Underlying strata Rayleigh wavespeeds measured at 90 to 200 ms⁻¹. Peat wavespeed believed to be below 50 ms⁻¹ , therefore the cause of the excessive movements.

Right: *TGV schematic* ***Left:*** *Geophone trace.* ***Bottom:*** *WANDS schematic.*

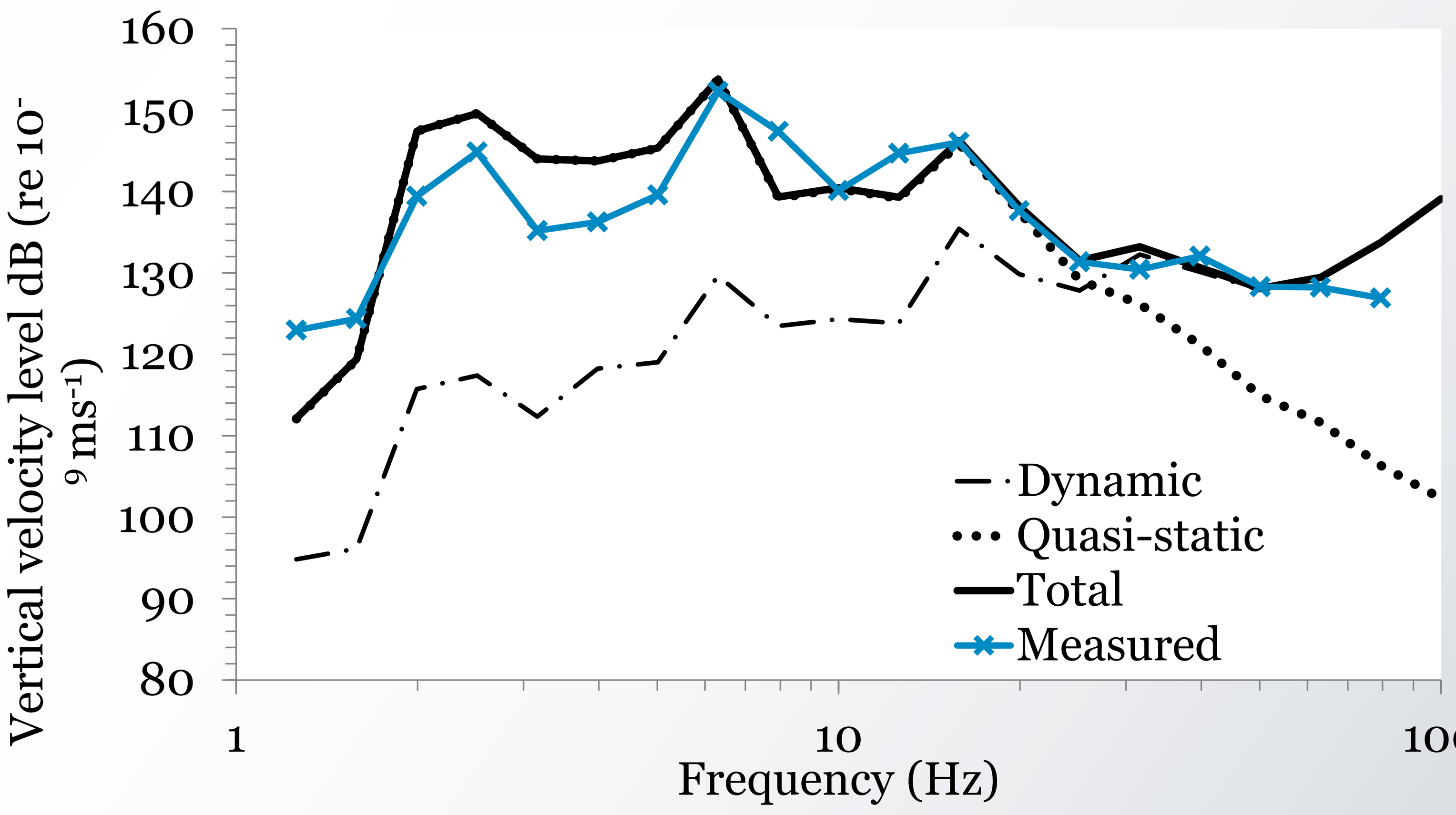




Peak Displacement: *Single load. 2 m peat layer over stiffer halfspace – WANDS and TGV.*



TGV result: *1/3 octave band pass-by response power spectrum of the rail for 2 m peat layer over stiffer halfspace loaded with a full train at 50ms⁻¹.*



Modelling Results:

- Good agreement between WANDS, TGV and site data (see left) for all ground geometry types. WANDS consistently predicting 19% lower displacement than TGV. WANDS – only single moving load investigation carried out due to computing requirements.
- Significantly larger displacements when run with multiple loads – due to individual axle displacements reinforcing following axle displacements.
- Excellent agreement between site geophone measurements and TGV for full train dynamic analysis (see left). Close agreement between peat layer over stiffer halfspace and peat layer over rigid foundation.
- Overall indication that both models can be useful in critical velocity effect prediction. Knowledge of site wavespeeds and ground geometry key to accuracy.

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