

Project C	Understanding the development of track standard deviation
Part of	Research Challenge 1, TRACK4LIFE
Project timing	Started June 2015
More information from	Dr Louis Le Pen
Project partners	Network Rail; Network Rail High Speed Ltd London Underground Ltd (LUL)
Associated projects	EU project CAPACITY4RAIL FP7-TRANSPORT: Grant agreement 605650. EPSRC EP/K03765X/1: Track Systems for High Speed Railways EU project In2Rail, H2020-MG-2014: Grant agreement 635900. WP3, Deliverable 3.3: T2F wrote Chapter 4.5 on settlement analysis with VTI.

Project aims

Predicting the rate of geometry deterioration of a section of railway track is difficult, and current methods are generally over-reliant on experience and empiricism. This project aims to develop an understanding of the relationships between the measurable parameters of track stiffness and track settlement, and the key performance parameter of geometrical standard deviation, taking into account the interactions with rail geometry and vehicle dynamics, through

1. a review of current models for predicting the development of sleeper / track settlement and changes in standard deviation with trafficking
2. vehicle / track interaction (VTI) analyses with a varying ballast / subgrade stiffness and the ability to incorporate permanent settlements, and
3. short- and long-term field measurements.

Progress to date

Project aim 1. A review of current approaches to predicting settlement and standard deviation has been carried out, with reference to benchmark rig tests (Fig.C1). This work has been presented at a major international conference [2017], and a more detailed position paper is in preparation.

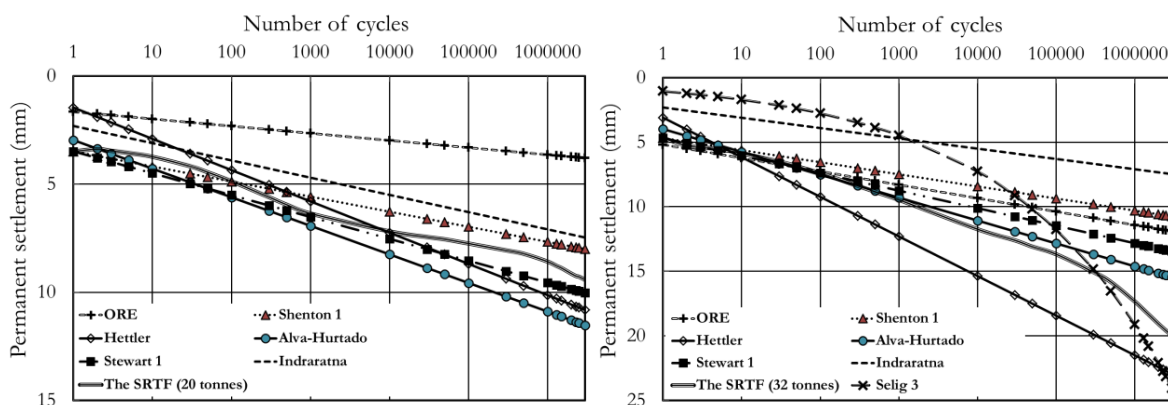


Fig.C1: Comparison of ballast settlement rules with data for (a) 20 tonne and (b) 32 tonne equivalent axle load

Project aim 2. Vehicle Track Interaction (VTI) models have been developed to incorporate track stiffness variation and, through an iterative approach, differential settlement. Two settlement prediction equations - Sato (1995) and Guerin (1996) - have been evaluated [C7], together with a stochastic variation in track support system stiffness based on measured data (Fig.C2, Fig.C3). The two empirical models give different results for the evolution of track geometry over time; hence studies are continuing.

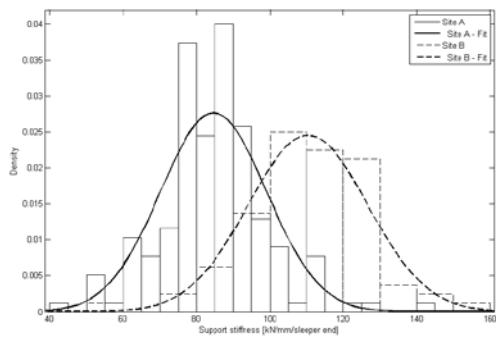


Fig.C2: Stochastic variation in track system support stiffness used in VTI models

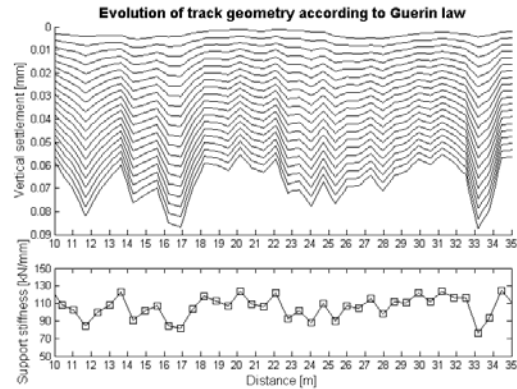


Fig.C3: Evolution of track geometry deterioration in VTI analyses using Guerin settlement equation

Project aim 3. Trackside monitoring and analysis techniques have been developed to enable measurement of track stiffness and settlement over greater lengths of track. Recent field work at Alutsgarden, Sweden using low-cost MEMS accelerometers has shown the repeatability and suitability of these types of sensors for quasi-pervasive deployment. An example of the type of stiffness dataset now being acquired is shown in Fig.C4.

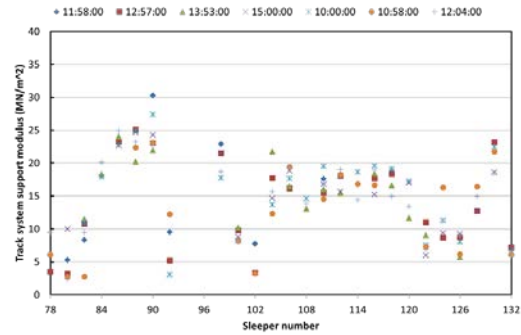


Fig.C4: Track system support modulus measured using MEMS at Alutsgarden, Sweden.

Planned further work (Programme objectives in brackets)

- Development of improved correlations, referenced to data generated from the cross-programme field study sites and laboratory tests in RC1A (1B.1, 1B.2, 1B.5)
- Further field studies using low-cost MEMS sensors covering in the order of 100 sleepers, to evaluate track stiffness on a per sleeper basis – deployment over significant lengths of track will facilitate meaningful comparison with track recording car data and settlement measurements (1B.2, 1C.3)
- Further development and application of improved and more sophisticated FE / VTI models (1B.1, 1B.3, 1B.4)
- Use of data to optimise track system performance (1A.4)
- Incorporation of results into integrated performance and maintenance models (1C.6)

Journal papers

[C7] Grossoni, I, Andrade, A, Bezin, Y and Neves, S. The role of track stiffness spatial variability on long-term track quality deterioration. *Proceedings of the Institution of Mechanical Engineers Part F, Journal of Rail and Rapid Transit* (in review)

Related publications

Abadi, T, Le Pen, L, Zervos, A, & Powrie, W (2016). A review and evaluation of ballast settlement models using results from the Southampton Railway Testing Facility (SRTF). *Procedia Engineering*, 143, 999-1006. [doi: 10.1016/j.proeng.2016.06.089](https://doi.org/10.1016/j.proeng.2016.06.089)