Project F	**Understanding the behaviour of switches & crossings (S&C) and areas of stiffness change**
Part of	**Research Challenge 2, DESIGNER SWITCHES AND CROSSINGS, and Research Challenge 3, NOISE-LESS TRACK**
Project timing	Started September 2015
More information from	Dr Yann Bezin
Project partners	Network Rail Progress Rail AECOM London Underground Limited Getzner
Associated projects	EU project In2Rail, H2020-MG-2014: Grant agreement 635900

Project aims

This project aims to obtain detailed data on the behaviour of switches and crossings to establish scientific evidence of their performance, in terms of the:

1. effect of layout geometry and rail profile shape
2. deformation under train loads and variability as a function of geometry and stiffness change
3. rate of geometry deterioration in areas of stiffness transition
4. noise and vibration generated from negotiating switches and crossing panels.

Progress to date

Project aim 1. A prototype laser measurement trolley has been developed for on-track use to acquire more detailed input and validation data from the field (Fig.F1). Detailed geometrical features in S&C (plan geometry, rail shape and changes over distance, cutting and machining operations, etc.) have been implemented in simulations. Advances in simulation technology have been used to develop an understanding of how innovative crossing shapes can improve performance.

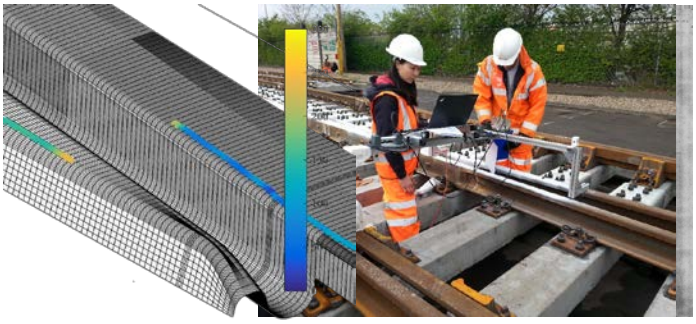

Fig.F1: Laser measurement of S&C rail surface for validation and simulation input

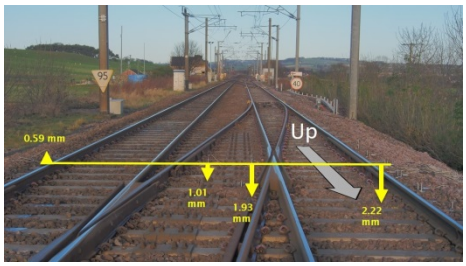

Fig.2: Wooden Gate site instrumentation and measurement

Project aim 2. Track deflection during train passage has been measured before and after the installation of under sleeper pads (USPs) at Wooden Gates on the East Coast Main Line [F5] (Fig.F2). An undesirable "see-saw" effect, associated with the use of long bearers, has been observed for the first time. Evidence for improved load distribution and reduced variation in deflection resulting from the installation of USPs was also gathered (Project B).

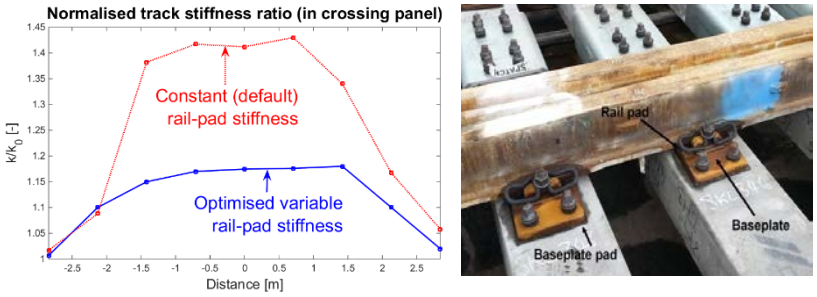

Fig.F3: crossing panel resilient pad optimisation

Behavioural differences between direct and indirect fixing of crossing components to bearers have been assessed. Optimisation algorithms have been coupled to advanced vehicle-track models to show that resilient elements in crossing panels can be optimised to improve the long term behaviour of the asset [F11] (Fig.F3).

Project aim 3. Simulation models have been developed (Fig.F4) to investigate the effect of superstructure bending stiffness reinforcement methods (e.g. the V-Tras design) on the dynamic vehicle-track interaction in transition zones and the potential improvement in differential settlement. Similar ideas for reinforcement have been tested through simulations in the context of S&C, to protect them from local ballast settlement.

Project aim 4. Field monitoring of noise from two switches at Lorelei (Germany) has provided data on S&C track dynamic properties, rail roughness, rail vibration and noise during train passage. Higher roughness has been observed on switch rails. The data are being used to validate a hybrid noise prediction model.

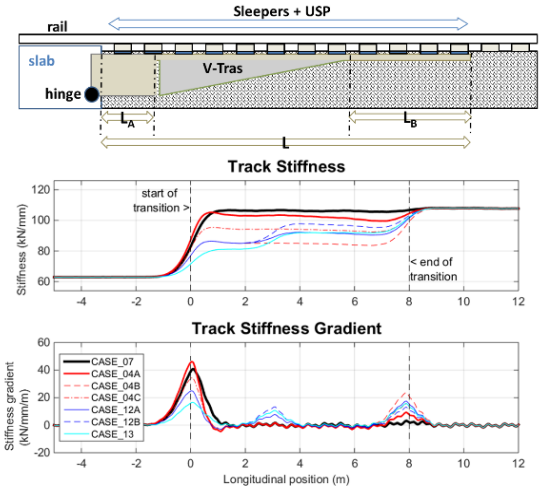

Fig.F4: Transition zone support improvement and stiffness gradient investigation

Planned further work (Programme objectives in brackets)

- Additional field work at Stoats Nest, Wooden Gates and other sites where the NR60 mk2 switch is in use, to understand crossing casting foot failures and new design performance (2.1, 2.5).
- Laboratory tests of crossing assemblies to link service loads and variable support to failures (2.4)
- Completion of the whole model for vehicle-track interaction at S&C and calibration using site and laboratory data, to support the assessment of improvement methods at S&C and transitions (2.3)
- Completion of the hybrid model for noise and vibration at S&C (3.1)
- Use of data to optimise track system performance (1A.4)
- Incorporation of results into integrated performance and maintenance models (2.5).

Journal papers

[F5] Le Pen, L, Watson, G, Hudson, A & Powrie, W (2017). The behaviour of under-sleeper pads at switches and crossings (S&C) – field measurements. *Proceedings of the Institution of Mechanical Engineers Part F, Journal of Rail and Rapid Transit.* doi:10.1177/0954409717707400

[F11] Grossoni, I, Bezin, Y & Neves, S (2017). Optimisation of support stiffness at railway crossings. *Vehicle System Dynamics.* doi:10.1080/00423114.2017.1404617

Related publications

Bezin, Y. (2016) Railway turnout damage prediction and design implications. *China Academy of Railway Science (CARS) International Conference on Train/Track Interaction & Wheel/Rail Interface, Beijing, 20-22 June 2016*