Monitoring Track Defects on a Ballasted High Speed Railway

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1 Introduction

All railway track wears out, settles and becomes deteriorated. This wear is likely to be uneven along a railway line, meaning some sections wear out at a higher rate than others. At some locations the accelerated deterioration track may lead to a track defect. Geometry faults, loss of sleeper support (hanging sleepers), ballast attrition and damage to other track componentry are symptomatic of track defects and are likely to accelerate deterioration further. Isolated track defects and high rates of deterioration are frequently associated transitions zones. Although track defects are known to occur and reoccur at particular types of location and that adverse geometry and support conditions typically associated with a defect have the propensity to enhance the applied loads in and around the defect zone, there is less consensus and supporting evidence for how and why defects initially form. Trackside monitoring techniques can be used to study real track defects and provide this evidence, improve our understanding of complex track behaviour within defect zones and evaluate maintenance techniques.

Figure 1 A Track Defect

2 Trackside measurements

Figure 2Trackside monitoring equipment

Motion transducers such as geophones or accelerometers fixed to railway track components are frequently used to record the movement of the track in both research and industry due to passing in-service trains (Bowness et al., 2007). Track deflections can be obtained by filtering then integrating a calibrated signal, once for velocity or twice for acceleration. The deflection time histories can be analysed to investigate the performance of the track. Recent research has shown that low cost MEMS accelerometers are now capable of providing data of adequate quality for obtaining deflection time histories. The lower costs enables large and more pervasive deployments for trackside monitoring, which will be important for enabling smarter railway infrastructure.

Trackside measurements can be interpreted to obtain a 'characteristic displacement' describing the range of movement. This can be used to understand how the track is performing. For example voids are often associated with excessive deflection.

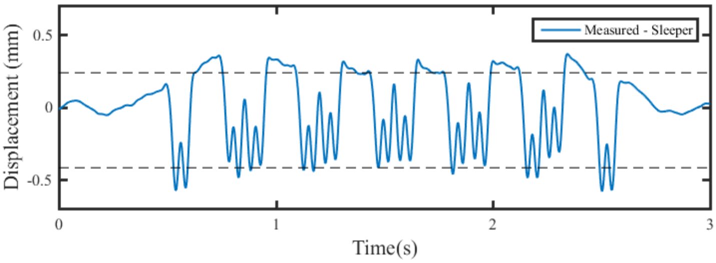

Figure 3 Displacement time history of well performing track

2.1 Obtaining track modulus

Often a measure of track stiffness is desired from trackside measurements. This is normally obtained using a load deflection relationship for railway track using a Beam on Elastic Foundation model. This requires knowledge of the load and the track deflection. For in service trains track deflection may be obtained from the displacement time history, however the applied load is uncertain because of variable occupancy and dynamic effects. (Le Pen et al., 2016) proposed a method of calculating the track modulus in the frequency domain, which is independent of wheel load. The method, based on a Beam on Elastic Foundation model, relies on determining the ratio between two 'dominant frequencies' in a spectrum for track movement. The Track Modulus is a useful parameter for describing the track under normal circumstances it may not be appropriate for defect zones.

3 Case Study

Figure 4 shows results for track in a defect zone subject to continuous monitoring and a maintenance intervention at the end of June (targeting hand packing). The track was deflecting excessively before maintenance, these were reduced afterwards and remained stable for at least 4 months. The track modulus was stable and plausible.

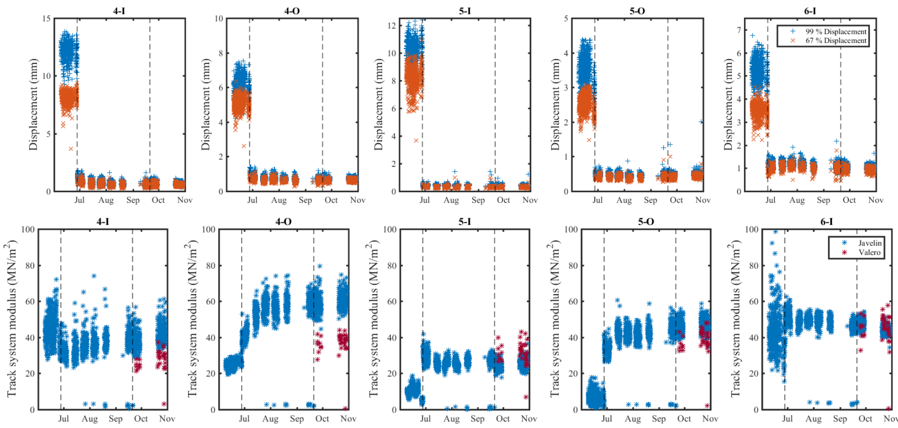

Figure 4a) Characteristic displacement for each train passing a defect zone. b) Track modulus evaluated in the frequency domain for each train passing a defect zone

4 Summary

Lower cost monitoring technologies and analytical tools allow more continuous approach to lineside monitoring where interpretation of track movements enables quantification of track behaviour and evaluation of the success of maintenance. This has been successfully applied to a defect zone where track was performing poorly.

References

Bowness, D., Lock, A. C., Powrie, W., Priest, J. A. & Richards, D. J. (2007) Monitoring the dynamic displacements of railway track. *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit* **221(1)**:13-22.

Le Pen, L., Milne, D., Thompson, D. & Powrie, W. (2016) Evaluating railway track support stiffness from trackside measurements in the absence of wheel load data. *Canadian Geotechnical Journal.*