University of Birmingham
Research at Birmingham

Discussion on “Field Test Performance of Noncontact Ultrasonic Rail Inspection System”

Kaewunruen, Sakdirat

DOI:
10.1061/JTEPBS.0000134

License:
None: All rights reserved

Document Version
Peer reviewed version

Citation for published version (Harvard):
Kaewunruen, S 2018, 'Discussion on “Field Test Performance of Noncontact Ultrasonic Rail Inspection System”', *Journal of Transportation Engineering, Part A: Systems*, vol. 144, no. 4, TEENG-4486. https://doi.org/10.1061/JTEPBS.0000134

Link to publication on Research at Birmingham portal

Publisher Rights Statement:
Checked for eligibility: 19/02/2018
https://ascelibrary.org/doi/10.1061/JTEPBS.0000134
©2018 American Society of Civil Engineers

General rights
Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

•Users may freely distribute the URL that is used to identify this publication.
•Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
•User may use extracts from the document in line with the concept of ‘fair dealing’ under the Copyright, Designs and Patents Act 1988 (?)
•Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy
While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.

Download date: 23. Apr. 2024

Discussion of "Field Test Performance of Noncontact Ultrasonic Rail Inspection System" by Stefano Mariani, Thompson Nguyen, Xuan Zhu and Francesco Lanza di Scalea.

February 2017, Vol 143 No 5, 04017007
DOI:10.1061/JTEPBS.0000026

Sakdirat Kaewunruen[1]

In general, the development of novel technology for rail inspection is very welcome indeed. The paper under discussion was well written by the authors. The field investigation results at the Rail Defect Test Facility of the Transportation Technology Center in Pueblo, Colorado are critical for rail inspection management in practice. In the paper under discussion, the authors have focussed on the effectiveness of noncontact air-coupled ultrasonic inspection system (or so-called 'UCSD System') on rail defect detection using the imbalance of two ultrasonic arrays. The 'new-generation' UCSD system collects data on the gauge side of rail(s). The authors have found that the velocity of the inspection vehicle or the test speed plays a key role on the performance of defect detection in the field. Their experiments show that

---

[1] Senior Lecturer in Railway and Civil Engineering, School of Engineering, The University of Birmingham, Edgbaston B152TT United Kingdom, E-mail: sakdirat@hotmail.com; s.kaewunruen@bham.ac.uk; Formerly, Technical Specialist, RailCorp – Track Engineering, Level 13, 477 Pitt St, Sydney, NSW 2000 Australia; Visiting Executive Fellow, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge MA 02139-4307 USA, E-mail: sakdirat@mit.edu

reasonable performance of the UCSD system can be achieved at the test speeds between 1.6 and 8 km/h. In addition, it is highly appreciative that the authors concluded that there are limitations of the system and the authors plan to develop more work in order to distinguish between defects and welds; and to expand the coverage area of the system over rail head.

The field trials by the authors were carried out on curves with radii of 233m (or 7.5°) and 350m (or 5°). Note that the curve radius (R) has been converted from R = 50 / sin (D/2). The assumption is based on 30.5m (100ft) chord and D is the degree of curvature in radians. It is very frequently found that in practice various types of rail defects can develop on railway tracks with sharp curves (i.e. <350m radius) depending on the characteristics of rail (i.e. standard carbon rail, head hardened rail, residue stress, manufacturing imperfection), operational parameters (i.e. train speed, axle load, rolling stock imperfection, cant deficiency), and maintenance quality (e.g. grinding frequency, tamping method, etc.). A common rail defect is of course the rolling contact fatigue (RCF) on gauge corner (or called 'head check' or 'gauge corner'). This RCF defect can further grow and cause rail squats, rail studs, transverse defects and other modes of failure. Figure 1 shows an example of moderate rail squats. The real examples of various rail defects found on curved tracks can be seen in Ishida (1989; 2015), Li et al. (2008), Grassie (2012), Grassie et al. (2012), Wilson et al. (2012), Kaewunruen and Ishida (2014, 2016), Kaewunruen et al. (2014), Kaewunruen (2015), and Andersson (2015). Note that the type of defect, its size and severity help track engineers to prioritise inspection and maintenance tasks. On this ground, not only is the defect identification essential to rail industry, the classification of defect type and maintenance prioritisation is also mutually crucial to mitigate safety risks in railway operations. It is even more important that early-age rail defects are detected quickly enough to enact predictive and preventative track maintenance, instead of costly corrective one. The defection of transverse defects might be slightly too late for any preventative actions.

The field data shown in Figure 1 demonstrates that rail surface defects can potentially spread over the rail head. Note that the field observations showed that rail surface defects can also develop at both low (inner) and high (outer) rails in curved tracks. The dimension and scale of rail defects are again dependent on various factors. If rail corrugations and wheel burns are present, additional vibration might also provide additional problems to the system in practice. As such, suitable device installation and noise cancelling technique will be required to enhance reliability of data analyses such as receiver operating characteristics (ROC), damage index (DI), probability of detection (PD), and probability of false alarms (PFA).

Hopefully, the field experience and some practical findings in this discussion would be useful and should encourage the authors to extend their future research and development with respect to the classification and quantification of rail surface defects in practice.

References

Andersson, R. “Surface defects in rails – Potential influence of operational parameters on squat initiation”, *Licentiate of Engineering Thesis,* Department of Applied Mechanics, Chalmers University of Technology, Gotenburg, Sweden, 2015.

Grassie, S. “Studs: a squat-type defect in rails”. *Proceedings of the Institution of Mechanical Engineers Part F Journal of Rail and Rapid Transit*, 226(3), 243-256, 2012.

Grassie S., Fletcher D.I., Hernandez E.A.G. and Summers P. “Squats and squat-type defects in rails: the understanding to date”. *Procs of the Institution of Mechanical Engineers Part F Journal of Rail and Rapid Transit*, 226(3): 235-242, 2012

Ishida M. "Rolling contact fatigue (RCF) defect of rails in Japanese railways and its mitigation strategies," *Electronic Journal of Structural Engineering*, 13(1), 67-74, 2013.

Ishida M. “Statistical Analysis of Rail Shelling on Shinkansen”, *Proc. of 4th International Heavy Haul Conference, Institution of Engineers*, pp.205-209, Brisbane, Sep. 1989.

Kaewunruen S., Ishida M. “Field monitoring of rail squats using 3D ultrasonic mapping technique,” *Journal of the Canadian Institute for Non-Destructive Evaluation*, (invited), 35(6), 5-11, 2014.

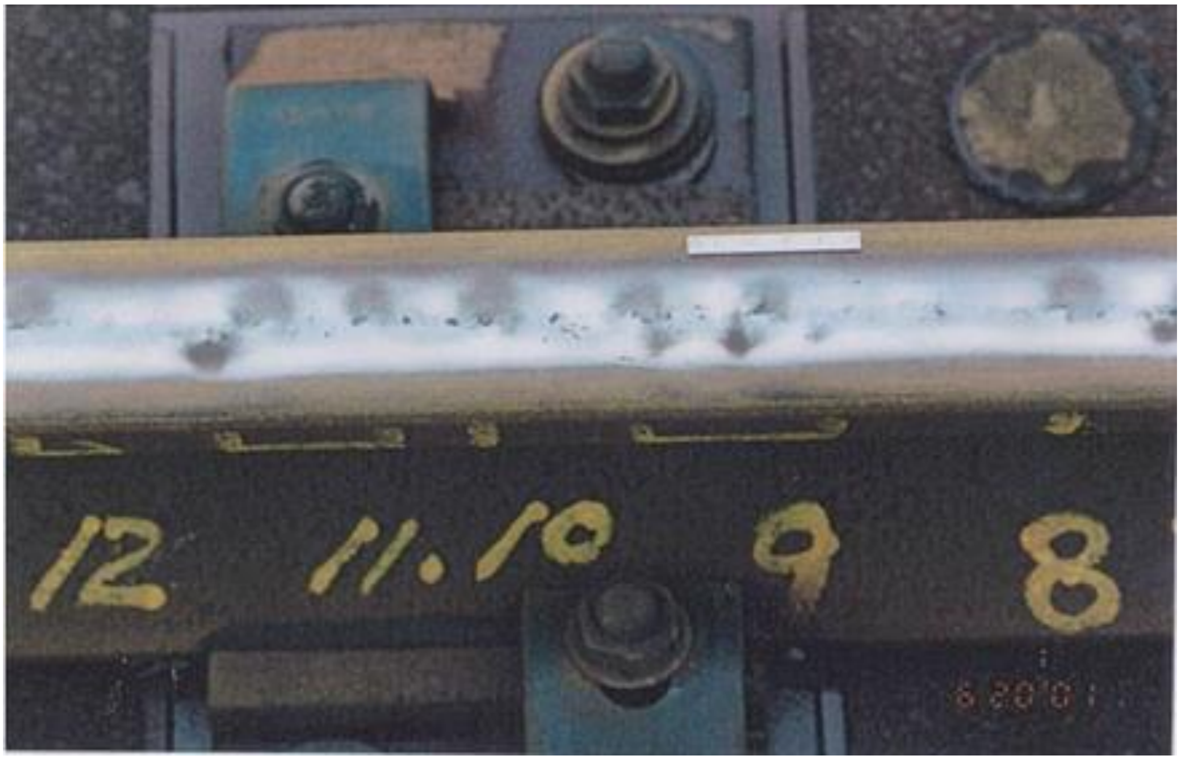
Kaewunruen S., Ishida M. “In Situ monitoring of rail squats in three dimensions using ultrasonic technique,” *Experimental Techniques*, 40(4), 1179-1185, 2016.

Kaewunruen S., Ishida M., Marich S. “Dynamic wheel-rail interaction over rail squat defects,” *Acoustics Australia*, 43(1), 97-107, 2014.

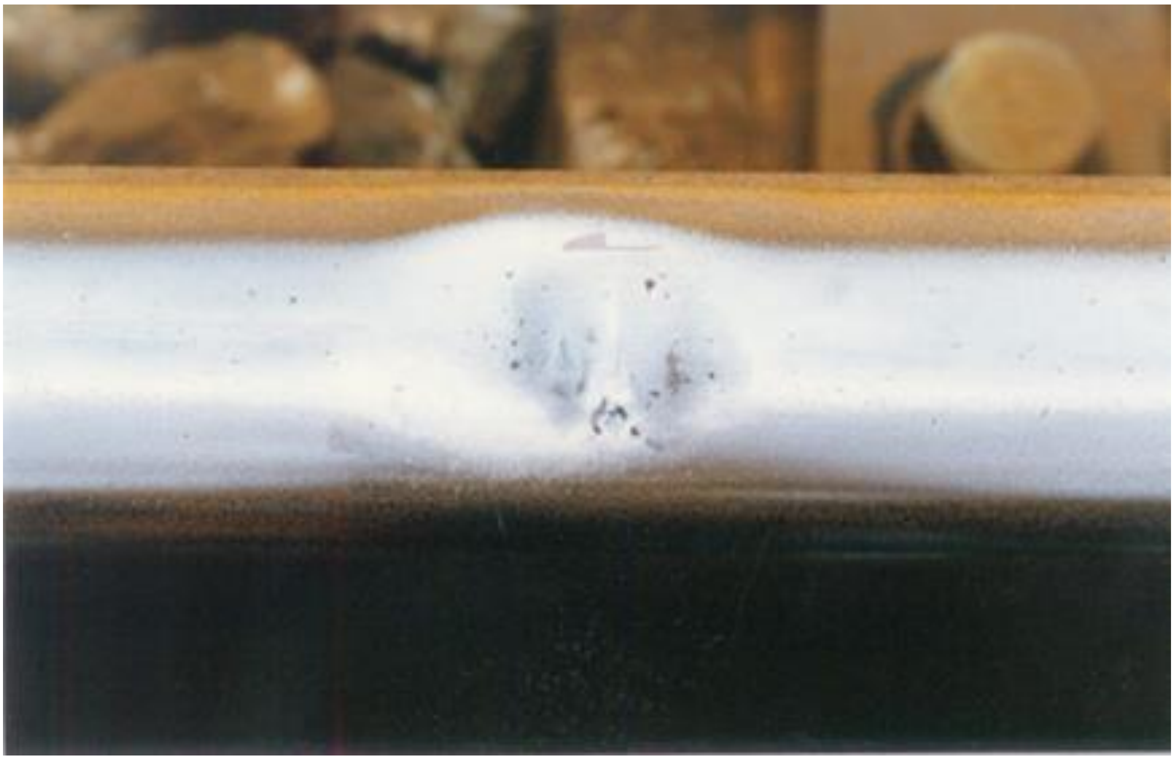
Kaewunruen S. “Identification and prioritization of rail squat defects in the field using rail magnetisation technology,” *Proc. SPIE 9437, Structural Health Monitoring and Inspection of Advanced Materials, Aerospace, and Civil Infrastructure* 2015, 94371H (April 1, 2015); doi:10.1117/12.2083851.

Li Z., Zhao, X., Esveld, C., Dollevoet, R. “An investigation into the causes of squats - Correlation analysis and numerical modeling” *Wear*, 265(9-10): 1349-1355, 2008.

Wilson A., Kerr M.B., Marich S., and Kaewunruen S. “Wheel/rail conditions and squat development on moderately curved tracks”, *Conference of Railway Engineering*, Nov 17-19, Brisbane, Australia, 2012.



a) WEL-related stud (multiple squats)



b) RCF-related squat (single squat)

Figure 1. Rail squats in railway tracks based on their initiation types (photos taken in 2012 by Sakdirat Kaewunruen)