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1	Discussion of "Field Test Performance of Noncontact Ultrasonic Rail							
2	Inspection System" by Stefano Mariani, Thompson Nguyen, Xuan							
3	Zhu and Francesco Lanza di Scalea.							
4								
5	February 2017, Vol 143 No 5, 04017007							
6	DOI:10.1061/JTEPBS.0000026							
7								
8	Sakdirat Kaewunruen ¹							
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10 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 11 investigation results at the Rail Defect Test Facility of the Transportation Technology 12 13 Center in Pueblo, Colorado are critical for rail inspection management in practice. In 14 the paper under discussion, the authors have focussed on the effectiveness of 15 noncontact air-coupled ultrasonic inspection system (or so-called 'UCSD System') on 16 rail defect detection using the imbalance of two ultrasonic arrays. The 'new-17 generation' UCSD system collects data on the gauge side of rail(s). The authors have 18 found that the velocity of the inspection vehicle or the test speed plays a key role on 19 the performance of defect detection in the field. Their experiments show that

¹Senior 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

20 reasonable performance of the UCSD system can be achieved at the test speeds 21 between 1.6 and 8 km/h. In addition, it is highly appreciative that the authors 22 concluded that there are limitations of the system and the authors plan to develop 23 more work in order to distinguish between defects and welds; and to expand the 24 coverage area of the system over rail head.

25

26 The field trials by the authors were carried out on curves with radii of 233m (or 7.5°) 27 and 350m (or 5°). Note that the curve radius (R) has been converted from R = 50 / sin28 (D/2). The assumption is based on 30.5m (100ft) chord and D is the degree of 29 curvature in radians. It is very frequently found that in practice various types of rail 30 defects can develop on railway tracks with sharp curves (i.e. <350m radius) 31 depending on the characteristics of rail (i.e. standard carbon rail, head hardened rail, 32 residue stress, manufacturing imperfection), operational parameters (i.e. train speed, 33 axle load, rolling stock imperfection, cant deficiency), and maintenance quality (e.g. 34 grinding frequency, tamping method, etc.). A common rail defect is of course the 35 rolling contact fatigue (RCF) on gauge corner (or called 'head check' or 'gauge 36 corner'). This RCF defect can further grow and cause rail squats, rail studs, transverse 37 defects and other modes of failure. Figure 1 shows an example of moderate rail 38 squats. The real examples of various rail defects found on curved tracks can be seen in 39 Ishida (1989; 2015), Li et al. (2008), Grassie (2012), Grassie et al. (2012), Wilson et 40 al. (2012), Kaewunruen and Ishida (2014, 2016), Kaewunruen et al. (2014), 41 Kaewunruen (2015), and Andersson (2015). Note that the type of defect, its size and 42 severity help track engineers to prioritise inspection and maintenance tasks. On this 43 ground, not only is the defect identification essential to rail industry, the classification 44 of defect type and maintenance prioritisation is also mutually crucial to mitigate

45 safety risks in railway operations. It is even more important that early-age rail defects
46 are detected quickly enough to enact predictive and preventative track maintenance,
47 instead of costly corrective one. The defection of transverse defects might be slightly
48 too late for any preventative actions.

49

50 The field data shown in Figure 1 demonstrates that rail surface defects can potentially 51 spread over the rail head. Note that the field observations showed that rail surface 52 defects can also develop at both low (inner) and high (outer) rails in curved tracks. 53 The dimension and scale of rail defects are again dependent on various factors. If rail 54 corrugations and wheel burns are present, additional vibration might also provide 55 additional problems to the system in practice. As such, suitable device installation and 56 noise cancelling technique will be required to enhance reliability of data analyses such as receiver operating characteristics (ROC), damage index (DI), probability of 57 58 detection (PD), and probability of false alarms (PFA).

59

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.

64

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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)