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# The inspection of level crossing rails using guided waves

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## HIGHLIGHTS

- Description of the costs and limitations of current inspection methods for level crossing rails.
- Introduction to Guided Wave Testing (GWT) for rails.
- Description of the applicability of this method to the inspection of level crossing rails.
- Practical experiences and results of trials by Network Rail.

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ABSTRACT

Level crossing rails are high risk areas due to the combination of the limited effectiveness of current inspection methods and high corrosion rates which often exist. This paper discusses the current UK standard practices for the periodic inspection of level crossing rails using visual (VT) and conventional ultrasonic (UT) methods. The limitations of these methods are discussed and how these limitations affect the overall maintenance program for level crossings.

A new inspection method, guided wave testing (GWT) is then described with particular emphasis on its advantages for inspecting level crossings. GWT was first commercially used for the inspection of pipes from around 1999 (Alleyne et al., 2001) [1] and has now gained very widespread usage.

Finally, a review is given of the current Network Rail trial of GWT on level crossings using the G-Scan system, with representative results which demonstrate the effectiveness of GWT for this application.



## 1. Introduction

Level crossings allow road traffic to cross railway lines at track-level by means of a set of removable roadway panels (often referred to as the 'deck'), which fit between the rails. The deck panels vary in materials and geometry but fit tightly between the rails with the minimum gap required to allow the passage of trains. This inevitably means that the rail within the crossing is not visible (apart from the top of the head and gauge-face). Additionally, the deck panels tend to trap moisture and road-salt around the rail causing accelerated corrosion of the lower sections of the rail, especially the toe, see Fig. 1. The corrosion rates observed in level crossings vary significantly from one crossing to another, depending on the local conditions. Some crossings exhibit no corrosion even after more than 15 years of service, others may exhibit critical corrosion within 2 years of service. The inspection frequency for each crossing is decided by the local track management team based on their experience of the corrosion rate observed during previous inspection intervals.

Using current testing methods, detection of defects at the toe of the rail is only possible using visual inspection and sizing of these defects can only be carried out using manual measurement of the loss of rail foot width. These inspections require the entire deck to be removed to allow direct access to the rail which is a very invasive and expensive process. There are currently just over 6500 level crossings in the UK which, on average, require visual inspection every 2 years with an estimated annual cost of over £2.5 million. This is the estimated cost for inspection alone and does not include re-railing, emergency road closures or delay costs.

In most cases visual inspection shows the rail to have no defects and the deck is simply replaced, however, in a significant number of cases the rail is found to have severe corrosion which requires rail replacement within 24 h and emergency measures to be put in place. Occasionally the corrosion reaches such an advanced state

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**Fig. 1.** Corrosion of the rail foot commonly found within level crossings with little or no loss in rail depth.

that the rail breaks before the defects are detected as shown in Fig. 1. In the situation where severe corrosion is found during visual inspection there is usually insufficient time or resources available to replace the rail immediately. The deck must therefore be replaced, to allow for the re-opening of the road, and a speed restriction placed on the line until an emergency possession can be obtained to allow re-railing. In practice, the re-railing is usually carried out within 48 h due to the financial penalties which are incurred for applying speed restrictions.

## 2. Current inspection methods

In general, the majority of the rail in the network is inspected ultrasonically and visually every 8 weeks. The ultrasonic inspection utilizes several transducers coupled to the rail head with different beam angles to look at head and base defects which can be deployed using a manually operated trolley or mounted on an inspection train. The ultrasonic inspection is optimized for the detection and sizing of defects within the head and web sections of the rail where the majority of defects occur, however, UT methods are effectively blind to the corrosion defects commonly found in level crossings.

### *2.1 Ultrasonic testing (UT)*

The main ultrasonic test method which is most applicable to level crossings is known as U15 in which the depth of the rail at the centre-line is measured using a vertically oriented (zero degree) transducer, as shown in Fig. 2 [2]. The corrosion found at level crossings typically does not affect the centreline but is concentrated at the toe sections of the rail as shown in Fig. 1, therefore, the result of the U15 inspection often does not correlate with the rail condition within the crossing and potentially catastrophic defects can go undetected. Additionally, some crossings cannot be ultrasonically inspected with the manual inspection trolley as

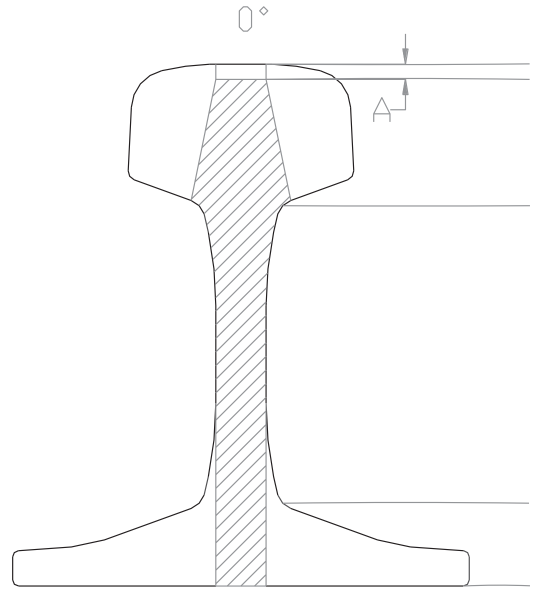


**Fig. 2.** The tested area of the rail using the zero degree ultrasonic rail depth measurement is limited to the centre-line only. The dead-zone (A) is typically between 3 and 8 mm.

the flanges on the inspection wheel will not fit between the rail and the deck.

The case-study for Belmont Forest, shown in the results section of this paper, is good example which highlights the limitations of UT inspection at level crossings. In this case a recent UT inspection had not detected any significant problem with the rail shown in Fig. 9 which required emergency replacement.

### *2.2 Invasive visual testing (VT)*

The lifting of level crossings to allow VT is a complex and expensive process and requires planning and booking of road closures a minimum of 1 year in advance (on average 2 years in advance).

Once possession of the track is taken heavy machinery is used to remove each deck panel one by one, see Fig. 3. An average team of six men are required and the process of removing the panels which can take more than 2 h to complete. Replacement of the panels is the reverse process and requires a similar amount of time.

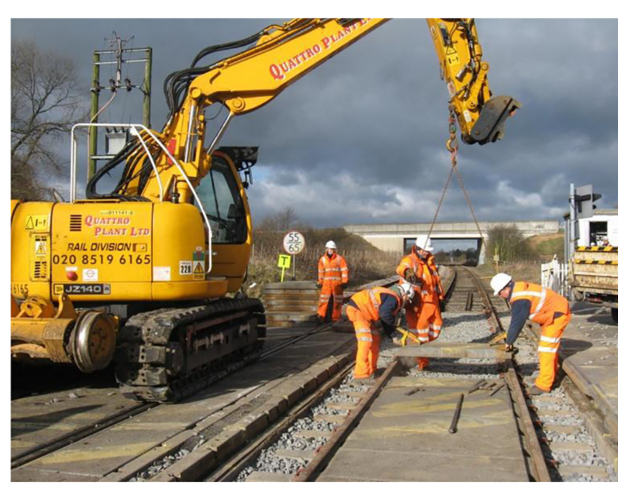


**Fig. 3.** Lifting the deck to allow visual inspection of the rail.