RAILECT
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Phased Array Ultrasonic Inspection of Aluminothermic Rail Welds
- The Automated Solution -

RAILECT was a collaboration between EU SMEs and research organisations with the objective to develop and produce a novel "clamp-on" ultrasonic testing device for the volumetric examination of aluminothermic (AT) rail welds. During the project, it was estimated that only 15-20 minutes were necessary for the full assessment of the weld.

Introduction: There are millions of aluminothermic field welds on Europe's rail network. Occasionally flaws develop during and shortly after welding that can lead to early failure and this can cause train derailment, disruption to train services and costs to the rail network, train operating companies and maintenance operators. The welds are made as a casting and are more difficult to inspect than joints made by other welding processes. The RAILECT project was conceived to provide a convenient means of inspecting the welds using a multiple phased array ultrasonic system.

Sample Manufacture and Defect types: The project focused on one rail weld profile (CEN60, see Figure 1) that is commonly used on the European rail network and is in accordance with European CEN standards.

A number of rail weld samples were manufactured for the project that contained a range of defects that included porosity and shrinkage (see Figure 2), and lack of fusion.
Some samples were later mechanically tested for the purpose of an Engineering Critical Assessment (ECA).

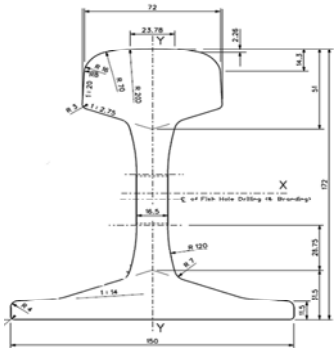

Figure 1 CEN60 rail profile.

Figure 2 Defective samples; (a) failure; (b) porosity; (c) shrinkage.

Industrial Requirements and Modelling: It was a requirement that the developed RAILECT ultrasonic phased array equipment was portable, robust, easy to operate, usable in all weathers and gave clear indications of defective welds.

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The modelling work investigated primarily the coverage of the weld, and the response from different defect types. This was carried out with both ESBeamTool and CIVA software. The probe frequency and focal law parameters were varied during the modelling experiments so that the most appropriate settings for full volumetric weld coverage could be identified.

System Design: In order to meet the industrial requirements given above a commercially available ultrasonic phased array instrument was used together with the developed phased array probes that were designed and built after the initial modelling work. Figure 3 shows the concept drawing of the inspection tool.

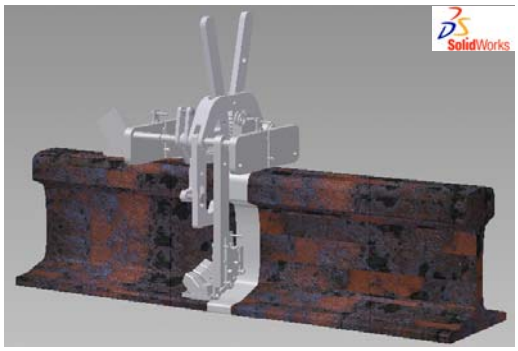

Figure 3 Concept drawing.

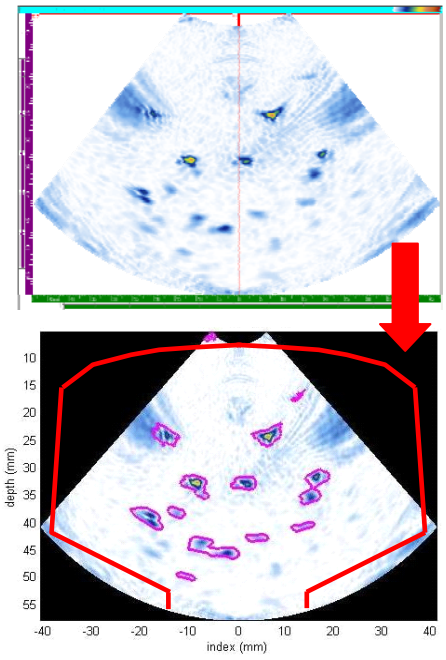

Figure 4 Data processing.

Laboratory and Field Trials: Laboratory tests of the defective welds showed that ultrasonic indications could be correlated with known flaws, and that these could all be detected from just two applications of the device. Figure 4 shows an example of a sectorial scan taken from the rail head containing porosity and the correlation made during data processing. Preliminary field trials were carried out as soon as the first prototype was made available - although not fully completed. This had a considerable impact on the project outcome. Resulting from this demonstration, various improvements were made to the first iteration of the RAILECT device and this was rewarded by the final demonstration on Network Rail's test track (see Figure 5) which was a successful event.

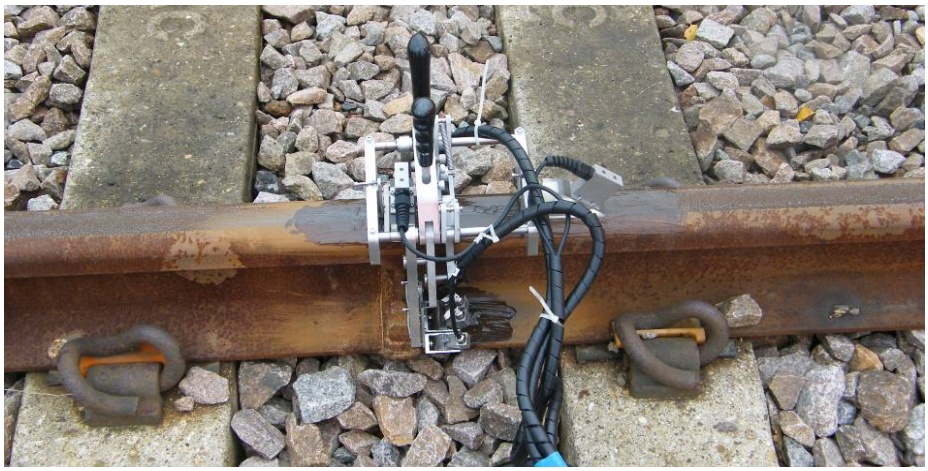

Figure 5 Final inspection tool on High Marnham's test track at the Rail Innovation and Development Centre.

Conclusion: The PAUT system produced within the course of the RAILECT project proved the feasibility of an automated phased array system for inspection of rail welds. Modelling studies were validated by the experimental trials. Probe locations and parameters such as focal laws were investigated and optimised so that the maximum volumetric coverage of the rail weld could be achieved. Videos of the final demonstration will be accessible on the project website soon at www.railect.com.

For further information about the RAILECT system, please contact:

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