Trackbed maintenance planning – UK & USA

DEPTH OF BALLAST, BALLAST FOULING LEVELS, FORMATION FAILURE AND SUBGRADE EROSION

Changes can occur at different stages in the lifetime of a ballasted trackbed under repeated loading. These include the generation of fines which may clog ballast void space, the failure of the formation leading to ingress of fines through pumping and localised settlement of the formation leading to the growth of ballast pockets.

Traditional trackbed inspection strategies such as visual patrols and track geometry measurements are generally late indicators of subgrade and ballast quality related issues.

Monitoring ballasted trackbed with Zetica’s Advanced Rail Radar (ZARR) allows decisions to be made on timely and cost effective maintenance interventions. Combining track geometry measurements with GPR provides unique information to plan a holistic ballast and trackbed management strategy.

Regular monitoring with GPR also allows decisions to be made on timely and cost effective interventions to remediate structures. For example, early indications of ballast thickening derived from inspection train based GPR systems can be flagged for detailed follow-up with ground GPR surveys (see figure below).

Example (left) of contouring the thickness of ballast derived using GPR collected in the centre and over the shoulders of two lines (Up and Down) over an embankment. The red arrow marks the extent of the thickest ballast (>1m) correlating with a zone of embankment instability.

A cross section (left) shows a possible failure surface in the embankment that could be inferred from a measured ballast pocket.
Trackbed maintenance planning – Ireland

DEPTH OF BALLAST, FORMATION FAILURE AND SUBGRADE EROSION

Zetica’s Advanced Rail Radar (ZARR) system is deployed in many countries across the world. The system utilises ground penetrating radar (GPR) to continuously map changes in the thickness and quality of the ballast layer across a network.

Zetica Rail completed a survey for Irish Rail on the main Dublin to Cork line using an existing track geometry recording vehicle as the survey platform. The object of the survey was to map changes in the geometry of ballast layers as well as target areas of subgrade erosion, drainage problems and to detect buried structures. The results were combined with track geometry to provide a strategic tool for maintenance planning.

The example data panel above shows (top-bottom) – greyscale radargram, digitized layers in the center, digitized layers over the shoulders, colour strip charts showing thickness of ballast against defined thresholds, ballast layer roughness, a combined ballast thickness and layer roughness index, and a contoured map of depth to fouled ballast/formation. Zoomed view of radargram shows an example of sub-grade erosion.

The GPR reports and GPR-derived trackbed indices are currently being used as part of a major remediation and renewal programme over the full route. The information is an important tool which is being proactively used to allow focused planning of trackbed remediation works on those areas most in need of rehabilitation. This allows an optimisation of available budgets and is thus a cost-effective tool in the trackbed remediation programme.
Line upgrade – UK

DEPTH OF BALLAST, FORMATION FAILURE, ASSET MAPPING

Example (right) 0.25mi of GPR data (a) collected on Network Rail’s UTU3 inspection train. Changes in the thickness of the primary ballast layer (b) are clearly indicated in a ‘Manhattan Skyline’ plot (c) as deviations from the design depth.

Figure (below left) shows a section of track before relaying works took place. Figure (below right) shows the trackbed following extensive upgrade works. The works allowed line speeds to be increased from 70mph to 125mph on a main line in the UK.

The red rectangle confirms a change in formation treatment with new ballast and sub ballast layers. The green rectangle shows a new junction with 5 drive units and an automatic warning system (AWS) magnet. The blue rectangle confirms that the newly laid ballast layer conforms to the minimum design depth specified for the required load and line speed.
BBRI-Zetica carried out a rail radar scan between mileposts MP575 and MP576 to image ballast, sub-ballast and top of formation to identify irregularities which may identify the causes of a track geometry (cross level) exception. This exception had resulted in a slow order extending between MP575.068 and MP575.754.

The location of the significant track geometry left/right surface exception (arrowed above) at approximately MP575.488 is characterised by a well-defined ballast pocket that extends across the width of the trackbed and to a modelled depth of 36 – 40 inches below top of tie. In order to remediate the existing problem it was recommended that the trackbed be re-engineered (formation treatment / re-ballasting) between MP575.450 and MP575.550 (length of 528ft) to a minimum depth of 40”’. The use of a geotextile liner and sand protection blanket was recommended to improve trackbed stiffness and drainage over this section.