

ASSESSING THE RESILIENCE OF THE UK RAILWAY NETWORK CONSIDERING BRIDGE VULNERABILITY AND RAILWAY OPERATIONS

ABSTRACT Bridges are strategic points within the railway network, acting as critical links that enable the flow of rail operations. Historically, bridges have not been recognised as key network elements, often managed as isolated assets rather than integral components whose performance can influence the entire system. Their reliability and condition directly affect network resilience, as disruptions at these points can lead to widespread operational consequences.

Bridge management within Network Rail uses examinations that provide the intelligence needed to trigger maintenance and renewal interventions. These interventions are guided by a predefined structures policy within five-year control periods, ensuring decisions are systematic and data-driven. Recently, there has been a strategic shift towards assessing bridge performance at a network level, enabling more effective interventions that consider broader operational impacts through a holistic review of all available information.

In the railway, resilience refers to the system's robustness and its ability to recover swiftly from significant shocks such as extreme weather events. It includes both resistance to disruption and rapid restoration of normal operations. Managing unacceptable risks is becoming critical in the face of climate change.

Motivated by these challenges, this study introduces a Bridge Route Resilience Index. The BRRI combines degradation modelling forecasts, bridge vulnerability indicators from evaluations, and operational context to benchmark resilience at both route and line levels. It enables managers to connect asset-level actions to operational outcomes and supports climate-adaptation decisions for future investment cycles.

The BRRI maps each railway line to one of four preparedness levels (Reactive, Basic, Proactive, and Robust/Adaptive) linked to target service outcome (Resist, Rapid Recovery, Bounce Back, Repair or Close). Leveraging on existing Network Rail datasets, this study provides a practical and scalable method for (i) benchmarking the route-level resilience, (ii) linking asset-level actions to network operations and (iii) prioritising climate adaptation for bridge portfolio.