Railway Bridge Maintenance

Second edition

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Nigel Ricketts

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Foreword to the second edition

Those of us working on the railway are the custodians of a great engineering legacy of which we should be justifiably proud.

This legacy is visible in the population of bridges that are dotted across the mainline network in Great Britain. There are celebrated and spectacular examples, such as the Forth Railway Bridge in Scotland and Brunel's Royal Albert Bridge between Devon and Cornwall; however the vast majority of this portfolio is formed of smaller functional railway arches and decks that support the railway across valleys, roads and rivers up and down the country. These vary widely in form and construction, reflecting the practices of the time and the different design approaches used by engineers, in many cases prior to the introduction of formal codes and standards.

Britain's railway system may be the oldest in the world but it is also one of the busiest in Europe, and growing. It is a fascinating and demanding technical and managerial challenge to maintain and adapt heritage structures, so that they can meet future needs while continuing to deliver a safe, reliable and efficient railway. Our long term success is closely bound to the knowledge and skill of those that manage this portfolio through the various phases of the asset lifecycle. The diversity of that portfolio, alongside the uncertainty in the operational and maintenance history of individual assets, means structures management is heavily reliant on evaluative judgements made by engineers. In seeking to improve, we must therefore find ways to better support these engineers and provide them with the information they need to optimise works interventions.

Railway bridge maintenance techniques have evolved through experience as each generation has learned from the successes and failures of works completed by its predecessors and taken advantage of new techniques and materials. A primary aim of Frank Turton's original book was to bring together experience and practical information acquired over many lifetimes and make it readily available for the next generation. Network Rail recognises that this need exists as much within the railway industry today as it did when it was first published in 1972. We are delighted to have worked with the Institution of Civil Engineers and Nigel Ricketts in updating such a highly regarded manual.

As well as offering good practice, we hope this book generates discussion and that future innovation and

development of maintenance techniques will lead to a further revision over a much shorter time period. It's worth noting that while major new projects tend to grab headlines, the routine maintenance and renewal activity necessary to sustain the existing infrastructure represents a large proportion of spending each year. The successful delivery of these complex work programmes is deserving of far greater recognition. Yet, regrettably, the value of maintenance activities is often only highlighted when preventable failures cause service disruption. We must champion the need for this work and strive to find ways of delivering it more efficiently.

With this new edition, *Railway Bridge Maintenance* will retain its position as essential reading for the industry. Railway leaders across the world should learn much from our experiences in managing Britain's ageing and heavily used bridge stock.

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Network Rail
May 2017

Preface

Railway Bridge Maintenance by Frank Turton has, since the 1970s, been the only reference book that specifically supports engineers engaged on the maintenance of the rail bridge population, both in the UK and worldwide. There have been many texts published on rail bridge design but very few on maintenance and repair of the existing bridge stock.

At the time of its original publication, the book was purchased by rail engineers who are now of the generation reaching retirement age. Associated with this, since the 1970s, there has been a complete turnaround in the fortunes of the rail industry from one of managed decline to that of expansion and fragmentation. Asset management of rail infrastructure is no longer carried out by a single organisation such as British Rail, and many in the rail industry have not had the experience of maintenance practices, good and bad, that were carried out in the past. This has led to over-complication, reinvention and, in some instances, lack of recognition of issues that could compromise structural safety.

In short, Frank Turton's book is still required but needed updating to accommodate modern asset management processes, technical understanding and engineering developments that have occurred in the last 40 years. Having said that, the population of bridge structures is largely the same, and the new edition is an attempt to augment rather than completely rewrite the original text, which is still very relevant to today.

Frank Turton joined the LMS Railway in 1929 and worked on the design, construction and repair of many rail and road bridges, until his appointment in 1948 as Bridge Engineer to the London Midland Region of British Railways. Subsequently, until his retirement in 1967, he was the Works Engineer for the British Railways Board, with special responsibility for the design policy of all civil engineering structures and their standards of maintenance.

Frank Turton envisioned a text that treated the subject of maintenance in a comprehensive manner that would be useful to all those involved in the railways system. This book pursues that original vision. ICE Publishing and Network Rail are grateful to the executors of the Frank Turton Estate for granting permission to update this text and publish this new edition.

Nigel Ricketts
2017

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- The route asset engineers, bridge examiners and others for supplying the up-to-date information and photographs necessary to make the project a success.

About the author

Nigel Ricketts is a Chartered Civil Engineer with over 40 years' experience in rail and highway bridges of all types. He spent his early career working for British Rail where he gained good basic training in design and construction, at a time when it was simpler for young engineers to move between departments and gain practical hands-on experience.

A change of direction followed a move to the Transport Research Laboratory where as a Research Engineer he was involved in bridge assessment research, bridge testing and management systems. This also included a period employed by the Highways Agency as a Bridge Specialist before he returned to TRL as Head of the Bridges Research Group.

He joined Network Rail in 2001, initially as the South East Structures Engineer with responsibility for managing the route's bridge stock. In 2003 he was appointed to the post of Route Civil Engineer (South East), a role responsible for the overall management of the South East Route building and civil engineering infrastructure.

In 2009 he was appointed as Network Rail Professional Head, Buildings & Civil Engineering with responsibility for the Building and Civil Engineering asset policy and standards, and also taking on the role of ultimate technical authority for sign-off of Network Rail civil engineering projects.

Nigel retired from Network Rail in 2014 and now works as an independent consultant. He lives in Berkshire, is married and has a daughter and two grandsons.

Introduction

The focus of this book is to assist the asset engineer in the maintenance of bridges associated with existing railway infrastructure, largely constructed in the 19th and early 20th centuries, but continuing to be maintained and upgraded as part of a key national transport system.

When originally built, railway systems had to be constructed to reasonably easy grades and curvature in order to achieve the intended line speed from the limited power of early steam locomotives. They had to be driven through the landscape rather than over it, requiring cuttings, embankments, tunnels and many bridges, both above and below the tracks, to achieve the grades and alignment required.

The great majority of bridges were small- to medium-sized structures that could be built using brickwork, stone or timber, depending on the local availability of materials. But larger spans and clearances were required, and, as industries developed, cast and wrought iron came to be in great demand for bridges where traditional materials were unsuitable.

Many of the fabricators and builders of these early metal bridges came to be looked upon as specialists, and were designing to the limits of knowledge at the time, which, in the case of cast iron later resulted in structural failures and safety incidents due to lack of understanding of the material. In more recent times, the development of prestressed concrete, modern steels and composite materials have all brought new, sometimes complex, issues to the design and maintenance of bridges.

The modern asset engineer responsible for rail bridge safety has to have a wide range of knowledge and experience to enable safe decisions to be made on structures with ages ranging from the early 19th century to the present day. The safe maintenance of rail bridges is not an area for narrow specialisation but requires a broad and often deep level of knowledge to deal safely with the issues encountered in operating a growing railway on an ageing asset stock.

In truth, very few engineers in their early career will have had the opportunity to gain this level of knowledge, but within an experienced asset team, bridge maintenance offers a very effective learning environment.

The whole field of bridge maintenance is so wide that to cover every aspect in detail in this single volume is impracticable. Its intention, therefore, is to provide an

overview that the reader can augment with information gathered from experienced colleagues or the many good technical resources available. Much of this guidance may be contained in design manuals or technical standards, and this book aims to help the reader to quickly target relevant information from the volumes published by industry. It is interesting to note that the great majority of engineers currently practising will have never seen a rivet driven, yet they will inevitably be called upon to take charge of riveted structures that will be in service for many years into the future.

This book is an update of an earlier volume published in the 1970s – and much has changed since then. The original author, for example, expressed caution on the reliability of the – then new – high-strength friction grip (HSFG) bolts that are now widely used. Yet he was much more relaxed about the possibility of adding prestressing to existing steel structures, which now would be frowned on as lacking robustness in a railway environment.

At that time, concrete cladding of steel structures was also considered reliable, but recent incidents have indicated otherwise. Analysis techniques and modelling in use today were yet to be developed, so structures were reconstructed or repaired in ways that might now be questioned.

These issues are mentioned because modern bridge maintenance engineers will encounter them. They need to be aware of past practices and construction details still existing in the bridge population that have to be considered and safely managed going forward. All maintenance engineers have to live with the past, and the more they understand the technology and techniques used to construct their assets, the more successfully they are likely to manage them.