Repair of Historic Timber Structures

Repair of Historic Timber Structures

Second edition

David Yeomans

Published by ICE Publishing, One Great George Street, Westminster,
London SW1P 3AA.

Full details of ICE Publishing representatives and distributors can be found
at: www.icebookshop.com/bookshop_contact.asp

Other titles by ICE Publishing:

Appraisal and Repair of Timber Structures, Second edition.

Andrew Lawrence and Peter Ross. ISBN 978-0-7277-6178-1

Designers' Guide to Eurocode 5 – Design of Timber Buildings EN 1995-1-1

Alexander Porteous, Peter Ross and Haig Gulvanessian CBE.

ISBN 978-0-7277-3162-3

Practical Design of Timber Structures to Eurocode 5

Hans Jørgen Larsen and Vahik Enjily. ISBN 978-0-7277-3609-3

www.icebookshop.com

A catalogue record for this book is available from the British Library

ISBN 978-0-7277-6438-6

© David Yeomans and Thomas Telford Limited 2020

ICE Publishing is a division of Thomas Telford Ltd, a wholly owned
subsidiary of the Institution of Civil Engineers (ICE).

All rights, including translation, reserved. Except as permitted by the
Copyright, Designs and Patents Act 1988, no part of this publication may
be reproduced, stored in a retrieval system or transmitted in any form or
by any means, electronic, mechanical, photocopying or otherwise, without
the prior written permission of the Publisher, ICE Publishing, One Great
George Street, Westminster, London SW1P 3AA.

This book is published on the understanding that the author is solely
responsible for the statements made and opinions expressed in it and that
its publication does not necessarily imply that such statements and/or
opinions are or reflect the views or opinions of the publishers. While every
effort has been made to ensure that the statements made and the
opinions expressed in this publication provide a safe and accurate guide,
no liability or responsibility can be accepted in this respect by the author
or publishers.

While every reasonable effort has been undertaken by the author and the
publisher to acknowledge copyright on material reproduced, if there has
been an oversight please contact the publisher and we will endeavour to
correct this upon a reprint.

Cover photo: Hotel Indigo historic timber-framed building undergoing full
external restoration in Stratford-upon-Avon, Warwickshire. Nick Maslen/
Alamy Stock Photo.

Commissioning Editor: James Hobbs

Production Editor: Madhubanti Bhattacharyya

Marketing Specialist: April Asta Brodie

Typeset by The Manila Typesetting Company

Index created by Laurence Errington

Printed and bound in Great Britain by TJ International, Padstow

Contents

	Preface	vii
	Acknowledgements	ix
01	Introduction: initial considerations	1
	Purpose	1
	The overall process	2
	Conservation standards	4
	Medical analogy	4
	Differences from new build	7
	Design codes	8
	The structure of the text	8
	Definition of terms	9
	References	10
02	Structures and materials	11
	Introduction	11
	Pre-fire structures	11
	Post-fire structures	18
	Timber	26
	Iron	30
	Roofing materials	30
	References	31
03	The form and behaviour of historic joints	33
	Introduction	33
	Mortice and tenon	33
	Notched joints	41
	Scarf and bridle joints	42
	The half lap	43
	Joints in tension and moments on joints	43
	Ironwork	44
	References	48
04	The survey	49
	Preliminary survey	50
	Detailed survey	53
	Common types of distress	55
	Equipment	57
	References	59
05	Structural behaviour	61
	A cautionary tale	61
	ISCARSAH <i>Recommendations</i>	62
	Force of habit	64
	Joint behavior	65
	Loads	65
	References	83

06	The strength of timber	85
	Early understanding	87
	Grading methods – knots	88
	Other factors	93
	Moisture content	95
	A practical example	97
	Conclusions	98
	References	99
07	Intervention strategy	101
	The structural report	101
	Historic character	102
	Original structural scheme?	103
	To dismantle or not?	105
	Earlier repairs	106
	Reliance on the carpenter	106
	References	107
08	Decay and repair	109
	Classification of repairs	109
	Design codes	109
	Mechanical fasteners	110
	Adhesive bonded reinforcement	118
	Timber replacements	119
	A patch at a mortice	119
	Refacing of a member in bending	121
	New beam ends	121
	Strengthening members in bending	128
	Provision of supplementary structure	129
	References	131
09	Case studies	133
	A purlin failure	133
	St Mary-at-Hill	135
	An A-frame roof	138
	Trinity College Gate	140
	References	143
	Bibliography	145
	Appendix – Hankinson’s formula	149
	Index	151

Preface

The first edition of this book was published in 2003, but there have been several developments since then, so that it has been increasingly looking rather long in the tooth. Since 2003, the International Scientific Committee on the Analysis and Restoration of Structures of Architectural Heritage (ISCARSAH) has produced its *Recommendations* for the analysis and restoration of historic structures, the International Standards Organization has produced an informative annex for ISO 13022 *Assessment of Existing Structures* to deal with heritage structures and the International Council on Monuments and Sites International Wood Committee has issued a new 'Wood Charter'. Two European working groups have also been looking at the structural assessment of historic timber structures. Having been involved with all of these initiatives, it seemed sensible that I should revise the book, to incorporate some of the ideas of these committees. But rather than simply updating the work, this has necessitated a major reworking, in part with the addition of new material, also taking a rather different approach to the subject.

Bringing a work for engineers up to date normally means taking account of recent developments in design codes. Indeed, the first edition was produced just at the time that Eurocode 5 was being published. However, there are a number of reasons why that route has not been followed here. The purpose of Eurocodes is not to improve engineering standards but rather to allow for international 'trade' within Europe, that trade to include professional services. This does not necessarily facilitate the conservation of historic buildings, particularly since those in different countries will have been built to different historic standards and traditions of workmanship. It is also the case that modern design codes do not serve conservation engineers well, as will be discussed in more than one chapter within this book. We also have to recognise that, in spite of a growing interest in conservation, research in this area remains rather limited. Moreover, to be brutally frank, many researchers have stayed at their desks and in their laboratories and have been reluctant to go out into the field to understand what engineers in practice might be doing, still less what carpenters do – or once did. It is as if they thought that, as carpentry makes your hands dirty, thinking about it might make their brains dirty (not originally my joke).

The result is that this work can be less of a handbook to be taken down from the shelf and used like designers' manuals but more a guide to approaches to historic buildings in general and timber frames in particular. What is it then that colours my approach?

The first observation to make is that conservation involves teamwork and the engineer often needs to engage with other professionals far more than one might in new construction: architects, surveyors, conservation officers and carpenters. One might have to explain one's choices or listen to and understand the views of others that constrain those choices. One might equally be dealing directly with clients and have to explain one's recommendations to them. That means understanding something of the history of carpentry, and something of the conservation legislation. I have even had to work with lead consultants, both architects and surveyors, who knew far less about these matters than I did.

The second observation is that modern design codes and standards are written with new construction in mind. The result is that there are implicit assumptions about such things as the materials used or how joints will be made that simply do not apply to historic structures. This means that one has to navigate one's way round these codes with a degree of caution. Largely for that reason, this book does not set out to be a manual to be followed in the way that codes are often followed. There are occasions when the engineers need to think for themselves. Therefore, this book is not so much a manual as a discussion of the issues presented by a historic structure. It occasionally questions clauses in the present design codes and, for example, presents a personal view of the assessment of timber strengths. In forming these views, I have drawn on conservation projects that I have been involved in, and my work with the various committees mentioned.

There has recently been a greater international interest in the engineering aspects of conservation. There are postgraduate studies at the University of Miño and there is the International Conference on Structural Health Assessment of Timber Structures, held every two years. Although interest in the subject internationally has suggested that the book might be expended to deal with other than British structures to give it an international perspective, as far as that is possible for a book in English, space restrictions have meant that only a brief reference to the differences between British and other European traditions has been possible.

Acknowledgements

As any other author, I have benefited from the help of others over a long period of time; too many to do justice to them all. I have learned from contractors I worked with, particularly Peter McCurdy and Hugh Harrison, from my colleague Andrew Smith with whom I worked for some years, from colleagues on the ISCARSAH committee, too many to list, and, more recently, those on the European working groups on which I have served, particularly Helena Cruz, Nicola Macchioni and Eleftheria Tsakanika. I must also acknowledge the help provided by Rob Thomas, the librarian of the Institution of Structural Engineers.