Technical note

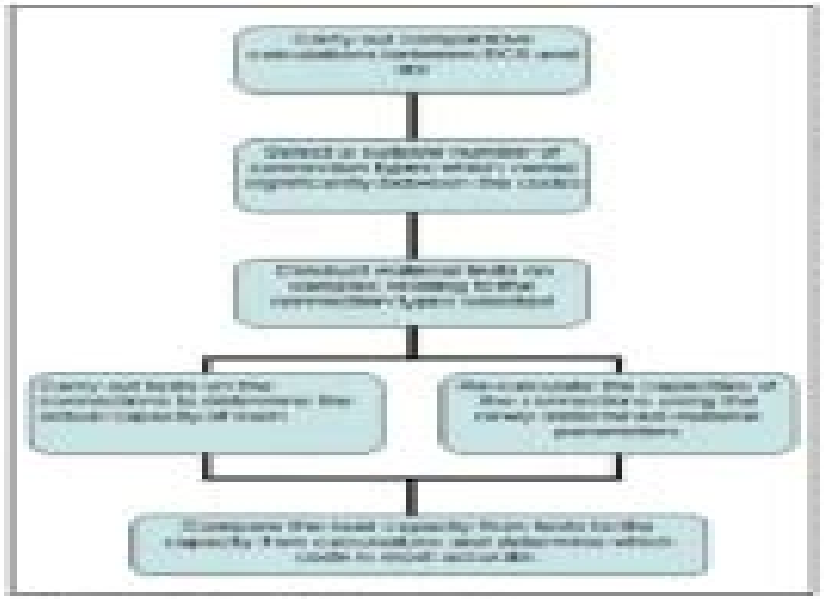
Comparing timber shear connection design using EC 5 and BS 5268

Mark Clegg won the Michael Horne Prize* 2008 for outstanding project work. Here he describes his research

This technical note reports on the current design methods adopted by the British Standard for several types of timber shear connections, and makes a comparison with the methods described in Eurocode 5. Calculations and verifying tests were conducted to determine which code most accurately predicted the load capacity of the connections.

Timber connections are a means of transferring loads from one member to another and ensuring stability of the overall structure. Early examples of timber connections consisted of simple wooden pegs and tied hoop joints, which were in keeping with the simple construction that was prevalent in those times. As time has passed and structures have become more complex, so have the means by which members are connected. Today, a large variety of fasteners are available, enabling strong connections to be achieved in a speedy and economical manner.

There are several different ways in which timber can be connected to resist the differing forces which are being applied; this technical note deals with single and double shear type connections with dowel type fasteners.



1 Methodology adopted for the comparison

Previous research

The current method of connection design was established by H. W. Johansen[1] in 1949 when he developed his yield model. The paper he published identified that the strength of a simple connection is a function of the fastener's bending strength, the timber's crushing strength, and the amount of load required to pull the fastener out of the timber. Johansen developed formulae relating to three possible failure modes for single shear connections, and four possible modes for double shear connections.

Design codes and methods

Connection design in the UK is currently based on BS 5268-2:2002 'Structural Use of Timber'. It is expected that in 2010, this will be replaced by the European Standard, EN 1995-1-1:2004 'Eurocode 5: Design of Timber Structures' along with the relevant UK National Application Document.

Both codes of practice are based on the research conducted by Johansen, although additional failure modes have been identified, as the fastener have been adapted to account for variable thicknesses and embedding strengths of the timber.

When comparing the formulae from both codes, it is seen that in general only minor changes have been implemented, although there is a clear difference due to equations 4 through to 7 for single shear failures and 10 to 12 for double shear failures. This is the addition of $F_{ax,\alpha,Rk}$ / 4 in the Eurocode, which represents an increase in strength due to what is described as the 'characteristic axial withdrawal capacity of the fastener', which was neglected by Johansen in his research but not used in BS 5268.

The characteristic axial withdrawal capacity allowed for by Eurocode 5 occurs when the fastener has rotated within the timber and an axial force is introduced into the fastener by means of friction between the fastener and the timber. The amount of load resisted by this frictional effect varies depending on factors such as the thickness member/s of the fasteners, the thickness and density of the timber, and the type of the fastener head.

The method adopted for the comparison is summarised in Fig 1.

Determining the theoretical connection capacities

Initially, numerous calculations were conducted to determine the load capacity of a vast variety of connection types. It was fundamental that the calculations were computed by a few reasons.

The British Standard is based upon permissible stress design, so a material safety factor has already been applied to the allowable timber stresses, thus the loads applied are true unfactored loads. Eurocode 5 adopts the alternative approach of limit state philosophy, whereby characteristic loads (5% percentiles) are increased by a partial safety factor and the characteristic fastener strengths (5% percentile) are reduced by a partial safety factor.

To alleviate this problem the allowable stresses of the timber were based on the values provided by BS EN 338:2003 'Structural timber — Strength classes' which gives unmodified design stresses.

When considering timber it is apparent that many variables can

Timber Designers Manual Using Ec 5

Padhraic Smyth

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Timber Designers' Manual Jack A. Baird,E. C. Ozelton,1984 Timber Designers' Manual E. C. Ozelton,J. A. Baird,2008-04-15 This major structural engineering manual covers overall detail design of structural timber and includes extensive tables and coefficients for speedy reference The current edition takes account of revisions to BS 5268 Part 2 and outlines the new Eurocode on timber It is available for the first time in paperback Structural Elements Design Manual: Working with Eurocodes Trevor Draycott,Peter Bullman,2009-10-26 Structural Elements Design Manual Working With Eurocodes is the structural engineers companion volume to the four Eurocodes on the structural use of timber concrete masonry and steelwork For the student at higher technician or first degree level it provides a single source of information on the behaviour and practical design of the main elements of the building structure With plenty of worked examples and diagrams it is a useful textbook not only for students of structural and civil engineering but also for those on courses in related subjects such as architecture building and surveying whose studies include the design of structural elements Trevor Draycott the former Buildings and Standards Manager with Lancashire County Council s Department of Property Services has 50 years experience in the construction industry For 20 years he was also an associate lecturer in structures at Lancashire Polytechnic now the University of Central Lancashire in Preston For many years he served on the Institution of Structural Engineers North West Branch professional interview panel and the North West regional committee of the Timber Research and Development Association Peter Bullman worked for Felix J Samuely and Partners Taylor Woodrow Construction and Building Design Partnership before joining Bolton Institute now the University of Bolton as a lecturer in structural engineering He has taught structural design on higher technician degree and postgraduate courses and has run courses to prepare engineers for the IStructE Chartered Membership examination **Structural Timber Design to Eurocode 5** Jack Porteous,Abdy Kermani,2008-05-23 Structural Timber Design to Eurocode 5 is a comprehensive book which provides practising engineers and specialist contractors with detailed information and in depth guidance on the design of timber structures based on the common rules and rules for buildings in Eurocode 5 Part 1 1 It will also be of interest to undergraduate and postgraduate students of civil and structural engineering The book provides a step by step approach to the design of all of the most commonly used timber elements and connections using solid timber glued laminated timber or wood based structural products It features numerous detailed worked examples and incorporates the requirements of the UK National Annex It covers the strength and stiffness properties of timber and its reconstituted and engineered products the key requirements of Eurocode 0 Eurocode 1 and Eurocode 5 Part 1 1 the design of beams and columns of solid timber glued laminated composite and thin webbed sections the lateral stability requirements of timber structures and the design of mechanical connections subjected to lateral and or axial forces as well as rigid and semi rigid connections subjected to a moment The Authors Jack Porteous is a consulting engineer specialising in timber engineering He is a Chartered Engineer

Fellow of the Institution of Civil Engineers and Member of the Institution of Structural Engineers He is a visiting scholar and lecturer in timber engineering at Napier University Abdy Kermani is the Professor of Timber Engineering and R D consultant at Napier University He is a Chartered Engineer Member of the Institution of Structural Engineers and Fellow of the Institute of Wood Science with over 20 years experience in civil and structural engineering research teaching and practice The authors have led several research and development programmes on the structural use of timber and its reconstituted products Their research work in timber engineering is internationally recognised and published widely Also of Interest Timber Designers Manual Third Edition E C Ozelton J A Baird Paperback 978 14051 4671 5 Cover design by Garth Stewart

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Roof Construction and Loft Conversion C. N. Mindham,2008-04-15 Full of detailed construction drawings this book covers cut roofs bolted truss roofs trussed rafter roofs trimmed openings andventilation A major section deals with loft to attic room conversions givingguidance on planning procedures as well as dealing with structuralmatters and specifying

conversion work The Fourth Edition features a new chapter covering the growingnumber of engineered timber components available in the housebuilding industry The use of I beams and roof cassettes isdetailed for roof and room in the roof construction The text hasbeen fully updated to current standards and features additionaldetailed construction drawings The chapters on attic conversionand construction have been expanded and a new attic conversiondecision flow chart added The book will prove invaluable to architects house builders roofcarpenters building control officers trussed rafter manufacturersand students of building technology The Author C N Mindham BSc has had a wide experience in the constructionindustry After three years with TRADA as Eastern Regional Officer he spent 11 years developing a timber engineering business tobecome one of the country s largest producers of trussedrafters He became Managing Director of a company designing andmanufacturing trussed rafters joinery and prefabricated timberbuildings a post he held for eight years Subsequently he startedhis own consultancy for the timber industry which has led him tohis current position as Managing Director for a joinery andengineering company Also of interest Loft Conversions John Coutts 1 4051 3043 1 9781 4051 3043 1 The Building Regulations Explained and Illustrated Twelfth Edition M J Billington M W Simons and J R Waters 0 6320 5837 4 9780 6320 5837 4 Cover design by Garth Stewart Cover illustrations courtesy of VELUX and Mr C Lovell Wellingborough Northamptonshire **Staircases - Structural Analysis and Design** M.Y.H. Bangash,2019-07-16 In recent years both free standing and geometric staircases have become quite popular Many variations exist such as spiral helical and elliptical staircases and combinations of these A number of researchers have come forward with different concepts in the fields of analytical and numerical design and of experimental methods and assessments The aim of this book is to cover all these methods and to present them with greater simplicity to practising engineers Staircases is divided into five chapters Specifications and basic data on staircases Structural analysis of staircases Classical methods Structural analysis of staircases Modern methods Staircases and their analysis A comparative study Design analysis and structural detailing Charts and graphs are included and numerous design examples are given of freestanding and other geometric staircases and of their elements and components These examples are related to the case studies which were based on staircases that have already been constructed All examples are checked using various Eurocodes The book includes bibliographical references and is supported by two appendices which will be of particular interest to those practising engineers who wish to make a comparative study of the different practices and code requirements used by various countries detailed drawings are included from the USA Britain Europe and Asia Staircases will serve as a useful text for teachers preparing design syllabi for undergraduate and post graduate courses Each major section contains a full explanation which allows the book to be used by students and practising engineers particularly those facing the formidable task of having to design detail complicated staircases with unusual boundary conditions Contractors will also find this book useful in the preparation of construction drawings and manufacturers will be interested in the guidance given **Design of Structural Elements** Chanakya

Arya,2022-05-04 The fourth edition of Design of Structural Elements Concrete Steelwork Masonry and Timber Designs to Eurocodes is a concise single volume introduction to the design of structural elements in concrete steel timber masonry and composites It provides design principles and guidance in line with Eurocodes current as of 2021 Topics include the philosophy of design sustainable development basic structural concepts and material properties After an overview of structural design the book contains self contained chapters with numerous diagrams and worked examples on design in reinforced concrete structural steelwork and steel concrete composites masonry and timber based on EN 1990 1997 Selected extracts from these publications assist familiarity Elements considered cover reinforced concrete and composite floors isolated foundation cantilever retaining wall load bearing and panel walls stud wall and connections The text is ideal for student civil and structural engineers on degree and diploma courses and also practising civil and structural engineers and other built environment professions The online Support Materials for adopting course instructors includes an extensive set of solutions to the problems in the book and PowerPoint slides for use in lectures www routledge com 9781032076317 **Civil Engineer's Reference Book** L S Blake,1994-03-21 After an examination of fundamental theories as applied to civil engineering authoritative coverage is included on design practice for certain materials and specific structures and applications A particular feature is the incorporation of chapters on construction and site practice including contract management and control **InCIEC 2015** Marina Yusoff,Nor Hayati Abdul Hamid,Mohd Fadzil Arshad,Ahmad Kamil Arshad,Ahmad Ruslan Mohd Ridzuan,Haryati Awang,2016-06-18 The special focus of these proceedings is on the areas of infrastructure engineering and sustainability management They provide detailed information on innovative research developments in construction materials and structures in addition to a compilation of interdisciplinary findings combining nano materials and engineering The coverage of cutting edge infrastructure and sustainability issues in engineering includes earthquakes bioremediation synergistic management timber engineering flood management and intelligent transport systems

The Repair of Historic Timber Structures David T. Yeomans,2003 England has a surprising number of timber framed buildings many dating back to pre 1700 which are listed buildings There is now an increasing demand for these buildings to be adapted to suit modern day requirements This book takes a practical approach and discusses materials and carpentry techniques used in the repair of these buildings along with a qualitative account of the structural behaviour of the timber elements

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