

Comparing timber shear connection design using EC 5 and BS 5268

Mark Clegg won the Michael Home 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. Easy examples of timber connections consisted of simple wooden pegs and lap type joints, which were in keeping with the simple construction that was present 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 steel. The differing forms which are being applied, this technical note deals with single and double shear type connections with dowel type fasteners.

Previous research

The current method of connection design was established by H. W. Johansen in 1948 when he developed his 'yield model'. This paper he published clarified that the strength of a simple connection is a function of the fastener's tensile strength, the timber's crushing strength, and the amount of load required to pull it in between out of the timber. Johansen developed formulae leading 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: 2002 Structural Use of Timber. It is expected that in 2012, 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, and the formulae have been adapted to account for variable timberwood and embedding strengths of the timber.

When comparing the formulae from both codes, it was seen that in general only minor changes have been implemented, although there is a clear difference to equations 4 through to 7 for single shear failure and 5 to 8 for double shear failure. This is the reduction of $F_{t,90}$ / 4 in the Eurocode, which represents an increase in strength due to what is described as the 'characteristic value withdrawal capacity of the fastener', which was realised by Johansen in his research but not used in BS 5268.

The characteristic value withdrawal capacity allowed for by Eurocode 5 occurs when the fastener has rotated within the timber and a withdrawal force is introduced into the fastener by means of friction between the fastener and the timber. The amount of load resisted by the frictional effect varies depending on factors such as the timber resistance to other fasteners, the thickness and density of the timber, and the size of the fastener itself.

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 two codes were compared by a fair means. The British Standard is based upon characteristic stress design, so a material safety factor has already been applied to the ultimate stress stresses, thus the loads applied are true unfactored loads. Eurocode 5 argues the alternative approach of limit state philosophy, whereby characteristic loads (50th percentile) are increased by a partial safety factor and the characteristic load decreased by a partial safety factor and the characteristic load decreased by a partial safety factor.

To illustrate this problem the ultimate 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 variations can

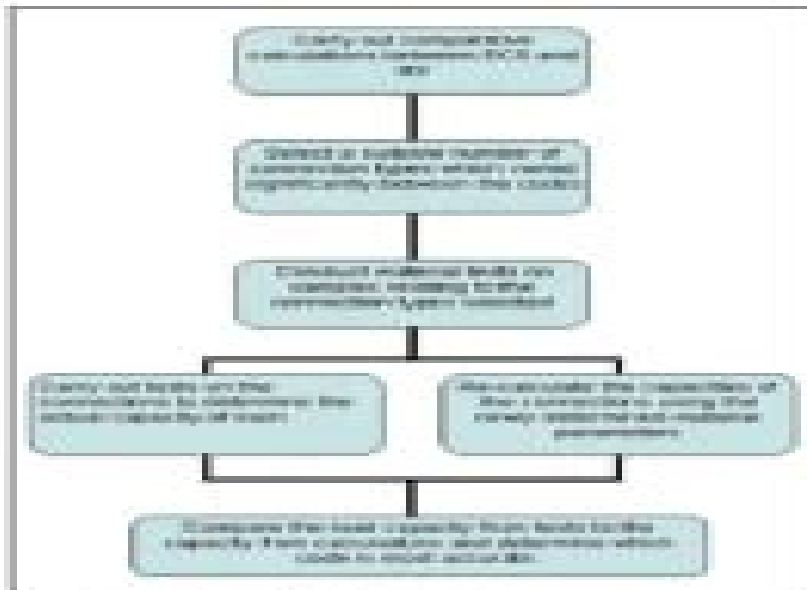


Fig 1 Methodology adopted for the comparison

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Timber Designers' Manual Jack A. Baird, E. C. Ozeltun, 1984 *Timber Designers' Manual* E. C. Ozeltun, 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

Structural Elements Design Manual Trevor Draycott, Peter Bullman, 2009 Trevor Draycott and Peter Bullman cover the behaviour and practical design of the main building elements timber concrete masonry and steelwork

Multiple-bolted Joints in Wood Members Peter James Moss, 1997 **Metric Handbook** Pamela Buxton, 2021-11-25 The Metric Handbook is the major handbook of planning and design data for architects and architecture students with over 100 000 copies sold to successive generations of architects and designers It remains the ideal starting point for any project and belongs in every design office The seventh edition references the latest regulations and construction standards and includes new chapters on data centres and logistics facilities alongside basic design data for all the major building types For each building type the book gives the basic design requirements and all the principal dimensional data and succinct guidance on how to use the information and what regulations the designer needs to be aware of As well as buildings the Metric Handbook deals with broader aspects of design such as materials acoustics and lighting and general design data on human dimensions and space requirements The Metric Handbook is the unique reference for solving everyday planning problems

Art Book News Annual, volume 4: 2008 Art Book News Annual, volume 4: 2008 , **General Technical Report FPL** , 1978 **Timber Connections** Rohana Hassan, Azmi Ibrahim, Zakiah Ahmad, 2023-04-19 This book describes the application of mathematical and fundamental theory as stated in the relevant standards namely EYM and NDS Timber is one of the important building materials in the field of engineering other than concrete and steel However there is still a lot of unexplored knowledge about timber including how timber connections are made One of the main types of timber connection is mortise and tenon Mortise and tenon are widely seen as one of the most important traditional timber structural joint In order to understand the load carrying capacity and performance of the structural mortise and tenon joint the existing theoretical background of timber joint design is made as a reference Current equations applicable in estimating the load carrying capacity of timber joint uses the European Yield Model EYM Therefore the main aim of this book is to share the basic design knowledge inclusive of safety factor limitations as engineering main factor in structural design **Structural Defects Reference Manual for Low-Rise Buildings** Michael F. Atkinson, 2014-04-21 The Structural Defects Reference Manual for Low Rise Buildings has been written to assist professionals and students involved in building construction to

identify causes of structural failure Each chapter carefully addresses design materials and workmanship factors which contribute to structural defects The main structural elements roofs wall

Sustainable Timber Design Michael Dickson,Dave Parker,2014-12-17 This new resource covers the material selection structural design and connections detailing of truly sustainable timber buildings through consideration of the nature of wood and the heritage of timber construction including the importance of forestry and conservation a review of modern techniques to improve the durability fire resistance and predictability of structural timber elements and their vital connections analysis of the many architectural and structural options from roundwood shells through glulam arches and gridshells to long span hybrid structures case studies from around the world illustrating the principles discussed and the true potential of timber construction Historically there has been an imbalance between the availability of information on structural timber design and the much more widespread familiarity with traditional structural materials such as steel and concrete This book aims to help redress the balance by presenting the essential design principles involved in the creation of elegant user friendly timber buildings that are practical economic and thoroughly sustainable Designed to support specialist study into the benefits of 21st Century timber engineering this book also offers architects engineers and other construction professionals practical advice on all aspects of modern timber architecture

Progress in Mechanics of Structures and Materials Peter J. Moss,Rajesh P. Dhakal,2020-10-28 This is a collection of peer reviewed papers originally presented at the 19th Australasian Conference on the Mechanics of Structures and Materials by academics researchers and practitioners largely from Australasia and the Asia Pacific region The topics under discussion include composite structures and materials computational mechanics dynamic analysis of structures earthquake engineering fire engineering geomechanics and foundation engineering mechanics of materials reinforced and prestressed concrete structures shock and impact loading steel structures structural health monitoring and damage identification structural mechanics and timber engineering It is a valuable reference for academics researchers and civil and mechanical engineers working in structural and material engineering and mechanics

Design of Structural Timber William McKenzie,Binsheng Zhang,2007-09-12 This textbook provides a comprehensive source of information on practical timber design and introduces the nature and inherent characteristics of timber given in relation to the requirements of Eurocode 5 EC5 The scope of the book ranges from an introduction to timber as a material to the design of realistic structures including and beyond those usually considered essential for undergraduate study Readers are encouraged to make frequent reference to the appropriate design codes Although written primarily for undergraduate civil and structural engineers the book also provides an invaluable reference source for practising engineers in many building civil and architectural design offices

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 and ventilation A major section deals with loft to attic room conversions giving guidance on planning procedures as well as dealing with structural matters and specifying

conversion work The Fourth Edition features a new chapter covering the growing number of engineered timber components available in the housebuilding industry The use of I beams and roof cassettes is detailed for roof and room in the roof construction The text has been fully updated to current standards and features additional detailed construction drawings The chapters on attic conversion and construction have been expanded and a new attic conversion decision flow chart added The book will prove invaluable to architects house builders roof carpenters building control officers trussed rafter manufacturers and students of building technology The Author C N Mindham BSc has had a wide experience in the construction industry After three years with TRADA as Eastern Regional Officer he spent 11 years developing a timber engineering business to become one of the country's largest producers of trussed rafters He became Managing Director of a company designing and manufacturing trussed rafters joinery and prefabricated timber buildings a post he held for eight years Subsequently he started his own consultancy for the timber industry which has led him to his current position as Managing Director for a joinery and engineering 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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