COST ACTION E55

MODELLING OF THE PERFORMANCE OF TIMBER STRUCTURES

PRESENTATION OF THE NATIONAL DELEGATIONS

DRAFT, MAY 11, 2007

AUSTRIA

1. Research Institutions

Institute of Timber Engineering and Wood Technology (TU Graz), http://www.lignum.at

Vision

The Institute for Timber Engineering and Wood Technology wants to encourage the students and teach them the necessary sensitivity in engineering. The Institute contributes to resource-saving and ecological construction by the development and the use of products from the re-growing resource wood.

Main ideas of the Institute

An ambitious education of students is the main goal of the Institute for Timber Engineering and Wood Technology. A fundamental knowledge is taught to the students by fundamental- and research oriented lessons as well as the implementation of many practical topics. Inside the Graz University of Technology the Institute is an important member in the department of Constructional Engineering of the faculty Civil Engineering. Discipline spanning team work and competence are important basics of the members of the institute. They are engaged to increase the international reputation of the university by their ambitious work and activities. The institute operates in the area of basic oriented research as its central competence, knowledge transfer and comprehensive findings to specific applications for maximum use by society and project partners. The scientific offspring is especially brought forward by providing lessons, which cover a huge area within the own scientific field, by integrating them into active research programs, by offering them contacts to various national and international famous research institutions and last but not least by PhD students at the Institute.

Ensuring the personal integrity in scientific work for all scientists in combination with allocation of the required liberty is the major goal, in order to achieve a maximum of scientific findings and knowledge in the sense of the main ideas of the institute. Collaboration is given with national and international companies, which ensures being up-to-date of the research programs and interacts with the fundamental research, in order to achieve a maximum of innovation. Research work along the structural hierarchical chain 'wood' is consistent with demands of the society in respect to sustainability and the permanently growing request of ecological, resource-efficient buildings because of the global energy problem in regard to the CO_2-topic.

Maximum output in teaching and research can be established by the collaborators, when they complete their competence mutually. Each collaborator should enjoy the advantage of personal evolvement.

Competence Centre "holz.bau forschungs gmbh"
www.holzbauforschung.at

Guiding ideas of the holz.bau forschungs gmbh

The holz.bau forschungs gmbh aims with their contributions on an improvement to save and increase the importance of the material wood and timber in the building industry. The holz.bau forschungs gmbh has the self-conception as an institution linking the basic science to oriented research and educational work of the university and stimulating and realizing organizations and companies in the field of wood and timber economics. The holz.bau forschungs gmbh deals on one hand with short-term and result oriented research services and on the other hand is engaged in medium- and long-term research topics. The holz.bau forschungs gmbh has its core competence in the area of working and linking on research questions of timber engineering and wood technology. It addresses itself in the development, the preprocessing and the targeted transfer of know-how to reach a maximum potential of implementation in the branches of timber engineering and wood technology.

2. Planned and ongoing Research Activities

Consequences of truncated distributions for the semi-probabilistic and probabilistic safety concept

(planned sub-area 2.1 APTM of submitted new competence centre; duration 2008 -2012)

Abstract:
In the field of the project P03 qm_online II of the holz.bau forschungs gmbh the influence of truncated distribution functions due to applied proof-loading has been examined by extensive parameter study carried out by G. I. Schuëller and M. F. Pellissetti (University of Innsbruck) in collaboration with the holz.bau forschungs gmbh. Emphasize of this study has been taken on determination of the influence of assumed representative statistical distribution model and distribution parameters and influences due to variation of the parameter proof level. Based on erected proof loading device in the facility of an industrial partner (Leitinger Holzindustrie Gmbh) as output control for the production of finger jointed construction timber (KVH®) the task has been to quantify the increase of the 5 %-quantile of tension strength and increase of safety thanks to elimination of flaws in the lower extreme boundary of the distribution.
Based on current knowledge an extension of existing proof loading concept to proof grading is planed for the next generation of the holz.bau forschungs gmbh. Due to static measurement of modulus of elasticity this additional parameter enables classification and in-time application of individual proof-levels and hence stiffness grading. For this application it is necessary to know the representative statistical distribution functions of the population of base material board or girder (strength, modulus of elasticity, density) to be able to determine influences on the graded material by variation of certain thresholds of underlying grading criteria.
Starting with statistical analysis of existing data sets for determination of representative statistical distribution models and describing parameters the influence due to defined thresholds of chosen grading criteria on correlated mechanical properties will be examined by application of multivariate statistics. Gained knowledge will also enlarge the judgment of existing and further grading devices concerning predictability of design relevant mechanical properties strength and stiffness. These results will give an important input concerning judgment and improvement of the reliability of timber structures in the COST Action E55.

Statistically based best fitted distribution functions for strength of timber structures

(planned sub-area 2.2 MMSM of submitted new competence centre; duration 2008 -2012)

Abstract:

The knowledge of the representative statistical distribution functions and related distribution parameters (as mentioned above) is the basis for statistical description of mechanical properties of timber structures (elements like reference volumes (RVE's), components like boards, girders, systems like GLT, KVH®, CLT). But nevertheless further statistical parameters like coefficient of determination are necessary to link properties together. Results of this project are the basis for application of multivariate statistics for implementation of describing stochastic in 'stochastic finite element methods' (SFEM).

Based on intense statistical analysis of existing internal and external data sets above mentioned results are extracted and prepared for further application in mentioned SFEM. Emphasize is taken on quantitative and qualitative determination of representative statistical description. Distribution models like normal distr. (ND), log. normal distr. (LND) and Weibull distr. (WD) are applied for statistical analysis.

Generally the design of timber structures needs reliable determined 5 %-quantiles of strength, which are statistically sensitive and highly influenced by enormous deviating parameters like grading, provenience, wood processing and position in stem. Emphasize of representative models has to be taken on the lower quantile range (0 % till 10 %).

The extracted knowledge will give important input for the COST Action E55 concerning description of the stochastic of selected mechanical properties of timber and timber structures.

Simulation and tests of important k-factors

(planned sub-area 2.2 MMSM of submitted new competence centre; duration 2008 -2012)

Abstract:

Materials used for engineering applications and therefore exposed to the area of conflict between safety and economical requirements, call for a comprehensive know-how regarding their mechanical effects. Additionally, the integration of stochastic as a crucial aspect for safety considerations is indispensable, especially for materials with widely diverging mechanical parameters. Timber is a broadly applicable, naturally grown light-weight material characterized by significantly diverging specific parameters. This is especially the reason why timber requires an overall description of its mechanical properties, variability and stochastic.

It is the aim of this project to imbed stochastic in the material non-linear finite elements method in order to enlarge it to a stochastic FEM (SFEM). The project together with the models elaborated and studies carried out in the course of these, serve as the basis for the overall consolidation of stochastic and applied mechanics and to find further application for studying specific structures. In this way, analyses of 1D beams and 2D planar shell components are envisaged, accounting for a variation of initial parameters. Further checking the existing normative specifications of these parameters should be carried out. Following extended detailed studies - based on various previous projects - should be executed. In this way, the calculation of deformations and in particular of strength capacities can be carried out by using virtually generated structures (such as glulam, cross laminated timber, or structural timber), virtual elements and components (such as boards, or board segments) by specific variation of the initial parameters like E-modulus, component strength, density, failure characteristic categorisations, system definitions. Assessments of strength capacities of various timber structures, primarily based on simulations, can be done. These strength capacities of various timber structures can be compared by taking into account that these structures are virtually built up with the same components. Further, this research

enables for comprehensive transfer possibilities like optimised product developments, for instance, glulam or cross laminated timber. Progress in this scientific area can be seen as an important step towards an optimized cut of logs. Improved possibilities in analysis of occurred damage cases are another important step on the way to reliable timber engineering.

By that way the project should end up with numerical simulation of important k-factors as they are k_{sys} and k_{size}. Experimental evaluation will have to be carried out, to prove the numerical results. The extracted knowledge will give important input for the COST Action E55 concerning basic strength properties of timber and timber structures.

Reliability analysis of single storey buildings

In Middle Europe the winter of 2005/2006 brought beside a lot of snow also damaged and collapsed single storey buildings caused by it. Although this fact has the same status for all common materials it's – because of the advantageous load to span relation – of particular interest and importance for single storey buildings produced with timber, glulam and wood engineering materials respectively.
Analyses work of the damages done by experienced experts after that winter showed that many of the investigated buildings give reason for complaints. In particular unsatisfying workmanship, design errors and insufficient or absence of maintenance activities are reasons for that status. Summarizing most of the mentioned problem areas can be avoided by a appropriate quality management system.
As a consequence the intended work will focus on the established problems by means of working out the following main topics:

- Inventory, analysis and benchmark of structural systems used for single storey buildings
- Analysis and benchmark of damaged and collapsed structures
- Baed on the mentioned topics development of an expert system for the estimation of the reliability for single storey buildings
- Development of an "instruction manual (maintenance and service plans)" for the end user

3. Recent Publications

Brandner R (2006) Systemeffekte von aus Konstruktionsvollholz aufgebauten Querschnitten. Diplomarbeit an der Fachhochschule Salzburg, in collaboration with the Competence Centre holz.bau forschungs gmbh, pp. 299

Brandner R, Schickhofer G (2006) System effects of structural elements – determined for bending and tension. WCTE, , pp. 8, Portland, United Staates

Brandner R, Jeitler G, Schickhofer G (2007) Statistischer Längeneffekt von stabförmigen Strukturen – Allgemeine Betrachtungen. Forschungsbericht im Rahmen des Projektes P03 qm online_II, holz.bau forschungs gmbh, Graz, Austria

Jeitler G, Brandner R, Schickhofer G (2007) Versuchstechnische Ermittlung des Längeneffektes auf die Zugfestigkeit von stabförmigen Holzprodukten. Forschungsbericht im Rahmen des Projektes P03 qm online_II, holz.bau forschungs gmbh, Graz, Austria

Schickhofer G, Brandner R, Jeitler G (2006) Das schwächste Glied in der Kette bestimmt den Level. Beitrag im Rahmen des 12. Internationalen Holzbau-Forum 2006, Garmisch Partenkirchen, pp. 29

Schickhofer G, Brandner R (2007) Challenges of EN 1194:new. Vortrag im Rahmen des 1. Grazer Holzbauseminars (1.GraHSE), Graz, Austria

Brandner R (2007) Determination of shear modulus of elasticity of GLT. Vortrag im Rahmen des 1. Grazer Holzbauseminars (1.GraHSE), Graz, Austria

Brandner R (2007) New aspects of regulations concerning strength models. Vortrag im Rahmen des 1. Grazer Holzbauseminars (1.GraHSE), Graz, Austria

Brandner R (2007) Ermittlung und Darstellung der Zusammenhänge zwischen Biege-, Schub- und Torsionsmodul für BSH. Vortrag im Rahmen der 7. wissenschaftlichen Beiratssitzung der holz.bau forschungs gmbh, Graz, Austria

Schickhofer G, Brandner R (2007) Zukunft der Brettschichtholzforschung an der TU Graz. Vortrag im Rahmen der 7. wissenschaftlichen Beiratssitzung der holz.bau forschungs gmbh, Graz, Austria

Brandner R (2006) Festigkeits- und Steifigkeitspotential der Lamellen aus Fichte für die BSH-Produktion. Vortrag im Rahmen des Fachnormenausschusses FNA012, Wien, Austria

Brandner R, Schickhofer G (2006) Potential der BSH-Lamelle aus Fichte, auf Zug – Festigkeits- und Steifigkeitspotential der Lamellen aus Fichte für die BSH Produktion. Vortrag im Rahmen des vorbereitenden Arbeitskreises für die Überarbeitung der EN 1194, München, Germany

Brandner R, Schickhofer G (2006) Potential des BSH-Trägers aus Fichte, auf Biegung – Biegekennwerte von BSH aus Fichte. Vortrag im Rahmen des vorbereitenden Arbeitskreises für die Überarbeitung der EN 1194, München, Germany

Brandner R, Schickhofer G (2006) Ermittlung eines Trägermodells. Vortrag im Rahmen des vorbereitenden Arbeitskreises für die Überarbeitung der EN 1194, München, Germany

Brandner R (2006) Darstellung des Festigkeits- und Steifigkeitspotentials von BSH-Lamellen in Hinblick auf das Trägermodell. Vortrag im Rahmen des 2. Grazer Holzbau-Workshops (2.GraHWS), Graz, Austria

Brandner R, Schickhofer G, Ruli A, Halili Y (2006) Leistungspotential von Brettschichtholz – Beanspruchung auf Längsdruck und Querdruck. Forschungsbericht im Rahmen des Projektes Non-K-Ind B_S_H – Leistungspotential von Brettschichtholz der holz.bau forschungs gmbh, Graz, Austria

Brandner R, Katzengruber R, Jeitler G (2005) Biegeprüfung von Balkenbindern. Forschungsbericht im Rahmen des Projektes K-Ind P03 qm_online der holz.bau forschungs gmbh, Graz, Austria

Brandner R, Frühwald K, Jeitler G, Unterwieser H (2005) P05 grading – Untersuchungen an keilgezinkten Gurtlamellen für den Kaufmann-Holzschalungsträger HAT 20 Plus. Forschungsbericht im Rahmen des Projektes K-Ind P05 grading der holz.bau forschungs gmbh, Graz, Austria

Brandner R (2005) Schubfestigkeit – Ermittlung der 5 %-Quantile sowie der charakteristischen Schubfestigkeiten gewichtet nach der Absatzmenge. Forschungsbericht im Rahmen des Projektes K-Ind P05 grading der holz.bau forschungs gmbh, Graz, Austria

Augustin M, Ruli A, Brandner R, Schickhofer G (2006) Behaviour of glulam in compression perpendicular to grain in different strength classes and load configurations. WCTE, 146 (1) – 146 (8), Portland, United States

Augustin M, Schickhofer G, Ruli A, Brandner R (2006) Behaviour of glulam in compression perpendicular to grain in different strength classes and load configurations. CIB W18 39-12-5, 1-16, Venice, Italy

Katzengruber R, Schickhofer G, Brandner R, Jeitler G (2006) Tensile proof loading to assure quality of finger-jointed structural timber. WCTE, 1-9, Portland, United States

Schickhofer, G.; Bogensperger, T.; Gehri, E.: Forschungsaktivitäten und normative Entwicklung im Bereich der Schubkenngrößen. - in: 2. Grazer Holzbau-Workshop'06. am: 23.06.2006

Jöbstl, R.-A.; Bogensperger, T.; Moosbrugger, T.; Schickhofer, G.: A Contribution to the Design and System Effect of Cross Laminated Timber. - in: CIB W18, 39th Meeting. (2006)

Moosbrugger, T.; Guggenberger, W.; Bogensperger, T.: Cross-Laminated Timber Wall Segments under homogeneous Shear - with and without Openings. - in: WCTE 2006, 9th World Conference on Timber Engineering (2006) World Conference on Timber Engineering ; 2006

Jöbstl, R.-A.; Moosbrugger, T.; Bogensperger, T.; Schickhofer, G.: Forschung an der TU Graz – Neue Erkenntnisse zur Nachweisführung von biegebeanspruchten BSP-Elementen. - in: 5. GraHFT'06, Tagungsband, Brettsperrholz – Ein Blick auf Forschung und Entwicklung. (2006), S. C1 - C18

Moosbrugger, T.; Guggenberger, W.; Bogensperger, T.: Forschung an der TU Graz – Steifigkeitsuntersuchungen an BSP-Scheiben-Elementen. - in: 5. GraHFT'06, Tagungsband, Brettsperrholz – Ein Blick auf Forschung und Entwicklung. (2006), S. G1 - G14

Bogensperger, T.; Unterwieser, H.; Schickhofer, G.: The Mechanical Inconsistence in the Evaluation of the Modulus of Elasticity According to EN384. - in: CIB W18, 39th Meeting. (2006), S. 1 - 12

Traetta, G.; Bogensperger, T.; Moosbrugger, T.; Schickhofer, G.: Verformungsverhalten von Brettsperrholzplatten unter Schubbeanspruchung in der Ebene. - in: 5. GraHFT'06, Tagungsband, Brettsperrholz – Ein Blick auf Forschung und Entwicklung. (2006), S. H1 - H16

Jöbstl, R.-A.; Bogensperger, T.; Schickhofer, G.; Jeitler, G.: Mechanical behaviour of two orthogonally glued boards. - in: Proceedings of the 8th World Conference on Timber Engineering. (2004), S. 357 - 364

Bogensperger, T.; Schickhofer, G.: Neuartige, ebene Flächentragwerke im Ingenieurholzbau. - in: Kreative Ideen im Ingenieurbau (2004), S. 25 - 40 Dresdner Baustatik-Seminar ; 8

Information about the Austrian Delegates:

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(See WG I)

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(See WG II)

Working Group Members:

WG I: System Identification and Exposures

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Prof. G. Schickhofer is head of the institute of Timber Engineering and Wood Technology at Graz University of Technology and head of the Competence Centre holz.bau forschungs gmbh.

In the last years and in the frame of both research institutions following topics like timber shell structures, hardwood, grading and output control (proof loading), connection systems and related standardizations have been carried out or still in progress.

WG II: Vulnerability of Components

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R. Brandner is research assistant at the Competence Center holz.bau forschungs gmbh in Graz. In his diploma thesis he dealt with the statistically based explanation of system effects of primary redundant structures. Since 2005 he is involved in the revision of EN 1194 and works in detail on modeling of GLT in bending, tension and compression. By the way he participates in the research projects P03 qm_online and P05 grading assigned for statistical analysis of size effects, expectable grading characteristics and proof loading. With the establishment of the next generation of the holz.bau forschungs gmbh (scheduled starting with 2008) emphasize of his work will be taken on comprehensive statistical description of mechanical properties of timber components and system structures.

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Th. Bogensperger is research assistant at the Institute of Timber Construction and Wood Technology of Graz University of Technology. He was engaged in steel constructional engineering and passed his PhD about a generalized beam theory and tapered beams for steel bridges in 2000. After work in the industry and at the Institute for Structural Analysis of Graz University of Technology, he worked on numerical simulations of timber structures and timber connections at the Institute since 2003. Favorite FE- software is the general purpose program 'ABAQUS'. He is also engaged in writing software tools, in order to virtually generate timber structures with diverging properties, which is the numerical basis of deep investigation of particular effects of timber structures.

WG III: Robustness of Systems

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Since 2004 M. Augustin is scientific assistant at the Institute for Timber Engineering and Wood Technology at Graz University of Technology where he graduated with a diploma thesis about strength grading. In this research area he has been engaged in several projects for – amongst others in the EU-project ’Intelliwood’. With this experience as a basis and his interests in safety and reliability analysis he will begin his work on his PhD which deals with the ’Reliability analysis of single storey buildings’ in the next future.

CROATIA

1 Research Institutions

University of Zagreb, Faculty of Civil Engineering, Zagreb (GFZ), www.grad.hr

Structural Department

Structural department is represented by Prof. Rajčić (PhD, scientific advisor). It is traditionally one of the nine departments on the Faculty of Civil Engineering Zagreb, separated in four chairs: Concrete and masonry structures, Steel structures, Wooden structures and Bridge structures. Scientific and research activities are carried out through six R&D domestic scientific project, one R&D technological domestic project and few international projects. Currently the research activities are concentrated on developing the knowledge of reliability theory for the structures made from new materials, composite structural elements wood-structural glass, sustainability of bridges, appliance of the structural reliability theory in developing of the structures, reliability optimisation of the steel frame system with different types of joints, development of experimental methods for research of structures and life-cycle cost of concrete structures. One technological project with prototype is finished. The name of the project is «Croatian modular wooden house». The results of the researches are published in domestic and foreing journals and thay are presented on scientific and applied science conferences and congreses in Croatia and abroad.

At the Chair of Wooden structures the members are involved in pre-normative research and the researh of new innovative wood based or composite structures with wood, numerical modelling, building expert systems for decision making problems in structural design.

University in Rijeka Faculty of Civil Engineering www.gradri.hr

Department of Structures and Engineering Mechanics

Head of Chair of Timber Structures, Adriana Bjelanović (PhD, Str.C.E, assistant professor, senior scientific assistant) represents Faculty of Civil Engineering. The Chair of Timber Structures is a constitutive part of Department of Structures and Engineering Mechanics. In the area of Timber Engineering, the delegate is actively involved in pre-normative research, applied research and application of artificial intelligence techniques in timber structural engineering. The other members of Department of Structures and Engineering Mechanics focus their scientific investigations in areas of numerical modelling and developing of theory-based models, and in the field of including the finite-element procedures in the software packages, as well.

2 Planned and ongoing research activities

Composite stuctural systems timber-structural glass and timber-steel (from 2007-2010)

Accepted and financed by Ministry of Education and Science, Croatia. Team consists of 5 structural engineers, one architect, two PhD students and two foreing colaborators)

Main researcher:

Prof. Vlatka Rajčić, Ph.D,C.E., Structural Department, University of Zagreb, Faculty of Civil Engineering, Croatia.

Project summary:

This project will observe composite girders of wood composed with two materials (glass or steel). That are estetically, economically and technologically very interesting girders in which the best characteristics of every material can be used. They have very good rate of weight and load-carrying capacity, technologically is very interested because there is no need for heavy mechanization for lifting. Used as a facade and floor load-bearing systems they can be produced like prefabricated elements or at «site». Facades are already have been built with glass, but it is not calculated as load-carrying part so economically those facade systems will be in advantage.

Purpose and aim of proposed research project:

The general aim of the project is widening of knowledge about new, ecological, esteticaly interesting structural systems using the wood as the most acceptable, natural material as well as composites of wood with two materials which are absolutely recycleable, advance the characteristics of the buildings (smaller weight, lower heat losses, possibility of 100% recycling and sustainability of construction sector). Today combination of wood and glass is frequently used for facades, winter gardens and simmilar structures. They are not treated as structural composite system because of the unaquaintance of their composite behaviour. So, evaluation of load-carrying capacity and servicibility of composite systems are the main goal of the project. This project also will define imperfections of the composite systems and measures by which those faults could be avoided or diminished as much as possible. Obtained results will be used for Croatian (NAD) to EC5. The purpose of the project is to define and research characteristics of new, structural systems which could be (because of advanced estetic and economic acceptability) demanded as new structural systems in residental and commercial buildings. There is increasing commercial interest in requirements for eco-friendly products both in manufacture and construction element and components used in buildings. These elements or components and their design concepts are being widely accepted as innovative construction techniques by the construction industry.

Research application:

Definitly composite structures are future of building construction and there is increasing interests of the construction industry of Europe for them. The use of composite structural systems wood-constructive glass and wood-steel shows economic advantages especially for building new floor construction or reconstructions of old wooden floors or for building facades or vertical load-carrying structural systems. Except in house building, composite structures wood-constuctive glass or wood-steel are applicable in building of pedestrian or motor way bridges because of high estetic values and high load -carrying capacity.

Cooperation:

- ALU-KON, Zagreb, producer of laminated glass with PVB interlayer and tempered safety glasses
- MPA Otto-Graf Institut Stuttgart,
- EC DG JOINT RESEARCH CENTRE, Institute for the Protection and Security of the Citizen, European Laboratory for Str. Assesment, Ispra, Italy

Failure mechanism and Behavior Models of Innovative Joints in Timber Structures

(Project in evaluation phase. Purposed by Dr. A. Bjelanović. Two PhD students, full time working on the project, duration 2007-2010 will complete the research team of head and four collaborators)

Abstract:
The investigation field represents the improvement of timber structure joint connections as well as development of their theoretical behavior models and failure mechanisms. The joints are an extraordinary important factor of the structure's bearing capacity and serviceability. New techniques of joining elements serve as an evidence of advancements in timber structures. The following investigations, based on laboratory tests and numerically obtained analysis with parallel development of theoretical behavior models, are scheduled:

1. Element joints of timber-framed structures made with glued-in rods of smooth and ribbed reinforcement and with rods based on fiber-reinforced polymers (FRP) applicable in designing hidden connections of frame elements.
2. Joints of timber elements made with glued-in steel sheet where glue and gluing pressure are decisive for the joint's bearing capacity. The joints are applicable in angle connections of frame elements, but also in the connections and extensions of truss girders' elements.

The research aims to get to new concepts of bearing capacity and applicability of described joints with emphasis on understanding of their behaviour. The procedure would involve the comparison of laboratory materials and glue testing as a constitutive joint element with computer model results. The computer model will be verified and evolved within the project framework. Several existing commercial computer programmes contain some elements typical of such joints. The project will try to develop them on the basis of understanding wood constitutive models, possible shapes of delaminating considering wood orthotropic and the line loading in relationship to fibre direction and constitutive models of modern polymer glues. For all the suggested glue-based joints groups the study includes three procedures: laboratory research, numerical FE samples parametric modelling, analysis of FE numerical models, and theoretical analysis of joints behaviour and failure mechanisms. The project will try to develop them based on understanding wood constitutive models, possible shapes of delaminating considering wood orthotropic and the line loading in relationship to fibre direction and constitutive models of modern polymer glues. The analysis results of experimental tests, numerical FE models and theoretical models within each joints group will be mutually compared with the goal of their qualitative and quantitative estimation.

Because of the importance of joints for structural reliability, the research project may provide a useful discussion platform at the COST action E55.

3 Recent publications

Bjelanović A., Rajčić V. (2005) Drvene konstrukcije prema europskim normama (Timber construction in accordance with EuroCodes), Hrvatska sveučilišna naklada i Građevinski fakultet Sveučilišta u Zagrebu, Zagreb, pp. 1-457 (ISBN 953-169-115-0), reprint 2007

Rajčić V., Bjelanović A. (2005) Classification of timber, Građevinar 57 (2005) 10, pp. 779 – 784

Rajčić V., Bjelanović A., Rak M. (2004) Bearing capacity of glued and wound steel bars contained in oak elements, Građevinar 56 (2004) 3, pp. 155 – 161

Rajčić V., Bjelanović A. (2006) Comparison of the Pull–out Strength of Steel Threaded Bars Glued in GluLam Elements Obtained Experimentally and Numerically // 39th CIB W-18 Conf. / comp. by H.J. Blass. Firenca: International Council for Research and Innovation in Building and Construction (Available on-line, www.rz.uni-karlsruhe.de)

Bjelanović A., Rajčić V. (2006) Fracture behavior of bolted joints using steel threaded bars glued in oak elements // 4st ESWM Conference: European Society for Wood Mechanics and COST Action E35, pp. 250-255

Rajčić V., Bjelanović A. (2005) Comparison of the EC5 and actual Croatian codes for wood classification and design with the proposal for more objective way of classification // 38th CIB W-

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Rajčić V.,.Bjelanović A., Rak M. (2004) Experimental test of glued bolt joint using threaded steel bars. 8th World Conference on Timber Engineering (WCTE) Lahti: RIL Finland, 2004, pp. 317-320

Bjelanović A., Rajčić V. (2003) Timber structural design based on neural network application and FE 3D parametric modeling. 7th International Conference on the Application of Artificial Intelligence to Civil and Structural Engineering , Egmond aan Zee, Civil-Comp Press Stirling UK, 2003, pp. 159-167

Rajčić, V., Rak, M.: (2002) Continuous shear connecting- the best way to compose timber and lightweight (EPS) concrete, the Proceedings of the 7th World Conference on Timber Engineering, WCTE., August 2002, Shah Alam Malaysia, Volume 2, page 179-187.

Rajčić V., Bjelanović A. (2003) FEA model of the edge crack under tensile stresses. 2nd International Conference of the European Society for Wood Mechanics, Stockholm: ESWM, 2003, pp. 355-360

Rajčić V.(2006) „Glulam construction of long span in Croatia" Holzbaugespräche : Forum Innovation & Praxis, FH Technikum Kärnten, Spittal, Austria.

Rajčić, V, Lončarić, V (2006) Non-destructive assessment of wood cultural heritage objects- case study of sanation and reassignment, International Conference "Heritage Protection-Construction Aspects", Dubrovnik, Secon, HDGK.

Ribarić D., Bjegović D., Grandić D., Bjelanović A. (2007) Repair methods for the ex torpedo launch pad in Rijeka. 2nd International Conference on Experimental Structural Engineering (2AESE), Shangai, College of Civil Engineering, Tongji University, December, 2007. (Accepted)

4 Information about Croatian delegates

Management Committee Member:

Prof. Vlatka Rajčić
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Dr. Vlatka Rajčić is a Chairman of Timber Department at Faculty of Civil Engineering in Zagreb, lecturer of several subjects on undergraduate and postgraduate study (including Timber Constructions) and scientific advisor at University of Zagreb. For more than decade she has been actively involved in experimental R&D projects connected with wood with special emphasize on composite structures (wood-concrete, wood-constructive glass), bonding of timber, glued-in connectors, expert systems for wood quality assurance. She is actively involved in several Croatian code Committees (Wood design, Adhesives, Aluminum design) and working group for compiling national technical regulation for timber structures. She is Croatian delegate in COST actions E29 "Innovative Timber & Composite Elements/Components for Buildings, E55 "Modelling of performance of timber Structures and IE0601 "WoodCultHer". She is member of team of experts in the field of structural glass which aim is setting up a strategy on the pre-normative works for future Design Guidelines/Code on the use of glass in structural applications under organization of DG Research & JRC Ispra. She is licensed structural designer with several glulam structures with significant spans. She is coordinator of HG1 of Focus Area Cultural Heritage "Education, training & ethics" inside European Construction Technology Platform. She is secretarair of Croatian Construction Technology Platform and secretair of Croatian Society of Structural Engineers (HDGK).

Working group members:

WG I: System Identification and Exposures components:

Dr. Adriana Bjelanović
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Dr. Bjelanović is the head of Department of Structures and Engineering Mechanics on Faculty of Civil Engineering in Rijeka and the chairman of Chair of Structures. She is president of Croatian code committee for timber structures and member of working group for compiling national technical regulation for timber structures. Received a PhD from University in Zagreb. At the moment, assistant professor and senior scientific assistant at the Faculty of the Civil Engineering in Rijeka. Fields of research and work are wood construction and application of AI in Civil Engineering.

WG II: Vulnerability of

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DENMARK

1 Research Institutions

Aalborg University (AAU), www.aau.dk

Department of Civil Engineering (AAU/DCE), www.civil.aau.dk

AAU/DCE is represented by Prof. J.D. Sørensen affiliated with the Section of Structural Mechanics. The section covers research fields within structural mechanics, structural dynamics, loads and safety. Main focus areas include probabilistic modelling of loads and load bearing capacities of civil and structural engineering systems, including wind turbines. Further, system reliability analysis, risk analysis, reliability assessment of existing structures, wind turbines, deteriorating structures, risk-based optimal inspection and maintenance planning are important areas for applied research. The section is participating in several activities related to the above research field. In the area of Timber Engineering research the group is actively involved in pre-normative research and in the development of probabilistic modelling of timber structural behaviour.

Danish Building Research Institute (AAU/SBi), www.sbi.dk

AAU/SBi is represented by Jørgen Munch-Andersen, Department of Building Design and Technology. SBi is the leading centre of expertise in Denmark regarding applied research in the building construction sector and serves as government advisors within that field. SBi writes and publishes Directions on good building practices in collaboration with the construction sector. Key areas for Building design and Technology are safety and durability of buildings, performance criteria and building detailing. The institute has a long tradition within applied research timber in engineering.

Technical University of Denmark, DTU, www.dtu.dk

Department of Civil Engineering (BYG DTU), www.byg.dtu.dk

BYG DTU is represented by Associate Professor S. Svensson affiliated with the Division of Construction materials. The division's research covers material science of traditional and novel building materials. The wood science research at the division has its main focus on the following research areas:

- Wood - water relation
- Hygro-mechanics of wood, wood based components and connections
- Load duration effects on load carrying capacity of wood components and systems

The division has a long record of research accomplishments at an international level in the two areas ‘Wood Science and Engineering’ and ‘Timber Engineering’. For many years research efforts has been within the major focus areas, and the resources both in terms of experimental equipment and modelling

capabilities are highly developed. The research group has extensive personal relations throughout international wood research. Members of the research group have participated in numerous projects in the EU Framework Programmes as well as in a number of other internationally sponsored projects. The group was the initiator of one of the earliest initiatives to promote the research area when arranging an international Conference on Wood Water Relations (COST Action E8), and group members have since been engaged also in the research cooperation of all other relevant COST Action groups.

2 Planned and ongoing Research Activities

3 Recent Publications

Faber M.H., Köhler J. and Sorensen, J.D. (2004) Probabilistic Modeling of Graded Timber Material Properties Journal of Structural Safety, Volume 26, Issue 3, Pages 295-309, July 2004.

Köhler J., Sorensen J.D., Faber M.H. (2005) Probabilistic Modeling of Timber Structures. Proceedings of the international Conference on Probabilistic Models in Timber Engineering, Arcachon, France 2005.

Köhler, J., Sørensen, J.D. and Faber, M.H. (2006) Probabilistic modelling of timber structures. Accepted for publication in Journal of Structural Safety, 2006.

Sørensen, J.D., S. Svensson and B.D. Stang (2005) Reliability-based calibration of load duration factors for timber structures. Structural Safety, Vol. 27, 2005, pp. 153-169.

Hoffmeyer, P. 2003: Strength under Long-Term Loading. In: Thelandersson, S.; Larsen, H.J. (Eds.): Timber Engineering. John Wiley & Sons, Ltd.

Svensson, S., T. Astrup and P. Hoffmeyer, 2006. Testing long-term behavior by a duration-of-deformation method. Proceedings of the 9th World Conference on Timber Engineering, Portland, Oregon, USA.

Engelund, E. T, T. Astrup, S. Svensson and P. Hoffmeyer 2006. Modelling time to failure in constant deformation experiments. Proceedings of the 9th World Conference on Timber Engineering Portland, Oregon, USA

Frandsen, H. L, S. Svensson and L Damkilde, 2007: A hysteresis model suitable for numerical simulation of moisture content in wood. Holzforschung, 61

Frandsen, H. L, S. Svensson and L Damkilde, 2007: A revised multi-Fickian moisture transport model to describe non-Fickian effects in wood. Holzforschung, in print.

Jönsson, J. and S. Svensson, 2004: A contact free measurement method to determine internal stress states in glulam. Holzforschung, 58 pp. 148 - 153.

Lam, F., S. Abayakoon, S. Svensson, and C. Gyamfi, 2003: Influence of proof loading on the reliability of members. Holz als Roh- und Werkstoff,61 pp. 432-438.

Svensson, S. and S. Thelandersson, 2003: Aspects on reliability calibration of safety factors for timber structures. Holz als Roh- und Werkstoff,61 pp. 336-341.

Svensson, S. and T. Toratti, 2002: Mechanical Response of Wood Perpendicular to Grain when Subjected to Changes of Humidity. Wood Science and Technology 36, pp145-156.

Krabbenhøft, K. 2004: Moisture transport in Wood. A study of physical-mathematical Models and their numerical implementation. Ph.D. dissertation. BYG.DTU. Technical University of Denmark

Stang, B. D., Munch-Andersen, J.: Reliability of timber structures – Results of a study of the Danish codes. Reliability of Timber Structures, COST E24, May 27-28, 2004, Florence.

Sørensen, J. D., Damkilde, L., Munch-Andersen, J.: Load bearing capacity of roof truses. In: Proc. of 9th ASCE Joint Specialty Conference on Probabilistic Mechanics & Structural Reliability (PMC2004). July 26-28, 2004, Albuquerque, New Mexico. American Society of Civil Engineers and Scandia National Laboratories.

Munch-Andersen, J: Bracing of timber members in compression. In: Proc. of 37th meeting of CIB-working commission W18 - Timber Constructions. 30 August to 3 September 2004, Edinburgh, UK. Lehrstuhl für Ingenieurholzbau und Baukonstruktionen, Universität Karlsruhe. Karslruhe 2004.

4 Information about the Danish Delegates:

Management Committee Members:

Prof. John D Sørensen

Aalborg University

jds@civil.aau.dk

Prof. John D Sørensen is Professor in stochastic modeling and reliability analysis of wind turbines at Department of Civil Engineering, Aalborg University. He is active in probabilistic modeling of strength and loads, risk analysis and reliability assessment of civil engineering structures, including wind turbines. He is involved in JCSS, CEN/TC250/SC1 and Danish Code Committee for Loads and Safety. He was an active member of the COST Action E 24 'Reliability of Timber Structures'. He is one of the contributors for the recently released 'Timber Probabilistic Model Code' of the Joint Committee on Structural Safety. He is leader of WG3 in COST action E55 'Modelling the Performance of Timber Structures'.

Associate Professor Staffan Svensson

Technical University of Denmark

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Associate Professor Staffan Svensson is responsible for the wood science research and teaching at the Department of Civil engineering, Technical University of Denmark. His research interest and activity is on the hygro-mechanical behavior of wood and load duration effects on wood and wood based components. He was an active member of the COST Action E 24 'Reliability of Timber Structures' and is also a member of WG2 in COST action E55 'Modelling the Performance of Timber Structures'

Working Group Members:

<u>WG III: Robustness of Systems</u>

Senior Researcher
Jørgen Munch-Andersen
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Jørgen Munch-Andersen has expertise in both structural engineering and building design. He has been involved in national and Nordic research projects on reliability of timber structures and is writing directions and guidelines for the design of timber structures fulfilling both requirements to strength and building physics. His is further investigating failures during major wind storm and snow falls and dealing with design of glass. He is a member of the Danish Code Committee for Loads and Safety.

FINLAND

1 Research Institutions

Technical Research Centre of Finland, VTT, www.vtt.fi

VTT is a government institution with over 2700 employees. Research funding is provided from three main sources: government budget 25%, public and private research funds 35% and industry contracts 40%. VTT's expertise in the areas of building technology and the built environment enables development and expert services related to actual construction, use, maintenance and ownership. Research related to Construction technology covers topics in the areas of economy & production technology, acoustics, fire technology as well as timber, concrete and steel engineering.

Concerning the expertise regarding wood as a building material, the following activity descriptions apply. Our material technology research includes the study of the mechanical, chemical and physical characteristics of wood and wood-based products as well as the microstructure of wood. Our manufacturing technology research covers manufacturing processes of sawn timber and wood-based panels, products and composites as well as management of production chains. In order to ensure that the performance and durability of wood-based products in applications are as expected, both the essential technical characteristics and the life cycle impacts are examined. Research related to Timber Engineering covers topics in the areas of mechanical performance of timber structures and connections, thermal and humidity-related performance, biological durability and service life, surface treatment, fire-related characteristics, acoustics and vibrations as well as environmental impacts.

2 Planned and ongoing Research Activities

Quality of timber construction - Guidance for buildings and load bearing structures

(This is a finalized sub-project of a large Finnish-Swedish project: 'Innovative design, a new strength paradigm for joints of, quality assurance and reliability for long-span wood construction' 2004 -2006)

In this project, quality requirements are set for the design and construction of timber buildings, so that sufficient reliability, durability and overall usefulness of the building can be ensured. These results are particularly meant for the design, construction, use and maintenance of high span or otherwise demanding timber structures and joints. However, the procedures developed may be used also for other structures as well. The background of this study is linked to the failures that have occurred in Europe during the past years and to the malfunctions in the building process recognised by the indutry members of the project. The objective is to develop a procedure on how to produce high quality in timber building.

Considering timber buildings, the following should receive special attention:

- Handling of information and communication between the building project partners
- Security during construction, specially on temporary bracing of load bearing structures

- Considerations on performance of connections and how these are effected by variable humidity conditions

- Swelling and shrinking of timber elements

- Cracks caused by shrinkage of moist wood

- Orthotropic strength of wood

- Fire safety

The scope of this report is on the quality assurance of the end-product quality, which is achieved by a functional cooperation among the project partners, sufficient coverage and quality of design and on the documentation to be produced in a building project.

This report describes the following means for quality assurance:

- The project description

- The moisture control plan

- The assembly plan

- The security measures

- Tolerances of work, materials and building components

- The maintenance manual

New quality assurance methods were developed.

Reference: Puurakenteiden laadunvarmistus, Toratti T. . RIL 240-2006 (in Finnish, an English translation is available titled: Quality of timber construction - Guidance for buildings and load bearing structures.)

Contact person: Dr. Tomi Toratti (tomi.toratti@vtt.fi)

Innovative design, a new strength paradigm for joints (2003–2007)

(This is a finalized sub-project of a large Finnish-Swedish project: 'Innovative design, a new strength paradigm for joints of, quality assurance and reliability for long-span wood construction' 2004 -2006)

The objective of the project was to enhance the use of timber in long-span structures by (1) improving the design methods for the joints used in them, (2) by developing new types of joints suitable for use in them.

Based on some 150 tension tests of large dowelled joints, a new design method for the timber failure mechanisms in dowelled joints was developed. The new method is based on a new concept of failure criterion. It clarifies the design and shows more accurate correspondence to experimental data than before.

The effect of moisture changes on the load-bearing capacity of large dowelled joints was investigated both with experimental tests and with numerical simulations. The results showed that the load-bearing capacity is reduced by decreasing moisture. Highest decrease in load-bearing capacity was found in joints initially exposed to restrained shrinkage deformations in the joint area.

As a new type of joint, rubber foil adhesive joining technology was shown to give the possibility for lap joints with extremely high load bearing capacity. They performed well as medium size and large joints. They are also of particular interest in situations with impact loading or enforced deformations e.g. due to moisture changes and showed good characteristics when applied to joining of both wood-to-wood and wood-to-steel parts.

As a special non-traditional joint type, a special self-drilling type of dowel joint was evaluated by means of finite element analyses (FEA). The numerical approach showed the capability of capturing the fundamental behavior of the joint in terms of maximum load bearing capacity and deformation mode of the dowels, which allows to optimize the joint parameters by numerical simulation.

Reference: Hanhijärvi A, Kevarinmäki A and Yli-Koski R. (2006). ”Block shear failure at dowelled steel-to-timber connections”. Proc. CIB-W18 Meeting, Florence Aug, 28-31, 2006.

Contact person: Dr. Antti Hanhijärvi (antti.hanhijarvi@vtt.fi)

Strength grading of timber with combined measurement techniques (COMBIGRADE)

(nearly completed project with TKK, Metla and several other partners; duration 2003 – 2007)

Abstract:

A large experimental research has been made in following steps:

1000 spruce and 1000 pine logs have been sampled

Logs have been scanned by X-ray and acoustic methods before sawing to 5 different dimensions

Sawn timber has been tested by commercial grading equipment based on following techniques: optical surface scanning, flatwise bending, determination of longitudinal natural frequency, determination of knottiness and density by X-ray, determination of transmission time and energy of ultrasonic sound pulse. Additionally, measurement of annual ring width, knots, density and moisture content has been made in laboratory.

Bending tests with 1000 spruce and 1000 pine specimens and tension tests with 450 spruce specimens have been completed.

Results are being analysed and will be published 2007. Report of the first phase of project exists (2005). It includes the statistical evaluation of different grading methods and their combinations, and also an attempt to numerically simulate grading process. As a result of simulation yields to different grades and strength of graded timber is predicted. Especially the effect of sample size to reliability of grading is evaluated.

This research has been made in close cooperation with Finnish sawmilling industry, and with several European grading equipment manufacturers. Results will be reported in COST E53 workshops. Our aim is to continue research in this area in form of a European cooperation project.

Contact person: Prof. Alpo Ranta-Maunus (alpo.ranta-maunus@vtt.fi), Dr. Antti Hanhijärvi (antti.hanhijarvi@vtt.fi)

Structural modelling of wood (WoodFEM)

(project starts 2007)

Abstract

The objective is to develop new computational tools which can be used for prediction of failure of timber structures under combined effect of moisture gradient and external load, and cracking of wood during drying or under weather exposure. FEM will be used for moisture transport and stress analysis. Application projects with experimental verification will follow. Later, the work is expected to be specialised in different application areas: load bearing structures, kiln drying and timber exposed to rain.

Contact person: Prof. Alpo Ranta-Maunus (alpo.ranta-maunus@vtt.fi), Dr. Antti Hanhijärvi (antti.hanhijarvi@vtt.fi)

3 Recent Publications

Hietaniemi J., Toratti T., Schnabl S., Turk G. 2006 : Application of reliability analysis and fire simulation to probabilistic assessment of fire endurance of wooden structures 2006. VTT, Espoo. 97 p. + app. 23 p.VTT Working Papers : 54

Toratti T., Talja A.: Classification of human induced floor vibrations. Building acoustics. Journal of Building Acoustics 2006 vol 13 no 3.

Toratti T., Turk G., Schnabl S. : Reliability analysis of a glulam beam. Journal of Structural Safety. In press.

Toratti T., Kevarinmäki A. 2001, Development of wood-concrete composite floors. IABSE Innovative Wooden Structures and Bridges, Lahti 2001.

Toratti T., Talja A., 2006: Classification of human-induced floor vibrations in buildings. World Conference on Timber Engineering WCTE2006, Portland USA 2006.

Hanhijärvi A, Kevarinmäki A and Yli-Koski R. (2006). ”Block shear failure at dowelled steel-to-timber connections”. Proc. CIB-W18 Meeting, Florence Aug, 28-31, 2006.

Frühwald, E., Serrano, E., Toratti, T., Emilsson, A., Thelandersson, S. (2007). Design of safe timber structures – How can we learn from structural failures in concrete, steel and timber? Report TVBK-3053. Div. of Struct. Eng., Lund University.

* Anon. 2006. RIL 240-2006: ”Puurakenteiden laadunvarmistus _ Suunnittelu, valmistus työmaatoteutus käyttö” (”Quality assurance of timber structures, design, manufacture, construction and use”) (In Finnish, this publication was also translated into English but not published yet).

Relations between strength of sawn timber and non-destructive indicators, Hanhijärvi, Antti; Ranta-Maunus, Alpo; Turk, Goran, Probabilistic Models in Timber Engineering - tests, Models, Applications. COST E24 Final Conference. Arcachon, France, 8 - 9 Sept. 2005 (2005), 8 p.

Practical aspects of target reliability level in code calibration: Ranta-Maunus, Alpo, Probabilistic Models in Timber Engineering - tests, Models, Applications. COST E24 Final Conference. Arcachon, France, 8 - 9 Sept. 2005 (2005), 9 p.

Potential of strength grading of timber with combined measurement techniques. Report of the Combigrade-project - phase 1 , http://www.vtt.fi/inf/pdf/publications/2005/P568.pdf , Hanhijärvi, Antti; Ranta-Maunus, Alpo; Turk, Goran, 2005. VTT Building and Transport, Espoo. 81 p. + app. 6 p. VTT Publications : 568

Analysis of strength grading of sawn timber based on numerical simulation, doi-link: 10.1007/s00226-004-0254-4 , Turk, Goran; Ranta-Maunus, Alpo, Wood Science and Technology . Vol. 38 (2004) No: 7, 493 - 505

Analysis of strength grading of sawn timber based on numerical simulation , http://www.vtt.fi/inf/pdf/tiedotteet/2003/T2224.pdf, Turk, Goran; Ranta-Maunus, Alpo 2003. VTT Building and Transport, Espoo. 38 p. + app. 28 p. VTT Tiedotteita - Research Notes : 2224

4 Information about the Finnish Delegate:

Management Committee Members:

Dr. Tomi Toratti
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Dr. Tomi Toratti is Senior Research scientist in the group of Structural Engineering in VTT.

Recently he has worked in research projects under the topics of quality in timber building and failure assessment and floor vibrations. He is also the technical Secretary of CEN/TC124 timber structures.

Other researchers in VTT working in this area are:

Prof Alpo Ranta-Maunus (alpo.ranta-maunus@vvt.fi),
Dr. Antti Hanhijärvi (antti.hanhijarvi@vtt.fi)
Dr. Ari Kevarinmäki (ari.kevarinmaki@vtt.fi)
Mr. Markku Kortesmaa (markku.kortesmaa@vtt.fi)

GERMANY

1 Research Institutions

Technische Universität München, Munich (TUM)

Chair of Timber Engineering and Building Construction (HB), www.hb.bv.tum.de

The Chair of Timber Engineering and Building Construction (head: Univ.-Prof. Dr.-Ing. Stefan Winter) is part of the department of Civil Engineering and Geodesy. The chair is represented by extraordinarius Univ.-Prof. (ret.) Dr.-Ing. H. Kreuzinger, Dr.-Ing. R. Pawlowski and Dipl.-Ing. P. Dietsch. The chair has long experience in structural research and additional computer based simulation, also linked to climatic exposures and dynamic loads. Since the past year, the chair is involved in a large number of studies to evaluate existing wide span structures and repair damage. Both Professors are associates in the direction of the materials testing laboratory (MPA) in which all necessary laboratories including climatic chambers and well trained staff to run laboratory and on-site tests is available. The chair is represented in a large number of European standardisation committees and European research consortiums as well as national technical committees supporting building regulators. Both Professors are state appointed experts and check engineers for timber structures.

Universität Karlsruhe

Lehrstuhl für Ingenieurholzbau und Baukonstruktionen (UKLIB), www.holz.uni-karlsruhe.de

UKLIB represents the part of the „Versuchsanstalt für Stahl, Holz und Steine“ dealing with timber and masonry, headed by Prof. Dr.-Ing. Hans Joachim Blaß. It is both a university research institute and an accredited testing laboratory for materials and structures. The major activities are research and development work for the industry as well as for government organisations, both in free competition in an open market. This involves experimental as well as theoretical research work, testing, and evaluation. UKLIB also provides advisory services to national and European standardisation organisations. UKLIB is active in the international harmonisation of test methods (RILEM and CEN) and has participated in European research co-operation (AIR). The most important field of work during the last 30 years was and still is research of timber connections with mechanical fasteners.

University of Stuttgart

Institute of Structural Design, University of Stuttgart (KE), www.uni-stuttgart.de/ke/

The Institute of Structural Design (Head: Prof. Dr.-Ing. Ulrike Kuhlmann) is engaged in the research on the range of steel, timber and composite structures. Within the research on timber structures the main focus areas are timber concrete-composite structures covering the global behavior as well as the joint behavior between timber and concrete under constant loading as well as cycling loading, the time dependent behavior of pure timber and composite structures and the stability of beams with respect to the time dependent behavior.

The Institute is represented by Jörg Schänzlin.

2 Planned and ongoing Research Activities

Main research topics (HB):

- Evaluation of failure mechanisms in wide-span timber structures

This topic was spotlighted with the collapse of the Bad Reichenhall ice-arena roof, for which expert advice was given by both Professors. Foundation of this extensive research project were numerous expertises and examinations of wide-span timber structures, performed by the chair as well as information on more than 100 structures collected from official authorities, professional institutions and own research. The results have triggered more intensive work in the following areas:

- Monitoring of wide-span-timber structures (e.g. by AE analysis)
- Assessment of durability of glues (e.g. urea-resin glues) in climatically exposed structures
- Reinforcement of statically critical parts of existing structures
- Methods to improve the product quality of glued laminated beams
- Instruction of Architects and Engineers in design and construction management of wooden structures
- Instruction of buildings owners/trustees in monitoring and building maintenance

- Gluing and reinforcement of timber structures
- Adaptive load bearing structures
- Connectors, e.g. screws and three-dimensional nailing plates
- Massive timber structures, e.g. cross-laminated timber
- Timber-Concrete-Composites
- Building in the building stock
- Multistorey timber buildings with high energy efficiency
- Fire safety in timber structures
- Interaction of user and building construction – interior climate design

Actual and planned research topics (HB):

- Evaluation of failure mechanisms in wide-span timber structures
- Two-dimensional elements in multi-button- , cross-laminated-timber, timber-concrete-structures, connections and joints of these elements (HTO)
- Mechanism of fire spread in timber buildings (HTO)
- Fire safety in multi-storey timber buildings (HTO)
- Optimized timber-concrete-elements out of high-strength and self-compacting concrete and cross-laminated timber or high-strength wood based panels (AIF)
- Fire expert in building stock (EU - Leonardo)

Extension of the database containing failures of timber hall structures and evaluation (UKLIB)

(Planned project, duration 2007-2008)

The recently finished research concerning failures of timber hall structures and their analysis brought out a system to simply record and describe failure cases. To give more comprehensive statistics of failures it is necessary to record further cases. These were already collected. Hence it is planned to complete the database and to give more detailed answers to research questions and a deeper understanding why timber hall structures fail.

Load-carrying capacity and stiffness of connections with dowel-type fasteners which are prone to splitting using FEM (UKLIB)

The distances between the dowel-type fasteners have an effect on the splitting tendency of connections with dowel-type fasteners. The splitting tendency increases with decreasing fastener spacing parallel to the grain and decreases the effective number of fasteners. Splitting may be prevented by reinforcing the connection and consequently, the effective number of fasteners increases. Self-tapping screws with continuous threads represent a simple and economic reinforcement method. The screws are placed between the dowel-type fasteners, perpendicular to the dowels axis and to the grain direction. In this arrangement, the reinforcements are loaded axially in tension.

According to the German Draft DIN 1052:2004-08, the load component Fax in the reinforcements is calculated taking into account the load-carrying capacity Rla of the dowels in the connection. Thus, the axial load component per reinforcement is $Fax = 0{,}3 \cdot Rla$.

Splitting may be prevented, when the load component $Fax = 0{,}3 \cdot Rla$ is smaller than the load-carrying capacity of the reinforcing screw loaded in tension. This equation was developed using a complicated analytical model, which presumes a crack length which is equal to the spacing between the screw axis and the dowel. Mostly, the cracks are much longer than the spacing. For this reason, the equation displayed above could by unsafe.

To check this equation for the complex circumstances, like different spacing and crack lengths, numerical investigations are necessary.

Development of prefabricated timber wall elements for seismic and windstorm loads (UKLIB)

The Black Forest situated company HIB (Holz - Isolier - Bau) Elemente GmbH is producing prefabricated timber wall elements, which can be easily joined together on the construction site. The prefabricated elements are simple to handle and are environmentally sustainable. UKLIB and HIB GmbH are developing a shear wall element which can carry large lateral loads and has high energy - dissipating capacities for providing protection from seismic and windstorm loads. First, a wall testing assembly for vertical and lateral loads including systems for measurement and control as well as analysing and visualisation software will be developed and built-on. On this testing assembly the HIB shear walls will be tested and weak spots on the walls as well as on the testing assembly shall be detected. A numerical model for the behaviour - prediction of the shear walls under both vertical and lateral loading is going to be developed. From the experimental and numerical findings HIB walls should be reengineered and improved. In the following steps, prototypes of the reengineered shear walls will be tested, remaining weak spots will be ascertained, the numerical model will be stated more precisely and final results on the behaviour on vertical and lateral loads will be released.

Calculation models and rules for splitting in connections (UKLIB)

In connections of cross girders three-dimensional metal plate hangers, anchors or angle bracket are often used. Generally the spacing between the punched holes for the dowel-type fasteners is small. This leads to timber splitting especially when using e.g. nails or self-tapping wood screws. Therefore the load bearing behaviour of the connection is individual which at present needs multiple tests to determine the load bearing capacity. Hence it is the main objective of the investigation to derivate a calculation model taking into account the timber splitting behaviour. The spacing as well as the formation of the holes, the individual splitting behaviour (due to nails or screws) and the cross-sectional dimensions of the members are to be taken into account in the process. The practical benefit is to substitute calculations for multiple tests.

New fields of application of wood fibre insulation boards in timber constructions (UKLIB)

Wood fibre insulation boards in timber constructions are used as thermal and acoustic insulation. As plate-shaped material for wood panel constructions wood fibre insulation boards are suited for the transfer of loads caused by wind or earthquake. So far this task is undertaken by plywood, particle boards or OSB. In particular thicker wood fibre insulation boards could undertake this task. In this research project new fields of application of wood fibre insulation boards will be developed. Therefore the behaviour of wood fibre insulation boards under loads will be determined.

Simulation and bending tests of softwood glulam beams (UKLIB)

(planned project with Technische Universität München, Holzforschung München, duration 2007 -2008)

Recent bending tests of softwood glulam beams do not confirm the characteristic bending strength of strength classes GL32 and GL36, respectively. This affects the reliability of timber structures made of glulam which belongs to these grades. This may be caused by the current requirements to lamellae and finger joints. Even a change in structural and mechanical properties of the timber during the last two or three decades is imaginable. Hence the main objective of the project is the determination of appropriate grading models which enables strength class GL32 and GL36. Furthermore the derivation of a more consistent design model for the characteristic bending strength of softwood glulam is planned.

Verification of existing rheological models for the description of the time dependent deformations (KE)

(Planned to be started within June 2007)

Within the recent studies different rheological models have been compared concerning their results if they are extrapolated for a period of 50 years. Within these studies simplified equations for the determination of creep coefficients after 50 years with respect to normal creep, mechano-sorptive creep, load history, etc. have been developed. Original starting point of these studies was, that several models for the description of the time dependent behaviour of timber-concrete-composite structures have been proposed; however the results of these models differ partly significantly.

Within this project, the deflection of existing structures will be measured. By means of a test loading the elastic structural stiffness will be determined. Basing on these measurements, creep coefficients will be re-identified. In order to reduce the influences of load history, unknown surrounding conditions and their history, unknown imperfections, e.g. several identical rafters of not heated roof structures shall be measured. By the comparison between the measurements and the models the most accurate model shall be determined. If necessary, an extension of the models shall be proposed in order to determine the deflection after 50 years.

Influence of the time dependent behavior on the torsional buckling of slender timber beams (KE)

(Planned to be started within June 2007)

The influence of the time dependent behavior of timber on the stability of columns has been already studied and a design proposal has been developed. Therefore the question arises, whether these proposals are also valid for torsional buckling, since there are differences between normal buckling and torsion buckling like differences due to the internal stresses, the influence of torsion of the beam, the influence of the cross section. Within this research project the application of the design methods for columns on torsional buckling shall be verified by numerical studies. If this fails, the modified imperfections shall be developed or effective creep coefficients, considering the increase of the deformation due to creep and the additional deformations due the effects of Theory II. Order. Finally a design proposal will be developed in order to allow the consideration of creep and inelastic strains in the design of torsional buckling.

Behaviour of connections between timber and concrete under cycling loading (KE)

(Started on December 2006)

Timber-concrete-composite structures seem to be predestinated, since the single loads can easily distributed, the protection of the wooden elements can be realized by the concrete slab and the common equipment of the bridge can be used. With respect to the design the fatigue behavior of the bridge has to be studied. Whereas the fatigue behavior of the single components is given in the standards, the behavior of the connection is not determined. For this reason different connection types will be studied aiming on the determination of Wöhler-curves.

3 Recent Publications

Chair of Timber Engineering and Building Construction

Kreuzinger, H.: Grenzzustände - Dynamik. - In: Symposium "Brücken aus Holz" - Tagungsband. München, 22.-23. Februar 2007. S. 30-33.

Winter, S.: Grenzzustände - Statik. - In: Symposium "Brücken aus Holz" - Tagungsband. München, 22.-23. Februar 2007. S. 28-29.

Winter, S.: Aktuelle Schäden an Holzkonstruktionen - Bestandsaufnahme. - Erschienen u.a. in: 8. Holzbau-Praxistag FH Augsburg - Tagungsband. Augsburg, 09. Februar 2007. 12. Internationales Holzbau-Forum - Tagungsband, Garmisch-Partenkirchen, 6.-8. Dezember 2006. Ingenieurholzbau Karlsruher Tage 2006, Forschung für die Praxis. 5.-6. Oktober 2006, Karlsruhe. Hrsg.: Bruderverlag, Albert Bruder GmbH, Karlsruhe. S. 17-22.

Kreuzinger, H.: Aktuelle Schäden an Holzkonstruktionen - Schlussfolgerungen. - Erschienen u.a. in: 8. Holzbau-Praxistag FH Augsburg - Tagungsband. Augsburg, 09. Februar 2007. 12. Internationales Holzbau-Forum - Tagungsband, Garmisch-Partenkirchen, 6.-8. Dezember 2006. HOLZBAU Aus der Praxis – Für die Praxis, Berner Fachhochschule Architektur, Holz und Bau Biel, Dezember 2006.
Ingenieurholzbau Karlsruher Tage 2006, Forschung für die Praxis. 5.-6. Oktober 2006, Karlsruhe. Hrsg.: Bruderverlag, Albert Bruder GmbH, Karlsruhe. S. 17-22.

Kreuzinger, H., Straßenbrücken – Anforderungen und Detaillösungen, In: HOLZBAU Aus der Praxis – Für die Praxis, Berner Fachhochschule Architektur, Holz und Bau Biel, Dezember 2006.

Kreuzinger, H.: Strassenbrücken – Anforderungen und Detaillösungen. - In: 12. Internationales Holzbau-Forum - Tagungsband, Garmisch-Partenkirchen, 6.-8. Dezember 2006.

Kreuzinger, H.: Schwingungen - Umgang mit Schwingungen bei Fussgängerbrücken in Holz. - In: 38. SAH Fortbildungskurs - Tagungsband, Weinfelden, 9.-10. November 2006.

Kreuzinger, H.; Mestek, P. :Anwendung und Berechnung von Brettsperrholz - Normen, Zulassungen, Anwendungsbereiche. - In: 5. Grazer Holzbau-Fachtagung - Tagungsband. Graz, 29. September 2006. S. B1 - B12.

Winter, S.; Notwendige europäische Aktivitäten für die verstärkte Holzverwendung. In: Tagungsband anlässlich des Kongresses – Feuersicheres Bauen mit Holz. Europäische Entwicklungen. Hrsg.: Fachverband der Holzindustrie Österreichs, Wien, S. 62-68, 2006

Winter, S.; Brandschutz im Holzbau – Normative und baurechtliche Regelungen – Teil 1 bis Teil 3. - In: Zeitschrift bauen mit Holz, Ausgabe 01/2006, 2/2006 und 3/2006

Winter, S.; Problematik der Europäischen Normung und deren Einfluss auf die Wirtschaftlichkeit und Wettbewerbsfähigkeit des Holzbaus. In: 11. Internationales Holzbau-Forum - Tagungsband, Garmisch-Partenkirchen, 7.-9. Dezember 2005.

Kreuzinger, H.; Niedermeier, P.: Holz-Glas-Verbundkonstruktionen - Glas als Schubfeld. - In: Ingenieurholzbau Karlsruher Tage 2005, Forschung für die Praxis. 6.-7. Oktober 2005, Karlsruhe. Hrsg.: Bruderverlag, Albert Bruder GmbH, Karlsruhe. S. 7-15.

Kreuzinger, H.; Niedermeier, P.: Holz-Glas-Verbundkonstruktionen mit Glas als tragender Scheibe. - In: Festtagung aus Anlass des 60. Geburtstags des Herrn Prof. Dr.-Ing. Radu Bancila, 6. Mai 2005, Timisoara. Hrsg.: Editura Solness, Timisoara. S. 26-40.

Winter, S.; Pawlowski, R.; Bletzinger, K.-U.; Adaptive lightweight roof structures in civil-engineering, development of a method for structural design. - In: Tagungsbandbeitrag Konferenz “Il eccomas" thematic conference on smart structures and materials, Lissabon, Juli 2005.

Winter, S. Überführung in die EN-Fassung von Eurocode 5 Teil 1-2 (Entwurf, Berechnung und Bemessung von Holzbauten – Allgemeine Regeln: Bemessung für den Brandfall) – Überprüfung des Sicherheitsniveaus. Forschungsvorhaben, Deutsches Institut für Bautechnik, Berlin 2005

Lehrstuhl für Ingenieurholzbau und Baukonstruktionen

Karlsruher Berichte zum Ingenieurholzbau:

Band 1 (2005). Blaß, HJ; Denzler, JK; Frese, M; Glos, P; Linsenmann, P: Biegefestigkeit von Brettschichtholz aus Buche.

Band 2 (2005). Bejtka, I: Verstärkung von Bauteilen aus Holz mit Vollgewindeschrauben (Dissertation).

Band 3 (2006). Blaß, HJ; Fellmoser, P: Druckrohrleitungen aus Holz: BMBF-Verbundprojekt Erschließung und Bewirtschaftung unterirdischer Karstfließgewässer in Mitteljava, Indonesien.

Band 4 (2006). Blaß, HJ; Bejtka, I; Uibel, T: Tragfähigkeit von Verbindungen mit selbstbohrenden Holzschrauben mit Vollgewinde.

Band 5 (2006). Frese, M: Die Biegefestigkeit von Brettschichtholz aus Buche. Experimentelle und numerische Untersuchungen zum Laminierungseffekt (Dissertation).

Band 6 (2006). Blaß, HJ; Frese, M: Biegefestigkeit von Brettschichtholz-Hybridträgern mit Randlamellen aus Buchenholz und Kernlamellen aus Nadelholz.

Band 7 (2006). Blaß, HJ; Fellmoser, P: Schadensanalyse von Bauwerken in Indonesien nach einem Erdbeben.

Band 8 (2007). Blaß, HJ; Uibel, T: Tragfähigkeit von stiftförmigen Verbindungsmitteln in Brettsperrholz.

CIB-W18 Contributions:

Frese, M; Blaß, HJ: The influence of the grading method on the finger joint bending strength of beech. In: Proceedings. CIB-W18 Meeting, Florence, Italy 2006. Paper 39-18-2.

Uibel, T; Blaß, HJ: Load Carrying Capacity of Joints with Dowel Type Fasteners in Solid Wood Panels. In: Proceedings. CIB-W18 Meeting, Florence, Italy 2006. Paper 39-7-5

Bejtka, I; Blaß, HJ: Self-tapping Screws as Reinforcements in Beam Supports. In: Proceedings. CIB-W18 Meeting, Florence, Italy 2006. Paper 39-7-2

Blaß, HJ; Frese, M: Beech glulam strength classes. In: Proceedings. CIB-W18 Meeting, Karlsruhe, Germany 2005. Paper 38-6-2.

Blaß, HJ; Bejtka, I: Self-tapping screws as reinforcements in connections with dowel-type fasteners. In: Proceedings. CIB-W18 Meeting, Karlsruhe, Germany 2005. Paper 38-7-4.

Blaß, HJ; Fellmoser, P: Influence of rolling shear modulus on strength and stiffness of structural bonded timber elements. In: Proceedings. CIB-W18 Meeting, Edinburgh, UK 2004. Paper 37-6-5.

Contributions for 8th World Conference on Timber Engineering:

Blaß, HJ; Görlacher, R: Compression perpendicular to the grain. In: Proceedings of the 8th World Conference on Timber Engineering, Volume II, Lahti, Finnland 2004.

Blaß, HJ; Fellmoser, P: Design of solid wood panels with cross layers. In: Proceedings of the 8th World Conference on Timber Engineering, Volume II, Lahti, Finnland 2004.

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Blaß, HJ; Frese, M: Combined Visual and Machine Strength Grading. In: Proceedings of the 8th World Conference on Timber Engineering, Volume I, Lahti, Finnland 2004.

Institute of Structural Design

Schänzlin, J.: Zum Langzeitverhalten von Brettstapel-Beton-Verbunddecken, Universität Stuttgart, Institute of Structural Design, No. 2003-2, phd-thesis, february 2003

Bursi, O.; Ballerini, M.; Piazza, M.; Zandonini, R.; Fournely, E.; Kuhlmann, U.; Kürschner, K.; Schänzlin, J.: Shear transfer in composite members: testing, modelling, standards and damage, In: Simones da Silva L., Mendes, J. (Eds.), Improvement of buildings´ structural quality by new technologies, Proceedings of the international seminar, Lisbon, 19-20 April 2002, COST Action C12, European Commisssion, EUR 20728, 2003, pp. 21-36

Kuhlmann, U.; Schänzlin, J.: Composite of board stacks and concrete with integrated steel slim-floor profile, In: Schaur, C.; Mazzolani, F.; Huber, G. et al (Eds.): Improvement of Buildings' Structural Quality by New Technologies. COST C12 Final Conference Proceedings, January 2005

Kuhlmann, U.; Schänzlin, J.: Composite of Timber and Concrete, In: Schaur, C.; Mazzolani, F.; Huber, G. et al (Eds.): Improvement of Buildings' Structural Quality by New Technologies. COST C12 Final Conference Proceedings, January 2005

Kuhlmann, U.; Schänzlin, J.; Merkle, R.; Bux, H.: Brettstapel-Beton-Verbunddecken mit integriertem Slim-Floor-Profil, final report of DBU-AZ 21168

Schänzlin, J.: Comparison of different models describing the time dependent behavior of timber, In: conference proceedings WCTE 2006 - 9th Conference on Timber Engineering, Portland, OR, USA, August 06-10, 2006,

Schänzlin, J.: Leichte Betondecken durch Verwendung von Brettstapel-Beton-Verbunddeckenmit integrierten Slim-Floor-Profilen, In: Deutscher Ausschuss für Stahlbeton DAfStb (Hrsg.), 46. DAfStb-Forschungskolloquium, Stuttgart, March 30-31, 2006, S. 233-242

Schänzlin, J.: A contribution for the description of the time dependent behavior of timber using different models, final report of DFG SCHA 1465/2-1

Teichmann, G.: Influence of creep and moisture on the lateral torsional buckling of timber beams, In: Tagungsband 6th PhD Symposium in Civil Engineering, Zürich , August 23-26, 2006, S. 152-153

Kuhlmann, U.; Teichmann, G.: Influence of creep on lateral torsional buckling of glued laminated timber beams, In: Tagungsband WCTE 2006 - 9th Conference on Timber Engineering, Portland, OR, USA, August 6-10, 2006

Kuhlmann, U.; Aicher, S.; Michelfelder, B.: Trag- und Verformungsverhalten von Kerven mit Schlüsselschrauben als Schubverbindung bei Holz-Beton-Verbunddecken, Final report of AiF No.13204 N/1, 2004

Kuhlmann, U.; Michelfelder, B.: Grooves as shear connectors in timber-concrete composite structures, In: Proceedings of the 8th World Conference on Timber Engineering, WCTE 2004, Lahti, Finland, June 14-17, 2004, pp. 301-306

Kuhlmann, U.; Michelfelder, B.: Optimized design of grooves in timber-concrete composite slabs, In: Tagungsband WCTE 2006 - 9th Conference on Timber Engineering, Portland, OR, USA, August 06-10, 2006

4 Information about the German Delegates:

Management Committee Members:

Univ.-Prof. (ret.) Dr.-Ing Heinrich Kreuzinger

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H. Kreuzinger was Professor in the field of structural mechanics with special emphasis on dynamics before being appointed Professor for timber engineering at the "Fachgebiet Holzbau" which he lead from 1991 until 2006. His emphasis in the field of dynamics lies in the vibrations of bridges and floors. In the field of timber engineering, he has worked in the field of multilayered plates, resulting in the shear analogy. He also contributed to fatigue in timber structures. He was member of the Code Committees for DIN 1052 and EC 5 in which he headed the part on timber bridges. H. Kreuzinger is a state appointed check expert for concrete and timber structures.

Prof. Dr. Hans Joachim Blass

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University Education: 1974-1980 Karlsruhe University, Diploma in Structural Engineering

PhD: 1987 at the faculty of Civil Engineering at Karlsruhe University

Head of UKA-LH, professor at Karlsruhe University. He has more than 20 years of experience in timber engineering in research institutes and universities in Germany, Canada and the Netherlands. In 1992-1995 he was coordinator of the Structural Timber Education Programme STEP, an initiative under the EU Comett Programme. He is also coordinator of CIB-W 18 dealing with the application of timber engineering research results in practice. He was chairman of CEN TC250, SC5 “Eurocode 5”. In the context of this project, he is experienced in teaching, research und standardisation work and due to his additional activity as a consulting engineer has also practical experience in timber engineering.

Working Group Members:

WG I: System Identification and Exposures

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Dr. Robert Pawlowski is research associate at the Chair for Timber Engineering and Building Construction. His activities in research are related to the field of structural engineering with a special emphasis on wide-span roof structures and bridges. This includes aspects of structural design and structural analysis, monitoring processes and evaluation of structures. Apart from these activities, his focus lies on structural design of adaptive structures, analyzing the possibilities that result from the adaptation of internal forces and the deformations of lightweight roof structures. R. Pawlowski is a member of the engineer's chamber Bayern.guidelines and rules for quality control systems for timber products and building systems.

Dr. Matthias Frese

University of Karlsruhe
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www.holz.uni-karlsruhe.de

University Education: 1991-1998 Karlsruhe University, Diploma in Structural Engineering

PhD: 2006 at the faculty of Civil Engineering at Karlsruhe University

About 3 years practical experience in civil engineering (concrete, steel and timber constructions)

Employee of University of Karlsruhe, Lehrstuhl für Ingenieurholzbau since 2001

Research in the fields of:

-strength grading of sawn timber

-strength and stiffness properties of soft- and beech wood glulam

-failure analysis on timber structures

WG II: Vulnerability of Components

Jörg Schänzlin, Dr.-Ing.
University of Stuttgart
Institute of Structural Design
Joerg.schaenzlin@ke.uni-stuttgart.de
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Jörg Schänzlin is scientific assistant at the Institute of Structural Design and lecturer for timber structures at the University of Stuttgart and the University of Applied Science in Konstanz. Within his recent research he was dealing with the determination of the time dependent behavior of timber concrete composite structures.

WG III: Robustness of Systems

Dipl.-Ing Philipp Dietsch
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Philipp Dietsch is teaching assistant at the Chair for Timber Engineering and Building Construction. Apart from his teaching assignments in timber engineering, his focus lies on the structural research on wide-span timber structures, e.g. stress combinations in differently shaped timber beams and load transfer in bracing systems. He contributed to the expertise about the Bad Reichenhall ice-arena collapse and was part of most activities at the chair related to the assessment and evaluation of failure mechanisms in existing timber structures. Thereupon he focused on monitoring processes and repair/ reinforcement strategies such as the reinforcement of beams under shear and tension perpendicular to the grain.

IRELAND

1 Research Institutions

National University of Ireland, Galway (NUIG), www.nuigalway.ie

Department of Civil Engineering, www.nuigalway.ie/civeng/

NUIG is represented by Dr. Annette Harte and Dr. Peter Rodd, both of whom are members of the Department of Civil Engineering and the Timber Engineering Research Group. The main focus of the research group is the structural engineering behaviour of timber and timber products. The group has a strong background in numerical modelling and extensive experience in the testing of timber. Current research areas include: development of novel engineered timber beams; reinforcement and prestressing of timber; adhesive bonding of timber; mechanical timber jointing and machine grading of timber.

Enterprise Ireland, www.enterprise-ireland.com

Enterprise Ireland is represented by Mr. Valez Picardo. Enterprise Ireland is the Irish state development agency focused on transforming Irish industry. Our core mission is to accelerate the development of world-class Irish companies to achieve strong positions in global markets resulting in increased national and regional prosperity. Our focus, for Irish companies, is in five main areas of activity: achieving export sales; investing in research and innovation; competing through productivity; starting up & scaling up and driving regional enterprise.

The Institute for Industrial Research and Standards (predecessor of Enterprise Ireland) was responsible for establishing the database of strength properties of the main home-grown species. It also researched grading systems both visual and mechanical as well as finger-jointing of home-grown Sitka spruce. Approval testing of prefabricated roof trusses and panel boards (OSB) were also carried out. Papers have been presented to CIB W18 and reports produced for the Forest Service and COFORD (National Council for Forest Research and Development).

The Construction & Timber Markets department in Enterprise Ireland works with the National Standards Authority of Ireland in developing standards and representation on CEN committees relating to timber.

2 Planned and ongoing Research Activities

Structural Optimisation of Wood-based Composites.

(planned research project at NUIG, 2007-2010).

The present generation of wood-based composites have relied primarily on empirical knowledge and experience for their analysis and design. This has been due to the complexity of these materials in addition to their inherent variability. This approach is unsuitable for the development of the next generation of wood-based composite components due to the requirements for reduced development times and costs together with efficient designs meeting a wide range of performance criteria.

The objective of the project is the development of modelling procedures that will enable the determination of the sensitivity of mechanical/physical behaviour of the wood-based composites to changes in design parameters. These parameters include the physical lay-up of the composite and the configuration and properties of the constituents. The procedures used are based on both analytical and numerical approaches. Where appropriate, existing strategies used in the reinforced plastics industry will be adapted. Otherwise, new modelling techniques will be devised. All modelling approaches will

be validated by laboratory testing. Knowledge gained from the application of these models to prototype designs will allow manufacturers to optimise component performance. This will be achieved by carrying out parameter studies to determine the influence of a range of design variables on performance.

Flexural Strengthening of Glulams with FRP Reinforcement.

(Ongoing PhD research project of at NUIG, 2003-2007).

This research project involves the reinforcing of Irish grown Sitka spruce glulams with glass fibre reinforced laminates (FRPs). Flexural strengthening results in a change of failure mode in the timber from a brittle tension failure to a ductile compressive failure leading to a more desirable structural member. In this project, an extensive test program to evaluate the bonding of FRPs to timber using a range of adhesive types was carried out. Bending tests to evaluate performance of glulams with full length and curtailed reinforcement is nearing completion. Numerical modelling of reinforced members incorporating anisotropic plasticity and geometric nonlinearity has been carried out to develop an understanding of the debonding mechanism.

Prestressed FRP Flexural Strengthening of Glulam Beams

(Ongoing PhD research project of at NUIG, 2006-2009).

The use of FRPs to reinforce timber members leads to an increase in the overall strength of the member and also results in ductile behaviour. Further advantages are gained by prestressing the FRP laminate in that the quantity of fibre required is reduced leading to a more economic design. In addition, the introduction of prestress via an eccentric tendon causes a pre-camber, offsetting the dead load deflection and effectively increasing the stiffness of the beam. This project involves the development of theoretical models for the design prestressed timber beams. These models will be validated by an experimental programme and numerical modelling procedures.

Bio-based Adhesives for Engineered Timber Applications

(Ongoing Masters research project at NUIG, 2007-2008)

This project involves the characterisation and testing of a range of bio-based adhesives for use with timber. Shear testing of small samples will be performed on durability cycled specimens. Those adhesives that successfully pass the durability testing will be used in the manufacture of full scale engineered beams, which will then be tested to evaluate their structural performance.

3 Recent Publications

Raftery, G. & Harte, A.M., Shear Testing of Adhesively Bonded Glass-Fibre Reinforced Polymer - Softwood Interface, accepted for publication in the J. of Institute of Wood Science.

Raftery, G., Harte, A.M.& Rodd, P.D., 2007, Hygrothermal Compliance at GFRP-Wood Interfaces, Proceedings of 3rd International Conference on Advanced Composites in Construction (ACIC 2007), Bath, UK, Apr. 2-4, ISBN 0-86197-138-8. Eds. A.P. Darby & T.J. Ibell, pp. 261-270.

Zhu E, Guan Z, Rodd PD and Pope DJ. (2006). Effects of Openings on OSB Webbed Wood I-Joists. ASCE, Journal of Structural Engineering. (Under review).

Raftery, G., Harte, A.M.& Rodd, P.D., 2006, Durability Assessment of Adhesives and Reinforcements at the GFRP-Wood Interface, Proceedings of 3rd International Conference on FRP Composites in Civil Engineering (CICE 2006), Miami, USA, Dec. 13-15, ISBN 0-615-13586-2. Eds. A. Mirmiran & A. Nanni, pp. 271-274.

Rodd P D, Zhou T, Pope D J. (2006). Punched Metal Plate Fasteners and The Johansen Equations. World Conference on Timber Engineering, WCTE 2006, Portland, USA.

Raftery, G., Harte, A.M. & Rodd, P.D., 2006, Performance Evaluation of Adhesives and Reinforcements in GFRP-Wood Connections, Proceedings of 9th World Conference on Timber Engineering, Portland, Oregon, Aug. 6-10 (CD-ROM).

Bahadori Jahromi, A., Zhang, B., Harte, A., Walford, B., Bayne, K. & Turner, J., 2006, Effect of additional webs on structural performance of I-beams, J. Institute of Wood Science, Vol. 17, No. 2, Issue 99, pp.148-158.

Bahadori Jahromi, A., Kermani, A., Zhang, B., Harte, A., Bayne, K., Turner, J. & Walford, B., 2006, Influence of cross-section on the strength of timber beams, J. Institution of Civil Engineers, Structures & Buildings, Vol. 159, Issue 2, pp.103-114.

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Raftery, G. & Harte, A.M., 2005, Evaluation of Wood Adhesives for a Glue-Laminated Softwood, Proceedings of Wood Adhesives 2005 Conference, San Diego, Nov. ISBN 1-892529-45-9. Ed. C.R. Frihart, pp.115-122.

O' Toole, C & Harte, A.M., 2005, Design Optimisation of Timber I-Joists, Proceedings of Annual Symposium of Irish Society for Scientific and Engineering Computation. University College, Cork, May, p.20.

4 Information about the Irish Delegates:

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Dr. Annette Harte

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Dr. A. Harte is a senior lecturer in Civil Engineering at NUIG and heads up the Timber Engineering Research Group. The research activities are based on the development of timber products for construction. This includes research on glulams, I-joists, adhesive bonding and reinforcement and prestressing of timber. She was a member of COST Action E24 'Reliability of Timber Structures' and is the Vice-Chair of the Management Committee of COST Action E55 'Modelling the Performance of Timber Structures'.

Working Group Members:

<u>WG I: System Identification and Exposures</u>

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WG II: Vulnerability of Components

Dr. Annette Harte
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WG III: Robustness of Systems

Dr Peter Rodd
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For the past three years Dr. P. Rodd has been a fixed term lecturer in the Department of Civil Engineering in NUIG. Prior to this he was for many years Reader and Head of the Structural Timber Research Unit in the Department of Civil Engineering in the University of Brighton in the UK. His main areas of interest and expertise are in the fields of mechanical timber jointing and the development of novel timber and timber based beam systems. He was an active member of the Cost C1 action (The control of semi-rigid timber joints) and is a long serving member of the UK Timber Engineering Group.

ITALY

1 Research Institutions

University of Pavia, http://www.unipv.it

Department of Structural Mechanics, http://dipmec.unipv.it

The Department is represented by Prof. L. Faravelli (expert) and Prof. F. Casciati (MC member). The research activity relies on the co-operation of students of the PhD Course in Civil Engineering. It covers different aspects of structural engineering, as dynamics, reliability and numerical simulation. Smart structures and systems are developed at an interdisciplinary level from both a theoretical and an experimental point of view. The laboratory is equipped with a (uni-axial) shaking table (1m by 1m), a bi-axial (tension and torsion) universal testing machine and its thermal chamber, plus sensors of different type and scope. Fatigue tests of aluminium, brass and shape memory alloys are frequently carried out. "In situ" health monitoring of historic masonry structures is conducted in Italy and abroad. The consequent retrofitting by innovative techniques is designed and implemented.

In the area of Timber Engineering research the group is actively involved in the development of probabilistic modelling of timber structural behaviour and in the realization of smart joints.

University of Catania, http://www.unict.it

Department ASTRA, http://www.unict.it/farch

Dr. S. Casciati, of the School of Architecture, located in Syracuse, is serving as expert in COST E55. Her research activity is mainly focused on structural health monitoring, with consequent problems of diagnosis and prognosis of ancient buildings. Special care is devoted to the problems of robustness and its modelling.

Timber Engineering is met in the retrofitting of ceilings and roofs. Vibration testing identification is pursued, as well as the retrofitting by special smart connections. The main goal is to increase the structural robustness.

University of Florence, ???

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IVALSA, CNR, ???

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2 Planned and ongoing Research Activities

Conservation of historical buildings

(running at the University of Pavia and supported until December 2007, by CNR, the Italian National Research Council)

Abstract:

The conservation of historical buildings must be consistent with the Venice and Cracow charts: any intervention must be non-invasive and reversible. The goal can be reached by innovative techniques adopting smart materials and/or devices. With reference to the timber parts of ancient buildings this mainly requires to conceive and implement smart connections between wood components and between wood structural elements and the building where they are anchored.

The research project will be conducted in connection with the COST action E55. The expected achievements of the proposed research project will provide major contributions to this COST action. Simultaneously the COST action E55 will provide a platform of international experts to frequently discuss critically the achievements of the research project to the benefit of the overall impact and relevance of the work.

3 Recent Publications

Casciati F., 2006, Structural Monitoring for the Design and the Retrofitting of the Monumental Heritage, in Structural Health Monitoring and Intelligent Infrastructures, 1, 49-54.

Casciati F., Casciati S., Domaneschi M. (2005), Wood-Panel Smart Joints for Dynamic Excitations, Proceedings COST E24 Final Conference, Arcachon.

Casciati F., Faravelli L. and Rossi, R., 2005, Architecture Optimization for Wireless Sensor Networks, Proceedings SPIE Smart Structures and Material, Conference 5759, SPIE .

Casciati S., Osman A., 2005, Damage Assessment and Retrofit Study for the Luxor Memnon Colossi, Journal of Structural Control & Health Monitoring, 12, 139-156.

Casciati S., Domaneschi M., Faravelli L., and Mottini M. (2005), Coupling Random Imperfection Fields with Laboratory Results from Wood Specimens, Proceedings COST E24 Final Conference, Arcachon.

Casciati S. and Domaneschi M. (2007), Random Imperfection Fields to Model the Size Effect in Laboratory Wood Specimens, Structural Safety.

El-Borgi S., Smaoui H., Casciati F., Jebri K., Kanoun F., 2005, Seismic Evaluation and Innovative Retrofit of a Historical Building in Tunisia, Journal of Structural Control & Health Monitoring, 12, 179-195.

4 Information about the Italian Delegates:

Management Committee Members:

Prof. Fabio Casciati
Department of structural Mechanics - University of Pavia
fabio@dipmec.unipv.it
http://dipmec.unipv.it

Prof. Ario Ceccotti

Dr. F. Casciati is Full Professor of Scienza delle Costruzioni at the University of Pavia, Italy, since 1980, and is the Coordinator of the Ph.D Course in Civil Eng. of the Univ. of Pavia since 1994.

He was acting as vice-chairman of the COST action E24 (2000-2005) and is presently serving as member of the Management Committee of the COST action E55.

Author of more than 200 papers (more than 50 were published in international journals) and of 3 books. He is President of the European Assoc. for the Control of Structures since 1993, and served as President of the Intern. Association, IASC, from 2000 to 2004.

F. Casciati is editor od Smart Structures and Systems, member of the Advisory Board of Nonlinear Dynamics and member of the Editorial Board of Struct. Safety, J. of Struct. Control & Health Monitoring, Computers & Structures, J. of Vibration & Control.

Working Group Members:

WG I: System Identification and Exposures

Dr. Sara Casciati
Dept. ASTRA, School of Architecture in Syracuse, University of Catania
saracasciati@msn.com
http://www.unict.it/farch/

Sara Casciati got the MSc degree in Civil Engineering at Stanford University in 2003 and the PhD degree in Civil Engineering at the University of Pavia in 2005. She is assistant professor of Structural Mechanics at the School of Architecture in Syracuse since October 2006.

Structural health monitoring and structural robustness are the main topics on which her research activity is focused. She published more than papers in international scientific journals.

WG II: Vulnerability of Components

Prof. Fabio Casciati
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See above

WG III: Robustness of Systems

Prof. Lucia Faravelli
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Lucia Faravelli is Full Professor of Structural Safety at the University of Pavia since 1991 and Faculty member of the Graduate School in Civil Engineering since 1994.

She is member of the Board of Directors of 1) the European Association for the Control of Structures and 2) ICASP-CERRA. She was serving as Visiting Research, Virginia Polytechnic Institute and Technical University, Blacksburg, Virginia (USA), 1985; Visiting Researcher, Stanford (USA), 1986, with a NSF Award.

She was Chairperson of the ESF program CONVIB (2001-2005) on vibration control ; and Chairperson of the HCM Stochastic Mechanics ERBCHXCT940565

She is Editor of the Journal of Structural Control and Health Monitoring and member of the Editorial Board of "Smart Structures and Systems" and "International Journal of Reliability and Safety" (IJRS).

.She is author or co-author of more than 200 scientific papers and served as co-chairperson of three ESF-NSF workshops on Smart Sensor Technology.

NORWAY

1 Research Institutions

Norwegian University of Science and Technology, NTNU, Trondheim, www.ntnu.no

Department of Structural Engineering (NTNU/KT), www.ntnu.no/kt

NTNU/KT has about 80 employees PhD students included, and is represented by Prof. K. Bell and Prof. K.A. Malo. The department works within; Biomechanics, Computational mechanics and program development, Concrete technology, Design of concrete-, metals- and timber structures, Fracture mechanics and fatigue, Impact and energy absorption, Nanomechanics and Wind engineering. The department has large and well equipped structural laboratories suitable for testing of most structural materials. The group working with timber engineering consists currently of 4 persons.

Department of Architectural Design, History and Technology at the Faculty of Architecture and Fine Art (NTNU), http://www.ntnu.no/ab

The Faculty is educating MSc in Architecture and MSc in Fine Art and is represented by Prof. J. Siem. One of the focus areas at the Faculty is wood as a building material. The group working with wood as a building material consists currently of 3 persons.

Norsk Treteknisk Institutt, Oslo (NTI)

Norsk Treteknisk Institutt (NTI), www.treteknisk.no

NTI is a private research association for sawmills and wood industry in Norway. Our main tasks are research and development projects, quality control, quality documentation, laboratory tests and diffusion of knowledge from R&D work for the Norwegian wood industry.

Facts about NTI

The R&D centre for the sawmill and timber industry in Norway. Established in 1949. 150 member companies representing sawmills, glulam- and roof truss manufacturers, wood working industry, wood preservation industry and suppliers of machines and equipment, 36 employees and annual turnover app. NOK 32 mill. App. 25 % abroad. Accredited laboratories for mechanical testing and chemical analyses of wood based products since 1994. Appointed as a Registered Certification Organisation (RCO) by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in Japan as of 11 March 2003. Notified Technical Body for CE-marking of timber structures and wood based panels. Inspection body and secretariat for the majority of the timber trade's quality schemes. Library specializing in wood technology with 15.000 titles, domestic and international databases.

Vision

Norsk Treteknisk Institutt (NTI) shall be the R&D centre, the centre of competence and the meeting centre for the Norwegian wood industry.

Business idea

NTI shall promote the member companies' profitability by using updated knowledge about wood, its properties, processing methods and usage. The means to succeed in this are R&D by objectives, diffusion of knowledge, counselling and quality documentation.

2 Planned and ongoing Research Activities

Modelling and Development of Connections in Timber Structures.

(NTNU/KT joint project with University of Life Sciencies, Norway and NTI, Norway, research team includes one PhD student, full time working on the project; duration 2006 -2010)

Abstract:

The overall objective of the project is to develop methods and gain knowledge and competence in numerical modelling of the material behaviour of wood materials in interaction with metal fasteners. The scope is on the short term response and ultimate load bearing capacity of connections in timber structures exposed to various types of loading.

It is also an objective to investigate more competitive connections in load bearing timber structures, determination of their stiffness and characteristic mechanical response to loading. Special emphasis will be put on frames with rigid corners.

Scantling Rules for Fishing Boats of Wooden Carvel Construction

(NTNU/KT joint project with The Food and Agriculture Organization of the United Nations (FAO); duration 2007)

Abstract:

Fishing is the most dangerous occupation in the world. In developing countries more than 80 % of the boats are below 12 m in length and work is underway to establish safety regulations applicable to these vessels.

As part of this work, FAO has been requested to develop a scantling rule suitable for fishing boats in developing countries. Most developed countries with a fishing industry have scantling rules for fishing boats in order to assure a certain level of safety for the crew. However in developing countries there are hardly any scantling standard for wooden boats in use and no international standard that can be recommended. In many countries fibreglass reinforced plastic (FRP) has become an important material for building fishing boats, but wood remains the most important construction material for fishing vessels in Africa, South America and parts of Asia. Traditional carvel construction with nails and bolts used for fastenings is the predominant construction method in these areas.

The research project generates basis data for the development of a scantling rule for fishing boats of wooden carvel construction up to 15 m length. The project includes use of computer models to determine stresses in major strength elements and testing of critical strength elements of wooden boats.

Comfort Properties of Timber Floor Constructions

SINTEF-NBI (Norway) joint project with NTNU/KT and University of Life Sciencies (UMB), Norway, 2006 -2010.

The overall objective of the project is to develop methods and gain knowledge and competence to design timber floor constructions with increased span width compared with existing, common solutions. The scope is on the vibration response of floor constructions exposed to human activities and common vibration sources in relevant building categories. The project will be organized with five Work Packages (WP). The iteration between the different subprojects is of major importance and will generate new knowledge at this item. The project is planning with one PhD student with work on numerical modelling and the experimental programme associated with this activity. We will also assign M.Sc. students to this project at the involved universities.

Roof Structures and Connections with Round Timber.

((NTNU/KT joint project with industry, duration 2005 -2007)

Abstract:

I some higher parts of Norway the timber resources will often not fulfil the requirements for production of structural components. However the strength is high if not the timber is sawn into lumber. To utilize these resources for structural use especially in the rural areas, stronger and more efficient connections are needed. The project develops roof structures and connections for round timber suitable for farm buildings and recreational facilities.

3 Recent Publications

Aasheim, E. Glulam trusses for olympic arenasStructural Engineering International, Volume 3, Number 2, 1993

Aasheim, E., Solli, K., Colling, F., Falk, R., Ehlbeck, J., Görlacher, R.Norwegian bending tests with glued laminated beams - Comparative calculations with the "Karlsruhe calculation model"CIB-W18/26-12-1 Athens, USA 1993

Aasheim, E.Glulam trusses for the 1994 Winter OlympicsPacific Timber Engineering Conference, Gold Coast, Australia 1994

Aasheim, E.; Solli, K.H.Size Factor of Norwegian Glued Laminated BeamsCIB-W18/28-12-2 København, Danmark 1995

Kleppe, O., Aasheim, E.Timber Bridges in the Nordic CountriesNational Conference on Wood Transportation Stuctures, Madison, USA 1996

Aasheim, E.Cyclic Testing of Joints with Dowels and Slotted-in Steel PlatesCIB-W18/30-7-3 Vancouver, Canada 1997

Bell, K, Eggen, T.E.: Stability of Timber Beams and Columns. Proceedings of the IABSE conference on Innovative Wooden Structures and Bridges (pages 155-161), Lahti, Finland 2001. Published as IABSE report, Volume 85.

Bell, K., Eggen, T.E., Haugen, B.: Nonlinear analysis as basis for design of timber structures. Proceedings of the 5th World Conference on Timber Engineering (WCTE'98), (Vol 1, pages 464-470), Lausanne, 1998.

Bell, K., Karlsrud, E.: Large Glulam Arch Bridges - A Feasibility Study. Proceedings of the IABSE conference on Innovative Wooden Structures and Bridges (pages 193-198), Lahti, Finland 2001. Published as IABSE report, Volume 85.

Bell, K., Wollebæk, L.: Large, mechanically joined glulam arches. Proceedings of the 8th World Conference on Timber Engineering - WCTE 2004 (pages 55-60), Lahti, Finland, June 2004.

Bell, K.: Computational Mechanics in Timber Structure Design. Invited keynote lecture. Proceedings of the 15th Nordic Seminar on Computational Mechanics (NSCM15), edited by E. Lund, N. Olhoff and J. Stegmann, (pages 33-42). Department of Mechanical Engineering, University of Aalborg, Denmark, 2002.

Bell, K.: Computer Based Analysis and Design of Plane Timber Structures - Problems and Solutions. Proceedings of the Int. Wood Engineering Conference (IWEC), edited by K.A. Gopu, (Vol 3, pages 376-383), New Orleans, 1996.

Bell, K.: PC aided analysis and design of plane timber structures. Proceedings of the 8th Nordic Seminar on Computational Mechanics (NSCM VIII), (4 pages), Department of Structural Mechanics, Chalmers University of Technology, Gothenburg, 1995.

Bell, K.: Stiffness properties in timber structure analysis and design. 9th World Conference on Timber Engineering - WCTE 2006 (8 pages), Portland, Oregon, USA, August 2006.

Dahl K., Bovim, N.I & Malo K.A.: Evaluation of Stress Laminated Decks Based on Full Scale Tests. 9th World Conference of Timber Engineering, August 6 – 10 2006, Portland, OR, USA.

Larsen, K. E. Hakonsen, F., Siem, J. and Solberg, H. (2003): Element building in wood. Arkitektnytt 03/03, p. 3.

Larsen, K., E., L., Hakonsen, F., Siem, J., and Solberg, H., (2003): A school of modern wooden house building. Treteknisk informasjon, 2/2003, p. 30-31.

Malo, K.A., Holmestad, Å and Larsen, P.K.: Fatigue Tests on Dowel Joints in Timber Structures IABSE Conference "Innovative Wooden Structures and Bridges", Lathi, Finland, August 29-31, 2001.

Malo, K.A., Holmestad,Å. & Larsen, P.K.: Fatigue Strength of Dowel Joints in Timber Structures. 9th World Conference of Timber Engineering, August 6 – 10 2006, Portland, OR, USA.

Malo, K.A.: Impact Behaviour of Roadside Round Wooden Posts. 8th World Conference of Timber Engineering, Vol II, ISBN 951-758-443-1, June 14 – 17 2004, Lahti, Finland.

Malo, K.A: Pseudo-Dynamic Test Method, Experiments and Accuracy. Int. Workshop on Earthquake Engineering on Timber Structures, COST Action E29 "Innovative Timber & Composite Elements/Components for Buildings, Univ. of Coimbra, Nov 9-10, 2006, Coimbra, Portugal.

Meløysund, V., Lisø, K. R., Siem, J. and Apeland, K., (2006): Increased Snow Loads and Wind Actions on Existing Buildings: Reliability of the Norwegian Building Stock, ASCE Journal of Structural Engineering, 132, 11.

Prestrud, O. and Siem, J. (2003): Roofs, terraces and balconies. Byggdetaljer, Norwegian Research Building Institute, Oslo.

Rönnquist, A., Wollebæk, L., Bell, K.: Dynamic behavior and analysis of a slender timber footbridge. 9th World Conference on Timber Engineering - WCTE 2006 (8 pages), Portland, Oregon, USA, August 2006.

Siem, J. (1999). Capacity and ductility of dowel connections in wooden constructions. NTNU. Doctoral thesis.

Siem, J. (1999): Wooden beam layers in private houses. Load carrying capacity of open fireplaces and ovens. Byggdetaljer, Norwegian Research Building Institute.

Siem, J., Meløysund, V., Lisø, K. R. (2003): Snow- and wind-loads on existing buildings – Report from project 1 and 2 in the R&D program"Climate 2000". Report 114. Norwegian Research Building Institute, Oslo.

Wollebæk, L., Bell, K.: Stability of glulam arches. Proceedings of the 8th World Conference on Timber Engineering - WCTE 2004 (pages 61-66), Lahti, Finland, June 2004.

Management Committee Members:

Erik Aasheim
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Research Manager at Norsk Treteknisk Institutt in Oslo, Norway. Background as a structural engineer and since 1973 involved with research and development of timber products and timber structures. Have been involved with many national and international projects, e.g. regarding glulam, grading and timber bridges. Chairman of the Norwegian Timber Code committee and active in several COST actions and CEN working groups. Also involved with quality control and certification work.

Kjell Arne Malo
Norwegian University of Science and Technology
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http://www.ntnu.no/kt

Professor at the Department of structural engineering at the Faculty of engineering science and technology.

Background in design and behavior of steel and aluminum structures exposed to dynamic loading. Since 2002 involved in timber structures, both teaching and research. Main interests and field of competence are structural design issues, material modeling, laboratory experiments, dynamic loading, and numerical simulation of wood and connections. Member of the Norwegian Timber Code committee, and responsible of the education in timber engineering at NTNU.

Working Group Members:

WG I: System Identification and Exposures

Kolbein Bell
Norwegian University of Science and Technology, NTNU
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http://www.ntnu.no/kt

Professor at the Department of structural engineering at the Faculty of engineering science and technology.

Background in computational mechanics and computer program development. Since about 1995 involved in timber structures, both teaching and research. Main interests: timber bridges and nonlinear analysis as basis for design, but also failure of timber structures

Jan Siem
Norwegian University of Science and Technology, NTNU
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http://www.ntnu.no/ab

Professor at the Department of Architectural Design, History and Technology at the Faculty of Architecture and Fine Art.

Background as a structural engineer in concrete, steel and wood structures for 12 years, researcher at the Norwegian Research Building Institute (SINTEF Building and Infrastructure) for 4 years with special

and rehabilitation of old timber structures. Member of the Norwegian Timber Code committee, and currently concerned about the implementation of Eurocode 5, in both teaching curricula and practical engineering.

interest in timber structures and since 2001 Professor at NTNU, structural engineering in architecture. Chairman of the Norwegian glulam committee and member of the Norwegian Timber Code committee.

PORTUGAL

1 Research Institutions

University of Coimbra, Coimbra (UC), www.uc.pt

University of Coimbra, www.uc.pt

The University of Coimbra is represented by A. M. P. G. Dias, affiliated with the Group of Structural Analysis at the Department of Civil Engineering. The group activities include teach and research. The research is focused in the study of structural materials, namely timber and concrete and in the optimization and reliability of structures. The research developed in the field of structural materials involves experimental and numerical approaches. Its main goals are the development of new structural solutions, rehabilitation and strengthening of existing structures, contribution to the development and improvement of the design codes and the production of tools to assist the design, the erection and the maintenance of the structures.

The research in the timber field as well as the teaching of timber structural design for undergraduate students began in 1998. The main fields of research are: composite timber-concrete structures, material characterization of the Portuguese wood species and structural rehabilitation.

University of Minho, Guimarães (UM), www.uminho.pt

Civil Engineering Department (UM/DEC), www.civil.uminho.pt

UM/DEC is represented by Jorge Branco member of the Structures Group (www.civil.uminho.pt/structures) at UM/DEC. The group focus on most structural materials (such as concrete, masonry, steel and timber), in numerical and experimental techniques (such as advanced computational modelling, characterization of constitutive laws, non-destructive testing, reliability and dynamics), in product development for the building industry, in the definition of design rules, in techniques for diagnosis, inspection and survey of existing structures and in techniques for strengthening of existing structures. The objective is to address the aspects of conception, analysis, design and detailing of structures, in a perspective of high performance associated with increased safety, lower costs in the full life-cycle analysis and reduction of environmental impact.

In the area of Timber Construction the main research is focused on the mechanical characterization of timber and timber composite elements (glass, concrete, steel and fiber), in static and dynamic behaviour of traditional, strengthened and innovative connections of timber elements. Timber Construction research area started in 2001.

The National Laboratory for Civil Engineering (LNEC), Lisbon, www.lnec.pt

LNEC is represented by Dr. Helena Cruz, affiliated with the its Timber Structures Division (NEM).

LNEC was created in 1946. It is a public institution of science and technology, which is subject to the Ministry for Public Works, Transports and Communications, covering the broad field of civil engineering.

Major objectives of LNEC's activity are INNOVATION by the implementation of four year research plans, APPLICATION of new technologies in studies under contract with a view to solve specific problems within the framework of civil engineering and the building construction industry and DIFFUSION in technical and scientific circles of the results of its activities.

The Timber Stuctures Division of LNEC develops its activity in the fields of: timber products and its application in buildings; durability and conservation, construction, follow up, assessment and rehabilitation of timber structures.

Its current activity includes:

- Contract work (evaluation of performance and durability of materials, joints, timber products and building systems; assessment of natural durability and efficacy of preservative products; certification; expertise on structures monitoring, deterioration and safety assessment; evaluation and durability of strengthening and repair products and techniques);

- Standardization at national and international level (CEN/TC38, 112, 124, 175);

- Research projects (strength grading and mechanical properties of structural timber; wood based panel products for building purposes; durability of timber structures; non-destructive evaluation, consolidation and strengthening of in-situ timber members and joints;

- Collaboration with post-graduate studies, teaching and dissemination of information.

Polytechnic Institute of Castelo Branco, IPCB (www.est.ipcb.pt)

IPCB is represented by Luís Jorge. In cooperation with Coimbra University and the National Laboratory for Civil Engineering, IPCB develop R&D activities in the field of timber engineering with special emphasis on timber-concrete composite structures (new connection systems, use of LWAC and long term behaviour) and timber bridges. IPCB is also partner on the development of actions for technology transfer on designers and constructors.

New University of Lisbon, UNL, www.fct.unl.pt

Civil Engineering Department (UM/DEC), www.dec.fct.unl.pt

UNL/DEC is represented by Prof. Luis C. Neves, member of the Structures Group at UNL/DEC. The group focus on the numerical and experimental analysis of structural materials, with a particular emphasis on the analysis of existing structures, diagnostics and assessment of structures, deterioration modelling and maintenance and retrofitting techniques.

These objectives are materialized in the analysis and characterization of existing timber structures in a lifecycle perspective in a probabilistic framework, including the probabilistic effects of deterioration, loads, and maintenance actions.

2 Planned and ongoing Research Activities

Behaviour of glued composite timber based structural elements

LNEC participates in a research project running from 2005 to 2008 in collaboration with the University of Coimbra (FCTUC) and funded by the National Foundation for Science and Technology (FCT). The main goal of this project is the evaluation of the short- and long-term behaviour of bonded connections involved in: a) bonded timber-concrete slabs; b) beam-end repair by replacement with a bonded timber prosthesis; c) prestressed timber beams. It aims to establish numerical models and execution procedures suitable for such repair/strengthening systems.

The involvement of LNEC will focus primarily on the understanding of the phenomena involved in the adherence and ageing of structural adhesive joints, particularly to concrete. It also studies a number of commercial structural adhesives, mainly epoxy formulations, particularly their sensitivity to high service temperature conditions.

Another (PhD) project is running in the same period at LNEC, in collaboration with Oxford Brookes University, UK, on the Performance and durability of composite repair and reinforcement systems for timber.

The proposed project aims to investigate the adhesion phenomena involved in bonding timber with structural adhesives suitable for in-situ repair projects and the way these interact with wood and fibre composites.

The project will study the influence of service temperature and humidity, moisture content and surface properties of timber, load history and applied stresses. Finally, it is intended to develop test procedures to assess and to predict the long-term behaviour of bonded joints between timber and various composite materials suitable for timber structure strengthening and repair.

Evaluation of the integrity of glued laminated timber structures in service

This PhD project (LNEC in collaboration with the Technical University of Lisbon) aims to develop methods for evaluating the performance of glued laminated timber in service. It focus on glued laminated beams made of spruce and type I adhesive, that are mostly used in Portugal, and glulam made of deep impregnated preservative treated maritime pine and type I adhesive, as a suitable material for hazard (use) classes 3 and 4 (EN 335-2).

The influence of preservative treatment and cure temperature on the performance of freshly glued laminated beams is assessed by shear strength and delamination tests. A number of destructive, semi-destructive and non-destructive tests will be carried out after different levels of natural and artificial ageing of these beams to monitor possible modification of shear strength of the glue lines.

Fire behaviour of timber beams: consequences of different protection techniques

(planned joint project with UM/DEC and University of Aveiro (Portugal), the research team will be completed by two PhD students, full time working on the project; duration 2008 -2011)

Abstract:

The aim of the research project is to enlarge the theoretical and experimental background of the fire behaviour of timber beams for different fire resistances. An extensive testing program was planed on unprotected and protected beams. The effects of the cross-section, species, material (solid timber or glued laminated timber), and protection techniques are some of the parameters to be evaluate. All fire tests will be carried out at the Laboratories of Aveiro University under ISO-fire exposure where a standard furnace able to perform full-scale fire tests is available. Tests made on reference beams, without the fire action, and the numerical analysis will be performed in the facilities of the Structural Group of the University of Minho.

A fruitful interaction between experimental and numerical analysis will enable the researchers to adequately prepare the experimental campaign on the basis of first numerical results, and to simplify this task by eliminating the modelling of non-significant aspects. The numerical analysis will use the available orthotropic models developed at University of Minho

The results of the research project should permit to check the design methods given in Eurocode 5, part 1-2 and help to the preparation of the National annex containing all Nationally Determined Parameters.

Influence of the joint stiffness in the static and dynamic behaviour of timber structures: consequences of different strengthening techniques

(running PhD joint project with UM/DEC, University of Trento (Italy) and LNEC - National Laboratory of Civil Engineering (Portugal) supported by the Portuguese Foundation for Science and Technology – FCT, duration 2005 – 2008)

Abstract:

The lack of practical but realistic models for the joints in old, traditional timber structures generally leads to very conservative retrofits and upgrades needed to satisfy new safety and serviceability requirements. Besides, the misunderstand of the global behaviour of traditional roof trusses may result

in unacceptable stresses being applied elsewhere as a result of inappropriate joints strengthening (stiffening). Common timber roof structures are usually modelled with perfect hinges; occasionally for stability reasons, full moment transmission is assumed. However, these joints offer not negligible moment transmission capability and may be best classified as semi-rigid. The establishment of a suitable moment - rotation behaviour law for a joint integrates information on stiffness, strength capacity, and ductility; one objective of this work is to parametrically characterize the mechanical behaviour of common carpenter joints present in existing roof trusses, especially in terms of their moment transmission capability both under monotonic and cyclic loading.

The study includes a preliminary structural survey to assess joint geometry, materials and on site modes of failure, as well the experimental testing of full-scale samples, the calibration of an existing finite-element model of the joints with such experimental results, and the numerical model of different configurations. The unreinforced joint behaviour is interpreted also with simplified physical models. The effects of different types of retrofitting techniques are also experimentally assessed. All the tests will be modelled with the available orthotropic models developed at University of Minho.

The unreinforced and reinforced joints behaviour will be taken into account in the modelling of the overall behaviour of roof trusses and some recommendations in this respect will be drawn and disseminated.

Lifetime performance of timber-concrete connections

(running joint project with University of Coimbra, LNEC and TU Delft, duration of the project 2004 - 2008)

Abstract:

In the structural design of timber-concrete structures the short and long term behavior of the joints is an important issue. The aim of this project is to evaluate the short and long term behavior of timber concrete joints, namely its load carrying capacity and its short and long term stiffness, necessary to predict the lifetime performance of the composite structures.

In this study two types of joint were tested, dowel type fasteners and notches, in both cases with various configurations. The short term mechanical behaviour was already assessed in experimental tests. The long term behaviour is still being assessed, in four test configurations the specimens are being tested in uncontrolled climatic conditions, corresponding to approximately service class 2, while in the other five configurations the specimens are being tested in controlled climatic conditions (65% air relative humidity and 20ºC temperature).

These tests are complemented with advanced computational modelling were the joints short and long term behaviour is simulated. The objective of the simulations is to extend the knowledge about the phenomena involved and afterwards predict the behaviour for new configurations and for load durations longer than the ones considered in the tests. The results and knowledge obtained from the models and from the tests will be used to improve the models and methods available for design purposes.

Marine environment damage: methods of diagnosis, repair and maintenance

MEDACHS (Marine Environment Damage to Atlantic Coast Structures and Buildings: Methods of Assessment and Repair) is a research project, developed since 2005, in the framework of the EU INTERREG - Atlantic Area Programme, dealing with the study of constructions and materials performance in Atlantic marine environments.

The MEDACHS project aims to understand the phenomena of degradation in the marine environment for four materials (masonry, concrete, wood and steel), and to test and improve the methods of repair of the structures in this environment. The development of methods of measurement, which allows a diagnostic, is also a priority. The final objective is to find tools of decision for end users.

The LNEC' Timber Structures Division has been working to provide information on the parameters of degradation and ageing laws, methods of evaluation and techniques of repair and maintenance for wood structures under the scope of the project.

Structural application of round wood timber obtained from small diameter trees

(running joint project with University of Coimbra and LNEC, duration of the project (part 1) 2006 - 2008)

Abstract:

This research project is part of a wider research program that intends to give a contribution to increase the use of timber from small diameter trees in construction, namely by the use of Maritime pine round wood timber in structural applications.

The project involves the selection of Maritime pine round wood members representative from the raw material available in the Portuguese forest. This material needs to be removed by various reasons such as forest health and the decrease the fire risk. In order to grade this material, for structural applications, a standard for visual grading will be developed. The mechanical properties of the round wood members, graded according with standard, will be experimental assessed through laboratory tests. Additionally, the members will also be tested with non destructive techniques. The information obtained with the non destructive tests will be used to improve the grading methods and tools available to perform that operation at an industrial level. It is expected that this part of the research will result in higher yields and/or in a reduction of the costs associated with the grading of the round wood members. The project will be conducted in collaborations with other COST E55 members, and various actions are planned in the scope of this COST action.

Timber-glass composite systems. Architectural and structural possibilities.

(running PhD in industrial environment, DST – Domingos da Silva Teixeira, SA industry, supervised by UM/DEC and supported by the Portuguese Foundation for Science and Technology – FCT, duration 2006–2009)

Abstract:

Prefabricated industrialised systems currently present an area of strong architectural and constructive development. The uniformity, traditionally inherent in this concept, is nowadays superimposed by the feasibility of unitary series. As a complement, the increasing resort to composite solutions diversifies the range of functional, expressive and structural solutions of products, leading to results that any material alone, with its limitations, could not achieve. Therefore, any composite solution will aim at enhancing the intrinsic increased value of its components and the simultaneous minimization of the disadvantages that each material, separately, presents. This is the central idea behind composite systems and also the starting point for the development of the present research.

Structural timber-glass composite solutions present all conditions for, in a near future, assume great architectural significance. First of all, it will allow benefiting from natural lighting in a way not much explored so far, with consequent advantages at other levels. On the other hand, the transparency of glass, associated with its structural employment, could achieve the most transcendent features of this material, magic and illusion. Also at a structural level, glass compression capacity and timber tension resistance must be enhanced, the same way that tensile stresses must be avoided on glass surfaces. Simultaneously, the specificities of natural behaviour of timber have to be assumed, understood and contextualised.

The main objectives of the research project are the feasibility and optimization of architectural potentialities of timber-glass constructive solutions.

3 Recent Publications

Branco J., Cruz P. (2004) - Nailed connections between Pinus Pinaster Ait. Members. 8th World Conf. on Timber Engineering, June 14-17, Lahti, Finland, 2004, pp. 287-290.

Branco J. Cruz P., Dias S. (2005) - Old Timber Beams. Diagnosis ans Reinforcement. Proceedings of the Inter. Conf. “The Conservation of Historic Wooden Structures”, Gennaro Tampone ed., Florence 22-27 February, 2005, pp. 417-422.

Branco J., Cruz P., Piazza M., Varum H. (2006) - Strengthening Techniques of Portuguese Traditional Timber Connections. SAHC 2006. P.B. Lourenço, P. Roca, C. Modena, S. Agrawal (Eds.), New Delhi, 2006, pp. 359-366.

Branco J., Cruz P., Piazza M., Varum H. (2006) - Modelling of timber joints in traditional structures. International Workshop on “Earthquake Engineering on Timber Structures”. Coimbra, Portugal, November, 2006, pp. 1-15.

Branco J., Cruz P., Piazza M., Varum H. (2006) - Experimental Analysis of Original and Strengthened Traditional Timber Connections. 9th World Conference on Timber Engineering, August 6-10, 2006, Portland, Oregon, USA.

Branco J. Cruz P. Piazza M. and Varum H. (2006) - Portuguese Traditional Timber Roof Structures. 9th World Conference on Timber Engineering, August 6-10, 2006, Portland, Oregon, USA.

Branco J., Varum H., Cruz P.J.S. (2006) - Structural Grades of Timber by Bending and Compression Test, *Advanced Materials Forum III*, Materials Science Forum, Trans Tech Publications Inc., ISBN: 0-87849-402-2, Vol. 516, 2006, pp. 1163-1167.

Cruz H., Custódio J. (2005) – Bond repair of cracked beams. 9th International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture - STREMAH 2005. Malta, June 2005.

Cruz H., Custódio J. (2006) – Thermal effects on the performance of epoxy adhesives used for timber structural repair. 9th World Conference on Timber Engineering (WCTE 2006). EUA, August 2006.

Cruz H., Gaspar F.M., Rodrigues J. (2007) - Evaluation of the integrity of glued laminated timber structures in service. COST E34 International Workshop: Practical solutions for furniture and structural bonding. Larnaka, Cyprus, 22-23 March 2007.

Cruz P., Negrão J. and Branco J. (2004) A Madeira na Construção. Proceedings of the 1st Iberian Congress "Timber Construction" (CIMAD04). March, 2004, Guimarães, Portugal.

Dias A.M.P.G., Lopes S., Cruz H. (2004) - "Ensaios de longa duração em ligações madeira-betão realizadas com cavilha", CIMAD 04, Guimarães 2004.

Dias A. M. P. G. et al. (2004) - "Experimental shear-friction test on dowel type fastener timber-concrete joints", 8th WCTE Finland 2004.

Dias A. M. P. G. et al. (2004) - "Non-linear FEM models for timber-concrete joints made with dowel type fasteners", 8th WCTE Finland 2004.

Dias A.M.P.G. et al. (2004) - "3D FEM models for timber-concrete joints", Proceedings of the 7th International Conference on Computational Structures Technology, LNEC 2004.

Dias A., Van de Kuilen J.G.W., Lopes S., Cruz H. (2004) - "Influence of the interlayer on the behaviour of timber-concrete composites". First Symposium Cost E29, Florence, Italy. 2004

Dias A.M.P.G. (2006) - "Simulation of large deformations on timber joints using 3D FEM models". 3th European Conference on Computational Mechanics, Lisbon.2006

Dias A. M. P. G. et al. (2006) - "Densified veneer wood for notched joints in timber-concrete composite structures", 9th WCTE Portland. 2006.

Dias A. M. P. G. et al. (2006) - "Creep effects in timber concrete joints with dowels and notches", 9th WCTE Portland. 2006.

Dias A. M. P. G., Lopes S. M. R., Van de Kuilen J. W. G, Cruz H. M. P. (2007) - "Load-Carrying Capacity of Timber–Concrete Joints with Dowel-Type Fasteners". Journal of Structural Engineering, Vol. 133, No. 5. 2007

Dias A.M.P.G., Van de Kuilen J.W., Lopes S., Cruz H. (2007) - "A non-linear 3D FEM model to simulate timber–concrete joints ".Advances in Engineering Software 38 (2007) 522–530. 2007

Dias A., Jorge L., Ferreira M. (2007) - "Pontes mistas madeira betão". Construção Magazine, nº 20. 2007.

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Duarte A., Negrão J, Cruz H. (2004) – Rehabilitation of timber structural elements with reinforced epoxy plates. WCTE, Finland, June 2004.

Duarte A.C.R., Negrão J.H.O., Cruz H. (2007) – Use of reinforced epoxy plates for the rehabilitation of timber beams. COST E34 International Workshop: Practical solutions for furniture and structural bonding. Larnaka, Cyprus, 22-23 March 2007.

Gaspar F., Cruz H., Nunes L., Gomes A. (2006) - Glued laminated timber of maritime pine treated with a product alternative to CCA. 2nd International Conference on Environmental-Compatible Forest Products (ECOWOOD 2006). September 2006.

Machado J. S., Sardinha R., Cruz H. (2004) - Feasibility of automatic detection of knots in maritime pine timber by acousto-ultrasonic scanning. Wood Science Technology (2004) 38: 277-284.

Machado J.S, Cruz H. (2005) - Within-stem variation of maritime pine timber mechanical properties. Holz als Roh-und Werkstoff. 63, 2005, pp. 154-159.

Nunes L, Cruz H, Duarte A. P., Bordado J. C., Nero J. M. G. (2005) - Wood consolidation by impregnation with reactive polymers. Gennaro Tampone Ed. Proceedings of the International Conference "Conservation of Historic Wooden Structures". Florence, 22-27 February, 2005. Vol.2: (323-327).

Nunes L., Cruz H., Fragoso M., Nobre T., Machado J. S., Soares A. (2005) - Impact of drywood termites in the Islands of Azores. IABSE Symposium on Structures and Extreme Events. Lisbon, Portugal, September 14-17, 2005.

Lopes S. M. R., Dias A. M. P. G., Cruz H. M. P. (2004) - Behaviour of Timber Concrete Composite Slabs, Institute of Wood Science JournalVl.16 Nº 5, 2004.

Lopes S., Dias A., Jorge L., Cruz H. (2004) - "Investigação em pavimentos mistos madeira-betão". 1º Congresso Ibérico Madeira na Construção. CIMAD'04. Universidade do Minho. Guimarães. 2004.

Jorge L., Lopes S., Cruz H. (2004) - "Experimental research in timber-LWAC composite structures". International Symposium on Advanced Timber and Timber-Composite Elements for Buildings. COST Action E29. Florence. Italy. 2004.

Jorge L., Lopes S., Cruz H. (2004) - "Tests in Timber-LWAC Composite Beams with Screw-type Fasteners". 8th World Conference on Timber Enginnering. WCTE04. Lathi. Finland. 2004.

Jorge L., Lopes S., Cruz H. (2004) - "Estruturas mistas madeira-betão – relevância da ligação no desempenho estrutural". 1º Congresso Ibérico Madeira na Construção. CIMAD'04. Universidade do Minho. Guimarães. 2004.

Jorge L., Lopes S., Dias A., Cruz H. (2005) - "Research in timber-LWAC composite structures". International Conference on Concrete for Structures. Universidade de Coimbra. Coimbra. 2005.

Jorge L., Dias A., Ferreira M. (2006) - "Ponte mista madeira-betão na Estrada Florestal nº1 em Quiaios". 4as Jornadas Portuguesas de Engenharia de Estruturas. JPEE06. LNEC. Lisboa, 2006.

Jorge L., Lopes S., Cruz H. (2006) - "Castelated surface for timber-concrete composite connections". 9th World Conference on Timber Engineering. WCTE06. Portland. EUA. 2006.

Rodrigues D., Custódio J., Cruz H. (2007) - Selection of adhesives and quality control of structural repair by bonding on site. COST E34 International Workshop: Practical solutions for furniture and structural bonding. Larnaka, Cyprus, 22-23 March 2007.

4 Information about the Portuguese Delegates:

Management Committee Members:

Alfredo M.P.G. Dias

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Alfredo Dias is Assistant Professor at the group of Structural analysis from the Department of Civil Engineering. He is responsible for teaching and research activities. The teaching activities include general structural analysis and timber design. The research activities include the fields of timber structures and timber-concrete composite structures. In the field of timber structures is involved in the development of grading methods for round wood timber as well as on the mechanical characterization of the Portuguese Maritime pine with round sections. He is also involved in various projects related with the lifetime performance of timber-concrete connections and timber-concrete structures.

He has participated as National Delegate in the COST Action E29 ' Innovative timber & composite elements for buildings'. He has been also actively involved with the national standardization committee IPQ/CT14.

Jorge Branco
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Jorge Branco is member of the new research and development unit ‘Timber Construction’ and lecturer for ‘Timber Structures’ in the division of Civil Engineering in the UM.

His activities in research are related to timber and timber composite structures, strengthened and innovative connections and seismic engineering.

In his short experience, he has the opportunity to participate in several consultancy projects in top monuments in Portugal, including inspection diagnosis and strengthening design. He has collaborated with Portuguese timber industry with consulting, expert’s reports and technical developments for the construction of new buildings.

He is actively involved in the national standardization committee IPQ/CT14 and in technical approvals (ETAG’s) of new timber systems.

Working Group Members:

WG I: System Identification and Exposures

Dr. Helena Cruz

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Dr. Helena Cruz is the head of the Timber Structures Division of LNEC. She conducts R&D activities related to the application of timber in construction, with a focus on timber structures ageing/ biological attack/damage evaluation, assessment and repair. She has been involved in research projects dealing with strength grading of timber, timber-concrete slabs, assessment of traditional timber joints and repair by bonding on site, durability of adhesive joints, namely in glulam structures and related to the temperature effects on epoxy adhesive joints. She has been actively involved with the national standardization committee IPQ/CT14 (timber), COST E508 (Wood mechanics), COST E13 (wood adhesion glued products) and COST E34 (bonding of timber).

WG II: Vulnerability of Components

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Luís Jorge is director of the Structures and Materials Laboratory at the Civil Engineering Department of the Polytechnic Institute of Castelo Branco (IPCB) since 2006. The main research interests are on the domain of timber-concrete composite structures and timber bridges. He is the Portuguese delegate for the COST action E29 'Innovative timber & composite elements for buildings'. Since 2000 he is member of IABSE.

WG III: Robustness of Systems

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Luis C. Neves
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Luis Neves is currently assistant professor of the Structural Group of the Civil Engineering Department of New University of Lisbon.

His research activities are related to the lifecycle probabilistic analysis of structures, namely deteriorating timber structures. His work is focuses on probabilistic modeling of deterioration and its effects on safety.

SLOVENIA

1 Research Institutions

University of Ljubljana, Faculty of Civil and Geodetic Engineering, www.fgg.uni-lj.si

Faculty of Civil and Geodetic Engineering is represented by Prof. Goran Turk and Dr. Bruno Dujič.

Chair of mechanics:

Prof. Goran Turk is a member of Chair of Mechanics. The main course of research of this group is in the field of nonlinear computational mechanics. Some specific research are as follows:

1. Non-linear analysis of composite beams (wood-wood, wood-concrete, steel-concrete) which takes into account the effect of shear deformation and interlayer slip.

2. The effects of actual environmental conditions on behaviour of timber beams were studied in joint research with Slovenian National Building and Civil Engineering Institute.

2. Reinforced concrete: localization of strains and fire. The viscous behaviour of concrete and resulting localization of strains.

3. Dynamics. A new very effective finite element based on the interpolation of deformation quantities was applied in the study of dynamics of beams.

4. Stability of structures. The stability of timber, reinforced concrete and steel columns under fire.

5. The problem of determining characteristic value from small samples.

6. Reliability analysis of timber beams under fire.

Chair for Research in Materials and Structures:

Dr. Bruno Dujič is a member of Chair for Research in Materials and Structures which is one of educational and research units in the scope of Faculty of Civil and Geodetic Engineering. It has four permanently employed members (4 PhD. and one B.Sc. degree), one temporarily employed researcher (PhD. candidates) and two associated researchers (Ph.D. degree) employed on contracts. Members of unit are keeping lectures in Building Materials, Experimental Methods in Structural Engineering, Retrofitting of Structures, Decay of Building Materials and Solid Waste Management. The broader activities includes consulting, design and analysis of buildings and engineering structures (Dr. Bruno Dujič is responsible for timber structures), as well as development of methods for retrofitting of reinforced concrete and masonry and wooden buildings, including cultural monuments. Research work in targeted area is oriented to evaluation of existing and development of new laboratory and in-situ testing methods for lime-based materials and components of heritage buildings (renders, plasters and joints) and monitoring of microclimatic conditions in heritage buildings. Currently, the leading person of Chair, Assoc. Prof. Dr. Roko Žarnić is coordinator of the activities of Focus Area Cultural Heritage within the European Construction Technological Platform.

An overview of collaboration in past or on-going EC or international projects:

COST Action C16: Improvement of urban building envelopes (2001-2007)

COST Materials Action 530: Sustainable Materials Technology (2002-2007)

COST Action E29: Innovative Timber and Composite Elements/ Components for Buildings (2003-2007)

COST Action E49: Processes and Performance of Wood-based Panels (2005-2009)

COST Action IE0601: Wood Science for Conservation of Cultural Heritage (2007-2011)

EU FP6 CHRAF Priorities and strategies to support Cultural heritage Research Activities within ECTP and future FP7 activities (2006-2007)

EU FP6 FUTUREBRIDGE - High Performance (Cost Competitive, long-life and Low Maintenance) Composite Bridges for Rapid Infrastructure Renewal (2007-2010)

Slovenian National Building and Civil Engineering Institute, www.zag.si

Slovenian National Building and Civil Engineering Institute is represented by Jelena Srpčič, head of the Section for Timber Structures in the Department for Structures.

The main research topics of the section are in the field of long-term behaviour of glued laminated beams in artificial and natural changing climate and in the non-destructive methods for grading timber. Some specific research topics are as follows:

1. The effect of changing relative humidity on the deformational and strength properties of straight and curved glued laminated beams installed inside the buildings.

2. The effects of actual environmental conditions (changing relative humidity and temperature) on behaviour of glued laminated straight beams (joint research with Faculty for Civil and Geodetic Engineering, Chair for the Mechanics).

3. Introduction of non-destructive methods for grading timber into the production plants, defining basic strength properties of Slovenian softwoods (joint research with Faculty for Civil and Geodetic Engineering, Chair for the Mechanics, and Biotechnical faculty, Department for Wood Technology).

4. Improvements of the use of wood-based panels for construction (FP7 proposal).

2 Planned and ongoing Research Activities

Efficient and reliable strength timber grading

(Ongoing research project financed by Ministry of science and higher education of Slovenia (joint project UL Faculty of Civil and Geodetic Engineering, UL Biotechnical Faculty, Slovenian National Building and Civil Engineering Institute; duration 2004 -2007)

Abstract:

Strength grading of sawn timber will become necessary for all sawmills selling CE-marked construction products. For grading machine, which itself is a big investment for sawmill, tests need to be carried out with wood grown in the same region from where the timber used by the specific sawmill has been harvested. The combined grading method will considerably improve the quality of timber grading.

The objective of the project is to form an open data base of the strength related properties and to use this data to develop effective and accurate strength grading procedures.

For reliable grading of timber as much as possible knowledge about relationship between different timber properties is needed. Specifically the relationship between material properties obtained by non-destructive experiments with the actual strength is of vital importance. The determination of these relationships and methodology of how these can be used in efficient timber grading is an important contribution.

Grading of timber for engineered wood products (Gradewood)

(planned joint project with VTT Finland, BRE UK, CTBA France, Technical University Munich, Germany, SP Technical Research Institute of Sweden, HFA Holzforschung Austria, TUW Vienna University of Technology, Austria, UL Faculty of Civil and Geodetic Engineering; duration 2007-2010)

Abstract:

This project is related to sub-call B topics "Techniques for measurement and characterisation of the properties of wood, engineered wood and fibres" and "Efficient processes". Project is in the interests of SME's, because most wood product industries and timber builders belong to small or medium size

enterprises. Inexpensive technology will be developed for small wood industries, and fully automated technology for large enterprises.

The ultimate objective is to improve the competitiveness of timber as a structural material and to increase its market share in construction. This will be achieved by improving the cost effectiveness of the wood processing industry and the credibility of timber as a professional structural material by means of better practises of strength grading as part of the sawmilling process.

1. Improving the image of timber as a reliable material having predictable characteristics and ensuring safety of timber structures by improving the reliability of strength graded timber. Grading machines need to replace human visual grading in industrial production, because human visual grading is both slow (expensive) and inaccurate. Furthermore, attitudes in industry have to be improved to win the confidence of customers.

2. Developing intelligent grading - the development of procedures and practices in the supply chain for structural timber and engineered wood products, so that the 1st objective can be fulfilled within the economic constraints of a business. Machine strength grading needs to be combined with appearance grading, and should be done as early as possible in the production chain to enable the economic utilisation of the resulting rejects - these are unavoidable when strength grading is made in a reliable way.

3. Taking full advantage of the strength potential of wood as accurately as possible by using state of the art technology in strength grading and development of new methods as well as renewing the strength profiles given in EN338.

4. Providing information needed for new generation of standards and for using CE marking as positive brand indication for timber.

5. Educating producers, distributors, users and designers to facilitate the adoption of the objectives by the industries.

Found Risk Assessment as a New European approach to landslide hazards (FRANE)

(Ongoing joint project with University of Sannio, Italy, Urbater, France, Morphosis Progetti e Tecnologie Srl, Italy, Isle of Wight Centre for the Coastal Environment, UK, UL Faculty of Civil and Geodetic Engineering; duration 2007-2008)

Abstract:

Landslides affect many areas in Europe. They are characterised by a low probability of evolution as a very catastrophic event but may have very large direct and indirect impact on men, infrastructures and environment. This impact is becoming increasingly dangerous due to the rising anthropisation of the territory (continuous construction of new buildings, roads, railways, etc…). Methodologies for the identification and mitigation of risk are therefore a major issue.

As a matter of fact, many experiences during critical development of landslides have shown a lack of methodologies and above all a non-systematic approach of interpreted risks. Risk management is in practise accomplished by local and regional authorities only during the critical event in a necessarily improvised way. This "reactive" approach induces negative consequences on the identification procedure. For instance, very expensive monitoring systems have been installed on several large landslides without any well-established methodology linking the interpretation of the measures and the understanding of deformation mechanisms to the practical questions concerning the management of the risk, population might be evacuated based on an excessive use of the principle of precaution.

Furthermore, risk can extend well beyond local damage (for instance, risk of river damming which may induce major hydrological hazards: floods, inundation of sewage plants, loss of drinking water resources), so that it must be considered in a wide perspective.

Evaluation of racking strength of KLH system

(Ongoing research project for industry of cross laminated wooden plates KLH Massivholz GmbH; duration 2004-2008)

Abstract:

The new generations of massive cross-laminated (“X-lam”) wooden structures are recently becoming more popular in European market. The new trends are bringing also multi-storey structures. Special

attention is paid to buildings located in earthquake prone areas of middle and south Europe. Therefore, the appropriate guidelines for designing have to be set for existing and new timber structural systems to assure their seismic resistance.

The research project deals with X-lam wooden wall panels as product of Austrian Company KLH Massivholz GmbH. The main target of the project is to obtain reliable data on the mechanism of behaviour of massive X-lam wooden wall panels that will contribute to design and construction of seismic resistant and safe buildings.

In the scope of the project numerous of racking tests were carried out on full walls and walls with openings of different lengths and story height at combined constant vertical load and monotonous or cyclic horizontal load applied according to different loading protocols. Wall panels were tested at various boundary conditions which enabled wall deformations from cantilever up to pure shear. Influences of boundary conditions, magnitudes of vertical load and type of anchoring systems were evaluated on the base of deformation mechanisms and racking strengths of wall segments. Differences in mechanical properties between monotonic and cyclic responses were studied.

Additionally two full-scale one story models have been constructed and tested on the shaking table at the IZIIS Laboratory in Skopje, Macedonia in order to investigate the response of massive X-lam wooden wall system under earthquake excitation. The basic idea was to make a correlation between the results from the quasi-static tests and the results from the shaking table tests. Comparative tests on structural segments with two parallel walls of length 244 cm and story height linked together with wooden ceiling were dynamically tested with harmonic and seismic excitation. The main task is to define mechanical properties of dynamic responses of tested models. Dynamically developed failure mechanisms on wall segments could confirm reality of proper boundary conditions set at quasi-static racking tests executions.

The project was divided into three parts according to the following research topics:

- Evaluation of racking strength of full massive wooden walls and walls with openings
- Study of influence of openings on shear strength and stiffness of KLH walls
- Seismic and dynamic testing of KLH models

3 Recent Publications

Čas B., Trtnik G., Saje M., Turk G., Planinc I. (2006) Shear strain and buckling of plane timber trusses. WCTE 2006 : conference proceedings. Portland, 8pp.

Dujič B., Aicher S., Žarnić R. (2005) Investigations on in-plane loaded wooden elements - influence of loading and boundary conditions = Untersuchungen an Scheibenbeanspruchten Holz-wandelementen - einfluss der Belastung und der Lagerungsbedingungen = Etude des murs en bois charges dans leur plan - influence du chargement et desconditions d`appui. Otto-Graf-J., 16, 259-272.

Dujič B., Aicher S., Žarnić R. (2006) Racking Behaviour of Light Prefabricated Cross-Laminated Massive Timber Wall Diaphragms Subjected to Horizontal Actions = Wandscheibentragfähigkeit leichter vorgefertigter Kreuzweise verklebter Massivholzelemente bei horizontaler Beanspruchung = Portance de pans de mur prefabriques massifs et legers en bois lamelle-croise sous chargement horizontal. Otto-Graf-J., 17, 125-142.

Dujič B., Žarnić R., Aicher S. (2005) Racking of wooden walls exposed to different boundary conditions. V: CIB-W18 : Meeting thirty-eight, Karlsruhe, Germany, August 2005, (Meetings-International Council for Building Research Studies and Documentation, W18, Timber structures). Karlsruhe: Lehrstuhl für Ingenieurholzbau und Baukonstruktionen Universität Karlsruhe, 1-9.

Dujič B., Hristovski V., Stojmanovska M., Žarnić R. (2006) Experimental investigation of massive wooden wall panel systems subjected to seismic excitation. V: First European Conference on Earthquake Engineering and Seismology : 3-8 September 2006, Geneva, Switzerland : proceedings : a joint event of the 13th European Conference on Earthquake Engineering & 30th General Assembly of the European Seismological Commission. 1-10.

Dujič B., Žarnić R. (2006) Study of lateral resistance of massive X-lam wooden wall system subjected to horizontal loads. V: International workshop on Earthquake engineering on timber structures : november 9-10, 2006, University of Coimbra, Coimbra, Portugalska. Coimbra: University of Coimbra, 97-104.

Dujič B., Klobčar S., Žarnić R. (2006) Influence of openings on shear capacity of masive cross-laminated wooden walls. V: International workshop on Earthquake engineering on timber structures : november 9-10, 2006, University of Coimbra, Coimbra, Portugalska. Coimbra: University of Coimbra, 105-118.

Dujič B., Aicher S., Žarnić R. (2006) Testing of Wooden Wall Panels Applying Realistic Boundary Conditions. V: WCTE 2006 : conference proceedings. Portland, 8 pp.

Dujič B., Kokalanov G., Gramatikov K., Žarnić R. (2006) Numerical model for the determination of load-bearing capacity of wood-frame shear wall panels. V: Wood resources and panel properties: conference proceedings : Cost Action E44-E49, Valencia, Spain, 12-13 June 2006. Valencia: AIDIMA, Furniture, wood and packaging technology institute, 179-188.

Dujič B. (2006) Dynamic testing of two different timber wall construction systems: Report of a Short Term Scientific Mission to IZIIS - Skopje - Macedonia within the frame of COST E29 "Innovative Timber and Composite Elements/Components for Buildings". Ljubljana: Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, KPMK, 25 pp.

Hanhijärvi A., Ranta-Maunus A., Turk G. (2005) Potential of strength grading of timber with combined measurement techniques: report of the Combigrade-project, phase 1, (VTT publications, 568). [Espoo, Finland]: VTT Technical Research Centre of Finland, cop. 88 pp.

Hanhijärvi A., Ranta-Maunus A., Turk G. (2005) Relations between strength of sawn timber and non-destructive indicators. Proceedings of the Conference on Probabilistic Models in Timber Engineering, COST ACTION E24 : Reliability analysis of timber structures. 127-134.

Hozjan T., Turk G., Srpčič S. (2007) Fire analysis of steel frames with the use of artificial neural networks, Journal of Constructional Steel Research, doi:10.1016/j.jcsr.2007.01.013 (in press).

Hristovski V., Stojmanovska M., Žarnić R., Dujič B. (2005). Experimental and analytical evaluation of the racking strength of massive wooden wall panels-preliminary project phase. V: Earthquake engineering in the 21st century : to mark 40 years of IZIIS - Institute of Earthquake Engineering and Engineering Seismology : 27. August - 1. September 2005, Skopje - Ohrid. Skopje: IZIIS, 1-7.

Kocetov Misulic T., Dujič B., Gramatikov K., Žarnić R. (2006) Influence of loading protocols on hysteretic response of sheathing -to-framing nailed joints in shear walls. V: International workshop on Earthquake engineering on timber structures : november 9-10, 2006, University of Coimbra, Coimbra, Portugalska. Coimbra: University of Coimbra, 135-142.

Savšek-Safić S., Ambrožič T., Stopar B., Turk G. (2006) Determination of Point Displacements in the Geodetic Network. J. surv. eng., 132 (2) 58-63.

Schnabl S., Turk G. (2006). Coupled heat and moisture transfer in timber beams exposed to fire. WCTE 2006 : conference proceedings. Portland, 8 pp.

Schnabl S., Planinc I., Saje M., Čas B., Turk G. (2006) An analytical Model of layered continuous Beams with partial Interaction. Struct. eng. mech., 22 (3) 263-278.

Schnabl S., Saje M., Turk G., Planinc I. (2007) Analytical Solution of Two-Layer Beam Taking into Account Interlayer Sli pand Shear Deformation, Journal of Structural Engineering, ASCE, ST/2006/025111 (in press).

Schnabl S., Saje M., Čas B., Turk G., Planinc I.. (2005) Multilayered Timoshenko beams with interlayer slip : exact solution : paper 179. Topping B. H. V. (edit.). Proceedings of the Tenth International Conference on Civil, Structural and Environmental Engineering Computing, Rome, Italy, 30 August-2 September 2005. Stirling [Scotland]: Civil-Comp Press, 18 pp.

Schnabl S., Saje M., Turk G., Planinc I. (2007) Locking-free two-layer Timoshenko beam element with interlayer slip, Finite Elements in Analysis and Design, doi:10.1016/j.finel.2007.03.002 (in press).

Schnabl S., Turk G. (2006) Numerical modelling of charring in timber beams exposed to fire : Paper 144. Topping B. H. V. (edit.), Montero G. (edit.), Montenegro R. (edit.). Proceedings of the eighth International conference on computational structures technology, Las Palmas de Gran Canaria-Spain, 12-15 September 2006. Stirling: Civil-Comp, 10 pp.

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Srpčič J. (2004) Timber bridges - yesterday, today, tomorrow, Wood (Ljublj.), 2004, 56 (4), 95-100.

Srpčič J., Knez F. (2004): Prefabricated timber houses for Europe, Finance, 26.1.2004, add. Real estate Informer, 16, 33

Srpčič J. (2005) CE mark for prefabricated houses, Finance. 11.7.2005, add. Real estate Informer, 132, 26

Srpčič J. (2006) Proper construction and regular inspections: how safe are (our) timber structures: Delo (Ljublj.), 19. 1. 2006, 48 (15) 17

Srpčič S., Srpčič J., Krauberger N., Turk G. (2006) Determination of MC by nondestructive gravimetric method. Joint meeting of European Society for Wood Mechanics and COST Action E35 : Pre-Proceedings. Firenze: Il David, 208-211.

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Žarnić R., Aicher S., Dujič B. (2005) Influence of boundary conditions on racking strenght of wooden wall panels. V: Earthquake engineering in the 21st century: to mark 40 years of IZIIS - Institute of Earthquake Engineering and Engineering Seismology : 27. August - 1. September 2005, Skopje - Ohrid. Skopje: IZIIS, 1-8.Arnold A., Steiger R. (2007) The influence of wind-induced compression failures on the mechanical properties of spruce structural timber. Materials and Structures 40: pp. 57 – 68.

4 Information about the Slovenian Delegates:

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Prof. Goran Turk is a member of Chair of Mechanics at the University of Ljubljana, Faculty of Civil and Geodetic Engineering. He teaches Statics, Statistics and Operational Research (undergraduate studies) and Reliability of Structures (graduate studies). His research activity includes non-linear computational mechanics, reliability of structures and risk assessment.

He is/was active in a number of national and international research projects. He was an active member of recently completed COST action E24 Reliability of Timber Structures. He is now involved in COST TU0601 Robustness of structures.

Jelena Srpčič
Slovenian National Building and Civil Engineering Institute
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Jelena Srpcic is a head of the Section for Timber Structures in the Slovenian National Building and Civil Engineering Institute (ZAG, Ljubljana). Her field of work is very broad: from different types of mechanical tests on timber structural elements and construction products, the assessment of the condition of timber bridges and of the structural elements of buildings, particularly timber roof and floor structures, and is also involved in assessing timber cultural heritage. She is involved in implementation of the attestation of conformity procedures based on the requirements of the Construction Products Directive (CPD) and is a coordinator and an expert in the several projects financed by European Commission (PHARE) and International Finance corporation (IFC).

Se was active in a number of national and international research projects (cooperation with USA). She participated in COST actions: E5 (Timber Frame Building Systems), E8 (Mechanical performance of wood and wood products) and recently completed E24 (Reliability of Timber Structures). She is also involved in COST E29 (Innovative timber & composite elements/components for buildings).

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WG II: Vulnerability of Components

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Born 1971, Ph.D. from 2001, member of Chair for Research in Materials and Structures at University of Ljubljana, Faculty of Civil and Geodetic Engineering, Teaching Assistant for Building Materials and Experimental Analysis of Structures. He is involved in analytical and experimental research in materials and seismic resistance of timber and composite structures.

Recently his research activities were and still are tight connected with MPA Stuttgart Otto-Graf-Institute, JRC Ispra and IZZIS - Institute of Earthquake Engineering and Engineering Seismology in Skopje, Republic of Macedonia.

He is/was investigator in a number of national and international research projects, where some of them are/were r+d and applied industry projects. He was principal investigator on bilateral intergovernmental S&T cooperation projects with Republic of Macedonia and with Czech Republic. He was acknowledged by Consortium of USA Universities for Research in Earthquake Engineering for the participation on International Benchmark Workshop in the scope of CUREE-Caltech Woodframe Project for valuable contribution to the Benchmark effort by conducting and presenting a blind prediction of the structural response of a full-scale model of a two-story house that was subjected to shake table experiment at UC San Diego.

In this period and for next two years he is a head of Traffic and Construction Laboratory of the Faculty, where he developed and set-up specific testing device for evaluation of racking and shear properties of different wall compositions.

He is co-owner of CBD Ltd - Contemporary Building Design Company which plans innovative constructions - mostly from timber.

WG III: Robustness of Systems

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SPAIN

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Miguel Nevado works as private consultant on the field of timber engineering. Main areas of activity are:

- Diagnosis and repair of ancient structures.
- Court expertise.
- Technical support in design and erection of new timber structures.
- Technical support to local users of imported timber based structural materials.

He has been involved in several COST Actions related to FFP group (508, E5, E8, E9, E10, E24 and E29), and cooperates usually with the Spanish Administration in the development of new standards related to the structural use of timber.

Currently he's working on the implementation of structural reliability methods related to the use of home grown timbers, and the probabilistic assessment of existing structures.

Usually he cooperates with AITIM (www.aitim.es) Spanish Wood Based Industries Technical Resarch Ass., mainly in quality control of producers of timber structures and timber based housing.

RELEVANT PUBLICATIONS

Diseño Estructural en Madera (Aitim, Spain, 1999)

Nature and Shipbuilding (in Optimization Mechanics in Nature, London South Bank University, United Kingdom, 2004)

SWEDEN

1 Research Institutions

Lund University, Division of Structural Engineering, www.kstr.lth.se

The division is represented by Dr Tord Isaksson and MSc Eva Frühwald. The field of Structural Engineering deals with principles and methods for design of building and civil engineering structures. The objective in design is to create structures with adequate safety and serviceability under the influence of the relevant loads and actions during the lifetime of the structure.

The main research areas are:

- Concrete Structures
- Information Technology in the Building Process
- Masonry Structures
- Timber Engineering and Wood Science

The research is in general applied and is conducted in close co-operation with the industry. Most projects are initiated and formulated with clearly defined objectives originating from problems and needs identified in the building, civil engineering and industrial fields.

The common objective to the timber and wood research field is to improve the quality of the material with regard to its engineering properties. Better knowledge of the properties and the behaviour of wood and timber may lead to better utilisation of the material and enhances the development of new design procedures and more advanced use of wood as an engineered material. Some of the Swedish wood industries and building companies are also involved in the projects which increase the possibilities to disseminate results from the projects into practice.

Växjö University, School of Technology and Design

Växjö University is represented by Prof. Erik Serrano. At the school of technology and design, wood and timber related research is undertaken at the departments of a) civil engineering and b) forestry and wood technology. Timber engineering research is conducted in a cross thematic research group, shared by these two departments. Areas of research include wood mechanics, the static and dynamic behaviour of timber structures and elements, with special emphasis on stabilisation of multi-storey wooden buildings, mechanical and adhesive joints and deformations and vibrations of light-weight, timber floor elements. Most of the research is conducted in close co-operation with industry.

The timber construction sector of Sweden is facing tremendous challenges. Today’s relatively labour intensive and poorly industrialised production of wooden houses could very well be moved to other countries with low labour costs. In order to increase the competitiveness of Swedish wooden industry, increasing its markets shares for wooden housing in Sweden, as well as abroad, a fundamental change is needed. This change has been undertaken within other sectors, such as the automotive industry, during the last decades. Therefore, there should be a clear opportunity to take advantage of that industry’s experience in the process of transforming into the modern industrialised timber construction. The change must take place within several areas which, in a broad sense, relate to timber construction in order to create a competitive, industrialised industry.

2 Past and Present Research Activities

3 Lund University:

System reliability of timber structures with particular application for roof trusses

Structural timber exhibits a significant statistical variability both between members and within members. The consequences of this variability for the reliability (safety level) in timber structures are not fully understood. To study this effect a roof truss is chosen to perform computer analysis (using the Monte Carlo method). Some of the stochastic variables that are to be studied are between and within member strength, external loading and variability in joint behaviour. Further the reliability of timber truss system is affected by structural load sharing including non-linear behaviour of joints.

Reliability of timber structures under moisture actions

Moisture conditions are of great importance for the performance of structural elements and systems made of wood. The objective of this project is to improve design methods by development of a methodology for probability based analysis of timber components and systems under moisture actions. Serviceability aspects as well as safety aspects are addressed. Statistical descriptions of load capacities and performance factors will be determined from Monte Carlo simulations of effects of moisture actions for different service conditions. Current design methods used in codes will be evaluated and modifications will be suggested if necessary.

Internal Stresses in Wood Elements Caused by Natural Humidity Variations

Internal stresses perpendicular to grain are generated in wood cross sections due to continuously varying non-uniform moisture distributions created by natural humidity variations. Such internal stresses are very important for the strength of wood in all those cases when fracture is initiated perpendicular to grain, which is valid for most modes of failure in timber elements and joints.
The research includes experimental investigations of stress-strain behaviour of wood perpendicular to grain during moisture variations, as well as constitutive modelling and computer simulation of moisture induced stresses in timber cross sections.

Within Member Strength Variation

The main goal with the project is to gain a better understanding of the implications of the lengthwise variation in strength of timber members, and to study its consequences on reliability of timber structures in different situations occurring in practice. A stochastic model for lengthwise variation of strength based on extensive test results for Swedish timber has been developed. The model is applied in various studies of reliability of timber elements and systems.

Design for durability

The objective is to provide an engineering methodology that enables the specifier and the customer to predict the performance over time of wood-based products in the construction sector. This methodology will be applicable to planning and design of buildings, cost-optimization, maintenance of existing buildings, and material-neutral comparisons of the long-term performance of different construction products across a wide range. The design should be based on reliability methods comparable to those used for design for structural failure and serviceability. A state-of-the art report is written and an ongoing project aims at providing a pilot study for a specific design situation. Further, there are plans for a more comprehensive national project as well as projects on a European level.

Design of safe timber structures – how can we learn from structural failures in concrete, steel and timber?

The joint Swedish-Finnish project “Innovative design, a new strength paradigm for joints, QA and reliability for long-span wood construction (InnoLongSpan)” was conducted 2004–2007. The project dealt with two main issues: (1) design of joints used in long span timber structures and (2) documenting reliability and developing quality assurance of large and demanding timber structures. In the second subtask, a survey of failures in large scale timber structures was carried out with the objective to obtain in-depth information about causes for failures in wood structural systems. The purpose is to learn from such experience in order to improve control systems and education of timber engineers. It could be concluded that more than 50 % of the failures studied were caused by flaws in the design process, whereas building site errors were responsible for about 25 % of the failures. Typical failure modes observed were instability due to lack of bracing, bending failures and tension failure perpendicular to the grain. Measures to prevent future failures should include improved training of engineers in those fields (design of joints, tension perpendicular to the grain, bracing, etc).

4 Växjö University:

The activities within the research groups at Växjö University have as long term aims to promote the increased use of wood in general, and the use wood and timber as a sustainable resource for industrialised construction in particular.

Within ongoing and planned projects, studies are being and will be performed relating to the production of multi-story timber houses, where the production can take place at production plants or at the building site. The projects span the range from the forest, through value adding processing at saw mills and through the manufacturing of components and building systems, to projects relating to the properties of the final products, and the processes involved in the chain.

Planned and ongoing projects within the sub-area of *Timber Engineering* involve the study of the wood material, components and joints, as well as the study of system behaviour in multi-story timber buildings. Five PhD-projects are running within this field:

“Long Span Floor Design”

“High Performance Structural Timber Walls”

“Influence of Moisture Variations on Timber Joints during Construction and Use”

“Structural and acoustic performance of wall and floor connections in timber framed dwellings”

“Modelling of internal properties of sawn timber”

Other ongoing projects include

“Value-adding processes by wet and dry gluing of timber”

“Efficient jointing techniques for multi-storey timber construction”

“Deformations and vibrations in timber floors – modelling and design methods”

“Documentation of some technical aspects at ‘Limnologen’ - A 7-storey timber building”

Planned research areas include:

“The hygromechanical behaviour of laminated wood products”

“Fracture in wood – Material, components and joints”

“The use of contact free deformation measurement for wood and timber applications”

“Timber construction in a life-cycle perspective”

Växjö University also took part in the project “Innovative design, a new strength paradigm for joints, QA and reliability for long-span wood construction (InnoLongSpan)” mentioned above under Lund University. Through Erik Serrano work was performed in both the survey of failures and in a sub-task relating to the numerical modelling of dowel type joints.

5 Recent Publications

Lund University

Visit www.kstr.lth.se: List of publications.

Växjö University - Scientific papers in journals (2005-2007)

Ditlevsen, O., Källsner, B.: Span dependent distributions of the bending strength of spruce timber. ASCE Journal of Engineering Mechanics, 131(5), 485-499, May 2005.

J. Eriksson, S. Ormarsson, H. Petersson et al. An experimental and numerical study of the shape stability in glued columns. Holz als Roh- und Werkstoff, Vol. 63:423-429, 2005.

J. Eriksson, S. Ormarsson, H. Petersson. Finit-element analysis of coupled non-linear heat and moisture transfer in wood. Numerical heat transfer – Part A – Applications. 2006 - Vol.50 Issue.9, pp. 851-864.

J. Oja, B. Källsner, S. Grundberg. Predicting the strength of sawn wood products: A comparison between X-ray scanning of logs and machine strength grading of lumber. Forest Products Journal, Vol 55(9).

S. Ormarsson, D. Cown. Moisture-Related Distortion of Timber Boards of Radiata Pine: Comparison with Norway Spruce, Wood and Fiber Science, 37(3):424-436.

K. Salmela and A. Olsson: Dynamic Properties of a Sawn Timber Floor Element with High Transverse Bending Stiffness, Journal of Building Acoustics, 13(4), 295-310, (2006).

E. Serrano and B. Enquist. Contact-free measurement and non-linear finite element analyses of strain distribution along wood adhesive bonds. Holzforschung, 59 (6) 2005 pp. 641-646.

Serrano, E., and Gustafsson, P.J. Fracture mechanics in timber engineering –Strength analyses of components and joints. Materials and Structures (2007) 40:87–96.

J. Sjödin and E. Serrano. "A numerical study of the effects of stresses induced by moisture gradients in steel-to-timber dowel joints". Holzforschung, 60 (6) 2006 pp.694-697.

J. Sjödin, E. Serrano and B. Enquist. Contact-free measurement and numerical analyses of the strain distribution in the joint area of steel-to-timber dowel joints. Holz als Roh- und Werkstoff 64 (6) 2006 pp. 497-506.

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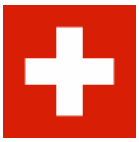

SWITZERLAND

1 Research Institutions

Swiss Federal Institute of Technology, Zurich (ETH), www.ethz.ch

Institute of Structural Engineering (ETH/IBK), www.ibk.ethz.ch

ETH/IBK is represented by Prof. M.H. Faber and Dr. J. Köhler, both affiliated with the Group of Risk and Safety at ETH/IBK. The research mission for the group is to develop new theories, techniques and procedures for the enhancement of decision making in the area of civil engineering with the perspective of improving the quality of life for the individuals of society. Main focus areas include applied decision theory, risk management, risk assessment, life-cycle costing, structural reliability theory together with probabilistic and statistical modelling and assessments. Fundamental research is ongoing in the areas of sustainability, risk perception, risk aversion and risk acceptance criteria. The group is leading and participating in several activities related to management of risks due to natural hazards as well as hazards in a broader context.

In the area of Timber Engineering research the group is actively involved in pre-normative research and in the development of probabilistic modeling of timber structural behaviour.

Institute for Building Materials (ETH/IfB), www.ifb.ethz.ch

ETH/IfB is represented by Prof. P. Niemz, the head of the Group 'Wood Physics'. The group is engaged in the research of the physical and mechanical properties of wood and wood products and the basics of non-destructive wood testing. Main focus areas include:

Determination of mechanical-physical material properties (macro- and micro range)

Research on moisture absorption, swelling and improvement of wood (i.e. thermical improvement, modelling of moisture transport in large scale components, calculation of tensions due to climatic changes)

Non-destructive material testing (basics of error detection, utilisation of neutron-radiograghy)

Heat treated timber and its alteration in structure and properties

Swiss Federal Laboratories for Materials Testing and Research (EMPA), www.empa.ch

EMPA is represented by Dr. K. Richter and Dr. R. Steiger, both affiliated with the EMPA Wood Laboratory (www.empa.ch/wood). The Wood Laboratory pursues research and development as well as ambitious services to promote the sustainable use of wood specifically in capital goods. The activities focus on wood derived materials and their utilisation in products, processes and systems within the forestry-wood production chain, with special emphasis on application in building and construction. A team of qualified specialists solves the given questions mainly with inter- and transdisciplinarly structured co-operations, thus using available competence and infrastructure of other disciplines and laboratories.

The current research programs of the Wood Laboratory are:

Material modification for new wood based applications. Here the Lab contributes to a better understanding of the organization and function of the wood cell wall and its composition from the

nanoscale to the macroscopic level. The knowledge derived from this pure research will enable a new value-added utilisation of wooden resources and promotes the transfer of highly developed biological concepts into technical applications.

Durability of wood and wood based products. Strategies are developed to improve the durability and robustness of timber applications in buildings with regard to the encountered impacts and stress factors, whilst considering side-effects on human health and environmental impact of the proposed technologies.

Materials and systems for timber engineering. A scientific basis shall be provided for an efficient use of timber and wood based composites in engineered structures with the objective to adjust the reliability and fitness of wood in service under predicted strains. This requires a sound knowledge of the material characteristics of all types of wood used in service as well as in combination with other materials such as composites, or in load bearing structures.

Bern University of Applied Sciences (BFH)

The Berner University of Applied Sciences Architecture, Wood and Civil Engineering (BFH) department is one of the leading Swiss universities of applied sciences in wood construction, design and engineering. The department is a competence centre with both national and international reputation and links. In the area of wood technology, it is considered to be the only university of applied sciences of its kind in Switzerland and stands comparison with international standards.

Today, a team of approximately 80 people (engineers and lecturers) works in planning, coordination and execution of national and international research projects in the area of construction and wood engineering. In particular, the Material and Wood Technology unit, counts more then 12 employees actively involved in applied research and development.

Services for third parties

The center of competence performs tests, designs, expert reports or advisory services for the economy and society. Services such as feasibility studies, product and production improvement, product testing, etc. are offered. The laboratories are accredited by METAS (Swiss Federal Office of Metrology and Accreditation) according to ISO/IEC 17025.

Knowledge and Technology Transfer

Practice-oriented training events enable our center of competence to ensure the transfer of knowledge and technology to the wood and construction sector. The events are major platforms for the intensive exchange of information with the economy and are an excellent way to maintain existing contacts and making new ones.

2 Planned and ongoing Research Activities

Prediction and Assessment of the Life-cycle Performance of Timber Structures

(planned joint project with ETH/IBK, ETH/IfB, EMPA and BFH, the research team will be completed by one PhD student, full time working on the project; duration 2007 -2010)

Abstract:

The safe and sustainable use of materials in construction necessitates that the life-cycle performance of structures can be predicted and reassessed with sufficient accuracy. Recent research achievements in the field of materials science and structural reliability provide a framework for the quantification of safety, durability and life-cycle costs of structures. These achievements are so far mainly used in the field of concrete and steel structural engineering. The knowledge about the behaviour of timber materials and structures is still considered as being insufficient for its use in such a framework. The aim and main objective of the proposed research project is to provide the basic framework and knowledge required for the efficient and sustainable use of timber as a structural and building material. This will be achieved by building on four main research activities: the identification and modelling of relevant load and environmental exposure scenarios, the improvement of knowledge concerning the behaviour of timber structural elements, the development of a generic framework for the assessment of the life-cycle vulnerability and robustness of timber structures, and the improvement of methods for the evaluation of the strength and stiffness behaviour of existing timber structures. The proposed research project will be

conducted in connection with the COST action E55. The expected achievements of the proposed research project will provide major contributions to this COST action. Simultaneously the COST action E55 will provide a platform of international experts to frequently discuss critically the achievements of the research project to the benefit of the overall impact and relevance of the work.

Development of an Efficient Scheme for Timber Machine Stress Grading

(running PhD joint project with ETH/IBK and EMPA in the framework of COST Action E53 'Quality Control for Wood and Wood Products'; duration 2006 – 2009)

Abstract:

Despite the high potential of modern machine grading systems to assess the timber strength, machine grading is rarely utilized in practice; timber at the market is still predominantly visually graded. The high potential of machine grading for improving the efficiency of using timber in load-bearing structures and therefore to assure and competitiveness of timber with other building materials is not used to the full extend. This, because many timber-producing companies do not invest in expensive grading systems and current normative policies do not allow the consistent integration of the information gathered during the grading process and therefore do not facilitate the probabilistic modeling of graded timber material properties. In order to stay competitive the forestry-wood-structural timber chain needs to increase its efforts towards improved methods of quality control throughout the whole production line.

The aim and main objective of the proposed research project is to provide all involved parties an efficient scheme for machine timber grading.

The work will deliver a theoretical framework for the probabilistic modeling of graded timber material properties. A best practice procedure for timber grading will be developed considering all the needs and technical requirements identified throughout this project. In a case study, in close collaboration with the Swiss timber industry, the possible benefits of advanced grading systems will be shown and the results will be actively disseminated.

The research project is conducted in connection with the COST action E 53. The future achievements of the proposed research project will provide major contributions to this COST action. Simultaneously the COST action E53 will provide a platform of international experts to frequently discuss critically the achievements of the research project to the benefit of the overall impact and relevance of the work.

Ductile adhesive interface for glulam

(Ongoing research project of BFH in cooperation with EMPA and HTW-Chur).

Abstract:

The new European Structural Design Codes favour materials with ductile properties because of their greater structural reliability and robustness. The bending resistance is higher than that of brittle materials of the same cross-section and the same nominal failure stress. Ductile materials are capable of stress redistribution and can absorb kinetic energy: they perform favourably in extreme loading situations such as a vehicle crash or earthquakes. In comparison to steel or concrete, the timber beam is brittle: improving that could help to enhance the robustness of this environmentally friendly material.

The project is built on four main pillars. The first step is the development of calculation models to describe the load-bearing behaviour of a ductile glulam beam as a tool to help establishment the required load-bearing properties of the adhesive interface. The next step is the manufacture of different adhesive mixes by the partner adhesive company. Selected adhesives will be used to manufacture glulam beams for bending tests. Finally, the long term behaviour, in particular creep and chemical stability, needs to be closely monitored.

Because of the importance of ductility as a major criterion for structural reliability, the research project may provide a useful discussion platform at the COST action E55. It is also of educational relevance: one MSc student (in cooperation with EPINAL, France) and one PhD student (Bauhaus-Universität in Weimar) are working on the project.

Automated long-term Monitory System for Timber Structures

(Ongoing research project of BFH).

This research project tackles the need to monitor timber structures in order to be able to recognize structural weakening and make timely repairs to prevent possible collapse.

As a first step, a methodological approach will be defined as a help to achieve a long-term monitoring of timber structures.

The measuring-systems needed for the monitoring of timber structures are either not yet available on the market or, if available, only at great cost. Hence, in cooperation with industrial partners, measurement and control devices will be developed to maturity and readiness for mass production.

Appropriate testing and analytical methods for damaged or vulnerable timber structures

(Ongoing research project of BFH).

In this project general methods will be developed for the testing of damaged or aged buildings. Numeric methods will also be developed to analyze the test results in order to determine the remaining load-bearing capacity of the timber members.

There is a tremendous market for the inspection of existing timber buildings and structures which may be already partly damaged. There is a need to define the general approach for these inspections. It seems prudent to start with existing test methods, which have been successfully applied to other materials, and to adapt them as needed for timber structures.

The research unit Timber Construction at the BFH-AHB has gained some years of experience with existing testing methods. In doing so, the researchers have recognized that many of them are not really appropriate for timber. There is a tremendous need for more appropriate testing methods on the one hand and more suitable analytical possibilities on the other to determinate the remaining load capacity.

The results of this project will help industrial partners to adapt existing testing and analytical methods – or, if being needed, to develop completely new ones - to make them more appropriate for timber structures. This will help to ensure that more accurate testing can be conducted and more helpful remedial actions can be defined.

3 Recent Publications

Arnold A., Steiger R. (2007) The influence of wind-induced compression failures on the mechanical properties of spruce structural timber. Materials and Structures 40: pp. 57 – 68.

Blumer, S. (2006) Moisture induced stresses and deformations in parquett floors – An experimental and numerical study. Diploma thesis ETH Zurich / Lund University. ISSN 0281 – 6679.

Blumer, S., Howald, M., Niemz, P. (2007) Ermittlung ausgewählter mechanischer Eigenschaften von Massivholzplatten mittels Eigenfrequenzen mittels Eigenfrequenz - Teil 1: Material und Methodik. Holztechnologie 48: 2. S. 1-4.

Blumer, S., Howald, M., Niemz, P. (2007) Ermittlung ausgewählter mechanischer Eigenschaften von Massivholzplatten mittels Eigenfrequenzen mittels Eigenfrequenz - Teil 2: Versuchsergebnisse und Interpretation. Holztechnologie 48: 3. S. 1-6.

Brunner M., Engels I. (2006) Special adhesive for ductile glulam beams. World Conference on Timber Engineering WCTE 2006, Portland, USA.

Brunner M., Jung P. (2006) On the increasing importance of tensile loading perpendicular to the grain in some new timber structural products. World Conference on Timber Engineering WCTE 2006, Portland, USA.

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Dr. J. Köhler is research associate at the Group 'Risk and Safety' at the institute of structural engineering at ETH Zurich. He is an expert in probabilistic modelling and risk analysis and was an active member of the COST Action E 24 'Reliability of Timber Structures'. He is one of the main contributors for the recently released 'Timber Probabilistic Model Code' of the Joint Committee on Structural Safety. He is the Swiss delegate for the COST action E53 'Quality control for wood and wood products' and he is the main proposer and the Chaiman of the Management Committe of COST action E55 'Modelling the Performance of Timber Structures'.

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Dr. R. Steiger is an expert in timber engineering and a research associate at the Wood Laboratory of the Swiss Federal Laboratories for Materials Testing and Research EMPA. His activities in research, r+d as well as consulting are related to the field of structural engineering with a special emphasis on timber structures. This includes aspects of reliability of timber structures, mechanical behaviour of timber structural elements and timber grading. He is actively involved in several Swiss code committees. He is e.g. president of the commission SIA 265 'Timber Structures' and he is member of the commission SIA 260 'Basis of Design and Maintenance of Structures'. Furthermore he is member of the CEN technical committee (TC) 250/SC 5 for EUROCODE 5 'Design of Timber Structures'. Related with EMPA's activities in quality control and testing, R. Steiger frequently deals with consulting, experts' reports and examination of damaged timber structures.

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WG I: System Identification and Exposures

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A. Müller is the head of the research and development unit 'Timber Construction and Building Physics' and lecturer for 'Timber Constructions' in the division of wood engineering in the BFH-AHB. As an authorised expert for timber constructions and timber bridges he was involved in certifying new timber products, construction technologies and especially timber bridges in Germany for many years. Since he started his engagement in Switzerland he has performed numerous experts' assessments for failed and malfunctioning timber structures. Mr. Müller is a member of the engineer's chamber Baden-Württemberg and of the technical committee of the 'Study Group Glulam' - CTT Council of Timber Technology.

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Dr. K. Richter is head of the Wood Laboratory of EMPA. He conducts wood technology research related to the application of wood products in building and construction, with a focus on wood adhesion, surface treatment, and timber modification. For more than a decade he has been actively involved in life cycle assessment and environmental evaluation of wood products. He acted as management committee member in Cost action E13 (Wood adhesion and glued products) and is currently participating in the follow-up Cost action E34 'Bonding of timber', where he chairs the working group 'Bonding timber on Site'. He is member of the commission SIA 265 'Timber Structures' and leads the Swiss delegation of CEN TC 193/SC1 'Wood Adhesives'. As head of the Wood Laboratory he has contributed to the drafting of guidelines and rules for quality control systems for

timber products and building systems.

WG II: Vulnerability of Components

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Dr. C. Sigrist is professor for timber construction BFH-HBA. Next to his implication in timber design he worked for several years with the materials steel and concrete in the areas of post tensioned construction and heavy lifting (construction methods). Over several years he gained expertise in the field of connection technology and timber grading. The quality control within the production of glulam of all major producers in Switzerland takes place under his lead. He was the Swiss delegate for various COST actions (COST E5, E15, E29) and was responsible for several research projects issued from and related to these actions. He is member of the commission SIA 265 'Timber Structures' and furthermore he is member of the CEN technical committee (TC) 124.

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Peter Niemz is director of the Laboratory for Wood Physics and Non Destructive Testing Methods at the Swiss Federal Institute of Technology (ETH) since 1996. He was awarded the title of Professor in 2002.

Main points of his work are the study of physical-mechanical characteristics of wood and timber materials as well as the structure characteristic relations of timber materials and their modeling. He is the Swiss delegate for the COST action E35 'Fracture mechanics and micromechanics of wood and wood composites with regard to wood machining' as well as an active participant in the COST actions E34, E40, E49 and E53. Since 2002 he is member of the IAWS (international Academy of Wood Science).

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WG III: Robustness of Systems

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Prof. Dr. M. H. Faber is chair of the Group 'Risk and Safety' at the institute of structural engineering at ETH Zurich. He is active in research related to rational decision making in civil engineering problems subject to uncertainty. This includes all aspects of probabilistic modelling; risk based optimal design, experiment planning, maintenance planning, life cycle analysis, acceptance criteria and recently also sustainability. He is actively involved in JCSS, ISO, ESRA, IFED, IABSE, CERRA, fib, Swiss Dam Committee and Swiss Code Committee. In the completed COST action E24 'Reliability of Timber Structures' he was leader of the working group on 'materials modelling and reliability of timber components'. The main outcomes of the COST E24 Action are related to necessary pre-codification modelling aspects concerning the performance of timber components in regard to strength and stiffness properties.

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Dr. Maurice Brunner is Prof. for Structural Analysis and Design. Before his academic calling he was active for many years in the Swiss consulting business and successfully contributed to the design and construction of several structures in steel, concrete and timber. His main research interests are composite structures, ductility issues in timber structures, strengthening of timber structures with prestressed FRP, and the structural performance of wood adhesives. He has participated in various COST actions including C12, E13 and E34.

NETHERLANDS

1 Research Institutions

University of Technology Eindhoven, (TUE),), www.tue.nl/en/)

Faculty of Building and Architecture, Structural Design (BK/SDCT), www.bwk.tue.nl/co/

The SDCT-group (Structural Design and Construction Technology) is being represented by Dr. A.J.M. Leijten, PhD student Ir. J.C.M. Schoenmakers and Prof.dr.ir. A.J.M. Jorissen.

The research of the Timber Unit is aimed at optimisation and innovation of structural systems, composite structures, structural elements and components and its connections. The research projects are both fundamental and applied but always aimed at solving practical design problems for timber structures and its components. Furthermore, structural timber courses for Bachelors and Master Students are provided. The presence of a testing lab facilitates Master thesis work were experimental support is required. As one of the few groups in Europe bamboo for structural application has been a specialized field for the last decades, resulting in a number of PhD thesis.

Most of the research is carried out in cooperation with Master students. Recently this resulted in research on the failure mechanism of load-bearing beams caused by connections, multi storey timber buildings (both post-and-beam and timber frame structures), an architectural and structural timber design including determination of the structural timber properties, a calculation model for the determination of the structural properties of glued laminated bamboo, the strength of glued in rods in chemically modified timber, the embedment strength of large diameter dowel type fasteners, the embedment strength of dowel type fasteners in two different bamboo species.

Research is ongoing in the field of traditional carpentry connections in which the strength of connections with wooden dowels is of most interest, full threaded screws, applicability of the so-called “Zollinger” buiding system, applicability of poplar structures, notched beams with various notch geometries.

Furthermore, two PhD projects are ongoing:

- Failure of load-bearing beams caused by connections.

  In this project the strength of connections loading the timber perpendicular to the grain is studied.
- Concepts for the repair of timber structures.

  In this project an evaluation raster for the preservation of valuable timber structures will be developed.

SHR Timber Research, Wageningen, www.shr.nl

SHR Timber Research in Wageningen is represented by Prof.dr.ir. A.J.M. Jorissen. SHR is

an independent research institute carrying out wood related projects for mainly the industry and public organizations (national and local authorities, body for the protection of monuments). Laboratory facilities are available in the field of structural design (limited), wood modification (chemically and thermally), wood durability, timber facades (protection against wind and water), building physics (limited), finishing (coatings), furniture.

Wood chemists, wood anatomists, physics, structural engineers, coating chemists and laboratory staff work together on very different topics related to wood.

Delft University of Technology (TUD), www.tudelft.nl

Delft University of Technology (TU Delft) is the oldest and largest university of technology in the Netherlands with about 5000 employees. The faculty of Civil Engineering and Geosciences is one of 8 faculties with the department Structural and Building Engineering being the centre of research for structural design. The timber research group consists of nine people with backgrounds in physics, wood technology, building engineering and structural engineering. Education is given in Timber and Timber Structures from the 2nd grade until the 5th grade at Master's level. In addition, post academic courses are given. Currently, five Ph.D. projects are running:

- the influence of drying schedules on the mechanical properties of timber
- service life modelling of timber structures
- numerical modelling of timber joints
- structural behaviour of timber joints
- performance of wooden façade elements

Research activities that are relevant for the framework of COST E55 are focused on grading, timber joints and 3D timber structures, as well as service life modeling. Among others, research has been performed into structural assessment of old timber floors, timber joints with wooden dowels, 3D numerical modeling of tube joints, large size timber to timber joints, structural roundwood for lookout towers, large span timber domes, embedding strength of timber and timber-concrete composite floors.

2 Recent Publications

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Prof. dr. ir. A.J.M. Jorissen, professor in structural timber engineering, Section of Structural Design, Faculty of Building Science, Eindhoven University of Technology, Eindhoven, The Netherlands.

He has a part time professorship since 2003 for two days in the week on a secondment contract from SHR (Stichting Hout Research). He made career in consultancy companies where he was responsible for a large number of the timber structures. Currently, he is employed by the timber research institute SHR and deals with matters such as national and international standardization, damage reports, etc. He acted as National Technical Contact in the drafting of the timber design standard Eurocode 5. The 1998 PhD thesis of Prof. Jorissen titled “Double shear timber connections with dowel type fasteners" after which he was involved in many research and deign projects.

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Jan-Willem van de Kuilen is associate professor Timber and Timber Structures at the Faculty of Civil Engineering and Geosciences of Delft University of Technology. His activities deal with teaching and research, with the main research areas being service life modelling of timber structures, modelling of the behaviour of timber joints and timber grading. He has been an active member in a number of COST Actions, including COST E24 'Reliability of Timber Structures', COST E29 'Innovative timber and composite elements / components for buildings' and COST E53 for grading. He is member of several national and international committees for structural design and machine grading and strength class assignments. Before joining TU Delft he worked for 12 years as a researcher in timber engineering at TNO Building and Construction research.

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Dr. ir. A.J.M. Leijten, associate professor, Structural Design, Faculty of Building Science, Eindhoven University of Technology, Eindhoven, The Netherlands is involved in timber engineering research since 1982, and wrote a PhD on an novel timber connection for heavy timber structures in 1998. He is a recognized expert in the field of timber connections and moved recently from TU-Delft to TU-Eindhoven and over the years he was involved in many timber research projects. He took responsibility for re-drafting the chapter on timber connections in the European timber engineering design code Eurocode 5. In 2002 he enjoyed a sabbatical at UBC, Vancouver, Canada and in 2005 at Kyoto University Japan, where he focused on the earthquake resistance of connections. He is active in national and international timber engineering research and structural design code committees.

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Edi Montaruli is a Ph.D. student working in the field of service life modelling of timber structures. The aim of the project is to formulate a damage accumulation model to determine the lifetime and the residual strength of existing timber structures by combining mechanical with decay models. Therefore, laboratory decay tests are being performed and new non-destructive techniques will be applied to characterize the incipient and state of decay of wood.
She has been working in 2005 as researcher at the National Italian Research Council, IVALSA-CNR in San Michele all’Adige, Italy. There she worked in the non-destructive test laboratory for timber grading.
Edi Montaruli received her M.Sc. degree in Physics, with specialization in Physics of Matter, from Università di Bari (Italy) in 2003.

WG II: Vulnerability of Components

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Carmen graduated 2004 as a civil engineer from Karlsruhe University of Technology (TH) in Germany. She then started to work as a structural engineer at the company Schmidlin Facadetechnology AG in Aesch, Switzerland. After one year, she joined the Trees and Timber Institute of the National Italian Research Council, IVALSA-CNR, where she worked in the field of seismic performance of Xlam buildings. In 2007 she started her PhD project on numerical modelling of timber joints at the TU Delft. In this work, failure modes, yield criteria, joint geometries and fastener behaviour will be studied.

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Ir. J.C.M. (Dennis) Schoenmakers, PhD candidate in structural timber engineering, Section of Structural Design, Faculty of Building Science, Eindhoven University of Technology, Eindhoven, The Netherlands.

He finished his Masters thesis in 2006 dealing with connection failure perpendicular to the grain due to crack formation. After his graduation he started a PhD-project titled "Failure of load-bearing timber beams caused by connections". This project is strongly related to the previously mentioned graduation project. It is aimed at describing and explaining splitting problems in timber beams subjected to loads perpendicular to the grain by dowel-type connections. It is intended to increase our knowledge about the splitting failure mechanism by means of conducting experimental and numerical research with the finite elements. This will lead to more reliable predictions of the splitting strength and therefore in more reliable connections in timber structures, as the safety margins become more transparent.

WG III: Robustness of Systems

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Peter de Vries is a research associate at Delft University of Technology in the field of timber structures. He has been working on a number of projects dealing with roundwood including grading of roundwood, the development of joints for roundwood applications and a hyperbolic watch tower of replaceable elements, which was awarded the Timber Innovation Prize 2006. A special connection system has been developed for this tower and structural safety analysis is performed with partially failed members. He is currently working on a research project on the modelling of the structural performance of timber joints with different geometries.

Members of COST E55:-
Research Institutions

About Building Research establishment (BRE)

BRE is the pre-eminent centre for research in the built environment within the United Kingdom. Our Management System complies with BS EN ISO 9001 'Quality Management Systems' and is closely aligned to BS 7799 Information Security Management Part 1 Code of Practice.

BRE is a UKAS accredited testing laboratory, number 0578 and has been accredited at its main site for a range of tests against BS EN ISO/IEC 17025 (General Requirements for the Competence of Testing and Calibration Laboratories).

Our quality policy is to:
- Comply with all relevant legislation
- To provide authoritative and independent services and products that fully satisfy our clients' requirements
- Seek continual improvement in the effectiveness of the quality management system and in the provision of our services and products

The Chief Operating Officer is responsible for implementing the Policy. This will be achieved by:
- Establishing, implementing and maintaining a quality management system certificated against ISO 9001:2000
- Setting and reviewing measurable quality objectives and ensuring those objectives are met
- Providing the necessary resources and ensuring responsibilities and authorities are determined and communicated within BRE
- Reviewing the effectiveness of the quality management system and assessing opportunities for its continual improvement.
- Seeking structured quality feedback from our customer.

BRE is the UK's leading centre for research and consultancy on:
- *construction quality, process and productivity*
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- *energy efficiency of buildings*
- *renewable energy in buildings*
- *certification and listing (www.RedBookLive.com)*
- *aircraft cabin environments*
- *building performance - structures, materials and systems*
- *prevention and control of fire*
- *risk science*
- *crime and security*

A complete review of BRE's services can be found on BRE's website at www.bre.co.uk.

BRE is committed to making its comprehensive expertise and experience available to the benefit of those involved in the construction and associated industries, from multinational companies and government departments to individual architects and builders. It does this through:
- *commissioned research, development and testing programmes for individual clients and consortia,*

- *consultancy and advice*
- *tools and methodologies which promote sustainable design and construction (including BREEAM, EcoHomes, SmartWaste, etc)*
- *product testing for certification purposes*
- *Best Practice programmes (e.g. Energy Efficiency; Construction Best Practice)*
- *publication of BRE Digests, Good Building Guides, Good Repair Guides, research reports, books, etc.*
- *conferences, seminars, workshops and other events*
- *training*
- e-commerce activities (including BRE's online bookshop at *www.BREbookshop.com*)

BRE operates from six sites:
***BRE Garston**, near Watford - the main site, with a range of special- and general-purpose laboratories and test facilities,*
***BRE Scotland**, at East Kilbride - serving the particular needs of the construction communities in Scotland and Northern Ireland.*
***BRE North East**, at Middlesbrough – a specialist facility for large and full scale testing work*
***BRE Highlands**, at Inverness – servicing the North of Scotland*
***BRE Wales**, at Port Talbot - addressing the needs of the Welsh Assembly Government*
***BRE Ireland**, at Limerick – responding to the development and construction agenda in Eire*

BRE's areas of activity are represented by centres of excellence, organised into three divisions:

<table>
<tr><th>Construction</th><th>BRE Environment</th></tr>
<tr><td>

Ground engineering and remediation
Concrete
Timber
Structural performance
Steel construction
Building Fabric
Heritage, archaeology, stone and masonry
Waste and recycling of construction materials including design for deconstruction
Whole Life Performance

</td><td rowspan="3">

Tools and methodologies - BREEAM, EcoHomes, Environmental Profiles and a series of tools and techniques encouraging low energy design and effective energy management
Sustainable communities, including the Sustainability Checklist
Sustainable Masterplanning and Sustainable Construction
Building energy management and audits
Building Design Consultancy - developing output specifications
Technical and Policy support to initiatives run by Government, Carbon Trust, Energy Saving Trust and others
Energy consultancy & research
Management of the Low Carbon Buildings Programme
Policy support, analysis and energy modelling associated with the English House Condition Survey
Energy and innovation in housing
Housing stock modelling
Energy services analysis and reporting
Building integration of renewable energy
Energy & greenhouse gas emissions modelling
Impact assessment of major initiatives and programmes
Crime risk management consultancy
Social research and consultancy
Acoustics
Environment and Health
Environmental Engineering

</td></tr>
<tr><td>BRE Certification (incorporating LPCB)</td></tr>
<tr><td>

Certification of products, services, systems and personnel
Issuing of European Technical Approvals (ETAs)
Notified body under the Construction Products Directive (CPD)
Fire safety engineering
Fire safety design
Fire Risk Assessment
Fire testing including:

Reaction to fire
Fire suppression
Structural fire performance

</td></tr>
</table>

• *Fire resistance*	• *Water* • *Productive Workplace* • *Sustainable Construction* • *Aviation – aircraft cabin environments*

BRE and BRE Trust also have a number of subsidiary companies operating in specific market sectors, these include:

- ***BRE Waste and Environmental Body Ltd (BREWEB),*** *established to provide a means for companies to use Landfill Tax credits to fund environmental research at BRE and elsewhere*
- ***BRE Bookshop****, a joint venture company between BRE and EMAP Construct, established to publish and market construction-related guides, books and reports from BRE and elsewhere.*

About BRE Trust

After 75 years in the public sector, BRE became a private company in March 1997 and is now owned by BRE Trust (formerly the Foundation for the Built Environment or FBE).

BRE Trust is a research and education charity for the public benefit, registered by the Charity Commission (registered charity number 1092193). All of the companies owned by BRE Trust contribute their profits to supporting the Trust's mission…

to champion excellence and innovation in the built environment

BRE Trust achieves this by funding and managing a strategic research programme in the built environment sector. By 2004 BRE Trust was supporting about 50 research projects and nearly 20 PhD scholarships, and had committed more than £4 million in funds. During 2005 the BRE Trust established strategic research and development partnerships with four UK universities. BRE Trust aims to strengthen the UK's capacity to carry out leading-edge building environment research and promote its practical application.

This Partnership is developing centres of excellence at four UK universities in the following built environment topics:

- Fire Safety Engineering at the University of Edinburgh
- Innovative Construction Materials at the University of Bath
- Sustainable Building Design in the Welsh School of Architecture at Cardiff University
- Energy Utilisation Research at the University of Strathclyde

Associated with each Centre is a new Research Chair, the holder of which is also the Centre Director. The Research Chairs are being funded jointly by the BRE Trust and the four universities, with The Royal Academy of Engineering and The Welsh Development Agency contributing to the Chairs in Fire Safety Engineering and Sustainable Building Design respectively.

While working in different fields, each Centre and associated Research Chair have some common objectives, including:

- Seeking and promoting new areas of research
- Fostering cross disciplinary and other programmes to benefit industry
- Providing innovative programmes of education and continuing professional education

The BRE Trust comprises some 160 members – firms, professional bodies and other organisations – drawn from a wide spectrum of construction, building owner and associated interests. It was created to ensure that BRE remains independent of specific commercial interests, and retains its reputation for objectivity and impartiality in research and consultancy. In addition, BRE Trust gives BRE a direct relationship with the industry and commercial sectors that are influenced by its work.

BRE Delegates:

Dr Vahik Enjily

BSc, PhD, CEng, FIStructE, FICE, MIMechE, FIWSc

Vahik is *International Director of all construction disciplines*. He has previously held the following principal positions:

- Director of the Centre for Timber Technology & Construction of BRE.
- Director of Timber Engineering & Construction of BRE
- Head of Structural Timber Engineering of Design Division (Grade 7 of Civil Service) of BRE
- Principal Scientific Officer of Timber Section of PRL (Grade 7 of Civil Service)
- Senior Scientific Officer of Timber Section of PRL
- Structural Engineer, Timber Research & Development Association (TRADA).
- Research Assistant and Part time Lecturer at Oxford Brookes University
- Quantity Surveyor, R J Barwick and Sons Building Contractors, Dover, Kent.

Publications: Vahik has published extensively (over 250 publications, reports and client reports) on strategies, initiatives, research, design, construction and process of Timber Engineering and Construction. His publications cover an extensive range of Timber Structures, Structural properties of timber & timber products, Structural components such as wall panels, trussed rafters, girders, ply-web beams, mezzanine floors, bridges, full-scale roofs, SIP panels, etc. His work on TF2000 six-storey timber frame building covers many publications on various aspects of whole building behaviour such as construction process, benchmarking, differential movements, racking stiffness, disproportionate collapse, brick shielding effect, acoustics and fire. He has also written a few strategy reports for various International companies on confidential bases.

Dr Julie Bregulla

Dr Julie Bregulla

Dipl.-Ing., PhD, CEng, MICE
Associate Director
Building Research Establishment (BRE), UK
Visiting Lecturer, University of Surrey, UK

Dr Bregulla is an Associate Director of the materials and engineering group of the Building Research Establishment (BRE). Her specialist expertise is in the structural behaviour of lightweight structures in fire. At BRE she is responsible for leading BRE's structural integrity framework with the UK government, coordinating BRE's specialist consultancy in development of UK Building Regulations, specifically Part A "Structure" and Part B "Fire Safety". She supports British and international companies in the research, development and third party certification of innovative products, ranging from lightweight timber based systems and materials, glued components, Structural Insulated Panel technologies to more traditional systems and materials. She is member of COST E29 (innovative timber composite for construction) where she leads the working group on documentation. She is also actively participating in UK as well as international code committees, such as CEN TC124 and ISO TC165.

Dr Bregulla is a Chartered Civil Engineer and since 2005, a visiting lecturer at the University of Surrey where she reads timber design.

Dr Gerard Canisius

Napier University & Centre for Timber Engineering

Dr. Binsheng Zhang (Ben)
Lecturer in Structural Engineering, School of the Built Environment, Napier University, Scotland, UK

Age: 48

Qualifications:

1987.9 PhD, Tongji University, Shanghai, CHINA.
1984.9 MSc, Tongji University, Shanghai, CHINA.
1982.1 BSc, Tongji University, Shanghai, CHINA.

Key Experience: Dr. Ben Zhang has twenty years' teaching, research, consultancy and industrial experience in structural engineering. His main research interests include the structural design and analysis of concrete, steel and timber structures and non-destructively and/or destructively experimental investigations of high strength high performance construction materials, structural components and full structures under various loading and environmental conditions. During his work as a CPD Learning Materials Developer at the Centre for Timber Engineering of Napier University, Dr. Zhang produced numerous teaching materials and design examples on timber structures to the Eurocodes and British Standards and conducted research activities for CTE. Prior to this, Dr. Zhang was working as a Structural Engineering Consultant at E. Collinson & Co. Ltd in Preston on design of steel and fabric silos for nearly two years, performing structural design and calculations to ensure silos (diameter/side length up to 6.3 m, height up to 18 m and volume up to 400 m^3 or weight up to 400 tonnes) and concrete bases fit for purpose and integrity under normal and extreme working conditions to the latest British standards, Eurocodes and other design codes. Further back, Dr. Zhang was employed in Structural Group of the Civil Engineering Department at Glasgow University for 14 years. As a Research Technologist and a Research Fellow, he conducted a number of EPSRC and industrial projects on numerical analysis and experimental investigations of mechanical and structural behaviour of plain, reinforced and prestressed concrete under varying loading forms and designed a 2000 kN biaxial servo testing machine and a furnace for structural testing at high temperatures. As a Teaching Assistant, he lectured construction materials and structural design to varied levels and supervised final-year and MSc project students. Dr. Zhang's research work involved the structural design and analysis of concrete and timber structures and experimental investigations of high performance construction materials and structural components under various loading and environmental conditions. As a result of his research, many technical reports were finished and a number of papers were published in reputed international journals, including *ACI Materials Journal*, *Magazine of Concrete Research*, *Cement and Concrete Research*, *Concrete Science and Engineering*, etc.

Employment Experience:

2004.8 – present: School of the Built Environment, Napier University, Edinburgh
2003.9 – 2004.7 CTE, Napier University, Edinburgh
2002.4 - 2003.8: E. Collinson & Co. Ltd., Preston
1988.9 - 2002.3: Department of Civil Engineering, University of Glasgow, Glasgow
1987.9 - 1988.8: Department of Materials Science and Technology, Tongji University, Shanghai, CHINA

Brunel University

Dr. Mizi Fan
Senior Lecturer in Engineering, Brunel University, UK

Age:

Qualifications:

Key Experience:

Employment Experience: