

**COST Action E55
Modelling of the Performance of
Timber Structures**

3rd Workshop

**VTT Technical Research Centre
Espoo, Finland**

13-14 March 2008

Summary¹

¹ Prepared by Annette Harte and Jochen Köhler

1. Organisation

The 3rd workshop of COST E55 in Espoo, Finland was organised by Tomi Toratti. His excellent work in organizing the event is much appreciated. Also, the sponsorship by VTT of an excellent dinner on the evening of 13th March is gratefully acknowledged.

2. Participation

The following 55 COST E55 participants participated in the meeting:

Bogensperger, Thomas	MC	AT	Harte, Annette	MC	IE
Brandner, Reinhard	WG	AT	Rodd, Peter	WG	IE
Brunner, Maurice	MC	CH	Fragiacomo, Massimo	WG	IT
Köhler, Jochen	MC	CH	Baltrusaitis, Antanas	MC	LT
Müller, Andreas	WG	CH	Norvydas, Valdas	WG	LT
Sandomeer, Markus	WG	CH	Pranckenviciene, Vilija	MC	LT
Sigrist, Christophe	WG	CH	Jorissen, André	MC	NL
Steiger, René	WG	CH	Leijten, Ad	WG	NL
Blass, Hans Joachim	MC	DE	Schoenmakers, Dennis	WG	NL
Dietsch, Philipp	WG	DE	v.d. Kuilen, Jan-Willem	MC	NL
Frese, Matthias	WG	DE	Sandhaas, Carmen	WG	NL
Kreuzinger, Heinrich	MC	DE	Rønnquist, Anders	WG	NO
Pawlowski, Robert	WG	DE	Bell, Kolbein	WG	NO
Schänzlin, Jörg	WG	DE	Malo, Kjell Arne	MC	NO
Kirkegaard, Poul Henning	WG	DK	Siem, Jan	WG	NO
Munch-Andersen, Jørgen	WG	DK	Branco, Jorge	MC	PT
Sørensen, John Dalsgaard	MC	DK	Cruz, Helena	WG	PT
Svensson, Staffan	MC	DK	Dias, Alfredo	MC	PT
Toratti, Tomi	MC	FI	Jorge, Luís	WG	PT
Fortino, Stefania	WG	FI	Palma, Pedro	WG	PT
Fulop, Ludovic	WG	FI	Frühwald, Eva	WG	SE
Mirianon, Florian	WG	FI	Häglund, Martin	WG	SE
Ranta-Maunus, Alpo	WG	FI	Serrano, Erik	MC	SE
Chaplain, Myriam	WG	FR	Srpčić, Jelena	MC	SI
Racher, Patrick	MC	FR	Turk, Goran	MC	SI
Bjelanovic, Adriana	WG	HR	Weckendorf, Jan	WG	UK
Čizmar, Dean	WG	HR	Zhang, Ben	MC	UK
Rajčić, Vlatka	WG	HR			

3. Workshop content

Day 1: 13th March 2008

Joint sessions on the topics of the 3 WG's (Papers and other material on

<http://www.coste55.ethz.ch>):

Session with technical presentations related to WG I, chaired by Tomi Toratti.

Tomi Toratti (Finland): Introduction, Failure Assessment Template, Failure Assessment Publication

Jochen Köhler (Switzerland): Evaluation of Experience– a generic procedure for the assessment of failures and malfunctions

Kolbein Bell (Norway): Discussion on the analysis of failure

Jørgen Munch-Andersen (Denmark): Snowload in Denmark

Robert Pawlowski (Germany): Monitoring of wide-span timber roof structures – development of a simple and robust monitoring system

Session with technical presentations on the topics of Ductility and Moisture Induced Stresses related to WG II, chaired by André Jorissen.

André Jorissen (The Netherlands): Introduction

Hans Joachim Blaß (Germany): Ductility Aspects for Joints

Martin Häglund (Sweden) (Keynote): On moisture induced stresses in timber structural elements

Alpo Ranta-Maunus (Finland): Moisture induced stresses in glulam components

Stefania Fortino et al.(Finland): A 3D moisture stress FEM analysis of timber structures

Session with technical presentations related to WG III, chaired by John Dalsgaard Sørensen.

Poul Henning Kirkegaard (Denmark): A Probabilistic Approach for Robustness Evaluation of Timber Structures

Ludovic Fulop (Finland): Robustness evaluation of failed timber structures

Markus Sandomeer (Switzerland): Representing the spatial distribution of strength related timber material properties by means of hierarchical modelling

Day 2: 14th March 2008

Joint sessions on the STSMs and general topics

Session with reports on COST E55 STSMs, chaired by Annette Harte.

Jan Weckendorf (UK): A Comparison of Design, Construction and Dynamic Performance of Timber Floors in the UK and Finland (STSM at VTT, Finland)

Dennis Schoenmakers (The Netherlands): Analyses of the bearing behavior of dowel-type fasteners by means of non-contact full-field optical deformation measurements (STSM at DTU, Denmark)

Session with technical presentations on general topics, chaired by Annette Harte.

Pedro Palma (Portugal): Timber carpentry connections: influence of geometry

Maurice Brunner (Switzerland): A flexible adhesive interface to increase the bending resistance of glulam

Thomas Bogensperger (Austria): A contribution to the characteristic shear strength of a CLT wall under shear

Parallel discussion sessions of the WGs

Discussions took place in the parallel sessions of all Working Groups to review progress to date and to agree a strategy for future work. Minutes are given in the following:

Working Group 1:

Publication:

The present status of the publication is as follows: the separate chapters have been gathered together (from the workshop presentations, but this has not been sent to the WG1 members for checking or updating). With regards to this, the plan of action is as follows:

1. The report will be sent (as it is at present) to the WG1 members who are authors in the different chapters. The authors should go through their chapter and update or correct as necessary and send a revised version (as a word file) to Tomi Toratti by 1st May 2008.
2. The Swiss failure template is to be included, so this file should be provided as a word file ASAP.
3. After this round of updating the publication will be sent to Jochen Köhler to be placed in the website and used for COST reporting.
4. Further additions are still possible but not after May 2008.

Failure template on collecting information

This failure template is intended to be used for timber constructions.

The aims of this template are to

- help the assessor and unify assessments.
- provide means for the development of a database.
- improve codes and best practices if necessary.

- identify the causes of failure in detail.
- identify bad detailing and give alerts for the designer.
- identify dangers related to failure perpendicular to grain, shear, moisture stresses.

The template provides means for attaching visual information (and such is very recommended) as well as simple and uniform terminology.

If there is national (EU) need for unification: task group could see how they identify such needs in their countries together with the national authorities involved.

Ad Leijten will propose (Jürgen König) the use of the failure template to the horizontal group of TC250 as an informative annex of relevant standards.

Other topics with regard to actions of new task groups:

- There is a need for a standard on erection of timber buildings (addresses the issue of human error and quality of works), such standards exist already for concrete and steel.
- Standards on assessment of existing buildings (Swiss proposal for TC250), renovation and repair.

Unsolved questions:

- How will the failure data or the failure template be made available?
- Is a common pan-European database on failures feasible? (if it involves all materials) how would the funding be organized? Driver: society, WG1 could make a suggestion (if ideas come up).

Working Group 2:

Moisture induced stresses

- A major task is to evaluate if moisture induced stresses, as a result of natural varying climate, have an influence on the safety and serviceability of timber structures. Current design codes for timber structures do not directly account for the excitation caused by moisture gradients.
- Will the code description for the structural material wood be more reliable when moisture induced stresses are directly accounted for?
- Try to develop simplified design rules to take into account moisture induced stresses. Parallels to thermal actions are evident and if a proposal is made to account for moisture variation as actions for moisture dependent building materials this should follow the stringency and transparency of part 5 in Eurocode 1: Actions on structures – Thermal action (EN 1995 1-5).

Joints ductility

- Need to define requirements of deformations/rotations in a structure to have ductility.
- Need to define ways of including joint ductility in a format suitable for input into robustness models of WG 3.
- Development of guidelines on joint stiffness.
- Definition of load-slip configurations in a suitable format for probabilistic calculations of
 - single dowel type fastener joints
 - multiple dowel type fastener joints
 - other joints

Organisation of the next meeting (WG2)

- Next meeting will again concentrate on moisture induced stresses and joint ductility.
- The structure of the meeting should be changed to a workshop-based rather than presentation-based format.
- Allow a very limited time for plenary presentations
- A discussion document to guide the workshops on each topic will be prepared and circulated in advance of the meeting.
- The document on moisture-induced stresses will be prepared by Staffan Svensson and that on joints by André Jorissen.
- At end of action there should be guidance documents on at least these two topics.

Working Group 3:

Review collapses with respect to robustness

Look at examples which focus on

- what can be learned with respect to robustness.
- how could the structures have been changed in order to increase robustness.
- the identification of key elements

The following collection of examples will be considered:

- Scandinavian investigation of structural failures by Frühwald et al, 2007.
Fulop Ludovic will distribute information on relevant timber structure failures.
- German investigation of 130 structural failures.
Phillip Dietsch will distribute information.
- Danish structural failures
Jørgen Munch-Andersen will distribute information.

John Sørensen will distribute papers on the Danish approach for robustness.

The examples will be discussed at the next meeting in Zagreb based on the above information. All WG3 participants are expected to contribute.

Benchmark examples

The following example structures are considered:

- Norwegian sports hall – first results presented at this meeting (paper to be distributed by **Poul Henning Kirkegaard**).
- Austrian bridge

- Solid timber building

Information on the structures can be obtained from **Poul Henning Kirkegaard**.

The purpose and aim of the examples are

- to investigate system reliability (spatial distribution of strength and stiffness) and robustness of timber structures using probabilistic methods.
- to model failure modes (different types incl. connections – behavior after failure: ductile / brittle).
- to discuss how to model the effect of human errors (unintentional errors and defects).
- to model local failures – due to local extreme snow load, design/execution/maintenance error in connections.
- to identify key elements, and how to design key elements.

WG3 participants are expected to present results of the benchmark examples at the next meeting in Zagreb.

Deliverables from WG3

The main deliverable from WG3 is a guideline 'Recommendations for practical design for robustness of timber structures'. Further a possible update of the JCSS Probabilistic Model Code on timber structures will be considered, especially with respect to system reliability and robustness aspects. The following actions were agreed:

- A draft content of the guideline will be circulated before next meeting (Sørensen)
- At next meeting:
 - Agree on content list.
 - Distribute tasks to WG3 participants to write draft sections of the guideline.

4. Workshop Conclusions

The Helsinki meeting was our third regular workshop. We had 13 technical presentations in our joint WG sessions followed by discussions related to the individual WGs in the parallel sessions.

In the session on the topics of WG1 we had 5 presentations. These covered the issues of failures and failure assessment as well as structural monitoring. The work of WG1 is coming up to a conclusion since a first draft of the failure publication is almost ready for circulation among WG members for comment. The final document will be available on the action website in May. A number of different formats for the failure template have been proposed. The next meeting of WG1 will look at finalizing the template. When the WG1 tasks are completed, this working group could perhaps look at the issue of 'Assessment of Existing Structures', which forms part of the Memorandum of Understanding. The chair of WG1 may change for this purpose.

In the session on the topics of WG2, we had 5 presentations – one on Joint Ductility and four on Moisture Induced Stresses. The group felt that it was now ready to delve deeper into these two topics and that extended discussions focused on these areas should be held at our next meeting. The aim is to develop simplified design rules for moisture induced stresses and to identify load-slip behavior of different joint configurations for input into the WG3 models for system robustness.

In the session on the topics of WG3 three presentations took place. This WG is now ready to analyze structures with respect to robustness. Failures have been identified which will now be examined. Three existing benchmark structures have been identified which will be analyzed and discussed at the next meeting.

Two reports on STSMs supported by COST E55 were presented. In addition, there were 3 presentations on general topics related to Working Group 2.

A proposal was put forward from the organizers of Structures and Architecture (ICSA2010) conference to hold a special session on COST E55. This conference will be held in Guim Araes in Portugal from 14-16th July 2010. As this is close to the end of the action, it could prove to be a very useful means of dissemination of the results of the action. The conference website is www.icsa2010.com.

5. Outlook, next meeting in Zagreb

The Zagreb meeting is planned for September 25th & 26th, 2008. This meeting will be a workshop for Working Groups 2 and 3. The structure of the workshop will involve more discussions, perhaps with some small presentations within the working groups. Working Group 2 will continue their consideration of the topics: moisture induced stresses and design of joints for ductility. Joint behaviour is to be quantified in terms of system effects. A discussion document will be circulated to members in advance of the meeting to enable them to prepare for the meeting. Working Group 3 will carry out a review of collapses with respect to robustness. In addition, three benchmark examples will be examined, comprising a Norwegian sports hall, Austrian bridge and a solid timber building. Details of the structures are available and WG3 participants are expected to present results of the benchmark examples at the meeting.