

## Parallel Working Group (WG) Meetings E55 – Discussion, presentation and planning of work

### WG 2 Meeting - Moisture induced stresses

Chair : Staffan Svensson

Staffan started the meeting with a presentation on 'Climate effects as Load Action on timber structures'. It is proposed to have six factsheets on moisture induced stresses. Staffan has just completed an STSM to ETH where climate as an action was discussed. He has almost completed the first factsheet on Climate Exposure, which looks at how to model indoor and outdoor climate. This will be published in the book of factsheets.

*Comments: It is important to remember that the temperature of the structural part is not the global indoor climate as it may be under a partition or in the roof. Other issues such as sunlight on the member lead to local variations. The factsheet should focus on the extreme case.*

The other five factsheets relate to wood and water. These will be on the website and should be dynamic documents. A problem for many of these fact sheets is that the data required is not widely published. Much of it is in reports produced by various institutes and not written in English. It is hoped to get the co-operation of these institutes in gaining access to this data so that the factsheets will contain the most accurate information.

Wood and water I - Equilibrium moisture state of wood in natural climates will include physical and empirical models, data and examples on how to calibrate the model and evaluate the model error and model parameters. Experiments have been carried out in a deterministic way but we need probabilistic data. Also, there is very little published data on adsorption-desorption tests at low end of the scale. More data is required.

Wood and water II – Moisture transport in seasoned timber in natural climates. This is governed by two coupled diffusion equations describing moisture and vapour transport in the lumens and cell walls. The models are available for this but the problem is that it is hard to find an experiment that gives the appropriate data. There will be an STSM to Denmark in November to try to get more data.

Wood and water III – Moisture induced strain. Swelling and shrinkage in the cross grain directions are proportional to moisture content in the range 5-20%. A simple proportional model is proposed.

Wood and water IV – The influence of moisture state on the mechanical parameters of wood. There is a problem with a lack of accessible data on the relationship between moisture content and the mechanical properties. Some data is available in Step Chapter 4. A probabilistic approach is needed.

Wood and water V – Moisture induced stresses will deal with the two main issues arising from moisture, namely, constraint due to moisture induced strain and stress relaxation and accelerated creep. There are 3-D models to calculate moisture induced stresses but the available test data is 1-D. In order to simplify the reliability analysis, a proposal was made to separate the moisture induced stresses and duration of load effects so that the problem is time independent. This approximation is very close.

#### *Discussion/comments:*

*Irene Usardi and Davide Tonori will have an STSM to VTT to work with Tomi Toratti and Stefania Fortino from Jan – May 2010. They will look at the identification of different climatic regions within Europe and they will gather temperature and relative humidity data for each region. Also, indoor climate data will be collated.*

*At VTT, some beams (300 x 100) will be placed in a conditioning chamber at a fixed relative humidity and temperature for 3 months and deformations and structural properties will be measured.*

*Moisture induced strains have to be applied by engineers but the question is how to do it. If a moisture load is put in the code, then we need to reduce  $k_{mod}$  and  $k_{def}$ .*

*There are too many failures with current values of  $k_{mod}$  &  $k_{def}$ .*

*We could make  $k_{mod}$  a function of section size.*

*We could ban tension perpendicular to grain to transfer load but this is would not allow us to have arches and there is also an issue with joints.*

**WG 2 Meeting - Ductility**  
**Chair : André Jorissen**

André introduced the four separate factsheets on ductility that have been proposed: General notes on ductility, Static ductility, Dynamic ductility, and Benchmark examples. Some more factsheets may be proposed, e.g. on timber-concrete composite beams. For the joint publication, the first factsheet only will be included.

*Comments: Peter Rodd said that the evaluation of plate connectors presented in Trondheim was in error, and he will update the results. Roberto Tomasi said that there is a definition in Eurocode 8 on how to define dynamic ductility but is not so easy to apply. Testing must be carried out.*

*Bruno Dujic said that the displacement evaluation is more important in modern seismic analysis. In this respect, the equivalent elastic damping is the most useful parameter to consider.*

*Roberto Tomasi said that they have carried out many cyclic tests at the University of Trento and different definitions of ductility gave very different results.*

*Two definitions of dynamic ductility were examined in Portugal and there was no clear-cut advantage of one over the other. There is no point in giving one definition for the seismic case – you need to do tests to see which is applicable. At the end of the day, the objective is that we are looking for a number for ductility on which you can distinguish between different types of connections.*

Sigrud Mulders made a presentation in which she discussed 10 definitions of static ductility and their suitability for evaluating the ductility of multiple bolted connections. Using results from 14 tests on connections with 9 bolts, it was found that definitions 1-7 were not conclusive while definitions were 8-10 possible. As the failure was brittle due to splitting, the only conclusive definition is number 10. Further work will be done in evaluating other test results

*Discussion: Reference was made to a paper presented at the CIB W18 in Canada by Salenikovich about ductility definitions on cyclic tests. This should be examined.*

*The capacity for nails given in EC5 leads to an increased number of nails resulting in brittle behaviour. The old values in the Swiss code are double the values in the Eurocodes.*

*Bruno Dujic has a lot of cyclic test results and he will examine them with respect to ductility on a STSM for 1 month to Prof. Ceccotti.*

## **Joint E55 Session and Closure**

**Chair: Jöchen Kohler**

Staffan Svensson summarized the discussion on Moisture Induced Stresses. It was decided to progress the work even though everyone did not support it. There will be 6 fact sheets on this topic. One of the fact sheets will be ready for the publication and the other 5 will be made available on the action web page. For these there is a lot of data missing. Much work has been done but the data is published in reports and not papers. It is hoped that the research bodies will make the data available. The main areas for which information is required are: adsorption/desorption, mechanical properties as a function of moisture content, shrinkage/swelling data.

André Jorissen reported on the results of the discussions on Ductility. Four factsheets have been identified. The first one, General notes on ductility, is nearing completion and will be published in the document. A presentation on static ductility took place followed by some useful discussion. An STSM will take place in the near future to consider the dynamic ductility definitions.

Goran Turk reported on the outcomes of the discussions on robustness. This WG 3 meeting took place jointly with WG 1 of TU0601. Six factsheets based on the ideas presented in the joint workshop will be prepared and these will be completed in four weeks in time for the publication. Two further fact sheets are being considered: one dealing with a glossary of terms and relationships and the other on direct and indirect code requirements and how they affect robustness. For the benchmark problems, each example will be examined by two people to evaluate the reliability indices.

The Chair reported on a task group meeting held in Munich in September to discuss the state-of-the-art in assessment of timber structures. After examining the different methodologies, it was decided that the quantitative basis was not the best approach and that further work is required on this topic. Anyone with ideas for a better basis for assessment should e-mail Phillip Dietch or Jochen Köhler. As most of the current members of this task group are from Germany, it is hoped to get a wider representation from different countries.

The Chair thanked all of the contributors who helped make it an excellent workshop. The joint aspect of the workshop was approved by those present.

The next meeting will take place in Coimbra from 25-26<sup>th</sup> March 2010.

The meeting was declared closed.