Improved Moisture

Improved glued wood composites – modelling and mitigation of moisture induced stresses

Project Start Month: January 2008

Project Duration: 36 months

Project Consortium

Project Coordinator

VTT
Dr. Tomi Toratti
VTT PL1000 FIN-02044 VTT Finland
+358 20 722 4631, tomi.toratti@vtt.fi

Project Partners

KTH, Royal Institute of Technology,
Contact person: Lars Berglund
KTH, Dept of Fiber and Polymer Techn ,100 44 Stockholm, Sweden
Tel: +46 8 790 8118
Email: blund@kth.se

MPA, University of Stuttgart**,**
Contact person: G. Dill-Langer
Pfaffenwaldring 32, D-70569 Stuttgart (Germany)
Tel: +49 711 685 62280
Fax: +49 711 685 66829
gerhard.dill-langer@mpa.uni-stuttgart.de

TUW, Vienna University of Technology
Contact person: Karin Hofstetter
Karlsplatz 13/202, 1040 Vienna, Austria
Tel: +43 1 58801 20214
Fax: +43 1 58801 20299
Email: karin.hofstetter@tuwien.ac.at

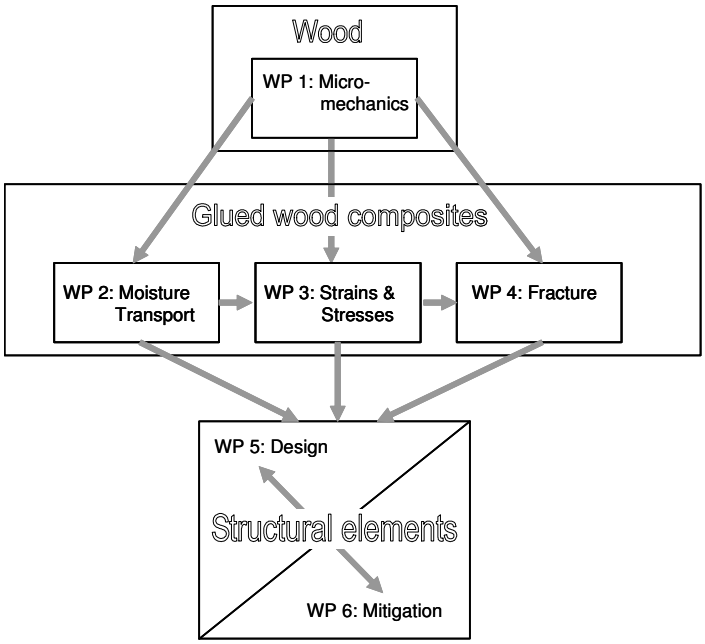
HIT, School of Civil Engineering Harbin Institute of Technology
Contact person: Enchun Zhu
P.O. Box 2453,
202 Haihe Road, Harbin 150090, PR China
Tel: +86 451 86283093
Fax: +86 451 86282704
Email: e.c.zhu@hit.edu.cn

Project Objectives

The objective of this research is to facilitate the understanding of the nature of moisture induced stresses, and to develop new computational tools to assess strength of structures, and cracking of wood under weather exposure. The ultimate goal is to develop innovative wood composites which are significantly less sensitive to moisture variations. Specific objectives are:

1. Improvement of safety, credibility and market share of glued wood composites in construction;
2. development of new wood products for markets where wood is not commonly used and
3. improvement of durability and extension of service life of wood products by solving the problem of cracking during end-use.

Project Approach



This project will develop numerical models to simulate wood behaviour in different scales, from micro structure to cylindrically orthotropic continuum. The models are based on experimentally determined material properties and verified by measurements of strain fields, and by observing fracture of structural size specimens.

Understanding of wood failure under combination of moisture induced and mechanical loads will be the benefit of the new models. For example, discontinuities of material properties that are generated in glued structures at the gluelines may cause severe stress concentrations. Structural modelling is needed also in smaller scale, to consider different properties between earlywood and latewood, and to analyse this impact to cracking of wood. The origin of moisture-induced stresses will be studied by means of micromechanical models. A physically-based multi-scale model for wood will be developed, which allows for prediction of moisture transport and mechanical properties of wood with consideration of hygro-mechanical couplings and mechano-sorptive effects. In particular, the (micro-)stress and (micro-)strain fields in wood resulting from changes in the moisture content will be quantified. The results of the micromechanical modelling will serve as input for numerical simulations at the macroscale. In particular, fracture mechanics based models will be developed for investigation of crack initiation and propagation.

Practical results include design criteria for glued laminated timber under combined mechanical and moisture loads, innovative solutions for mitigation of the moisture effects in wood composites and for reinforcement of the structures. Specifically, the following structural engineering problems are dealed with in the applications of the project:

- design of beams at support area under combined effect of shear force and moisture induced stresses;

- design of curved beams under combined effect of bending moment and moisture induced stresses, in which so introduced stresses perpendicular to grain will also be of a particular concern;

- design of large connections against timber failure at connection area (splitting of wood); and

- cracking of wood composites under moisture induced stresses.

The project is divided into work packages in such a way that theoretical work is undertaken in WP1-4 and the results are applied to codes and standards in WP5, development of new solutions to tackle the moisture related problems is made in WP6.

Expected Project Impact

The results will provide the following benefits:

- profound understanding of the effect of transverse anisotropy on the stress distribution in wood based composites and its influence on the performance characteristics
- numerical analysis tools for study of the effect of moisture variations on the performance of wood based composites during service life
- results will be used as background material for development of standardisation of wood based composites
- results will enhance safety and competitiveness of timber composite structures.

Results are published in such a form that they can be utilised in European standardisation and in further development of Eurocode 5.

An important channel of dissemination is Building With Wood Web Site where all results of this project will be published. The objective of this web site is to serve i.e. structural engineers and building industries by publishing information in such form that it can be directly used by these professionals.

Full exploitation of results in load bearing structures can be made after results are adopted in European standardisation.WP5 and WP6 include presentation of results in such meetings where the code writers participate, such as CIB W18. Coordinator of this project acts as chairman of CEN TC 124 which gives a direct channel for utilisation of the results in standardisation.

Societal, industrial, economic and environmental relevance. Several wood industries are involved in the project. They either provide some funding to this project or manufacture the specimens for testing, and can dirctly exploit the results. The project is presenting a way of developing and analysing glued wood composites, which is more advanced than current industrial practice. Results increase the use of renewable materials in construction.

Potential to create new business opportunities. Results will enhance safety and reliability of timber structures and accordingly improve the reputation of wood as a structural material. Additionally, new products will increase the competitiveness of timber construction and will lead to increased market share of wood materials in building sector.

Contact

The coordinator or any of the project partners stated above