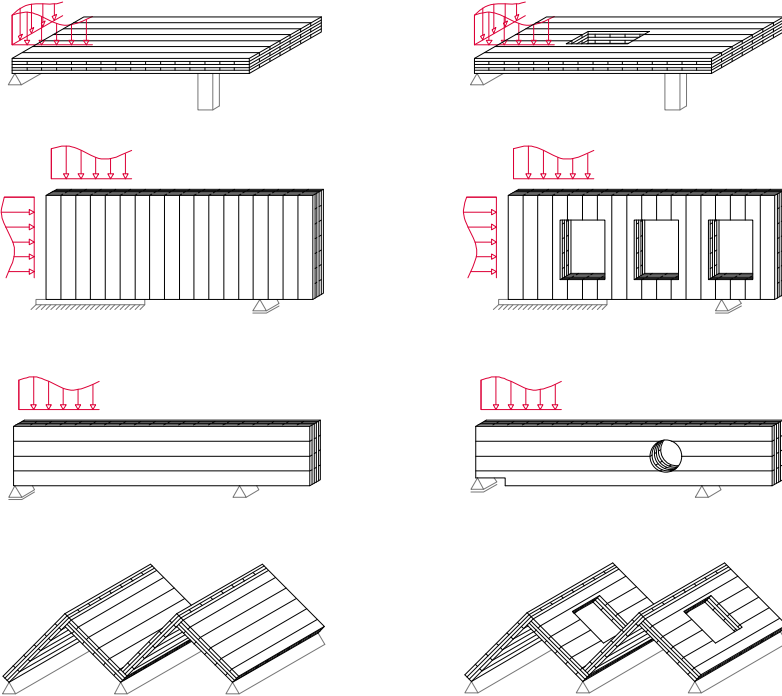


Properties, Testing and Design of Cross Laminated Timber



Editors:

Reinhard Brandner, Roberto Tomasi, Thomas Moosbrugger, Erik Serrano and Philipp Dietsch

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A state-of-the-art report by
COST Action FP1402 / WG 2

With contributions by:

Ishan K. Abeysekera, Stefano Bezzi, Andrii Bidakov, Anders Björnfot, Thomas Bogensperger, Reinhard Brandner, Daniele Casagrande, Thomas Ehrhart, Mariano Fiorencis, Maurizio Follesa, Andrew C. Lawrence, Ildiko Lukacs, Thomas Moosbrugger, Peter Niebuhr, Dag Pasca, Claudio Pradel, Gerhard Schickhofer, Erik Serrano, Elizabeth Shotton, Mike Sieder, Christophe Sigrist, Gregor Silly, Andrew J. R. Smith, Marta Stojmanovska, Roberto Tomasi, Vasileios Tsipiras, Tobias Wiegand

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Reinhard Brandner, Roberto Tomasi, Thomas Moosbrugger, Erik Serrano and Philipp Dietsch

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Preface WG 2

Cross laminated timber (CLT), as structural, plate-like timber product, was developed in Central Europe about 30 years ago. Meanwhile, it gained global recognition due to its high resistance and stiffness in- and out-of-plane and its versatile applicability. It provoked some revolution in the international building sector as it allows rather easily to substitute mineral-based building products, like concrete and brick, in for example family and multi-storey residential, office and school buildings. Building with CLT even has led to a renaissance of timber in our cities. Reasons therefore are the fast erection times and dry building sites allowing concurrent works of other crafts. Furthermore, CLT allows relatively thin wall and floor elements increasing the utilizable living and working space, relatively low masses of total wall and floor elements reducing demands on lifting and mounting equipment, and easy fixing of installations and other finishing works without anchors.

Now and after the construction market / industry crisis, which started in US in 2007, again and worldwide a dynamic development of CLT production capacities is observed, which exceeded one million cubic meter per year already in 2017. Although these capacities have been erected globally, the vast majority of CLT still comes from Central Europe, with a share of two-thirds of the worldwide production from Austria. Despite its important position and relevance in the timber construction sector, in Europe standardization of CLT is still in a very early phase. In a first step the European product standard for CLT, EN 16351, was established but it is still not in force. In addition, it misses regulations and information on a number of important issues, e.g. establishment of a CLT strength class system, regulations on mechanical properties and harmonization of layer thicknesses and layups. Apart from missing regulations for the product itself, there are many other issues which mandate for European standardization. These comprise: testing and evaluation, design and execution. Also missing are details and regulations on building services also in conjunction with building physics detailing, in particular guidelines for execution and monitoring, taking care of the vulnerability of timber at high moisture content. Meanwhile, some national regulations as supplements to Eurocode 5, the European design standard for timber structures, contain rules for the design and execution of CTL structures, e.g. the Austrian National Annex K in ÖNORM B 1995-1-1 (2015).

The European design standard for timber structures, Eurocode 5, is currently in revision. Apart from revising existing chapters it is also aimed at implementing new products and design approaches which have become engineering practice but so far miss European standardization. This comprises also the design of CLT. The preparation work for implementing CLT in Eurocode 5 and related background documentation was the task of the project team PT SC5.T1. Their proposal is now ready for implementation as long as a European consensus can be achieved.

Parallel to this revision process of Eurocode 5, the COST Action FP1402 “Basis of Structural Timber Design – from research to standards” started its work in Autumn 2014 in frame of the European Cooperation in Science and Technology (COST). The aim of this Action was to overcome the gap between established scientific outcomes and demands from engineers, industry and authorities. The work within this COST Action was accompanied by semi-annual meetings organized mainly as workshops and theme specific conferences and training schools as well as short-term scientific missions (STSMs) which outcomes substantially contributed to the overall success of our Action.

Working group 2 (WG 2) “Solid/Massive Timber”, one of four working groups in COST Action FP1402, aimed on collecting, discussing, assessing, harmonizing and condensing of fragmented state-of-the-art concerning CLT with focus on testing and design. Initial intensive WG 2 discussions identified and outlined open issues, missing approaches and regulations. Further focus was on these issues which were categorized as median or high priority. These intensive discussions were followed and supported by an online questionnaire sent to engineers worldwide with overwhelming response and unison with WG 2 internal discussions in most issues. Parallel to this, literature related to CLT and engineering questions was collected and categorized according to four main topics addressed in WG 2 which were later dealt with in the four Task Groups (TGs):

- TG 1: Design of CLT elements (chaired by Thomas Moosbrugger),
- TG 2: Testing and evaluation (chaired by Erik Serrano),
- TG 3: Properties of CLT (chaired by Tobias Wiegand; later merged with TG 1),
- TG 4: Design of CLT systems (chaired by Roberto Tomasi).

Each TG aimed on presenting the state-of-the-art in TG STAR (state-of-the-art report) documents, outlining a condensed knowledge, relevant for scientists and lecturers; base documents of agreed content, as basis for code writers and standardization committees; proposals and suggestions, dedicated to practice; and identified open points and gaps, as source for potential initiators of future research

projects and investigations. Beside these internal activities, collaboration was sought and kept alive with other WGs in COST Action FP1402 as well as with other COST Actions, standardisation committees and the project team PT SC5.T1. A number of joint activities and publications underline these liaisons.

The WG 2 / TG STAR documents represent one of the main written outputs of each TG and constitute the main chapters of the WG 2 STAR, as presented in the following. This STAR aims on discussing many points related to CLT from an objective point-of-view, providing possible solutions, and outlining necessary further steps to go. It demonstrates a compilation of important written outcomes from WG 2 and represents and involves contributions from academia and practice across Europe, representing some European point-of view on CLT as building product, related to properties, testing and design. It is the result of a number of extraordinarily motivated WG 2 members, scientists, engineers and architects, to contribute, on a voluntary basis, to the success of our WG 2 and our COST Action FP1402. The efforts of all these WG 2 members and their TG chairs are thankfully acknowledged! As chair of WG 2 we express our sincere thanks to all participants at meetings and conferences, all members which had been in some liaison with our group and especially to all members of WG 2 and their colleague who had been active in the background. It has been impressive, enriching and motivating working with all of you in frame of this group! We also take the liberty to say thanks to the chair of COST Action FP1402, for initiating and leading this COST Action, implementing our WG 2 and for all support provided throughout these last four years.

Now it is time to let the readers and users of this STAR speak! Any response to our work is appreciated. Enjoy studying and working with our STAR.

Reinhard Brandner and Roberto Tomasi, Chair of COST Action FP1402 / WG 2

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