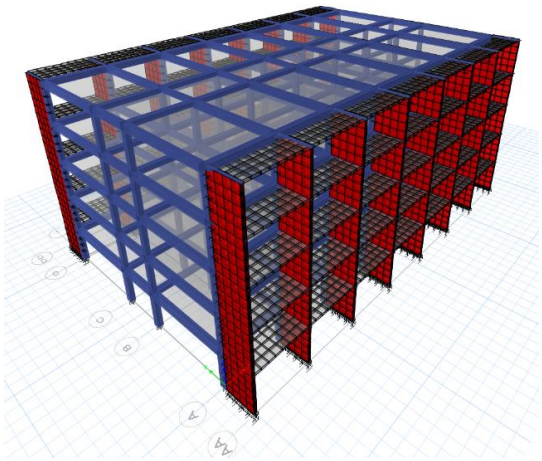
Technische Universität München
Lehrstuhl für Holzbau und Baukonstruktion
Univ.-Prof. Dr.-Ing. Stefan Winter

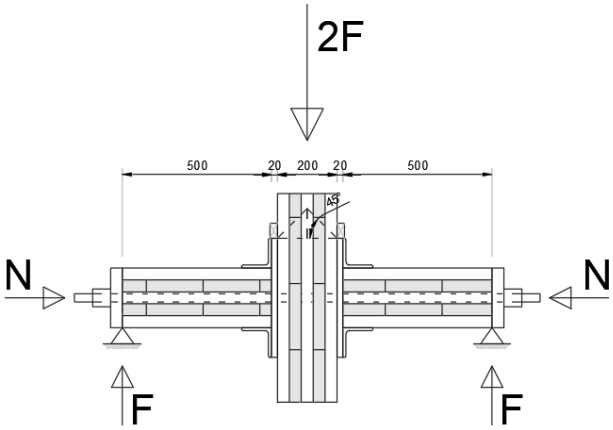
Am Lehrstuhl für Holzbau und Baukonstruktion ist folgendes Masterarbeitsthema zu vergeben:

Post-Tensioned CLT connections

Planning and execution of tests and evaluation of the results on post-tensioned connection between CLT elements



Finite element model of the CLT strengthening system applied on two sides of the existing RC building.



Sketch of one proposed specimen for testing the PT-connection with CLT members.

Hintergrund/Background

In the framework of the EU project Pro-GET-onE [1,2], the potential improvement on a framed RC structure, using CLT panels, has been exploited inserting CLT panels as extension for the existing frames (plane perpendicular to the external façade) increasing the global stiffness of the system, providing additional ductility (coming from the deformation of the steel connectors at the base of the panels), and allowing the structure to works as a “bookshelf” in which it is possible to provide different architectural solution and a new performing envelope.

This connection between the CLT-panels is composed by a vertical continuous CLT member (wall) and two horizontal ones (floors). The steel unbonded cable will pass through the horizontal elements along their development and across the vertical one. It will be tensioned bringing a pre-compression to the system that increases the rotational stiffness of the connection and provides also a re-centring behaviour.

The analytical model proposed by Wanninger & Frangi [3,4] was used and validated for a column/beam system (glulam elements). In order to adapt the analytical model to this new configuration it is necessary to test the behaviour of the connection and, therefore, guaranteeing the accuracy of the analyses. With respect to the designed connection for the actual research project, the validation tests will be downsized in order to minimize the amount of material needed, but nevertheless keeping the objective of proving the connection with 1:1 scale specimens.

Aufgabenstellung/Task

The aim of the work is to experimentally investigate the mechanical behaviour of the connection. On the basis of the analytical model proposed by Wanninger & Frangi [3,4] a variation is proposed that provides the use of elements in CLT to constitute the connection. The study of the connection is aimed at determining its rotational stiffness and behaviour and therefore the determination of the moment-rotation law. With the increase in rotation the neutral axis decrease, while the internal stresses at the lower edge critically increase. The insertion of a steel plate allows to extend the contact surface, and therefore to avoid problems related to compression perpendicular to grains. Furthermore, it allows to increase the stiffness and the resistance of the connection.

The experimental tests are also aimed at analysing different materials for the vertical element (wall), CLT spruce, CLT birch tree [5] and LVL are currently possible solutions for the tests.

The following points should be included in the elaboration and serve as thematic support:

- international literature research regarding the use of post-tensioning solutions with relative analytical model;
- identification of relevant parameters to be traced in the experimentation phase;
- planning and execution of tests to determine the behaviour of the connection;
- analysis and possibly validation of the results and compilation.

Ausarbeitung/Elaboration and work development

All calculations made with software must be adequately explained with the results and supported by appropriate checks. The input and result files required for “computer” calculations and the text of the bachelor thesis must be presented in written form and also in digital form on a suitable data carrier (e.g. USB stick).

In addition, the results obtained from the analytical model will be compared with the results obtained in the experimental phase. In this phase the student will be directly involved in the planning and execution of the tests. Meaning that he/she will collaborate in the preparation of all the specimens in the laboratory at the beginning, he/she will follow the execution of the tests and, finally, he/she will take part to the assessment of the results. It will be necessary to evaluate the accuracy of the analytical model with the experimental data and, if necessary, to evaluate the discrepancies to identify the causes and then, in a hypothetical subsequent phase, to propose variations/correction in the analytical model.

In addition to the written form of the thesis, the main results should be presented in a short summary in English (abstract). A short presentation should be made during the processing time and after the presentation of the thesis.

The final thesis paper should be written in English.

Quellen/References

1. Ferrante, A.; Mochi, G.; Predari, G.; Badini, L.; Fotopoulou, A.; Gulli, R.; Semprini, G. A European Project for Safer and Energy Efficient Buildings: Pro-GET-onE (Proactive Synergy of inteGrated Efficient Technologies on Buildings’ Envelopes). Sustainability 2018, 10, 812.
2. Badini, L.; De Stefano, C.A.; Custodi, A.; Predari, G.; Ferrante, A. Seismic Strengthening of Existing RC Structure Through External 3D Exoskeleton. In Proceedings of IANSE Congress, New York City, 2019, New York; pp. 1018-1024.
3. Wanninger, F.; Frangi, A. Experimental and analytical analysis of a post-tensioned timber connection under gravity loads. Engineering Structures 2014, 70, 117–129, doi:10.1016/j.engstruct.2014.03.042.
4. Wanninger, F.; Frangi, A. Experimental and analytical analysis of a post-tensioned timber frame under horizontal loads. Engineering Structures 2016, 113, 16-25, doi:10.1016/j.engstruct.2016.01.029.
5. Jeitler, G.; Augustin, M.; Schickhofer, G. BIRCH GLT&CLT: Mechanical properties of glued laminated TIMBER and cross laminated TIMBER produced with the wood species birch. In Proceedings of WCTE 2016 - World Conference on Timber Engineering.

Betreuung/supervisor(-s)

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