Zukunft Bau

STRUKTUR / GLIEDERUNG KURZBERICHT

Titel

Langfassung Titel: “Optimisation and Systemisation of Joints in Timber Construction for the dissemination of the resource-saving construction method”

Anlass/ Ausgangslage

kurze Beschreibung des Problems und des Lösungsansatzes
max. 450 Zeichen (mit Leerzeichen)

Complex, moment-resistant joints in timber construction are currently mostly designed and dimensioned as unique pieces. The aim of this research project was to simplify and systematise the design of complex connection geometries in timber construction and thus to increase the acceptance of the material wood for demanding engineering structures. This can be achieved through the use of the component method, which enables the design of different joints in terms of load carrying capacity and stiffness, using a standardized procedure, the disassembly of the joint into components characterized by springs. The aim of this project is to implement the component method in timber construction and to facilitate the access of the practice to this method by a compilation of typical components and a design example.

Gegenstand des Forschungsvorhabens

Beschreibung der Arbeitsschritte und des Lösungswegs
max. 4.300 Zeichen (mit Leerzeichen)

With the help of the innovative component method the accurate prediction of the load-deformation behaviour enables system reserves to be activated by redistribution of internal forces and joints to be optimized. In line with sustainable development within the construction industry, this not only saves material and energy but also increases the market share of the renewable material wood by increasing the attractiveness of timber construction, even for demanding engineering structures. Due to the changed awareness and the increasing desire to use sustainable construction methods more and more, timber construction on a national and international level offers the opportunity to expand its fields of application through innovative construction and design methods. Furthermore, by using the component method, a desirable standardization of joints in timber construction is promoted. The cost-effectiveness of wooden structures is thereby significantly increased, and thus the competitiveness with other construction methods, which have been using the advantages of a standardized design for a long time (see typified joints in steel construction), further increased. Mainly structures with large spans and a frequent repetition of the same structural elements and joints, such as halls or office buildings with a flexible floor plan, but also skyscrapers, may be seen as a potential for the application of timber construction.
In the component method, the dimensioning of an overall joint is carried out by disassembling the complex joint into smaller, calculative detectable individual components (see Figure 1). In a first step, therefore, already executed timber joint and structures were analysed and for the load-deformation behaviour relevant individual components were identified and catalogued. This approach was also followed in the experimental investigations on a typical moment-resistant timber joint. The examined joint of a column base was broken down into smaller components, which in turn were further investigated by experimental, analytical and numerical methods (see Figure 2). The detailed investigations that were carried out in this way enabled the development of an analytical model for the load bearing capacity and stiffness of the components and their validation with the test values. A total of 72 connections were experimentally investigated in order to determine the influence of different parameters on the respective component properties. Figure 3 shows examples of the load-deformation curves of the tensile tests parallel to the grain direction. The influence of the reinforcement and the type of fasteners are clearly visible.
The calibration and validation of the spring model of the overall node was carried out on the basis of ten large-scale joint tests (see Figure 4). The individual components of the spring model of the overall joint can be determined in each case by the experimental results of the component tests or by normative rules. The spring models developed in this way were examined in detail within the scope of a parameter study on the influence of the respective component properties. Figure 5 shows an example of an experiment of the series T1.X (pressure contact + dowel group) and the corresponding spring model.
The results of the experimental investigations on the individual components showed in some cases significant deviations with respect to the stiffness K_{ser} compared with values from DIN EN 1995-1-1. The load-bearing capacity, on the other hand, was relatively well predicted for most of the tests by the standard. Since the accuracy of the developed component model depends on the accuracy of the component properties used, a further, in-depth investigation of the load-deformation behaviour of joints in timber construction as well as an adaptation and extension of the associated normative rules is recommended.
Finally, the research results were prepared in the form of a design example for the practice. In this case, the examined column base was exemplarily calculated according to the current version of DIN EN 1995-1-1 and with the help of the component method.

Fazit

Beschreibung der geplanten Ziele und der erreichten Ergebnisse
max. 700 Zeichen (mit Leerzeichen)

The analysis of existing constructions has shown that the majority of joints in timber construction may be considered as semi-rigid. With the aid of the component method, its moment-rotation characteristic can be determined and used for an economic determination of the internal forces and dimensioning of the entire structure. An optimization of the joints can be achieved via a targeted dimensioning of the individual components and the introduction of reinforcing elements. The experimental investigations showed the strengths and weaknesses of the current normative rules for the determination of the load-deformation behaviour. Thus, the determination of the load-bearing capacity is already possible with today's rules, in the field of connection stiffness, however, there is a need for further research to achieve an improvement in the prediction quality. On the basis of the experiments, it is also recommended to reinforce complex joints with fully-threaded screws as transverse tensile reinforcement in order to avoid premature, brittle failure of the joint and to be able to use load-bearing reserves. The applicability of the component method in timber construction could thus be confirmed, however, the load-deformation properties of the relevant components should be known as accurately as possible. A prediction and targeted avoidance of brittle failure mechanisms is thus possible.

Eckdaten

Kurztitel: “Optimisation of Joints in Timber Construction”

Forscher / Projektleitung:
Prof. Dr.-Ing. Ulrike Kuhlmann
Julius Gauß, M.Sc.

Gesamtkosten: 168.870,12 € €

Anteil Bundeszuschuss: 106.920,00 €

Projektlaufzeit: 24 Monate

BILDER/ ABBILDUNGEN:

5 - 7 Druckbare Bilddaten als **eigene Datei** (*.tif, *.bmp, ...) mit der Auflösung von mind. 300 dpi in der Abbildungsgröße (z.B. Breite 10 - 20cm). Bilder frei von Rechten Dritter.
Bildnachweis jeweils:

Figure 1: Bild 1.jpg/.emf
Derivation of the individual joint components

Bild 2: Bild 2.jpg/.emf
Experimental setup of tensile tests parallel to the grain direction

Bild 3: Bild 3.jpg/.emf
Experimental setup of joint tests, 4-point bending test

Bild 4: Bild 4.jpg/.emf
Load-deformation curves of component tests tension parallel to the grain for differently reinforced single fasteners (left) and fastener groups (right)

Bild 5: Bild 5.jpg/.emf
Spring model for one of the examined component tests