Statistics of damages to timber structures in Germany

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ABSTRACT

The paper reports results of a comprehensive failure analysis with the focus on timber structures located in Germany. Data of 550 damages and corresponding circumstances were recorded, classified and evaluated. Statistical distributions of the structure characteristics and the kind of damages are described. The majority of the damages are distributed on cracks along the grain, by far, decay, tension and shear failure follow. In about 90% of the damages glulam is affected. Nearly one thousand damage-cause-relations show that constructions resulting in stresses perpendicular to the grain, alternating climates and overloading rank as one of the main reasons for damages. Spending more time on proper design and on careful details is seen as the key consequence of this analysis.

1. Introduction

At the beginning of 2006 many timber structures in Germany and in the adjoining foreign countries, partly built decades ago, collapsed. Although in most cases the failure occurred under weight of snow, one cannot conclude with certainty that snow load out of the ordinary was the single reason. Many recent failures show that a combination of two or more reasons has to be considered to explain failure.

At present there is no integral statistical and systematic reflection covering general damages to timber structures in Germany with the main emphasis on roof structures. Cases discussed in the literature are single assessments of damages which can hardly lead to a generalised perspective. It was, therefore, the first objective of this investigation to provide a basis for this reflection: The initial step was the creation of a comprehensive database containing data of damages. In turn therewith an appropriate system was to be developed including data classification, description and analysis. The second objective was to answer different research questions including those a priori unknown and to reveal striking features.

The investigation lasting four years is fully detailed in [1]. It was funded by Deutsches Institut für Bautechnik (institute of the Federal and Laender Governments for a uniform fulfilment of technical tasks in the field of public law). A similar investigation about failures of timber structures particularly in the Scandinavian countries was published in 2007 [2]. In contrast to [1], it is characterised by different approaches and provides a comprehensive annexe with detailed descriptions of each failure case.

2. Recording data

2.1. Data origin

Data was collected from expert's reports and came from a comprehensive former database of damages reported to the Studiengemeinschaft Holzleimbau e.V. (association of German and foreign glulam manufactures), a database of the University of Munich and a smaller one of the University of Graz. Few cases are based on the literature or were directly communicated to the authors. The data as a whole was rather nonuniform and the quality inconsistent. The majority refers to the investigation area Germany.

2.2. Data classification

As a rule timber structures are assembled of recurrent structural parts. These in turn are connected to each other by recurrent construction principles. Consequently, timber structures — in the sense of this work, roof structures — are very comparable. This simplifies data recording and the common contemplation of structure characteristics, damages and their causes.

A system was developed for a quick and reliable data capture. An Excel sheet serves for data memory. The problem-oriented statistical analysis system SAS is employed for data description and evaluation. The data capture works with parameters which can only take on different keywords for qualitative data and measures for quantitative data. This serves as a classification of the heterogeneous data. Fig. 1 depicts the scheme with a selection of important keywords or measures. The original scheme in [1] contains at least 60 parameters and 230 keywords and measures to classify and describe circumstances of damage as economically and precisely as possible.

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