Abstract:
Failure analysis on timber hall structures

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At the beginning of 2006 many timber hall structures in Germany and in the adjoining countries, partly built decades ago, collapsed. That was the background for a research project focusing on an integral and systematic reflection of recent failures of those timber hall structures.

Reports on damages of timber hall structures were collected and relevant data were used to build up a database. A failure is recorded by a certain vocabulary, consisting of keywords. Within further research an extension of vocabulary and data is possible. A problem-oriented statistical analysis system served for evaluation.

An analysis of 550 failures in 428 halls showed that the years of construction range from 1912 to 2006. The locations are widely scattered, almost exclusively over the former West German regions. Particularly often affected are sports halls, depots and production halls. Damage is mainly observed in simple and continuous beams as well as frames. In most cases the components consist of glulam of the national strength classes Güteklasse II and I and of glulam class BS14. The glulam had been produced by more than 39 different manufacturers. Therefore accumulation due to particular manufacturers can be excluded. 70% of the damages are cracks in grain direction. 5% each are shear failure, decay and tension failure. The rest of 15% concerns serviceability and appearance of the components. The stability of a quarter of the halls or components is at risk. Another quarter collapsed or failed. About a quarter has an ensured stability. No data are available for the rest. The distribution of failure indicates an accumulation in the months January to March. Particularly often observed are damages of constructions with tensile stress perpendicular to the grain. Alternating climates are of great importance for cracks in grain direction. The influence of the shrinking of wood and causes of failure concerning load, material quality, planning, building physics and construction is moderate. Undesirable consequences due to assembly, maintenance and moisture are rare.

The most important consequences to avoid damages include: improving the quality of training, planning and standards as well as avoiding systematic tensile stress perpendicular to the grain.

At present, data do not indicate further measures in addition to the initiated supervisory measures concerning the use of glulam in halls exposed to increased moisture.

Areas requiring further research are among others shrinking and swelling anisotropy as well as shear strength of glulam.