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The Snowy Winter of 2005/06 – "Snow from Yesterday?"

Consequences for Wood Construction in Agricultural Buildings

The large quantities of snow, which fell in 2005/06 not only caused the tragic collapse of the ice rink in Bad Reichenhall, but also damaged many agricultural buildings. For all those involved, the question arises, what are the consequences for both existing and planned structures. Available investigation results show that generally a combination of faulty construction and large snow masses led to the damages. Currently, mandatory building inspection is not in sight. As a result, owners remain responsible for their buildings.

(Foto: Norbert Baradoy)

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As a result of farm growth, stables as well as storage- and machinery halls are often becoming bigger and bigger. More and more frequently, riding halls are added. Utilization and the aspect of maximum flexibility often require column-free structures, which need long-span supporting structures for reasons of construction technology. This requires the use of steel- or structural timber constructions. The preliminary results of a Germany-wide study commissioned by the German Timber Promotion Fund show that in 88 cases of damage in buildings used for different purposes (supermarkets, trade fair-, ice sport-, storage-, riding halls, stables), the ratio of wood- and steel constructions was 72 : 11. Even though steel halls were also affected, public attention focused on wood bearing structures in particular due to the tragic collapse of the ice rink in Bad Reichenhall. However, wood construction cannot be regarded as the fundamental reason for the failure of the structure used there. According to the press declaration of the public prosecutor's office in Traunstein from 20th July 2006, the report of the experts commissioned showed that among other reasons the permissible construction height of the beams, which were planned and built according to the rack structure invented by Kämpf (swiss carpenter), was exceeded significantly. As a result of these shortcomings along with faulty construction, necessary building security was not reached right from the beginning. In addition, the main reason for the collapse of the hall is seen in the use of water-soluble urea-formaldehyde glue, which was approved exclusively for a dry ambient climate, when the hall was built in 1971/72 and is therefore not suitable for the ambient conditions of an ice sport hall, where humidity is high. Due to the effect of humidity, the load-bearing capacity of the glued joints was impaired to a point where the construction ultimately failed under the snow load.

Reasons in Existing Buildings

The current status of data evaluation shows that the main reasons for damage distributed over all kinds of building utilization are snow loads above the tolerance limit, room-climatic reasons and missing transverse pull calculations for the load bearing structures as well as faulty material, construction and planning (*Fig. 1*). Other reasons are missing or faulty reinforcing elements, later alteration measures and additional loads.

Snow loads above the design limit must be attributed to wrong assumptions of the planners or structural engineers. Room-climatic reasons resulting from long heating due to the long-lasting cold spell led to severe drying of the binders and increased crack formation. This usually does not affect agricultural buildings. The question of transverse pull, which mainly occurs in laminated board beams in addition to the bending stress in the beam and can lead to the ripping of the cross section was integrated into the standard in 1988 during the revision of DIN 1052 [1]. The necessity to consider this loading condition case during static calculations was confirmed only by long years of practical experience with long-span load-bearing structures and resulting binder heights. Defects of material particular in laminated board constructions are mainly caused by techniques of wood processing and –production which were common in the past for structural timber constructions [2]. In most cases of faulty workmanship, the plans and examined specifications were not correctly realized at the construction site. This also applies to missing or faulty reinforcing elements. Later alterations to structural elements are one reason for the failure of supporting structures. Even though such alterations may not be realized without prior calculation by a structural engineer and approval, unauthorized alterations were nevertheless carried out in technical constructions and in particular in older supporting structures, whose static system was often fundamentally changed, e.g. when craneways were installed.

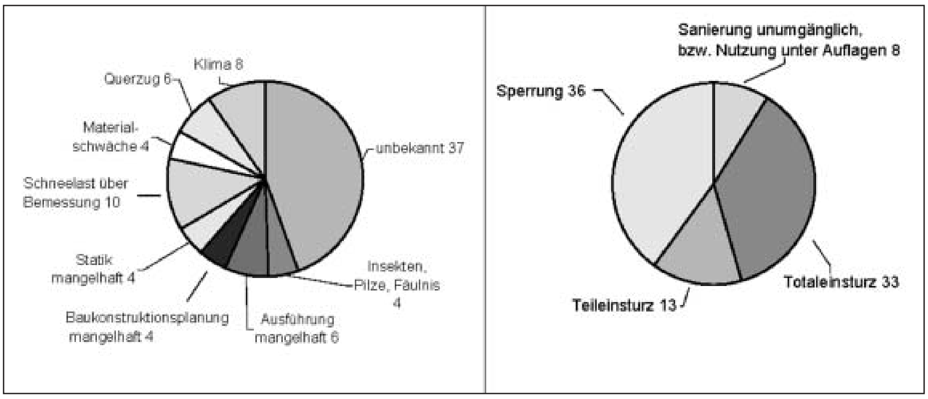

Fig. 1: Distribution of the reasons for damage in buildings in the winter 2005/2006 (evaluation on behalf of the German Timber Promotion Fund, 2006)

In addition, notches cut after the completion of the construction, e.g. in glued binders for cable ducts, weaken structural parts. This category also includes additional loads caused by building equipment installed later or suspended ceilings, for example, which had not been taken into account in the original static calculation.

Necessary Measures to be taken by the Owners

The owner is primarily responsible for the building. If the necessary constructional documentation (static calculation with a text description of the assumed loads, plans) is available, an initial examination of assumed loads, deviations from the plans during construction, or later alterations by the owner can be carried out. In case of doubt or if plans are no longer available, engineers or architects should be consulted. An important aspect is building maintenance, which means that the owner must first inspect the structural elements in particular. This inspection must focus on the general constructional condition of the load-bearing structure, damage to connecting elements e.g. due to corrosion, leaks in the roof which lead to the penetration of moisture into the structure, or excessive crack formation. In taller buildings, these visual examinations require the use of a lifting vehicle or a scaffolding. Structures, which cannot be inspected due to roof panelling, are problematic. Here, the owner must gain access to the roof area. If unusual alterations are noticed, a planning specialist or a technical expert must be consulted. On the internet, the central department of the board of building and public works in the Bavarian Ministry of the Interior, for example, provides concrete instructions for owners also with regard to current estimated snow- and ice loads. For the evaluation of long-span load-bearing structures, the chambers of engineers suggested mandatory building inspection. However, this suggestion did not meet the approval by the local and highest building inspection authorities. Therefore, its future realization is not expected.

Consequences for new buildings

When owners are planning a new building, it is decisive for the question of wood construction that the comprehensive experiences of the past decades in structural timber construction enabled the above-mentioned deficits to be overcome by means of improved production processes and stricter quality assurance requirements. Wood products, such as technically dried cut wood (e.g. solid structural wood), laminated boards and wood materials for use in construction are subject to strict control requirements with regard to quality assurance. For the spring of 2007, the introduction of an RAL quality sign for structural timber construction is planned. For wood construction, the August 2004 version of DIN 1052 ("Design, Calculation and Dimensioning of Wood Structures") [3] will exclusively apply after a transitional period as of the end of 2007. DIN 1055 ("Loads on Supporting Structures"), which also includes requirements for snow loads, has been revised as well and will apply without any transitional period as of 1st January 2007. In the static calculation of load-bearing structures with regard to the snow load, not only standard design loads are considered, but also the form and the inclination of the roof, additional technical equipment (e.g. snow guards), projecting roof ends, or height jumps so that potential concentrations of the snow masses can be taken into consideration in a very differentiated manner in the static calculations carried out by the structural engineer. When realizing wood construction projects, one must also make sure that the quality assurance of the products used from cut wood and wood materials to the laminated boards as well the companies commissioned is guaranteed and proved (by means of the relevant quality signs). This also applies if wood from the owner's forest is intended to be used. If the building owner provides the wood himself, the construction companies must sort and use the material based on the relevant standards.

Conclusions

Especially after the experiences of the last winter, it is necessary to inspect the load-bearing structures of older buildings carefully. Mandatory building inspection, which was demanded in the media, is not expected. Thus, the building owners remain responsible for the inspection of buildings. Standards revised in the past years as well as new techniques and quality monitoring in the production of structural timber constructions speak against the decision not to use wood in future construction projects, due to the experiences of the last winter. Especially with regard to rising steel costs, due to greater demand on the world market, wood as a sustainable building material, which is in some cases available on the farm, remains indispensable in farm construction.

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