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Sustainable Construction Materials from Renewable Raw Materials

Straw and LNS Material

In the course of the improving sustainable materials in civil engineering it is necessary to develop products capable of meeting current standards. The long history of using straw in construction is being continued in new research. Increased activities in this area should lead to a general acceptance of straw by building officials. Both sandwich construction and materials [LNS (Light Natural Sandwich)] support the possibility of creating sustainable buildings. They must also be able to meet current standards in order to remain competitive.

The Institute for Production Engineering and Building Research has monitored a straw bale house in the Rhoen region for about three years. The temperature and moisture properties of the straw bale walls have been studied. In the course of these studies it could be ascertained that the walls (with mud plastering) ultimately dried out over time. The moisture measured in the walls fell from about 65 % at the beginning of the study to about 50 % after the house was occupied and heated (*Fig. 1*). The study could thus clearly prove that straw bales, if installed properly, have no dampness problems. Here it is important to consider constructive moisture protection, for example, roof overhangs or protective facades.

Further efforts towards a general official acceptance of straw bales as a construction material, in co-operation with the Professional Association for Straw Bale Construction in Germany e.V. (fasba), are directed at flammability and heat conductivity. Flammability tests at the MPA in Braunschweig show that plastered straw bale walls can fall into the categories from F60 to F90. The heat conductivity fell into the category WLG 045.

Moisture Reaction of LNS Boards

As in all natural construction and tools, moisture plays an important role. The core material of the LNS materials consists of plant stalks (cereal straw, Miscanthus, reeds or bamboo) glued parallel to each other with an adhesive foam.

The possibilities for using these materials include interior construction as well as furniture and doors. Here, the deformation due to moisture or temperature changes are important. For this purpose, comparative studies with popular cardboard-comb were conducted.

A test often used in door manufacturing was used. The materials were subjected to moisture and temperature changes for several weeks. After conditioning at 23 C° and 50 % relative humidity to a constant weight,

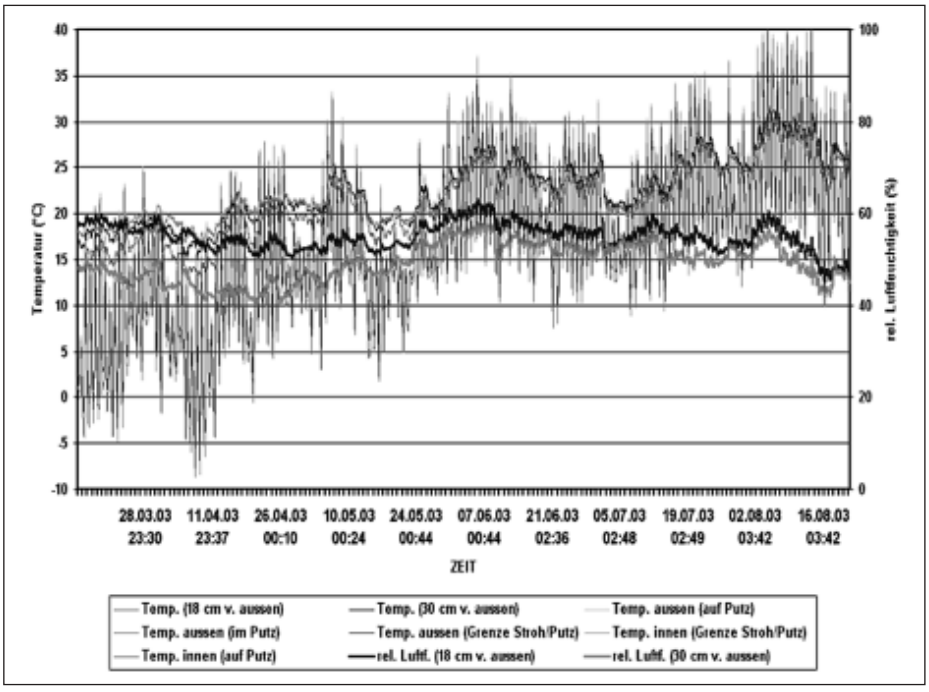

Fig. 1: Course of temperature and moisture in a straw bale wall in Junkershausen (Rhön)

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Keywords

Sustainable construction, use of straw, LNS materials

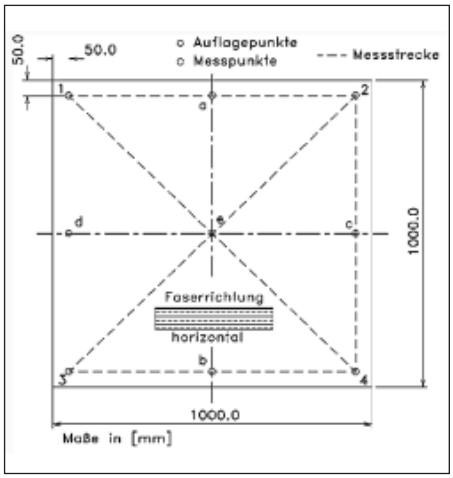

Fig. 2: Positions of measuring points on the LNS material

the boards (measuring 100 • 100 cm, *Fig. 2*) were subjected to a climate of 40 °C and 95% relative humidity for two weeks. Subsequently, the conditioning situation was reintroduced (*Fig. 3*). During the entire period, a meter was used to measure the changes at six different spots on the boards.

LNS boards with various core materials (rye straw, Triarrhena (Miscanthus) and cardboard- combs) were studied and comparisons were also made with plywood boards. The results from these measurements show that the materials with a Triarrhena core react similarly to the competitive and reference product (cardboard comb). The deformations over the course of the measurements were hardly more than 1 mm (*Fig. 4 and 5*).

Another result of the study was that the direction of the core materials (Triarrhena) in relation to the plywood covering layers had an influence on the deformation of the board. Core material adhered vertically to the fiber direction of the covering boards had far better results as those glued in the parallel direction. Apparently in the prior case, the deforming influences are better compensated. The measurements also show that the deformation reduced following the moisture phase even if it did not completely disappear.

Parallel to these studies, smaller samples from the same material were used for saturation behaviour. It could be shown that the covering plywood layers became thicker rather than the core materials.

Summary

Straw bale studies conducted over the past few years clearly show that this is a very sustainable construction material, unfortunately still not recognised. Many efforts are underway to change this. A number of obstacles must still be overcome, particularly in regard to behaviour under humid conditions. Unfortunately the tests necessary here under DIN are a large hurdle, since the standard used originally came from electric engineering. Although the current research efforts show that with appropriate use, the straw bales are not problematic with regard to dampness, much work is still required before the general official acceptance of this material is attained.

The tests conducted on moisture behaviour of LNS materials have made it clear that this is a competitive product. Due to other special characteristics, further implementation possibilities for this material are opened, in which high temperatures and humidity play a role.

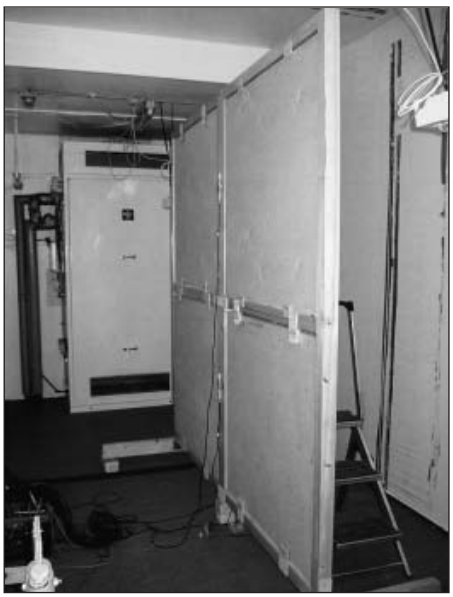

Fig. 3: Experimental design of deformation measuring

Literature

[1] *Möller, F., C. Hoch und A. Schröder*: Leicht und stabil. Landtechnik 55 (2000), H. 1, S. 24 -25

[2] *Möller, F., H. Wieland, F.-J. Bockisch und H. Georg*: LNS-Materialien optimiert. Landtechnik 56 (2001), H. 5, S. 336 - 337

[3] *Wieland, H., T. Ashour und F.-J. Bockisch*: Stroh - Renaissance eines alten Baustoffs? Landtechnik 57 (2002), H. 4, S. 222 - 223

[4] *Wimmer, R., H. Hohensinner und L. Janisch*: Wandsysteme aus Nachwachsenden Rohstoffen. Wirtschaftsbezogene Grundlagenstudie im Auftrag des BMVIT, Wien, 2001

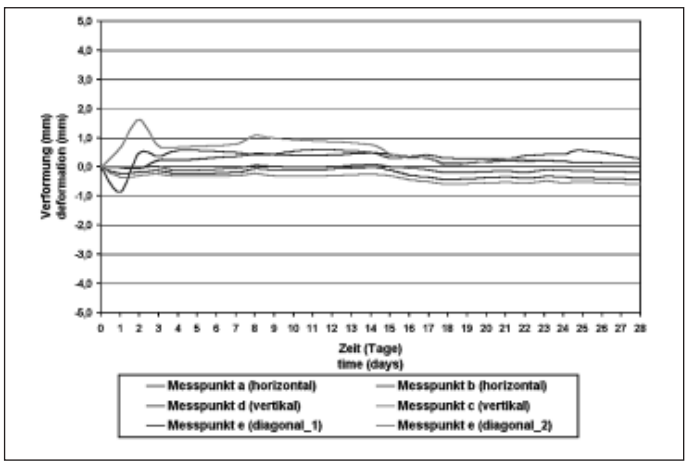

Fig. 4: Deformation of a LNS plate with cardboard-comb core

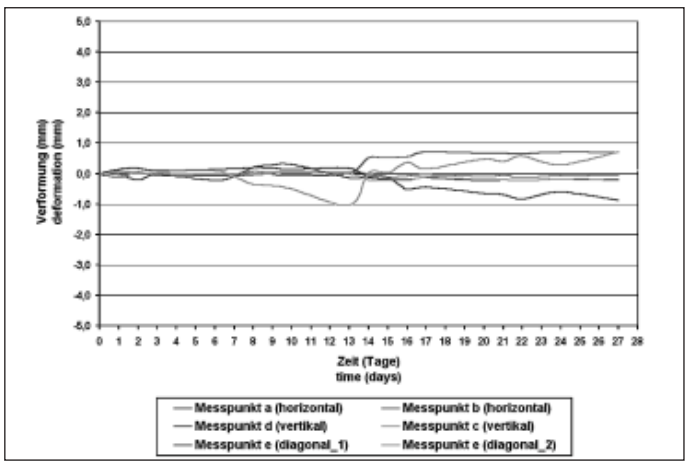

Fig. 5: Deformation of a LNS plate with triarrhena core