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How can the properties of LNS materials be improved?

Measuring of thermal conductivity and moisture behaviour

LNS (Light Natural Sandwich) materials are made from renewable raw materials and can be used in many sectors. Improvements of the properties can be obtained by the change of the stalk core materials. Tests were carried out for reducing the thermal conductivity. Different parts of the stalks of Triarrhena were examined as well as the use of wood fibres as fill-in material for the spaces in the stalk cores. Additionally the sensitivity of the materials to moisture was investigated and the possible growth of fungus connected with that.

The basic concept for the development of LNS was the idea to develop a material, which is only composed of renewable raw materials. The natural characteristics of the plant stems were used. Due to their static properties, they can bear high loads by light construction. In combination with steady layers and with a natural glue, a material can be produced, which can be used in many areas, due to its low weight (Fig. 1).

Studies for the reduction of the thermal conductivity

Based on the structure of the stem cores of LNS, the materials only have a medium thermal conductivity. Inside the plates the stems as well as the holes are laying in the direction of the heat flow, when the materials are used as walls. This leads to a faster passage of the heat through the wall. Because of this, investigations were made to reduce this effect.

Part 1 of the investigation consisted in the use of different sections of the Triarrhena stems. The upper, the middle and the lower section were examined. The stems differ, due to growth, in their diameter (decreasing from down to upwards, between 5 and 15 mm). From the stems of the three different sections plates with the same surface layers were made and examined according to DIN EN 12667 for their thermal conductivity (*Fig. 2*). The samples had the dimensions 500 • 500 mm and a thickness of 38 mm. The structure consisted of 2 surface layers from plywood with a thickness of 4 mm and a Triarrhena core of 30 mm. The results showed an increasing heat conductivity (above: λ = 0.123 W/mK, center: λ = 0.137 W/mK and down: λ = 0.157 W/mK) from above downwards. This is due to the larger number of cavities going through the material with increasing stem diameter. A LNS plate with the same structure and a core made of rye straw had only a thermal conductivity of λ = 0.084 W/mK. From these results, part 2 of the investigations follows. It should be determined, how a filling of the cavities with a usual insulating material from renewable raw materials affects the thermal conductivity.

As material for this, wood fibers were used. Due to their refinement they can be well filled into the cavities between the stems, as well as into the open stems themselves. For the trial, cores from the lower

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Keywords

Renewable raw materials, Light Natural Sandwich (LNS), thermal conductivity, fungi

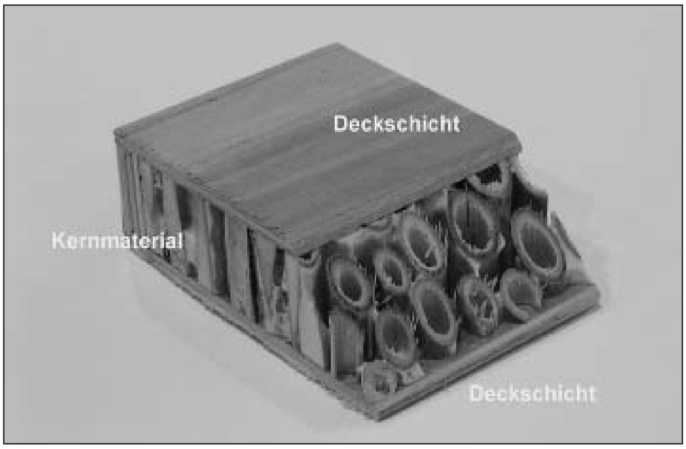

Fig. 1: Structure of LNS (Light Natural Sandwich)

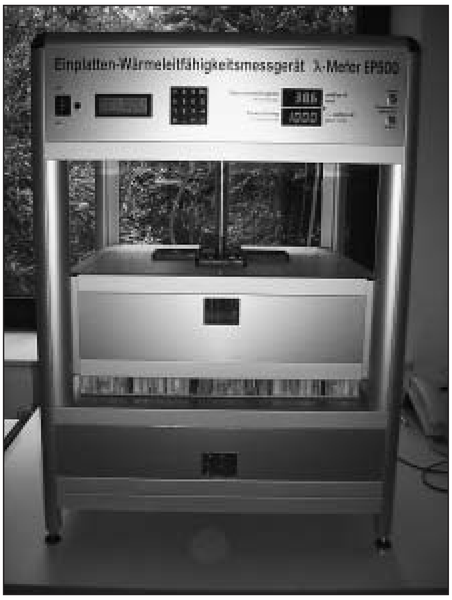

Fig. 2: Measuring the thermal conductivity

segments of the stems were used, because it could be assumed that a reduction of the thermal conductivity would become most clearly apparent here. The structure of the samples was like the structure in the first part of the investigations. The used sample material without wood fibers had a thermal conductivity of λ = 0,154 W/mK, that with a filling one of λ = 0,130 W/mK. The thermal conductivity was approx. 18 % lower.

Studies of the influence of humidity

For materials from natural materials, their behaviour during climatic changes is important. We examined the dampness admission and dampness delivery and the thickness change under temperature and humidity changes. The test run was as follows: first the samples were stored under a climate of 23 °C and 50 % humidity (balance dampness according to DIN EN 12429), until the changes of the weights (measured all 24 h) were smaller than 0.05 %. Subsequently, an increase of the temperature to 40 °C and of humidity to 90 % took place. This test is used in the door industry for stability analysis. This climate is kept constant over 2 weeks. Every 24 h the samples are weighed and measured. At the expiration of this time, the balance dampness (23 °C/ 50 %) is reset.

This dehumidifying runs over 14 days, too. It is to be checked, whether the samples regenerate again completely. The investigations took place in a climatic chamber (temperature constancy with ± 0.1 °C; dampness constancy with ± 1 %). For this test, three sample bodies were used for each material (dimensions: 75•75•38 [m]; 30 [mm] core material with 2•4 [mm] plywood surface layers). As core materials were tested: Triarrhena, rye straw, honeycomb from paperboard and polystyrene as well as samples from laminated fiber for comparison. Samples of the plywood surface layers (4 respectively 6 [mm] thickness; Surface: 60 respectively 70 [cm^2]) were also investigated. As to be expected, the laminated fiber samples exhibited the slowest-acting behaviour. It can be assumed that the dampness admission is not completely reversed after 2 weeks. It is shown that the plywood surface layers take up proportionally to most moisture, but did not release it after 2 weeks again. The raise of the weight, which could be observed with the polystyrene samples, is based exclusively on the dampness admission of the surface layers, whereby their dampness admission is still decreased by the gluing of one side. For the samples with rye straw core, the smaller mass became apparent. Paperboard and Triarrhena cores had an equal up-take. The surface layers contribute to approximately 2/3 to the dampness admission. Due to the smaller mass, the paperboard core take up proportionally more water and achieve by this a higher dampness. It can be assumed that the adhesive affects a decreasing dampness admission of the rye and Triarrhena cores, because it encloses the stems and sealed the surface.

An indication for this can also be seen in the occurrence of mould fungi growth (*Fig. 3*). This arises mainly at the edges, i.e. at the cut surfaces of the stems. Here the micro organisms have free admission and possibilities for growth, particularly at the knots. This growth appears here preferentially, because in the knots, an increased sugar concentration can be found which the plant needs for building leaves or roots. Visible growth begins after approx. 3 - 4 days during the humidification phase (40 °C/ 90 % humidity), before that, no growth could be observed.

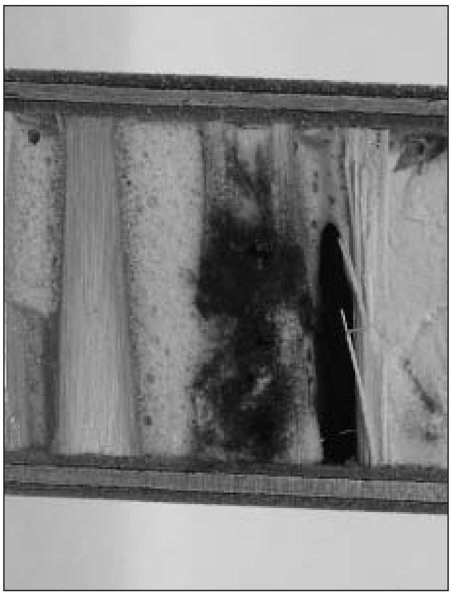

Fig. 3: Growth of fungi on a stalk core of Triarrhena

Conclusion

Due to its variability in the range of the core materials and the surface layers LNS is a versatile applicable material. Although it consists completely of renewable raw materials, it is relatively insensitive to moisture. By use of additional materials, the characteristics of LNS for further purposes can be changed and/or adapted, so that further areas of use can be developed.

Literature

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