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Light and stable

Development of LNS (Light Natural Sandwich) materials for building elements in construction

A building element system consisting of light sandwich material (LNS) was produced for interior construction at the Hjortsoj project. The special aspects of LNS material are the low density, high form stability and the use of only natural raw materials. The aim of the Hjortsoj project is, alongside the application of environmentally-friendly material, the making and the assembly of a light and quickly-erected wall element system.

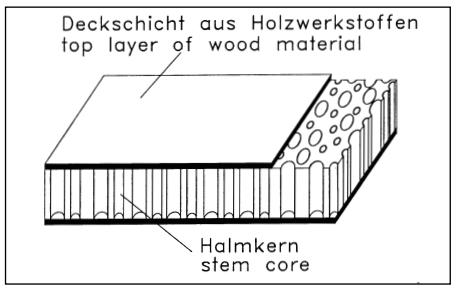

Fig. 1: LNS material structure

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Keywords

LNS building elements, natural raw materials, work easing

Currently, the basic work for the industrial production of LNS materials is being prepared as part of an EU research project (FAIR CT 98-3784) with seven other research partners at the Institute for Business Technology and Building Research, FAL, Brunswick. Of special interest for agricultural businesses is that, through the cropping of especially high value regenerative raw materials, a higher share of the created value remains with the farmer.

Figure 1 shows the construction of a light sandwich material from regenerative raw materials. Used as surface layer material was plywood or other timber material with light construction qualities. The honeycomb core of the LNS material consists of parallel-arranged plant stems (e.g. cereal straw, miscanthus, bamboo stem) which is bound with glue foam to form a matrix. The stems are glued at right angles to the surface layer. Suitable are only undamaged stems of higher stability with, at the same time, low density. For glue can be used casein glue, glue based on plant proteins, or any other kind of commercially available wood glue. An important aim for this development work was the optimal utilisation of the natural properties of the applied plant material. For this, the plant materials were applied as quasi semi-products. This approach saved energy in the processing on the one hand and on the other, allowed the synthesis properties of the plant to be used to full effect in the end product. Within the core, the stems or stem cuttings retained their natural fibre-pipe structure.

Material properties and utilisation areas of LNS materials

Through the variation of thickness, construction, type of wood used for the surface layers, as well as the relationship of surface layer thickness to core material thickness, the material properties can be matched to the respective requirements. A correspondingly large variety of property profiles of LNS materials are possible. *Table 1* shows LNS material properties in comparison to conventional materials.

Through the property combinations of
- reduced density
- high degree of firmness and form stability
- reduced heat conductivity
- natural raw material

the properties required for insulation material, as well as for lightweight construction material ingredients and construction materials, can be achieved.

The application of this sandwich material is especially practical where the requirement is for lightweight and stable materials made

Board type	Board structure Total thickness [mm]	Surface layer [mm]	Core [kg/m²]	Density [kg/m³]	Bending rigidity [N/mm²]	Bending E-module [N/mm²]	Lateral pressure rigidity [N/mm²]	Lateral traction rigidity [N/mm²]
LNS straw	19	Birch plywood 1,5	Straw gelatine 80	205	≤ 18	4000	≤3,3	≤1,5
LNS miscanthus	30	Birch plywood 2,5	Miscanthus PUR 190	295	≤33	≤5000	≤15	≤2,5
LNS hemp	25	Birch plywood 2,5	Hemp PUR 155 (200)	290	≤18,5	≤3700	≤5,6 (7,0)	-
Fibre insulation board	10-20	-	-	200-400	1-3	150-600	-	-
Chipboard	20-25	-	-	550-800	15-22	2400-3500	0,8-1.5	0,3-0,7
Wood fibre board medium hard	6-16	-	-	400-800	8,5-18,5	1500-4500	1-2,5	0,15-0,35
Wood fibre board hard	6-16	-	-	400-800	8,5-18,5	1500-4500	1-2,5	0,15-0,35
Block board	13-45	-	-	450-600	20-55	3000-8500	1,5-2,5	-
Veneer board	-	-	-	450-700	65-130	7000-14000	1,5-3	-
Plastic sandwich board	20	GFK	PVC	230	≤35	≤3800	≤1,2	≤2,2

Table 1: Properties of LNS and other building materials

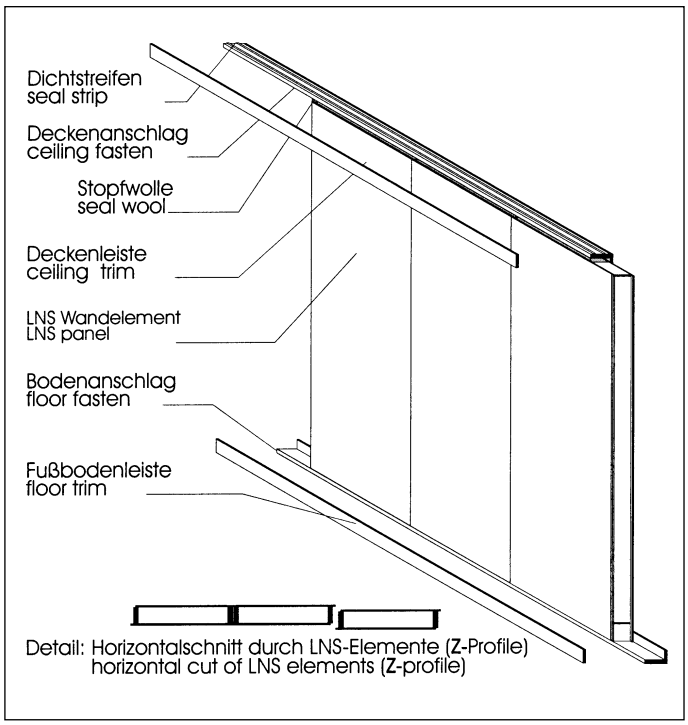

Fig. 2: LNS building elements for interior work

of natural products, e.g. for furniture, interior construction as well as in automobile assembly.

Production and price of LNS materials

Currently, LNS materials in technical sizes are manufactured at the Institute for Business Technology and Building Research, FAL. At the end of the EU research project (FAIR CT 98-3784) in 2001, an industrial production technology is to be developed. The cost of LNS material will presumably be between that of chipboard and block board i.e. from 350 to 700 DM/m^3. With this, the product is notably more economic than plywood (800 to 1700 DM/m^3) or plastic sandwich board (from 2000 DM/m^3).

Interior wall system using LNS building elements (project Hjortsoj)

An LNS material building element system for interior construction was produced for a demonstration project in Hjortsoj/Denmark (*fig. 2*). The target in particular was the speedy and simple assembly of the wall elements which had to be completed by two handworkers without any complicated assisting equipment. The measurements of the wall, and a wall thickness of 120 mm, were given by the project's Danish partners. A standard building element was produced according to these measurements.

Used for the upper layer of the sandwich material were 9 mm thick plywood sheets from birch wood quality BB/C. The core consisted of 100 mm thick straw-stem-core-material boards using rye straw from the variety Danko. The core was completely protected from outside influences because it was closed-in all-round on the narrow surfaces of the element. For this, pure wood strips were used on the sides with a cross section of 100•30 mm, and 9 mm plywood used above and below (*fig. 2*). The core and outer layers were glued with a casein glue according to a recipe from Buttermann & Cooperrider. The density of this LNS material was around 160 kg/m^3. The weight of a standard element measuring 2200•1200•118 mm was around 58 kg. For the measurement of reaction to moisture, moisture sensors were integrated at four points between core and surface layer and this allowed the wall reaction to moisture to be monitored continuously. The room moisture content was heightened to 70% over several months through the use of a water steamer. Additionally, sound measurements were taken.

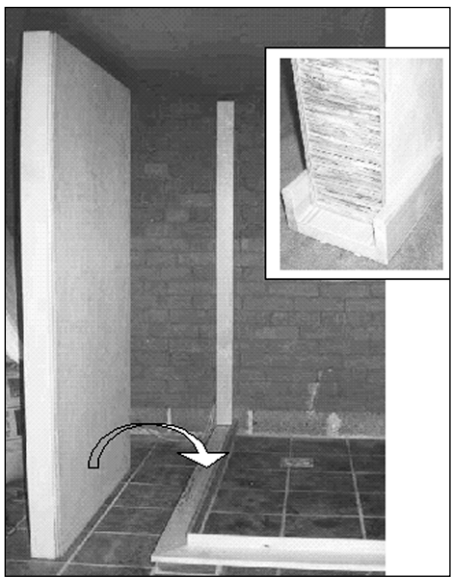

Fig. 3: Installing of LNS building elements into joint trims; cross section of wall and floor joint trim (upper right)

In the assembly of the building elements all individual parts were screwed to one another. This allows a simple dismantling of a LNS wall at any time for inspections. The following work operations were necessary for the assembly of the interior wall:

1. Positioning of the foot and ceiling joist on ceiling and floor (*fig. 3*).

These were functional construction elements and not facing elements which fix the wall elements within an U-profile at floor and ceiling. A side of the U-profile can be dismantled to allow lateral insertion.

2. Cutting the building elements to required size where the wall length does not allow a complete multiplication of the sample measurement.
3. Positioning of the vertical connection joists to the outside walls (cross section 99•30 mm) with insulation strip between joists and outer wall.
4. Sliding-in and screwing-down of the wall elements one beneath the other, to the outer wall connecting joists as well as to the floor and ceiling joists.

Surface treatment

All types of surface treatments suitable for timber material can be used, e.g. preservative application, waxing, oiling, varnishing or coating. These operations can be carried out economically and precisely during the preparation of the elements, before the actual assembly. Surface treatment of the finished wall with filler or the application of a laminate such as wallpaper is not necessary because of the good finish of the surface and the precise fitting together of the elements.

First conclusions

LNS building elements made from regenerative raw materials represent an environmentally-friendly and cost efficient alternative in construction. They are particularly suitable for inner separation walls which have to be speedily assembled and dismantled. Because of the small weight of the relatively large construction elements (58 kg with a short-side length of 1.2 m), the simple assembly, and the very good surface quality of the building element which doesn't require any further handling or decoration, interior walls can be assembled in shortest time. In project Hjortsoj a five metre long wall with a corner angle of 90° was erected by two people within four hours.