S-HOUSE – SUSTAINABLE BUILDING DEMONSTRATED BY A PASSIVE HOUSE MADE OF RENEWABLE RESOURCES

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Summary

Sustainable construction can be defined as follows: Not only the building concepts but also the components and materials which are used have to meet the present needs of the users without burdening future generations with waste disposal problems or prolonged use of an out-dated building design. Thus sustainable architecture means: form follows ethics, i.e. the design is the result of a careful consideration of functions, materials and their life-cycle performance including long term perspectives, present and future human needs and social aspects. This is the basic principle under which the S-House, a passive solar house made of renewable resources, is constructed.

Passive solar house technology is already well known. Building materials based on renewable resources are present in some areas (e.g. wood). But the combination of both is quite unique. This combination is made visible by the S-House, an office and demonstration building at the Center for Appropriate Technology in Böheimkirchen / Austria. After a careful planing phase the building was put up in early 2005. In this paper the process of the S-House building phase is described. Details of the building are mentioned in addition to important background information.

The challenge of the S-House-project consists in combining the high energy standard of passive solar house technology (less than 15 kWh/m²a) with the use of renewable resources and herewith to benefit from the advantages of both.

1. Introduction to the S-House concept

On an operative level the principles of sustainable building ask for consideration of four main issues. These are: time, material, efficiency and appropriateness to the given situation. Most of the buildings in Austria are made for a very long utilization phase leading to lots of old houses that are out of date and out of fashion.

The construction domain is among the economical sectors with the largest material flows and has an extremely high energy consumption for production and transport of construction materials. Furthermore it has to be dealt with quantitative and qualitative problems of material flows which are responsible both for ecological damage and rising costs for disposal.

This was already mentioned by Wimmer et al. at the SB02 in Oslo, where results of preliminary studies have shown that beneath an improved thermal insulation mainly the amplified use of materials made of renewable resources presents a promising solution to these problems.

Figure 1 The S-House in Böheimkirchen / Austria is made of renewable resources. The logo growing in a corn field. © GrAT

With the high performance of straw bale buildings the “factor 10” concept – i.e. reducing the material, energy and area consumption by a factor of 10 – is implemented in the building sector. Thereby the whole consumption within the live cycle is considered. The reduced energy consumption during the utilisation phase is realised by the passive house technology. Using renewable resources like straw in the construction reduces the material and energy consumption during the whole life cycle.

Compared to building materials based on minerals and fossil resources the resource efficiency is much higher than in state of the art buildings. The ecological footprint for manufacturing a straw wall is about 2400 m²a per square meter of wall surface. Compared to a conventional construction with 25000 m²a reduction is even more than a factor of 10.

There are of course several functional units that can not be made of bio-based materials, for instance the electrical installation. These applications are designed on a modular basis and can be dismantled easily. The valuable materials can thus be reused in other products and follow the technical material cycle. After the phase of use the modular construction elements made of renewable resources can still be reintroduced to biological cycles. Thereby they do not harm the environment with toxic substances and do not contribute to the waste problem.

With using locally available renewable materials, low energy consumption during construction and utilisation, no disposal problems at the end of life the appropriateness to the given situation can be met.

In this holistic approach the construction of the building, the building itself and the use is put to serve the common goal of disseminating the potential of renewable resources throughout the building sector.

Figure 2 The 3D model of the S-House in Böheimkirchen / Austria. © GrAT

The S-House demonstrates sustainable building with a physical example open to the public. The construction phase is well documented at the www.s-house.at homepage.

Essential for every house of the future are the following points which are served by the S-House:

- Sustainable planning (e.g. by use of innocuous and non-toxic building materials)
- Economic efficiency of sustainable construction: during planning already the whole life cycle of the building (construction, use, removal deconstruction) is taken into account and the negative impact on the environment is minimized.
- High functionality and quality
- Minimized consumption of energy and resources
- Use of regional building materials made of renewable resources
- CO_2 neutrality
- Environmentally sound solutions for a healthy room climate
- Testing of long-term functionality
- Easy separation of building materials during deconstruction and plans for recycling and reuse (end of life concept)
- Dissemination of sustainable building technologies based on renewable resources by an exhibition hosted in the demonstration building and by other means

2. Key innovations

The combination of renewable building materials with the concept of passive solar houses to the ends of sustainable building asks for the development of new techniques. Over all the S-House construction includes 19 innovations that cover construction details within the whole house from ground work over windows, wall construction, to the roof. Some of the key innovations are described in the following.

2.1 Construction detail straw bale wall

The wall construction of the S-House consists of the layers shown in the figure 3. Static forces are beard by an inner wooden plate construction which also functions as a vapor seal. The plates are joined together and form a box. The straw bales are attached to the plates by the use of cords for enhanced thermal bridge free heat insulation. On the outside the straw bales are plastered with clay to make the ventilated facade less vulnerable. With the Treeplast screws (especially developed for the S-House) the counterlathing is mounted to the straw bales carrying the wooden sheathing.

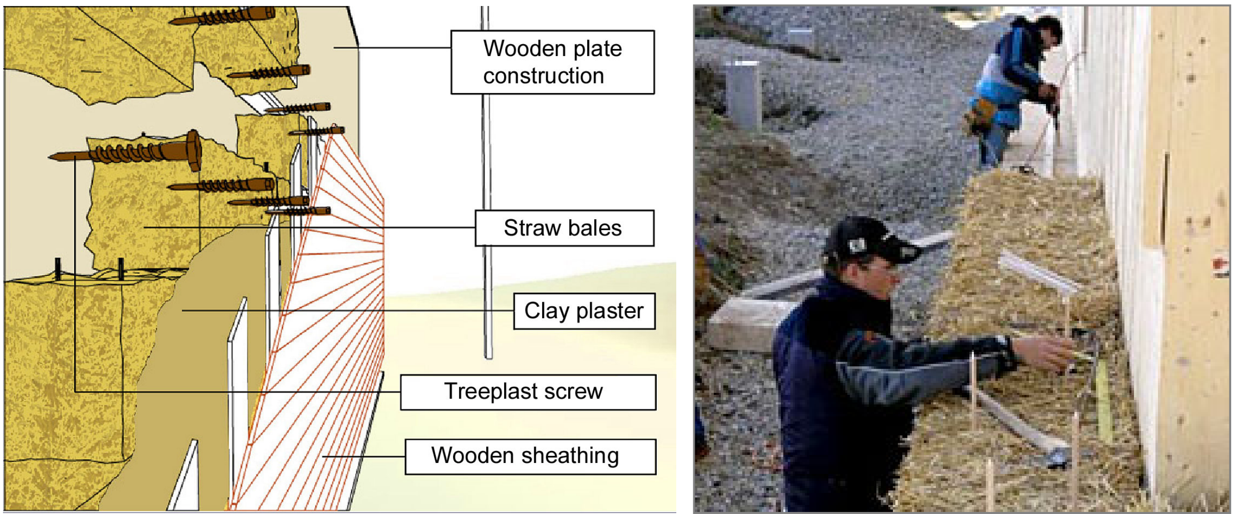

Figure 3 The wall of the S-House showing the layers of the straw bale insulated novel construction in a model and on the building site. © GrAT

2.2 Construction detail Treeplast screw

Building with straw bales encounters the problem of how to fix various components or structural elements to the wall. Straw bales show an inhomogeneous, comparatively rough structure. Ordinary nails or screws as used with other building materials are not applicable. So far there is a lack of devices that can cope with the specific requirements.

With consequent straw bale building not only the shape of a device is important but also the material of use. Therefore an Eco-design process was used to develop an environmentally sound solution.

The shape of the 365 mm long screw was optimized with a biomimetic tool from Claus Mattheck. The stresses in the material have thus be reduced considerably and further reduced the material consumption. As material the lignin based biopolymer Arboform was used. It is made of renewable resources and is biodegradable but water proof.

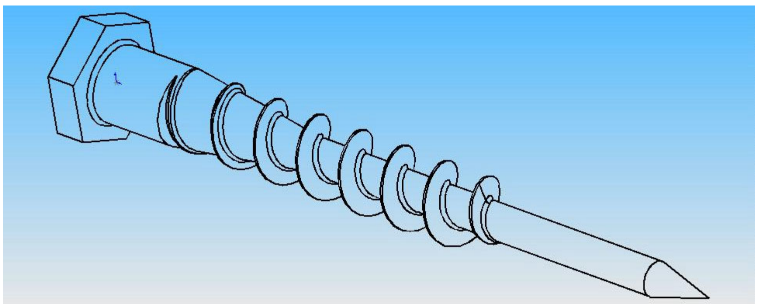

Figure 4 The Treeplast screw for mounting various items to straw bale constructions. © GrAT

The Treeplast screw is produced on ordinary injection molding machines that are known from manufacturing plastic parts in high quantities. The screw can easily be mounted with an ordinary spanner or electric drill/driver and thus also dismantling after the phase of use is no problem.

2.3 Biomass heat storage stove

Another innovative detail is a new type of biomass stove. This stove stores the heat in an medium with high heat capacity. The modularly built stove – usually used as stand alone oven with radiative heat transfer – was adapted to the requirements of passive solar houses. The combustion air used for burning is taken from the outside of the building, because the controlled ventilation must not be disturbed by ovens.

Figure 5 The stove for the S-House especially adapted to the requirements of passive solar houses.

In passive solar houses additional heat production is needed only with exceptionally long and cold weather condition. But there are a whole lot of requests from people how want to live in a passive solar house showing that a small stove with visible flame will raise the comfort of living considerably. In such cases this stove with a power of 2.5 to 4 kW is an ideal solution.

3. Long term monitoring

An important aspect for a successful dissemination of new building materials are tests and long term monitoring. Although there are straw bale houses in use that are almost 100 years old not many scientific monitoring programs have been accomplished so far. Thus the long term behavior with respect to heat transfer, humidity in the building material etc. is not sufficiently documented yet. An extensive monitoring concept provides realistic and exact data about the used constructions which constitute a basis for further optimization and dissemination of building materials made of renewable resources.

In the wall sensors have been installed to measure relevant parameters for building physics. The parameters are divided in those with high dynamics an those with rather static behavior. The CO_2-content or humidity within the building can be considered to show high dynamic when for instance a group of visitors appears at the exhibition. Of lower dynamic or even static behavior for instance the humidity within the insulation material can be considered. Such data are measured with longer time intervals.

Additionally to the straw bale construction four test boxes are filled with other insulation materials. These test boxes are also equipped with measuring sensors to compare the different behavior and to receive reference data. All the electronically measured parameter are adequately prepared and online available via the internet (www.s-house.at and www.nawaro.com).

To address one of the most common prejudices the microorganisms in the wall are monitored. Microorganisms are around everywhere and so they are on building materials. This is not a problem as long as they are not becoming to many and start to degrade the materials. This is usually not the case as long as the materials are not getting permanently wet. An university institute specialized on microorganisms will observe the occurrence of different species and their quantity over a time period of some years.

4. Balanced Technology – Dissemination of renewable resources in the building sector

The exhibition on sustainable building of best practice development, which is hosted in the S-House, is open to the public and will contribute to a broad dissemination. The high performance at considerably low cost of bio-based materials will be demonstrated herewith, and give another impulse to sustainable building in Austria and world wide.

Renewable resources play an important role in the shift of our economic system towards sustainable development. Particularly in the building sector there is a multitude of functional solutions based on renewable resources on the one hand and a high dissemination potential due to the enormous material flow on the other hand.

Central aim of the exhibition in the S-House is the dissemination by offering extensive information about the manifold product range of building materials based on renewable resources and their correct implementation. The exhibition grants access to the developed solutions to all participant groups and interested private persons.

5. Conclusions

The realization of the S-House demonstration building enables the creation of an information centre for renewable resources which opens access to sustainable technologies for a broad public and displays long-term measuring in a realistic user scenario. Modern architecture presents the variety of possible applications of building materials based on renewable resources and herewith promotes their dissemination.

The internet based platform on renewable resources on www.nawaro.com established by GrAT is already in service and provides information about products made of bio-based materials (mainly from the German and Austrian markets). It is appreciated by companies manufacturing products as well as by architects and private people building their own sustainable house. Together with the S-House this information platform completes the picture of new solutions.

Introducing the new technology shown by the demonstration building has a strong potential to considerably minimise environmental damage world wide. Thus international co-operations already exist and are intensified even more.

The S-House was nominated by Austrian officials for the Global 100 Eco-Tech Awards at the Expo 2005 in Aichi, Japan.

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