Straw bales stacked in a field are a common sight in Germany's countryside. Straw is also a wonderful insulation material; the actual problem is getting it into the wall of a house. A challenge Benjamin Krick was also facing when building his Passive House. Pictures (11): Passive House Institute

Interview

From the field into the house wall

How Benjamin Krick's Passive House ended up with straw bale insulation

On the streets of Seeheim-Jugenheim in southern Hesse, the straw bale house belonging to Benjamin Krick stands out. As a staff member of the Passive House Institute, Dr. Krick was sure that the house he wanted to build for himself would definitely be a highly energy efficient Passive House. The subject of his doctoral thesis was straw bale constructions, so it seemed logical to combine the two. Now he just had to somehow get the straw bales into the house's walls… How he managed to do that, Benjamin Krick explaines it in this interview, and also tells us what happens to his shower water.

Please, describe your house.

My straw bale house, which we completed in 2013, is an extension of the house belonging to my parents. It stands on a corner plot. As a staff member of the Passive House Institute, I was sure that I wanted a Passive House, and at the University of Kassel the subject of my doctoral thesis had been straw bale constructions. Everything else fell into place itself. At present, there is a two-room flat on the ground floor which is rented out. I live in the 70 m² flat on the upper floor, which is accessed via an exterior staircase and includes an open gallery. The wood frame construction allows for generously-sized corner windows.

The house belonging to the parents is at the back, the Passive House with straw bale insulation in the front. The production of straw requires very little energy and straw is very suitable as an insulation material.

Towards the south, the roof is almost completely covered with solar thermal collectors and a photovoltaic system. The solar energy thus provides us with hot water and generates electricity. The greened northern roof looks beautiful and ensures slower rainwater drainoff for a better micro-climate and relieves the sewage system.

What are the advantages of an insulation consisting of straw bales?

As far as I know, straw bales are the only insulation material that can be installed into the wall straight from the field. It therefore requires very little energy for production; as a natural product, straw does not contain any harmful substances, that is if the grain hasn't been sprayed too intensively. The sprayed insecticides are usually washed off by the rain.

Inexpensive to buy

If you want to be on the safe side, you can use organic straw. The straw is also very inexpensive to buy. For the about 25 tons of straw which I used, I had to pay 1800 Euros, delivery included. Nevertheless, as a natural building material, the delivered straw does not have exact dimensions, so installation requires time and therefore incurs costs.

Insulation must be thicker

With a thermal conductivity of 0.052 W/(mK) straw has a relatively poor insulating value for an insulation material. In order to achieve the same level of thermal protection as conventional insulation materials, the insulation must be thicker by around a third. This may be a disadvantage if the prices for building land are high. Since straw is a natural product, it starts rotting if it gets wet. Therefore, special attention must be given to flawless installation in terms of building physics, so that the straw stays completely dry.

The baling press with which straw bale insulation was produced for Benjamin Krick's house.

A crane had to be used to move the approximately 300 kilogram straw bale so that it could be used as insulation for Benjamin Krick's house. The straw bales came from the field next door.

Where are the straw bales from?

My straw bales came from the field next door, barely a kilometre away from our house. They were specially pressed into five sizes using a square baler. The bales are rectangular, 1.20 metres high and 70 centimetres thick, with a length between 0.90 and 2.60 metres. That's how it was planned. Unfortunately, they were all a little bit longer, so that the windows had to be made slightly smaller. Making such large straw bales smaller is very difficult.

Depending on the harvest

For the straw bales, I engaged the farmer who cultivates the fields. He dealt with the mowing, threshing, baling and transport of the bales. Of course, it all depended on the weather and the grain harvest, because straw is a by-product; the main product with which the farmer earns money is the grain.

In practical terms, how are the straw bales installed in the walls of the house? How are they fixed in place?

My house is a timber frame construction. The load-bearing frame is on the inside, and the bales are stacked on the outside. A structure similar to a ladder is inserted between each layer of bales, that is every 1.20 metres.

300 kilograms heavy

Completed! The insulation has been installed. The bales are stacked on top of each other, after each layer of straw a structure resembling a ladder is inserted.

The bales lie at the level of the rungs, the side rails are screwed to the frame on the inside, and the sub-construction for the cladding, consisting of fibre cement, is fixed on the outside. With a weight of up to 300 kilograms, the straw bales were so heavy that they had to be moved using a crane.

Took longer

It took longer than planned. That is why, if I had to build once again, I would prefer to use smaller bales which can be moved by hand. This makes more sense, at least for such a small building site.

How are the straw bales themselves protected from the weather?

During the construction phase we protected the bales with tarpaulins. This is a tiresome but necessary task which must also be performed with regular timber constructions. The problem with weather can be mitigated considerably through prefabrication by a carpenter, for example. A good idea! The straw bales are now protected by the ventilated façade and the roof consisting of fibre-cement. Some people apply plaster or even loam to the straw bales on the outside as well, and have had success with this, but I was afraid to try that.

The gallery on the upper floor of Benjamin Krick's house in Seeheim-Jugenheim.

Loam walls inside the straw bale house: the clay plaster itself is protected by a coating based on an ancient recipe.

Is insulation using straw bales more cost-effective than with a compound insulation system?

As I already mentioned, this insulation cost me about 1800 Euro. Thus, the insulation material is initially much cheaper than e.g. polystyrene and especially cheaper than other ecological building materials. This fact might be relativized due to the higher space demand and the additional effort for installation.

Individual case

Thus, it depends on each individual case. However, what is certain is that the insulation and its installation are not the major costs incurred for a house, no matter which insulation material is used. I think the wish to save investment costs is not a good reason for choosing this building material. First of all, because of the minor relevance with reference to the overall construction costs. Secondly, most of the costs are incurred for building operation in any case, without the insulation, and that becomes extremely relevant.

Here is something interesting: straw bales usually don't have a thickness smaller than 36 cm. Installed in a wall, this equates to a U-value of just below 0.15 W/(m²K).

Avoid thermal bridges

If someone uses straw bales for construction and ensures that thermal bridges are avoided and that good windows and a ventilation system with heat recovery are used, he will have a good chance to build a Passive House almost in passing. Then, he can also save on the building services systems and running costs in particular!

Is it possible to attach straw bales to any type of façade?

Not every kind of façade, because some façades must be made of inflammable or fire-resistant building materials – straw is

out of the question there. On the other hand, a lot is conceivable in the case of small buildings especially, even in existing buildings. There are some examples of this. The reason why there aren't more examples is the more complicated installation process. Compared to applying a compound insulation system, this is certainly a special solution for which specially trained professionals are required.

Loses little heat but gains a lot of it from the windows: in his Passive House, Benjamin Krick only has to use additional heating for three months, with the heating switched off for the rest of the year.

Suppliers

Straw cannot simply be purchased on the market like polystyrene. However, with "Baustroh", a supplier of straw bales is available who offers a level of convenience similar to that offered by "normal" building material suppliers.

How do your walls look like inside?

On the inside, my walls have three layers of adobe plaster applied directly. The adobe plaster is applied using a method known as "Kalk-Kasein-Milch" (lime-casein-milk), which I mixed myself based on an ancient recipe with low-fat curd and lime. Lime albuminate is formed from these ingredients which makes the adobe plaster wipe-resistant without greatly impairing the moisture regulating effect.

The straw insulation provides for a unique wall decoration inside.

Ancient recipe

This functioned really well and was great fun, too. The climate inside the house is incredible on account of the adobe plaster and the interior walls of solid mudbrick and also due to the higher surface temperatures. They are a result of the good level of insulation. And, of course, on account of the fresh and preheated air from the ventilation system.

How do you heat your Passive House?

I don't heat it most of the time because the house loses very little heat and a lot of heat is gained through the large windows. Additional heating is only necessary for about three months in the main winter period. This takes place partly via the solar thermal system in conjunction with a thermoactive ceiling system. Heating coils with hot water flowing through are laid in the concrete ceilings and also in some walls, which spreads an incredibly pleasant warmth throughout the house.

Less expensive

The forward flow temperature can be very low here. This is ideal in combination with the solar heating system or even with a heat pump. Panel heating is absolutely recommended and is also less expensive than radiators, at least in a Passive House.

Nuisance!

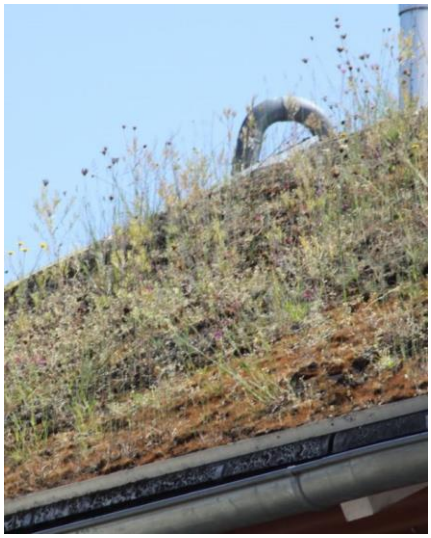
In the first winters, if the heat from the solar heating system was insufficient, I used an electrical heating rod in the solar storage tank for supplementary heating. Unfortunately, that broke even though it was supposed to last at least 15 years. What a nuisance! Conclusion: you should have as little technology as possible, i.e. a passive construction like mine. Then it is easier to bear with a faulty heating system.

Heat using gas lamps

Right from the beginning, I had a small gas lamp installed in each room. They are connected to a gas cylinder system together with the two cooking stoves. The lamps provide little light but give off considerable heat, at least enough for a Passive House. In the extremely cold winter of 2016/2017, we used these lamps for heating as well as cooking. We used only three large gas cylinders, which is about 100 kg of liquefied gas. That's equivalent to the calorific value of one full tank of my VW bus.

Small heating load

The CO_2 released by the gas lamps in the rooms is reliably removed by the ventilation system. I'm very happy with this archaic method of heating, but it won't appeal to everyone. The ingenious thing about Passive House buildings is that they offer diverse possibilities for heating systems, depending on the user's taste and purse.



On this side the roof is greened, on the other side a PV system and solar thermal collectors are installed.

Your Passive House is a Passive House Plus which produces regenerative energy. Is it enough for you?

Yes, that's right. For me, making a contribution not only towards improved energy efficiency but also renewable energy generation was important. Annually, my 4.2 kWp system produces more energy than the electricity and gas that I use. I have measured this and done all the calculations.

Green power

Of course, despite all this I am still connected to the power grid, into which I feed any surplus electricity in the summer and with which I can meet my demand in winter. Of course, that's when the output of the solar energy system isn't enough.

Is your house very distinctive?

Yes, very much so! But that has nothing to do with the fact that it is a Passive House or that it has straw bale insulation. It's because of the façade's "red waves", the solar energy systems and the green roof.

Ecological building materials and sustainable methods of construction are obviously very important for you.

Yes, indeed. I think it should be for everyone. What is even more important to me is the fact that buildings which use a lot of energy cause the greatest damage. The production and disposal, also of problematic building materials, is secondary in contrast. Anyone who wants to build an ecological and sustainable house should pay attention to a low operating energy demand first.

Recycling water

Once this is achieved, one can continue with the choice of building materials, the heat supply system and the energy generation. With my greened roof and a greywater treatment system, I went a step further: the water from the shower, washing machine and the washbasin is conducted through a bed of reeds in the garden for filtering, and then flows into the rainwater cistern.

Bed of reeds

This water is reused for watering the garden, flushing the toilets and for my washing machine. In essence, my experiences with this experiment have also been good.

END

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