

## Episode 89

# Can You Build to Passivhaus Standard Using Only Natural Materials?

The show notes: [www.houseplanninghelp.com/89](http://www.houseplanninghelp.com/89)

Intro: Our featured interview is with Bjørn Kierulf from Createrra. They are based in Bratislava, Slovakia, and build with all sorts of lovely materials - straw panels, wood, limestone bricks, clay plasters . . . and the list goes on.

Bjørn is very well respected because of these buildings. They get that balance right where not only has the construction phase got a tiny carbon footprint, the materials all have low embodied energy, but then the building lasts for decades and when you've finished with it, well, it just goes back into the ground. And all that, and you've got an ultra low energy building while you're using it. So this is really the Holy Grail! Can it become a reality? We're going to find out.

I started by asking Bjørn to tell me a little bit about his background.

Bjørn: Well, my wife is an architect. I am just an industrial designer. So she was interested in doing something that makes sense, so we looked round, looking at different materials, different ways to build. So in fact we started with natural materials before we started with Passivhaus.

Ben: Where do you start? Are there any natural materials that are better than others?

Bjørn: Well most natural materials are fibrous. And they have fairly good insulation values for a thermal comfort. Especially also in summer they have good protection against overheating as well, better than most like fibreglass insulations or other light insulations. So these fibrous materials are in fact very user friendly for what we need to do. The problem is that of course we have to protect them against humidity, moisture, but that applies I think to all kinds of materials.

Ben: But this is going to be harder or not so if you approach it in the right way?

Bjørn: Of course you won't get as thin an insulation at the moment as you would let's say with some artificially made materials, maybe aerogel are the best materials at the moment but very expensive and difficult to apply. If you can work with thicker insulations like thirty / forty centimetres and that doesn't really matter to you then I think natural materials are an option.

Ben: You've mentioned that they're fibrous, so can you just give us a couple of examples of what we're talking about when we say natural?

Bjørn: Well it might be wood fibre, which is pressed in different plates. It can be very soft but it can also be fairly hard and dense. It's still diffusion open but in different degrees. Wood fibre, you can also blow in wood fibre. You have wood fibres which in a different way like cellulose which has already been through a manufacturing process and is a waste product. But then you have materials like straw, which I use quite a bit at the moment. I think it's a very exciting material because it does have all these, it's fibrous, it insulates well, it has good water diffusion values, it has some protection against humidity on the, what do you call them, these parts of the straw, the round...?

Ben: I'm not actually sure! [Ben laughs.] Yes, those bits!

Bjørn: Those bits, exactly! They're covered by a protective layer, natural protective layer, because when the straw is growing in the field you have very high humidity of the rain and it has to protect itself. In fact it has a lot of things built in and it can take big loads, so when you have straw which is compressed it can take loads as well. There are very few materials and insulations that can take structural loads as straw does.

Ben: Does it have to be compressed and if so how is this done?

Bjørn: Well you can press it in bales, like you know from the field. That would do the job no problem.

Ben: That would be airtight enough? Just in bales from the field?

Bjørn: Absolutely, this has nothing to do with airtightness, this is just...

Ben: The insulation qualities?

Bjørn: Exactly. That's the insulation quality you can get from it. The airtightness you have to do in a different way and I think I'll talk

more in detail about that a bit later! [Ben and Bjørn laugh.] So what you get is a bale that insulates fairly well. It has maybe 20/30% less insulation value than EPS or one of these materials, so you need a little bit extra thickness maybe, but otherwise it has the advantage of well, taking the structural loads and of course after the building will be demolished you can just put it on your compost heap and that's it. You can kind of feel good about that as well.

Ben: Do you see this progressing a lot in the next few years or is there a reason that it hasn't taken off? I know in the UK - my wife loves straw - but you have to pay a lot more insurance if you have a straw house.

Bjørn: Well that doesn't really make sense because the insurance companies, if they look at the data available and you have a straw wall which is plastered with clay, in fact it will provide a 2-hour fire protection, which there is very few materials that can do that. So in fact it's a very, very safe way to build. So many people are surprised by this but there are various tests being done already in Europe, the Czechs have made one, the Germans, the English as well I think, in America they all showed the same results. In fact when you have densely pressed straw there is no air to make it burn. It's like putting fire on a telephone book. It's hard work. You have to crush the papers before it really burns well and when you cover that with clay plaster which is the other natural material you use in combination with the straw, you have the perfect fire protection.

Ben: Does that mean that if a fire has started somewhere that just nothing will happen for 2 hours? Is that what you mean by, just to clarify it, fire protection?

Bjørn: Yes, in the tests that have been done you have 1000 degrees on the inside fire going on for 2 hours and you have been leaning against the wall on the outside without anything happening. No change in temperature. Everything fine.

Ben: Clay plaster, I'm assuming that's the inside. Is there also lime render on the outside? Is that a common combination? I've been to see one straw bale house, I'm not sure it got to Passivhaus, but that was how that one was.

Bjørn: Yes, straw bale building has been in the hands of self-builders for most of the time until now and of course self-builders have been using lime plaster on the outside directly. This works in most cases, if the details have been done properly. It's very important to talk

about these details because if they are not done properly, the absorption, water absorption, of these materials is quite high, which is the largest danger. So we are in fact looking at some other possibilities to add, for example, a wood fibre board on the outside of the straw and plaster that with commonly available industrial certified renders which are much thinner.

Ben: Are they natural as well?

Bjørn: They are not natural at the moment, so that's of course one of the things that needs to be solved. It's always, with natural materials, it's always a problem about getting the balance right between materials that will last long under humid conditions like the facades or foundation and so on, and having a natural material at the same time, and not using any chemicals.

There is a trade-off in many places and there will be for the foreseeable future but I think there is a huge development going on where natural materials are the basis of innovative products. And I can see that there are some very interesting things coming in the future. The Swiss, they presented at BAU in Munich, that's the big exhibition, building exhibition in Germany. They presented a fluid straw. It sounds funny but they used enzymes to treat the straw and when it dries out it becomes really very different properties and very interesting properties and it's a completely natural product, so there are things going on.

Ben: So they're mashing it up. What happens in the foundations then of these buildings, or is that what you're saying, that sometimes you'll just have a concrete foundation to know that that's going to be airtight underneath?

Bjørn: Yes. Very often we do use concrete but there are ways how to do it differently. At the moment we are developing with some Danish guys what they have been doing in fact for quite some years. They use mussels in the same way that we make foam glass to make a foundation and we might be putting some of our ring beams directly onto these crushed mussels or shells.

Ben: Really?! Mussels as in the sea? I was wondering what that was for a second, thinking do you mean that? You do mean that!

Bjørn: Yeah, it's empty shells of course and crushed. They don't have any water absorptions and they insulate because there are air gaps in between. It doesn't insulate as well as foam glass crushed or aggregate like foam glass aggregate which we use much more

often. You can then put a ring beam on that and build your straw house on that and have a safe foundation.

So there are ways of doing this, some of them are experimental. We have used for example wooden elements put directly on foam glass for our own straw bale dome, which is our office in fact, and that works perfectly well. There is no problem with it but I'm not sure I would do that for our clients yet. So we again we have to look at who we are doing it for, trying, experimenting with new ideas all the time and I'm quite confident that you can build a house completely with natural materials that will last very very long and it's just getting there which is a bit hard at the moment.

Ben: Hemp is another material that I've heard some good things about. Have you had any experience with that as a foundation material?

Bjørn: Well, I don't think any fibrous materials, even hemp, would be good in any places where you can get higher moisture content. So for foundations I don't think it's ideal. You do have hemp concrete...

Ben: Hempcrete, is that different?

Bjørn: That's a little bit different. Hempcrete again doesn't have a very good insulation value. I'm not saying it won't work for some areas but it definitely doesn't work to get a highly efficient building from a thermal point of view. So I'm not using hempcrete myself. What I am using, is like I try to, the best insulation value you can get from the natural materials and then have the structural thing separately from that. Maybe a bit of wood or something and then using clay plaster just for the plaster part. So with that you can get very far. For the foundation I think there is a lot more experimenting needed.

Ben: We talked about airtightness briefly a while back and you said we're coming to that later. Can we come to that now?

Bjørn: Absolutely. Airtightness is very important. It has been neglected a lot by self-builders. Many of these self-build straw houses are very draughty so when you have a little bit of wind it gets cold inside, you can't heat it really well, although you have a very well insulated house. And of course it can cause a lot of damage in the construction. The reason is that any humid air going through any gaps through the construction will condensate somewhere in the structure and that might be, well, decilitres per day in some cases so it can really cause a lot of problems. So what we should look at is have a construction which lets vapour go through the construction unhindered or easily. At the other side not having any

airflow going through the construction because the airflow will transport a lot of moisture with it as well and that's what would cause the damage. Now to achieve that you can use, for example, clay plaster which is airtight, but you will run into quite a few problems because the clay plaster has to be connected to wood somewhere.

Ben: Why?

Bjørn: You will have a beam going into the wall for example so you will, or a stud in front of the wall and you won't be able to make a continuous layer. Everywhere where clay plaster meets another material you will get the crack or something like that. It won't last really then some movement in the building. You will have electrical installations in the wall, that's hard to get airtight behind that again. So that's a lot of work and difficult to achieve.

What we have developed together with the company selling these Ecococon straw panels is an airtight layer on the outside of the insulation, straw insulation. Of course first thing I have to say is you never put airtight layers on the outside. You always put them on the inside in cold climates so anybody listening to this should be aware of that, that this is not the typical way to do, and it works only if it's also completely diffusion open, vapour open. It has to let vapour go through and it needs a SD value of less than 0.2 metres to make that work at all. And it should be covered with the wood fibre board which is able to transport any excess vapour to the outside. So there are certain conditions but we have done some calculations where we can now build the straw panels, wrap it in an airtight membrane which is completely vapour open...

Ben: And what is that made of?

Bjørn: That's made of, again not a natural material...

Ben: It's okay, it's alright, we'll get there one day!

Bjørn: [Bjorn laughs.] Yeah, exactly, that's what I'm thinking! It's made of polypropylene or polyethylene which is fairly well recyclable so it's no PVC or anything like that. So I think it's fairly harmless having the few kilograms of membrane, it's really very thin. And then we cover that again with wood fibre board. So this opens up the possibilities. In the inside we don't need to, we can easily do the electrical installation, the plaster doesn't have to be exactly made. All these things do speed up the building process and makes everything cheaper and you get a result which is good. We have

had 5 blower door tests now done in buildings like that all getting below 0.3 (air changes per hour at 50 Pascals) which is kind of I think very good Passivhaus result really.

Ben: And on the outside you mentioned this wood fibre board, can you just clad it with anything?

Bjørn: Yes. You can put wood panels, ventilated wood façade or any kind of ventilated façade in fact. You are completely free to do that. And if you want to put a render on it then you definitely need to have a render which has a very very low moisture content uptake and so the AV value should be 0.1 or something like that. Which is in fact all certified plasters for wood fibre board fulfil that criteria anyway. So as long as you use wood fibre boards and use a certified render you should not run into any problems.

Ben: A little bit earlier in the interview you were talking about how you might have a timber frame in there or some timber element. So do a lot of straw bale buildings have that or can they be structural on their own?

Bjørn: Straw does have the potential to be structural, so you do have several load-bearing straw bale houses. We have our own dome which has 6m in diameter inside which is load-bearing and works perfectly well. So there are possibilities. The problem is you can't calculate it that easily so we use usually rather wood. You don't need that much really to make a good load-bearing construction. Fill it up with the straw, or like we do we use these Ecococon panels which are already a combination of straw with wood construction which you can then use as the structural part and calculate properly. The straw is the added benefit. You get some extra lateral and also of course load-bearing capacity.

Ben: Are there any other key elements in creating this natural building or have we covered most of them?

Bjørn: Well, you do have like foundation, walls, roof, and the whole interior which needs to be from floor cover to plaster and so on. There is a whole range of materials that can be used to get that whole building made from natural materials. And there are areas where you can get it done very easily today, and there are areas like the foundations which are a little bit more difficult. There are areas like windows where you do have wood, aluminium windows but which probably can be separated into different materials later on when the building is being demolished.

So, but you do have technical installations like electrical cables and so on which are still wrapped in PVC and well we need to get rid of all this. What is important for me is that materials is a much larger problem for humanity than let's say energy. We do have a lot of energy coming down to the earth from the sun. We just haven't learnt how to harvest that energy efficiently enough yet. Passivhaus helps us to lower the energy demands so that we can harvest it more efficiently and use more of it. That's why we go into the Passivhaus Standard for one reason. The other reason is for the comfort.

But when we look at the future I think the energy crisis will be managed in the next 10 or 15 years fairly easily. But after that, just think about it. Everything around us is being made up from some kind of materials. Mostly there are some toxic materials mixed into this. There are not only 500 materials that are being used in building buildings like they were in the beginning of the last century, the beginning of the 20th century we had 500 building materials that were being regularly used. Today we have about 50,000 different substances being used in our buildings and we have no idea what's going into these materials.

So sorting that out in the long term means really having the possibility to put your house on the compost heap instead or recycling it in a sensible manner, like the aluminium you can recycle forever. Well that's going to be much, much harder than solving our energy crisis.

Ben: Do you think it does come down to population as well? This topic seems to come up from time to time, that we're actually at a stage where we can't have this growing population. Either we as humans make the decisions, or it's going to come to us the other way! [Ben laughs.]

Bjørn: Well I'm always a positive person so I think there are solutions.

Ben: Me too! Send people out into space!

Bjørn: Well I think we do have technology and we can apply our brain, using natural materials in a much more efficient way than we do today. Or all materials for that sake. We do have a huge potential how to deal with this problem.

I don't think over-population or anything like that is really the core of the problem. The core of the problem is how we deal with that and just take the cradle to cradle concept, maybe you also know about

it? You don't really try to stifle the consumption but you try to produce products that can be recycled properly. That means in a technical cycle or a natural cycle and by having these two cycles working well you should have no problems having enough materials for our use also in the future.

It's a little bit like a cherry tree, it has a lot of blossoms. In fact it needs only one cherry to produce another tree so the rest is all waste if you look at it. I think it's very beautiful a cherry tree in blossom and the difference in how we deal with over-production is that our over-production ends up on the wasteland and pollutes. These blossoms they fall down and nourish the ground for the tree to grow for the next year. So there is a difference in how we need to change the way we look at this.

Ben: Just finally, maybe we could have a couple of examples of houses that you've built and maybe reflecting on their performance? Whether the people living in the houses have been happy?

Bjørn: Yes, we do now have 5 Passivhauses which are built I think nearly purely with natural materials, except for the foundations and maybe some of the roof membranes. But they work extremely well. They have perfect comfort in summer and winter. We do have installed ventilation of course in all of these, that's part of the Passivhaus concept. The feeling of these houses is also kind of much warmer because of the materials used, like that's a feeling.

Ben: I've noticed that before when I've been to straw bale houses, the acoustic is quite different inside.

Bjørn: Much better usually. And it's also a lot of times because of the wood but also the plaster does, it's definitely better than if you have a brick wall which is like hard surfaces. The feedback we have from our customers is very positive and so they are very happy to show other people around in their houses and I don't have to say an extra word of, you know they're doing all the marketing for us! So that's really great! I think even people who have not been thinking about straw houses before, when they see the panels and how flat they are and how nice it looks and how efficient you can build it, then it becomes really very attractive. So, yes the experience at the moment has been very very positive and I'm really looking forward to doing more of it.

Ben: Bjorn, thank you very much.

Bjørn: Yes, you're welcome. Thank you.