

Episode 96

Is Natural Ventilation Fit for Purpose?

The show notes: www.houseplanninghelp.com/96

Intro: Today's podcast is with Kara Rosemeier from the Passive House Academy New Zealand. She's been someone that I've wanted to chat to for a while but we hadn't settled on a topic. However, it presented itself!

I did an episode called achieving 'Passivhaus Standard with Natural Materials' and Kara challenged me about using the word 'natural' . . . Surely everything is natural? So she's going to explain this in a moment. Then that leads us to talking on indoor environments and ventilation. We're focusing particularly natural ventilation in this session.

First though, I wanted Kara to share a little bit on her background and where she is today.

Kara: So I started out in physiotherapy but for most of my life I was doing building physics, being either a consultant, researcher or teacher in this area. Currently I am the Director of the Passive House Academy New Zealand. No affiliation with the Irish Passive House Academy. I'm a board member of the Passive House Institute New Zealand, a building physics consultant and a part-time lecturer at university.

Ben: Our topic today is all about natural ventilation and whether it's fit for purpose. And we're going to dive in to that in a moment, but I thought the broader question which I know you have a slightly different take on because we've done episodes on this before, I always think of natural as being good, so what is natural in your view?

Kara: Alright, so in the interest of full disclosure I may be particularly sensitive to the connotations of the term 'natural'. As 'this is just not natural' is one of the favourite abuses thrown at non-heterosexual people like me! So if this is supposed to mean that there are no examples of non-straight sexual relationships in the animal kingdom, this is clearly misinformed. But the more likely intended meaning is you're sick, you're an abomination.

Now that makes me question the division between natural - with this connotation of healthy, good, desirable - and unnatural meaning unhealthy, bad and unwanted.

But for our topic, well the question really is, are buildings natural at all? Are buildings natural to begin with and if we go with the proof that we can find fauna doing the same then we could perhaps say that some form of apartment buildings can be found with certain species of insects. But I can't come up with any animal building free standing enclosures for a single family so, birds nests don't count really, so doing building like we're building by this measure seems to be completely unnatural.

And our closest naturals, well naturalists seem to believe this, that they are unnatural and I believe we should make up our mind whether humans are part of nature or not. I think we are and that therefore everything we do is natural.

Ben: When we use natural in expressions, natural materials, straw bales, I always think of it as things that don't have much processing. That have a small carbon footprint. Would that be a better way of describing it or are you going to tell me that there's some other reason that I shouldn't be saying that? [Kara and Ben laugh.]

Kara: Well I'm just wondering if natural is the shortcut. 'Natural' is that really helping us? There's some problems defining it proper. Is it helping us make good decisions about housing and I very much doubt this.

Well, it is a shorthand that evokes connotations of healthy and benign but that's mostly undeserved. And well, just as there are poisonous and dangerous things and beings out there in nature not all natural materials are good natured. So the picture we get in our head when we think about nature are tree-lined meadows with flowers, birds singing, sun shining. Well we typically forget about natural disasters like earthquakes, hurricanes, tsunami and the like. So that's all part of nature too.

But to give you one example, I measured radon concentrations in a home built from rammed earth, well the walls at least were rammed earth and the floors. And the homeowners were very concerned about using natural building materials but the radon concentrations that I measured, they exceeded three times the maximum recommended by the WHO for radon. I can't say with certainty that the rammed earth was the main culprit but it's quite likely as radon is emitted from decaying materials and soil, so it's quite likely that

the rammed earth was contributing significantly to this high reading. And wood even completely without glues is emitting formaldehyde. Not many people are aware of that. And timber dust is a potent carcinogen, so it's not like nature tells you anything about whether a material is natural, tells you about whether a material is healthy.

Ben: Are you getting at the fact that actually, in our houses there will be very little that isn't emitting something or other?

Kara: Well yes that too, but the making the distinction between natural and unnatural materials doesn't help me know any better what I'm confronted with in my indoor environment, so we need materials and construction that do not cause, or at least minimise harm to people and fellow creatures. For this we need to know about production processes and ingredients and performance indicators of these materials. Just well the label natural does not substitute all this.

Ben: I bet I'm going to fall into the trap again sometime Kara, so don't get upset with me! [Ben and Kara laugh.] Let's move on to natural ventilation then. Can we still call it that or do we have to call it...? You tell me. What's it all about?

Kara: I think it's a completely misleading term. [Ben laughs.] If your building envelope is so leaky that no human intervention is necessary for the provision of fresh air on a calm day, and we need well about 30m³ per person every hour, you have a horribly draughty home on a windy day. So that would be like punching holes in your water pipes to occasionally have a shower and no one in their right mind would do this.

Well if you exclude this option, the leaky building envelope, then someone needs to open windows and doors at regular intervals if you do not have a mechanical ventilation system installed. So this requires constant human intervention. If we go with the, well in my view more or less meaningless distinction that natural is free from human intervention, then natural ventilation is as unnatural as it gets. Free running is a much better term if you translate this to not being mechanically pressurised.

Ben: I know you're in New Zealand.

Kara: Yes.

Ben: At the beginning of this year I was in Australia and I came across this quite a few times so I imagine you have in New Zealand too.

They talked about, *oh Passivhaus, not really interested in that because we have an indoor / outdoor lifestyle*. So they felt very comfortable and I can sort of see that too, that it just, so long as your environment outside is pleasant and has not got lots of pollutants, you're not on a busy road, then actually that's part of 'natural' again?

Kara: Yes, the great New Zealand myth. Statistically actually New Zealanders spend more time indoors than Europeans do, but we'd like to think of ourselves as very outdoorsy. It's not really reflected in what we're actually doing. But indoor / outdoor flow is all very well if I have a tap and can control it. So if I can close windows, or it can close holes in my building enclosure it will not be exposed to whatever goes on on the outside randomly on the inside. So yes, I'm all for indoor / outdoor flow if it's controllable, if the building envelope is the demarcation line that I can control.

Ben: I'm not an advocate of natural ventilation but I feel that I should be at least fighting that corner. There must be a reason . . . I've come across a few people who absolutely swear by natural ventilation and say that it's quite a developed process. I can't remember what all the terms are but you're using the thermals etc. to make this flow through the house, so how would you argue against that?

Kara: With a low rise building in a temperate climate stack effects are not a reliable driver for air exchange. So without mechanical help . . . so for the stack effect you either need a large temperature differential or you need a height differential. Without mechanical help you're mostly left with wind as the only driver for air exchange, but wind of course is also notoriously unsteady.

For the pressure that's necessary to affect your air exchange it also matters where on the façade the wind impacts. And there's at least a windward and leeward side of a building and you'll have positive and negative pressures on parts of the façade as a result. But you don't know where is what at any given time so whether opening a window will affect how many cubic metres of air exchange. Without constant pressure you don't know what's happening really and whether you get any meaningful air exchange. Well you could leave the window open indefinitely just to be sure but that of course wastes a lot of energy and isn't so comfortable either and it does not even contribute to better indoor air quality as once you've done one complete air exchange you're exchanging fresh air with fresh air, so it's not really helping either. It's really tricky getting good indoor air quality when your answer is basically blowing in the wind.

Ben: Mechanical ventilation then. At what stage are you suggesting that we have it? Is it when we get very airtight? Obviously if we're building from scratch we'd love to go to very airtight buildings but perhaps we should look at that stage before of just the house where at the moment the air is blowing straight through.

Kara: Well yes, forced ventilation is the good alternative to the free running ventilation. It requires, for the level of control you want, it requires a reasonably airtight building envelope to begin with. But then there are various versions of forced ventilation: extract only, supply only, of course the golden pass would be air balanced heat recovery ventilation system as you do in Passivhauses. But generally the mantra for healthy and comfortable indoor environments is 'build tight, ventilate right'.

Ben: Okay, let's have a think about indoor air quality for a moment because we haven't ever covered this in a podcast before. What are the factors that are going to affect us in the house, because in the house I'm in at the moment I don't even think about it. But what's going on in the environment around me?

Kara: An ever growing mix of substances that you bring into the indoor environment, and well, people are concerned about emissions from building materials but what's in your sofa? What's in your reusable shopping bag? At Christmas my supermarket was gifting me a shopping bag and it smelt horrible when I brought it home so I had to evacuate it. It's a nice textile and feels really good but it smelt horrible and I had to evacuate it on the balcony for about a month or so until I could bring it in! It's other, it's cleaners, it's well lots of things that are in the indoor environment and they will emit a cocktail of pollutants.

And most of them we have no idea what they are. We have no idea what concentrations they are in and that makes it, well ideally you would want a strategy for good indoor air quality would start with source control but that's in the regulatory context that where most things aren't declared or labelled properly. That has clear limitations so source control is not a really good option to safeguard your indoor air quality.

The other thing you could do as well, extract your pollutants where they are emitted, like extract moisture in kitchens and bathrooms directly before they can spread through the house or contain formaldehyde, for example, with coatings. Something like this, but that also has some limitations so what you're left with is the ultimate thing to control your indoor air quality is dilution. And that's what

ventilation is basically. So when you bring in about 30m³ of fresh air per person every hour then you can be reasonably certain that your contaminants are diluted to a level where they are not harmful.

Ben: When you talk about bringing fresh air in, what if the air outside isn't fresh? We touched on this a while back, but what happens then?

Kara: Yes, again the idea of that fantastic natural ventilation that in your head you're, well, sitting next to that meadow of flowers in the back and all is very good and nice. Next to the motorway natural ventilation is a bit more problematic. But then too it really helps if you're able to filter the incoming air as you can do this with a pressurised ventilation system. You can't do this when you just open a window. So filtering outdoor air pollutants out before you bring air in, that makes the air really fresh and makes the air healthy for you to consume and helps with diluting pollutants rather than increasing pollutant concentrations and it's particles on the outside. It could be ozone, it could be all kinds of things that are in a higher concentration in the outdoor air actually. So filtering air before you bring it in is a really good idea.

Ben: And I'm assuming those filters don't get everything that we might want to take out of the air, or do they?

Kara: That depends on how fine they are. So for Passivhauses you'd typically use F7 which is a rather fine filter and that filters out almost everything that could be harmful. It filters out what makes all the difference for people suffering from allergies as it filters out pollen for example. So it filters out most of the particles and yeah that makes a difference for the quality of the air you get into your indoor environment.

Ben: Can we go through some of the elements that can be monitored in the house? I've been to schools for example before, this seems a very common thing that when they've moved from a typical type school into a Passivhaus school, they talk about concentration being better in the afternoon because before the build-up of CO₂ would continue throughout the day and then there'd be that lethargy in the afternoon and the kids just don't concentrate as well. So can you describe a few of those? CO₂ is one we know about but are there others you can tell us about?

Kara: Other potential indoor air contaminants? There are numerous. Nitrous dioxide, carbon monoxide particles. CO₂ is typically used as an indicator because the gasses are indoor air contaminants. Their concentration is correlated with CO₂.

So CO₂ is relatively easy to monitor, that's why it's used as an indicator for all kinds of other things that may be in the indoor environment. And that's reasonable with, well, some exemptions like radon for example has nothing to do with CO₂ concentrations but other indoor air contaminants that you'll typically find they're quite well correlated with CO₂ concentrations.

And yes, CO₂ concentrations is one thing that I've measured for research that I've done in new houses in New Zealand here, and these houses were all manually ventilated or free running houses and they all had rather concerning CO₂ concentrations for long periods of the time that I measured. I measured over a week and the air quality according to an international standard that categorises indoor environments depending on its CO₂ concentrations above outdoor concentrations was not so very good for long periods of time in those houses. But again it's not surprising if your only driver for air exchange is wind and these were all low rise houses and we're a relatively moderate climate then well it depends on whether the wind is blowing or not whether you get your good air exchange or whether your indoor air contaminants are building up.

Ben: This might be a slight aside, however if you grow plants in the house does that help at all or is that just nonsense?

Kara: Yes it helps, well there's some research that says it helps with some forms of indoor air contaminants like volatile organic compound. In formaldehyde there's apparently some evidence there. Obviously it does not help with CO₂ because CO₂ is what these plants are emitting overnight.

Ben: Just as we get towards the end, have we wrapped up this 'natural ventilation fit for purpose?' I'm imagining you're saying no, it's not fit for purpose?

Kara: No it's not fit for purpose if your purpose is a comfortable and healthy indoor environment then natural ventilation does not deliver that.

So we haven't talked about the comfort aspect yet. But well natural ventilation overnight, so if you need to get up at night time every 2 and a half hours to get your air exchange going that's not very comfortable. The air that comes in through your windows inevitably will be cold air. That's not very comfortable. So from an energy point of view of course it doesn't make sense either if you can

recover heat from the outgoing air to 90% or more and you get coefficients of performance of 1 to 16. So 1kw hour electricity gives you 16kw hours heat back in, well, your climes. In my climate perhaps only 10. But it's still significantly higher than what you get from even a very good heat pump. And you don't need to do anything if you have a well-adjusted, balanced ventilation system with heat recovery. You get consistently fresh air delivered and don't need to worry.

Ben: While I've got you on there was something else I wanted to ask you, because in my documentary 'The Future of Housing - And How Airtightness Can Help', we showed one scene where we did a very basic retrofit on a house and sealed it up a little bit using foams and sealants so the airtightness would have gone from, I can't remember what it was, 8 maybe down to 5ish [air changes per hour at 50 Pascals]. And I showed the documentary up in Scotland at one of the universities, and they were very concerned about the air quality. Now no change was made to the ventilation strategy at that point. Would that have been a bad retrofit in your eyes because, you said this a little while back, *build tight, ventilate right?*

Kara: Well if the people who live in this house are operating their windows as they should then well all is good. If they don't then they still have the poor air quality they had before the tightening went on. So the tightening, well it doesn't make that much of a difference for your air quality. They were at 8 air changes before?

Ben: Yes.

Kara: Alright, 8 and 5 or 8 and 3 for your air quality doesn't make a difference at all. If they were at 40 air changes per hour previously and you've brought them down to, whatever measures were undertaken, they brought them down to 3, then I'd say yes. At 40 they probably were extremely draughty and probably ventilated more than enough through the leaks in their building envelope but of course they would have paid the price for this in comfort and in money. But no, 8 or 3 for their indoor air quality that doesn't make a difference. They do need to operate the windows to get good indoor air quality or install a mechanical ventilation system.

Ben: Is there anything else that you want to chip in on this topic? We've gone through it quite quickly but are there any gaping holes?

Kara: I think we've covered the basics of it. I could go on for hours and hours but I think we've, well probably what needed to be said was said.

Ben: Okay! Well Kara it's been absolutely fantastic to have a chat with you and particularly since I tried to get you on the show before and you needed a bit of gentle persuasion, so thank you very much!

Kara: [Kara laughs.] It's been lovely talking with you.