

Episode 227

What's the best way to build an airtight structure? – with Paul Jennings

The show notes: www.houseplanninghelp.com/227

Ben: Each month, how many air tests would you say you carry out?

Paul: It's very variable. It really depends if you've got a big project where there's a lot of testing going on, or if you're just doing a set of individual self-builds where typically, you'll have one test every few months. On any individual job, you might have two or three or even four of them in a week, but the next week you might only have one.

It's the big jobs – stuff like the Colchester Co-Housing is about to start; we're waiting for that, so that'll be a lot of testing. And then there's the big jobs like the Passivhaus swimming pool they're starting on in Exeter. We're talking about the design at the moment, but that's going to be a lot of testing on that job.

Ben: What does it tend to be in terms of construction type, popular to least popular?

Paul: Popular in the market I work in, which is a pretty limited market, is mostly Passivhaus, you have the Airtight OSB, the Propassiv and the Durelis. They seem to be very good, very successful. Cross Laminated Timber, there seems to be quite a lot of that.

Recently I've been testing modular construction so, factory-built stuff which has great potential I think. Because it has to be transported to site on the back of a lorry, it has to be reasonably robust. And actually, what we're finding is, they can't build it leaky. A volume housebuilder, if they put their house on the back of a lorry, it'd fall apart before it got to site. Whereas these modular constructions, they're much more robust, they're much more airtight. Essentially, every one we've tested, we've been achieving the airtightness you'd want if you had a heat recovery ventilation system. And you wouldn't say that of volume builders.

Ben: Would you say that each construction method, system has its pros and cons? Is that a given?

Paul: Yes. But some of them have similar pros. The CLT has similar pros to the Airtight OSB boards.

Ben: Let's work through some of these because having seen a number of builds going the whole way through and coming up to airtightness, we know that you can get to Passivhaus with any of these. But I'm starting to wonder whether some ways are better than others. Do you think that too?

Paul: Some ways are easier than others.

Ben: Maybe easier is what I'm after. Because they can all be achieved, so it'd be interesting to talk through the different build systems. Where would you like to start? What's the most logical one?

Paul: The most recent really good one I had was a CLT bungalow, Cross Laminated Timber bungalow. That achieved less than point zero eight.

Ben: What does that mean? What's the airtightness layer?

Paul: The airtightness is essentially the timber. It's pressed together, glued together. I think this one had mostly eight laminations. And then it had a roof that was a sandwich panel. It had some lamination, some insulation, some more laminations on the top. And of course, they are big panels. They're much bigger than the standard two-point-four times one-point-two sheet of OSB or sheet of airtight OAB Propassiv or Durelis. So, there's less taping involved.

Ben: And the tape is at all the major junctions?

Paul: Yes.

Ben: How does it get its strength then?

Paul: The Cross Laminated Timber, it is strong. It's strong in of itself and it's screwed together for fixing them together. And the tape really is where the panels butt-up to each other, where you've got two roof panels spanning over several internal walls typically, but you'll be taping the joint between them, taping around the windows, obviously taping around things like sun pipes, if you've got them, ventilation ducts you're going to have – basically, once you tape to the timber, you've got airtightness.

In the early days of Cross Laminated Timber, people would put a membrane on the outside. I'm starting to think that's not worth bothering with. It's unnecessary. You do need something because

Cross Laminated Timber doesn't meet the insulation values so, you're going to have to insulate it either internally or externally, but the easy one seems to be to insulate it externally and make it airtight on the inside. And that's very airtight, even in a small bungalow which is often harder to achieve because the surface to volume is against you.

Ben: I would always think of CLT in some ways to be specialist, but you're seeing more and more?

Paul: Definitely seeing more. There does seem to be a flavour of the month. There are fashions in these things.

Ben: I visited one the other day and was very impressed that it just gives you that nice feel as well. There's something very cosy about a CLT build. Obviously, you're going to decorate over the top of it and then you're not going to get that.

Paul: A lot of them they don't. They're left with the exposed timber on the inside and it's beautiful. It's a natural feel. The only one that comes close to that, I think, is straw bale with a clay plaster inside. That again has a natural feel. But in that case, you'd normally paint it as well. But CLT is beautiful.

Cost effective? It's getting more cost effective. People were importing them from Poland and places like that, which is the same as the windows we use by and large. Apparently, there is now a CLT factory in the UK; I don't know how that's getting on. We've heard that there was an attempt to do modular construction with CLT, at least a couple of attempts, which is suffering problems because of the weight of it, because it is heavy. So, if you've got to move it and align it, then you've got concerns about that.

I haven't tested any of those yet. I've just quoted for doing some, so we'll see. It'd be nice to get that direct experience.

Ben: I saw you on-site at one of Jae Cotterell's projects, Buckinghamshire Passivhaus, and that one there got an astounding zero-point-zero-seven air changes per hour at fifty pascals. That's using their PH15 system. Why does that work so well, in your humble opinion?

Paul: Well, one it works because of what they're using. Fundamentally, they're using Airtight OSB. That's much easier than doing anything with membranes. That's a good thing because my involvement with earlier tests on them, they changed from using membranes in the roof to using the board in the roof. That's definitely helped them get better results.

Again, the main thing is because they've thought it through. The best, most important tool for airtightness is the brain, thinking, planning, preparing. Don't react on site. Don't change things at the last minute. They're building a Passivhaus school in south London and the contractor said, 'can't we do the airtightness on the inside?' To which the architect said, 'yes, you could. But you'd be in huge risk.' That sort of change at this stage in the project where you're out on the ground, you add risk. You really want to get your designing done early, get your planning done early and then don't mess with it. Because every time you change it, there will be unforeseen consequences. Usually those will be things that make your airtightness worse, or harder at least.

Ben: And as we record this today, we've been doing something quite interesting which has been going to look at some airtightness taping and seeing how actually that could've been improved. So, how do we make sure on site that if we have got some taping that needs doing, that it's being done to the best possible degree that it can be?

Paul: There's a question. First is choice of materials. The right manufacturer, the right tape. If you've got a big gap under a window that's sixty millimetres wide, don't try and do it with a fifty millimetre tape. Pick the tape that's wide enough for the gap.

Ben: Should that gap not be filled with something else first? Is that what you mean by a gap?

Paul: Yes, absolutely it should.

The classic one is curtain walling where you have a bottom rail that's maybe a hundred millimetres off the floor with the curtain walling coming down on to it, and there's a big gap under it and no-one's bothered with it. We've seen that a number of times. And even they've complained to the window supplier, 'your windows are leaking.' Well, you've got a hole across the bottom underneath it.

The other sort of thing that happens is where people are putting in a floor that's incomplete. So, the final floor is going to be raised up but it isn't yet raised up. So, there's a gap that's going to get covered over. Sometimes it's going to get airtight sealed and then covered over, sometimes it's going to be covered over and not airtight sealed. We know which one we prefer for obvious reasons.

The first thing is taping. Get the right sizes, get the design, think about it. Really there are two good brands for tape. That's the bottom line.

Ben: Will you tell us what those are?

Paul: There are two good brands, two best brands in the world. The SIGA brand, made in Switzerland, and the Pro Clima which is German, although I don't think it's actually made in Germany. Those are the best brands in the world for airtightness.

They have a wide range, they continue to learn off each other and other people and develop new products and come up with new ideas. You can see something that SIGA have done one year, and next year Pro Clima have got an equivalent, and vice-versa. Because it's fair enough. People want to learn, people want to do better.

SIGA tends to work on bigger projects with bigger contractors, Pro Clima is better at supporting smaller self-builders. But they're each trying to grow. The thing at the moment is the market is growing fast enough that there's room for them and for others as well. So, I don't think, I hope they're not cutting each other's throats.

We work with both of them, we've had training with both of them and the main thing with either of them is the difference between a good tape correctly applied and any sort of tape badly applied or even a good tape badly applied is much bigger than the difference between the best tapes. The tiny difference between the best tapes versus the huge difference between a good and a bad installation.

Ben: So, we're talking about training here with those specifics. Any quick tips before we get back to our different build methods?

Paul: The first tip is clean surfaces. Tape onto dust will stick to the dust, it won't stick to the surface under the dust. So, you have to get rid of the dust. If it's a masonry surface, if it's concrete or if it's brick block work, generally you're going to need to prime that surface to get a good seal onto it. So, you're going to have to put on a liquid sealant which then goes off, then you can tape onto it.

Don't try to apply tape in very long lengths. If you have very long lengths, you'll end up with bits of it dangling, bits of it sticking to itself, bits of it creasing and making it harder. If you have a bit of tape that you can have between your two hands extended, maybe one-point-two, one-point-four metres, that's a comfortable length and you should be able to install that correctly, neatly, tidily. I'm afraid I have a rule of thumb. If I look at a piece of taping and it looks c**p, it usually is c**p.

Ben: The visual check.

Paul: The visual check, yes.

Stuff goes wrong, people have creases. The thing with creases is you have to go over them and make them work. One of the things we were doing today was saying, 'this tape's not well-adhered' and tearing it off. At that point, if the tape's coming off, you can't patch it up. You've got to pull it off and go over it again, literally back to the surface or if the tape comes off partially and delaminates, you're going back to that to seal over it.

Ben: Getting back to our construction systems, any other timber ones that we need to mention? CLT, we talked a little bit about I-Beams and using Durelis Board.

Paul: The other thing that people have tried to use is SIPS panels – Structured Insulated Panel Systems – which have the potential to be very airtight. So far, I haven't seen anybody that's using the Airtight OSB as one of the faces of a SIPS panel system, because that's another way that would improve it.

The key thing I always ask is, are you injecting your foam into a box you've made, in which case it will fill it, or are you cutting a piece of foam into a section of wood and then putting sides on it? Because that won't be as airtight. That's a key distinction between the types of SIPS panel which I want to know about.

The other thing I've had with SIPS panels is they have to be taken care of. If SIPS panels get wet, especially if they get soaking wet, they're going to be a problem on site. They're going to take a long time to dry out. I've done tests before now where you suddenly discover it's getting worse. Why is it getting worse? Because the airtightness tape is coming off the SIPS panel because it's still wet.

Ben: Anything else to think about with SIPS panels? Pros and cons?

Paul: We've had very good results with SIPS panels. If you're using SIPS in a sloping roof, trying to align them precisely, trying to get them so you have a ridge that looks consistent at the same line, I've seen people have problems with that.

The other thing with anything like this, they're not particularly heavy, SIPS panels, but any time you're lifting, you've got to be safe.

Ben: That's SIPS. Shall we talk about masonry for a bit? That's what my build has been, and it's been fascinating to see how it's come together. I guess this probably applies to all methods as well: the simplicity helps a lot, doesn't it? If you've got a simple form then you've a better chance for your airtightness.

Paul: That's one of the arguments that the Green Building Store did with their demonstration passivhaus up there is that you want systems that normal builders are used to building. Yes, it's got a wide cavity because it needs more insulation, but literally everything else can be sourced from a normal builders' merchants. The Denby Dale Passivhaus, a great example, nice house.

I tend to think that any house that's got a cavity in, any masonry or indeed any other construction with a cavity in, is a weakness for airtightness. Because if air can move laterally, it can get around things, can leak where you don't expect it to. So, these days I much prefer a masonry build that's a masonry wall, ideally wet plaster for airtightness on the inside but it might be a parge coat and then dot and dab over it, and the insulation on the outside and render or rain screen or whatever it is. That's much more robust for airtightness. Because at that point, you have to have a continuous hole from the inside to the outside. You can't have a hole through the inner leaf, then air moving in which way it likes in a cavity and then coming out somewhere else. It's more robust for airtightness.

It's why a lot of our older, late Victorian, early twentieth century houses are much better for airtightness, much more robust, than the stuff built with plasterboard in the sixties, seventies onwards. And they're much easier to fix. If you've got a wet plaster system, you can deal with it. If you've got a plasterboard house, a lot of the time you need to knock it down.

Another thing about masonry builds, people say they've got a masonry build but almost every masonry build has a timber frame roof. So, they've got timber frame in it anyway and they've got to deal with that. So, in a sense, as soon as you've gone to a masonry build, you've doubled the number of built forms you've got in your house.

Ben: That's what I was going to say. If you think about the PH15 system that uses the green racking board, then that shows you the airtightness. This is one of the things on my own build – it was fascinating to see because you've just got to know in your head where is the airtightness line going, but it goes from the plaster, up to a membrane, then around and then to the slab on the bottom or whatever it might be. So, there's that aspect too that does everyone know where the airtightness is and are they protecting that?

Paul: Yes. The more complicated a build is, the harder it is, always. Look at some of the big shopping centres and you look at the complexity of the number of changes of direction, the roofs, all the rest of it.

Just looking at the proposed Exeter Passivhaus swimming pool, I think we had twenty-two different roof details. Some of them will be a hundred metres long, but there's lots and lots of different ones. And the scope for people on site getting confused, doing the wrong thing, not checking stuff properly, it's enormous.

Talking about the Pro Clima products, we have the Vana tape, which is the dark blue tape, and then we have the Profil tape, which is the light blue tape, and the key difference is the Profil has a split back so, you can typically apply it around windows so you can get a small, thin part onto the frame which will be hidden by plasterboard, and then you use the rest of the tape onto the wall. But we've even had jobs where people are using Profil everywhere. It's harder to use and it's more expensive than the Vana tape, but they have only one tape because then you can't use the wrong tape.

Ben: Let's move on to modular construction and your thoughts on that. You'd mentioned you'd done a few and I actually didn't think this was something we did much in the UK.

Paul: Well, we don't, but there's a lot of people trying to develop it. It's a response to the need to build a lot of houses, a lot of dwellings quickly. Factory construction avoids a lot of the issues of on-site construction, less of an issue with the weather, less of an issue with shortage of trades, less of an issue with all of our people on-site going back to eastern Europe because of Brexit.

But at the moment, they're all in development, as far as I know. I've not seen one that anybody's built large numbers of yet. I was testing some last week and they're saying they've got orders for forty, which is a great start. It would be good to get the prototype sorted first but this is the modern world. You sell it before you finish it. But they were all getting under one air permeability, one-and-a-half air changes. So, they're basically building to standard, they're meeting what we'd like to see for an MVHR system. And this is a prototype and we know that they can get it better. They've improved it noticeably just me working with them for a day on their prototype. So, it made quite a big difference. And working with them again to make it more robust for volume production.

Not all of them, but some of them are talking about modules coming off the production line every fifteen seconds. Huge numbers. Some of it undoubtedly is pie in the sky and will never happen, but on the other hand, there's great potential there.

The other thing is, you can't build it as bad as you can build a new house. A modular construction is going to be craned onto a lorry,

taken to site and craned off again. In order for that to work, it has to be fairly robust. It has to be fairly airtight. You have bits of flapping material on a module that's being driven down the motorway at sixty miles an hour, by the time it gets to the end, they won't be flapping, they'll be gone. You will seriously damage it.

If a volume builder built something on the back of a lorry and drove it down the motorway, it wouldn't be there at the end of the journey. Because they just do not do the quality, the robustness. I hadn't appreciated it quite so clearly that modular construction can't be built as badly as volume construction. It just can't be done because it won't survive the trip on the back of the lorry.

Ben: Where do you think we're going? Is it still just a mixture of all of these different build methods or are there trends?

Paul: There's definitely progress and trends. One is membranes are losing out to the Airtight OSB, and for refurbishment particularly, to the blowerproof paint on airtightness. So, membranes are a smaller part of the market than they used to be. But of course, at the same time, the refurbishment market is a bigger market than the new build market. We need to tackle refurbishment and we need to tackle it better. And we're not. We're learning lessons but really we're taking our time over getting it and I don't think we can afford that time.

Ben: What about affordability then? Are any of these approaches better from that perspective? Unfortunately, we all have to think of our pockets.

Paul: The key thing a lot of the time is still the land. It's very hard to find plots. We're seeing some interest with people who own land doing community land trusts. So, you take the land out of the equation. That has the potential to provide truly affordable housing.

In Gloucestershire, Warwickshire and places like that, if you take the land out of the equation, then maybe you can build houses that nurses can afford to live in, policemen can afford to live in, teachers can afford to live in, which often they can't otherwise, or to a very low standard, very small.

And in terms of the construction methods, a lot of the things, one of the big advantages with the module is time on site. Because time is money. So, if you can do modular construction, take it to site, you're less subject to weather delays and you can build it faster, just every week you're on site there's a cost. If you're a contractor, if you're supervising construction, you've got site cabins, site toilets, you've

got all of those things you have to do which is just an overhead. If you can halve your time on site by doing modular construction, then that's worth doing. And compared to volume housebuilders, you get better construction quality, you'll have less issues.

Also, because it's essentially checked before it leaves the factory, you've got a guarantee. Because at the moment, we're still only doing sample testing of new houses. And all of us in the industry know that large builders test the ones they want to test. It's not as it should be. It's not building control coming in and saying, 'let's test that one this week.' 'Oh, can't you do that one over there?' It's like, 'that's the only one that's ready. You can do that one.' You know, we know and the government ought to be paying for research to go and check this, that if you go and test five that are on that site, none of them will get that same standard.

Ben: Finally, thinking of Passivhaus and how we're doing in the UK, what advice would you have for anyone striving to get a good airtightness target, no matter which build system they're using?

Paul: The main advice is think about it, learn about it, go and look at, visit, take advantage of Passivhaus open days and talk to people who've already built them. Look at the stuff that's on the internet. There's lots of stuff on the internet. UK Passivhaus Conference is in Leeds this year, and we get quite a few self-builders coming along to find out more. The AECB Conference.

There are networks of people and a lot of them are very committed people. They give their time, they give their energy and they often don't charge as much as they should for it, because they believe in it.

Ben: Paul, it's always fun to have a catch-up with you. Until the next time, thanks.

Paul: Cheers Ben.