HOUSE PLANNING HELP

Episode 255

How do you specify high performance windows? - with Chris Herring

The show notes: www.houseplanninghelp.com/255

Chris: I'm not an architect. I've been a practical builder and I've been involved in windows for a long time. But clearly, windows are key to any building. They are really very important in terms of the feel of the building, the architectural feel of the building, how we feel in a building, the amount of light that they let in.

So, they're really quite critical. They're not just another building element, they're a really critical one, I think.

Ben: What are the different functions that a window will fulfil?

Chris: That's the thing that makes them so complex really, because they fulfil so many functions. They have an architectural function, they've got physical functions, they're part of the fabric, they're part of the thermal envelope so they've got to have thermal performance, you've got to be able to get out of them, you've got to let light into them, they're sometimes protecting against fire, there are safety issues.

What you're doing when specifying windows is bringing all of that together, and they're often in conflict.

So, with architects, it's fashionable to have very large areas of glazing, people want to see big vistas from their building sometimes, or architects just like the feel of it, and then that's in conflict with function. You might result in overheating or you then need more expensive provisions to make the windows work because they're so much bigger.

The functions don't all work together and we have to compromise and get the best we can for anybody specifying windows really.

Ben: As a self-builder, is our first cue coming from the architect or designer, or if we're doing that ourselves? Is that where we will begin on the selection process?

Chris: I think you will. I mean, it's obvious that your architect is going to be very important to you, that they're your advisor and they're designing your building. But I think it's very important now for all building components that manufacturers or suppliers are a key part of the design process.

As buildings become more complex and components become more complex and the performance levels become more complex and difficult to meet, I think it's going to be suppliers, manufacturers who actually provide more of the information in some ways. So, become more part of the team.

What we see is, particularly on complex jobs, on non-domestic jobs, where that supply chain isn't properly sorted out – and I'm actually dealing with one at the moment – it becomes very chaotic. Because the supplier is not able to really support the best solutions because they're tendering. They're not in the contract. They can't bring their knowledge to it. So, I think what I'd like to see in the future and what I hope we'll see in the future is product suppliers who add a lot more, which is what we try to do at the Green Building Store. That's what we see as our role, to help people to specify windows well, in the case of windows, so that they understand what they're specifying, will work with architects. And the more we can work in partnership, the better I think the building will be.

Ben: As I think back to that part of the process when I did my own build, I certainly remember that perhaps out of the whole building, it was the most complex, both checking window schedules, numbers, measurements and you're not convinced a hundred percent.

So, I think we've got a lot to dig into here, but I'd like to attempt to go technical on some of these things and just look at a few of the terms that surround high performance windows. Because I think really in this podcast, we're generally interested around that.

Is it worth just talking about the difference between double glazing and where we started, maybe single glazing, and how we've arrived at triple glazing first of all?

Chris: We've seen an incredible evolution in windows in the last few years.

In the early Eighties when I first came into building, we were fitting double glazing, but fitting fairly minimal double glazing. And we thought that was okay. Now, I would never fit anything but triple with big cavities. It's a huge step and we've jumped there from typically U-values in windows of around maybe four, to U-values of below one. That's a massive jump.

Okay, the industry isn't quite there. The industry is one-point-four or something like that – I can't remember the building regulations now, but in that area. But nevertheless, even that is a massive jump over twenty, thirty years or something like that.

So, there has been a big evolution and I don't think actually that the industry has properly caught up with that and understood the implications, particularly in terms of issues of overheating, of course, which are very big for buildings.

Ben: Maybe we'll come on to that a bit later. Is comfort a big driver of high performance really? Because that's the benefit at the end, isn't it? Are there any other key benefits? Because that one's huge.

Chris: That's quite difficult to answer, in a way. The whole thermal envelope is key to the performance of the building and fundamentally in the end that's about carbon emissions.

We've got to make energy efficient buildings. I think it's just a given. There is no point building buildings and just building them badly because of what we fundamentally do. You've only got to tweak it, as you know as you've just completed a passivhaus. With a little bit of attention to detail and a little bit of extra skill, you can make a building that's much, much better.

And triple glazing you need. If you just look at the simple logic of the building, you need triple glazing to make that work in this climate. So, it kind of drives you there.

Having said that, comfort, once you're at Passivhaus levels of performance, comfort is absolutely key and it's a key selling point. Obviously, it makes buildings more comfortable as well as more energy efficient. So, the windows as part of that package, as part of a system really, they don't stand alone. It's that sense of we are looking at buildings as systems and actually complex systems. So, we need to put the window in that context really.

So, we need triple glazing because the Passivhaus Standard drives us there, and it drives us there because the building physics drives us there. The key to that is, in many ways, comfort, because we need every surface to be warm. Because then we don't need to heat the building very much. As soon as you get a cold spot, you're going to get mould, you're going to get discomfort, you've got down-drafting, you've got all these problems. So, the system stops working. So, it's the building as part of the system that drives us to triple glazing in this climate.

If we lived in Northern Italy or something like that, we probably wouldn't. We'd be double glazed. It depends where we are, what the system demands, if you like.

Ben: Let's look at some of these terms. First of all, energy balance.

Chris: This is the difference between the window and anything else in the building, obviously. Everything else is just about energy loss, fundamentally, or stopping it. But with a window, it's very different because what we're looking at is we've got obviously energy loss and we've got more from the window than any other part of the fabric because our technology is not that good.

I mean, glazing is amazing. I was just staring at a piece of glass the other day and thinking it's quite stunning. And the invention of glass, must have been absolutely revolutionary. We had windows with just shutters and openings or windows with paper, semi-opaque coverings. And to have glass we could see through …

So, windows are amazing but nevertheless the technology we've got now which is the material technology at the moment, are not likely to change, I think, for the next – well, I wouldn't like to say how long, but let's say the next twenty, thirty years probably. It gives us these sealed glazing units. We've got U-values, we've got thermal transmission that's a lot worse than the fabric of the building.

That's a starting point. Windows are always going to be a weak point. Except that they also bring heat into the building, solar going into the building. So, that balance between the gain and the losses is what's so significant with windows.

Now, obviously if you're north facing, you've got no significant energy balance, it's just loss. So, the logic is you want smaller windows because then they're pure loss, a pure weak point. But other aspects, you've got the balance there. And again, what Passivhaus looks at is that balance. How do we get the best balance? And again, triple glazing gives us the best balance generally in this climate zone.

Ben: U-values, λ-values (lambda-values) and g-values. Does one lead on more to the other? How would you define these terms?

Chris: This is the thing where how far do you want to go in terms of understanding and how far do you just want to be led by a supplier? So, people can dig into this and really try and get an understanding.

We teach quite a lot about these values because they're tools. Without them, you don't quite understand how the performance is working, so then you're taking somebody else's word for it. If you've got some tools, if you understand a bit more, you can make better judgements. I still think you need to take advice because a little bit of knowledge can be a dangerous thing, as we know.

So, let's just look at those a little bit.

Very simply, we've got a piece of glass in a frame. That's what a window is. There will be a heat loss through the piece of glass and we give that as a U-value. So, that's the heat loss per metre squared per degree kelvin difference between inside and outside. So, watts per metre squared K (W/m^2K).

We can do the same thing with the frame of the window which would be very different because the heat loss through the frame is different from the glass. In fact, it's usually worse than the glass. The glass now is better than, if you imagine a thin piece of wood or a thin extrusion of PVC compared with a wall of a Passivhaus with, say, three-hundred millimetres insulation, it's obviously a lot worse. So, the U-value typically, the frame values, are one of the real weak points. And of course, the glass you've got solar gain and the frame you haven't. So, all those things to consider.

We've got an extra little element which is a ψ-value (psi-value) which is the heat lost through the edge of the glass, effectively, where the glass meets the frame. We give that a linear value. So, that's a heat loss per metre perimeter of the glass.

We add those three factors together, the frame value, the glass value, and the ψ-value, the edge of the glass, and that gives us the u-value of the total window.

Each window will be different, obviously, because you've got a different proportion for a different size of window, different proportion of glass and frame. So, every window will have a different U-value. Which is why in Passivhaus methodology, we don't really talk very much about the U-value of the window except for sales work so people can compare windows. But what we look at are those three values and we plug them into the Passivhaus Planning Package so that each window is modelled separately.

That's something we don't do in UK methodology where we actually just use a crude U-value for the standard window, which makes it very inaccurate.

The next thing to consider is obviously the solar gain. We talked about the energy balance. And that's given by the g-value. The g-value gives the proportion of solar gain that actually gets through the glass. The more panes of glass and the more coatings we put in there, the more you restrict the amount of sun that can get through the glass.

The typical g-value, the percentage of solar gain getting through the glass in a triple glazed window, will usually be in the fifty to sixty percent range. It might be just above sixty, it might be just below fifty. But it would depend exactly on the configuration of the glass, but in that sort of range.

If we had a double glazed window, we might be at seventy percent, and for single glazed it might be at eighty or ninety percent. But the balance would be worse because obviously a lot more heat loss. So, we're looking at balancing them all the time. That's the g-value.

Λ-value is thermal conductivity. This is a little bit harder to get your head around. This applies to every material, as U-values do. So, it's actually the inherent quality of the material.

Obviously, if we take a piece of aluminium or a piece of expanded polystyrene, they've got very different amounts of thermal conductivity, the amount of heat can get through per metre thickness of that material. So, a λ-value is given as the heat loss, which is given in watts, per metre thickness of the material per degree difference between the inside and the outside. So, that's watts per metre K (W/mK). So, the metre is the thickness of the material.

It's quite different from the u-value, which is about an area value, if you like; it's per metre squared. And we'll use that thermal conductivity to then calculate the U-value.

Ben: Obviously, we're going into quite a bit of detail. We sometimes limit ourselves on the podcast, but I did want to cover that.

Let's rewind a moment to PHPP. What are we putting in around those windows? Yes, every window is modelled individually, but to do with all of those different values et cetera – I don't know whether this is easy to describe off the top of your head?

Chris: It's quite simple. Actually, there is a standard calculation, a formula for calculating which saves simply adding up, as I said, the heat loss from the glass, the heat loss from the edge of the glass, heat loss through the frame. Just add them together. That's the calculation.

It's done to a European standard, EN10077 Part 1 and Part 2, which I don't remember many of these but I remember that because it comes up fairly regularly.

Ben: Which seems impressive.

Chris: It always feels impressive, yes.

So, that's a simple calculation. What PHPP does is it simply does that calculation. So, we put in the U-value of the frame, the U-value of the glass, the ψ-value of the glass, and for each window it calculates the total heat loss and it does give us the U-value of the window. That's not important. What's important is the heat loss through that window.

It builds in one more thing which is another ψ-value for the installation. Now, this is an area that certainly the industry in the UK is not conversant with.

When we install a window in a wall, we've obviously got a u-value for the wall which is fairly uniform. A wall, obviously given things like timber studs, but fundamentally we can take a U-value for the total wall. We've got a thermal loss through that window which we calculate in the way I have said. But then there's a little bit more. And that little bit more is the detail of the installation, the way the window is actually inserted into the wall. This is not about air leakage or anything like that, it's physically the amount of heat lost through that junction.

Generally, there will be some heat loss and again that heat loss will be given as a linear value. So, the value of heat loss per metre perimeter of the window. That's another ψ-value, and again it's given in watts per metre K (W/mK).

To get the installed value of the window, we add that heat loss to the total heat loss of the window. This is something we don't do in UK methodology. And in Passivhaus methodology, it's given a lot, the installed value of the window. Because that is actually more important.

If we lose that ψ-value, that installation value, into the fabric of the building, which is what we do in the UK; we fudge it into the rest of the fabric, we don't realise the implications of installing the window badly. So, getting the detailing, making very poor detailing.

We can take a really good window with a U-value below one, say at point-eight, install it well, and the installed value would also be point-eight. We'd have effectively an installation ψ-value of zero,

nothing to add. Or if we installed it badly, we can be up in one-point-something.

So, in effect we can install a nice triple glazed window at point-eight and end up with effectively what would just be a double glazed window. So, we throw our money away by installing badly or we don't get good performance, whichever way you want to look at it.

Ben: Having built a masonry Passivhaus, and you get to see almost the difference of trying to keep that continuity of insulation. Because that's a big thing, isn't it? That a lot of the time the windows will be in line – traditional buildings I'm talking about here – with the masonry perhaps.

Chris: Yes, I think that's right. If we imagine that detailing, if we take a traditional cavity wall with an internal and external skin and we put the window in the external skin, we've got a massive thermal bridge there. We've got a massive source for heat to be transmitted as a result of the way we've installed.

If we install the window in line with the insulation, then that thermal bridge will be minimised or eliminated in fact. And yet, we won't be aware of that with conventional building in this country. Whereas when we're building a Passivhaus, we'll have modelled that because we're forced to. We'll know exactly where the influence is, and we will know much more accurately what the performance of our building is.

So, that detailing is incredibly important and something people struggle with and architects struggle with. We see it all the time. And it's something now actually, in our company, we offer our detailing for free because we think it's so important that people get that right, and we'll model it for people as well.

I think again coming back to what the suppliers and manufacturers offer, I think this extra value of supporting people further, supporting architects, supporting clients, I think it will become more and more important for suppliers to add those extra values to supply. It's not just a widget that's somebody else's problem how they fit it, the supplier should be going further down the chain and advising people how they fit it and helping them to get that detailing right.

Ben: Is there anything else we need to know in this conversation that needs to round it off today?

Chris: I think there are a number of things that come to mind that are useful for people to be aware of.

One of the big issues in low energy buildings and Passivhaus buildings is overheating. Now, if we model in PHPP, we're going to have a fairly good idea of the overheating. It's not fool-proof. It gives us the overheating for the whole building; it doesn't differentiate between different rooms, things like that. So, we need to come at that also with intelligence.

There are some simple tricks. Obviously, overhangs make a huge difference, but there are other things. For instance, full height windows.

If we think about it, this is an interesting aspect. If you take a window down to the floor, it doesn't increase the light level in the room very much because you're only lighting quite a small area. Your light is coming into a small area of flooring, if you like. It's higher light that has more effect in terms of lighting the building. However, it will result in increased overheating because we're still heating the floor up fairly close to the window and that's heating the room up.

So, if we can certainly be aware that full height glazing is more of a risk in terms of overheating – so an overhang to shade a full height window will need a much bigger overhang. We probably haven't got that. So, in that case, although our overhang can be shading the top half of the window, the bottom half going down to the floor is not shaded and therefore is resulting in overheating.

Now, we might want a full height window because we want it architecturally or we want to be able to see our garden in full or whatever, that's fine. But understanding the design implications of what we've chosen is important. And generally, we find that designers are not aware of those sorts of things.

So, tricks like that.

Another one would be very simple, thinking about the implications for safety glazing. If we've got a window in our regulations that's above eight-hundred from the floor, we don't need safety glazing. It cuts the costs quite a lot.

So, there are quite a lot of things that we can help with as a supplier. We will take you through all of those aspects, both the performance aspects and regulation aspects, to help you get best value.

Ben: In terms of self-builders who come to you with questions, are there any common questions that come up that might be worth just mentioning here as well, as we wrap up?

Chris: One of the questions is always around double and triple glazing. 'Do I really need triple glazing?' Because culturally, we're not that used to it in the UK yet.

Ben: But that sounds like you're rewinding the conversation quite a lot there. That's interesting.

Chris: I am. But in a way, that is one of the fundamentals that people will come with. Now, they tend to come to us for triple glazing because that's all we do. We made the decision some years ago that that's what we would offer.

I suppose another question is around the use of aluminium cladding actually in windows.

We don't really engage very much with the conversation around the use of uPVC windows for instance. uPVC windows will give perfectly good performance, we can go to Passivhaus standards with them; they're fine. It's a very controversial area over the environmental impact of uPVC. All the work I've seen, all the evidence I've seen shows that uPVC is very environmentally damaging so, we would only offer timber windows.

We don't engage that much in that conversation because people will have chosen to come to us because we have timber windows, mostly, but we do engage quite a lot in the conversation around whether to aluminium clad windows. And I think that's probably the largest area of discussion that we might have.

It's an interesting discussion because aluminium obviously has a very high environmental impact. The energy used in smelting aluminium, certainly virgin aluminium, is very, very high. Even recycling takes quite a lot of energy and there's evidence that if we increase the use of aluminium, we're actually drawing more virgin aluminium into the supply chain because the recycling is at a certain level and doesn't increase that fast. So, I think we are increasing the environmental impact of a window by adding aluminium cladding.

The other misunderstanding I think in that, is the nature of modern paint systems which are quite different. People are frightened about painting windows because the experience from the Sixties and Seventies in this country is of appalling windows with appalling paint systems. Modern paint systems, factory finished systems, are just a world away from that. And in many ways, you can regard them as plastic cladding of windows really.

So, that discussion is quite difficult. We've always tended to encourage people to go to non-aluminium clad windows because the evidence seems to show that it lowers the environmental impact of the window. We have bowed to demand, if you like, and now offer aluminium clad as well.

Ben: I went for aluminium clad and I must admit, I did not think about the environmental performance particularly of that. It just caught in this conversation. But quite a few manufacturers – and I don't know whether this is true – they tell you that if you go for timber, they'll all rot over time if you're not a hundred percent with the maintenance.

Chris: Yes, I mean, you need to maintain a painted window. You will need to paint it after ten years. If you add up the costs of that painting, it's probably going to be quite similar to the aluminium cladding.

What they don't tell you with aluminium cladding is that it fades over time and you will lose the appearance of your building over twenty, thirty years. It depends exactly how long you think the lifespan of your window is going to be.

It's a complex balance and I'm not saying you made the wrong decision Ben, but most suppliers won't even discuss that with you really. We will. We won't push it down your throat. If people come to us and ask for aluminium clad, we'll give them aluminium clad. If they want to discuss the issues then we'll certainly discuss that with them. And we do outline some of that information on our website as well, so that people can think about those issues.

Ben: Chris, I think we have covered a lot of ground. So, we should pat ourselves on the back today. Thank you very much for your time.

Chris: You're welcome, Ben.