HOUSE PLANNING HELP

Episode 247

Two radical retrofits that use an internal wall insulation strategy – with Bill Butcher

The show notes: www.houseplanninghelp.com/247

Bill: I do a lot of consultancy on design reviews, not going right through to Passivhaus. And so much of a successful build is about what I call the comfort zone of the builder that you're going to be having a relationship with. It's more than just employing, when you're asking a builder to do something outside of their knowledge base.

Ben: But you know Passivhaus and you've had these builds over the last few years. Are you still thinking that masonry is a good approach or should we be heading more to kits, systems, anything that just makes it simpler to get it spot on?

Bill: I think for self-build, one-off dwellings, it has its advantages. Because obviously system builds, kit houses or off-site methods, become cheaper with scale, economies of scale. For a one-off build which has to take into consideration where it is, planning restrictions, and particularly client wants, if you like, aesthetics, it gives the builder with the masonry – well, basically you can get all the materials from your local builder's merchant. He's got control. He/she has got control over the process far more than going out to a timber frame company, for example.

And that's what we find, where there is more complication on a one-off build with that relationship between a large subcontractor, as such, with the timber frame. Who is the main contractor? Who's got control over it? And time wise. Basically, you can get on with it quicker if you're building with local materials. When I say local, blocks and bricks from your local builder's merchant.

So, there are swings and roundabouts. There is no one perfect way of building.

Ben: I wasn't suggesting there was.

Bill: No. They all work.

Ben: I am intrigued because obviously my own house is masonry and I know that there are – well, I say it's masonry, I suppose not entirely. It does have timber within it, timber trusses. Within the inside, you've got stud walls and this and that. But interesting on mine, and I've never really asked this question of Chris and the team, but downstairs is masonry dividing up the rooms, and upstairs is timber. What would be the reason behind that?

Bill: Usually for structural reasons in the sense that ground floor masonry holds the intermediate floor up. And also, masonry is better for sound.

Ben: Definitely better for sound.

Bill: And with wet plaster, as we use for the airtightness, it just gives a very solid finish that's going to last forever. But also, the cave effect. Your decrement factor. You've got a better decrement factor with block work. It's more even in temperature, for obvious reasons, because it behaves more like a cave, as opposed to a lightweight i.e., timber frame.

For example, on Denby Dale house with the massive South West glazed area, that wouldn't have worked with timber frame. It would have overheated too much.

But I feel it's down more to what your builder is used to.

Ben: So, there is some control element, is there?

Bill: Absolutely. Because it's teamwork. If your builder is used to working with brick and block, even though you've got a wider cavity, you've still got a strip foundation, which they understand it might be wider. They still understand solid concrete floors on top of polyurethane insulation or XPS insulation. It's all materials within their knowledge base. So, they are then going to price, if you're wanting them to put a fixed price in, reasonably.

If it's a technology or methodology that they're not used to, an estimator – because it's the builder taking the risk, it's their mortgage on the line, if you like – they're going to price tighter to something that they're confident with. And that is the main reason, I think, that people still build a lot of masonry passivhauses.

Ben: Is there anything that could go wrong with a masonry build then? Let's say the team – not your team of course – is not quite so accomplished. What are the things that could go wrong?

Bill: Wet plaster, for example, is a dying art because most builders want to do dot and dab, as they call it, which is gluing with dabs of adhesive, plasterboard to the inner leaf of blockwork. Which of course we know doesn't work in terms of thermal performance. We can't have that. The main reason that they like doing that, the main contractor, is for speed and drying out of the building because there's obviously far less water in the process.

So, wet plaster, if done properly, is fine. One of the disadvantages is that you don't have a service void, which you do or can do with timber frame methodology. And without going into great detail, what you're doing is channelling wires into the blockwork pre-plastering, particularly the electric boxes, back boxes to your sockets and your switches. That can be an area of failure.

But otherwise, I think as long as you've taped the joins with the floor, the junctions with your window reveals, and the windows themselves, I feel it's fairly safe.

Ben: Shall we talk about a couple of retrofit projects that you've done? We mentioned Stirley Barn before – that was slightly different because you were using timber frame – so, tell us about Cumberworth first.

Bill: So much is to do with the client, what they know, and what they want. So, Cumberworth was half a barn conversion and half a 1990s extension. So, there were two halves to the building. We had two strategies for the two bits of the build. But the basis of it was that it had been converted and built well in the early 1990s, but there was no mains gas there. They were reliant on LPG for central heating. So, they were spending three-and-a-half-thousand pounds a year on LPG and were still cold.

Ben: How big is the building?

Bill: It's a hundred-and-fifty square metres.

Ben: Goodness.

Bill: Yeah, goodness. So, they were cold as well. They also had a wood burning stove in this. And they were pretty fed-up.

They came to me to ask whether I knew anything about putting a wind turbine in the field, because that's the way they thought they could actually save on energy. I said, 'no, you don't need to do that. The best thing to do is get this house to perform better.' But the trouble is, you're ripping out value to do it. When I see a building which is in need of total renovation, it's going to be relatively

cheaper to do than ripping out value of reasonable kitchens, reasonable bathrooms and so forth.

Anyway, they were so fed up with where they were, but they didn't want to move because it's such a beautiful spot. So, that was it. They bought the fabric first philosophy and they moved out, rented a house, and left us to wreck the place, if you like.

Ben: So, when you retrofit, there is really a range of measures that you can do. So, this is a deep retrofit. Did you say EnerPHit? Did you set an energy target?

Bill: No, we didn't. Because I knew how difficult it is to get the airtightness in a retrofit.

We were lucky in that they were knowledgeable about the previous projects we'd done, and we know that if we get somewhere near EnerPHit, it's transforming a building. So, we used the appropriate materials and technologies for internal wall insulation, which is a whole subject in its own right, thermal bridging detailing, airtightness, and of course, ventilation. So, a full MVHR – Mechanical Vent Heat Recovery system.

Ben: And you had to go internal insulation. Was that some planning constraint?

Bill: In theory, it could have had external wall insulation, but the buildings here in North Yorkshire, we really are in an exposed situation. That was another thing about Cumberworth and Lower Royd later. They are right on the top of the Pennines. They are really exposed to a lot of moisture. And actually, the natural stone that these buildings are built of around here suit that type of environment. And to build in any other way is totally out of character for this region. And that's what the customer wants.

So, you either transform the building with renders or timber cladding around the outside – in some ways, that would make it easier to do a radical retrofit – but mainly it's the internal wall insulation.

Ben: What approach do you take so that you don't trap any moisture?

Bill: That's the big one, isn't it? It depends on the wall build-up. In the Cumberworth case, we've got a four-fifty wide ex-barn wall which is basically two stone leaves with rubble filled in the middle, so there's no cavity as such. And your moisture danger is rising damp because we've no DPC in a Victorian barn, rain driven damp, particularly where we are in this high exposure region on the Pennines with a porous stone, and then the third moisture risk is

interstitial condensation which is the condensation of internal moist air reaching the dew point where it turns to water as it meets a cold wall. So, if you put internal wall insulation on it, you are by its very nature making the masonry colder.

So, we used a software program called Wufi – a German software program – to actually model the wall to see what moisture risks there are which takes into account where you are, the orientation of the wall – obviously a West wall up here is in more danger than the East wall because most of our rain comes from the West – the rising damp, the type of stone it is, which quarry it's from, the mortar joints and so forth, and then obviously the insulation strategy you've got inside.

Ben: These programs, we've talked before about PHPP and so forth. They're pretty comprehensive. You've mentioned a number of variables.

Bill: Well, it's certainly better than what we've had before. The standard methodology has been the glazier system, which isn't as sophisticated, or we feel isn't as sophisticated as Wufi. Even that can fail. On all these projects, we're pushing the boundaries, and we've got moisture sensors in the walls so we can make judgements on their performance. And I might say that all of the buildings are performing fine.

Ben: That's a relief.

Bill: It is a relief. Yes, we do stick our necks out.

Ben: What else do we need to know about the strategy for this retrofit? We've talked a little bit about insulation. So, that internal …

Bill: Well, what I didn't say was that the 1990s part of the project is a cavity wall. So, the risk is less. You've got DPCs so you don't get rising damp, you've got a cavity albeit not a brilliant cavity but a proper cavity, so you shouldn't get rain-driven damp. In effect the only danger then is interstitial condensation, of the condensing of the internal moist air on to the cold wall behind the insulation. So, we ended up using a different, simpler strategy, and less expensive.

Each wall type can have a different strategy for internal wall insulation.

Ben: And it just has to link up carefully.

Bill: Very much so. You design to have continuity of insulation as much as possible – easier said than done with retrofit – continuity of airtightness strategy in all the elements, floors, walls, windows, roof – again, easier said than done in retrofit.

So, we're not looking for the same airtightness results as we are in new build. New build is easy compared to retrofit.

Ben: One of the big ones is what's below as well. So, were you changing anything beneath? You mentioned no damp-proof membrane or that kind of thing. Insulation I suppose is probably the big one.

Bill: In Cumberworth, because we don't get down to the energy demand we can in new build, we certainly needed a heating system. And the client wanted to go for underfloor heating. They also went for a ground source heat pump. They happened to have a very boggy field in front of the house which was very good for ground source. Air source and ground source heat pumps work most efficiently at delivering thirty-five degrees C water, hot water if you like, for your central heating system. And that suits underfloor heating more than radiators.

That then informs how you do the floor. Because we don't want to be heating up masses of concrete in a floor because of the slow cooling and heating – it doesn't respond.

Ben: I was going to say, generally for new build, you're warded off underfloor, aren't you?

Bill: You are indeed. But with a big retrofit, your heating demand is something like at best twenty-five. It might be thirty-five, forty. And your walls are a u-value of point-three as opposed to point-one-five. So, you can see that it's not at the levels of new build. So, underfloor heating becomes more relevant, I think, with these retrofit jobs.

So, you tend to build with a concrete slab on the ground, or on hardcore. So, you dig out what's there. Damp proof membrane, concrete slab, then your insulation – in our case, two-hundred millimetres of polyurethane or XPS – and then your seventy-five mill. heating screed on top. So, you're only heating up seventy-five mill. of screed. Not the whole slab.

Ben: Do we get to the easy bit then of the roof?

Bill: Yes, that's relatively easy.

Ben: Compared to everything else in a retrofit.

Bill: Yes. Is it a cathedral roof or is it a cold roof? The difference being, is it in the line of the pitched roof, or is it in your flat ceiling? In the Cumberworth case, in fact in most of our retrofits, we have cathedral roofs. So, we tend to have our insulation within the actual structural timber roof.

What we tend to end up doing is almost having a studwork parallel with our rafters, if you can get what I mean. So, we end up with insulation between the rafters, insulation again, and then within the studwork which is between the purlins, more insulation. So, we would use more rigid bats between the rafters – so, a mineral wool in our case – and the studwork, and then just ordinary loft fibreglass insulation between.

So, we're building up to a u-value, if we can get right down to something like point-one-two, which is new build standard.

So, yes, in answer to your first question, it is easier to get to that u-value, and the airtightness actually.

Ben: But still quite a bit of work on the roof.

Bill: Oh, loads of work. Of course. This is a deep retrofit.

Ben: Ventilation then. Was this a slightly easier part of the project?

Bill: It was actually. Although, of course, it's intrusive. MVHR is big pipes, a big machine, relatively. We built a plant room as part of the alterations to the building, and then you've got to run ducting.

In the new build it's relatively easy because you can build with quite deep intermediate floor, particularly with the Posi-Joists, the metal ones. So, you can run, in a new build, all your ducting within that space, and then distribute it around the building.

With a retrofit that's not the case. You don't have that luxury with your intermediate floors. So, you have to be quite savvy. Quite often, we'll run it in the corridors of the house where you don't mind lowering the ceiling. It's not noticeable.

Anyway, we did it, and you can do it, and it's working at the ninety-four percent efficiency. It's brilliant.

Ben: That's obviously a big strength of Green Building Store, isn't it? Having your ventilation department on hand.

Bill: Yes, quite.

Ben: So, we've covered a lot of the key aspects. Is there anything else we should mention before we look at how you moved on again for the next retrofit that came your way?

Bill: Oh yes, the windows, which was peculiar on this job.

We'd actually replaced the windows five years previously with timber triple glazed outward opening windows, which we made at the time. So, there was no way we were going to chuck them away.

So, part of fabric first methodology is that you get continuity of insulation. Because if you do it well in ninety percent of your building, for example, the ten percent becomes very vulnerable to condensation and cold bridging. So, the reveals between the very good wall insulation we were doing, in to the window frame, only allowed for a ten mill. insulation.

To maintain that u-value that we'd got on the walls of point-three, we had to use vacuum insulated panels which look like coffee packs so they're custom made to fit. They have a lambda value which is three times better than polyurethane or six times better than the wall insulation. So, we were able to use those vacuum insulated panels in the reveals underneath the window board and behind plasterboard, all taped in together for airtightness.

Ben: It's just like a massive jigsaw, these retrofits, aren't they?

Bill: Yes.

Ben: You've got your different approaches and …

Bill: Yes [laughs].

Ben: But when we move on to Lower Royd, you're starting all over again really, aren't you?

Bill: We are, yes.

Ben: Yes, it's the same methodology, but what are you going to tell me here? Are we internal insulated again?

Bill: Yes, we are indeed, but we used a different strategy at Lower Royd. One of the disadvantages with our rough stone walls we have here in the Pennines is that they're wobbly. And a rigid insulation as we used at Cumberworth, which was a rigid perlite board from Germany called TecTem, was that you have to dub the wall out and flatten it. Which actually takes more work than anything else.

So, we used a different material from Italy. You can hand apply it, but we sprayed it. A cork and lime wet process with a lambda value of 0.045. So, it's as good as polystyrene or normal fibreglass or wood fibre, but with the added advantage that you didn't have to flatten the walls. So, it was straight applied. We'd build it up in four twenty-five mill. layers.

That was both airtight, vapour and capillary open to all those moisture issues that I talked about earlier on the barn at Cumberworth, and with a beautiful finish. Being a lime product as well, it inhibits mould growth.

It dealt with all the risks all in one hit.

Ben: So, that's your airtightness layer as well, did you say?

Bill: Yes.

Ben: Wow. Were there any other quirks of this building? I realise we haven't described what it was to begin with. We're now on Lower Royd.

Bill: Well, the advantage of Lower Royd in terms of economics was that it was a virgin barn, so you've got nothing to rip out, and the farmhouse part of it because we converted the barn and upgraded the existing farmhouse, which was really in a 1960s state. There wasn't a lot of value in it. So, we completely started again.

Ben: That's the time to do this, isn't it?

Bill: It absolutely is. But they're rare to get nowadays. That is not reality for most of us.

Ben: What else was different and what else was the same, as we go through this second retrofit project?

Bill: One of the main differences is the heating strategy. You remember at Cumberworth there was no mains gas. Well, we had that at Lower Royd. Even though we were out in the countryside, luckily for our clients, a dairy farm further up here in the Pennines had gas laid on. So, they were able to take advantage of that.

The clients had assumed that they were going to go for a ground source heat pump, but in terms of economics, for example, a ground source heat pump may cost you twenty-grand to get into the building as opposed to gas and a standard boiler – and we're talking about the smallest condensing boiler, off the shelf from your local builder's merchant – costing, installed, fifteen-hundred, two-

grand. You're better off with that saving of fifteen-grand, say, to be put into your fabric. The cheapest energy is the energy you save. That heating system can always be changed to an air source or ground source heat pump in the future.

Ben: Was there anything that you brought from the retrofit before, into this one? New learning or was it really just you have to do each one as it comes?

Bill: Yes, you do the most appropriate in terms of economics and moisture risk, particularly with the internal wall insulation. So, it was more the knowledge that we gained from Cumberworth was brought into Lower Royd, but the main difference was the internal wall strategy and what we used.

And we're going to be moving on later this year to a similar large barn conversion, here in the village, another one in Meltham. And we haven't decided yet what internal wall insulation we're going to be using.

Ben: But another internal wall. It's interesting.

Bill: Yes. The clients just assume that's what we're going to go for.

Ben: Maybe just as we wrap up, can you take us through the stages that you go through in the retrofit, from design right through to construction? What does it actually look like?

Bill: These processes always start with the client wanting a fine house, really. And nowadays, the general public in our opinion anyway, or a certain section of the public, are far more knowledgeable about energy and buildings now. And of course, with the climate change issues that we have at the forefront nowadays, people are really thinking about it.

So, if you're ending up with an internal wall strategy, it really informs you that you can cause a lot of damp and mould problems within buildings if it's not done properly.

What else have we learnt? It's just ingrained in our personality as a firm nowadays. We cannot go back, actually, to how other builders are doing things still. And it's just a fact, really. We've just got to carry on.

What we've got to do and what we try and do is make it more economic. In other words, look at what we're doing, how we're doing it, do we need to go that far? And in fact, we're looking at the issue of maybe putting less insulation on the wall. So, we're

weighing up the advantages of a lesser u-value on the walls for the saving, but still having the same airtightness and a good ventilation strategy.

What we are finding is that the airtightness is probably, from an energy and comfort point of view, the first thing to be thinking of. And almost insulation comes second. It's more important to get a continuity of insulation. It's much better to have fifty mill. of insulation everywhere done well, than it is to have a hundred mill. of insulation done reasonably well on only seventy-five percent of the building.

It's things like that, that you learn over time.

Ben: What advice would you give to someone just thinking about a retrofit, wanting to research it, wanting to get the right design, right build? How can we leave this interview?

Bill: Well, either to read up on it yourself, talk to other people that have done it, get a professional designer on board either to learn with you or who has learnt already, ideally with builders and suppliers actually who have experience, and basically tying it all together.

A good retrofit is, as we said earlier, more difficult than new build. So, we're looking all the time to try and simplify it. But you have to take into account there has been so much bad retrofit done over the last few years, and we really must take lessons from that and do it in a more risk-free way.

Ben: Bill, it's been fun to catch up again. Thank you for all of your information. Much appreciated.

Bill: Thank you, Ben. It was lovely to meet you again.