Joe Lstiburek says, Don't dense-pack unvented cathedral ceilings

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It's not really news, but it's worth reading: Joe Lstiburek says that unvented cathedral ceilings shouldn't be filled with dense-packed cellulose insulation.

Read about it here:
http://www.buildingscience.com/documents/insights/bsi-043-dont-be-dense/

ASKED BY MARTIN HOLLADAY, GBA ADVISOR
POSTED WED, 12/15/2010 - 13:42

TAGS: ENERGY EFFICIENCY AND DURABILITY

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21 Answers

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1. As an alternative to Lstiburek's suggestion of applying rigid foam over the roof sheathing, would creating a sort of ventilated rain screen space between the roof sheathing and a metal roof (using 1x 4's) be an effective solution?

   ANSWERED BY BRYAN SHEPHARD
   Posted Wed, 12/15/2010 - 15:25

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2. Bryan, that's a good solution for a few reasons. First it separates the vapor impermeable roofing from the insulated cavity, allowing moisture to dissipate into the vent space. Second it allows the roof sheathing to serve as an exterior air barrier, which would not be possible if the joist cavity were vented below the sheathing.

   ANSWERED BY THOMAS JEFFERSON
   Posted Wed, 12/15/2010 - 15:34

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3. Actually, Dr. Joe DOESN'T say not to dense-pack unvented cathedral ceilings. He says that strategy can work in arid climates with vapor-open roofing and in any other climate with foam either above or below the roof deck in addition to the dense-pack.

   Bryan, your suggestion would work - AS LONG AS there was no vapor impermeable membrane on the roof sheathing. Traditional felt underlayment would work fine, but most of the new plastic roof inderlayments are too impermeable and peel-n-stick is out of the question.

   ANSWERED BY RIVERSONG
   Posted Wed, 12/15/2010 - 15:54

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4. Pretty simple really. Don't put your vapor barrier on the cold side of the roof.

   ANSWERED BY GREG DUNCAN
   Posted Wed, 12/15/2010 - 17:13

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5. Not so simple. As Dr. Joe points out, many roofings ARE a cold-side vapor barrier.

   ANSWERED BY RIVERSONG
   Posted Wed, 12/15/2010 - 17:32

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6. Greg,
   It's not so simple, really. If you put enough vapor-impermeable foil-faced polyiso on the cold side of your roof, and don't put a vapor barrier on the interior, you'll be fine.

   ANSWERED BY MARTIN HOLLADAY, GBA ADVISOR
   Posted Wed, 12/15/2010 - 17:33

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7. When I drill-n-filled my 1 3/4 story home with dense pac cellulose my insulation contractor recommended that I dense pac the slant walls. I didn't do it because I have plans to insulate and vent the roof but he left me with the impression that filling the slant walls was standard practice for them. The slant roof being the local of ice dam formation in my climate I imagine the dense packing can exacerbate damage here.

   ANSWERED BY J CHESNUT
   Posted Wed, 12/15/2010 - 18:38

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8. Chestnut,

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If there was no insulation in the slant ceiling and then it was filled with cellulose, that would reduce the likelihood of ice dam formation by substantially reducing heat loss to the roof.

Many cellulose manufacturers and veteran installers claim problem-free slant and unvented cathedral ceiling installations (though I would recommend against it), and that's probably because most roofing in existing homes does breathe to some extent and the dense pack significantly reduces air flow to the roof deck and can also safely store and release occasional moisture.

ANSWERED BY RIVERSONG
Posted Wed, 12/15/2010 - 18:45
Edited Wed, 12/15/2010 - 18:46.

9. Joe Lstiburek's article on cellulose insulation has been generating a fair amount of discussion -- enough that Bill Hulstrunk, the technical manager at National Fiber (a manufacturer of cellulose insulation), decided to respond to the article. Hulstrunk's e-mailed response has been widely forwarded. Here's what he wrote:

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"We have received several emails regarding Joe Lstiburek's latest email on using cellulose in unvented roof assemblies. This article actually appeared several months ago in the ASHRAE Journal and since than, I have been able to gather additional information on this building failure from a colleague who was on site with Jim Fitzgerald.

"The building in question had preexisting moisture problems including interior mold and staining of window sills. Jim F was brought up to Canada to teach the local crews how to dense pack roof assemblies. Jim was frustrated because due to "politics", he was not allowed to supervise the installation crews, but instead was relegated to a small office. The built up flat roof assemblies on this project were both very complicated and several feet deep in sections.

"With the information above, it is not surprising that this unvented roof assembly eventually failed. The factors leading to this failure included:

1. Inadequate density of the cellulose allowing the opportunity for warm moist air to move through the cellulose and for the cellulose to separate from the wood roof deck
2. Limited drying potential to the exterior due to the built up roof
3. Limited drying potential to the interior due to the high interior humidity levels
4. Unusually high diffusional moisture flows due to the high interior relative humidity levels

"For an experienced crew it is extremely difficult to consistently dense pack roof assemblies that are over 18 inches deep using the limited slot assess method and staggered hose method identified in the photos. The inexperience of the Canadian crews never had a chance of doing this successfully. The issue here is that the density of the cellulose starts dropping off once it leaves the end of the hose, and with a two inch hose you will be able to successfully dense pack about a foot away from the hose end horizontally and vertically. In very deep cavities such as these, after dense packing along the ceiling on your first pass, you need to reinsert the same hose back through the cellulose closer to the roof deck in order to bring the upper layer of the cellulose up to proper density. Shorter cavity depths are much easier, but larger (over 18 inch) cavity depths require multiple passes and the use of smaller diameter hoses on the second pass to achieve consistent cellulose density.

"The failure mechanism in this project included inadequate cellulose density which allowed for separation of the cellulose from the exterior roof sheathing. During the winter months, the high indoor relative humidity levels diffusional moisture coupled with moist air flow through the loose cellulose allowed moisture to pass through the cellulose and condense on the roof sheathing above and drip back into the cellulose below. The cellulose was not able to dry towards the exterior due to the built up roof above. Nor was it able to dry successfully to the interior due to the elevated indoor humidity levels below. A dozen years later, we should not be surprised that the roof rotted off this building.

"Some of the lessons learned from this unfortunate building failure:
• Any building with a preexisting moisture problem should not be weatherized before the moisture issues are resolved.
• Cellulose density is critical for the long term durability and performance of unvented roof assemblies, deep flat roof assemblies (18 inches or more) should only be attempted by experienced installers using multiple passes with the installation hose.
• All areas of complex roof systems must be accessible; insulating only parts of unvented roof will lead to durability issues and possible roof failure in the uninsulated portions.
• Unvented roof systems that can only dry towards the interior require active control of indoor relative humidity levels during the winter months
• When buildings are tightened up, proper air exchange must be maintained with mechanical ventilation.

" We have learned a lot since the 1990's when this project was done and since

than seen failures in every type of insulation system, from fiberglass to foam. The use of this project by Building Science Corporation (BSC) to scare people away from using dense pack cellulose in this proven application is nothing short of a cheap publicity stunt and a thinly veiled advertisement for the foam and fiberglass manufactures who support BSC financially.

"Tens if not hundreds of thousands of roof assemblies have been successfully dense packed since the 1980's and today it is common practice to dense pack roof assemblies in both retrofit and in new construction. Unvented roof assemblies dense packed (3.5 lbs/cuft) with cellulose are more robust than those filled with foam due to the hygroscopic properties of the cellulose insulation which provide active moisture transport and dispersal. More information regarding this can be found on our website at www.nationalfiber.com .

"Please let me know if you have any questions.

Bill Hulstrunk, Technical Manager"

ANSWERED BY MARTIN HOLLADAY, GBA ADVISOR
Posted Mon, 12/20/2010 - 12:51

10. Three cheers for my friend Bill Hulstrunk (who also teaches Super-Insulation for Net Zero at Yestermorrow), and one of the most knowledgeable people on cellulose insulation.

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The cellulose insulation industry has, for many decades, been fighting the disinformation campaigns of the fiberglass industry and their trade organizations, such as NAIMA, and more recently of the spray foam manufacturers and installers.

I've long wondered why Dr. Joe has such a bent towards foam - even though he apparently agrees with me that a house must be designed like a living cell:

"We need to design, construct, operate, and maintain buildings in the same way that nature builds cells — with efficiency, elegance, and unerring deference to the natural laws of physics, chemistry, and biology. A green architect or builder must be a student of science first; great buildings will follow."

- Joseph Lstiburek, Building Science Corporation

ANSWERED BY RIVERSONG
Posted Mon, 12/20/2010 - 15:16
Edited Mon, 12/20/2010 - 15:18.

11. Thank you Martin for your last post. Again you are the reason that this site worthy.

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ANSWERED BY AJ BUILDER, UPSTATE NY ZONE 6A
Posted Mon, 12/20/2010 - 15:25

12. For me, this is the most revealing statement: "Unvented roof systems that can only dry towards the interior require active control of indoor relative humidity levels during the winter months."

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In other words, if you install a roof of that description, the roof may fail if the homeowner turns off the ventilation fan.

That would be enough to scare me (speaking as an ex-builder) away from the system. I don't need the liability.

ANSWERED BY MARTIN HOLLADAY, GBA ADVISOR
Posted Mon, 12/20/2010 - 15:29

13. Martin,

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You can avoid unvented roof systems because of the impossibility of controlling occupant behavior in a very tight house. Or you can build vented systems in which cellulose works better than any other insulation material, which are significantly better than unvented roofs in every way, and work passively without occupant intervention.

Now THAT'S what I call a Passive House.

ANSWERED BY RIVERSONG
Posted Mon, 12/20/2010 - 15:36

14. Robert,
I agree: vented ceilings are the way to go if you are using cellulose.

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ANSWERED BY MARTIN HOLLADAY, GBA ADVISOR
Posted Mon, 12/20/2010 - 15:45

15. So true about many households I have been in. No one is concerned with keeping the moisture level low enough. And they mostly are adding it, in all ways... plants, boiling huge pots of water, entire family of 4 taking hot water tank emptying showers, humidifiers humming along, etc.

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So I agree, we do need to build homes that passively take care of moisture.

ANSWERED BY AJ BUILDER, UPSTATE NY ZONE 6A
Posted Mon, 12/20/2010 - 15:48

16. I agree with Robert that the ideal way to reduce risk is to include venting. Of course this is a challenge with some roof designs, and in fact it must be unusual to have *vented dense-packed* cellulose. That requires

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a sheathing layer (or another rigid boundary) above the insulation and then space between that layer and the impermeable roof. A more likely solution would be *vented loose fill* cellulose, with a vented space below the sheathing. But where possible, vented dense pack makes a low risk and airtight roof.

ANSWERED BY THOMAS JEFFERSON
Posted Mon, 12/20/2010 - 16:03

17.

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In fact, an excellent way to insulate and vent a parallel-chord roof/cathedral ceiling system is to sheath the trusses with 3/8 CDX covered with #15 felt, install 2x4 flat sleepers over each truss and a thicker layer of sheathing of your choice with whatever peel-n-stick nonsense and roofing that floats your boat. Then vent the 1½" air gap bottom and top and dense-pack the trusses from below.

This creates a perfectly vented and insulated roof assembly with a complete secondary drainage plane below the roofing/sheathing - like a rainscreen siding approach. Both the secondary sheathing and the primary roof sheathing can dry to the vent cavity for long-term reliability and durability.

But, of course, this requires designing for function and letting the aesthetic follow, rather than the more usual designing for form and hoping that it will function.

ANSWERED BY RIVERSONG
Posted Mon, 12/20/2010 - 17:57
Edited Mon, 12/20/2010 - 17:58.

18. Helpful? 0 Sign in to vote

Robert, I've been considering a similar setup and was wondering if it would work. I'm in the process of hand-hewing a timber frame and am riving some white oak shakes. The roof assembly I am thinking about from inside out would be ADA drywall, about 20 inches of dense-pack cellulose, timber frame, 1/2" CDX, tremco acoustical sealant/15# felt, 1x rough-sawn vertical strip, 1x rough-sawn horizontal nailer, and the white oak shakes. Are there any issues with this assembly?

ANSWERED BY JAMIE MALCOLM-BROWN
Posted Mon, 12/20/2010 - 19:02

19. Helpful? 0 Sign in to vote

Jamie,

If you could post a cross-section or link to one it would be easier to understand what you're trying to do (attachments are now allowed).

What contains the 20" of cellulose? If the CDX and vertical spacers are attached to the timber rafters, what's the on center spacing of the rafters? If you're using the sheathing as the air barrier, how is it continuous with the wall air barrier? And, if not, then why the Tremco on the CDX?

ANSWERED BY RIVERSONG
Posted Mon, 12/20/2010 - 19:18
Edited Mon, 12/20/2010 - 19:19.

20. Helpful? 0 Sign in to vote

I don't have a cross-section but the attached image is of a similar hewn frame (the one I'm working on will be 24x20). Horizontal members will be placed 2' on center (you may be able to see the notches in this image) between the principal rafters which are 8' on center. The CDX will cover the entire frame with the tremco over the seams. I was hoping to build a secondary wall outside the timber frame but decided it would be easier to do inside. So there will be a double wall gusseted to the timber frame. I know it ends up burying the timbers but trying to achieve air-tight drywall with exposed timbers would be difficult. On the roof above the 1/2 CDX will be the crosshatched 1X lumber which will serve as a vent and nailers for the shakes.

ANSWERED BY JAMIE MALCOLM-BROWN
Posted Tue, 12/21/2010 - 11:28
Edited Tue, 12/21/2010 - 11:28.

21. Helpful? 0 Sign in to vote

Jamie,

First, you would have been better off by starting a new thread, since you would be notified of all responses by email (you might still want to do that and repost what you've done here or ask Martin to move them).

Second, I still can't make sense of what you're proposing. It sounds like you're wrapping the entire timber frame in plywood as the air barrier (so you don't need ADA) and then gusseting a secondary frame inward at both the walls and roof plane for an insulation cavity. To do that, you'll need to either stud in between the wall posts or use horizontal girts.

But, with such a small space, I don't understand why you wouldn't build outward

and leave the frame exposed (which will also make it dryer and more durable). You could pad out the primary timbers with 3/4" furring centered on each post and rafter, sheath with CDX over that for a continuous air barrier (while leaving a gap between that and the timbers for inserting DW), then build an exoskeleton of Larsen Trusses sheathed with rough sawn boards on the roof covered by felt and shakes and felt and rough sawn siding on the walls.

Where are you building this? What stage are you at? I'm glad to answer your questions here and am also available for consultation at HouseWright (at) Ponds-Edge (dot) net.

ANSWERED BY RIVERSONG
Posted Tue, 12/21/2010 - 12:17

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