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TECHNICAL BULLETIN PL:BECS 072100-053118.1: FOAM-FILLED FOLLY

This bulletin cautions against foam-filled, non-vented roof assemblies, which have been accepted by the building code for a number of years. As an initial, limited dissemination of this bulletin received informative replies from other consultants, architects, building inspectors, and insulation installers, I have revised it to incorporate such input. PL:BECS disseminates such technical bulletins whenever construction-related failure patterns are encountered to inform other construction professionals so that such pitfalls can be avoided. Please see the website, **plbecs.com**, under **Publications**, where such bulletins will be posted. Please feel free to share this with colleagues in the construction industry and others who may be interested.

This bulletin is titled "**Foam-Filled Folly**", and refers to the relatively recently code-accepted roof assembly approach wherein the entire roof cavity is filled with foam and the cavity is not vented. I believe the theory behind this approach is that the closed-cell foam will act as a vapor barrier, precluding the intrusion of moist interior air into the roof cavity, thus obviating the need for venting the roof cavities.

Based on my science background as well as familiarity with the behavior of various materials, I have always avoided this approach, even declined to participate in any projects where this method was to be followed contrary to my recommendations, lest I too become entangled in the consequences I expected of this approach. Only a few months ago, I even stepped out of an otherwise interesting and significant project rather than becoming party to this foam-filled cavity method others insisted on following.

Initially, my hesitancy to follow this foam-filled cavity approach sprang purely from a theoretical basis, for I expected the foam to often shrink away from the framing, or crack, thus negating its capacity to act as an effective vapor barrier. Further, even in cases where these effects could be avoided, I expected that moisture would migrate directly through the framing rafters separating the foam-filled bays, as wood is certainly not vapor-proof and absorbs moisture from the atmosphere. It was my expectation that moisture would inherently find its way into these roof assemblies, which, by virtue of the foam-filled cavities and absence of any venting provisions, would then have essentially no means to dissipate this moisture, leading to fungal decay.

As a still-limited number of these non-vented, foam-filled assemblies had been installed and given sufficient time to begin manifesting problems, my failure expectations began as purely hypothetical. More recently, I heard several reports from owners and inspectors noting the "expected" symptoms in these foam-filled cavities, but I still had not personally seen this predicted failure mode.

This changed when I was called out to a home with a 2-year-old addition which used such a roof assembly. The owner reportedly began noticing staining and dripping from the ceiling, and when the builder investigated, moderate decay was uncovered along the roof ridge above the enclosed space. Removing the plywood roof sheathing uncovered the foam-filled cavities, revealing that the foam in all but one cavity had shrunk and pulled away from the framing, opening large gaps, ranging up to 1 ½" wide, through which moist interior air could migrate unimpeded into the cavities, with no place to go from there. Consequently, fungal decay was well on its way along the ridge top in spite of this roof's relatively young age. Although several very warm dry days had followed the removal of the plywood sheathing, allowing the moisture to dissipate prior to my arrival, moisture readings in the framing upon my arrival still ranged between 26% and 40%, indicating saturation of the lumber. In short, this home's symptoms exactly matched those I expected to begin encountering with increasing frequency as this roof assembly approach becomes more widespread.

Now, let me share the input I received from other construction professionals regarding this assembly type in response to my initial limited distribution of this bulletin. Two other enclosure consultants/inspectors noted that they had observed similar fungal infestation symptoms within this assembly type, and one noted having observed these even in the much drier climate of eastern Washington state, so my observations do not appear to reflect an isolated case. A number of architects replied that they too had avoided this foam-filled, non-vented assembly type due to their concerns about its lack of moisture-dissipating capacity, exactly matching my own initial concerns. One consultant also noted observing accelerated degradation of asphalt roofing shingles in this assembly type due to the higher temperatures resulting from the absence of venting, which also has the effect of cooling the roof.

One foam insulation installer noted that the separation of the foam from the framing most likely reflected an installation flaw, and mistakenly took my bulletin as arguing against the use of foam insulation itself, so let me address the installation flaw issue and clarify that PL:BECS is not opposed to foam insulation itself, but rather the use of such foam in non-vented assemblies lacking a continuous, uninterrupted vapor barrier.

Let me begin with the installation flaw assertion, which I perhaps should have addressed in my prior bulletin. The installer asserted that it is entirely possible to get the foam to adhere to the framing members and remain bonded, and that the fact that it failed to do so in this case reflected that perhaps the wood framing was too wet to allow such bonding to take place. I absolutely agree that the de-bonding I observed should be avoidable, and that applying the foam to wood with an excessive moisture content can preclude the foam's adhesion. I am also not asserting that this system cannot work in any climates and for any conditions. There may well be combinations of climates, interior uses, installation quality control, installation wood moisture content, etc., to allow even this unvented foam-filled system to function. However, one design maxim I have learned, and which PL:BECS thus advocates, is that it is inadvisable to design systems which require a very precise combination of factors to come together to perform well, and that it is always advisable to design systems which can accommodate some things "going wrong" without a high risk of overall failure. For example, it is entirely possible that the wood framing in the example cited in this bulletin may have been too moist, thus compromising the foam's bond to the framing members, allowing greater amounts of interior moisture to enter the framing cavities, thus exacerbating the fungal infestation observed. However, as it rains roughly 160 times each year in the Seattle area, and yet more frequently as one approaches the west side of the Cascades, it is my assertion that this will unavoidably result in many projects being installed too wet, with no means to dissipate any embedded moisture. In contrast, with a properly vented roof assembly, any excessive moisture which may be incorporated during installation can be dissipated during ensuing months.

To correct the impression that PL:BECS is opposed to the use of foam insulation, let me clarify that I believe that foam insulation could well be used successfully if sprayed against a continuous baffle system designed properly to allow moisture dissipation and vented top and bottom, and if a truly continuous vapor barrier could be placed on its warm side to preclude intrusion of interior atmospheric moisture into the framing members.

I repeat my strong recommendation that this foam-filled, unvented roof cavity approach be avoided in favor of properly designed, properly vented assemblies with both high and low vents providing ample air flow for each framing bay. Figures 1-8 illustrate the observations made at the home cited in this bulletin.

Sincerely
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Fig. 1: Fungal Decay Along Ridge

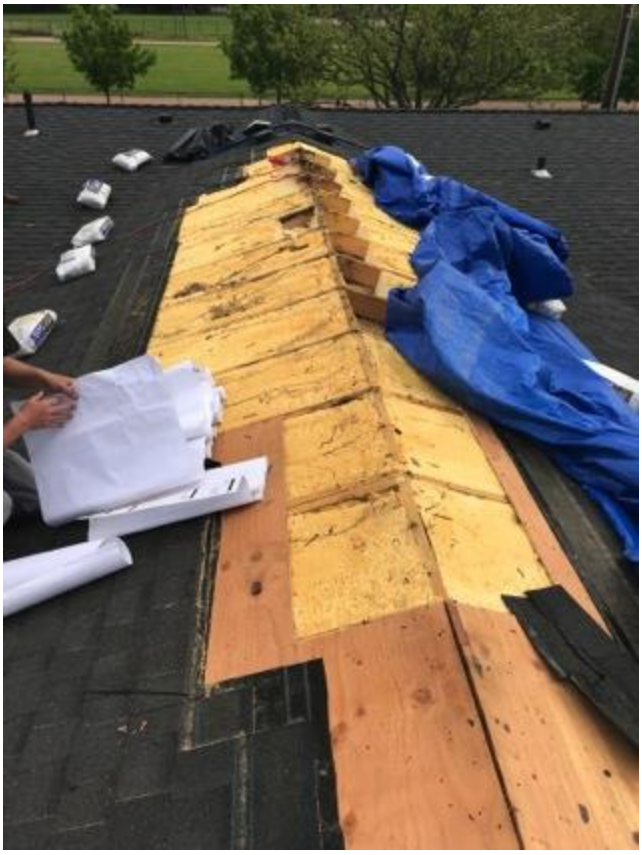

Fig. 2: Foam-Filled Over-Framing

Fig. 3: Stained Foam Insulation

Fig. 4: Stained Foam Insulation

Fig. 5: Gaps at Wiring & Along Foam Edge

Fig. 6: Stained Foam Insulation, Foam Shrinkage

Fig. 7: Elevated Moisture Content, Decay

Fig. 8: Elevated Moisture Content, Decay