Supplemental Field Study of Sealed Attics

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Research Purpose and Goal:

This research proposes to supplement the current field study (Prevatt, 2016) involving 4 sealed attic homes, conducted by the University of Florida (UF) and Oak Ridge National Laboratory (ORNL), with an additional 15 homes. The goal is to provide more field data to improve the validity of the analytical assessment that has been proposed as a future phase of the currently funded work.

Expected Outcome and Impact on the Code:

It is possible that additional specification within the Florida Building Code is required in order to ensure proper design, construction, and operation of homes with unvented attics so that moisture can be managed and long term durability be ensured. This specification could include considerations for:

1) Air sealing of the attic with respect to outdoors.

2) Air exchange between the attic and the living space.

3) Duct leakage for attic located ducts.

Based on the results of field study of 4 homes, UF and ORNL propose an analytical assessment that would indicate relative moisture risk in sealed attics as a function of various design and performance characteristics, including the 3 variables listed above. The statistical significance of the results of the analytical assessment can be dramatically improved with data from a larger number of homes.

Definition of the Problem:

Unvented attics are becoming more commonplace in new residential construction. Research studies have been conducted recently that document elevated relative humidity (RH) in unvented attics of high performance research homes (Colon, 2011 and Boudreax, 2014). It is unclear as to whether the phenomena is widespread throughout the general population of unvented attics, and if it presents long term durability issues. It is speculated that increasing stringency of codes and above code rating systems such as EPA Energy Star are resulting in the construction of significantly more airtight ducts and ceilings, even in homes with unvented attics where the energy penalties are reduced. Specifically, requirements for total duct leakage and enclosure leakage in such programs continue to increase in stringency. In turn, the incidental air change between an unvented attic and conditioned living space required to manage moisture is being reduced, and in such cases intentional air change may need to be specified

Construction of unvented attics involves “sealing” the attic space by eliminating all attic venting to the outdoors. Insulation is applied on the underside (or sometimes on top) of the roof sheathing, enclosing the attic inside the home’s air and thermal boundary. Benefits of the approach include reduction of the thermal penalties for locating ducts and air handlers inside the attic, improvements in building air tightness, and a reduction of the influence of duct leakage on building pressure and uncontrolled infiltration.

The Florida Building Code section 806.4 outlines required conditions that must be met for unvented attics to be permitted. Section 806.4.4 deals with air permeability of insulation, requiring *air impermeable* insulation to be applied to the underside of the roof sheathing. Alternatively, if *air permeable* insulation is used under the roof sheathing, rigid board or sheet insulation must applied to the topside of the roof sheathing for condensation control. No provisions are included to quantify or define required integrity of the attic air sealing, but the language implies an intent to control air change with the outdoors, and to control the effect that moisture contained within the unvented attic may have on the durability of the roof sheathing.

The convention for insulating unvented attics in Florida is to use low-density spray polyurethane foam (SPF). While effective at creating an air seal if applied properly, quality control in the field typically only involves a visual inspection, which only reveals major imperfections in the air barrier. There are many circumstances that can lead to improper application of the SPF, creating gaps and voids that cannot be seen, allowing air transported moisture to enter the attic from the outdoors. The low density SPF is very vapor permeable, and it will allow moisture trapped in the attic to pass through it and migrate to the underside of the roof sheathing. Solar radiation will drive the moisture back down through the foam into the attic, but it is unknown whether daily or seasonal wettedness of the roof sheathing is impacting durability, and how the process is affected by varying amounts of moisture. In addition to potentially affecting durability of roof sheathing, elevated moisture inside an unvented attic has the potential to condense on cold surfaces, such as air handler cabinets (if present) and cause ceiling damage.

Moisture must be managed in unvented attics to ensure durability of components and longevity of the system. In addition to the potential for elevated moisture inside an unvented attic to originate from the outdoors due to an imperfect air seal, moisture in unvented attics originates in large part as a result of generation within the living space and subsequent transport into the attic due to buoyancy. Section 806.4.2 of the Florida Residential Code prohibits internal vapor retarders from being installed on the ceiling side of the attic floor under an unvented attic. Moisture management in unvented attics is accomplished through proper air sealing to the outdoors, and air change between the attic and the conditioned living space. Provisions for air change between the unvented attic and the living space are not provided in the code. Presumably, leaks in attic ductwork combined with leaks in the ceiling facilitate incidental air change between the attic and the living space (Lstiburek, 2014). As these building components are made tighter, incidental air change is reduced, and it is possible that intentional air change may need to be designed into unvented attic systems to ensure proper operation.

Work Scope:

The scope of this project is to conduct short-term tests on fifteen Energy Star homes with unvented attics in central and south Florida (climate zones 1 and 2) that have been built in the last 3 years. The testing and monitoring plan developed as part of the currently funded study (Prevatt, 2016) will be carried out in these homes. Essentially, an audit will be performed on each home and guarded blower door testing will be conducted to determine the air tightness of each attic with respect to the outdoors, and of the attic with respect to the living space. Pressure differences of the attic with respect to indoors and outside will be measured when the air conditioner is on and off. Temperature and RH will be measured in each of three locations in the attic (low, middle, high) and one in the living space for a period of 6 months. If ductwork or air handlers are in the attic, a surface temperature will be measured at a location representing the coldest surface when the air conditioner is running to evaluate the potential for duct sweating.

Budget:

$64,000

References:

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