Investigation of Exterior Duct Condensation Potential of Deeply Buried Cold Air Supply Ducts in Florida Vented Attics

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Research Question:

Is there adequate cause for concern about exterior duct condensation on ducts deeply buried in insulation in Florida that should be addressed by the Florida Building Code?

Code and Background Relevant to Florida:

The 2018 International Residential Code (IRC) has a provision for energy conservation credit for deeply burying ducts in attics under blown insulation if the duct insulation is covered by insulation rated at R13 in climate zones 1A and 2A. While this is not current Florida code, Florida's code cycle will address adoption of 2018 IECC in the near future. The issue of increased potential for duct condensation must be considered, and it is prudent to consider the issue before the future code is adopted.

Deeply buried ducts are defined as follows: the bottom of duct is no more than 5.5 inches above conditioned ceiling, must be covered with at least 3.5 inches of insulation on top, and have at least R-30 insulation on either side. The duct insulation R-value rating must be at least R13 in climate zones 1A and 2A and this does not include the R-value of attic ceiling insulation used in burying the duct. Meeting these requirements will allow the duct system to be modeled as an R25 effective duct insulation according to 2018 IRC. Under the 2018 IRC, a deeply buried attic duct system may also claim credit as a conditioned space duct if it meets specific air leakage and insulation criteria, and if the air handler is located in the conditioned space.

The potential for condensation increases if the duct exterior is surrounded by a porous insulation such as blown loose-fill insulation. Adding loose insulation around a cold air supply duct will result in a colder exterior duct surface without the benefit of a vapor retarder. Minor duct condensation has been noted in research publications of partially covered or buried ducts with R6 duct insulation (Grifiths et al. 2002), (Withers et al. 2016). Minor duct condensation was also found on R8 insulated and buried duct under lab-scale controlled 22 day test established to represent South Carolina summer conditions (Salonvaara et al. 2016). The condensation in these instances were not reportedly severe enough to result in dripping off of the duct to materials below.

Duct condensation, or sweating as it is sometimes called, is most likely to occur during July through November when the outdoor air is moist and there is substantial air conditioning load resulting in long run-times of the central ducted air conditioner. The 2018 IRC presumes that R13 duct insulation is adequate to keep the exterior duct surface temperature above the surrounding dewpoint temperature thereby eliminating condensation potential.

Critical Research Need

There has not been adequate published research of long-term performance of deeply buried duct systems in hot and humid climates. Particularly lacking is better assurance of low condensation potential in relatively cooler vented attic systems.

The most recent published research known at this time has come from (Malley 2016) and (Salonvaara et al. 2016). The body of work suggested that ducts in unconditioned space in climate zones 1A and 2A can be deeply buried as long as the duct insulation is greater than R8 with an outer vapor barrier. The Malley 2016 study reported on some simulation work, completed field inspections, and ran a controlled lab study. When condensation was observed on duct surfaces, it was reported to be of minor concern and low enough that dripping downward onto building materials was not observed. The Malley 2016 report indicated that the duct condensation evaluations occurred in vented attics with dark asphalt shingles.

This lead proposing author makes the point here, that the type of roof may have a significant impact on the potential for cold air supply exterior duct condensation in vented Florida attics. High mass roof such as tile, or roof assemblies that limit radiative energy into attics, such as metal roofs or attics with radiant barriers have cooler attics than those with asphalt shingles. A cooler attic with lower radiant energy towards the duct will result in a colder supply exterior duct surface temperature than a hot attic with hot roof deck temperature. This will increase the potential for condensation. What is not clearly established in existing publications is if the condensation potential is high enough for concern in cooler vented attics due to diminished radiative qualities or high roof mass.

Scope of Work:

1) Complete a literature review for published data on deeply buried ducts.
2) Complete simulations to evaluate buried attic duct condensation potential for 8 scenarios. The 8 scenarios include four different attic roof assemblies for south Florida and four different attic roofs for north Florida.
3) Perform lab study of duct condensation of deeply buried duct in a vented attic for vented attic configuration with a white metal roof assembly.
4) Write a final deliverable report on results.

A literature review will be completed that will seek the most current available publications on deeply buried ducts. After the literature review is completed, gathered information will be used to establish simulation testing scenarios considered to have higher potential for deeply buried duct exterior condensation in north and south Florida (climate zones 1A and 2A). We will perform simple 1-D heat transfer calculations to determine the minimum insulation levels to avoid possible condensation using available measured attic conditions as boundary conditions as the first step of simulation work. The following step will evaluate exterior duct surface condensation potential for at least four different residential roof assemblies for one home located in south Florida and the same four roof assemblies for one home in north Florida.

A laboratory field study will use an existing lab facility at the Florida Solar Energy Center. The lab has a reflective metal roof over a vented attic. This lab will be configured to limit attic sensible and radiant temperature as a means of increasing duct condensation potential. A cold air supply duct with R13 insulation jacket will be deeply buried under blown insulation that meets the requirements of the 2018 IRC. The lab will be instrumented with temperature, relative humidity, and duct surface moisture sensors to be used in analysis.

Deliverable:

A final report will be prepared that explains the purpose, methods, and results of the research. The final report will provide a summary on the potential for condensation on deeply buried R13 insulated cold air supply ducts. Recommendations for Florida code changes will be provided if the authors feel it is warranted.

Budget:

Budget total is $82,000 and covers all costs for labor, materials, and overhead. Work is proposed to begin fall 2017 and conclude at the end of May 2018.

References

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