Building America Case Study

Sealed Crawl Spaces with Integrated Whole-House Ventilation in a Cold Climate

Ithaca, New York

PROJECT INFORMATION

Project Name: Holly Creek Townhouses

Location: Ithaca, NY

Partners:

Ithaca Neighborhood Housing Services, *ithacanhs.org*

Consortium for Advanced Residential Buildings, *carb-swa.com*

Building Component: Ventilation, sealed crawl space

Application: New and/or retrofit; single- and multifamily

Year Tested: 2014–2015

Climate Zones: Cold (5–6)

PERFORMANCE DATA

Sealed crawl spaces can:

- Reduce moisture concerns in summer.
- Lower the risk of frozen pipes during winter.
- Increase comfort in the space above.
- Cut space-conditioning energy use by 15%–18% compared to a vented crawl space.

Building America SM U.S. Department of Energy

One method of code compliance for crawl spaces is to seal and insulate the crawl space rather than vent to the outdoors. However, codes require mechanical ventilation (International Residential Code [IRC] Section R408.3), either via conditioned supply air from the space-conditioning system or a continuous exhaust ventilation strategy. Ithaca Neighborhood Housing Services is a builder partner of the U.S. Department of Energy Building America team, Consortium for Advanced Residential Buildings (CARB). This partner intended to use the unvented crawl space in a recent development. In support of this project, CARB investigated a hybrid ventilation method that included the exhaust air from the crawl space as part of an ASHRAE 62.2-compliant whole-house ventilation strategy.

The CARB team evaluated this hybrid ventilation method through long-term field monitoring of temperature, humidity, and pressure conditions within the crawl spaces of two homes (one occupied and one unoccupied) in New York state. CARB also worked with the National Renewable Energy Laboratory to perform multipoint tracer gas testing on six separate ventilation strategies, varying parts of ASHRAE 62.2-required flow supplied by the crawl space fan and an upstairs bathroom exhaust fan. The tracer gas testing was conducted to identify effective reciprocal age of air (RAoA), which is equivalent to the air change rate in well-mixed zones for each strategy. This testing also characterized localized infiltration rates in several areas of the home.

The team examined the data to determine the frequency of relative humidity (RH) that exceeded 60% and to detect condensation under varying conditions. Pressure between the crawl space and the living space was also monitored to determine if the crawl space pressure remained negative with respect to the living space.

In the unoccupied home without air conditioning, the condensation potential totaled 494 hours over the monitoring period (estimated to be equivalent to full-year results); see the following graph. These instances of condensation potential were typically for short durations (a couple of hours), but nine instances of condensation potential lasted a half day to a full day and five instances of

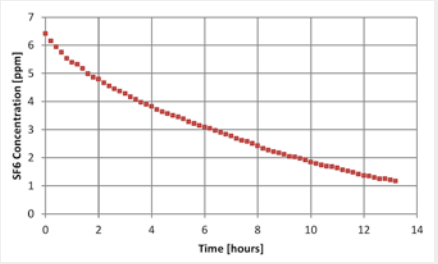
CRAWL SPACE CONFIGURATION

Air was exhausted from the crawl space with a Fantech FR 100 in-line fan. Flow was restricted with a Tamarack Airetrack 62.2 bathroom fan control.

The crawl space walls and ceiling were insulated with 3 in. of closed-cell spray foam. The crawl space floor included a polyethylene vapor barrier to keep moisture from entering from the floor.

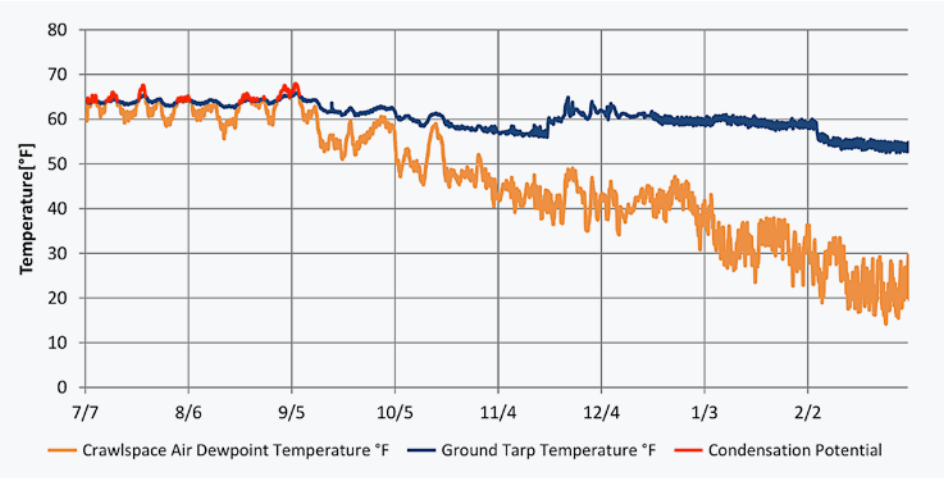
SHORT-TERM FIELD MONITORING

Several ventilation strategies were examined with tracer-gas testing. The tracer gas, sulfur hexafluoride, was released into the home and its concentration was monitored over time. The concentration versus time plot (graph below) was fit to an exponential decay function to determine RAoA coefficients for each test case.



For more information see the Building America report *Sealed Crawl Spaces with Integrated Whole-House Ventilation in a Cold Climate* at *buildingamerica.gov*.

Image credit: All images were created by the CARB team.



Crawl space condensation potential plot of a home without air conditioning

condensation potential lasted longer (the longest period lasted 3-½ days). The occupied home used window air conditioners, which significantly decreased the instances of condensation potential; this crawl space showed only 49 hours of condensation potential during the monitoring period.

Lessons Learned

This research resulted in several key findings:

- Long-term monitoring showed that moisture conditions exceeded 60% RH from April through November. During the summer months condensate occasionally had the potential to collect on the ground vapor barrier.
- The crawl space can become positively pressurized with respect to the house when bathroom boosts, kitchen hoods, or dryer vents are used. No rat slabs were installed in these homes and the vapor barriers were not continuous (resulting in leakage around structural support penetrations, sheet seams, and wear and tear from drainage stones underneath); therefore, radon could potentially be pulled into the living space during these worst-case depressurization cases.
- The team estimated that 30%–50% of crawl space fan exhaust air in these "sealed crawl spaces" was entering the crawl space from outdoors.

These initial findings suggest that Section R408.2 of the IRC may warrant a revision, such as the following guidance: *An unvented crawl space meeting code compliance through the use of an exhaust fan in the crawl space and passive vent from the living space should either use air conditioning in the living space or insulate the crawl space floor (along with the continuous vapor barrier). These measures will minimize the potential for summertime condensation in the sealed crawl space.* These conclusions are formed based on results from two homes in the cold climate region. Further investigation and a larger sample set are needed to verify these findings in a statistically significant manner.

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