



## BUILDING AMERICA TOP INNOVATIONS HALL OF FAME PROFILE

### INNOVATIONS CATEGORY:

1. Advanced Technologies and Practices
- 1.1 Building Science Solutions

## Unvented, Conditioned Crawlspaces

Building America researchers have found that in humid parts of the United States, closed, conditioned crawlspaces perform better than vented crawlspaces, reducing moisture problems and increasing energy efficiency.

Building America research on unvented crawlspaces has demonstrated 15% to 18% less energy consumption for heating and cooling while reducing humidity over 20%. These results have substantially influenced changes in the 2009 and 2012 versions of the International Residential Code (R408.3) allowing unvented, conditioned crawlspaces. Thousands of homes have now been constructed with this important innovation.



### BUILDING AMERICA TOP INNOVATIONS

**Recognizing Top Innovations in Building Science** – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

***Building America research has shown that in most climates unvented, conditioned crawlspaces save energy while improving comfort, health, and durability compared to traditional vented crawlspaces. This research has encouraged adoption of this innovation by builders and code officials.***

Traditional vented crawlspaces have shown significant evidence of structural, mold, and pest problems. Crawlspace vents are supposed to prevent moisture problems, based on the assumption that fresh air entering through vents on one side of the house would push out moist air on the other side. However, in humid climates, the air from outside is often more moist than the air in the crawlspace. When a crawlspace has high moisture levels, a home is likely to have high mold counts inside the living space (Malkin-Weber et al. 2008). Mold contributes to respiratory problems, such as asthma. Moist crawlspaces can also cause damage to a home's structural integrity since moist wood is more likely to develop dry rot and attract termites and carpenter ants. If a home's ducts are in a vented crawlspace, energy bills are likely to be higher. Leaks in a duct system allow unconditioned air to be drawn into the air conditioning system, increasing cooling costs by 20% to 30% (Yost 2003). Leaky crawlspace ducts also contribute to indoor humidity levels, leading to builder callbacks in new homes.

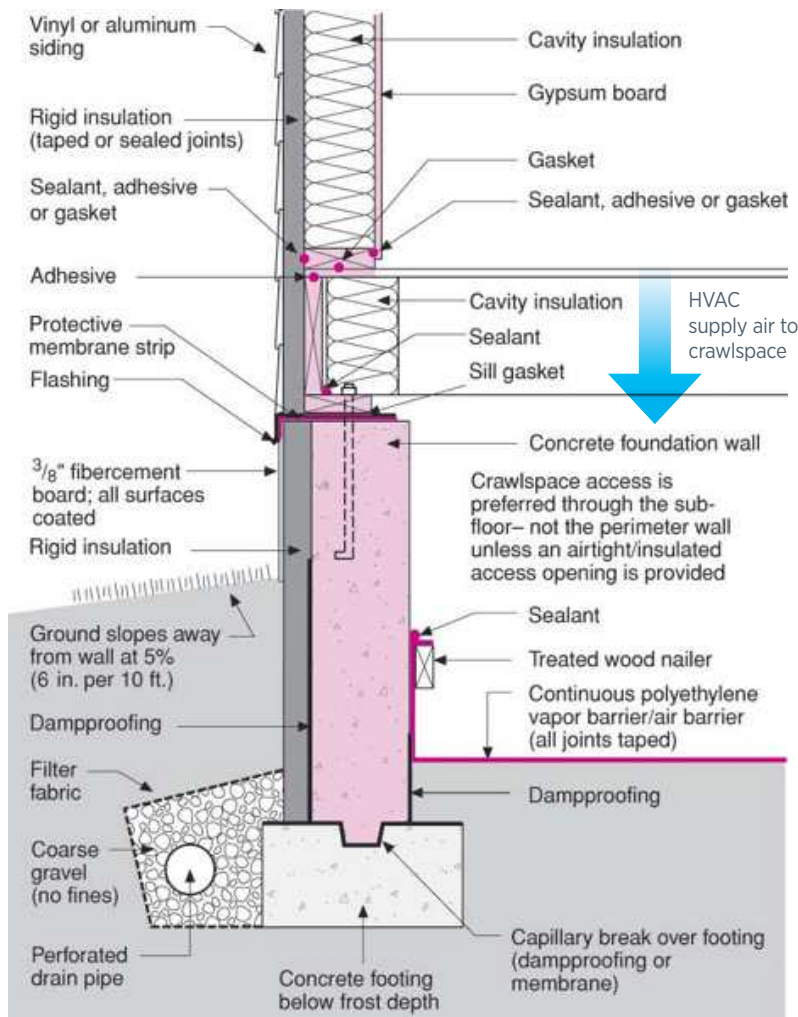
Building America researchers looked for solutions by conducting tests on vented and closed crawlspaces in the South, Midwest, Pacific Northwest, and New Mexico. In North Carolina, 12 new homes with identical floor plans were monitored for three years. Four had vented crawlspaces. Eight homes had closed crawlspaces with conditioned air supplied by the homes' HVAC systems. All had vapor retarders on the ground. Researchers measured temperature and humidity in the crawlspaces, moisture in the wood framing, and energy used to heat and cool the homes. The results were unequivocal. According to the report, "the closed crawlspaces provided far better performance under the harshest conditions [of outdoor temperature and humidity] than the vented crawlspaces did under even the mildest conditions" (Dastur and Davis 2005). In the closed crawlspaces, moisture levels in the wood were low enough in summer to discourage mold and termites and consistent enough throughout the year to discourage shrinking and swelling. In contrast, the relative humidity in the vented crawlspaces swung widely during the year and stayed above 70% during the warm months, making the wood

vulnerable to mold and termites. Additionally, homes with closed crawlspaces used 15% to 18% less energy for heating and cooling (Dastur and Davis 2005).

Building America researchers found similar reductions in crawlspace humidity for homes with closed crawlspaces in Baton Rouge (Dastur et al. 2009) and Ohio (Lstiburek 2004).

In the dry climates of the Western United States and the marine climate of the Pacific Northwest, however, researchers found that both vented and closed crawlspaces performed adequately in terms of humidity and energy use, as long as ducts were not in the crawlspace (BIRA 2007).

Building America research has found that closed, conditioned crawlspaces perform better than vented crawlspaces in most parts of the United States. When constructed according to Building America recommendations (Lstiburek 2004), conditioned crawlspaces can save energy, reduce the likelihood of moisture problems, freezing pipes, comfort complaints, and pest intrusion.



REFERENCES

**BIRA.** 2007. *Final Report: Results of Research on Systems For Prototype Homes.* Prepared by the Building Industry Research Alliance for the U.S. Department of Energy Building America. [www.consol.ws/services/consulting/files/reports/Final\\_Report\\_15C1\\_ResultsOfResearchSystemsForPrototypeHomes.pdf](http://www.consol.ws/services/consulting/files/reports/Final_Report_15C1_ResultsOfResearchSystemsForPrototypeHomes.pdf)

**Dastur, C. and B. Davis.** 2005. "Closed Crawlspaces Do Double Duty," *Home Energy.* [www.advancedenergy.org/buildings/knowledge\\_library/crawl\\_spaces/pdfs/Home%20Energy%20January%202005\\_low%20res2.pdf](http://www.advancedenergy.org/buildings/knowledge_library/crawl_spaces/pdfs/Home%20Energy%20January%202005_low%20res2.pdf)

**Dastur, C., M. Mauceri, and B. Hannas.** 2009. *Closed Crawl Space Performance: Proof of Concept in the Production Builder Marketplace,* Advanced Energy. [www.advancedenergy.org/buildings/knowledge\\_library/crawl\\_spaces/pdfs/NCEMBT%20Report.pdf](http://www.advancedenergy.org/buildings/knowledge_library/crawl_spaces/pdfs/NCEMBT%20Report.pdf)

**Lstiburek, J.** 2004. *Conditioned Crawl Space Construction, Performance and Codes.* RR-0401, Building Science Corporation. [www.buildingscience.com/documents/reports/rr-0401-conditioned-crawlspace-construction-performance-and-codes](http://www.buildingscience.com/documents/reports/rr-0401-conditioned-crawlspace-construction-performance-and-codes)

**Malkin-Weber, M., J. Coulter, T. Dixon, C. Dastur, and B. Davis.** 2008. *Vented Crawlspaces as Mold Amplification and Delivery Systems? Measured Performance and a Dry Alternative,* American Society of Heating, Refrigerating and Air-Conditioning Engineers. [www.advancedenergy.org/buildings/knowledge\\_library/crawl\\_spaces/pdfs/ASHRAE%20IAQ%20Paper%20Revised%202008-07-15.pdf](http://www.advancedenergy.org/buildings/knowledge_library/crawl_spaces/pdfs/ASHRAE%20IAQ%20Paper%20Revised%202008-07-15.pdf)

**Yost, N.** 2003. "The Case for Conditioned, Unvented Crawl Spaces," *Building Safety Journal.* [www.dcat.net/resources/bsj\\_may03feature.pdf](http://www.dcat.net/resources/bsj_may03feature.pdf)

(Left) Insulating along the exterior wall is one option for an unvented crawlspace.