



Building America Case Study

Technology Solutions for New and Existing Homes

Impact of Slab-Foundation Heat Transfer on Space-Conditioning Energy Use in Florida

Cocoa, Florida

PROJECT INFORMATION

Project Name: Flexible Residential Test Facility

Location: Cocoa, FL

Partners:

Florida Energy Systems Consortium
floridaenergy.ufl.edu

Building America Partnership for Improved Residential Construction
www.ba-pirc.org

Building Component: Foundations and floor coverings

Application: Single-family

Year Tested: 2014–2015

Applicable Climate Zone(s): Hot-humid

PERFORMANCE DATA

Space-conditioning savings for the carpeted slab floor:

- 3%–5% heating savings on days cooler than 55°F
- 1%–2% cooling savings on hottest days

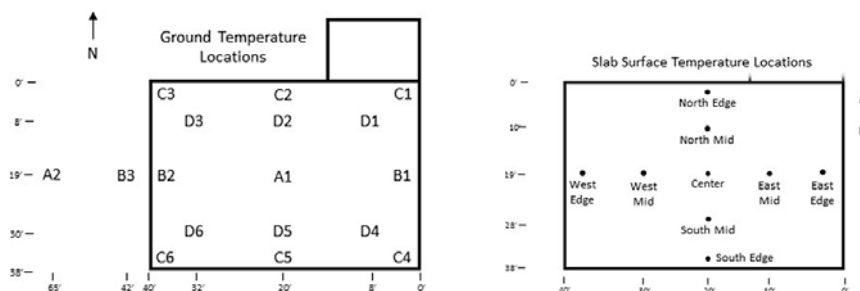
Uncovered slab floor: Lower interior temperatures under spring/fall floating conditions (no heating or cooling)

Research on heat transfer from slab-on-grade foundations in cooling-dominated climates has been limited over the last three decades of energy-efficiency research. However, slab-on-grade construction is very popular in cooling-dominated southern states where it accounts for 77% of new home floors according to 2014 U.S. Census data.

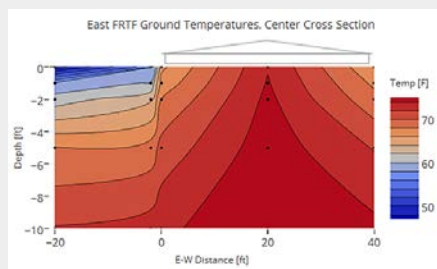
This lack of research is surprising because the area of floors in single-story homes is generally equal to exterior walls/windows or attic/ceilings, which have been evaluated extensively. Existing research has focused on heat losses from slab-on-grade foundations and insulation schemes in heating-dominated climates, although these climates most often feature basements or crawlspace foundations and very different ground thermal conditions.

The widespread conception is that tile flooring—as opposed to carpet—makes for a cooler home interior in warm climates. Empirical research is needed, however, because building-energy simulations such as DOE-2 and EnergyPlus often rely on simplified foundation models.

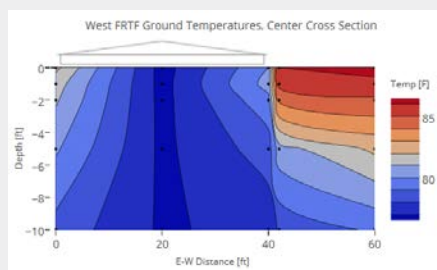
The U.S. Department of Energy's Building America Partnership for Improved Residential Construction performed experiments throughout an entire year from 2014–2015 in the Florida Solar Energy Center's Flexible Residential Test Facility to assess 1) the slab-on-grade influence in a cooling-dominated climate, and 2) how carpet vs. no carpet might influence heating and cooling in a building. Two nominally identical side-by-side residential buildings were evaluated—the East building with pad and carpet and the West with a bare slab floor. A detailed



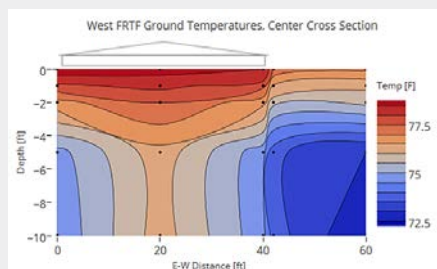
Ground Thermal-Performance Contours



The carpeted slab floor appears to be a small advantage for space heating in Central Florida.



During the cooling season, during both modest and more intensive cooling periods, the slab floor had only a small influence on cooling given that the ground temperature was very similar to the desired cooling temperature.

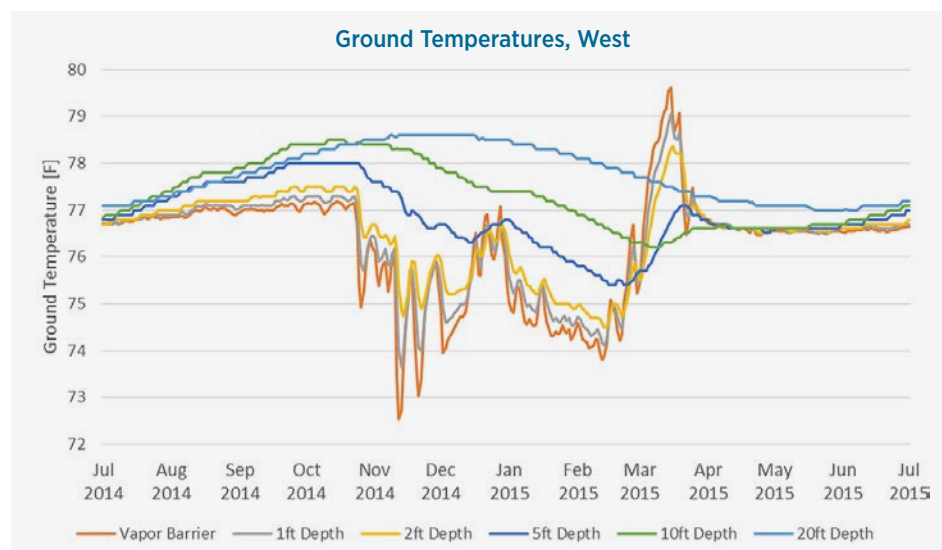


During the spring “shoulder” season with little low-cooling needs, the uncarpeted West building floated at a temperature lower than that of the carpeted building and showed modest cooling benefit.

For more information see the Building America report *Evaluation of the Impact of Slab Foundation Heat Transfer on Heating and Cooling in Florida* at buildingamerica.gov.

Image credit: All images were created by the BA-PIRC team.

grid of temperature measurements was taken on the slab surface at various locations, and at depths of 1, 2.5, 5, 10, and 20 feet. Although not measured directly, surrogate heat-flux estimates were made.



Daily temperature profiles for the center slab for July 9, 2014, to July 9, 2015, for the concrete-floored West building.

Lessons Learned

- The average monthly ground temperature in Central Florida at a 20-foot depth only varies by a few degrees during the year—from 77°F–78°F—and is out of phase with the outdoor air temperature; the minimum is in spring and the maximum is in late autumn.
- Based on temperature measurements, there are pronounced heat flows to and from the slab floor; the below-grade thermal contours vary with depth. Heat flows were greatest near the slab edge. The West building with the uncovered floor showed slightly greater variation in temperature during the year.
- Slab floors in Central Florida’s climate showed a limited influence on space cooling. Uncarpeted floors showed modest benefits that offset cooling needs in early springtime. Carpeted floors showed larger advantages compared to uncarpeted slab floors for space heating.
- No statistically significant differences were observed between the carpeted and uncarpeted buildings in terms of interior relative humidity or dew points during heating or cooling seasons.
- The experimental data contradicted the simplified Building Energy Optimization (BEopt) foundation model in EnergyPlus, which suggested cooling advantages for uncovered slab floors. Improved foundation simulation models for slab floors—such as SLAB and TRNSYS—need to be re-evaluated in light of empirical results.
- An important caution is that these results are highly sensitive to the climate where the data were taken, to different interior temperature conditions, and to soil conductivity and other soil conditions.