

Hotbox Test R-value Database

Straw Bale Wall Technology

Description Of Wall

Straw bale construction is an old building method that has undergone a revival in recent years, especially in the American Southwest. Straw bales were first used in construction in Nebraska in the late 1800s. Some of these early structures, built because of lumber scarcity in the region, are still in good condition. [Examples](#) of straw bale buildings can be found in most states and in Australia, Canada, Chile, England, Finland, France, Ireland, Mexico, Mongolia, New Zealand, Norway, Russia, and Wales



Oak Ridge National Laboratory (ORNL) has conducted two hotbox tests of two different straw-bale wall assemblies.

In 1996, the Oak Ridge National Laboratory (ORNL) constructed a bale wall that was stuccoed on the cold side and covered with gypsum drywall on the warm side. This test found the R-value to be only R-17 (RSI-3.0). On a per-thickness basis, this is just R-0.94 per inch (0.15 W/m°C). The explanation for this very low R-value, suggested to researchers, that an air gap resulted from the way the drywall was attached to the bale wall; this could have created convection currents in the wall, depressing the R-value.

The new test was designed to overcome problems that distorted straw bale's thermal performance in 1996 test. Several nationally known straw-bale home builders oversaw construction of the walls and the testing. It was decided that an 2.44 m X 2.44 m (8'X8') load-bearing wall would be built of straw-bales with stucco on one side of the wall and dry wall on the other. The bales were individually identified and the density of each was recorded. Because straw-bales are not uniformly shaped or sized, it was necessary to determine dimensional and structural similarity. An effective bale length of 0.945 m (3.1') was established by determining the mean of ten bales. The twenty-one similar straw bales were chosen and half bales were created from three to facilitate the construction. Bales were 19" (480 mm) wide and stacked flat. After being plastered on both sides, the wall was allowed to dry for almost two months (to 13% moisture content). After a two-month drying-out period, the wall was put in the test chamber.



The interior temperature was raised to 70°F, while the exterior temperature remained at 0°F for two weeks, in order to reach steady-state heat flow conditions. After this two-week period, the 19-inch wall had an R-value of 27.5, or 1.45 per inch.



Several special tools were made to construct the wall. A bale needle made of 6.35 x 10 -3 m (1/4") metal rod pounded flat and then grounded to a point at one end and then drilled with two holes for eyes was made.

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Summary Of Hot Box Test Data And Calculations

Tests performed 1996	
M-AIR	99.9
M-BAF	99.6
C-AIR	20.4
C-BAF	20.7

MTEMP	98.5
CTEMP	21.5
STWMCRH	60.6
STWMIDRH	86.3
STWCCRH	93.2
M-AIR-VC air velocity, meter side (MPH)	0.62
C-AIR-VC air velocity, climate side (MPH)	4.07
TMP-DC (Btu/Hr) Total measured energy into metering box (Btu/hr)	182.72
Qmb energy exchange through meter box walls (Btu/hr)	-0.005
Qwall calculated energy flow through specimen wall (Qwall - Qsurr)	182.73
Air-To-Air Ru wall overall R-value of sample wall (air-to-air), Rms air + Rwall + Rcs air (hr*ft2*°F/Btu)	27.83
Face-To-Face Rwall surface to surface R-value of wall (hr*ft2*°F/Btu)	26.97
Rms air	0.486

meter side air film resistance (hr*ft ² *°F/Btu)	
Rcs air climate side air film resistance (hr*ft ² *°F/Btu)	0.382