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BUILDINGS RESEARCH

Building a Better Trombe Wall

NREL researchers improve passive solar technology

Since ancient times people have used thick walls of adobe or stone to trap the sun's heat during the day and release it slowly and evenly at night. Today's passive solar buildings often improve on this ancient technique by incorporating a thermal storage and delivery system called a Trombe wall. Named after French inventor Felix Trombe in the late 1950s, the Trombe wall continues to serve as an effective feature of passive solar design.

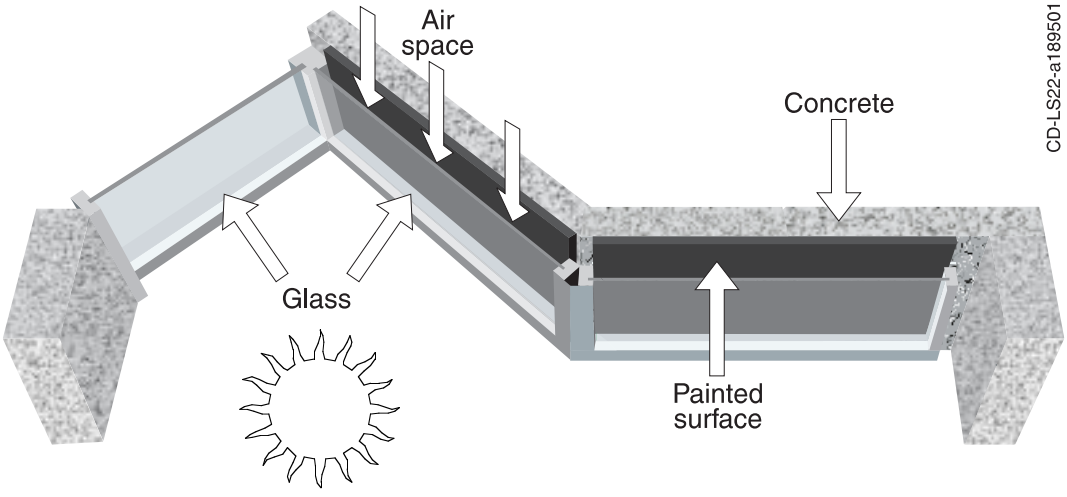
Trombe Wall Construction

A typical Trombe wall consists of an 8- to 16-inch thick masonry wall coated with a dark, heat-absorbing material and faced with a single or double layer of glass. The glass is placed from about 3/4" to 6" away from the masonry wall to create a small airspace. Heat from sunlight passing through the glass is absorbed by the dark surface, stored in the wall, and conducted slowly inward through the masonry.

Applying a selective surface to a Trombe wall improves its performance by reducing the amount of infrared energy radiated back through the glass. The selective surface consists of a sheet of metal foil glued to the outside surface of the wall. It absorbs almost all the radiation in the visible portion of the solar spectrum and emits very little in the infrared range. High absorbance turns the light into heat at the wall's surface, and low emittance prevents the heat from radiating back towards the glass.

For a 16-inch thick Trombe wall, heat will take about 8 to 10 hours to reach the interior of the building. This means that rooms remain comfortable through the day and receive slow, even heating for many hours after the sun sets, greatly reducing the need for conventional heating and cooling. Rooms heated by a Trombe wall often feel more comfortable than those heated by forced-air furnaces because of the radiantly warm surface of the wall, even at lower air temperatures.

Architects can use Trombe walls in conjunction with windows, eaves and other building design elements to evenly balance solar heat delivery. Strategically placed windows allow the sun's heat and light to



NREL's Visitors Center Trombe wall

enter a building early in the morning while avoiding glare and excess heat gain in mid-afternoon. At the same time, the Trombe wall absorbs and stores heat for evening use.

Trombe Walls at NREL

Several NREL buildings use Trombe walls to reduce heating and cooling loads. These walls were designed by researchers from NREL's Center for Buildings and Thermal Systems using computer software such as SERI-RES or BuilderGuide, which is commercially available through the Passive Solar Industries Council.

At NREL's Solar Energy Research Facility (SERF), a Trombe wall warms the shipping and receiving area where conventional heating methods would have been quite expensive. The 20- by 35-foot wall uses concrete to store and distribute heat for comfortable working conditions during winter. During the summer, when the sun is higher in the sky, almost all sunlight reflects off the glazing to keep the building's interior relatively cool. The SERF's Trombe wall is one of many passive solar features that reduce building energy use by 30% when compared with conventional construction.

NREL's Visitors Center sports a new kind of Trombe wall conceived by NREL's Center for Buildings and Thermal Systems staff. The wall has a zigzag design to reduce glare and excessive heat gains during the day. This undulating Trombe wall has three sections. One of the sections faces south and the other two are angled inward in a "V" shape. On one side of the "V" is a southeast-facing window that provides both light and direct heat gain in the morning when quick heating is most needed. On the other side of the "V" is a Trombe wall that stores hot afternoon sun for redistribution in the evening hours. The wall also uses exterior overhangs to shade it from the hot sun during summer.

Trombe Walls for Homes

NREL researchers are now monitoring the performance of a sleek new Trombe wall they designed for an extremely energy-efficient home in Grand Canyon National Park. When viewed from inside the home, the Trombe wall appears no different than other walls. But underneath the paint is a foot-thick concrete wall that absorbs and stores the heat in Arizona's abundant sunshine. This Trombe wall is actually an extension of the building's foundation, which rises three feet higher than normal to create thermal mass. The concrete is faced with slightly frosted double glazing. A selective surface of black metal foil reduces heat loss from radiation back through the glass. The inside surface temperature of the wall reaches 100°F by late afternoon. Heat radiates from the wall to the interior for many hours after sunset, with peak indoor temperatures occurring at about 10 p.m.

For more information on passive solar construction and the availability of computer design tools such as NREL's BuilderGuide software, contact the Passive Solar Industries Council at (202) 628-7400.

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