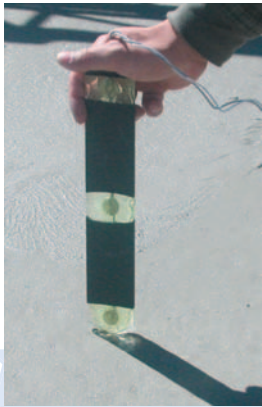


Thermochron and Hygrochron Button Innovations

*Project 0-1700:
Improving Portland
Cement Concrete
Pavement Performance*

Thermochron Buttons

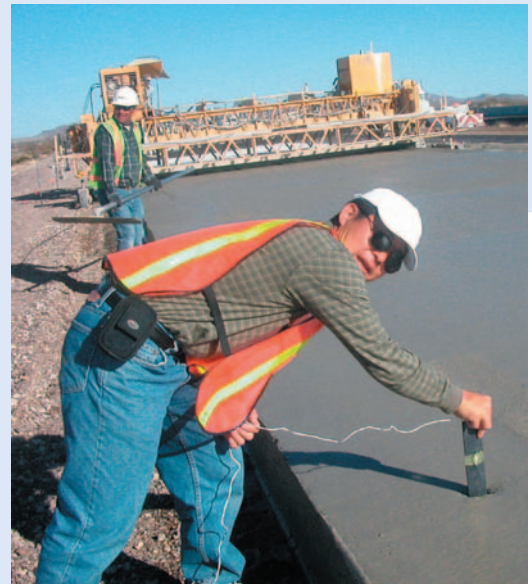


Engineers have known for some time the detrimental effects of high temperatures and excessive moisture loss, but have not been able to monitor them in an acceptable fashion. High-temperature and low-moisture conditions during construction lead to temperature and moisture loss levels in the pavement that produce excessive spalling. Spalling can be so severe that major rehabilitation is required in less than 10 years on pavements designed for 30 years. The Thermochron buttons (temperature) and Hygrochron buttons (moisture) developed in this research provide the engineer a cost-effective way to extensively monitor the pavement during construction, potentially saving millions of dollars over the years as well as keeping the goodwill of the traveling public. The picture below shows installation of the Thermochron buttons in fresh concrete.

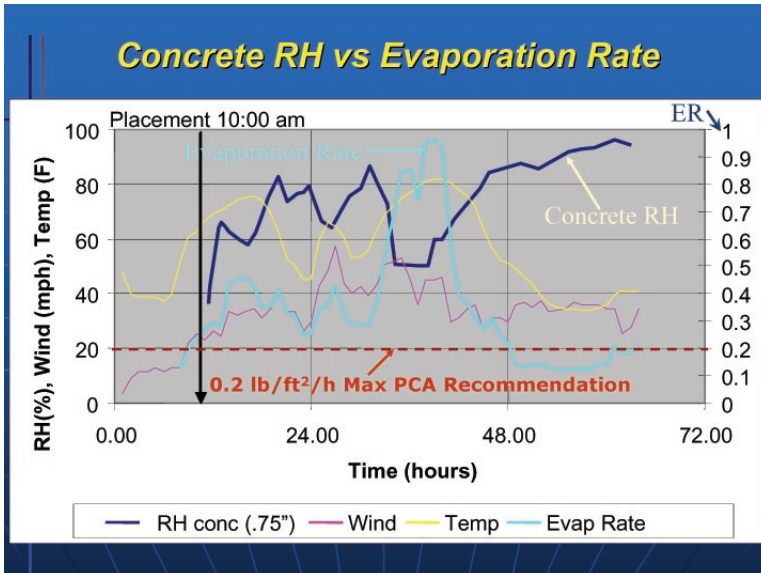
The Thermochron buttons are \$8 each, which allows economical monitoring of temperature in new construction, possibly replacing the conventional maturity meter at lower cost and with higher security (buttons are embedded in pavement and store data internally). In addition, the researchers have used Thermochrons to measure minimum temperatures at various depths over two winters. This data indicates that mid-depth temperatures in thick pavements are not as low as expected, which means steel designs can be optimized by region at considerable savings.

In a similar manner, the Hygrochron buttons store humidity readings which can be used in fresh concrete to indicate how effective the curing is under any condition. The graph on the opposite page shows results from monitoring concrete humidity during construction in Van Horn. Conditions became severe due to high winds and temperatures the second day, resulting in moisture loss at the pavement surface that could not be controlled by the curing compound. If contractors had ready access to information of this sort, additional measures could be taken during high evaporation periods to avoid strength loss or differential shrinkage conditions that lead to spalling.

Installation of Thermochron Buttons in new paving



2003 Benefits



As a rough estimate of possible statewide savings, the Texas Rigid Pavement Database was examined to determine what percentage of concrete roads fail due to poor temperature or moisture control during construction. The analysis determined that roughly 8.7% fail to reach design life due to close cracking (possible temperature problems) and 7.2% due to spalling (possible uncontrolled moisture loss), with some overlap between the two (i.e., some pavements experience both problems). Since 2.5 million cubic yards of paving concrete are used in Texas annually at an estimated cost of \$137 million, the failure rates account

for about \$20 million in replacement cost, allowing for the overlap. If these pavements average a 20 % reduction in design life, then the savings from correcting the problem might be as much as \$4 million / year.

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