COLD CLIMATE HOUSING RESEARCH CENTER
CCHRC

Promoting and advancing the development of healthy, durable and sustainable shelter for Alaskans and other circumpolar people.

Cold Weather Concrete Demonstration

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Project Concept

Pouring concrete in Alaska has always been subject to seasonal difficulties. Although mostly poured during the short summer months, concrete can also be placed during the winter months using insulated, heated enclosures. Both environments allow concrete to cure properly, however both have their drawbacks. Heating exterior enclosures during the winter is costly. A possible solution was demonstrated by the Cold Regions Research and Engineering Lab (CRREL), the Juneau Economic Development Council/ SpringBoard, CCHRC and University Redi-mix at the CCHRC Research and Test Facility. University of Alaska engineering faculty also participated. Successful use of this process would allow Alaskan contractors to extend the construction season without building enclosures and would result in cost savings – up to one-third, according to Dr. Charles Korhonen, retired CRREL scientist.

Standard concrete mixtures do not cure properly in temperatures much below 32 degrees Fahrenheit because the water freezes, significantly weakening the concrete. To demonstrate a new cold weather concrete mixture and the most reliable method of pouring it, the team did two test pours on frozen ground in unheated areas during March of 2007. Each pour had a separate set up and the slabs' curing time was monitored throughout the process. The compressive strength was tested at regular intervals after being placed.

Methodology

The test pour was set up at CCHRC's Research and Testing Facility in two different exterior locations. The ambient temperature at the start of the poor was about 10 to 15 degrees Fahrenheit. Each location was prepared differently. The first site was located at the east office entrance and no insulation was applied under the concrete form.

Related Topics:

SnapShot
- Substantially Superior Cements RS 2008-01

Website
- http://www.cchrc.org/product-testing

The second was located at the west side of the building next to the north lab and employed insulation to break the thermal connection between the concrete and the frozen ground.

Set Up

South Entrance Test Slab
Existing Gravel no Foam Insulation

The south entrance site was prepared by clearing away snow down to existing gravel fill. A form was constructed for pouring a five inch thick concrete slab. Inside the form, 5/8 inch rebar and wire mesh were placed in the standard fashion for reinforcement. The slab was poured directly onto the existing gravel.

North Lab Test Slab
NSF Gravel Fill and Foam Insulation

The ground next to the lab was prepared by thawing and removing the upper one foot of soil. The area was backfilled with five inches of compacted NFS gravel. Next two inches of Extruded Polystyrene foam (XPS) were placed over the gravel. A form was created and two layers of 5/8 inch rebar were laid in a grid pattern. Finally, a ten inch thick slab was poured using the cold weather concrete mixture.

Results

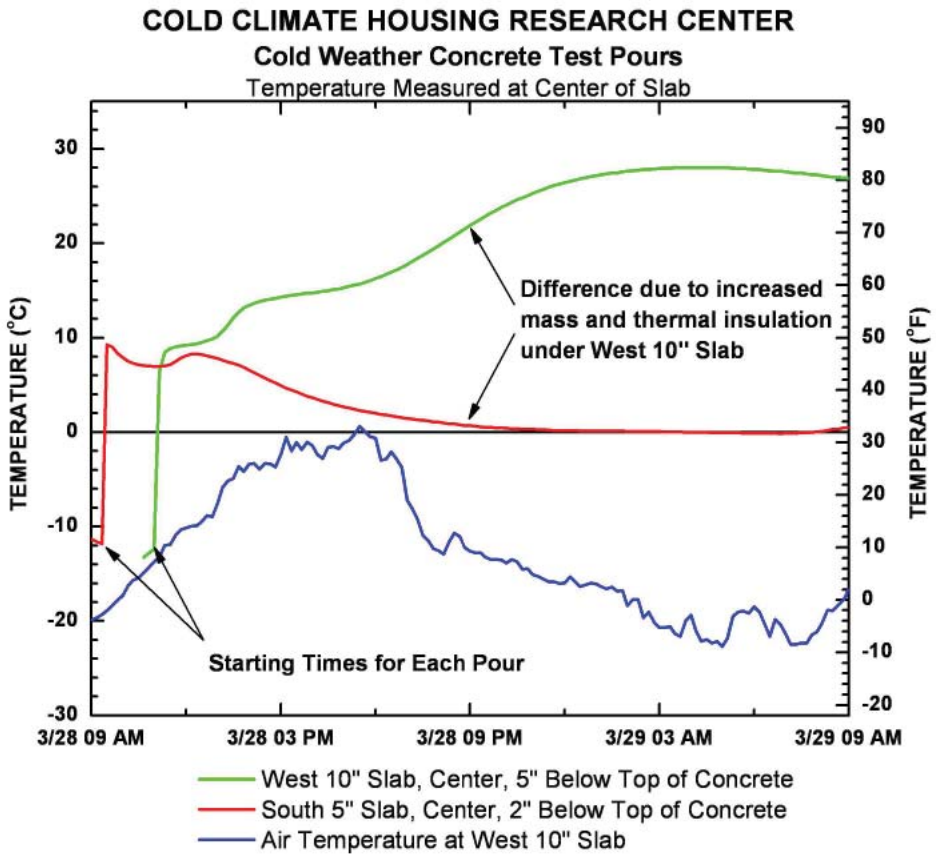
The tested formula perform well in cold weather overall. The team was able to lay two different slabs at ambient temperatures well below freezing (-10 degrees Fahrenheit). The pours were accomplished in the normal manner, though extra care was taken during placement so as not to disturb the sensors placed to measure curing temperature. The 10 inch slab was a little more difficult to finish with a smooth surface as there is so much less water in the mixture than usual. The four inch slab's broom finish was applied without difficulty.

The slab that was poured on top of XPS foam stayed warmer longer due to the thermal break and the greater volume of concrete used.

Tested Formula

- 611 lbs Portland Cement
- 1,814 lb ¾" aggregate
- 1,291 lbs sand
- 12 oz per 100 pounds of cement - Master Builders/ BASF Polyheed 997 water reducer
- 105 oz per 100 pounds of cement - Rheocrete CNI corrosion inhibitor
- 90 oz per 100 pounds of cement - Pozzutec 20 accelerator
- 6 oz air

Strength Tests Over a Seven Day Period		
Time Period	**Interior Strength**	**Exterior Strength**
24 Hours	1500 psi	1000 psi
48 Hours	1900 psi	1500 psi
7 Days	3400 psi	2100 psi



Final Note

The biggest drawback of the tested formula is that it costs approximately $350 per cubic yard in Fairbanks, due to the quantity and price of the admixtures used. University Redi-mix, who batched and delivered the CRREL-specified mix to CCHRC for this demonstration regularly, extends the practical concrete placement season using formulae of their own. One they recommend, at a cost of approximately $170 per cubic yard, is:

- 658 lbs Portland Cement
- 1816 lbs ¾" aggregate
- 1438 lbs sand
- 12 oz per 100 weight Glenium
- 45 oz per 100 weight Pozzutec 20
- 59 oz per 100 weight Rheocrete CNI
- ~ 6 oz air

CCHRC has not yet tested this formula.