Cold Weather Concreting

Society of American Military Engineers (SAME)
Tropics to Tundra: Spanning the Pacific
Anchorage, AK
27 Feb – 2 Mar 2007

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Outline

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- Effects of Cold Weather
- Current Practice
- Technology Description
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**Acknowledgement**

**JEDC** ... to *transfer technology from DoD labs to private companies and from the private sector to the DoD.*

**CRREL** ... to *address cold-weather problems for the benefit of the military and the Nation.*

**Why the Interest?**

Portland cement concrete cannot be placed at below freezing temperatures without thermal protection.

1. On the battlefield, engineers may not have access to insulation or heated enclosures.
2. In commercial construction, cold weather inhibits construction productivity.
Effects of Cold Weather

![Concrete sample](image1.png)

[Graph showing effects of different temperatures on the age and strength of normal concrete.](image2.png)

- **Room Temperature**
- **40°C**
- **5°C**
- **-5°C**

*Note: The graph illustrates the change in compressive strength (in MPa) over time (in days) for normal concrete under different curing temperatures.*
Current Practice

- Keep concrete warm
- Insulate or use heated enclosures
- Thaw materials and substrate
If it’s OK to protect the water in our car’s radiator…

…why not in concrete as well?
ACI – 212.1R (1985 vs. 1991)
Chemical Admixtures for Concrete

1985 - No materials are known which will substantially lower the freezing point of the water in concrete without being harmful to the concrete in other respects.

1991 - No commonly used accelerators will...
How it Works:

- Depress the freezing point
- Accelerate the hydration rate of cement
Technology Benefits

–5°C Capability

• 1/3 less cost
• Extends the season

In-place Cost $/m³

Summer
Antifreeze
Winter

60 Days
120 Days
Year Round
### Juneau, AK  
7 February 2007

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Cement</td>
<td>658 lb/yd³</td>
</tr>
<tr>
<td>Aggregate</td>
<td>1800 lb/yd³</td>
</tr>
<tr>
<td>Sand</td>
<td>1224 lb/yd³</td>
</tr>
<tr>
<td>AEA</td>
<td>2 oz/cwt</td>
</tr>
<tr>
<td>Mira 92</td>
<td>5 oz/cwt</td>
</tr>
<tr>
<td>DCI</td>
<td>2 gal/yd³</td>
</tr>
<tr>
<td>PolarSet</td>
<td>120 oz/cwt</td>
</tr>
<tr>
<td>W/C</td>
<td>0.384</td>
</tr>
</tbody>
</table>

- **Air Content**: 7.5%
- **Slump**: 7.75 in.

**Off-the-shelf products**
Technology Demonstration

- SLUMP 7.75 in.
- AIR 7.5%
Technology Demonstration
# Track Record

**CPAR**

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Project Type</th>
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</thead>
<tbody>
<tr>
<td>Hanover, NH</td>
<td>17-18 Feb ’94</td>
<td>Slab and Wall</td>
</tr>
<tr>
<td>Sault Ste. Marie, MI</td>
<td>15-17 Mar ’94</td>
<td>Pavement</td>
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</tbody>
</table>

**FHWA**

<table>
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<tr>
<th>Location</th>
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<th>Project Type</th>
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</thead>
<tbody>
<tr>
<td>Littleton, NH</td>
<td>10 Dec ’01</td>
<td>Bridge Curbing</td>
</tr>
<tr>
<td>Rhinelander, WI</td>
<td>27 Feb ’02</td>
<td>Pavement</td>
</tr>
<tr>
<td>North Woodstock, NH</td>
<td>12 Dec ’02</td>
<td>Footing</td>
</tr>
<tr>
<td>West Lebanon, NH</td>
<td>18 Dec ’02</td>
<td>Bridge Curbing</td>
</tr>
<tr>
<td>Concord, NH</td>
<td>14 Feb ’03</td>
<td>Sidewalk</td>
</tr>
</tbody>
</table>

**Others**

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Project Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York, NY</td>
<td>18 Feb ’04</td>
<td>Streets &amp; Sidewalks</td>
</tr>
<tr>
<td>Grand Forks AFB, ND</td>
<td>23 Feb ’04</td>
<td>Airfield Pavement</td>
</tr>
</tbody>
</table>
Summary

- Reduces cost
- Reduces fuel
- Reduces time and manpower
- Allows concrete to fully cure while at -5°C
- Extends construction season 3-4 months
- Placement directly on frozen substrates
- Recovery of full strength, even when exposed to lower than design temperatures
- Diminished public impact
- Continuous construction equipment use

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Contacts

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