Fly Ash IN COLD WEATHER CONCRETE

Cold weather can have detrimental effects on concrete construction unless adjustments are made and precautions are taken to ensure acceptable performance; however, placing concrete in cold weather provides an opportunity for better quality, as cooler initial concrete temperatures will typically result in higher ultimate strengths. Fly ash in conjunction with liquid admixtures such as calcium chloride, non-chloride accelerators, and mid-range water reducers will further enhance the strength of concrete in cooler weather.

The ACI defines cold weather as any time three consecutive days exhibit average daily temperature less than 40ºF, or if the temperature is less than 50ºF for more than half of any 24-hour period.

ACI prescribes minimum temperatures for fresh concrete as placed and maintained	
50ºF	Most slabs, pavements, sections less than 12” thick
50ºF	Most beams, columns, walls, sections 12 to 36” thick
45ºF	Large columns, footings, pedestals, mats, sections 36 to 72” thick
45ºF	VSections over 72” thick

Fly ash concrete can be used successfully in cold weather, provided certain mix adjustments are made and precautions are taken to retain acceptable performance characteristics.

Problems

The primary concern of cold weather concreting is the reduced rate of cement hydration. As the temperature drops, the rate of hydration drops, which in turn leads to decreased strength gain and increased setting times. Both conventional and fly ash concrete that performs well at normal temperatures may perform unacceptably in cold conditions because of the decreased rate of hydration.

Solutions

The key to using fly ash in cold weather concrete is adjusting the mix to improve performance and protecting the concrete until it has fully matured. When using the following methods, the typical benefits of using fly ash can be realized in cold weather.

For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Boral Resources Technical Sales Representative or call 1-770-684-0102

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Reduce Water/Cement Ratio. Reducing the water/cement ratio can reduce the effects of decreased hydration. Increased strength and faster setting times are achieved by requiring a lower slump, a higher cement content, or less water. Using fly ash to replace a percentage of the portland cement content reduces water requirements so that the concrete can be placed at a lowered slump.

Improve Performance. The use of fly ash in cold weather concreting has been successfully accomplished by adjusting the mix. Those mixes that perform too slowly can be adjusted further with liquid admixtures.

Methods for improving performance of fly ash concrete in cold weather include:

1. Use air entrained concrete when exposure to moisture and/or freezing and thawing are expected.
2. Require a lowered slump, which is easier to attain when using fly ash, because its spherical shape increases workability. Lower slump also reduces bleed water.
3. Increase portland cement content up to 100 lbs. per cubic yard to help develop early strength.
4. Heat the mix by:
   a. Using hot water in the concrete mix;
   b. Providing a heated enclosure for concrete;
   c. Heating subgrades before placing concrete;
   d. Heating concrete formwork;
5. Replace normal portland cement with rapid setting Type III portland cement; and
6. Add chemical accelerators such as calcium chloride (as approved) at a maximum of 2% by weight of cement, or add proprietary non-chloride accelerators as allowed by specification.

Protect Fresh Concrete. Concrete gains very little strength at low temperatures. Fresh concrete must be protected against the disruptive effects of freezing until the concrete attains a compressive strength of about 500 psi. A minimum of two days of protection should be provided.

Methods used to protect concrete include:

1. Provide insulation blankets and plastic to help the curing process. Leave in place for approximately 7 to 10 days.
2. Provide triple insulation thickness at corners and edges of walls and slabs.
3. Do not expose concrete surfaces to a sudden temperature drop. Gradually reduce insulation or enclosure temperature to control concrete cooling (no more than a 50°F drop in 24 hours).
4. Allow concrete to air dry before exposing it to freezing temperatures.

These methods may be used alone or in combination to reach the setting and strength gain characteristics required. The appropriate decision will afford an economically viable solution with the least impact on the ultimate concrete properties.