Guidelines for Concreting with Rapid Strength Cement Technology

CMAX® Cement is a modified type of Portland cement which is formed by the addition of a proprietary chemistry of Calcium Sulfo-Aluminate Cement. All good concreting procedures for Portland cement apply to CMAX® Cement mixed concrete with few major differences, which are:

- CMAX® Cement mixed concrete develops strength faster than Portland concrete by a factor of 50 to 1.
- CMAX® Cement mixed concrete develops 80% of its 28 days, and 60% of its one-year strengths within 24 hours after final finish.
- CMAX® Cement mixed concrete, contrary to Portland concrete, generates heat during transportation, 10º-15º F.
- CMAX® Cement mixed concrete does not bleed water during the curing phase.
- CMAX® Cement mixed concrete at final set, the compressive strength of concrete is 500- 700 PSI.

This guideline for placing CMAX® Cement mixed concrete at cold temperatures below 45º F is adopted from ACI publication #ACI 306R-88 with modifications to suit CMAX® Cement mixed concrete properties.

When placing CMAX® Cement mixed concrete in temperature below 45º F the minimum concrete temperature varies according to the section dimensions, as in table-1. However, since CMAX® Cement mixed concrete generate heat as it hydrates, the heat generated during mixing and transportation will vary according to the dose of UC Delay™ that is used. Therefore, the temperature of the concrete will rise by 10º-15º F in 60 minutes of mixing, assuming that a typical truck carries no less than 8-9 cubic yards of concrete. This mixing time includes transportation and placing of concrete.

The concrete temperatures at the batch plant will vary according to the ambient, cement, aggregates, and water temperatures. An empirical equation can be used to calculate the temperature of the mixing water at batch plant to meet the required minimum placing temperatures in table-1.

$$T_w = 4.5T_p - 3.5T_s - 45$$

Where: T_s: The weighted average temperature aggregates

and cement.

T_w: Mixing water temperature.

T_p: Required minimum concrete temperature according to table-1

For example, if the average aggregate and cement temperature is 35º F, and minimum required placing concrete temperature is 50º F, the mixing water temperature should be 57º F.

This equation is based on the weight of a cubic yard of concrete, 4000 lb. with 675-700 lb. cement content of CMAX® Cement, and water/cement of 40%. With a 5% tolerance in the weights of the components i.e. cement, aggregates, and water. This formula is valid for average aggregate and cement temperatures, Ts, up to 45º F. any concreting above this temperature should follow normal CMAX® Cement mixed concreting, where chilled water and extra dose of UC Delay™ is needed according to table-2.

Smallest section dimension in. (mm)	Minimum CMAX Cement® concrete temperature as placed F.	Average aggregate and cement temperature T_s F	Mixing-water temperature T_w F
<12 in (300)	50-55	25-30	110-95
		30-35	95-60
		35-40	60-40
		40-45	35-40
12-36 in (300-900)	45-50	25-30	70-60
		30-35	50-60
		35-40	40-50
		40-45	Chilled water<40ºF

Table 1

Table- 1 Minimum recommended CMAX®Cement mixed concrete temperatures for cold concreting <45º F.

The doses of UC Delay™, which are required for 50-60 minutes working time, (transportation and placing) and 80-90 minutes initial set time, are in table-2 at

different ambient temperatures. UC Delay™ must be added to the aggregates with the water before the cement.

Table-2 Recommended UC Delay™ dose at different temperatures, Oz/100 cement wt., for 50-60-minute working time and 80-90-minute initial setting time.

Ambient temperature F	UC Delay™ Oz/100wt of cement	
20-30	2-5	
30-40	6-8	
40-45	8-9	
	With chilled water <40º F	Normal water 60º- 65º F
45-55	8-9	10-13
55-65	9-10	
65-70	10-11	
70-75	11-12	13-17
75-80	12-15	
80-90	>15	

Table 2

Although it is not noticeable in Portland concrete, aggregates affect the setting time of CMAX®Cement concrete. Thus, a trial pour is required with new aggregates to determine the right dose of UC Delay™ for the actual conditions of the job site.

For all concreting with CMAX® Cement mixed concrete, it is recommended to use super plasticizer such as W.R. Grace's, ADVA-100®; or Sika's, Viscocrete 2100®. To minimize slump loss during transportation, 2-5 Oz/100cwt of W.R. Grace's, Recover®, or similar products maybe required. For freeze and thaw, an air-entraining agent may be used as required by specification.

The addition of these additives is usually carried out by the manufacturer's recommendations. However, in practice those are added during or after mixing, depending on the ready-mix facility.

The accompanied mix design has been tested at different ambient temperatures at our lab and the results are in table-3. District 10 of New York DOT, Long Island, supplied the aggregates that have been used in this mix. The slump after 10 minutes of batching was 8-9".

Table-3. Results of an in-house testing for cold weather.

Ambient temperature F	Aggregates temperature F	Mixing water temperature F	UC Delay™ Oz/100 cement wt.	Mix temperature at placing 60 Minute working time F	Initial set minutes	Compressive strength after placement, 1 hr. from water			
						2 hrs.	4 hrs.	1 day	28 days
35	42	40	6	45	100	2400	3600	5100	6200
40	42	40	6	50	75	3400	4100	5400	6700
40	40	60	8	50	90	2300	3600	5000	6100
50-60*	45	45	8-10	62-67	85-90	2700	3200	5200	6700
75-85**	65	60	10-15	70-75	70	2700	3800	5100	6300

Table 3

*Mixes have recently been used in northern California for highway I-80 rehabilitation programs. It was also used for LAX taxiway where flexural strength after 3 hrs. of finishing or 4 hrs. from introducing water were 550 psi.

**Mixes are currently used in Arizona for the rehabilitation program of I-10.