COLD WEATHER CONCRETING RECOMMENDATIONS

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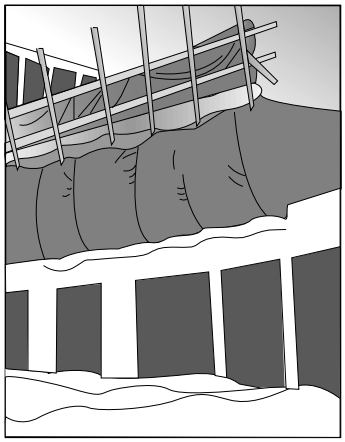
At low temperatures concrete sets slowly, and development of strength is delayed. Therefore, job planning for cold weather concreting should include one or more of the following recognized protective measures:

- **Raising temperatures of water and concrete materials. (See other side)**
- **Heating area in which concrete is placed.**
- **Using additional cement or high-early strength concrete.**
- **Adding Chemstrong® CF or Chemstrong® W, accelerating admixtures for both concrete and/or mortar (ASTM C-494 Type E & Type C).**
- **Use of calcium chloride.**
- **Special provisions for curing.**



Provide a heated enclosure.

Chemstrong® CF and/or **Chemstrong® W** accelerating admixtures are recommended for high-early strength gains, cold-weather concreting and to improve set times for all concrete applications.

COLD WEATHER PRECAUTIONS

1. The concrete should **not** be placed on or near any frozen subgrade. All surrounding surfaces should have approximately the same temperature. If necessary, raise temperatures with steam or protect with insulation.

2. **Chemstrong® CF** and/or **Chemstrong® W,** accelerating admixtures for both concrete and mortar, calcium chloride and or extra cement can be used to achieve high-early strength and to generate additional heat.

3. Place concrete at temperatures recommended by table 3.1.

4. Provide all possible protection to avoid heat loss from concrete walls and slabs. Retain heat, reduce risk of freezing and block out wind with heated enclosures or other coverings.

5. Maintain consistent concrete temperatures with proper insulated or heated enclosures to ensure gradual cooling. The recommended protection periods are shown in Table 5.1, 5.3 and 6.8.

6. The concrete temperature controls strength development. Curing and protection from start to finish should be continuous and uninterrupted to avoid heat and moisture loss until concrete develops its designed strength. **Rapid moisture loss in cold weather will produce low concrete strengths. This condition should be avoided at all times.**

7. For placement of concrete in below freezing temperatures, refer to Great Eastern Technologies' guide on low temperature concreting.

Table 3.1 - Recommended Concrete Temperature

Line	Air Temperature	Section size, minimum dimension, in. (mm)			
		< 12 in. (300 mm)	12-36 in. (300 - 900 mm)	36-72 in. (900 - 1,800 mm)	> 72 in. (1,800 mm)
Minimum concrete temperature as placed and maintained					
1	- - - -	55˚ F (13˚ C)	50˚ F (10˚C)	45˚F (7˚C)	40˚ F (5˚C)
Minimum concrete temperature as mixed for indicated air temperature*					
2	Above 30˚ F (-1˚ C)	60˚F (16˚C)	55˚F (13˚C)	50˚F (10˚C)	45˚F (7˚C)
3	0 to 30˚ F (-18 to -1˚C)	65˚F (18˚C)	60˚F (16˚C)	55˚F (13˚C)	50˚F (10˚C)
4	Below 0˚ F (-18˚C)	70˚F (21˚C)	65˚F (18˚C)	60˚F (16˚C)	55˚F (13˚C)
Maximum allowable gradual temperature drop in first 24 hr after end of protection.					
5	- - - -	50˚F (28˚C)	40˚F (22˚C)	30˚F (17˚C)	20˚F (11˚C)

*For colder weather a greater margin in temperature is provided between concrete as mixed and required minimum temperature of fresh concrete in place.

Table 5.1 - Length of protection period required to prevent damage from early-age freezing of air-entrained concrete

Line	Exposure	Protection period at temperature indicated in Line 1, Table 3.1, - days*	
		Type I or II Cement	Type III cement, accelerating admixture, or 100lb/yd^3 (60 kg/m^3) of additional cement
1	Not exposed	2	1
2	Exposed	3	2

* A day is a 24-hr period.

Table 5.3 - Length of protection period for concrete placed during cold weather

Line	Service Category	Protection period at temperature indicated in Line 1, Table 3.1, - days*	
		Type I or II Cement	Type III cement, or accelerating admixture, or 100lb/yd^3 (60kg/m^3) of additional cement
1	No load, not exposed	2	1
2	No load, exposed	3	2
3	Partial load, exposed	6	4
4	Full load	See Chapter 6	

*A day is a 24-hr period.

Table 6.8 - Duration of recommended protection for percentage of standard-cured 28-day strength*

Percentage of standard-cured 28-day strength	At 50˚F (10˚C) - days			At 70˚F (21˚C) - days		
	Type of cement			Type of cement		
	I	II	III	I	II	III
50	6	9	3	4	6	3
65	11	14	5	8	10	4
85	21	28	16	16	18	12
95	29	35	26	23	24	20

*The data in this table were derived from concretes with strengths from 3000 to 5000 psi (20.7 to 34.4 MPa) after 28 days of curing at 70° ± 3° F (21° ± 1.7° C). The 28-day strength for each type of cement was considered as 100 percent in determining the times to reach various percentages of this strength for curing at 50° F (10° C) and 70° F (21°C). These times are only approximate, and specific values should be obtained for the concrete used on the job.

TEMPERATURE CONTROL OF CONCRETE MIXES

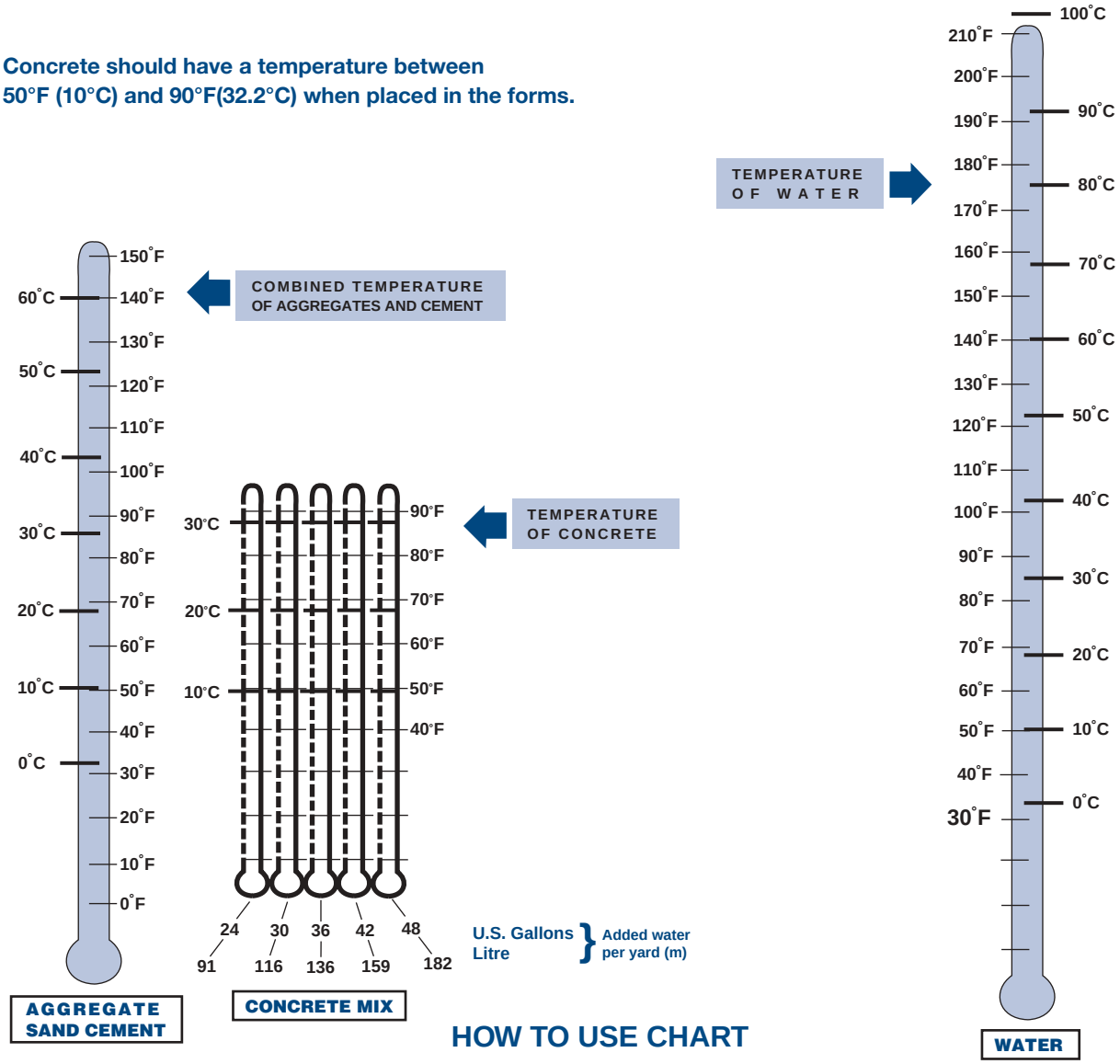
NOTE: Of the ingredients used for making concrete, mixing water is the easiest and most practical to heat. The weight of aggregates and cement in the average mix is much greater than the weight of water. However, water can store five (5) times as much heat as can solid materials of the same weight. The average specific heat [heat units required to change the temperature of one (1) lb (kg) of material one (1) °F (K)] of the solid materials in concrete (cement and aggregates may be assumed as 0.22 Btu/[lb • °F] 920 J/[kg • K]) compared to 1.0 (4,200) for water.

Determine by calculation the combined temperature of coarse aggregate, sand and cement using batch weights, observed temperatures of the mix components and their specific heat. Example:

Material	(A) Weight lb/yd³	(kg/m³)	(B) Specific Heat Btu/[lb • °F]	(J/[kg • K])	(C) Water Equivalent A x B Btu/[°F • yd³]	(MJ/[K • m³])	(D) Material Temperature °F (°C)		(E) Stored Heat C x D Btu/yd³	(MJ/m³)
Cement	470	(280)	0.22	(920)	103.4	(0.26)	150	(66)	15,510	(17.0)
Aggregates	3,300	(1,960)	0.22	(920)	726.0	(1.80)	40	(4)	29,040	(7.2)
					829.4	(2.06)			44,550	(24.2)

The combined temperature of the aggregates and cement will be: $\frac{E}{C} = \frac{44{,}500}{829.4} = 54^{\circ}F$ $\frac{E}{C} = \frac{(24.2)}{(2.06)} =$

Concrete should have a temperature between 50°F (10°C) and 90°F(32.2°C) when placed in the forms.



HOW TO USE CHART

1. Place rule on the center thermometer at the desired temperature of the concrete.

NOTE: *(a) If sand is surface dry, use the solid line on the body of the center thermometers as pivot point. (b) If there is free moisture in the sand, use dotted line.*

2. PIVOT rule at this point and swing the left end of the rule to the calculated, combined temperature of the aggregates and cement.
3. The temperature of the mixing water is read on the right, at the point where the rule crosses the thermometer.