

COLD WEATHER CONCRETE PLACEMENT

Cold weather is defined as for more than 3 consecutive days the average air temp is less than 40° F and does not raise above 50° F in a 12 hr period. The following are highlights of requirements of APWA 03 30 04 - 10 and ACI 306R-88 Standards concerning placement of concrete in cold weather conditions.

Once temperatures go below 50° F:

1. If an admixture is added to the concrete a new mix design must be submitted to the ENGINEER for evaluation. APWA 03 30 04 1.3 D
2. Ground surface and sub-grade, not limited to the standard 4"-6" of road base, must be at least 35°F but not higher than placement temps. Blankets may be placed over work area for a few days prior to placement but in most cases external heat must be applied. ACI 306R-88 Chpt 4
3. Cement content must be increased to a 7.5 bag/yd³ mix. APWA 03 30 04 2.5 E1
4. Non chloride admixtures may be used but placement, curing and protection requirements must be observed. APWA 03 30 10 3.4 A2
5. Temperature of concrete as placed should be as close to the minimum recommended value as possible (55° F) ACI 306R-88 Chpt 3.1
6. Concrete must reach a minimum strength of 500 psi to protect the concrete from **1 freeze cycle**. ACI 306R-88 Chpt 5
7. If subject to more than one cycle of freezing the concrete must reach a minimum of 3,500 psi before being exposed to ambient air temperatures. ACI 306R-88 Chpt 2.6
8. Concrete must be protected at least the number of days required in Table 5.3 of ACI 306R-88 Chpt 5.
9. Minimum exposure temperatures for concrete slabs will be determined from Tables 7.3.1-7.3.4
10. Concrete should not be exposed to temperatures 20°F above the minimum placement temperatures. ACI 306R-88 Chpt 7.4
11. The temperature of the concrete and the ambient air and recorded at least twice in 24 hr period. Temperatures should be taken at more than one location, on edges and corners.
12. Combustion heaters need to be vented to prevent carbonation (carbon dioxide reacting with calcium hydroxide to form calcium carbonate) of concrete which causes a weak and dusty surface. ACI 306R-88 Chpt 7.4
13. If concrete temperature is greater than 60° F and the air temperature is 50° F the concrete needs to be protected from drying by using a curing compound or steam heating ACI 306R-88 Chpt 8.2

The contractor is still responsible for following all requirements in ACI 306R and APWA. If a contractor decides to place concrete in cold weather they must provide documentation that of the ground temperatures (base and sub-base), procedures that will be used to protect the concrete from freezing, recordings of concrete and air temperatures during the placement and curing processes

TABLES FROM ACI 306R

Table 3.1 - Recommended concrete temperatures

Line	Air temperature	Section size, minimum dimension, in. (mm)			
		< 12 in. (300 mm)	12-36 in. (300-900 mm)	36-72 in. (900-1800 mm)	> 72 in. (1800 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(- 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 of Table 3.1, days*	
		Type I or II cement	Type III cement, or accelerating admixture, or 100 lb/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 of Table 3.1, days*	
		Type I or II cement	Type III cement, or accelerating admixture, or 100 lb/yd ³ (60 kg/m ³) of additional cement
1	1 - no load, not exposed	2	1
2	2 - no load, exposed	3	2
3	3 - partial load, exposed	6	4
4	4 - full load	See Chapter 6	

*A day is a 24-hr period.