



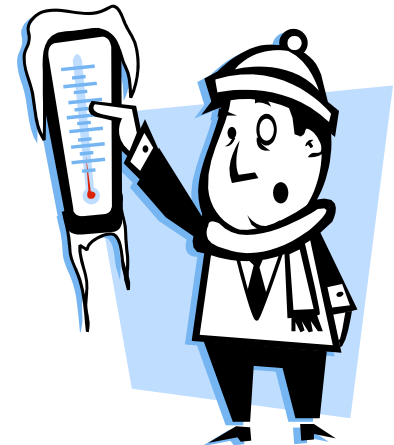
*EFFECTIVELY COMMUNICATING
COLD WEATHER CONCRETING*



DEFINITION OF THE DAY

COLD WEATHER CONCRETING EXISTS

- ✓ *When for more than 3 consecutive days , the Average Daily air temperature has fallen to **40° F**, or is expected to fall below **40°F** during the protection period; and*
- ✓ *The air temperature is not greater than **50° F** for more than One-Half of any 24 hour period.*



REPRESENTING THE READY MIX CONCRETE INDUSTRY
HOW DO WE EFFECTIVELY COMMUNICATE
COLD WEATHER CONCRETING

WHAT ARE OUR OBJECTIVES?

- ✓ **To Deliver** concrete at adequate achievable temperatures;
- ✓ **To Examine** favorable curing conditions onsite with our clients;
- ✓ **To Ensure** efficient strength gain before form removal and loading;
- ✓ **To Avoid** rapid exposure to cold weather preventing thermal gradients from occurring resulting in thermal cracking;
- ✓ **To Ensure Protection** of jobsite test specimens after casting, during initial field storage, and during transport to the lab; and
- ✓ **To Become** experts in Communicating Cold Weather Concreting



Concrete Temperatures as Defined per the Elements dimension, as Mixed and Placed per ACI 306R, Table 3.1.

COLD WEATHER CONCRETING

306R-3

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 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.

CONCRETE PLACEMENT TEMPERATURES

- ✓ Placement Concrete Temps should not exceed the target temperatures in Table 3.1 by **Greater than (>) 20°F**;
- ✓ Cracking, Blistering or Crusting of the surface will occur;
- ✓ Higher Temperatures, greater than (>)20° F result in;
 - Increased Water demand;
 - Increased Slump Loss;
 - Elevated thermal differentials
 - Leading to Increased Thermal Cracking;



CURING AND PROTECTION

- ✓ Freshly mixed concrete **must be protected** against the disruptive **effects of freezing**, until the degree of saturation has been sufficiently reduced by the Hydration Process, Saturation is 91.7%;
- ✓ Concern is observed when concrete becomes frozen within just a **few hours after placement** or before it has obtained **final set and 500 psi**;

CURING AND PROTECTION

- Prevent early age freezing;
- Use mix designs to achieve early age strengths;
- Use insulating materials to trap the heat generated from the heat of hydration;
- Build enclosures and provide heating units;
- Protect the surface immediately after finishing;
- Follow the length of protection per Table 5.1 or 5.3 ACI 306R.



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.



Compressive strength, percent
of 28-day moist-cured concrete

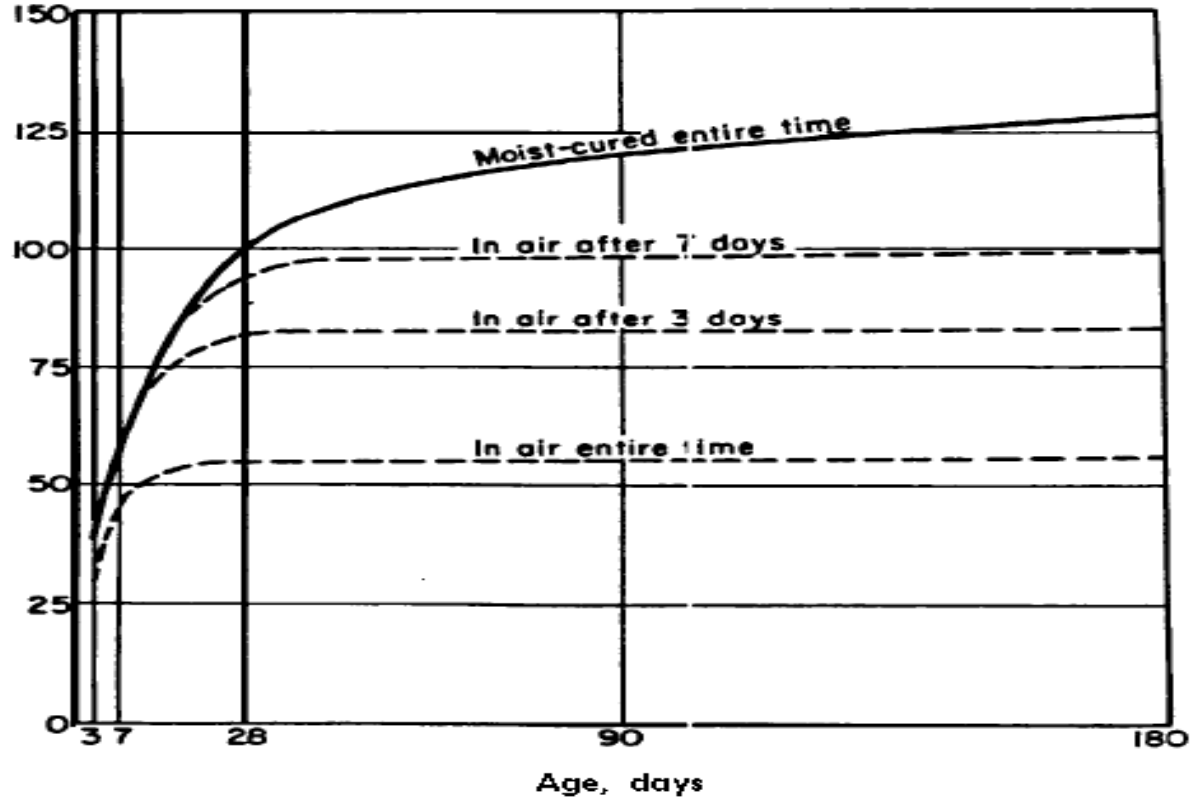
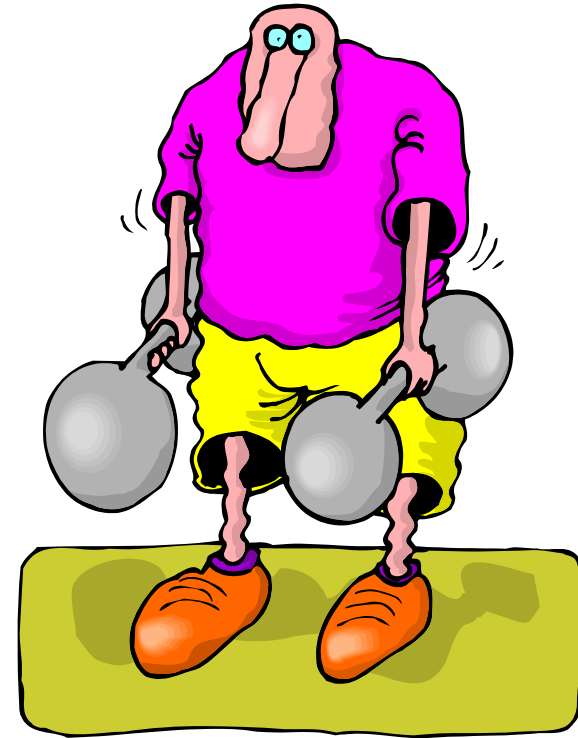


Fig. 6.5 - Compressive strength of concrete dried in laboratory air after preliminary moist curing (Price 1951)



Things to remember in Cold Weather Concreting

Don't Assume

- Use Type III cement
- Lower Fly Ash %
- Use Accelerators
- Lower w/c ratio's

Prior to

F/T cycle in saturated condition
concrete strength should be >
3500 psi

Protect

Fresh concrete from freezing
Until 500 psi

Effectively
Communicate



Production & Materials for Cold Weather Mixtures

Don't Assume

- Anticipate temp loss with deliveries greater than 1 hour;
- Estimate required delivery Temps;
- The concrete should be placed before temps. drop below the required values in Table 3.1.

PreHeat

- Mixer & Truck Drums
- Tarp & Heat Critical paths in the Plant
- Purge water lines before each batch



BE A WINNER EVERYDAY

Produce Effectively

Increase Concrete Temps

- Use Hot Water
- Use Heated Aggregates
- Use Heated Closures
- Use Tarps on Aggregates

Preparation before placement

- ❑ CONTACT SURFACES AT LEAST 35°F;
- ❑ NEVER PLACE ON FROZEN SUBGRADE;
- ❑ REMOVE ALL SNOW AND ICE;
- ❑ ERECT WIND BREAKS / BARRIERS; AND
- ❑ PROVIDE INSULATING BLANKETS



Heated Closures with drapes may need to be incorporated for Elevated Decks to maintain horizontal deck temperatures. Leave forms in place for Vertical placements for thermal protection.

Form Removal

- **Based on in-place strength, not time!**
- **Options include:**
 - Field cured cylinders
 - Cast in-place cylinders
 - Pull-out testing
 - Maturity testing as an indicator
- **Avoid rapid temperature drop**

Protection of Acceptance Samples



- ASTM C31 – STATES STANDARD CURED SPECIMENS ARE ACCEPTANCE SPECIMENS, NOT FIELD CURE SPECIMENS;
- THESE SPECIMENS ARE SUPPOSE TO BE BETTER PROTECTED TO REPRESENT THE MIX DESIGN AS SUBMITTED, NOT HOW IT CURES IN THE FIELD, SO SPECIAL PRECAUTIONS HAVE BEEN DESIGNATED IN ACI 318 AND ASTM C31 TO CONTROL THEIR MATURITY;
- STRENGTHS UPTO 6000 PSI > INITIAL CURE AT 60° TO 80° F IN MOIST ENVIRONMENT IMMEDIATELY;
- STRENGTHS GREATER THAN 6000 PSI > INITIAL CURE AT 68° TO 78°F IN A MOIST ENVIRONMENT IMMEDIATELY;
- 24 HOUR TEMPERATURE RECORDATION IS REQUIRED BY CODE, WHICH MUST BE DOCUMENTED ON THE TEST REPORTS;
- LEAVE PROTECTED UNTIL 8 HOURS AFTER FINAL SET, NOT TO EXCEED 48 HOURS IN THE FIELD;
- TRANSPORT SPECIMENS PROTECTED WITHOUT SHOCK, OR VIBRATION NOT TO EXCEED 4 HOURS .

Thank You

Questions?

