COLD WEATHER CONCRETE

CEMSTONE®
ENGINEERING SERVICES

CEMSTONE ENGINEERING SERVICES

October 1, 2018

To: All Cemstone Customers

RE: Cold Weather Concrete Practices

Due to the inclement weather conditions we have experienced in 2018, we are expecting an increased amount of late season concrete that will be placed this fall. The American Concrete Institute (ACI) 306R-16 “Guide to Cold Weather Concreting” states that cold weather concreting exists when the air temperature has fallen to or is expected to fall below 40°F during the protection period. The protection period is defined as the amount of time recommended to prevent concrete from being adversely affected by exposure to cold weather during construction.

During the fall and winter seasons, it is recommended to have a Cold Weather Concreting Plan for every concrete placement. It is your obligation to understand industry codes/standards and to follow best practices. When properly proportioned, produced, placed and protected, concrete will develop sufficient strength and durability to satisfy the intended service recommendations. The necessary degree of protection increases as the ambient temperature decreases. The objectives of ACI 306R-16 “Guide to Cold Weather Concreting” are:

- Prevent damage to concrete due to freezing at early ages
- Ensure that the concrete develops the recommended strength for safe removal of forms
- Maintain curing conditions that foster normal strength development
- Limit rapid temperature changes
- Provide protections consistent with intended serviceability of the structure

In addition, exterior flatwork must be durable to withstand freeze/thaw surface cycling and subsequent defects. ACI 318-14 Chapter 19 “Design and Durability Requirements” recommends the following for exterior plain concrete exposed to freeze/thaw cycling in the presence of water (F2) and water and deicing chemicals (F3):

- A minimum compressive strength of 4500 psi
- A maximum water/cementitious materials ratio of 0.45
- An air content of 6.0 ± 1.5% for ¾” or 1” aggregate in exposure class F2 and F3 for plain concrete

Some mix designs that meet DOT or municipal specifications do not meet the requirements listed above to mitigate surficial freeze/thaw defects such as scaling. All concrete should be cured to maintain moisture and the appropriate temperature for the first 7 days. After this initial curing period, the concrete needs to air-dry 30 days before being exposed to freeze/thaw cycles and deicing chemicals.

Salt crystallization, from the use of deicing chemicals, can form within the pores of both the cement paste and the aggregates potentially leading to concrete deterioration. In addition, they can also cause chemical changes to the cement paste, which also can lead to deterioration. Concrete is more likely to experience surface defects after the initial winter season when the concrete does not achieve adequate strength and/or is not allowed to properly air-dry. If there is insufficient time for drying, boiled linseed oil can be applied to the surface which will allow air drying while preventing additional water absorption. Cemstone does not recommend the use of acrylic curing compounds and/or sealers within 30 days of freezing temperatures or throughout the winter months. Acrylic membranes do not allow the concrete to properly air-dry prior to freeze/thaw cycles.

During the cold weather concreting season, Cemstone heats mixing water and/or aggregates to keep concrete temperatures at or above 60°F at the time of batching. Cemstone warrants that the concrete will obtain the adequate designed compressive strength when it is strictly tested in accordance with the corresponding ASTM procedure. Job site adjustments may be required for slump and/or air content for project specification range compliance.

Cemstone will not be responsible for concrete failures due to improper cold weather plans, improper placing practices, incorrect mix design selection, inadequate protection, improper curing and/or inadequate maintenance. Please advise your client of their responsibility for maintenance. A copy of ACI codes are available for purchase at www.concrete.org. If you have any questions or concerns about a mix design for your project, coarse aggregate selection or admixture packages, please do not hesitate to call your Account Representative or me.

Sincerely,

Lars Anderson
Cemstone - Engineering Services Manager
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CEMSTONE
ENGINEERING SERVICES

October 2018

ACI 306R - 16
COLD WEATHER CONCRETING

Cold weather exists when the air temperature has fallen to, or is expected to fall below 40 °F (4 °C) during the protection period. The protection period is defined as the time required to prevent concrete from being affected by exposure to cold weather. Concrete placed during cold weather will develop sufficient strength and durability to satisfy the intended service requirements when it is properly proportioned, produced, placed and protected. The necessary degree of protection increases as the ambient temperature decreases.

TOP 10 COLD WEATHER TIPS YOU NEED TO KNOW FOR STRUCTURAL CONCRETE

** ***Please note that ACI 306 addressed structural concrete. ACI 318 address durability such as surface defects which requires 4,500 psi for exterior concrete in a severe climate such as Iowa, Minnesota and Wisconsin.***

1) Concrete can resist the effects of one freezing-and-thawing cycle as long as it is air-entrained, not exposed to an external water source, and has reached a **COMPRESSIVE STRENGTH OF 500 psi**. For well-proportioned concrete mixtures, this is typically within 48 hours of placement when the concrete temperature is maintained at 50 °F.

2) Properly air-entrained exterior structural concrete should not be subjected to freezing and thawing in a saturated condition before developing a **COMPRESSIVE STRENGTH OF 3,500 psi.** If surface defects are a concern, 4,500 psi needs to be achieved.

3) **FROZEN SUBGRADE** can cause the concrete to freeze as well as cause finishing and durability issues. The subgrade should be (a) free of snow and ice and (b) have a temperature no greater than 20 °F cooler than the concrete being placed.

4) **MINIMIZE RAPID TEMPERATURE CHANGES**, particularly before the concrete has developed sufficient strength to withstand thermal stresses, which can cause cracking. Gradually remove insulation and other protection methods so that the surface of the concrete temperature decreases no more than 50 °F for concrete 12" or less in thickness in a 24 hour period.

5) The use of **HIGH EARLY STRENGTH MIX DESIGNS OR ACCELERATING CHEMICAL ADMIXTURES** is recommended during cooler temperatures to increase the speed of hydration and mitigate free water from freezing. Avoid calcium chloride if the concrete contains steel reinforcement. Accelerating admixtures must not be used as a substitute for proper curing and frost protection.

6) **TEST CYLINDERS** must be cured according to ASTM C 31 which specifies an initial temperature curing of 60 to 80 °F (cure boxes, blankets or other curing methods must be used in order to comply with ASTM specifications). ASTM C 31 also requires that cylinders must be initially cured in an environment free of evaporation and stored for not longer than 48 hours prior to being taken to the laboratory for final curing and testing.

7) **DO NOT USE UNVENTED HEATERS: CARBON DIOXIDE** from unvented fossil fuel heaters can cause carbonation of the concrete. Carbonation can result in craze cracking and a soft, chalky surface that will dust under traffic.

8) Allow ample time for **BLEED WATER** to dissipate before concrete finishing. Trapping or finishing bleed water into the concrete can cause higher water/cementitious materials ratios at the surface and may lead to scaling and/or blistering.

9) **PROPER CURING** procedures must be followed immediately after finishing is completed. Please see Cemstone's Concrete Flatwork Guidelines for more information.

10) **MONITOR CONCRETE TEMPERATURES**. Monitor temperatures at concrete corners and edges as they are vulnerable to freezing as temperatures are usually more difficult to maintain in these locations.

EXTREME COLD WEATHER SERVICE POLICY

FOR READY MIXED CONCRETE

2018/2019

CEMSTONE
LOCALLY OWNED SINCE 1927

In an effort to deliver **quality ready mixed concrete** in Iowa, Minnesota, and Wisconsin, along with providing safe working conditions for all of our employees and equipment, Cemstone has an Extreme Cold Weather Delivery Policy for the 2018-2019 winter construction season.

This policy states that, on any given day at any given location when the **ambient temperature** is **-5 °F** or below and/or when the **wind chill** factor is below **-20 °F** or other extreme winter conditions exist, ready mixed concrete deliveries will be delayed and may not be delivered. There are many factors other than daytime temperature that will be considered when making winter time deliveries. These factors include, but are not limited to: the overnight low temperature, road conditions, fog, ice, blowing snow, visibility, distance to the job site and travel advisories. All deliveries are at the discretion of Cemstone management in each region.

There may be a few rare cases when, after all things are considered, concrete will be delivered when conditions are slightly outside this policy. **The contractor will be responsible** for any quality issues that may occur due to the protection of the concrete or driving conditions that may delay delivery during extreme cold weather conditions. During these extreme temperatures, it is recommended to order more than one yard of ready mixed concrete. It is imperative that the trucks are unloaded in a timely manner to ensure the concrete quality.

STANDARD DELIVERY HOURS

– Monday thru Friday from 7:00 AM to 4:00 PM

During extreme cold weather, hours may vary allowing for proper warm up time for our equipment, heating water and aggregates, snow removal and clean up time so as to provide you the quality and service you expect from Cemstone.

STANDARD CUSTOMER SERVICE WINTER HOURS		START DATE	PHONE
Metro (Twin Cities)	6:00 am to 5:00 pm	November 5, 2018	651-688-9520
Jordan, MN	6:30 am to 4:00 pm	November 5, 2018	651-492-3939
Owatonna, MN	6:30 am to 4:00 pm	November 5, 2018	507-446-2410
Southwestern, MN	6:30 am to 4:00 pm	November 5, 2018	507-847-3001
Northern, MN	6:30 am to 3:30 pm	November 5, 2018	320-676-3365 | 800-955-6105
Durand, WI	7:00 am to 3:30 pm	December 3, 2018	715-672-5008
New Richmond, WI	7:00 am to 3:30 pm	December 3, 2018	715-246-4238 | 800-555-9415
Turtle Lake, WI	7:00 am to 3:30 pm	December 3, 2018	715-986-4442 | 866-279-2221
Northwood, Iowa	6:30 am to 4:00 pm	November 5, 2018	641-324-1063 | 800-658-3081
Fort Dodge, Iowa	6:30 am to 4:00 pm	November 5, 2018	515-955-6781

*During extreme cold weather, hours may vary. For morning deliveries you must call the prior day before 3:00 PM, so we can deliver and prepare materials for the service you exp*ect.

Please contact your account representative with any questions.

We appreciate your understanding and cooperation. It is Cemstone's goal to deliver a quality product to our customers without endangering the safety of our employees or yours.

For concrete placing services during extreme cold temperatures, please reference Cemstone's Extreme Cold Weather Service Policy for Concrete Placing Services.

EXTREME COLD WEATHER SERVICE POLICY

FOR CONCRETE PLACING SERVICES

2018/2019

CEMSTONE
CONCRETE PLACING SERVICE

In an effort to provide **quality concrete placing service** (pumping and conveying) in Iowa, Minnesota, and Wisconsin, along with providing safe working conditions for all of our employees and equipment, Cemstone has an Extreme Cold Weather Service Policy for the 2018-2019 winter construction season. This policy states that, on any given day at any given location when the **ambient temperature** is **-5 °F** or below and/or when the **wind chill** factor is below **-20 °F** or other extreme winter conditions exist, ready mixed concrete deliveries will be delayed and may not be delivered or placed.

PUMPING

When the air temperature and/or the wind chill temperature at or below **-10 °F,** the following policies are to be followed:

- If a balance load is needed to complete a pour, the balance load concrete will need to be ordered and loading before we will unload the last truck from the previously ordered total. The callback load status will be confirmed by dispatch before continuing the pour.
- No concrete with a temperature below 50°F will be pumped. The only exception to this will be if there is another truck on site that has concrete above 50 °F waiting to unload immediately following the below 50 °F temperature truck.
- Downtime during the pour will be limited to 30 minutes continuous time. Any downtime taking longer will result in the operator cleaning the boom and depositing the concrete on the ground. The pump will then re-prime and continue the pour. The contractor will be responsible for the disposal of the approximate ½ yard of concrete on the ground.

PUMPING ACCELERATED CONCRETE (all cold weather conditions)

- Maximum amount of accelerator will be 1% calcium chloride per yard, or non-chloride accelerator equivalent.
- Cemstone reserves the right to dump the hopper at the jobsite in extreme situations.
- We do not run “wet” with accelerated concrete (moving from one job to another without washing out the pump).
- Always be ready for pumps and conveyors with adequate room for setup.
- Make sure to order enough concrete to eliminate balance loads.

CONVEYORS

- If the temperature is below **20°F,** the conveyors are a “use at your own risk” item. The exposed hydraulics could freeze making the belt immobile.

STANDARD CUSTOMER SERVICE WINTER HOURS

– Metro (Twin Cities)	6:00 AM to 5:00 PM (starting Nov. 5)	651-686-4274
– Owatonna, MN	6:30 AM to 4:00 PM (starting Nov. 5)	507-446-2410
– Wisconsin	7:00 AM to 3:30 PM (starting Dec. 3)	715-986-4442

Please contact your account representative with any questions.

We appreciate your understanding and cooperation. It is Cemstone’s goal to provide quality services to our customers without endangering the safety of our employees or yours.

Operators will be advised by their supervisors to follow this policy closely when conditions warrant. Any questions regarding this policy should be directed to Placing Management or Account Representative.

For ready mixed concrete deliveries during extreme cold temperatures, please reference Cemstone’s Extreme Cold Weather Delivery Policy for Ready Mixed Concrete.

CEMSTONE
ENGINEERING SERVICES

EXTERIOR CONCRETE MAINTENANCE GUIDE

Exterior concrete flatwork such as driveways, patios, loading docks, building entrances and walkways can greatly enhance the aesthetics and value of your property. Many factors play a role in sustaining the durability of your concrete. Cemstone proportions exterior concrete mix designs according to American Concrete Institute guidelines. Having the correct mix design alone, will not guarantee durability. It is also how the mix is produced, placed, finished, cured and then maintained that determines the quality and longevity of the concrete. Early-age protection of the concrete surface is critical, therefore curing should begin immediately after final finishing. Inadequate curing will result in a significant loss of surface strength and durability.

How to Maintain Your Exterior Concrete

Sealing

Sealing helps maintain the appearance and durability of concrete. Sealers are designed to keep moisture and contaminants like deicing chemicals from being absorbed into the concrete. Since sealers will wear over time and no longer function as intended, concrete should be sealed on a regular basis. Reapply sealer per the manufacturer's recommendations or as needed. You can spot check your concrete to determine when sealers need to be reapplied. When water no longer beads on the surface of the concrete, it is time to reseal.

Preventing Freeze-Thaw Damage

Two key conditions must occur to create deteriorating freeze-thaw damage. The first condition is saturation of the concrete, and the second condition is freeze-thaw cycles. Without the combination of these conditions, damage will not occur.

The use of deicing chemicals often accelerates surface deterioration of concrete. This is especially true with new concretes which have not had ample amount of time for internal moisture to dry out. Deicing chemicals lower the freezing point of water and also allow water to saturate further into the concrete.

- Avoid using deicing chemicals on your concrete, especially for the first winter. Sand or traction grit can be used for traction.
- Promptly remove snow and ice accumulation manually from your concrete.

Other Maintenance Tips

- The best concrete maintenance is the preventative kind. Preventative maintenance involves cleaning with a broom or rinsing to remove dirt and debris when weather permits.
- Fertilizers contain substances which chemically attack concrete. Promptly sweep off any fertilizer that is inadvertently cast on the concrete when spreading lawns.
- Remove stains immediately. While sealer will help to protect concrete from stain absorption, it's still a good idea to remove oil, gasoline or other spills as soon as possible.
- Avoid using harsh acids for cleaning concrete. Use products designed for use on concrete.

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CONCRETE MAINTENANCE GUIDE

Uniform Color

Uniform appearance is created by following a uniform process during the installation. The subgrade should be a uniformly graded base material. All organic matter and clay soils should be removed from the subgrade. Make sure the mix design is the same for every pour and use a consistent water /cement ratio. Request to use the same brand of cement when matching existing concrete. Adding chloride accelerators may cause darkening. Over-finishing a surface or using different finishing techniques can change the appearance. The ambient conditions during placement as well as the curing method can also affect color.

Scaling

Scaling is the localized flaking or peeling of a weakened concrete surface exposed to freezing and thawing. Light scaling does not expose the coarse aggregate. Moderate scaling exposes aggregate (1/8-inch to 3/8 inch deep).

How to Prevent Scaling:

- Concrete needs to have adequate air entrainment.
- Use correct timing for finishing operations: Finishing too early may results in trapping of the bleed water minimized surface air content which decreases the freeze/thaw durability.
- High evaporation rates caused by high temperatures, high winds and/or low relative humidity can cause premature drying of the surface.
- Do not use deicing chemicals, instead use sand or traction grit to provide traction on icy surfaces.
- Never leave fertilizers which contain ammonium sulfate or ammonium nitrate on the concrete.
- Concrete slabs should be constructed for proper drainage to prevent water from standing on the surface.
- Provide proper curing to ensure the chemical reaction of cement with water occurs.

Cracking

Concrete expands and contracts with changes of moisture and temperature and deflects depending on load and support conditions. Cracks can occur due to the following:

- Plastic shrinkage cracks caused by high evaporation rates during placement
- Improper jointing
- Continuous external restraint
- Lack of isolation joints
- D-cracks from freezing and thawing
- Craze cracks from shrinkage of the dense paste layer at the surface
- Settlement cracks caused by inadequate subgrade

Pop-outs

Because concrete is made from natural products it may have some natural imperfections. A pop-out is a cone-shaped cavity in a horizontal concrete surface left after an aggregate close to the surface has expanded and fractured. A pop-out can be caused by either a physical reaction or a chemical reaction.

Physical: A physical reaction is when a porous rock absorbs water and freezes, causing the rock to expand and fracture.

Chemical: An example of a chemical reaction is when alkalies in the cement react chemically with the silica found in some aggregates, a gel is formed which expands causing a small surface pop-out.

According to the Aggregate and Ready-Mix Association of Minnesota, one can expect some pop-outs per square yard depending on the type of aggregate used. Pop-outs do not in any way decrease the structural integrity of a concrete slab. Please see ARM's "Understanding Concrete Popouts" for expectations.

This document does not include all placement and/or protection procedures necessary. Due to weather conditions at the time of placement and thereafter, proper hot weather concreting and cold weather concreting plans should be established prior to placement.

CHERRY STONE®
POULTRY & TRACTION GRITS




What is Cherry Stone made of?
Cherry Stone Poultry & Traction Grit is 100% natural quartzite. It is called "Cherry Stone" because of it's rose color.

What are the uses of Cherry Stone?
Cherry Stone was originally, and most commonly, used as a digestion aid for poultry birds. Since birds have no teeth, poultry grits are used to help digest food in the gizzard of birds. The hard, insoluble nature of Cherry Stone Grit also makes it ideal as a traction grit for slip-relief on icy and snow-packed walkways, driveways, and streets. Additionally, it is used for hobby crafts, aquariums, flower pot drainage, grill liners, paver joint sand, aeration, friction aggregate and is a key ingredient in Al's Gritty Mix. For more information on the uses, please visit www.cherrystonegrit.com.

How is Cherry Stone Grit used by poultry?
Cherry Stone is a clean, angular grit that is harder and sharper than granite. Birds have no teeth so these small stones are swallowed by the bird and travel to their muscular gizzard, a part of their digestive system where food is mixed and ground up as the gizzard contracts, breaking the food into small, digestible pieces. Grit is a very important part of the bird's ability to digest large particle-sized feed (including grains, grass, weeds, grain or kitchen scraps). Lack of grit can lead to digestive blockage, poor feed conversion, discomfort and even death. For more information on how to use Cherry Stone Grit for poultry, please visit *How to Feed Chickens.*

How much grit do birds need to eat?
That will depend upon the size, age, diet and production stage of the bird. Birds will naturally eat what they need for proper digestion. We recommend free access to Cherry Stone Grit whether free-range or contained.

When do I start giving the birds grit to eat?
Start birds on grit when birds leave the brooder and are introduced to outside forage or once grains or scratch are fed to them.

What size poultry grit do I need?
Cherry Stone Poultry Grit comes in four pre-sorted size options:

- Poultry Grit #1 is the smallest with average size of 1/16". It is best for turkeys age 1-5 days or chickens age 1-3 weeks
- Poultry Grit #2 averages 3/16". Recommended for turkeys age 6-21 days and chickens age 4-6 weeks
- Poultry Grit #3 averages 5/16". Recommended for turkeys age 3-8 weeks and chickens age 7+ weeks
- Poultry Grit #4 averages 3/8". Recommended for turkeys age 8+ weeks

When deciding between sizes for your birds, it is usually better to select a larger size than smaller.

How does Cherry Stone Poultry Grit compare to oyster shell?
Cherry Stone Poultry Grit is quartzite rock that does a more thorough job of digestion because it will not dissolve in the crop or the gizzard (parts of the bird's digestive system), upset the mineral balance of feed, or neutralize digestive juices. Birds are attracted to the pink-gray color. Crushed oyster shell is a source of supplemental calcium to produce strong bones and good egg shells, but it will dissolve in the digestive tract so it should not be used as a replacement for poultry grit. Although most modern poultry laying feeds contain sufficient calcium, many in the poultry industry recommend providing both grit and oyster shell to laying hens for healthier birds. Cherry Stone is insoluble grit while oyster shell is soluble grit. Insoluble grit is used by all poultry after the starter-chick feeding stage; soluble grit is usually only given to laying hens.

Can I mix Cherry Stone Poultry Grit with oyster shell?
Yes, they can be mixed together or provided separately.

Birds pick up stones from the ground, should I spread Cherry Stone Poultry Grit on the ground also?
Although spreading some on the ground can be done, a container that keeps the grit away from the floor to stop birds from kicking muck into the grit is often used. The important part is that the birds have free access to the grit.

I've bought Cherry Stone for years and now it's in a different bag. Has it changed?
TCC Materials purchased the Cherry Stone brand in 2012 and began bagging Cherry Stone at their Medford, MN packaging plant where they switched to plastic bags. Additionally, the plant went through a massive expansion where TCC Materials installed all new equipment in order to produce the sizes as specified. The grits are still sourced from the same pit as they have been since the inception of Cherry Stone.

Are there different colors of Cherry Stone?
Cherry Stone is a natural washed and screened product mined out of a vein running from south western Minnesota to eastern South Dakota. As the mining operation moves from one part of the vein to another, slight variations in color tone would be expected.

Why use Cherry Stone Traction Grit?
Cherry Stone Traction Grit works immediately at all temperatures when salt and chemicals won't. The crushed, fine, sharp stones will provide instant traction on ice or compacted snow. Unlike other chemicals, it will not hasten the deterioration of concrete surfaces or harm plants, grass or leave chemicals on pets paws. Apply as needed to walks, steps or other snow-covered or icy pedestrian areas.

Will Cherry Stone harm my concrete?
Cherry Stone Grit is all-natural and environmentally friendly. Because it is insoluble it will not stain concrete. Since it does not contain chemicals or salts it is safe to use on concrete and most surfaces. De-icing chemicals such as calcium chloride, magnesium chloride, and potassium acetate will accelerate deterioration of concrete. For more information on de-icing chemicals and protecting your concrete visit *A Homeowners Guide for Concrete Projects*.

Could I keep a bag in my car or truck?
Great idea, it will provide additional trunk weight and can be used for emergency winter traction by placing several handfuls under vehicle wheels between icy surface and tires. Since Cherry Stone Traction Grit is made of 100% quartzite, it will not dissolve, become muddy, stain or pollute.

How does Cherry Stone Traction Grit compare to sand or kitty litter for traction?
The hard, sharp aggregate in Cherry Stone provide excellent slip-resistance on icy surfaces. The stone sizes are larger and more angular than traditional sand which is more round in shape. Traction grit is sized to resist sticking into the treads of shoes and boots so the grit doesn't come inside with you as easily. Kitty litter is typically made of clay or limestone, it can dissolve, become soft and muddy making it less effective. Cherry Stone Traction Grit is also easier to sweep-up in the spring when the snow and ice has melted.

What Cherry Stone sizes are available?
Cherry Stone Poultry Grits come in 50 lb. plastic bags and 2,000 lb. bulk bags. Cherry Stone Traction Grit is available in 25 lb. handy bags and 2,000 lb. bulk bags.

Where can I buy Cherry Stone?
Please refer to our website for an interactive map: http://www.tccmaterials.com/where-to-buy-cherry-stone.cfm.

How can I become a Cherry Stone Dealer?
For a list of commercial distributors for Cherry Stone, please visit our distributor map at: http://www.tccmaterials.com/where-to-buy-cherry-stone-distributor.cfm. Please note that distributors generally sell to retail suppliers in full pallet quantities only.

I am a Cherry Stone dealer or distributor. How can I be listed on your website?
If you are currently stocking Cherry Stone, you can get free leads by getting listed on our where-to-buy interactive maps on our website. Please fill out the form found on the "Resources" tab of our website at www.cherrystonegrit.com or click here.

Cherry Stone Grit

100% Natural Quartzite Multi-Purpose Grit

Product Description

Cherry Stone® Grit is a fine, sharp, crushed rock used for various purposes. Originally used to aid in the proper digestion process of poultry, these small pebbles are 100% natural quartzite and act as food grinders in a bird's stomach. Cherry Stone Grit comes in four sizes to fit the needs of all size birds. #1 (1/16"), #2 (3/16"), #3 (5/16"), and #4 (3/8"). #2 Cherry Stone Grit is also used to give you immediate traction on icy walks, steps, and driveways without hastening the deterioration of concrete surfaces. Cherry Stone will not dissolve or become muddy like limestone grits and is non-staining and non-polluting.

When/Where to Use

- Interior/exterior locations
- Mix with poultry feed
- Spread on grounds where birds graze
- Traction on steps, walks, and driveways
- Emergency vehicle traction & weight
- Skid-resistant surfacing
- Decorative & landscape purposes
- Plant aeration
- Filtration
- Seal coating bituminous drives
- Paver/flagstone joint fill
- Lining/ballasting barbecue grills
- Stabilizing earthen walks & paths
- Flower pot drainage
- Al's Gritty Mix (component)
- Aquariums
- Hobby crafts

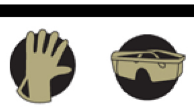
Advantages

- Hard, sharp, crushed aggregate
- Non-polluting & non-staining
- Environmentally safe
- Immediate results for traction
- Will not hasten deterioration of concrete
- Won't dissolve or become muddy
- Aesthetic appearance

Available Size

Available in 50 lb. bags
Also available in 3,000 lb. bulk bags

Helpful Items:



Gloves Safety Glasses

Application: Chickens

- Week 1: Sprinkle #1 on feed each day
- Week 2-3: #1 fed free choice
- Week 4-7: #2 fed free choice
- Week 7+: #3 fed free choice

Application: Turkeys

- Day 1-5: Sprinkle #1 on feed each day
- Day 6-21: #2 fed free choice
- Week 3-8: #3 fed free choice
- Week 8+: #4 fed free choice

Application: Other

For all other applications, use as needed for traction, weight, landscape, potting, filtration, aquariums, and other hobbies.

Notes

- Grit for free-choice feeding should be available at all times in clean hoppers near each watering station
- Birds will eat only what they need for proper grinding of their feed

Clean Up

Used product may be easily swept up when no longer needed.

WARNING: INJURIOUS TO EYES!

KEEP OUT OF REACH OF CHILDREN!

Uses	#1 (1/16")	#2 (3/16")	#3 (5/16")	#4 (3/8")
Poultry Grit	X	X	X	X
Traction Grit		X	X	
Paver & Flagstone Joint Fill	X	X	X	X
Seal Coating Bituminous Drives			X	X
Lining/Ballasting Barbeque Grills			X	X
Stabilizing Earthen Walks & Paths			X	X
Skid-Resistant Surfacing		X	X	
Plant Aeration	X	X	X	X
Friction Aggregate			X	X
Filtration	X	X	X	X
Flower Pot Drainage			X	X
Al's Gritty Mix		X		
Aquariums	X	X	X	X
Hobby Crafts	X	X	X	X

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Warning

Avoid contact with eyes and skin. If contact with eyes occurs, flood eyes repeatedly with clean water for 15 minutes and see a physician immediately. Do not rub eyes. Wash hands thoroughly after handling or before eating with warm, soapy water. Do not take internally. KEEP OUT OF REACH OF CHILDREN.

Warranty

Seller warrants that its product will conform to and perform in accordance with the product specifications. The foregoing warranty is in lieu of all other warranties, express or implied, including, but not limited to, merchantability and fitness for a particular purpose. Because of the difficulty in ascertaining and measuring damages hereunder, it is agreed that, seller's liability to the buyer at no point for any particular project shall exceed the total purchase price of said product.

Cold Weather Concreting Strategies

Choosing sustainable cold weather protection

by Ronald L. Kozikowski, W. Calvin McCall, and Bruce A. Suprenant

It's been estimated that the costs associated with cold weather concrete construction (for example, providing heated enclosures) can exceed the cost of ready mixed concrete alone.[1] This article provides a review of cold weather concreting practices and their effects on construction costs and quality, and proposes strategies for cold weather protection based on principles and concrete contractor experiences.

ACI Requirements and Recommendations

Contractors placing concrete on or against cold surfaces are often directed to three ACI documents: "Specifications for Structural Concrete (ACI 301-10),"[2] "Standard Specification for Cold Weather Concreting (ACI 306.1-90),"[3] and "Guide to Cold Weather Concreting (ACI 306R-10)."[4] But the cold weather concreting strategies provided in these documents have significant differences.

ACI 301 and ACI 306.1 are written in mandatory language and thus provide requirements when cited in project specifications. Section 5.3.2.1b of the 2010 edition of ACI 301[2] states: "Unless otherwise permitted, do not place concrete in contact with surfaces less than 35°F [1.7°C]." This requirement was not in the 2005 edition of ACI 301, and there is no similar requirement in the 1990 edition of ACI 306.1.[3]

ACI 306R-10[4], Section 6.1, states that: "Best practice indicates that all surfaces should be above the freezing temperature of water. However, take care to limit surface temperatures to no more than 10°F (5°C) greater or 15°F (8°C) less than that of the concrete to avoid inconsistent setting, rapid moisture loss, and plastic shrinkage cracking." These two sentences comprise two significantly different recommendations for surfaces that will come into contact with fresh concrete. While the first indicates that surfaces should be above 32°F (0°C)—slightly less than the ACI 301-10[2] requirement of 35°F (1.7°C)—the second imposes a temperature envelope based on the concrete temperature (this can be significantly higher than the ACI 301 requirement).

Table 5.1 of ACI 306R-10[4] provides recommended minimum as-placed concrete temperatures. For concrete sections less than 12 in. (305 mm) thick, for example, the recommended concrete temperature is 55°F (13°C). Thus, the surface temperature envelope would range from 40 to 65°F (5 to 18°C). Although ACI 306R is an ACI Guide and is not supposed to be referenced in project specifications, it often is. As a result, some inspectors attempt to enforce the recommendations, with potentially costly effects. For example, it's conceivable that an inspector could require a contractor to increase the minimum surface temperature from 40 to 45°F (4 to 7°C) if the concrete temperature were to increase from 55 to 60°F (13 to 16°C).

Regardless of the different cold weather provisions contained in current ACI committee documents, it's important to determine what surface and embedment temperatures may be detrimental to the concrete. This information can then be used to develop concreting strategies that provide effective, cost-efficient, and environmentally responsible protection of fresh concrete.

Cold Weather Concreting Strategies

Based on requirements and/or recommendations in the discussed ACI committee documents, cold weather concreting strategies for preventing early freezing and promoting strength development fall within two categories: placing concrete against cold formwork and reinforcing steel, and placing concrete against cold massive embedments.

When placing concrete against cold formwork and reinforcing steel surfaces, three strategies are provided (Fig. 1):

1. Use the warm concrete to heat the forms and reinforcing steel and then maintain the required concrete temperature by protection methods through the prescribed protection period (allowed by ACI 306.1-90[3]);
2. Heat the formwork and reinforcing steel to a minimum of 32°F (0°C), place the concrete, and then maintain the required concrete temperature by protection methods through the prescribed protection period (required by ACI 301-10[2] and recommended in ACI 306R-10[4]); or
3. Heat the forms and reinforcing steel to within 15°F (8°C) less than and 10°F (5°C) more than the as-placed concrete temperature, place the concrete, and then maintain the required concrete temperature by protection methods through the prescribed protection period (secondary recommendation in ACI 306R-10[4]).

When placing concrete against cold massive embedments, two strategies are provided (Fig. 2):

A. Heat cold massive metallic embedments (as designated by the specifier) to a minimum of 32°F (0°C), place the concrete, and then maintain the required concrete temperature by protection methods through the prescribed protection period (required by ACI 306.1-90[3] and ACI 301-10[2]; recommended by ACI 306R-10[4]); or
B. Heat cold massive metallic embedments (as designated by the specifier) to the temperature of the concrete, place the concrete, and then maintain the required concrete temperature by protection methods through the prescribed protection period (secondary recommendation in ACI 306R-10[4]).

The five strategies for both categories can be satisfied using one of the following options:

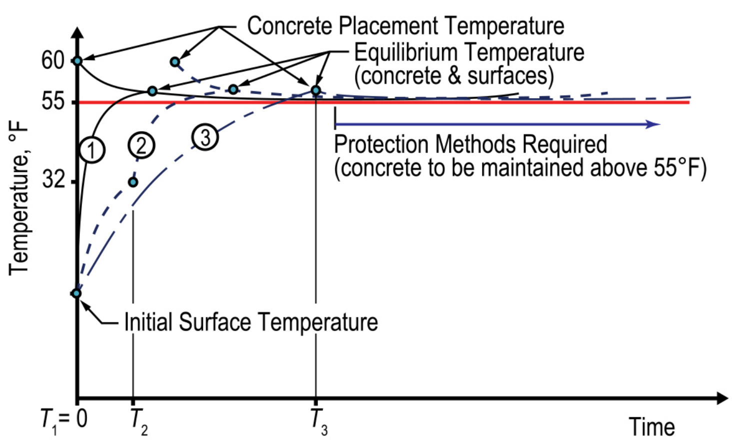

Fig. 1: Documents produced by ACI Committee 306 provide three options when placing concrete on cold forms and reinforcing steel: Option 1 is to allow heat from the fresh concrete to warm the cold surfaces, Option 2 is to warm the surfaces to 32°F (0°C) prior to placement by applying heat over time T_1 to T_2, and Option 3 is to warm the surfaces to a temperature ranging from 15°F (8°C) less than to 10°F (5°C) more than the concrete temperature by applying heat over time T_1 to T_3. The structure's embodied energy will increase accordingly (Note: °F = 1.8°C + 32)

- Require heating of cold surfaces and embedments to a minimum of 32°F (0°C);
- Require heating of cold surfaces and embedments to a temperature that is nearly the same as the as-placed concrete temperature; or
- Allow the as-placed concrete to warm the cold surfaces and embedments.

There are considerable differences in the amount of energy needed for each and thus the intrinsic energy associated with a project. While selection must be based on meeting the twin objectives of preventing concrete from early freezing and promoting concrete strength gain through the protection period, it must also be based on environmental impact and economic costs.

ACI 306R Objectives

Prevention of freezing

ACI 306R-10[4] lists the objectives of cold weather concreting practices. The main goal is to prevent damage to concrete due to early-age freezing. At about the time that concrete reaches a compressive strength of 500 psi (3.5 MPa), sufficient mixing water is expected to have combined with cement during hydration, thereby decreasing the degree of saturation of the concrete to below the critical level (level at which a single cycle of freezing causes damage). Most well-proportioned concrete mixtures reach this strength at 50°F (10°C) within 48 hours. If the concrete freezes before it reaches 500 psi (3.5 MPa), other ACI 306 objectives, such as strength gain and long-term durability, can't be accomplished.

When it comes to freshly placed concrete, only two possible mechanisms exist for early-age freezing: contact freezing or immersion freezing. For water to freeze on contact with a surface, it must be supercooled (cooled to

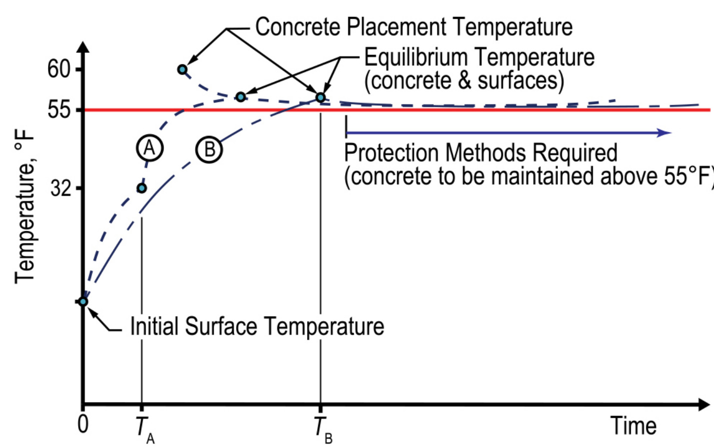

Fig. 2: Documents produced by ACI Committee 306 provide two options when placing concrete on cold massive embedments: Option A is to warm the surfaces to 32°F (0°C) prior to placement by applying heat over time 0 to T_A, and Option B is to warm the surfaces to the concrete temperature by applying heat over time 0 to T_B. The structure's embodied energy will increase accordingly

below 32°F [0°C]).[5] However, given the recommendations in ACI 306R-10,[4] ACI 306.1-90,[3] and ACI 301-10,[2] the minimum concrete temperature as placed must be at least 40°F (5°C). The mixing water will therefore be well above the freezing point, and contact freezing will not be possible, regardless of the temperature of the surface in contacts.

This can be demonstrated by pouring 50°F (10°C) water over any cold (below 32°F [0°C]) surface—the water won't freeze upon contact. However, it may still cool below 32°F (0°C) and freeze over time. This mechanism, immersion freezing, is what can occur in concrete.

When warm concrete is placed against cold surfaces, heat will transfer from the concrete to the cold materials and surrounding cold air. As a result, the concrete mixing water can cool sufficiently to reach the freezing point. Without supplemental heat, the concrete hydration can slow and extend the time needed to reach a strength of 500 psi (3.5 MPa). At the same time, this reduces the amount of heat the concrete generates internally and reduces the time needed for the cold surfaces and surrounding cold air to draw sufficient heat from the mixing water to cause freezing. Accelerators are often used in the concrete mixture to decrease the time it takes the concrete to reach 500 psi (3.5 MPa) and thus improve the odds that the concrete gains the necessary strength before mixing water freezes.

We recently demonstrated[6] that the mixing water in concrete placed at about 58°F (14°C) did not freeze when it came into contact with a No. 18 bar at –5°F (–21°C) (Fig. 3). Previous analytical work by Suprenant and Basham,[7] cited in ACI 306R-88,[8] included the assumption that concrete mixing water froze at 22°F (–6°C), while work by Swift et al.[9] assumed that the concrete mixing water froze when the concrete-reinforcing steel interface was below 32°F (0°C).

Our experimental results showed no freezing point plateaus for any of the concrete samples placed against cold steel. Based on this work, we can conclude that freezing of the concrete mixing water is not possible under the temperature conditions used in the study (concrete at about 60°F [16°C] and reinforcing steel at about –5°F [–21°C]).

It should be also noted that even a No. 18 bar comprising 5% of the gross volume of the specimen caused temperature drop in the concrete of only about 2°F (1.1°C) before it reached equilibrium with the steel. The recent experimental work also showed that the concrete heated up the reinforcing steel to 32°F (0°C) rather quickly. For reinforcing bars that are not considered massive embedments by ACI 306 (No. 9 bar or smaller), the test bars heated to 32°F (0°C) within 1 minute after concrete was placed. For the bars that are considered massive (No. 11, 14, and 18 bars), the concrete heated the bars to 32°F (0°C) within 5 minutes after concrete placement.

The Zero Law of Thermodynamics can be extended to predict the temperature of concrete cast against cold formwork surfaces and reinforcing steel. For example, if 58°F (15°C) concrete is cast against surfaces at –5°F (–21°C) (¾ in. [19 mm] plywood formwork and a No. 18 bar at a 5% concentration ratio), the equilibrium temperature will be about 53°F (12°C). However, immersion freezing is clearly not possible.

Strength gain

ACI documents recommend or require that the concrete be protected at minimum temperatures that range from 40 to 55°F (5 to 13°C). While concrete cannot freeze by contact and would be very difficult to freeze by immersion (may only be possible with massive embedments), this requirement keeps the concrete above freezing to promote strength gain. If the concrete is used to heat cold surfaces, it's likely to lose only about 5°F (3°C). Thus, the timing on when to use protection methods will be about the same as it would be if the surfaces were preheated before concrete placement.

There is also an interesting twist with respect to ACI 306R-10[4] recommended *minimum* concrete temperatures and ACI 301-10[2] and ACI 306.1-90[3] required *minimum* concrete temperatures. While all three documents use the same *minimum* concrete temperature as placed and maintained, ACI 306.1-90 provides contingency instructions:

"*Protection deficiency*—If the temperature requirements during the specified protection period are not met but the concrete was prevented from freezing, continue protection until twice the deficiency of protection in degree-hours is made up."

Thus, the "minimum" temperatures in ACI 306.1 can be violated with a protection deficiency plan in place. We are aware of cases in which the protection deficiency plan has been used. Typically, leaving insulating blankets in place for an extra day or two has been sufficient to make up the deficiency of protection in degree-hours.

Minimizing Concreting Issues

ACI 306R-10[4] recommends heating cold surfaces to avoid inconsistent setting, rapid moisture loss, and plastic shrinkage cracking. The recommendations are that cold surfaces should be heated to no more than 10°F (5°C) greater or 15°F (8°C) less than that of the concrete. These temperature limits are similar to what contractors anticipate when they place concrete in an enclosed building. But concrete is rarely placed in an enclosed building, and contractors are well aware of how cold temperatures can affect fresh concrete properties and finishing.

Further, because wall and column formwork will protect concrete from rapid moisture loss and plastic shrinkage cracking, it would appear that the temperature recommendation applies to exposed concrete flatwork.

Our tests showed that a cold bar surface had little effect on fresh concrete farther than 1 bar diameter away (Fig. 3). Also, numerical analyses conducted by Swift et al.[9] showed that variations in ambient air temperatures and formwork temperatures had negligible effects on the temperature at the concrete-steel interface. Taken together, it's apparent that cold surfaces located away from the exposed surface of

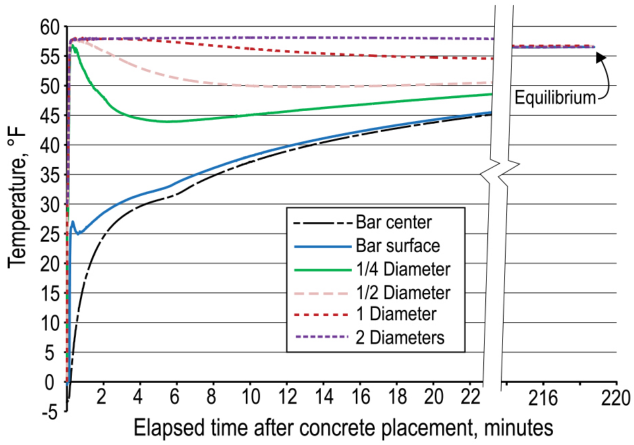

Fig. 3: Temperature readings for a No. 18 bar with a steel concentration ratio of 1%. The readings at the bar surface exhibit a slight temperature drop from 26 to 25°F (–3.3 to –3.9°C) at about 30 seconds. While a very small plateau is evident and could indicate the initial formation of ice, the plateau persists for only about 20 seconds. The amount of ice would be very small and would be melted as the concrete warmed the bar surface above 32°F (0°C). The temperature curves converge at about 220 minutes at an equilibrium temperature of 56.6°F (13.7°C). Based on the initial bar temperature of –4.1°F (–20°C) and the initial concrete temperature of 58.1°F (14.5°C), the calculated equilibrium temperature was 57.0°F (13.9°C)[6]

Fig. 4: Massive embedments are currently classified as steel sections larger than a No. 9 bar. Based on recent findings,[6] it is recommended that the massive embedment classification be increased to steel sections larger than a No. 18 bar (4 in.² (2500 mm²) cross-sectional area)

the concrete will not have significant effects on the concrete surface temperature. Therefore, it's not clear why the heating recommendations to minimize concreting issues are included in ACI 306R-10.

Recommendations for Cold Weather Strategies

Cold weather concreting strategies must protect the concrete from freezing and promote strength gain. Yet, the selected cold weather concreting strategy should also minimize the construction project's embodied energy.

Our previously published tests and discussions in this article can serve as the bases for three basic principles for developing cold weather concreting strategies:

- Neither contact nor immersion freezing of concrete mixing water is possible;
- Cold formwork and steel surfaces cause negligible decreases in the as-placed temperature of concrete; and
- Massive steel sections—those with cross-sectional areas larger than a No. 18 bar (4 in.² [2500 mm²]) (Fig. 4)—at temperatures of at least 10°F (–12°C)—will not freeze mixing water in concrete placed at a temperature of 55°F (13°C) or higher.

We further note that contractors' experiences with cold weather concreting confirm that:

- Heating of cold surfaces is a time-consuming and costly process. Depending on ambient conditions and project size, it can take 24 to 72 hours to heat formwork and reinforcing steel to above 32°F (0°C);
- Although a contractor will anticipate when concrete is to be placed and thus start heating cold surfaces accordingly, it's common to continue heating the surfaces even if the placement has to be delayed. This increases the cost of cold weather concreting yet provides no benefit to the concrete; and
- Because cold temperatures can affect the productivity of labor and equipment as well as the behavior of fresh concrete, there are practical limits for concreting operations. These can vary by location, but a practical temperature limit of –4°F (–20°C) has been reported in the literature.[10]

Based on the basic principles and contractor experiences, we propose the following cold weather concreting strategies for cold surfaces, massive embedments, and strength gain:

- **Cold Surfaces**—Recent research verifies that fresh concrete can be placed in contact with bars as cold as –5°F (–21°C) without detrimental effects. A conservative standard of practice would be to avoid placing fresh concrete on surfaces colder than 10°F (–12°C). This would generally eliminate the need to heat reinforcing steel and formwork prior to placement, resulting in a more sustainable solution to cold weather concreting;
- **Cold Massive Embedments**—The architect/engineer should identify on the contract documents those embedments that are considered massive and therefore will require heating. Based on the work by Kozikowski et al.[6] a steel member with a cross-sectional area larger than 4 in.^{2} (2500 mm^2) may be considered a massive embedment. Where the contract documents have identified massive embedments, these must be heated to 32°F (0°C) prior to concrete placement; and
- **Protection and Strength Gain**—Efficient strength gain is promoted in cold weather when freshly placed concrete meets the minimum ACI placement and maintenance requirements (Table 5.1 of ACI 306R-10[4]) during the specified protection period. However, if the temperature recommendations during the protection period are not met but the concrete was prevented from freezing, the protection period must be extended to obtain a strength equivalent to that which would have been reached during a shorter duration of warmer protection.

Note that these recommendations do not apply to placing concrete on ground. Other work is currently under way by ACI 306 members to measure the effect of cold subgrades on freshly placed concrete.

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