PCI Plant Quality Talk Series 2
Quality Enhancement Committee

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SERIES 2, ISSUE 1 – MATH FOR PRESTRESSED CONCRETE: PERCENTAGES

The word "percent" (%) means "per 100." For instance, if 98% of all plant employees wear proper personal protective equipment, then 98 employees out of 100 wear their safety equipment. A lab technician who scored 78% on an ACI exam answered 78 out of each 100 questions correctly.

Percentages and decimal numbers can both be used to express the same mathematical proportions. To convert a decimal number to a percentage, the decimal is moved two places to the right. This is the same as multiplying by 100. To convert a percentage to a decimal, move the decimal point two places to the left, which is the same as dividing by 100.

Percentages and decimal equivalents

0.3% = 0.003
1% = 0.01
5% = 0.05
10% = 0.10
33.3% = 0.333
100% = 1.00
125% = 1.25

The general equation is as follows:

$$\text{Percentage} = \frac{Part}{Whole} \times 100$$

Example 1:

- A production crew incorrectly located the weld plates in 10 precast concrete pieces out of a total of 65 pieces cast for a project. What percentage of the panels should be reported as nonconformances?
- The total number of panels cast is the *Whole* and the number of panels with weld plate issues is the *Part*.

$$\% = \frac{\text{10 nonconformances}}{\text{65 panels cast}} \times 100$$

$$\% = 0.15 \times 100 = 15\%$$

Example 2:

- Fine aggregate was sampled and dried to determine the amount of moisture present. The weight of the wet sample is 1400 g and the weight of the dry sample is 1350 g. What is the moisture content of the sand?
- ASTM C566 states that moisture content of aggregate should be based on its dry weight; therefore, the *Whole* is the dry weight. The *Part* is the amount of water removed during drying, which is the difference between the wet weight and the dry weight.

  1400 g – 1350 g = 50 g of water removed

$$\% = \frac{50\text{ g}}{1350\text{ g}} \times 100 = 3.7\% \text{ moisture}$$

Example 3:

- A concrete mixture is designed to achieve 7000 psi. What percentage of the design strength does a cylinder that tests at 7350 psi represent?
- Because we are asking for a percentage of the design strength, the design strength is the *Whole*, even though 7350 is the larger number. In this example the percentage is larger than 100.

$$\% = \frac{7350\text{ psi}}{7000\text{ psi}} \times 100 = 105\%$$

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Reference
ASTM C566, *Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying.*

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SERIES 2, ISSUE 2 – MATH FOR PRESTRESSED CONCRETE: VOLUME

It is necessary to calculate the volume of precast concrete members to know how much concrete it will take to fill the corresponding formwork.

Rectangular Shapes

The simple equation is:
Length × Width × Height = Volume

Concrete volume is usually discussed in terms of cubic yards.
One cubic yard (yd^3) = 3 × 3 × 3 ft = 27 cubic feet (ft^3)

If you have an 18 in. square beam that's 30 ft long, you will need to convert all the measurements to the same unit to determine the volume. In this case, let's use feet. 18 in. = 1.5 ft, so:

1.5 × 1.5 × 30 ft = 67.5 ft^3
To convert to cubic yards, divide by 27 (the number of cubic feet per cubic yard):
67.5/27 = 2.5 yd^3 of concrete

If you have a panel that's 5 in. thick, 12 ft 6 in. wide, and 26 ft 9 in. long, you will need to convert all the measurements to the same unit before calculating the volume. In this example, let's use feet. (To convert inches to feet, divide by 12.) So:
5 in. = 0.417 ft, 12 ft 6 in. = 12.5 ft, and 26 ft 9 in. = 26.75 ft.
0.417 × 12.5 × 26.75 ft = 139.4 ft^3
To convert to cubic yards, divide by 27: 139.4/27 = 5.16 yd^3

If that same panel included a block-out or opening that was 4 × 5 ft, then you would need to calculate that volume and subtract it from the total panel volume to figure out how much concrete it would take to fill the mold, but not the block-out. So:

0.417 × 4 × 5 ft = 8.34 ft^3
8.34/27 = 0.31 yd^3
5.16 – 0.31 yd^3 = 4.85 yd^3 of concrete

Cylinders

Determining the volume of a cylinder is a little different. The equation is:

Volume = $\pi \times r^2 \times h$

where

π = pi = 3.14

r = the radius of the cylinder (half the diameter)

h = the height of the cylinder

So, the volume of a cylinder that is 6 in. across and 12 in. high would be:

r = ½ of 6 in. = 3 in.

r^2 = 3 × 3 = 9 $in.^2$

h = 12 in.

3.14 × 9 × 12 = 339 $in.^3$

To convert to cubic feet, divide by 1728 (the number of cubic inches per cubic foot: 12 × 12 ×12 in.)

339/1728 = 0.20 ft^3

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SERIES 2, ISSUE 3 – HOT WEATHER CONCRETING

Hot weather problems are mostly encountered in the summer months, but need to be considered whenever fresh concrete is exposed to any of the following: high temperatures, high winds, low humidity, and direct sunshine.

The Effects of Hot Weather on Concrete

High concrete temperature causes a higher water demand, which can prompt the addition of water, resulting in lower strength and reduced durability. Higher temperatures accelerate the rate of slump loss and can cause loss of entrained air. Generally, concrete that is cured at high temperatures at an early age will not be as strong at later ages (28 days) as the same concrete cured at lower temperatures.

High temperatures, high wind velocity, and low relative humidity can each cause a high rate of evaporation, which can promote plastic shrinkage cracking before the concrete sets, and encourage early-age drying shrinkage. Thermal cracking may result from rapid variations in temperature, such as when concrete members are cast on a hot day followed by a cool night. High temperatures also accelerate cement hydration and contribute to the likelihood of thermal cracking in thicker concrete segments.

Hot weather conditions can result in a rapid rate of evaporation of moisture from the surface of the fresh concrete that makes a “spongy, rubber-like” surface that’s difficult to finish. It will also accelerate the set time of concrete, and therefore the finishing processes will need to occur at a faster rate. Typically, high relative humidity lessens the effects of high temperature with regard to rapid moisture loss.

Best Practice Options

- Follow supplier recommendations for adjusting concrete with the use of water-reducing and set-retarding admixtures.
- Use hydration control admixtures to extend workability times in high temperatures.
- Change the concrete mixture constituents or proportions to reduce the heat generated by cement hydration, such as by using a Type II moderate heat cement. Also, the use of fly ash, slag cement, or calcium carbonate can reduce potential problems with high concrete temperatures.
- Schedule concrete placement to avoid interruptions and delays in placing and finishing. Concrete should be placed immediately, and sufficient personnel should be available to place and handle the concrete.
- When possible, avoid the hottest part of the day when placing concrete.
- Do not sprinkle water on the surface of concrete members to facilitate finishing; this can result in a higher water-cement ratio at the surface, resulting in surface scaling.
- Lower concrete temperature by using chilled water or ice as part of the mixing water. Chilled water can reduce concrete temperature by up to 10°F; ice can reduce temperature by up to 20°F. The overall water content will need to be reduced based on the volume of the ice added to the mixture.
- Concrete temperature at the mixer shall be maintained below a maximum of 95° F, unless otherwise specified and managed.
- Sprinkling and shading the aggregate helps lower the temperature of the concrete.
- Use windbreaks, sunscreens, mist fogging, or evaporation retardants to slow evaporation and reduce the risk of plastic shrinkage cracking.
- Micro fiber may be used to reduce the risk of plastic shrinkage cracking.
- Do not exceed the maximum allowable mixing water content established for the concrete mixture proportions.
- During dry and hot days, when the temperature of the steel forms exceed 120°F, wet the formwork before placing concrete. Do not allow excessive water to pond, and make sure the casting surface is free of excess water before placing concrete.
- Start curing as soon as possible after finishing is completed. Cover to retain moisture in the enclosure, thus increasing humidity at the concrete surface.
- Ensure that test cylinders maintain their temperature and moisture for the initial curing, matching the members in the casting bed.
- Accelerators may be used in hot weather to expedite finishing operations and to avoid plastic shrinkage cracking.

References

ACI 305R-10 Guide to Hot Weather Concreting

PCI TM-103, *Quality Control Technician/Inspector Level III Training Manual*, provides a method for determining the potential for plastic shrinkage cracking based on weather conditions and concrete temperature.

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SERIES 2, ISSUE 4 – COLD WEATHER CONCRETING

Cold Weather Considerations

Cold weather is when air temperature has fallen to, or is expected to fall below, 40 degrees F during the protection period. These conditions require special safeguards when placing, finishing, and curing concrete.

In its plastic state, concrete will freeze if its temperature falls below about 25°F. If fresh concrete freezes, its potential strength can be reduced by more than half, and its durability will be negatively affected as well. Concrete should be protected from from rapid cooling to maintain favorable curing.

As concrete cures, cement hydration generates heat. Newly placed concrete should be protected to retain this heat and thereby maintain favorable curing temperatures. Large temperature differences between the surface and the interior of the concrete mass should be prevented, as thermal cracking may result when this difference exceeds about 35°F.

Best Practice Options

- Concrete temperature can be controlled by heating the mixing water and/or the aggregates. The aggregates should not be heated to above 180°F.
- Chemical admixtures can accelerate the rate of setting and strength gain. Accelerating chemical admixtures are commonly used in the winter. Nonchloride accelerators should be used for prestressed concrete or when corrosion of steel reinforcement or metal in contact with concrete is a concern. Accelerating admixtures do not prevent concrete from freezing.
- Accelerating the rate of set and strength gain can also be accomplished by increasing the amount of portland cement or by using a Type III cement (high early strength).
- Preparations should be made before concrete placement in cold weather conditions. Snow, ice, and frost should be removed and the temperature of surfaces and metallic embedments in contact with concrete should be above freezing. This might require heating the formwork before concrete placement.
- Insulated blankets and/or tarps should be ready before casting starts. Enclosures and insulated forms may be needed for additional protection, depending on ambient conditions. Corners and edges are most susceptible to heat loss and need particular attention.
- If heat is applied to accelerate curing, the concrete surface should not be allowed to dry out while it is in a plastic state as this can cause plastic shrinkage cracks. Subsequently, concrete should be cured.
- Concrete temperature at the mixer shall be maintained above 50°F. Under best practices, MNL 116 requires that the combined concrete and forms temperature maintain a minimum of 50 degrees after placement and during curing. Materials shall be free of ice, snow, and frozen lumps before entering the mixer.

References

ACI 306R-16 *Guide to Cold Weather Concreting*

PCI MNL-116, *Manual for Quality Control for Plants and Production of Structural Precast Concrete Products*

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SERIES 2, ISSUE 5 – PROPER STEEL FORM CARE

Purchasing metal forms and/or rails to create formwork for concrete is expensive. However, when forms are cared for properly they can provide years, and even decades, of useful service.

The use of release agents at fresh concrete contact surfaces is recommended in every case. The use of a release agent helps to prevent concrete from sticking to the forms, which can result in buildup and possibly damage the integrity of the concrete members. Concrete buildup can cause damage to the forms when trying to remove hardened concrete from them. Forms with permanently attached hardened concrete will produce a surface of reduced quality.

Form Setup

- Apply the release agent with a sprayer and wipe the forms down with a rag or mop to distribute the form oil evenly if there is excessive release agent on them.

During Form Use

- Ensure formwork is securely fastened to prevent blowouts or form buckling from the concrete pressure applied when placing and vibrating.
- Ensure the forms fit tightly together to prevent movement and potential form damage during concrete placement, and to prevent paste leakage, which causes honeycombing.

Cleanup and Maintenance

- Inspect forms after each use for surface damage or attached concrete.
- Remove concrete residue from the forms with a scraper.
- Closely examine the backs of the forms or the insides of the form rails and remove any concrete buildup. Removing buildup reduces the weight of the forms and the energy required of employees during setup.
- After cleanup, coat the face of the forms lightly with a form release agent to prevent corrosion, using either a spray or brush-on application.

Storage

- Store the forms under a roofed area, or in the worst case, place the forms under a securely fastened waterproof tarp.
- Spray or brush the form surfaces liberally with release agent if the form storage is expected to be longer than one month, then recoat them every two to six months while idle, depending on exposure.

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SERIES 2, ISSUE 6 – PLACEMENT OF CONVENTIONAL CONCRETE

- Fresh concrete should be placed in the form as near as possible to its final position for conventional concrete.
- A primary aim of proper placement is to have as little segregation or separation of the mixture components as possible. Placing concrete on top of previously placed concrete and allowing a natural self-leveling action helps prevent segregation and pour lines.
- Square-nose shovels, concrete hoes, come-a-longs, or other concrete tools should be used. Garden rakes, round-nose shovels, or garden hoes should not be used because they tend to cause segregation.
- If a chute is used to place the concrete, control of the chutes has a considerable effect on segregation. The chute should be located to minimize the vertical fall of the concrete and sloped so that the flow is steady, but not too fast.

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SERIES 2, ISSUE 7 – VIBRATION OF CONVENTIONAL CONCRETE

Why Vibrate Concrete?

- Vibrating concrete allows trapped air to rise to the surface and escape, and aggregates to align.
  - Applying vibration causes the aggregate particles to oscillate and move.
  - Coarse aggregate particles become more closely aligned with each other.
  - Fine aggregate particles fill all the small cavities between the coarse aggregate particles.
- Concrete becomes stronger and more durable.
- Reinforcement gets encapsulated. Reinforcing bar is an integral part of the concrete; it is vital that the steel is completely encased in concrete.

Best Practices

- Never vibrate the reinforcing bar. This practice leaves air voids and leads to rust forming and eventual failure of the concrete surface. It may also push large aggregates away, weakening the interface between the reinforcing bar and concrete.
- The correct application of vibration is vital for a homogeneous product. Employees operating vibrators should be properly trained.
- Using internal vibrators to move concrete horizontally tends to cause segregation and should be avoided. An exception is made where concrete must flow beneath a horizontal blockout, in which case the concrete should be deposited on one side of the blockout and vibrated until it flows beneath the blockout to a level slightly higher than the bottom of the blockout.
- Internal vibrators should not be forced into the concrete but allowed to sink in under their own weight.
- Avoid inserting or withdrawing the internal vibrator too fast. Withdraw internal vibrators at 1 to 2 in. per second.
- Lifts or layers of concrete to be vibrated should not exceed 24 in.
- The internal vibrator should penetrate the previous layer of concrete a minimum of 6 in., when depth allows, to integrate the concrete between the two layers.
- Avoid touching the form or mold skin with the internal vibrator.
- Avoid touching the reinforcing steel with the internal vibrator.
- Avoid running the internal vibrator outside the concrete, but do not turn vibrator off before removing it from the concrete.
- To ensure a properly functioning tool, vibrators should be cleaned and inspected for damage daily.

References

ACI 309R, *Guide for Consolidation of Concrete*

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SERIES 2, ISSUE 8 – HOUSEKEEPING AND PRODUCT QUALITY

Precast concrete quality starts in the initial steps of the production process. One important step is to clean around the production mold. This helps to ensure that debris doesn't get tracked or carried into the mold. It also makes for a safer work environment during the production process.

Best Practices

- Keep the area around the mold clean. After strip-out, remove debris from around the working area.
- Inspect the mold surface for debris while applying the release agent and remove any foreign material.
- Inspect the mold after the steel reinforcement is installed and before concrete placement. An industrial vacuum works well to remove the debris from between the reinforcing and form faces.
- Mechanic-style magnets on an extension rod work well for removing metal particles or tie wires before casting.

These steps should help eliminate any additional work to remove and patch debris after stripping the product.





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SERIES 2, ISSUE 9 – AGGREGATE MOISTURE

Why is understanding aggregate moisture important?

Consider this scenario for a 3 yd batch of concrete: A change in the moisture content of the sand from 2% to 6%, because of an overnight rain storm, has the same effect as adding about 18 gal. (150 lb) of water to your mixer! Sand, and even rock, can hold a lot of water that will affect concrete consistency if adjustments are not made.



The moisture content of the rock and sand used in making concrete has a large effect on the slump or spread of concrete, typically adding 10% to 40% of the total water to the mixture. The aggregate moisture can change the effectiveness of the water-reducing admixture, how much air can be entrained in a mixture, the slump life, and even the color of an architectural concrete. Allowing your batch computer to adjust for the proper moisture content of the rock and sand if using an in-line sensor on the aggregates allows a producer to consistently deliver the needed workability and strength. Proper adjustments allow optimization of concrete and save money. Below is one of many ways to determine aggregate moisture.

What you'll need

- Scale: typically one that is readable to 0.01 g
- Source of heat: electric burner or hot plate works well
- Frying pans: built-in handles help reduce the risk of burns
- Container to obtain aggregate from pile or bin
- Small scoop

Procedures

- Obtain a representative sample of the aggregate. This is a very important step in the process, as moisture content can vary widely within a bin or a pile. If taking from a pile, a quick stir with the loader before sampling helps. Taking a few scoops from different areas and recombining them in a container will also increase accuracy.
- Reduce your sample to a minimum of 500 g of rock or sand. This amount is usually adequate for determining moisture content for batching concrete.
- Weigh the sample of wet aggregate.
- Heat the sample until all of the water evaporates.
- Pro tip: To easily determine when the aggregate is completely dry, place a strip of printer paper directly on top of the heated aggregate. If the paper curls, there is still moisture evaporating from the sample.
- Allow aggregate to cool sufficiently to not damage the scale.
- Calculate the aggregate moisture to 0.1%, as shown below.

Example Calculation of Total Moisture

- Container weight: 300 g
- Container + wet sand: 1510 g
- Container + dry sand: 1472 g

$$\text{Aggregate moisture} = \frac{(\text{Container + wet sand}) - (\text{container + dry sand})}{(\text{Container + dry sand}) - (\text{container weight})} = \frac{1510 - 1472}{1472 - 300} = \frac{38}{1172} = 0.032 = 3.2\%$$

Remember to account for the aggregate absorption, as this amount of water doesn't contribute to the mixture or affect the slump, because it is inside the aggregate pores. The aggregate supplier can provide you with the absorption value.

Total moisture – Absorption = Free moisture

Use the free moisture in correcting batch weights of the aggregate and water for moisture content.

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SERIES 2, ISSUE 10 – BATCH PLANT AGGREGATE LOADER

One of most important jobs at a batch plant is the operation of the front end loader. The operator has the ability to feed the plant consistent materials, resulting in a consistent batching operation.

Common Issues

- Loading off the bottom of the pile
- Loading from different locations
- Stacking material too high
- Inconsistent moisture content

Best Practices

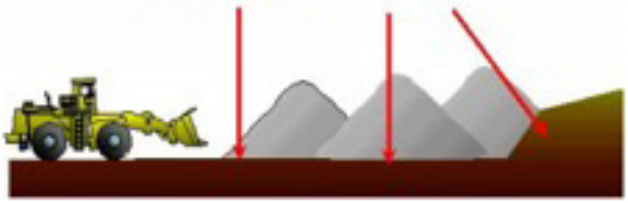
- Inspect aggregate stockpiles for debris and cross contamination before starting the loading operation.
- Keep the loader bucket at least 18 in. off the ground while loading the plant.
- Stack aggregates only as high as the loader will reach.
- Keep different size and color aggregates separated to prevent contamination.
- Contaminated aggregate can result in rejected fresh concrete or precast concrete members.
- Stir the aggregate within the storage before charging the batch plant.

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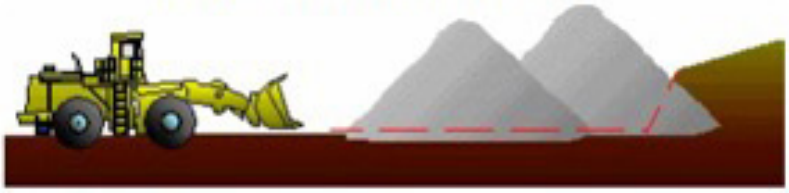
STOCKPILING TECHNIQUES FOR CLEAN STONE

DON'T DIG UP THE MAT



CONTAMINATION

DO KEEP THE BUCKET UP



DON'T STOCKPILE
NEAR CONTAMINANTS



DO REMOVE CONTAMINANTS

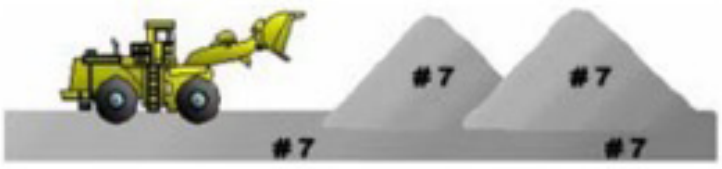


DON'T STOCKPILE OVER
LARGER SIZES

OVERSIZE



DO STOCKPILE OVER
SAME SIZE OR SMALLER



STOCKPILING TECHNIQUES FOR CLEAN STONE

DON'T CONE UP



DO DUMP TIGHTLY IN SINGLE PILES



DON'T DUMP OVER THE END



DO STACK AS HIGH AS LOADER WILL REACH



DON'T OVERLAP SIZES



DO SEPARATE DIFFERENT SIZES



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SERIES 2, ISSUE 11 – CEMENT MILL CERTIFICATES

What is a Mill Certificate?

A mill certificate is a quality assurance document used to verify/certify the material's chemical and physical attributes for the customer. The data represented on the mill certificate are typically averages of the tests performed by the manufacturer in the month reported. A mill certificate should be retained for each stockpile from which your plant receives deliveries (usually a lot, silo, or production number, as shown on the bill of lading).

Cement is manufactured by combining raw materials such as limestone, clay, sand, and iron, which are mixed and heated in a kiln at temperatures around 2700°F. Fluctuations in the amounts and chemistries of these raw materials can cause varying degrees of fluctuations in the physical and chemical properties of the cement. Because of these variables, it's important to understand that all cements are not the same. One cement isn't necessarily better or worse than the other, but different cements will perform differently, so they shouldn't be used interchangeably.

It is the job of the cement manufacturer to monitor the materials and processes and make changes in their processes to limit these fluctuations. Just like your plant wants to produce consistent concrete, a cement supplier wants to produce consistently performing cement.

What to Do With It

Mill certificate information is important for monitoring the physical and chemical trends over time. Below are examples of a few things to watch for and their potential effects on your concrete's performance:

- **Blaine fineness:** This is an indication of how finely ground the cement is. The higher the number, the finer the particle size. Finer cements exhibit higher early strengths, higher water demand, faster set times, and higher required air-entraining admixture dosages.
- **Minus(–) 325 mesh:** This is another indication of the fineness of cement. It's a measurement of how much of the cement will be retained on a #325 sieve. In conjunction with the Blaine, this value can give you a better indication of the particle size distribution. If the Blaine is very high (such as 4800) and 325 mesh is low (such as 82), it's an indication that there is a large amount of "super-fines," which have a tendency to easily hydrate with atmospheric humidity. Because they have already reacted, their presence is detrimental to concrete.
- **Vicat set time:** This is a measure of how quickly the cement will reach initial set (500 psi). It's reported on the mill certificate in minutes. The result reported on the mill certificate will not directly correlate to the concrete set time, but a change in cement set time will predict a change in concrete set time. A faster set time will likely result in a need to start finishing the concrete faster.
- **C_3A and C_3S contents:** Changes in these two compounds can affect early strength development, as higher contents will result in higher early strength. Higher C_3A-content cements will require a higher dosage of high-range water-reducing admixture than an equal amount of a lower C_3A-content cement.
- **Total alkalis:** The total alkalis impact the effectiveness of chemical admixtures and any supplementary cementitious materials (SCMs) such as fly ash or slag. Alkalis are typically reported as Na_2O equivalent. Changes in Na_2O equivalent on the mill certificate may indicate a change in how the admixtures and SCMs perform. Also, higher alkali content increases the potential for alkali-aggregate reactivity if reactive aggregates are in use.
- **One-day and 28-day strength:** Cement strength gives no indication of potential concrete strength, but can be used to troubleshoot concrete strength fluctuations. If the one-day strength drops on the mill certificate, you may see a drop in the concrete strength.

If the processes in your batch plant are optimized and monitored closely and you're still having issues, contact your cement supplier for guidance.

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SERIES 2, ISSUE 12 – BUGHOLES

Bughole Assessment/Troubleshooting

Providing customers with the desired quality of finish is very important, and the manner in which this expectation is satisfied can have significant cost impacts to the company. Final finishing processes to repair surface imperfections can bottleneck the production cycle, diminish aesthetic features, and reduce customer confidence in the product quality. Minimizing the potential for bugholes is an efficient way to achieve high-quality surface finishes at relatively low cost. Employees should be familiar with how the following production aspects affect surface quality, and be able to identify potential sources and evaluate solution options.

Form Conditions

- Dents, holes, build-up, and general roughness can potentially cause bugholes.
- The form material type can affect bugholes; wood forms are typically more forgiving than steel.
- Excess moisture should be removed from forms; trapped water can cause surface defects.
- A reactive release agent should be used, not a barrier type.
- Excess release agent/form oil should be removed from the form surface; too much form oil will cause very small bugholes and dark staining.

Concrete Handling

- The drop height of the concrete should be minimized to avoid trapping air.
- Place concrete slowly; this gives air in the form time to get out as it is displaced by concrete as the mold is filled.
- Allow enough mixing time to homogeneously blend the materials without adding too much extra time to any one batch.

Consolidation Method

- Use self-consolidating concrete or a highly fluid concrete, when possible.
- If vibrating conventional concrete, use the proper frequency and amplitude vibrator. Low-slump concrete responds better to low-frequency/high-amplitude vibration, whereas higher-slump concrete responds better to high-frequency/low-amplitude vibration.

Concrete Properties

- Select well-graded and clean aggregate.
- Use a coarse aggregate size that will pass between the reinforcing bar spacing.
- Have sufficient paste volume to fill the voids in the combined aggregate.
- Have sufficient viscosity to avoid excessive bleeding (higher T-20 test results).
- Ensure sufficient slump life to place all of the concrete batched.

Note: Please complete this form and return to the Quality Control Manager. All crew members should be observant and report to their foreman anything out of the ordinary on a project. *See something, say something.*

NOTES	ATTENDEE SIGNATURES
_____ DATE _____ PRESENTER	_____ _____ _____ _____ _____ _____