From Good to Great

Setting a Target on Measuring Moisture

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"80% of success is showing up." –*Woody Allen*

When it comes to producing Ready Mix Concrete, the pursuit of perfection is a continual, evolving process. Although we all strive to achieve better results, due to the ever changing conditions operationally, mechanically and environmentally; our overall goals and objectives seem to be obscured. Invariably too often good operators get caught in a web of reactive measures of fixing their production issues, rather than becoming proactive. Why is this case? Mainly because being proactive in identifying and eliminating root cause issues requires attention to detail, hard work and deliberate practice. Practice? We've heard of that right, but deliberate practice, what's that?

Deliberate Practice is a form of working towards specific, quantifiable goals in order to achieve increasingly better results. The Japanese call this method *Kaizan*. We've all heard the saying that practice makes perfect. But what most people often miss is the technique to perfect the way they practice. Most top performers simply work and practice harder than their counterparts. What makes these individuals unique is that it is not just the frequency or duration of practice, but *how they* practice that is the differentiating factor. The key here is that in order to become a peak performer you have to be willing to get better at something, and to get better at something you have to set goals that are quantifiable.

Take your techniques for moisture compensation. Although ASTM and local weights and measures impose rigid industry standards for almost everything under the sun for producing and placing concrete products, there is little, if any, effective standardization for measuring aggregate moisture. When it takes as little as three gallons of water in single yard of concrete to reduce the compressive strength of a load by as much as 250 PSI, producers are left with a narrow margin of error for success. Not only is strength an issue, but shrinkage, freeze-thaw resistance, excessive surface blushing and overall permeability are greatly impacted.

Without with the necessary metrics in place, to gauge success it begs the question: how can producers ever become deliberate practitioners and achieve a high degree of operational consistency with their varying moisture?

The answer lies in minimizing the reliance on reactive moisture techniques such as manual trimming and tempering at the mixer. This article is dedicated to establishing techniques and strategies to get to the root of the issue and targeting real goals for operational excellence in moisture control.

Target moisture can be derived from the following formula:

Target Weight = SSD * ((1 + TM%)/ (1 + ABS%))

Where

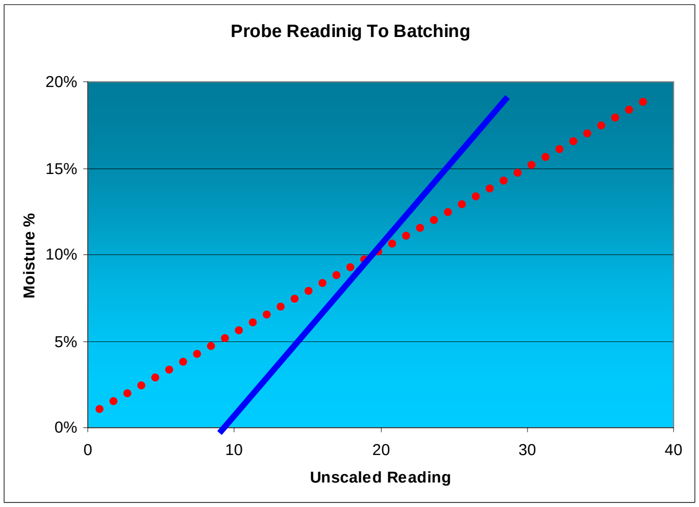
SSD = Surface Saturated Dry Weight
TM% = Percentage of Total Moisture (Wet – Dry / Dry)
ABS% = Absorbed Moisture (SSD – Dry / Dry)

Where common mistakes occur is inconsistent moisture readings from bin probes. Probes tend to wear on the surface giving inaccurate and misleading information. The only way to test moisture probes is by doing schedule material “bake off” tests. This should always be done by getting a sample of material directly from the bin that probe is reading from. This may require a bit more “prying” to get a sample, but is imperative for proper calibration. Taking a sample from a stockpile will not test whether the material reading from the probe itself is accurate, since involuntary blending of dry and wet material in the bin promotes a high degree of variability.

Another source of inaccuracy is through probe displacement. Probes tend to shift and alter their readings based on where they are mounted in their sleeve. A probe that is reading improperly may not necessarily constitute a hardware malfunction at all. The probe reading is directly affected by how the material passes over the face. A probe that is turned into the flow will give a higher unscaled (we’ll get to this next) value due to the increased impact on the sensor. Conversely, a lower reading may indicate the sensor has turned away from the material flow. At certain locations readings have been known to drop by a full 2%, which is almost 4 inches in slump.

Scaled Vs Unscaled The lineage in moisture technology has evolved from Electrical Resistant Systems, to Capacitive Systems and finally Microwave, which is the pervasive technique used today. Microwave systems were designed in the late 1980’s using ceramic antennae, fit with a detector circuit, which allowed for the exact measurement of attenuation transmitted via a specific frequency. When moisture is increased in material, two things occur: the amplitude (voltage) will be reduced and the resonant frequency will widen. Measuring the direct voltage is known as getting an unscaled reading. This unscaled voltage reading is then translated to a true scaled moisture value.

Integrating your moisture probe to your batching system is the key to proactive moisture compensation. The accuracy of the probe integration is influenced



dramatically by your calibration techniques. A single calibration set point will yield a linear scale as shown in the diagram (red dotted line). Using this line a 20 unit unscaled reading from the probe will result in approximately 10% moisture, a 30 results in 15%, 40-20%, etc. This assumes that the reading is in fact linear, however, due to variation in the frequency and voltage resonance, this is seldom the case.

Schedule Calibrations To overcome non-linear variations, it is necessary to calibrate the probe using several different set points samples, spaced over several different time periods. The more samples taken, the probe can “learn” by plotting a true representation of the unscaled values, thus making the linear representation more gradual or steeper depending on true voltage resonance. Set points should be calibrated initially at least three or four times and regularly checked every other week once established. The key is to do your sampling once you experience no less than a 1% shift in moisture reading from the probe. This ensures that the scale will slide enough to compensate for the moisture shift. Taking samples without this variation will maintain a linear bias and lower your degree of accuracy.

Don’t Stop At the Sand Just like a good game of golf, great results begin and end with a great follow through.

Producers tend to focus on sand as the main culprit in moisture variation and choose to leave out other coarser materials, which seemingly may not have the same absorption characteristics as sand.

The reality is that smaller coarse aggregates such as 3/8 also have a small enough surface area to carry plenty of moisture. Grout and other mixes that require smaller aggregates for increased flowability can require a substantial concentration of pea rock. Failing to capture these readings can result in inconsistent, highly saturated loads. A 1% change variability in moisture for a mix calling for 1300lbs of pea rock can shift the water by ±150 gallons. Specifically, in instances where coarse aggregate are fed directly from the crusher to the plant, there tends to be a higher degree of saturation due to the screening process. This type of setup requires the use of bin probes for any material under 3/8".

Further, special consideration needs to be taken with light weight material. In dry cast product plants, this is especially important due to continual use of porous material. The probability of errors in moisture is directly related to the amount of absorption in your aggregates. When you deal with a material that has a high degree of absorption (10-15%), you have a higher degree of variability in less than ambient conditions. Dry conditions warrant negative moisture compensation, where material is substituted for water in order to completely saturate the material. Wetter conditions, the opposite is true. Knowing material absorption characteristics, including that fact that absorption is not a constant, but rather a moving target is paramount in staying vigilant in the batching process.

Mixer Myths Another source of inconsistency is mounting a probe on the surface of a mixer. Most operations rely solely on this technique as their first and last effort at sourcing moisture issues. A probe mounted in your mixer is highly recommended as a check sum, or final countermeasure to product consistency that should be used in conjunction with your bin probes. This way it will indicate to your operators that your mix have fallen with an expected tolerance.at the completion of your mix time. It will also show if one of your bin probes has moved or not operating correctly.

If the mix is out of tolerance you can stop the mixer discharge until it can be inspected to reduce wastage

Worth the Effort So what is all this practice worth to you? The ends certainly do justify the means and in the case of deliberate practice, practice does make perfect. Tests have shown that these techniques achieve between ±.002 percent accuracy on total moisture.

This level of accuracy should enable you to produce the perfect product. For Ready Mix applications it means exacting yields and less time spent adjusting and tempering loads. Avoidance in tempering of half of the loads on a plant producing 600 yards per day can save you of over $100,000 per year in truck time. Direct savings are insignificant when compared to the inherent quality issues introduced by adding water at the slump stand or on the job.

For architectural products, lower variation in water consistencies result in accurate Aggregate/Cement ratios, which enables consistent coloration, reduction in cement usage and substantial reduction in quality issues. Consistent product results in lower operating costs and a higher contribution margins.

Proactive management techniques further simplify processes by allowing mix adjustments based on a % of Total Moisture. This gives producer's one value to dial in their moisture quality in their batch process. Instead of trimming or adding specific coarse materials, water and cement to bring mixes into spec, having a one stop shop for your target moisture % simplifies the batch process and keeps your operators from having to come up with creative, yet unconventional ways to compensate for inaccuracies.

The reality is that none of these goals can be achieved with out a finely tuned plant, conveyor system and a disciplined, deliberate approach to your operation. Once you've mastered your operation, you're ready to master your moisture and well on your way of understanding that both practicing and eventually mastering the little things, can make a big difference.

1 *What It Takes to Be Great,* Geoffry Colven, *Fortune Magazine*
2 *Best in Class Adding Water at the Job Site,* Brian Mclindsay, *Badger Meter*
3 *Batch Plant Basics 101,* Robert Ober, *Plant Architects*