



American Concrete Institute®
Advancing concrete knowledge

Quality Control and Robustness of SCC, Part 2

ACI Spring 2012 Convention
March 18 – 21, Dallas, TX

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The effective use of Moisture Equipment to control the water content during SCC Production

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Introduction

- Concrete raw materials:
 - Aggregate
 - Cement
 - Water
 - Admixture
 - Super Plasticiser
- Mix design
 - The 'recipe'

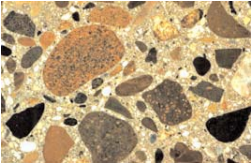


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Introduction

- Main problems
 - Separation
 - Heavy aggregates sink
 - Forms not filled properly
 - Bleeding
 - Bad surface finish
 - Curing problems
- Causes
 - Proportioning of dry materials
 - Moisture in dry materials
 - Over mixing
 - Incorrect admixture quantity

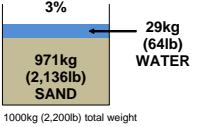


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Material weighing

- Concrete plants usually batch raw materials by weight
 - When weighing aggregates this includes the weight of the water
- 1,000kg (2,200lb) Sand at 3% moisture
 - 971kg (2,136lb) Dry Sand
 - 29kg (64lb) Water



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The Effect of Varying Moisture

- Weighing
 - 1,000kg (2,200lb) Sand
 - 1,000kg Sand at 3% moisture
 - 971kg (2,136lb) Sand
 - 1,000kg Sand at 7% moisture
 - 935kg (2,057lb) Sand

1000kg (2,200lb) total weight

1000kg (2,200lb) total weight

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The Effect of Varying Moisture

- Proportioning
 - 1,000kg (2,200lb) Sand
 - 900kg (1,980lb) Aggregate
 - 1,000kg (2,200lb) Sand at 3% moisture
 - 971kg (2,136lb) Sand
 - 841kg (1,850lb) Aggregate
 - Sand:Aggregate Ratio = 1.15
 - 1,000kg (2,200lb) Sand at 7% moisture
 - 900kg (1,980lb) Aggregate at 3% moisture
 - 935kg (2,057lb) Sand
 - 874kg (1,923lb) Aggregate
 - Sand:Aggregate Ratio = 1.07

1,900kg (4,180lb) total weight

1,900kg (4,180lb) total weight

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Effect of Moisture on Mix Water

- Example concrete mix
 - Cement = 350kg/m³ (589lb/yd³)
 - Sand and aggregate = 1,900kg/m³ (3,190lb/yd³)
 - Water added in mixer = 175kg/m³ (294lb/yd³)
- Variation of 1.0% in sand and aggregates (after any correction for moisture)
 - Water in aggregates = 1900 * 0.01 = 19kg (42lb or 5gal)
 - Actual water in mix = 175 + 19 = 194kg (427lb or 51gal)
- So 10% extra water is included in the mixer

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Effect of Moisture on Mix Water

- Example concrete mix
 - Cement = 350kg/m³ (589lb/yd³)
 - Sand and aggregate = 1,900kg/m³ (3,190lb/yd³)
 - Water added in mixer = 175kg/m³ (294lb/yd³)
- Improvement by 0.8% in sand and aggregates
 - Water in aggregates = 1900 * 0.008 = 3.8kg (8lb or 1 gal)
 - Actual water in mix = 175 + 3.8 = 178.8kg (393lb or 47 gal)
- So only 2% extra water is included in the mixer
- Small changes in sand and aggregate moisture = large changes in final mix

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Mix Homogeneity

- Moisture variation in mixer
 - Dry mix
 - Needed to record good average values for control systems
 - Wet mix
 - Homogeneity indicates good dispersal of SCC admixture
 - Final mix homogeneity important for consistency of final product
 - Mix times are important – do not overmix

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Aggregate Moisture Control

- Moisture measurement equipment
 - Measurement in aggregate bins or on conveyor belts

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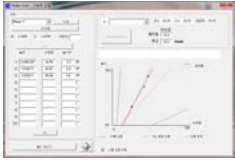
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Aggregate Control

- Calibration
 - Simple calibration process
 - Sample material being measured whilst recording sensor value
 - Test sample in laboratory
 - Moisture given by formula:

$$M = \frac{W_{wet} - W_{dry}}{W_{dry}}$$

M = Moisture
 W_{wet} = Weight of sample when wet
 W_{dry} = Weight of sample after drying to 'bone dry'



- Good quality equipment needs no recalibration
- Check calibration every 1-3 months

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Aggregate Control

- Control Example
 - Weigh 75% of target weight
 - Calculate average moisture of material
 - Recalculate target weight

$$T_{wet} = T_{dry} + \frac{T_{dry} \cdot M}{100}$$

M = Moisture
 T_{wet} = Target weight adjusted for moisture content
 T_{dry} = Original target weight

- Dose remaining weight

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Aggregate Control

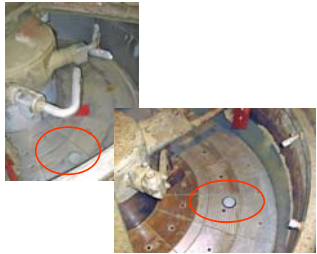
- Control Example
 - Example weighing 1000kg (2,200lb)
 - Step 1: Weigh 75% (750kg (1,650lb))
 - Step 2: Read average moisture from sensor (5%)
 - Step 3: Recalculate target
 - New Target = 1000 + (1000 * 5/100) = 1050kg (2,310lb)
 - Step 4: Dose remaining material (1050 – 750 = 300kg (660lb))

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Controlling the water

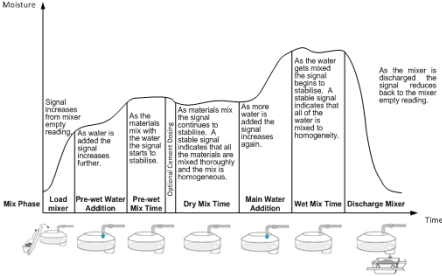
- In the mixer
 - Load materials
 - Measure in the dry mix
 - Add water to reach a target moisture value
 - Wet mix



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Mix Sequencing



Moisture

Time

Mix Phase: Load material, Pre-wet Water Addition, Pre-wet Mix Time, Dry Mix Time, Main Water Addition, Wet Mix Time, Discharge Mixer

Signal increases from mixer empty reading.

As water is added the signal increases further.

As the materials mix with the water the signal starts to stabilise.

As materials mix the signal continues to stabilise. A stable signal indicates that all the materials are mixed thoroughly and the mix is homogeneous.

As more water is added the signal increases again.

As the water gets mixed the signal begins to stabilise. A stable signal indicates that all of the water is mixed in homogeneously.


As the mixer is discharged the signal reduces back to the mixer empty reading.

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Microwave Moisture Sensors

- A cost effective moisture solution
 - Payback for a sensor and installation is less than 3 months (based on 50m³/day)
- What to look for in a microwave moisture sensor
 - Rugged/Reliable
 - Sensor is designed for use in aggregates/concrete
 - Accurate and easy to calibrate
 - Linear calibration will give an accuracy of 0.2%
 - Temperature stable calibration
 - Easy to integrate
 - 0-20mA, 4-20mA and 0-10v Analogue Outputs
 - Local presence for training, service and support
 - A proven brand



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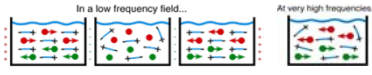
- Hydronix design, manufacture and sell microwave moisture measurement and control equipment
- Industry leader of digital sensors, controls and service
- First company to develop microwave technique in 1982
- Focus on sensor technology and service
- Over 50,000 installations world wide
- Continually investing in research
- Customer Focus – Your satisfaction, guaranteed!

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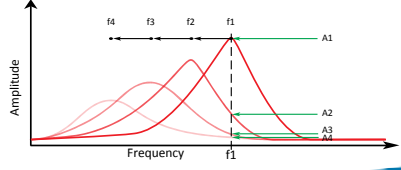
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How Microwave Technology Works

- Hydronix measures the dielectric properties of materials



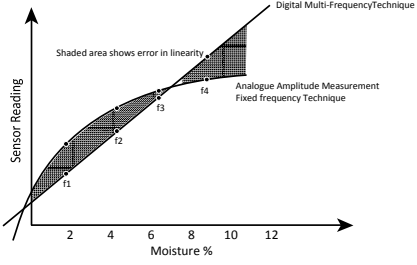
- “Classic” microwave measurement was at a fixed frequency



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Digital Moisture Measurement Techniques

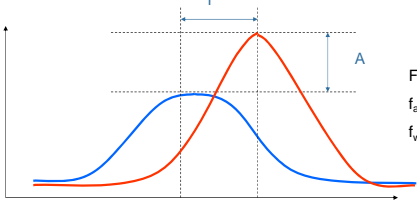


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Digital Moisture Measurement Techniques

- Resonant frequency shifts have a linear relationship with moisture variation in many non-metallic materials



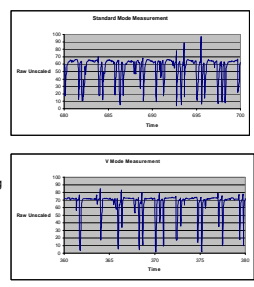
For ease of use:
 $f_{\text{air}} = 0$ unscaled
 $f_{\text{water}} = 100$ unscaled

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New Measurement Techniques

- Raw mixer sensor traces
 - Show noise from mixing blades
 - V Mode Measurement shows improved signal level and also reduced noise
- Reduction of noise from mixing shovels
 - Reduces amount of post processing needed

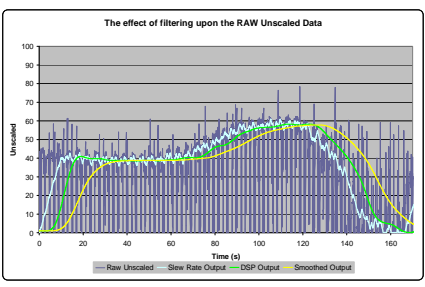


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New Sensor Features

- Digital Signal Processing
 - Modern filtering techniques
 - Reduces time lag from filtering
 - Improves stability of signal




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Hydro-Control VI

- Produce consistent, high quality batches
- Automatic or manual operation
- 3 water addition modes to reach moisture target
- Control fine and coarse valves for accurate control of moisture in mixer
- Stores up to 32,000 recipes
- Graphical display of moisture throughout the batch
- Repeatable batches +/- 0.1% moisture
- Calibrate recipe to a previous 'good' batch
- Records batch history of previous 1,000 batches



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Conclusions

- Aims
 - Control the moisture in the aggregates
 - Control the water addition into the mixer
 - Reduce the number of wasted batches
- Solutions
 - Sand and aggregate bin sensors
 - Mixer sensors
 - Water control systems



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Thank you

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