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

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The Effect of Varying Moisture

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

- Proportioning
  - 1,000kg (2,200lb) Sand
  - 900kg (1,980lb) Aggregate
  - 1,000kg (2,200lb) Sand at 3% moisture: 971kg (2,136lb) Aggregate at 7% moisture: 941kg (2,076lb)
  - Sand:Aggregate Ratio = 1.15
  - 1,000kg (2,200lb) Sand at 7% moisture: 935kg (2,057lb) Aggregate at 3% moisture: 941kg (2,076lb)
  - Sand:Aggregate Ratio = 1.07

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

- Improvement by 0.8% in sand and aggregates
  - Water in aggregates = 1900 * 0.002 = 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

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
    - This mixing and homogeneity = do not overmix

Aggregate Moisture Control

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

- Calibration
  - Simple calibration process
  - Sample material being measured whilst recording sensor value
  - Test sample in laboratory
  - Moisture given by formula:
    \[ M = \frac{W_{wet} - W_{dry}}{W_{dry}} \]
  - Good quality equipment needs no recalibration
  - Check calibration every 1-3 months

- Control Example
  - Weigh 75% of target weight
  - Calculate average moisture of material
  - Recalculate target weight
    \[ T_{new} = T_{old} + \frac{W_{wet} - W_{dry}}{W_{dry}} \]
  - Dose remaining weight

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))

Controlling the water

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

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
How Microwave Technology Works

- Hydronix measures the dielectric properties of materials

"Classic" microwave measurement was at a fixed frequency

![Amplitude vs Frequency Graph](image)

Digital Moisture Measurement Techniques

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

For ease of use:

- \( f_{\text{water}} = 100 \) unscaled
- \( f_{\text{water}} = 0 \) unscaled

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

New Sensor Features

- Digital Signal Processing
  - Reduced timing inaccuracies
  - Reduces low level from noise
  - Improves stability of signal

![Raw and Smoothed Output Graph](image)
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

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

Thank you