STANDARD OPERATING PROCEDURE

Cross-Conductance Sensor Array for Concrete Hydration & Setting Monitoring

DOCUMENT TITLE:	**Cross-Conductance Hydration Sensor SOP**	**DOC NUMBER:**	SOP-MAT-CC-003
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1. Purpose & Application Principles

This Standard Operating Procedure (SOP) specifies field preparation, sensor cell constant calibration, and real-time monitoring procedures for cross-conductance planar sensor arrays embedded in fresh cement paste and concrete. The sensor tracks early-age ionic hydration kinetics, ion dissolution, acceleration phase inflections, and initial/final setting times (Akram et al., 2023).

2. Instrumentation & Calibration Standards

• Quad-electrode cross-conductance planar probe array (316 stainless steel tracks).
• Precision LCR Meter / Impedance Analyzer (1 kHz to 100 kHz frequency sweep).
• Certified 0.01 M and 0.1 M KCl reference conductivity solutions.
• Pt100 / Thermocouple temperature compensation probe.

3. Step-by-Step Calibration & Embedded Field Protocol

3.1 Pre-Pour Cell Constant Calibration: Immense the cross-conductance sensor array in 0.01 M KCl reference solution at 25.0°C. Measure AC conductance at 10 kHz to establish baseline cell constant K_cell (cm■¹). Verify linearity across 0.01 M to 0.1 M KCl solutions.

3.2 Temperature Compensation Setting: Calibrate the integrated Pt100 probe; program automatic 2.0%/°C temperature compensation to normalize measured conductance G(t) to standard 25.0°C.

3.3 Field Embedding & Formwork Mounting: Anchor the sensor array securely inside the concrete formwork, ensuring at least 50 mm clear concrete cover. Protect cable lead-outs using heavy-duty flexible conduit.

3.4 Continuous Hydration Logging: Initiate automated AC conductance logging immediately upon concrete pour. Track initial dissolution peak G_max, induction minimum G_min, and acceleration derivative dG/dt.

3.5 Setting Time Inversion: Identify initial setting time t_initial at the maximum acceleration slope (d^2G/dt^2 = max) and final setting time t_final at the conductance deceleration plateau.

4. Technical Performance Acceptance Specifications

Parameter	Operating Range	Acceptance Criteria	Action / Corrective Measure
AC Excitation Freq	1 kHz to 100 kHz	10 kHz nominal (no polarization)	Increase freq if phase angle > -5°
Cell Constant K_cell	0.1 to 1.5 cm■¹	± 1.0% vs. KCl reference	Re-clean electrode tracks with IPA

Temp Compensation	-10°C to 60°C	Pt100 accuracy ±0.2°C	Recalibrate RTD channel on logger
Conductance Dynamic	0.1 to 100 mS/cm	Linearity $r^2 \geq 0.999$ in KCl	Check 4-wire Kelvin lead isolation
Setting Determination	0 to 24 hours pour	dG/dt inflection clear	Verify continuous 1-min sampling rate

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