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Predictive Maturity – A New Era in Concrete Curing

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For decades, Kraft Curing has been at the forefront of innovation in concrete curing. The introduction of new cements - using various types of fillers (hydraulic and inert) to replace Portland clinker (in an effort to reduce cement's CO_2 footprint) - is causing producers of precast and prestress elements to question when these products can be demoulded or detensioned without risking damage to the product. To address this issue - as well as the general issue of when a concrete product is suitable for handling - Kraft Curing's introduction, last year, of Match-Cure technology marks a milestone in quality control for precast and prestress concrete production.

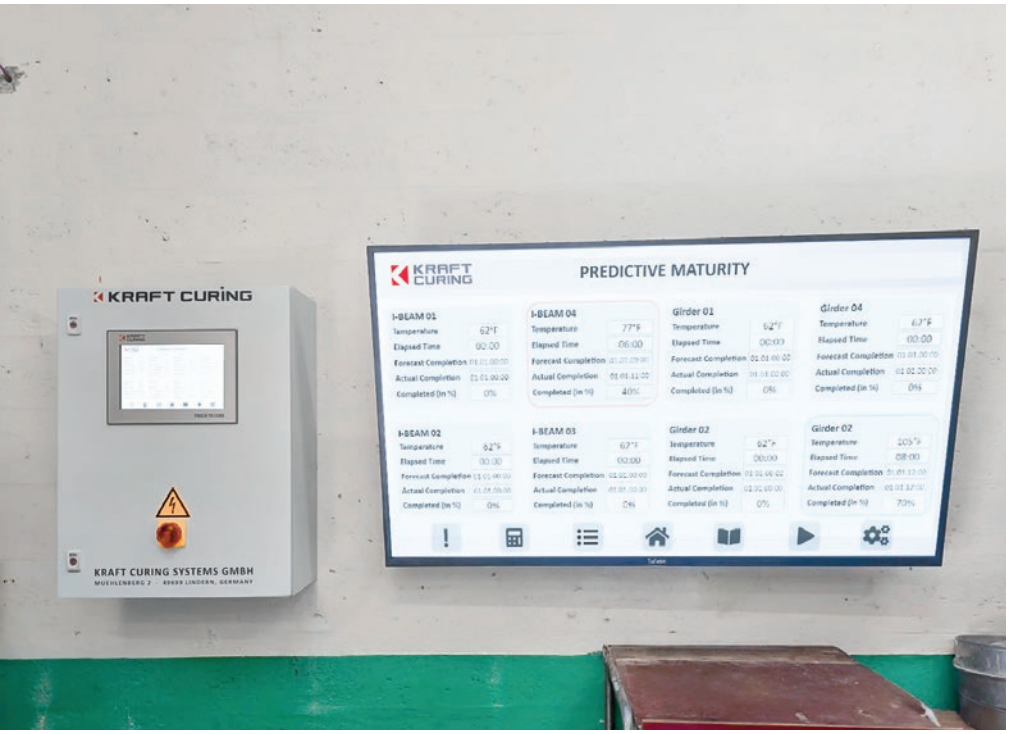
Designed as a comprehensive early-strength monitoring system, Match-Cure allows producers of precast and prestress concrete elements to ensure that the freshly poured element achieves the required strength prior to demoulding or tensioning - enabling the earliest possible detensioning or demoulding time, reducing energy and unnecessary labor costs while maintaining safety and product quality that may be a result of inadequate strength development.

Test cylinders or cubes, produced as test specimen when a precast or prestress element is poured, are placed into an insulated Match-Cure environmental chamber that allows for precise measurement and control of the test specimen temperature based on (precisely duplicating) the internal temperature of the actual concrete element.

As the produced concrete element gains temperature (either though hydration or an accelerated curing system) a heating unit inside the Match-Cure enclosure heats the specimen

Integration of Match-Cure into Kraft Curing's AutoCure ecosystem to prevent duplicate control and montoring systems and save money.

Match-Cure environmental chambers for a total of five (5) production areas/beds/



Large monitor provides data for each production table/form/mould showing current % completion and estimated completion time. Use of green, yellow or red outlines for each production area shows curing status.

while an exhaust unit cools (to a minimum of the ambient temperature) the temperature of the specimen if the temperature of the concrete element drops (perhaps due to wind, a failed curing cover, etc.). A cooling system is available as an option for regions which experience harsh winters.

The system accurately duplicates the temperature of the concrete element through the use of temperature sensors (located inside or outside the concrete element), available wired or wireless, continuously measure the curing conditions of both the concrete element and the test cylinder.

Temperature data from the element and the test cube or cylinder is transmitted to the AutoCure® control system. If the element's temperature exceeds that of the test cylinder, the heating system is activated to match the element's temperature. Conversely, if the element's temperature drops unexpectedly, an exhaust ventilator or optional cooling system responds to maintain the correct conditions.

For QC Quality Control monitoring, recording and verification of the accuracy of the specimen heating curve compared to the concrete element, the VaporWare V2® system independently records, stores, and prints all climatic curing data, including batch numbers, element descriptions, and timestamps, providing a fully auditable quality record of both the actual concrete product and the specimen in the Match-Cure environmental chamber.

With Match-Cure, producers gain a precise, controlled simulation of the actual curing conditions experienced by their concrete elements. Prior to demoulding or detensioning the actual concrete element, the specimen in the Match-Cure environmental chamber can be removed and compression tested to determine if the concrete compressive strength is sufficient to withstand the forces or demoulding or detensioning.

Match-Cure Ultra

Kraft Curing has advanced technology further by developing Match-Cure Ultra - a predictive maturity control system. Rather than waiting to see how precast or prestress concrete performs under given curing conditions, producers can now forecast and control exactly the time when a product will reach the required strength.

With Kraft Curing's Match-Cure Ultra, concrete producers can set curing parameters (temperature and duration of initial or pre-set, ramp and soak) to meet the compressive strength target that allows the concrete to be safely demoulded or detensioned. This marks a shift from reactive monitoring to proactive, data-driven production control!

The Science of Maturity

The foundation of the Match-Cure Ultra lies in predictive maturity, a testing method that assesses the progress of hydration in concrete. As cement hydrates, it releases heat. By measuring temperature inside the element with thermocouple sensors, maturity quantifies the rate of hydration and translates it into a maturity index.

This index reflects the "equivalent age" of the concrete, which is the time the material would have taken to reach the same strength under standard curing conditions, typically 20°C. By applying the Arrhenius law, the system accounts for the acceleration of hydration at higher temperatures or its slowing at lower temperatures. The result is a continuous picture of strength development inside the element itself, without the need for destructive testing at every stage.

Predictive Maturity is especially valuable during the early hardening phase and requires certain equipment to work, including sensors to capture temperature data, storage devices to log measurements, and dedicated software to process results into strength predictions.

From Measurement to Prediction

While conventional maturity measurement provides insight into current strength, Kraft Curing has transformed it into a predictive tool. The process begins with establishing a calibration curve, where test cubes or cylinders of a given concrete mix are cured under standard conditions at 20°C. These specimens are tested at defined intervals for compressive strength, and the results create a strength–time profile.

During actual production, sensors embedded in the concrete element measure the real temperature (hydration) evolution. By converting curing history into equivalent ages, the system can position the element along the calibration curve and predict its strength at any given moment. This means producers no longer need to wait for destructive tests to confirm readiness. Instead, they know in advance when concrete will achieve the desired mechanical properties.

A heavy-duty magnetic wireless temperature transmitter (gray enclosure) with Type K thermocouple wire for internal concrete temperature measurement

A wireless repeater placed throughout a factory or yard to ensure excellent signal strength throughout a large area. thermocouple wire for internal concrete temperature measurement

Insulated Match-Cure environmental chamber with test specimen with internal concrete temperature measurement.

How Predictive Maturity Works in Practice

The predictive maturity workflow is straightforward but powerful. A set of calibration specimens is prepared using the exact mix design of the production batch and stored at 20°C. After only a few hours, they are tested regularly for compressive strength, and the results are entered into the Match-Cure Ultra table. Once the specimens cover a 24-hour curing period, the program generates a complete maturity profile.

This profile becomes part of the maturity library—a database of mix-specific strength curves. For every future pour with the same formulation, the program uses this stored curve in combination with live temperature measurements to forecast strength development.

At the same time, test cubes or test cylinders stored in the Match-Cure enclosure continue to validate the predictions by curing under identical conditions to the element itself. When the program signals that the target maturity has been reached, a simple strength test of the match-cured test cubes or cylinders verifies that the concrete has achieved the predicted strength.

Managing the Curing Facility with Predictive Control

The combination of Match-Cure and AutoCure® turns maturity prediction into a facility-wide control system. Operators can follow strength gain in real-time and receive alerts if curing deviates from expectations, such as delays caused by colder ambient conditions, unexpected thermal gradients or a break-down in the curing system. Production planning becomes more reliable, as teams know exactly when forms can be demoulded or prestressed concrete elements can be released and can schedule production personnel accordingly.

Prestressed concrete production with Match-Cure environmental chambers

Equally important, the system optimizes the curing process itself. By automatically adjusting curing profiles to meet target strength and target completion, it prevents both under-curing, which risks structural failure, and over-curing, which wastes time and energy. This precise control means lower energy consumption, reduced cycle times, and fewer errors in production scheduling.

The system allows for "belt and braces" redundancy. When predictive maturity signals curing is complete/strength is reached, a test specimen may be tested in order to assure the required/predicted strength has been reached - adding more data points to the predictive maturity library and creating a more precise maturity curve for the following cure.

The Benefits of Predictive Maturity

The advantages of predictive maturity extend across the production chain. Quality improves, since every element is verified to have reached the required strength before handling. Time savings are substantial, as operators no longer rely on conservative buffer times but can act at the precise moment the concrete is ready. Energy efficiency increases, because the system avoids running heaters, steam generators, or hot air systems longer than necessary. From a management perspective, predictive maturity enhances planning and coordination. Knowing in advance when products will be ready allows staffing and logistics to be aligned with production output, minimizing idle time and bottlenecks. The result is a smoother, more efficient workflow, lower costs, and greater confidence in delivery schedules.

Eliminating Uncertainty in Concrete Production

Predictive maturity is more than a technological advance—it represents a fundamental change in how concrete production is managed. By enabling producers to decide when their products are ready and automatically adapting curing conditions to meet that deadline, Kraft Curing shifts control from uncertainty to certainty. This development is not just about faster turnaround or lower energy bills. It is about transforming curing from an art guided by experience into a science guided by real-time data and predictive modeling. ■

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