Enhancing Performance with Internally Cured Concrete (EPIC²)

Every Day Counts
Innovation for a Nation on the Move

Internal curing increases concrete's resistance to early cracking, allowing the production of higher-performance concretes that may last more than 75 years.

Photos: FHWA

Shrinkage cracking in concrete is a key limiting factor in achieving acceptable long-term performance in concrete bridges, roads, and repairs. When this cracking occurs at an early age, it leaves the concrete and embedded reinforcement exposed to degradation, reducing the service life of the structure. Unlike conventional curing where water is supplied on the concrete's surface, internal curing provides a source of moisture from inside the concrete mixture, improving its resistance to cracking and overall durability.

IMPROVED INFRASTRUCTURE THAT LASTS LONGER

Internal curing targets and mitigates the source of shrinkage cracking by providing curing water integrally to the concrete mixture. Over the last 30 years, extensive studies have shown that internal curing addresses the root cause of self-drying shrinkage that is particularly problematic in lower water-to-cementitious materials ratio concretes.

This material-level technology can be employed in any concrete mixture with an adjustment to mixture proportions. The most widely used approach includes pre-wetted lightweight aggregates, which have a high-absorption capacity and are naturally compatible with common concrete production practices. A portion of the normal-weight fine aggregate is replaced with a pre-wetted lightweight fine aggregate. The saturated, porous fine aggregates in the concrete mixture distribute the curing water throughout the concrete body. As the concrete loses water naturally due to continued hydration or environmental exposure, water is pulled out of the lightweight aggregate and creates internal curing. This allows cementitious microstructure pores to be refilled before they become empty, avoiding the negative pore pressures that cause concrete to shrink.

APPLICATIONS

Internal curing is primarily used in concrete bridge decks where a reduction in shrinkage coupled with lower-permeability mixture designs can provide substantially improved protection to the steel reinforcement. In paving and overlays, the technology reduces the magnitude of crack widths and curling deformations and can be used to extend the spacing between engineered joints. For patching and repair materials, internal curing minimizes the potential for restrained shrinkage cracking associated with high cement content mixtures designed to develop strength rapidly.

BENEFITS

Versatility. Internal curing can be used anywhere traditional concrete is used. It follows the norms of industrial concrete production, making it accessible to any producer already familiar with the state of practice.

Durability. Internal curing mitigates shrinkage cracking that is particularly problematic in low water-to-cementitious materials ratio concretes, allowing construction with lower permeability concretes to improve durability.

Cost Savings. Higher-durability concrete mixtures can last several times longer than traditional concretes, reducing the need to rehabilitate or replace critical elements such as bridge decks during the design life of the bridge, resulting in life-cycle cost savings.

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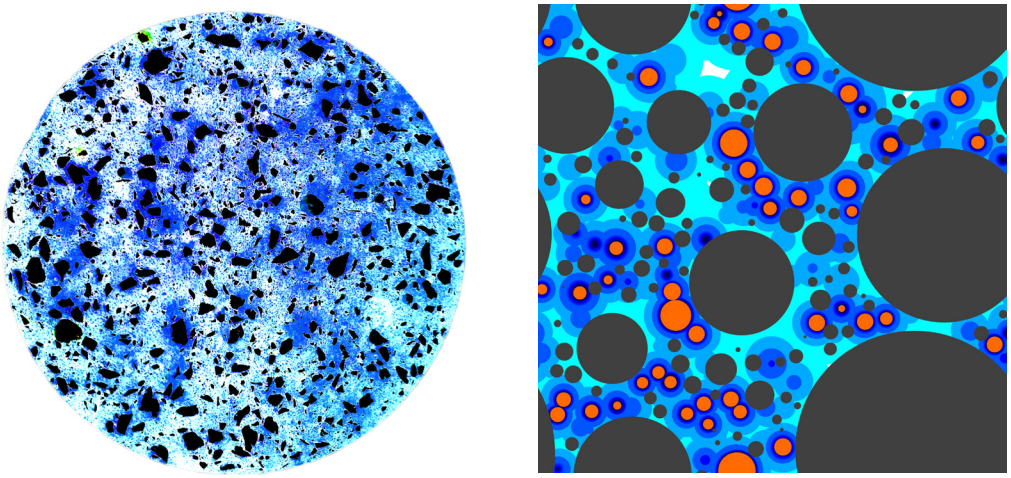
Embodied Carbon Reduction. Internally cured concrete mixtures can be designed with lower water-to-cementitious materials ratios and increased utilization of natural, waste, or alternative recycled cementitious products without reduced performance or increased risk of cracking.

STATE OF PRACTICE

State departments of transportation (DOTs), local public agencies, and transit authorities have begun implementing internal curing to meet their needs.

- Bridge Decks: New York State, Indiana, Louisiana, North Carolina, Ohio, and Utah DOTs; Western Federal Lands Highway Division; and the Illinois State Toll Highway Authority.
- Pavements: Kansas and Texas DOTs and the North Texas Tollway Authority.
- Pavement Patches: City of West Lafayette, Indiana; Texas DOT; and Michigan municipalities.



Images: FHWA

Internally cured concrete cylinder cross section with dye (blue, color corrected) showing areas of internal curing water movement at early ages (left) and the simulated distribution of internal curing water (right).

RESOURCES

FHWA EDC-7 Enhancing Performance with Internally Cured Concrete

NIST Internal Curing of Concrete Information Sources

U.S. Department of Transportation
Federal Highway Administration

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