RUTGERS Infrastructure Monitoring & Evaluation (RIME) Group

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Bureau of Research, Innovation & Information Transfer

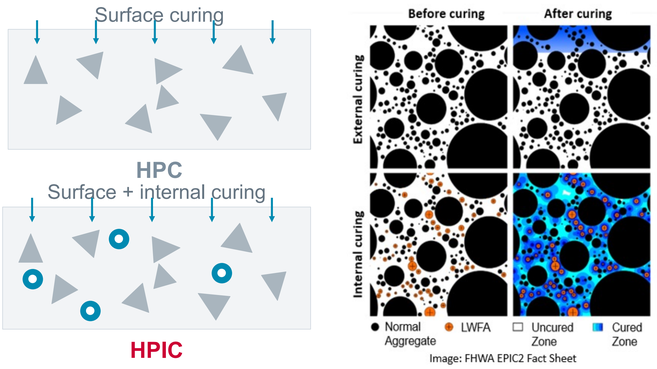
Extend Service Life of Concrete Bridge Decks with Internal Curing

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01 BACKGROUND & OBJECTIVES

High-performance concrete (HPC) has a dense, low-permeability matrix that limits moisture supplied by external curing. As hydration consumes pore water, autogenous shrinkage develops. Under bridge-deck restraint, shrinkage can initiate early-age cracking, allowing chlorides to reach reinforcement and accelerate corrosion.



High-performance internally curing concrete (HPIC) replaces part of the normal-weight sand with prewetted lightweight fine aggregate (LWFA). Stored water is released during hydration, supporting curing within the concrete and reducing self-desiccation.

Study Objectives

1. Evaluate materials: identify suitable LWFA and superabsorbent polymer (SAP) products for NJDOT HPC.
2. Verify performance: compare shrinkage, strength and durability; assess dosage and curing requirements.
3. Support implementation: demonstrate production, assess costs and inform NJDOT guide specifications.

02 MATERIALS & TEST PROGRAM



Shale | Slate | Clay | SAP

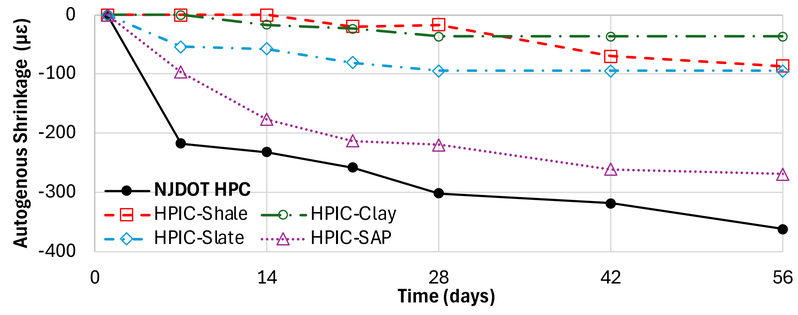
A review of 16 state DOT studies and supplier surveys informed the testing program. NJDOT HPC mixtures were modified using expanded shale, slate, clay, or SAP. Testing covered fresh properties, strength, chloride permeability, freeze-thaw durability, and free and restrained shrinkage.

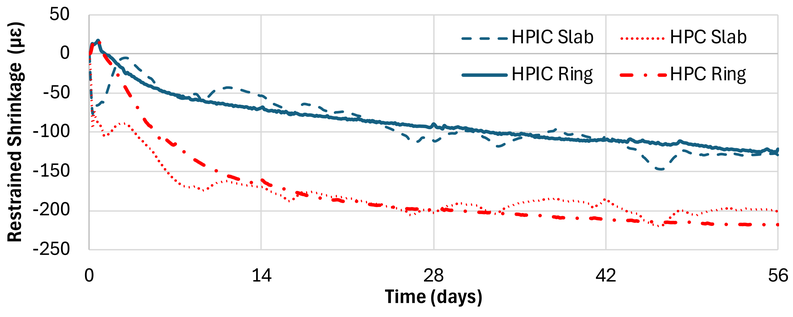
LWFA was soaked for 72 hours and drained for 24 hours. Stored-water dosages of 3.5, 7, and 10.5 lb per 100 lb of cementitious material were compared. Seven-day wet curing plus curing compound increased laboratory shrinkage compared with 14-day wet curing.

03 LABORATORY FINDINGS

Strength, chloride permeability, fresh properties, and finishability of LWFA-based HPIC were generally comparable to HPC. Expanded-shale HPIC maintained freeze-thaw resistance, while expanded-clay HPIC had lower resistance. SAP mixtures showed lower strength and stiffness.

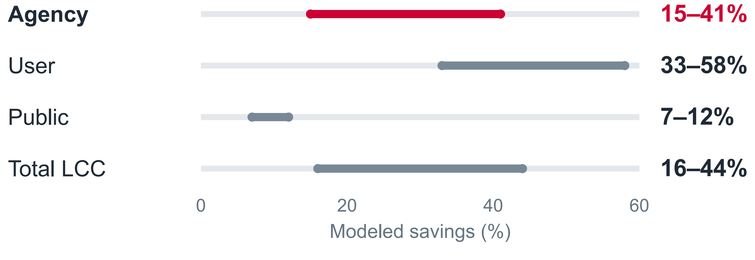
All HPIC mixtures reduced autogenous shrinkage, with larger reductions for LWFA than SAP. Expanded-shale HPIC also reduced shrinkage-related response in restrained ring tests and simulated bridge-deck slabs, particularly at early ages when HPC is most susceptible to cracking.





04 PROJECTED LIFE-CYCLE BENEFITS

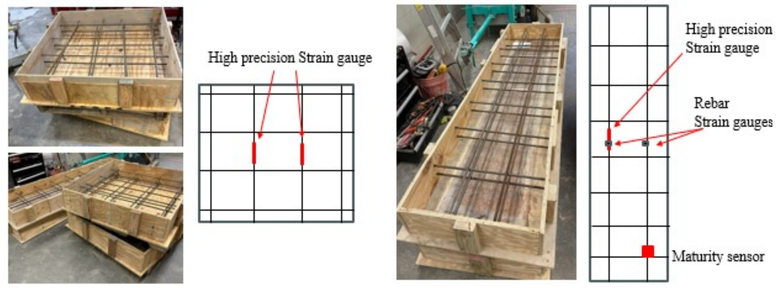
75-year analysis; assumed life: HPC 25 yr / HPIC 40–50 yr.
Total LCC applies a 0.3 weight to user costs.

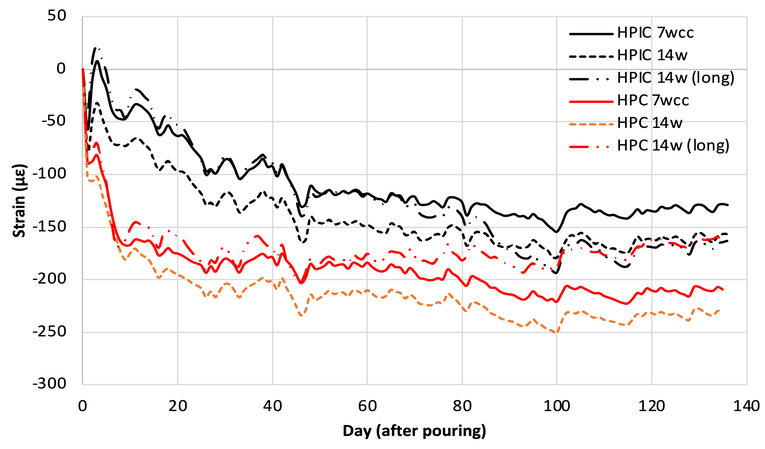


Over a 75-year analysis, HPIC was projected to lower costs through less frequent maintenance and rehabilitation. With a 10% unit-price premium, agency savings were about 31-41%. Service-life extensions are model assumptions, not field-verified outcomes.

05 FIELD DEMONSTRATION

Ready-mix HPC and expanded-shale HPIC were cast into 8-in.-thick reinforced slabs (4 ft × 4 ft and 2 ft × 8 ft). Eighteen vibrating-wire strain gauges (VWSGs) monitored field behavior for 136 days.





Slabs were cast outdoors in May 2025 and wet-cured for 14 days or for 7 days followed by curing compound. A 24-hour moving average reduced daily thermal fluctuations of 10–15 με.

HPIC shrinkage was 68% lower than HPC at 14 days and 29% lower at 136 days. These reinforced slabs simulated bridge-deck segments but were not highly restrained.

06 CONCLUSIONS AND IMPLEMENTATION

Expanded-shale HPIC is a feasible option for NJ bridge decks: it reduced shrinkage while maintaining strength and durability comparable to HPC. Internal curing complements, but does not replace, proper external wet curing.

Use 7 lb of stored water per 100 lb of cementitious material and retain 14-day wet curing. Determine LWFA moisture using the centrifuge method to support accurate batching. Instrument pilot bridge decks to verify in-service performance.

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