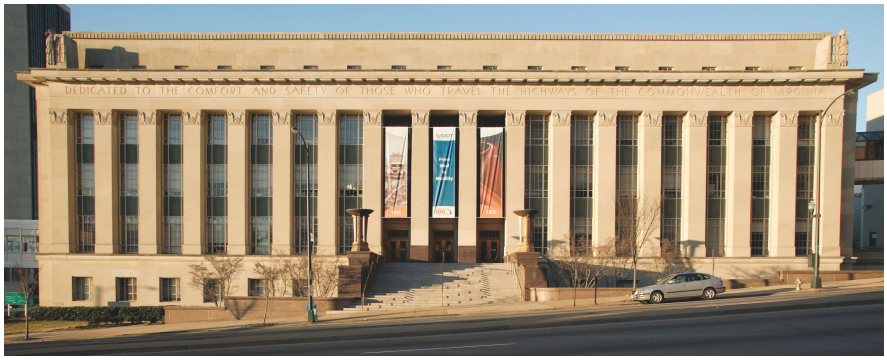
Introducing New Ideas to an Aging Bridge Inventory

Implementing best practices to extend and maximize service life

Rex L. Pearce

by Rex L. Pearce, Virginia Department of Transportation

A sustainable, effective response to an aging bridge inventory is one of the greatest challenges facing departments of transportation today. Paramount are the Interstate corridors—crucial to travel, commerce, and defense—which rely on bridges that have reached their design life. Absent the fiscal resources to support a replacement program of this magnitude, bridge maintenance, preservation, and service-life extension are critical.



Virginia Department of Transportation Building in Richmond, Virginia. All Photos: Virginia Department of Transportation Staunton District Bridge Section.

The Virginia Department of Transportation maintains 21,000 bridges and large culverts throughout nine regional districts.

The Staunton District Bridge Section is responsible for 3500 structures: approximately 2200 bridges (45% concrete) and 1300 culverts (85% concrete). Building on a history of innovation and preservation, nearly 95% of Staunton District's bridge inventory is not classified as structurally deficient.

Know Your Bridge Inventory

A current and comprehensive inventory assessment is the basis of an effective bridge maintenance program. With our good fortune of operating in a data-rich era, utilizing this valuable asset to the utmost is sound logic. Trends of structure aging, conditions, materials, techniques, successes—all are there to improve program maintenance and preservation efforts as well as future implementations. Asset query software developed in Staunton District affords extensive condition and element level evaluation.

A typical assessment is the recent Bridge Maintenance Study implemented for the three Interstate corridors within the Staunton District. This study produced a cost valuation of district Interstate bridges, latest condition trends by materials and components, and a prioritization of future maintenance efforts.

Bridge Deck Preservation

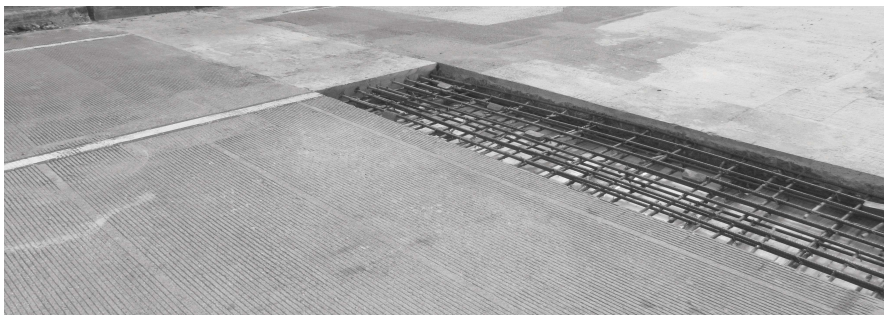
Overlays

A sound bridge deck is not only paramount to the safety of the traveling public, it is essential in minimizing deterioration to superstructure and substructure components. Staunton District administers several ongoing preventive-maintenance contracts: maintenance and repair, shotcrete and self-consolidating concrete (SCC), component sealing, bridge washing, and culvert lining.

In the 1980s, Interstate bridge decks began to exhibit deterioration due to chloride contamination. The district set out to overlay all Interstate corridor decks, which was accomplished by 2000. To offset the permeable concretes used in earlier eras that allowed greater chloride penetration, epoxy overlays were applied to sound decks; milling followed by latex-modified concrete rigid overlays restored the more weathered traveling surfaces. In the 1990s, silica-fume-concrete rigid overlays were added as a more cost-effective material. In the 2000s, Virginia bridge decks began to be constructed with low-permeability concretes, which are considered substantially more chloride resistant.

Jointless Bridges

In the 1970s, Staunton District began using continuity as the preference



Elimination of bridge deck expansion joint with closure placement.

to simple spans for improved design efficiency and the added reward of joint elimination at the piers. In the 1980s, integral bridge construction was added. In the early 1990s, Staunton District began closing (eliminating) bridge deck joints on existing bridges. Deck extensions and semi-integral abutments followed closely thereafter.

Contemporary Deck Preservation

Twenty-five years have passed since the earliest Staunton District Interstate bridge deck sealing. Ongoing chloride contamination, aging, cracking, and subsequent patching have necessitated a new generation of deck-preservation technology. Hydro-milling is becoming more of a standard practice in this arena.

Unlike standard mechanical milling operations, which proceed with a fixed depth of removal and must remain above reinforcement, hydro-milling dials in a targeted soundness, reaching below reinforcement where necessary to remove chloride-laden concretes. The result is a stable, deeply roughened concrete matrix extremely well suited to overlay.

Implementing a district-wide bridge deck preservation strategy using this technique, two Interstate bridges were recently restored. Preservation efforts included bearing reconfiguration to accommodate joint closures, deck extensions, hydro-milling, and overlay replacement for a comprehensive jointless solution. Extensive preservation of piers and abutments was previously accomplished.

Intended as a comparative basis of various closure and overlay concrete materials, with the assistance of the Virginia Transportation Research Council, these 575-ft-long bridges received several preservation solutions.

Bridge deck prepared for overlay by hydro-milling.

Preserved interstate bridge.

Joints were replaced with closure placements using innovative concretes. These included rapid-set latex-modified concrete (RSLMC), fiber-reinforced concrete (FRC), engineered cementitious composite concrete with polyvinyl alcohol fibers, FRC with monofilament polypropylene fibers, and FRC with steel fibers. Concrete overlay mixtures included RSLMC, silica fume (SF) concrete, SF concrete with shrinkage-reducing admixture, SF concrete with coarse lightweight aggregate, and SF concrete with fine lightweight aggregate. Comparative performance will be used in coming years as a basis for material selections.

Superstructure and Substructure Preservation

SCC and shotcrete are a mainstay to substructure and superstructure restoration. Sealant application to beam ends, piers, and abutments extends this preservation. Carbon-fiber wraps applied to concrete beams damaged from vehicular strikes restore lost capacity. Chloride extraction and cathodic protection are explored where practicable.

Nondestructive Evaluation Technologies

Nondestructive evaluation (NDE) of bridge elements is an evolving technology and is becoming competitive with standard investigations. Future generations of engineers and inspectors will be more attuned to the visual and audible digital assessments of bridge conditions. This technology is expected to further supplement chain dragging to find voids, petrographic analysis to assess integrity, and possibly concrete coring to evaluate chloride contamination or presence of alkaline-silica reaction. A recent in-depth investigation of the decks on the 15 most active Interstate bridges within Staunton District is being used as a comparison of various NDE technologies. Of interest are impact echo, infrared, and three-dimensional radar examinations. Advantages include high-speed inspections to assist in a program-level condition update. NDE may further merge inspections with the bridge-health-monitoring arena.

Conclusion

Participation in a professional forum invites the very human tendency to showcase the more spectacular accomplishments of our experience. However, it is the vast inventory of the routine—workhorse bridges and small crossings, the aging and the problematic—that represents the majority of our duties as guardians of the transportation infrastructure. Often the most noteworthy accomplishments look simply like the photo located at the top of the page.

As such, it is only through achieving excellence in best management practices of existing inventories that we can strive for the exceptional.

EDITOR'S NOTE

See the Concrete Bridge Technology article by Dr. Maher Tadros in this issue for more discussion of strategies for eliminating joints in bridge decks.