PCI Gulf South

Transportation Committee Meeting with ALDOT
June 11, 2020

Bridge Preservation

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Bridge Preservation

- There is an immediate need to develop and implement preservation strategies that extend service life of bridges backed by a financial analysis to justify future and/or initial expenditures.
- Bridge preservation strategies can lead to:
  1. Reduced annual bridge costs throughout the bridge design life
  2. Reduced short-term and/or long-term bridge funding requirements/backlog

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Moving Ahead for Progress in the 21st Century Act (MAP-21)

A summary of Highway Provisions by the Federal Highway Administration Office of Policy and Governmental Affairs, July 17, 2012

Performance Management
[1203]

The cornerstone of MAP-21's highway program transformation is the transition to a performance and outcome-based program. States will invest resources in projects to achieve individual targets that collectively will make progress toward national goals.

MAP-21 establishes national performance goals for Federal highway programs:

- **Safety**—To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
- **Infrastructure condition**—To maintain the highway infrastructure asset system in a state of good repair.
- **Congestion reduction**—To achieve a significant reduction in congestion on the NHS.
- **System reliability**—To improve the efficiency of the surface transportation system.
- **Freight movement and economic vitality**—To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
- **Environmental sustainability**—To enhance the performance of the transportation system while protecting and enhancing the natural environment.
- **Reduced project delivery delays**—To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

23 CFR Part 490

Department of Transportation, Federal Highway Administration
Code of Federal Regulations, 23 CFR Part 490

[Docket No FHWA-2013-0053]

National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program, Subpart D-National Performance Management Measures for Assessing Bridge Condition

Subpart D section 490.411 establishes a minimum level for condition of bridges so that the percentage of the deck area of bridges classified as Structurally Deficient does not exceed 10%.

Bridge Preservation Outline

The following items are considerations when assessing bridge preservation requirements.

- Corrosion Mitigation
- Service-Life
- Life-Cycle Planning/Analysis/Costs
- Transportation Asset Management Plans (TAMP)
- Bridge Maintenance
- Bridge Repairs
- New Bridge Construction
- Example Applications for extended service-life
  - MNDOT and TXDOT bridge construction specs/current practice using penetrating sealers
  - KYTC - Developing Material Specification and Application Criteria for Sealing Concrete Bridge Decks
  - CIP bridge deck vs. Precast bridge deck/NEXT D beams in Alabama

CORROSION MITIGATION

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Concrete Corrosion Inhibitors Association (CCIA)

Concrete Corrosion Inhibitors Association (CCIA)

https://www.cortecvci.com/whats_new/News_Letter/nucorrossion.html

- The Concrete Corrosion Inhibitors Association, Inc. (CCIA) has been formed to promote the use and understanding of corrosion inhibitors in concrete.
- The members of the new association are: Cortec Corp., Master Builders, Inc., Grace Construction Products, AXIM Concrete Technologies, Inc., and Sika Corp.
- This new association will develop and provide educational material, and also technical and statistical information. The goal of the CCIA is to encourage the use of corrosion inhibitors in concrete to improve concrete durability in marine applications, parking facilities and the infrastructure. The Association will also explore other avenues, such as by providing support to research and scientific inquiry, involving the use of corrosion inhibitors.
- The activities of CCIA will include disseminating literature and field data, promoting the use of a service-life prediction model and supporting efforts to use life-cycling-cost of concrete as the basis for determining the best value. By the use of seminars and the dissemination of user-friendly literature, the CCIA will assist architects, engineers and specifiers to understand the value of corrosion inhibitors.

ASPIRE Winter 2019

"Migrating Corrosion Inhibitors: A Positive Invasion Against Corrosion" by Julie Holmquist, Cortec Corporation

Uses in New Construction

Migrating corrosion inhibitor admixtures can be mixed directly into the concrete mixture. Some meet ASTM C1582[1] physical property standards for set time, compressive strength, flexural strength, shrinkage, and freeze/thaw durability (see **Tables 1** and **2**).[2,3] They may also meet ASTM C1582 requirements for corrosion reduction in a chloride environment.

Uses for Repair and Maintenance

Migrating corrosion inhibiting admixtures can also be used in repair applications to discourage further corrosion where corrosion damage has already occurred, as was done on the Randolph Avenue Bridge in St. Paul, Minn., where winters are harsh and deicing salts are regularly used. By 1986, the bridge, which was built in 1963, was in need of an overlay repair. The westbound lanes had more damage than the eastbound lanes and were overlaid slightly thicker (0.31 in. deeper on average), using a concrete mixture with a migrating corrosion inhibitor admixture. To serve as a control, the eastbound lanes were overlaid with the same concrete mixture but no inhibitor. Corrosion rates in the treated side remained lower, while corrosion rates in the eastbound control lanes spiked into the active range between the 2007 and 2011 readings.[5]

ASTM 1582

Migrating Corrosion Inhibitor						
	Control	Migrating Corrosion Inhibitor	Relative to Control		ASTM C1582 Requirements	Results
Average Integrated Current, C	155	29	n/a		≤ 50C when control is 150C	Meets Requirement
Ave. Area Corroded, in^2	8.93	2.36	29%		≤ 1/3 of control	Meets Requirement
Critical Chloride Content*, ppm	2861	2898	1.01%		≥ Critical Control	Meets Requirement

ASTM 1582 is a specification for admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete

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Hawaii DOT Specifications/Current Practice

Migrating Corrosion Inhibitors for New and Existing Bridges

shall have a Calcium Oxide (CaO) content of less than 13 percent and a total equivalent alkali content less than 3 percent.

C. Air-entraining admixtures shall meet the requirements of ASTM C 260. Air-entraining admixtures shall be added at the mixer in the amount necessary to produce the specified air content.

D. Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C 494, Type A, water-reducing or Type D, water-reducing and retarding. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions.

E. Admixtures with specific performance requirements designated in the plans shall conform to ASTM C494. They shall be compatible with any other ...

F. Corrosion inhibiting admixtures shall conform to the requirements of ASTM C1582. They shall be compatible with any other admixtures used in the concrete and shall not significantly affect concrete setting time.

2.06 PREMOLDED JOINT MATERIAL

Premolded joint material for expansion joints shall meet the requirements of ASTM D1751 or ASTM D1752.

2.07 JOINT FILLER

The filler for joints shall meet the requirements of SECTION 02566 – JOINT SEALING FILLER (P-605).

2.08 STEEL REINFORCEMENT

Reinforcing shall consist of deformed bar conforming to the requirements of ASTM A615, Grade 60. Shop drawings and mill test reports shall be submitted and accepted before fabrication of steel.

NDWP WIDEN TAXILANES G & L - PHASE I
HONOLULU INTERNATIONAL AIRPORT
STATE PROJECT NO. AO1121-24

STRUCTURAL PORTLAND CEMENT CONCRETE (P-610)
03300-4

(B) Concrete Sealer. The concrete sealer to be used after completing the deck repairs shall meet the following criteria:

(1) 100% Silane sealer containing corrosion inhibitor.

(2) No greater than 0.5 visual rating after 50 cycles according to ASTM C672, Standard Test Method for Scaling Resistance of Concrete Surfaces exposed to Deicing Chemicals with application of one coat at 125 square feet per gallon.

(3) No more than 0.75% increase in weight during ASTM C156, Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete with application of one coat at 125 square feet per gallon.

IM-H1-1(268)
676-3a
09/19/12

(4) At least 78% reduction with application of one coat at 125 square feet per gallon according to ASTM C1218, Standard Test Method for Water Soluble Chloride in Mortar and Concrete.

676.03 Construction Requirements. Conform to the requirements of Section 503 and as required in these specifications.

(A) Submittal Requirements. At least four weeks prior to the start of this work, provide eight copies of the following submittals in one complete set for acceptance. Indicate clearly the name of the product and its manufacturer on pertinent submittals. No work that is related to these submittals shall be performed until written acceptance has been received.

(1) Certifications, test data and assurances required in Subsection 676.02 - Materials.

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Hawaii DOT 10-year Corrosion Study in Marine Tidal Zone Area

Concrete panels were cast using corrosion inhibitors, crystalline waterproofing admixtures, varying amounts of fly ash, silica fume, water/cement ratios, and additional criteria. They were placed in a marina in Hawaii for 10 years. They were periodically checked and compared against control panels. The manufacturers did not know this research study was occurring. The materials were ordered by a concrete company paid for by a HDOT grant.

Findings:

- Corrosion initiated in year 7 in some panels, very close to the Life 365 prediction of 6 years.
- Recommend a .40 water to cement ratio OR lower
- Recommend including fly ash at 15% replacement of cement or higher or at least 5% of silica fume
- Include corrosion inhibitor with performance level equal to or greater than 4 gallons of calcium nitrites (CNI). *When Migrating Corrosion Inhibitors were introduced later, they showed performance equal to 4 gallons of calcium nitrites and replaced CNI in Hawaii with a rate of 16 ounces per cubic yard instead of 4 gallons.*
- As added protection, consider including Kryton Krystol Interrnal Membrane at 2% by weight of cement.

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Migrating Corrosion Inhibitors

- Protection directly to embedded metals
- Works even in cracked areas
- Much lower dosage rate than Calcium Nitrites (16 ounces vs. 512 ounces per cubic yard)
- Does not adversely affect mix design
- Does not affect finish properties when used with silica fume, fly ash, slag, etc.

- Certified to meet NSF Standard 61 (Potable Water)
  - CNI is 84% soluble in water at 70°F, whereas Migrating Corrosion Inhibitor is only 21% soluble at 70°F.
  - CNI is very likely to leach into water, and if it does, it is toxic.

Not all migrating corrosion inhibitors are the same; compare material/product data sheets before selection!

SERVICE LIFE

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Service Life of Bridges

- ASPIRE Winter 2017

PERSPECTIVE

Defining the Service Life of Bridges

Relationship of service life to the repair of precast/pre-stressed concrete bridge components

by the late Dr. Dennis R. Mertz, University of Delaware, and Edward P. Wasserman, Modjeski and Masters

The AASHTO LRFD specifications do not currently define service life for bridges.

Confusion exists among bridge owners and designers regarding the terms *design life* and *service life* as evidenced by the fact that the two are often used interchangeably. Article 1.2 of the American Association of State Transportation Officials' *AASHTO LRFD Bridge Design Specifications*[1] defines design life and service life as follows:

- **Design Life:** "Period of time on which the statistical derivation of transient loads is based: 75 yr for these Specifications."
- **Service Life:** "The period of time that the bridge is expected to be in operation."

Life-365^{TM} Service Life Prediction Model^{TM}

- Benefits of using a corrosion inhibitor can be evaluated using software known as Life-365.
- Life-365 is a model and computer program for predicting the service life and Life-Cycle Cost of Reinforced Concrete exposed to chorides.
- Life-365 predicts the time before onset of corrosion.
- Current Version 2.2.3, September 28, 2018
- Why are we (as an Industry) interested in Service Life?
  - Moving Ahead for Progress in the 21st Century Act (MAP-21) signed into law P.L. 112-141 on July 6, 2012 along with Performance Management Requirements for highway infrastructure assets (pavement and bridges) according to the United States Department of Transportation Federal Highway Administration 23 Code of Federal Regulations (CFR) Part 490
  - Funding appropriating penalty based on non-compliance with performance measures for assessing condition of NHS Bridges

History of Predicting Service Life of Concrete

1998	National Institute of Standards and Technology (NIST) workshop outlined the need for a consensus corrosion service life model was outlined
1999	Consortium was formed within American Concrete Institute's (ACI) Strategic Development Council (SDC) to fund development of he "Life-365" software program
2000	Life-365 v1.0 is introduced to the concrete industry. 2001 – version 1.1 is released 2008 – version 2.0 is released at the Transportation Research Board's Annual Meeting 2010 – version 2.0.1 is released 2012 – version 2.1.1 released 2013 – version 2.2 released, contains ability to localize humidity and temperature for more accuracy
2019	Life—365, Stadium, and many other software programs exist to evaluate service life

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Parameters that Affect Service Life in Service Life Modeling

Exposure Levels

Tidal Zone
Marine Spray Zone
Within 800 m of Ocean
Within 1.5 km of Ocean
Parking Garage
Urban Highway
Rural Highway

- Water to Cement Ratio (w/cm)
- Slab Depth or Column Width
- Clear Cover (thickness between top of rebar and top of slab or outside of column)
- Humidity of Location
- Temperatures of Location
- Composition of Mix Design
  - % Fly Ash
  - % Silica Fume
  - % Slag
- Corrosion Protection Options
  - Epoxy Coated Rebar
  - Calcium Nitrites
  - Migrating Corrosion Inhibitors of Amine Alcohol/Amine Carboxylate Mix
  - Any Additional New Technology Not in Presets
  - Corrosion resistant steel or stainless steel reinforcing
- Overlays and/or Sealers (may not be captured in Service Life models)

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Parameters that Affect Service Life

- Design & details
- Extreme events
  - Seismic
  - Storm/rain
  - Scour
  - Fire
- Quality of construction
- Exposure conditions/Project Location
- Vehicular demands on bridges
- Maintenance & Bridge preservation activities and/or repairs
- Type of construction and materials
  - Concrete
    - Precast
    - Precast/Prestressed
    - Cast-in-place
  - Steel
  - Timber

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LIFE CYCLE PLANNING/ANALYSIS/COSTS

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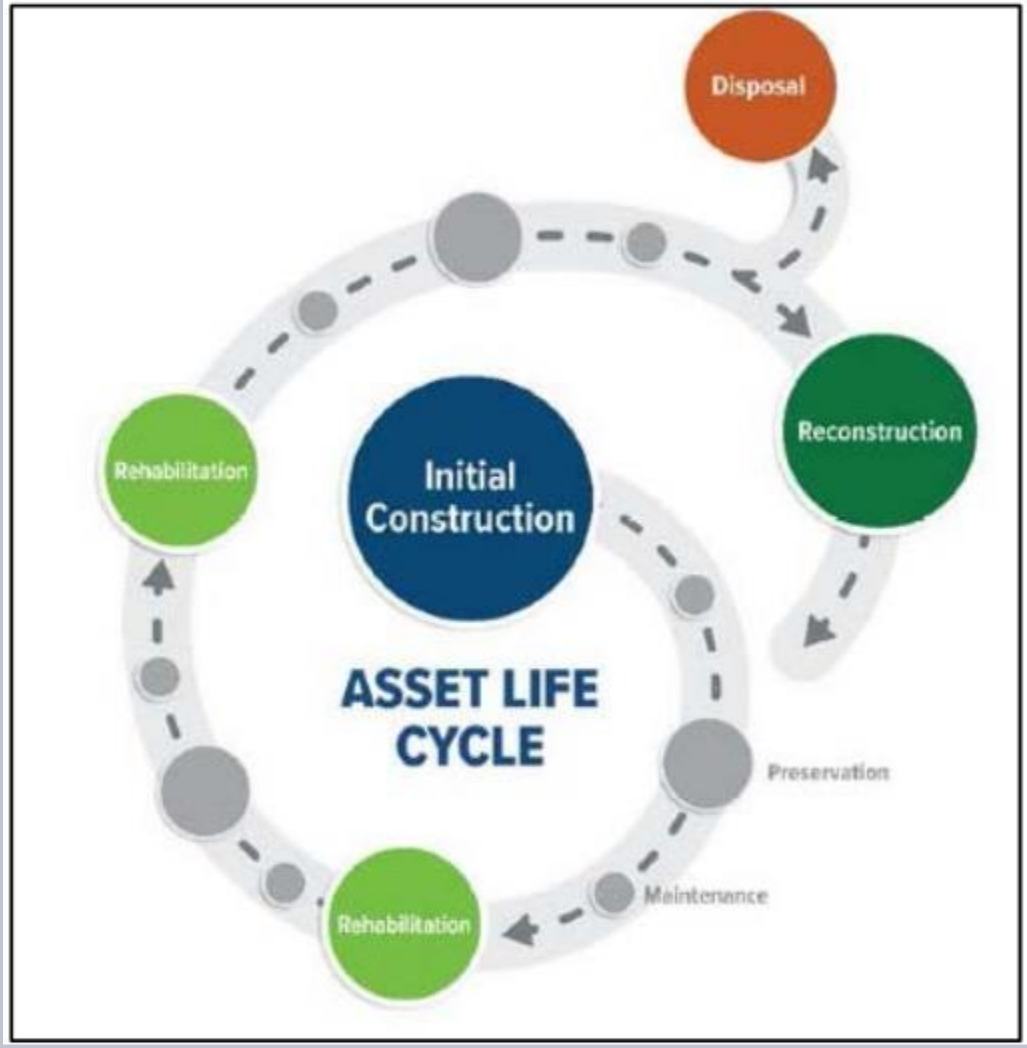
Life-Cycle Analysis/Costs

According to a Life Cycle Planning (LCP) white paper by FHWA's Transportation Asset Management Expert Task Group (July 2019)

- LCP seeks the most cost-effective strategy for managing assets over their entire life by capitalizing on timely and appropriate treatments to extend asset life at the lowest reasonable cost.
- 23 CFR 515.7 (b), State DOT shall establish a process for conducting LCP for an asset class or asset sub-group

- Life Cycle Planning Process



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Life-Cycle Analysis/Costs

- According to a Life Cycle Planning (LCP) white paper by FHWA's Transportation Asset Management Expert Task Group (July 2019)
  - Ohio DOT estimated that if they increase preservation activities by 5% on NHS bridges, that once a steady condition state was reached, ODOT could save $50 million annually

- Challenges:
  - Many agencies lack data or analytical tools to compute long-term costs and benefits of LCP
  - As LCP benefits become more widely understood, more agencies likely to evolve their processes to embrace LCP

TRANSPORTATION ASSET MANAGEMENT PLANS (TAMP)

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MDOT's Transportation Asset Management Plan

1.1 The Need for Transportation Asset Management

The United States and its States, including Mississippi, have built one of the world's most extensive transportation systems, representing trillions of dollars of public investment. This transportation network supports the economy and directly impacts the competitiveness of the Nation and the State of Mississippi. Transportation agencies turn to TAM strategies to maintain and improve the system. TAM ensures that the integrity of the infrastructure is preserved in the short- and long-term.

At its core, TAM supports the ability of transportation agencies to operate rationally and comprehensively with clear strategies to sustain a desired state of good repair over the life-cycle of the assets at a minimum practicable cost. Agencies that implement TAM principles can reap many benefits, including lower long-term costs for infrastructure preservation, improved performance, improved service to customers, and better use of available resources. TAM's focus on performance and outcomes can ultimately result in improved credibility and accountability for decisions and expenditures.

MDOT Bridge Maintenance Treatments

- Maintenance & Preservation is 1 of 7 MS Transportation Goals
- The following maintenance treatments were taken from MDOT's Transportation Asset Management Plan 2045

Element	Type of Maintenance	Treatments
Deck	Cyclical Maintenance	• Joint repair or replace 5 to 10 years. • Deck healer/sealer treatments 15 years. • Deck overlays (new and replacement) 20 to 25 years. • Drainage system cleaning and repair (including bridge scuppers) Annually. • Bridge washing annually.
	Corrective Maintenance	• Deck replacement (to current width). • Approach slab replacement or repair. • Minor deck rehabilitation. • Crack sealing or patching.
Superstructure	Cyclical Maintenance	• Bearing replacement 50 years.
	Corrective Maintenance	• Retrofit of fatigue-prone details. • Retrofit of Fracture Critical Members. • Bearing reset. • Bearing lubrication.
Substructure	Cyclical Maintenance	• Clean bridge seats and abutments 5 years.
	Corrective Maintenance	• Replace or repair damaged elements. • Scour remediation/countermeasures.
Painting	Cyclical Maintenance	• Bridge painting 20 to 25 years.

Under Executive Summary

Federal Legislation

In July 2012, Congress enacted legislation titled Moving Ahead for Progress in the 21st Century or more commonly referred to as MAP-21. MAP-21 is the latest in a line of funding and authorization bills that govern the federal surface transportation program, each leading to the next step of the ongoing transformation of policy and planning to improve accountability. The primary goal of this legislation is to improve how federal transportation funds are allocated with a concentrated focus on asset sustainability.

MAP-21 provides certain mandates that are designed to transform the framework for making investments in transportation infrastructure, while seeking to maximize preservation strategies. It further codifies the ongoing move towards a performance-based highway asset management program with additional life cycle cost requirements as well as requiring a new documented focus on risk management.

LADOTD's Transportation Asset Management Plan

Under Executive Summary

LADOTD Support

LADOTD strongly embraces the MAP-21 legislation and the direction that it provides. In fact, LADOTD's executive management believes that it very nearly mirrors and justifies the ongoing efforts to move asset preservation to the forefront, increases the opportunity to more fully use Life Cycle costs in the project selection process and provides the means to improve our long term asset sustainability.

The mission of LADOTD is to deliver transportation and public works systems that enhance quality of life and facilitate economic growth. LADOTD continues to make significant strides to provide a world class transportation system that fosters economic growth, international and domestic commerce, and tourism. The MAP-21 mandates and the required development of this TAMP is expected to only enhance this effort.

LADOTD's Transportation Asset Management Plan

Under Executive Summary

1.3 TAMP REQUIREMENTS

MAP-21 requires that each State department of transportation (DOT) develop a risk-based TAMP to improve and preserve the condition of assets on the NHS, that contains the following elements:

- A summary listing of the pavement and bridge assets on the National Highway System in the State, including a description of the condition of those assets
- Asset management objectives and measures
- Performance gap identification
- Life cycle cost and risk management analysis
- A financial plan
- Investment strategies

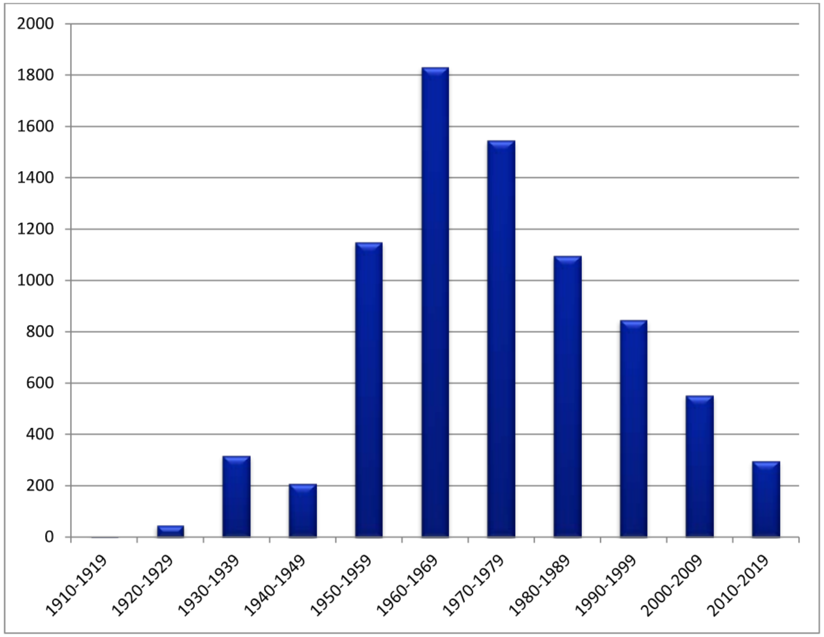
LADOTD's Transportation Asset Management Plan

Under 3.0 Asset Inventory and Performance Measures

Age of Bridges

The age of State maintained bridges by decade built is shown in Figure 3.6. The creation of the Interstate system had a significant influence on the number of bridges built in the 60's and 70's. Analysis shows that 45% of our bridges are over 40 years old and 65% were built before 1980. The opportunity to repeat this enormous effort will not come again due to the extra ordinary cost factors. Preservation of these assets is critical to meeting the transportation needs going into the future. These assets must be managed through their lifecycles and for the long-term.

Figure 3.6 Number of Bridges Built By Decade



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Under 3.0 Asset Inventory and Performance Measures

Challenges

Shift to Structurally Deficient Deck Area

As documented above, LADOTD made the performance goal switch from "number of deficient bridges" to "structurally deficient deck area" following Hurricanes Katrina and Rita in 2005. Those storms resulted in the destruction of a number of bridges, but most significantly it resulted in the loss of the twin 5.5 mile long I-10 bridges over Lake Pontchartrain. The chart in Figure 3.7 dynamically shows the very large increase in "% Structurally Deficient Deck Area" after 2005. Interestingly, the impact of losing over 3.5 million square feet of deck area, representing 2.3% of the total bridge deck area in the State is not at all reflected in the "% Deficient Bridges". This tremendous loss of these 2 bridges only represented 0.03% or 3 hundredths of a percent, of the total number of State bridges, so oddly enough for that year, the performance measure actually improved and exposed the inadequacy of this measure.

The switch from "% Deficient Bridges" to "% Structurally Deficient Bridges by Deck Area" appears to efficiently allow for a consequential impact to the performance measure if one of these very large bridges is negatively impacted, as it should if the bridge is removed from service or requires replacement.

LADOTD's Transportation Asset Management Plan

Under 5.0 Whole Life Management

The concept of Life Cycle Cost Analysis (LCCA) requires a focus on all costs associated with the life of an asset and provides a systematic approach to ensure the most appropriate choices are made to maximize the value of an asset.

The concept of LCCA has been a practice of LADOTD but has not been formally applied agency-wide in a policy driven manner. For instance, construction decisions that only consider immediate costs of a project, and fail to consider long term preservation and operations cost, don't provide the best value for an asset. Following that rationale, consider

5.2 BRIDGE MANAGEMENT

A benefit of LCCA is that it identifies bridges that are not yet structurally deficient and supports the planning of relatively inexpensive projects that can prevent those bridges from entering a state of deficiency, which thus extends their lives. This approach can be used to address more bridges, which more significantly reduces the number of deficient bridges. In the long-term, this saves money and keeps the inventory in better condition.

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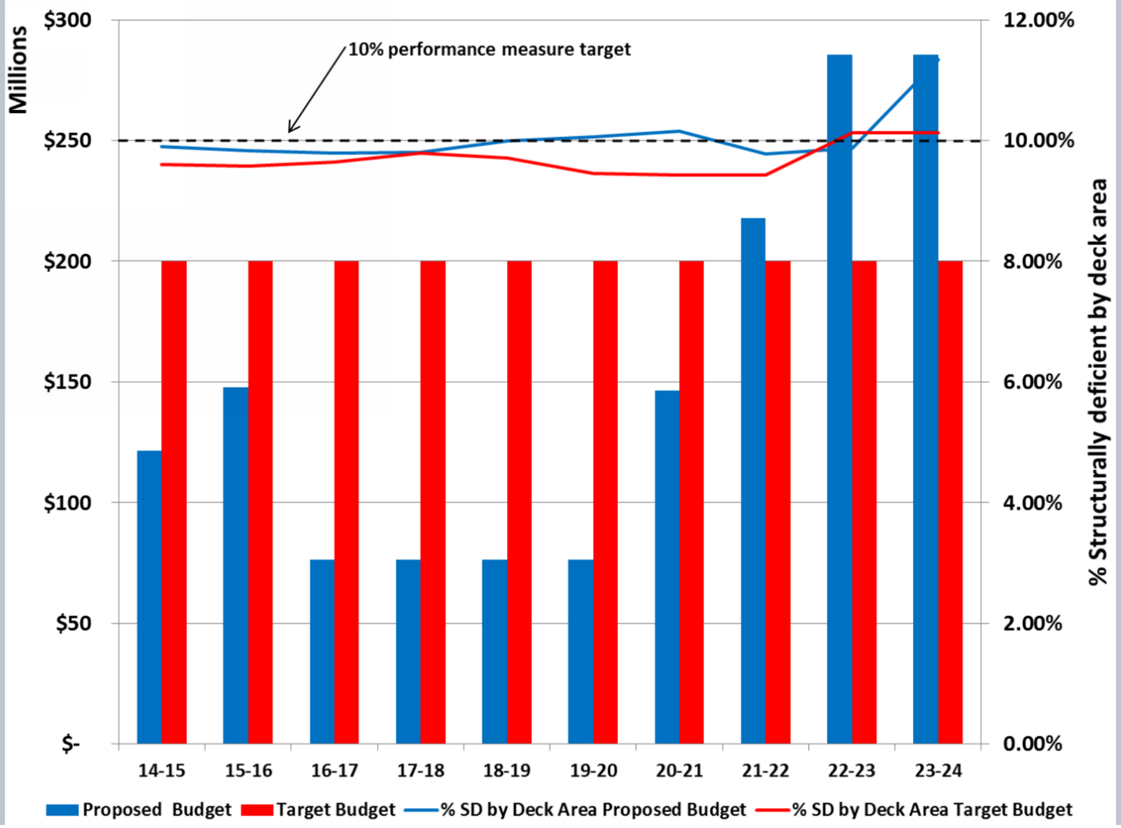
Under 7.7 Pavement and Bridge Funding Gap Analysis

Figure 7.14 Bridge Funding Gap Analysis
(all state maintained bridges by state fiscal year)



It should be noted that a ten year period for bridge analysis is an extremely short time frame, with most relevant analysis going out to thirty years. Extending this analysis out to the thirty year period for these projected budget numbers indicate a significant increase in deterioration in the final years of the analysis. Again while this is a projected analysis by

LADOTD's Transportation Asset Management Plan

Under 8.3 Bridge Specific Strategies

The bridge asset specific strategies are:

- Investigate additional data collection needs, or data coordination with other data stores, which could provide more enhanced and practical condition assessments that enable better predictive budgetary planning scenarios. i.e. higher traffic requires work scheduling around peak times, in some cases significantly increasing the overall cost and time to complete bridge preservation efforts.
- Maximize the useful service life of the bridge by allocating funding aimed specifically at preservation and rehabilitation treatment projects recommended by the BMS in lieu of bridge replacements. As an example, for a steel bridge, preservation could include cleaning and spot painting and rehabilitation could include rehabilitating a member or replacing a member. Designating funds for these treatments would extend the useful service life of the existing bridge prior to allowing the deterioration to reach the point of requiring a complete bridge replacement.
- Consider alternatives to full replacement of bridges.

Under 9.3 Summary of Planned Enhancements

Maintenance Management Strategies

Determine how to incorporate into the overall TAM strategies, the relevant TAM related maintenance activities, tracked in the maintenance management system, that support pavement and bridge preservation.

Investigate Performance Based Practical Design[9]

LADOTD, in conjunction with its local FHWA partners, is investigating Performance Based Practical Design (PBPD) in an effort to deliver a greater number of projects as a result of realizing cost savings by utilizing flexibility that exists in current design guidance and regulations.

Communication Plan

LADOTD will further enhance its existing communication strategy by making the best use of the data and analysis results to communicate the implications of asset management decisions to stakeholders and the public. In particular, these asset management capabilities should enable Department officials to be more proactive in working with the State Legislature and other external stakeholders to optimize funding and foster a clear understanding of the linkage between funding and performance.

ALDOT's Transportation Asset Management Plan

Under Strategies for Implementation

Strategy 7 includes improve preservation practices with a purpose is to minimize life-cycle costs to maintain assets

Under Life-Cycle Planning

"It is more cost-effective to keep assets in good condition than to allow them to deteriorate into fair or poor condition. When creating investment scenarios and considering the results, ALDOT focused on the alternatives that support good asset preservation practices."

Under Conclusions and Next Steps

"Improve preservation practices. Identify and adopt preservation practices which minimize life-cycle cost. This activity depends on the completion of life-cycle cost models, and draws upon the experiences of the ALDOT Districts and other state DOTs. New techniques are usually adopted first by a pilot district or in pilot projects, then deployed more broadly if they are shown to be cost effective under Alabama conditions."

Under Investment Scenarios, Analysis Results, Bridge Analysis Results

(3) Value of Preservation

Although most of Alabama's bridges currently in service were designed for a fifty-year life, in many cases the lifespan can be significantly extended using appropriate preservation treatments, such as:

- Routine interval-based treatments such as washing, lubrication and adjustment of bearings, deck flushing, joint sealing, and deck sealing
- Condition-responsive corrective actions such as painting, patching, bearing and joint repairs, and deck overlays

Routine maintenance treatments in the first category can be applied to whole classes of bridges on a scheduled basis, regardless of their condition, to slow the rate of deterioration. Treatments in the second category must be evaluated on a case-by-case basis, depending on condition, deterioration rates, and costs. A bridge management system with life-cycle planning capability can serve this need. AASHTO is developing this type of system, which ALDOT plans to implement when it is complete.

ALDOT's Transportation Asset Management Plan

Under Additional Steps

- **Establish a comprehensive preservation program** – Understand the impacts and cost-saving ability of regular preservation activities on pavement and bridges, rather than replacement. Establishing a preservation program for assets will assist in minimizing the financial burden over time and help produce a better transportation system.
- **Implement better predictive models** – The use of historical data and a deterioration model specific to Alabama's pavement and bridge categories will benefit the investment scenarios and decision making. Steps are being taken by ALDOT, but continuation and fulfillment of these actions is necessary.
- **Determine impact of improvements** – How long does a chip seal last? How long can ALDOT expect an overlay to remain in good condition? A lack of historical knowledge of preservation improvements limits analysis capabilities. An understanding of the improvements and what each action means to the system, both conditionally and financially, is necessary to help determine the correct strategies for ALDOT in the future.

ALDOT's Transportation Asset Management Plan

Under Additional Steps

- **Collaborate with other Bureaus** – The scenario work within the TAMP provides an opportunity for the Maintenance Bureau to collaborate with other Bureaus within ALDOT. ALDOT could capitalize on this work through the following actions:
  - Coordinate with the ALDOT long-range planning team to learn about the scenario work completed to date and use the data that is applicable to pavements and bridges.
  - Then, determine if more scenario work is needed for bridges and pavements and develop a plan to complete that work.
- **Focus on data presentation** – Present results in a compelling fashion to decision makers.

BRIDGE MAINTENANCE

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Bridge Maintenance

- What are the various bridge maintenance activities performed by the various State DOTs?
- Do the various State DOT agencies perform bridge maintenance activities with their own staff or contract the work out?
- Are bridge maintenance strategies in place to optimize the service-life and life-cycle costs of bridge assets?

LADOTD Preventive Maintenance Cost Information

D.3 Preventive Maintenance Cost Information

Table D.3-1: Preventive Maintenance Cost

Hydro-blasting & High Density Concrete Overlay	
Removal of deck / in	\$5/ ft^2-in
Latex modified concrete overlay	\$10/ ft^2-in
Management of Traffic on Interstate for this operation	\$14/ ft^2
Epoxy Deck Overlay System (Depending on allowable application time limits)	\$6-\$9/ ft^2

BRIDGE REPAIRS

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BRIDGE REPAIRS

- Typically bridge repairs are coordinated with the Bridge Engineer and could also include structural analysis calculations
- A construction sequence is typically provided to guide the Contractor along with including materials and references to Construction specifications
- Bridge repairs are typically bid/let with Contractors performing the bridge repairs; rather than State DOT personnel

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MDOT concrete spall repair

e. Apply a water-based rust converter to exposed reinforcing. The rust converter shall be the following, or an approved equal:

CorrVerter, Manufactured by Cortec Corporation
www.cortecmci.com

f. Apply a migrating corrosion inhibitor to the concrete cavity to be patched. The migrating corrosion inhibitor shall be the following, or an approved equal:

MCI-2020, Manufactured by Cortec Corporation
www.cortecmci.com

g. Patch concrete areas with a single component polymer modified repair mortar that contains a migrating corrosion inhibitor. The repair mortar shall be the following, or an approved equal:

MCI-2702, Manufactured by Cortec Corporatoin
www.cortecmci.com

h. All items of work related to epoxy patching prior to installation of FRP wraps shall be paid for under pay item 907-824-PP005: Bridge Repair, Repair Mortar Patch for FRP.

NOTE: In-place repair used MAPEi XS instead of the MCI 2702 with Mapei XS

NEW BRIDGE CONSTRUCTION

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New Bridge Construction

- Precast/Prestressed Concrete Girders
- Precast Reinforced Concrete Beams
- Precast/Prestressed Concrete Piles
- Precast Concrete Substructures
  - Caps
  - Columns
  - Lagging panels
  - Wingwalls
- Precast Reinforced Concrete Full-Depth Decks
- Precast NEXT D beams (8-inch top flange thickness)

Cast-in-Place Reinforced Concrete Bridge Decks

According to Transportation Research Board Strategic Highway Research Program's Design Guide for Bridges for Service Life (S2-R19A-RW-2)

- Cast-in-Place Concrete Bridge Decks are one of the most common systems in the United States
- Main disadvantages include quality of concrete produced as a result of workmanship and the curing processes
- Inspections of bridge decks have revealed numerous performance issues with CIP concrete, including cracking, corrosion of reinforcement, spalling, delamination, and concrete deterioration evidenced by scaling, wear, and abrasion
- Cracking of bridge-deck concrete reduces the integrity of the passivated concrete layer that surrounds the reinforcing steel, significantly reducing the encased reinforcement's resistance to corrosion

Precast Reinforced Concrete Full-Depth Decks

- According to Transportation Research Board Strategic Highway Research Program's Design Guide for Bridges for Service Life (S2-R19A-RW-2), section 4.5 Overall Strategies for Enhanced Bridge-Deck Service Life
  - Step 2. Identification of Feasible Bridge-Deck Systems, CIP and precast deck systems could be identified as potential alternatives
  - Consider need for accelerated construction to shorten overall user impacts
  - Maintenance of traffic requirements
  - Availability of special mix designs to provide a more durable concrete
    - Consider adding an Integral hardener to increase abrasion resistance according to ASTM C779 up to 6x
  - Step 3. Identification of Factors Affecting Service Life
  - Step 5. Check Service Life
  - Step 6. Identify Maintenance Requirements

Example Applications For Extended Service-Life

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Example Applications For Extended Service-Life

- Can we as an Industry design & construct transportation elements and projects that prevent or reduce the need for future maintenance?
  - Ans: Yes
  - Examples include:
    - durable concrete mix-design including additives
    - Corrosion resistance systems
    - Materials & products
    - Sealers (how many State Agencies require sealers?)
- This leads us to:
  - When does an owner agency and/or engineer prescribe certain project requirements into the specifications/bid documents/provisions?
  - Are projects including service-life goals and/or requirements?
- This leads us to:
  - What Industry research has been done to justify said provisions/requirements?
  - What resources are available to Owners, Engineers, Contractors, Academia to validate these requirements?
- Is cost a factor? Yes
  - Then how do we as an Industry assess costs when making project decisions and who is involved when considering:
    - Initial costs
    - Life-cycle costs
    - Maintenance costs
    - Traffic Control Costs
    - Public or road-user costs
    - Owner Agency costs

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KYTC - Developing Material Specification and Application Criteria for Sealing Concrete Bridge Decks

Report Number: KTC-19-09/SPR19-56-5-1F

The Kentucky Transportation Cabinet (KYTC) has more aggressively pursued preventive maintenance in recent years. Sealing concrete bridge decks is one preventive maintenance activity the Cabinet has actively pursued. KYTC's Divisions of Maintenance and Structural Design requested assistance from researchers at the Kentucky Transportation Center (KTC) in developing a material specification and application criteria for sealing concrete bridge decks at an appropriate time in their life cycle.

To develop a material specification and application criteria for sealing concrete bridge decks, KTC researchers conducted the following work:

1. Perform a national survey of departments of transportation (DOTs) for guidelines.
2. Perform a literature search to determine current practices and guidance.
3. Contact bridge deck sealer manufacturers for recommendations and review test methods.
4. Identify factors related to bridge decks that influence sealing.
5. Develop deck inspection criteria.
6. Prepare a final report that includes criteria for applying sealer to a bridge deck at the appropriate time and a material specification.

MNDOT and TXDOT bridge construction specs/current practice using penetrating sealers

MNDOT

- Requires bridge penetrating sealer (40%) or (100%) for bridge decks
- Item No. 2433.618 “Silane 40 Percent”
- Item No. 2433.618 “Silane 100 Percent”

TXDOT

- Item 428 – Penetrating Concrete Surface Treatment

CIP vs. Precast Bridge Decks/NEXT D Beam Service-Life in Alabama

Let's now compare the service life of a CIP bridge deck compared to a precast full-depth bridge deck using NEXT D beams in Alabama with and without migrating corrosion inhibitors for various exposure conditions (marine, non-marine, and salt) ALDOT's Class B Concrete for bridge decks (Section 501-Structural Portland Cement Concrete)

- NEXT D Beams:
  - 8-inch deck w/ 2.0 inch clear cover (top) and 1-13/16 inch clear cover (bottom)
- CIP bridge deck
  - 7-inch deck w/ 2.0 inch clear (top) and 1.0 inch clear cover (bottom)
  - Maximum w/cm ratio = 0.45

CIP vs. Precast Bridge Deck/NEXT D Beam Service-Life in Alabama using LIFE-365 Software

The following estimates were performed by Andrea Moore with M2 Solutions and David Tomley with Thompson Engineering

type deck	MCI	exposure	top deck	bottom deck
CIP	no MCI	non-marine	62.5	44.2
NEXT D beam	no MCI	non-marine	103.5	93.2
CIP	no MCI	salt	16.5	10.5
CIP	with MCI	salt	53.8	40.6
NEXT D beam	no MCI	salt	28.8	24.1
NEXT D beam	with MCI	salt	85.4	72.5
CIP	no MCI	marine	11.5	8.3
CIP	with MCI	marine	41.5	35.5
NEXT D beam	no MCI	marine	17.2	14.9
NEXT D beam	with MCI	marine	52.2	47.4

- Bottom of deck estimates were lower than the top of deck for all cases mainly due to reduced clear cover
- Precast decks/NEXT D beams provide for greater service-life compared to CIP bridge decks
- Service life estimates will vary depending on exposure conditions
- Bridge decks can achieve increased service-life by adding a migrating corrosion inhibitor

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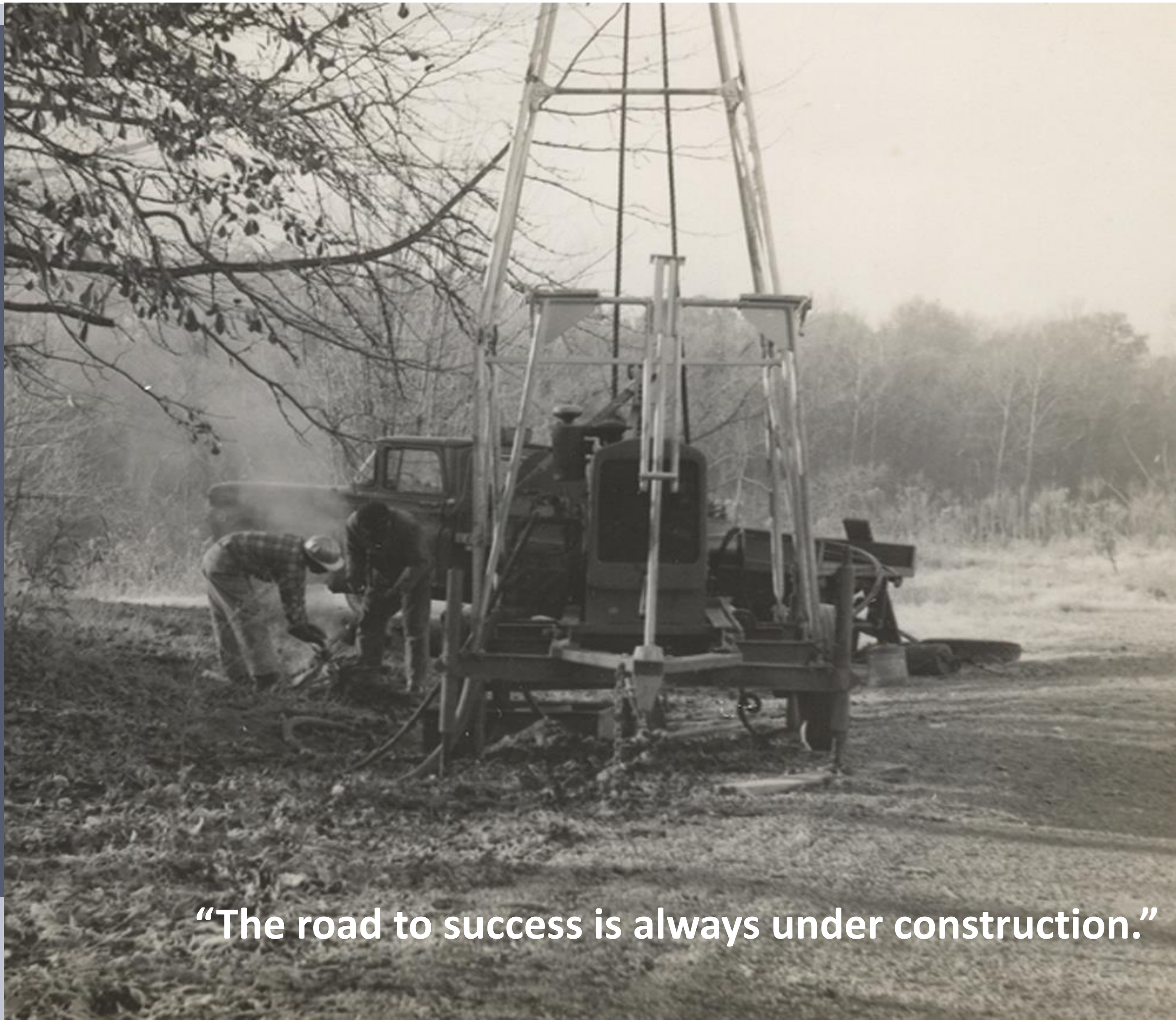
Bridge Preservation

Q/A



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