Featured State 1

IBC 24-FS01: Introduction

Graham Bettis, P.E., Texas DOT, Austin, TX

IBC 24-FS02: Preserving Texas Bridges

Steven Austin, P.E., Texas DOT, Austin, TX

With increased attention on bridge preservation, TxDOT has advanced several key initiatives over the past ten years to plan, program, and execute projects focused on extending the useful life of our bridges. TxDOT has dedicated more state and federal funds to bridge preservation actions than ever before. One of the key programs behind the success of TxDOT's bridge preservation efforts is the Bridge Maintenance and Improvement Program (BMIP) which has seen tremendous growth in the past ten years. Due to prior funding constraints, TxDOT's preservation program had been condition-based for many years. However, several recent initiatives are focused on ensuring programmatic, cyclical, and risk-based prioritization of preservation actions. TxDOT has developed bridge preservation plans for several major bridges and is investing in the development of comprehensive condition evaluations of these bridges to ensure that bridge preservation projects address all known defects. Additionally, TxDOT has established a working group focused on bridges with steel or timber piling in fair or poor condition to mitigate associated risks.

Common preservation actions include overlays, concrete structure repairs, beam end and bearings repairs, and zone painting. TxDOT forces are able to handle some of these repairs but the sheer size of our bridge inventory requires that much of this work be performed by contracted forces. For success of our projects, each of these preservation actions require capable contractors, intensive construction inspection, and effective contract management.

This presentation will provide an overview of these initiatives and the state of practice of bridge preservation in Texas.

IBC 24-FS03: Preserving Texas' Trusses

Robert Owens, P.E., Texas DOT, Austin, TX

The Texas Department of Transportation (TxDOT) has pioneered a historic bridge preservation program, centered on an engineering approach, is presented here with a focus on strategy, funding, and typical repairs. The funding model combines federal grants, state funds, and preservation partnerships, acknowledging the economic, cultural, and aesthetic value of historic bridges. Repairs involve practical rehabilitation strategies such as concrete restoration, corrosion mitigation, and truss strengthening, illustrated through case studies. An interesting aspect is TxDOT's consideration of preserving the truss as a monument, going beyond structural conservation to preserve both the physical structure and its history. In summary, this presentation offers a straightforward look at TxDOT's Historic Bridge Preservation Program, emphasizing funding importance and coordination. Attendees will gain practical insights into repairs, with a spotlight on cases studies of truss rehabilitation projects, positioning TxDOT as a practical model for states dealing with historic bridge conservation challenges.

IBC 24-FS04: I-35 NEX Central Project: Delivering Elevated Lanes in a Constrained Corridor

Marco Galindo, P.E., Texas DOT, San Antonio, TX; Francisco Palacios, Ferrovial-Webber JV, Austin, TX

The I-35 Northeast Expansion (NEX) program consists of five projects valued at just over $3 billion dollars in San Antonio. The program aims to improve safety and mobility, address anticipated growth in the region, and reduce travel time for commuters by constructing elevated structures that will add capacity to this urban area.

The I-35 NEX Central Project is a design-build project valued at $1.5 billion dollars and consists of designing, constructing, and maintaining of approximately 22 miles of elevated structures, including eight direct connectors at two major interchanges, and other operational improvements. This project poses challenges for the team including limited right-of-way, consistently high traffic volumes, heavy congestion, substantial presence of existing infrastructure and significant structural production, among other challenges that come with an urban mega-project. TxDOT, along with the Design-Builder, have partnered to provide innovative engineering solutions and construction techniques for the successful delivery of the project for the San Antonio community. This presentation will discuss multiple innovative solutions used to overcome some of these challenges including industrialization of structural elements, large diameter mono-shaft foundations, project construction segmentation, and 3-D modeling techniques.

Featured State 2

IBC 24-FS05: Concrete Deck Practices and Discussion of Results of Domestic Scan

Kevin Pruski, PE, Texas DOT, Austin, TX

TxDOT participated in the NCHRP 20-68 Domestic Scan 22-01 titled Recent Leading innovations in the Design, Construction, and Materials used for Concrete Bridge Decks. The scan included personnel from 18 states who discussed the varied practices of bridge deck design, materials, and construction techniques. Significant findings and team recommendations will be presented. The evolution of the TxDOT bridge deck design, resulting in a modified version of the AASHTO LRFD's Empirical deck, and construction practices is included.

IBC 24-FS06: Bridge Inspection Program in Texas

Mark Wallace, P.E., Texas DOT, Austin, TX

TxDOT reports approximately 56,600 bridges to the FHWA and carries another 2000 bridges and other structures in the database. The twenty-five highway districts manage the inspection work issued under contracts that are administered by the centralized Bridge Division. Nearly all routine, and approximately half of the NSTM and underwater inspections are done through 25 consultant contracts. The balance of inspections are performed by in-house forces, including a limited number of routine/inventory inspections, and approximately half of combined 1800 underwater and NSTM inspections.
Currently, TxDOT uses 20 consultant contracts to perform an average of 28,000 routine inspections per year, 3 contracts for approximately 200 NSTM inspections per year, and 2 contracts for approximately 100 UW inspections per year.
Structures can be damaged from human and natural causes, have deadloads increased through such events as overlays, and can be subjected to loads higher than typical trucks. All these circumstances have the potential for causing the need for load rating bridges to determine how they are affected. Occasionally, "new" trucks, such as SHVs and EVs, are mandated to be accounted for to prove their effects on bridges. The goal being to restrict loads when needed to maintain the safe load carrying capacity.
As technology changes and improves, the leveraging of gaining new, or more easily obtained data is always considered. Currently, TxDOT makes limited use of technology such as aerial drones and sonar. We are looking to use such technologies were practical, to gain better, more complete information on the condition of our bridges. The technology not only has the potential to provide more complete information, but information that was not previously available without significant effort. There is also a potential for increased safety for our inspectors, reduced inspection costs, and less driver impact.

IBC 24-FS07: TxDOT's Plan for Digital Delivery

Courtney Holle, P.E., Texas DOT, Austin, TX

TxDOT has made large strides toward digital delivery in recent years, starting with the creation of the Digital Delivery Section. This section leads and engages various stakeholders, internal and external, as TxDOT moves toward developing 3D project models that can be used throughout the lifecycle of their assets. This presentation will describe TxDOT's current state and future plans for digital delivery across the department including how bridges/structures is being integrated into the program.

IBC 24-FS08: TxDOT's Bridge Design for Expedited Construction

Hunter Walton, P.E., Texas DOT, Austin, TX

Accelerated Bridge Construction (ABC) designs and practices are useful to address both emergency projects and special needs in key projects to minimize construction zone impacts to the driving public. TxDOT standard practices and details are well targeted for accelerated construction and do not require drastic modification to expedite bridge construction. These details have been developed in conjunction with fabricators and contractors for practical application and construction methods. While certain innovative designs are gaining popularity, the expedited pace of bridge projects in Texas has not necessitated intricate designs. Instead, many traditional ABC methods have proven highly effective in minimizing construction time.

Proprietary 1

IBC 24-01: High Load Multi-Rotational Disk bearings for the Skillman Street Arch Bridge

Ronald Watson, R. J. Watson, Inc., Alden, NY

In 2021 the Texas Department of Transportation awarded a contract to Pegasus Link Constructors for the widening and reconstruction of 11 miles of I-635 on the east side of Dallas. Pegasus Link is a joint venture between Fluor and Balfour Beatty with AECOM as the lead design engineer. The contract value is $1.74 billion and involves the design, build, finance, operate and maintenance of this section of the highway for 15 years. One of the significant features of this project is the signature span carrying Skillman Street over I-635. This tied steel arch design incorporates some high load bearings supporting the superstructure. After a thorough search of available devices, the engineers at AECOM decided to incorporate Disk Bearings on this iconic structure.
Disk Bearings date back to the early 1970's and incorporate a polyether urethane load and rotational element. Disk Bearings have been used on thousands of structures all over the world and have an outstanding performance history in many different climates. This paper will highlight the design, manufacture and testing of these devices for the Skillman Street Bridge which has service vertical loads up to 4330 kips with horizontal loads as high as 69% of the vertical loads. Several other case histories will be presented with a goal towards demonstrating the versatility of these bearings.

IBC 24-02: Lateral Slide of Permanent Panel Bridges to Minimize Traffic Impact

Michael Parciasepe, Acrow, Parsippany, NJ ; Eric Hanson, Grace Pacific, Kapolei, HI

Two Permanent Panel bridges are being implemented on the same stretch of Highway on the West side of Oahu. Not only will these panel bridges be utilizing a MASH Approved TL-3 Rail system mounted to a panel bridge, they were installed using only a 45 minute closure of traffic.

The bridges were assembled and launched into place, adjacent to final alignment in preparation for a weekend closure of the existing structure. During that weekend closure, traffic was diverted onto the panel bridge while the existing bridge was demolished. The new bridge was then longitudinally slid into place using a roller and channel system. Once the bridge was in proper alignment, the bridge was jacked to remove the rollers and lowered down onto the bearings. Since a portion of the bridge was decked prior to the slide, traffic was able to cross the bridge while it was still off final alignment, the total traffic closure only lasted 45 minutes while the bridge was laterally slid into place and traffic re-opened. Once the bridge was in final location lowered onto bearings, the structure was fully decked and the guardrail system was installed.

The second bridge on the project will implement the same lateral slide methodology and be slid into place in Late November/Early December 2023.

IBC 24-03: Fibre Composite Pedestrian Bridges on the Dominion Trail

Michael Kemp, Wagners CFT, Cresson, Texas ; Ali Mohammed, Wagners CFT, Wellcamp, Queensland

The City of Frisco has embarked on a project to utilize green space as an active transportation trail, constructing the "Dominion Trail" walkway. The 1.26 mile pathway, mainly concrete slab on ground, required 3 elevated walkway sections to maintain accessibility through the topography. 500 lineal foot of bridge, and 267 lineal foot of prefabricated boardwalk was required. Fiber composite materials were selected with 9 bridges constructed with spans of up to 100 foot. The intent was to utilize lightweight composites to allow a light touch to the environment, reducing sizes of cranes required, and allowing a narrow corridor to be utilized for construction. Fiber Composite bridges also give superior durability performance, giving the city of Frisco a long life asset. This paper will discuss the structural aspects of design of frp footbridges and boardwalk, through to the installation methods.

Proprietary 2

IBC 24-04: Leveraging UAS, AI, and Digital Twin Technology to Transform Bridge Inspection: Robert Street Bridge

Scott Becher, Bentley Systems, NEPTUNE BEACH, FL; Barritt Lovelace, P.E., Collins Engineers, INC, St. Paul, MN

Owners and operators that are responsible for managing, inspecting, and repairing bridge infrastructure are currently faced with an increasingly difficult task. The rapid increase of structures that are due for repairs or replacement combined with an expanding network and labor force challenges requires an innovative solution from the industry. It is imperative that the owner/operators and the consultants they rely on leverage the latest technology to provide more accurate and consistent data in less time. As we increase our ability to collect and analyze large amounts of data using unmanned aerial systems (UAS), reality models, artificial intelligence (AI), and Internet of Things (IoT) sensing to create digital twins, we are transforming the way bridges are inspected and managed. Building reality models in a collaborative cloud-based platform introduces the new workflow of pre-inspection, on-site inspection and report delivery. This enables better asset assessment prior to on-site inspection, improved planning of resources and equipment, increased worker efficiency, reduced on-site time, increased safety for all workers and traveling public, data-rich delivery enhanced with insights to stakeholders and better decision-making based on more data than previously available. This joint presentation between Collins Engineers, inc., and Bentley Systems covers how using UAS , reality data models, AI, and IoT enabled a new and improved inspection workflow to preserve the century-old architectural marvel that is Robert Street Bridge.

IBC 24-05: Two Coat Inorganic Coating System for Steel Bridges

Kristen Blankenship, Carboline, St. Louis, MO

Design considerations for steel bridge coatings include exposure environment, aesthetics, application, and cost. Steel bridge coatings must offer protection against corrosion. Current techniques including traditional three coat zinc, epoxy, urethane systems, galvanizing, and thermal spray metallization. Another pathway for steel protection includes the use of decades old inorganic zinc spray applied coatings. This approach offers the performance of a metallized coating while using conventional spray application. What's new is the use of an inorganic topcoat that maintains performance and shop throughput while adding color and aesthetics. This study will compare a two coat inorganic coating system against a conventional three coat system, galvanized, thermal spray metallized, and sealed thermal spray metallized system in corrosion resistance lab testing. A comparison of applied cost and throughput will be presented along with a review of the chemistry of this approach and the sustainability benefits it offers.

IBC 24-06: Implementing F3148 Fixed Spline Fastening and The Combined Method

Jeff Greene, LeJeune Bolt Company, Burnsville, MN

The combined pretensioning method and F3148 Fixed Spline Fastening is changing bridge bolting, bringing massive labor savings and higher quality connections. Now approved by RCSC, AISC, AASHTO, and AREMA. Users will want to understand the impact of these systems on future bridge design and construction. ASTM F3148 bolts are a 144 ksi fixed spline fastener that uses the Combined Method of installation. Through the use of this higher strength bolt users can now design using fewer bolts per connection. The Combined Method of installation utilizes torque to produce a quantifiable snug tight condition and angle (nut rotation) to achieve an accurate and reliable pretention well above the specified minimum tension.

Young Attendees Special Session

IBC 24-SS01: Commercial St. Bridge: Finite Element Modeling of a Steel Delta Frame Structure for Accelerated Bridge Construction

James Bumstead, EIT, HDR, Pittsburgh, PA

Commercial St. Bridge is a five span, steel girder system supported by two delta frame arches located in the Pittsburgh area. The bridge consists of seven lines of composite steel plate girders and includes a unique, lateral slide-in methodology for accelerated construction. This presentation will provide a brief overview of the finite element model for this bridge in its final condition, including discussions of the global and local FEA models and the approach used to model the delta frame structure.

IBC 24-SS02: Springville, UT 1600 South - Bridge C 1093 over UPRR/UTA

Richard Jones III, P.E., CBSI, H.W. Lochner, Pittsburgh, PA; Steven Rodgers, P.E., CBSI, H.W. Lochner, Pittsburgh, PA

Bridge C 1093 is a single-span grade separated structure carrying 1600 South over UPRR/UTA tracks that replaced an at-grade crossing. The bridge length and profile were dictated by required horizontal and vertical clearances per UPRR/UTA guidelines. Due to the significant profile increase required, steel girders were used to minimize superstructure depth and approach roadway work. 50-foot approach slabs were required to mitigate post-construction settlement (up to 3").

IBC 24-SS03: Texas DOT - Bridge Construction & Maintenance

Daryn Sims, P.E., Texas DOT, Austin, TX

IBC 24-SS04: P3 Pathway Projects in PA

Cordell Rothrock, Bridging Pennsylvania Constructors, Camp Hill, PA

Current Topics and Issues for Bridge Own

IBC 24-SS05: DelDOT's Implementation of Risk-Based Inspection Intervals

Matthew Mortensen, P.E., Delaware DOT, Dover, DE

The 2022 final rule of the National Bridge Inspection Standards (NBIS) implemented changes to how states can determine bridges for extended intervals. This included introducing Method 1 - a simplified risk-based inspection interval as an option for bridge owners. DelDOT utilized Method 1 to develop a state policy for selecting bridges to be inspected at extended intervals. DelDOT's policy was submitted and approved by the FHWA. This presentation will discuss DelDOT's policy and its development.

IBC 24-SS06: Mitigating Fire Hazards at Texas Bridges

Steven J. Austin, P.E., Texas DOT, ,

Texas' bridge inventory is exposed to a number of hazards. Mitigating the hazards associated with encampments at Texas bridges has been a growing challenge for the state. Texas policy requires that the area below bridges be clear of any flammable or explosive material. Unauthorized occupants inside and below bridges have resulted in significant structural damage and traffic disruptions. This presentation will discuss TxDOT's experiences with this hazard and provide an update on efforts to mitigate this hazard.

IBC 24-SS07: Human-centric AI for Trustable Bridge Inspection and Maintenance Planning

Pingbo Tang, Ph.D., P.E., Carnegie Mellon University, Pittsburgh, PA

This presentation will overview the presenter's efforts in integrating human and machine intelligence to achieve reliable and explainable bridge deterioration modeling. Computer vision and natural language processing techniques can detect and analyze bridge defects from images and reports. Still, these algorithms have difficulty explaining condition ratings and how structural defects form critical failing trends that deserve immediate attention. Human inspectors can guide computers with their knowledge of physics to achieve explainable and reliable condition assessments.

State DOT Bridge Program Updates Speci

IBC 24-SS09: Louisiana Department of Transportation & Development Bridge Program

Kelly Kemp, P.E., Louisiana DOT & Development, Baton Rouge, LA

The presentation will describe the LADOTD Bridge Program including defining its two subprograms "On-System" and "Off-System, bridge inventory types and quantities, and our average annual project letting information. Selected projects will be shown to illustrate project types required to preserve our state routes, such as new bridges for new sites and replacements, repair and rehabilitation of existing bridges, innovations, alternative delivery methods, and bridge design and construction challenges. Aspects of preventive and reactive maintenance and asset management will be addressed.

IBC 24-SS10: Texas DOT Bridge Program

Bernie Carrasco, P.E., Texas DOT, Austin, TX

IBC 24-SS11: Bridges – A Keystone of Pennsylvania Infrastructure

Richard Runyen, P.E., Pennsylvania DOT, Harrisburg, PA

This presentation will provide a basic overview of the Pennsylvania Department of Transportation's (PennDOT) bridge program and offer a high-level look at Pennsylvania's bridge inventory, major ongoing and upcoming bridge projects, asset management approach, bridge inspection program, and current challenges the Commonwealth faces.

IBC 24-SS12: Show Me Bridges at the Missouri Department of Transportation

Bryan Hartnagel, Ph.D., P.E., Missouri DOT, Jefferson City, MO

This presentation will give an update on the Missouri Department of Transportation Bridge Program. Three major river bridges are under construction at this time and an update will be given on these projects. Our design build bridge bundling procurement method will also be described. Finally, innovations we have employed to improve bridge service life will be described.

T1 Steel – Inspection, Testing, and Repair

IBC 24-SS13: Inspection and Testing Access for T1 Steel

Jennifer Laning, P.E., TranSystems, ,

In response to the FHWA Memorandum for the Non-Destructive Testing of Fracture Critical Members Fabricated from AASHTO M244 Grade 100 Steel, bridge owners were required to perform hands-on inspection of tension members fabricated with T-1 steel, including visual inspection to verify the soundness of all tension butt welds and non-destructive testing (NDT) of the welds. Access to perform these visual and NDT inspections on large, complex truss structures is challenging and requires a great deal of logistics and expertise. This presentation will discuss the methods employed to perform inspection and testing on one of the largest trusses in the US and manage the collection of the inspection data.

IBC 24-SS14: Kentucky's T-1 Steel Inspection Program

Jason Stith, Ph.D., P.E., S.E., Michael Baker International, Louisville, KY

In 2021, FHWA sent out a directive requiring the inspect of "T-1" steel, toward this end the KYTC partnered with Michael Baker to develop and execute a plan to accomplish this federal mandate. Through early coordination and steady determination, over 2500 welds on 7 bridges across the state were tested and evaluated. This presentation will discuss this partnership and the steps taken to meet the federal mandate in a calculated, fiscally responsible, and safe manner.

IBC 24-SS15: Jennings Randolph T1 Steel Inspection, Findings, and Indication Remediation

Andrew Adams, P.E., Modjeski and Masters, Mechanicsburg, PA

During a comprehensive inspection of T1 steel details, surface breaking cracks were identified in two welds in the lower chord of the Jennings Randolph Bridge, resulting in its immediate closure. After investigating the impact of the cracks and other indications found, Modjeski and Masters developed remediation plans and partnered closely with the WVDOH to oversee the emergency repairs. This presentation will highlight the interpretation of UT findings and the development of straightforward and easy to implement repair solutions.

IBC 24-SS16: Performance Qualification of UT Technicians for T1 Inspections

Curtis Schroeder, Ph.D., S.E., Wiss, Janney, Elstner Associates, Northbrook, IL

This presentation will discuss performance qualification testing of UT technicians related to UT inspection of T1 butt welds. Discussed will be the performance test setup, scoring criteria, and results. In addition, this presentation will highlight findings from efforts to account for effects of paint on UT scanning through the development of calibration factors.

Suspension-Rehabilitation Design 1

IBC 24-07: Pittsburgh's Three Sisters Bridges Rehabilitation-Historic Bridge Rehabilitation Lessons Learned

Aaron Colorito, P.E., Michael Baker International, Moon Township, PA ; Michael Burdelsky, P.E., Allegheny County DPW, Pittsburgh, PA

Pittsburgh's historic Three Sisters Bridges (6th, 7th, and 9th Street) over the Allegheny River are nearing the completion of three rehabilitation projects that began in 2016. Although nearly identical in design, detailing, and construction, they have experienced age and deterioration in different ways. Numerous structural repairs were detailed throughout the rehabilitations to address different types of deterioration, damage, and deficient load-carrying capacity. These and other repair strategies are presented for structural steel, concrete, and masonry repair, including the challenging process of cleaning decades of soot and soil from the distinctive masonry substructure units of all three bridges. Challenges encountered during the rehabilitation projects are discussed from a designer's and owner's perspective.

IBC 24-08: Repair & Rehabilitation of Historic Suspension Bridges Great & Small

Benjamin Reeve, P.E., Structural Technologies, Fort Worth, TX

Suspension bridges of all sizes and uses are elegant accents across our transportation landscape. As longstanding engineering marvels, these ornate structures have a unique set of maintenance aspects. This discussion will be on the construction, monitoring/inspection, rehabilitation, and lessons learned on suspension bridges of all types and sizes. Recent rehabilitation projects discussed will include (original construction):
•Ambassador Bridge (1929; 1850 ft main span)
•Waco Suspension Bridge (1870; 475 ft main span)
•Missouri River Pipeline Suspension Bridge (1956; 457 ft span)
•Leo Frigo Memorial Bridge (1981; 450 ft span)
•Jefferson Barracks Bridge (1983, 1992; 909 ft span)

The discussion will involve suspended bridges spanning over 100 years of construction, touching on technologies used to monitor them through their service life, as well as rehabilitate the structures for increased demands while maintaining their historical significance. Monitoring and inspection technologies will include non-destructive (e.g. magnetic main flux method (MMFM)) and destructive (e.g. load capacity testing) test methods. Rehabilitation aspects to be discussed will include the replacement of the entire suspension system and will primarily focus on the suspender cables. While the basic structural design aspect of these bridges from throughout history is the same, there are particular similarities and differences between these suspension bridges of different sizes and transportation requirements that will be highlighted. Structural Technologies/VSL's experience in suspended spans provides the background, pictures and methods for this discussion.

IBC 24-09: Suspension Bridge Rehabilitation and Preservation Constructability Challenges

Joshua Pudleiner, P.E., STSC, AECOM, Philadelphia, PA ; James Mandala,. P.E., P.Eng., AECOM, New York, NY ; Barry Colford, AECOM, Philadelphia, PA,

There are 51 long span suspension bridges carrying vehicular traffic in North America. Of that number 50% of them are over 75 years old and 80% of them are over 50 years old. The US, has the oldest major cable suspension bridge inventory in the world with an average age of 73 years. The older of these bridges includes Williamsburg (1903), Brooklyn (1883) and Roebling (1867) with Wheeling (1849) being the oldest in the U.S. As they get older, the inspection, maintenance, preservation and rehabilitation of these bridges becomes even more vital as the majority of them carry critical infrastructure routes and their closure or even partial closure would cause significant disruption and have an adverse economic effect. Therefore, it is essential that they are well managed and maintained.
Over the past two to three years additional funding has been made available to owners of some of these bridges and there is a large program of work being undertaken to ensure and in cases extend the service life of these bridges.
This paper will examine some of the constructability issues faced by engineers when carrying out projects to preserve, rehabilitate or replace elements of these suspension bridges. These include:
•Suspender ropes testing and replacement
•Hand ropes and stanchion post testing and replacement
•Main cable internal wire inspection
•Main cable dehumidification
•Anchorage dehumidification
•Cable band bolt re-tensioning and replacement
•Main cable saddle bent bolt replacement

IBC 24-10: Rehabilitation of the 1870/1914 Waco Suspension Bridge

Patrick Sparks, P.E., Sparks Engineering, Inc., San Antonio, TX; Zach Webb, P.E., Lost Art Structures, Austin, TX

The landmark Waco Suspension Bridge was completed in January 1870, located at the Brazos River on the Chisholm Trail. It was designed by engineer Thomas Griffith of New York, who had previously worked at the Roebling company.
In 1914, the bridge was fully rehabilitated by the Missouri Valley Bridge and Iron Company. In that major project, the bridge was strengthened and widened. The bridge served for vehicular traffic until 1971 when it was restricted to pedestrian use.

In 2018, a number of critical conditions were identified, including a significant loss of strength in the suspension cables, corrosion and improper past repairs of the anchor rods, non-functioning saddle bearings, recurrent cracking in the towers, and deterioration of the wood deck.

The current rehabilitation project, completed in April 2023, involved complete replacement of the suspension cable system and anchors, improvements to the anchorages, sliding saddle bearings, strengthening the towers, and new decking. This paper describes the many challenges of investigation, diagnosis, rehabilitation design and construction of this landmark rehabilitation.

Materials & Research

IBC 24-11: Strengthening of White Bayou Bridge with FRP Composites

Vijaya Gopu, Ph.D., P.E., LTRC & University of Louisiana, Baton Rouge, LA; Walid Alaywan, Louisiana Transportation Research Center, Baton Rouge, LA

The aging infrastructure in the U.S. is requiring the use of innovative and cost-effective ways to repair, rehabilitation and upgrading of reinforced concrete bridges. FRP (Fiber Reinforced Polymers) strengthening systems are increasingly being deployed to accomplish this task. Weight restrictions on existing bridges caused by either the deterioration that has occured over the service life of the bridge or the change in the vehicle axle loads are harmful to commerce. The lack of resources to replace bridges that have exceeded their design service life has resulted in the aging bridges having to be kept serviceable by utilizing practical strengthening systems. Numerous research studies have been conducted in the U.S. over the past two decades to study various aspects of the FRP strengthening systems including the influence of these strengthening systems on the bridge behavior under service and ultimate loads, strength and stiffness, failure mechanisms, and durability of the repair. This paper presents the results of a project involving the implementation of three different CFRP strengthening schemes on an existing concrete bridge near Zachary, Louisiana. Details of the strengthening schemes are provided and the results of the load testing before and after strengegthening are discussed. The load test results are compared with those predicted by finite element analysis of the bridge and the impact of the strengthening systems on load rating of the bridge are examined. Details of the long-term monitoring system installed on the bridge to assess the durability of the strengthening systems are presented .

IBC 24-12: Performance of Carbon Fiber Strand in a Maine Cable Stay Bridge

Jeff Folsom, P.E., Maine DOT, Augusta, ME; Chris Burgess, P.E., S.E., GM2, Inc., Highlands Ranch, CO

MaineDOT in association with FHWA used federal IBRC funds in 2006 to implement a Demonstration Project for evaluating carbon fiber strands in bridges. The program involved installation of representative carbon fiber strands in cable stays of the Penobscot Narrows Bridge and Observatory in Maine.

The bridge uses a cradle system to carry stays from bridge deck through the pylon and back to bridge deck. All strands are independently placed in each stay, thus strands may be individually removed, inspected, and replaced while the bridge carries traffic. This feature provided an opportunity to install and monitor representative carbon fiber strands in the cable stays. Carbon fiber strands were installed for the purpose of assessing long-term performance during in-service conditions and evaluating for use on future bridges.

All the bridge stays were designed to each include two additional reference strands. Six epoxy coated steel strands (2 each in a short, medium, and longer stay) were successfully replaced with carbon fiber strands in June 2007. Data is collected from monitoring equipment installed on all strands (both traditional steel strand and carbon fiber) in the bridge to evaluate carbon fiber performance for future bridge post-tensioning installations. The bridge location in Maine ensures that test strands will be evaluated under a wide range of temperatures and wind loads.

Background will be shared about carbon fiber stay strand installation along with results from inspection and load monitoring that has been performed since 2007 through the most recent results to be obtained in November 2023.

IBC 24-13: Industry Engagement Survey for UHPC Beam End Encasement Options for the Construction of New Steel Bridges

Brian Lassy, E.I.T., University of Connecticut, Storrs, CT; Alexandra Hain, University of Connecticut, Storrs, CT; Sarira Motaref, University of Connecticut, Storrs, CT

The corrosion of steel girder ends presents a significant challenge to the maintenance of bridges, incurring substantial cost and time investments. In response to this issue, the Connecticut Department of Transportation (CTDOT) and the University of Connecticut (UConn) jointly developed a solution utilizing Ultra-High Performance Concrete (UHPC) beam end encasement. This repair method has been tested over ten years of research and is currently being implemented for 40 bridge rehabilitation projects in Connecticut. Due to its success, UConn and CTDOT are expanding the beam end encasement method to new bridge construction. The proposed design replaces a conventional steel bearing stiffener with a UHPC bearing column serving as both a structural element and protective encasement for the beam end, and includes details to integrate this new method into the construction process to ensure cohesion with CTDOT’s standard designs. This study will propose several innovative connection details between UHPC bearing columns and standardized steel K-frame diaphragms and present a comprehensive beam end design tailored to a sample bridge. This paper will also present an industry engagement survey that was conducted to evaluate the structural integrity, cost-effectiveness, and constructability of the connections between steel diaphragms and UHPC bearing columns. By engaging with industry experts in the development and evaluation of new construction methods, the results of this study will provide a highly applicable tool to aid in the nation’s goal of building a more resilient transportation network.

IBC 24-14: Can the Application of Higher Strength and Corrosion Resistant Reinforcement Improve the Crack Control Performance of Bridge Decks and Provide Improved Durability and Service-Life? An Illinois DOT Case Study will be Presented.

Salem Faza, Ph.D., CMC, Irvine, CA ; Tom Russo, CMC ; Maher Tadros, eConstruct USA,

This bridge pilot was the first use of ASTM A1035 LCCR on an IDOT project.
ASTM A1035 is marketed by CMC as "comparable" to stainless steel rebar (SSR) when the required durability and service life of a bridge deck is 100 years to the first major repair. The focus of the Illinois Bridge Engineers in applying ASTM A1035 at fy 80 ksi was to determine if a higher strength design would provide a more efficient and less costly application as compared to their typically used ECR designed bridge decks. Since this bridge selected allows a side-by-side comparison, actual installed cost was collected and compared to determine the final cost premium for a 100 year service life deck when using LCCR versus ECR.
This paper will include the design parameters as well as the results derived from the AASHTO crack control equations.
Using this ILDOT bridge findings, cost comparison estimates to other types of corrosion resistant reinforcement such as A1094, A767, and A955 would be illustrated. Characterization of the effect of bond strength on the concrete/bar system to control the crack width and service life of the structure.

Cable Stay

IBC 24-15: Load Rating of The Gerald Desmond Bridge

Javier Campos, P.E., S.E., Arup, Los Angeles, CA

The Gerald Desmond Bridge Replacement is a 2000-foot cable stayed bridge with two 515-foot tall mono-pole towers. The super-structure cross-section consists of steel-box edge girders composite with light-weight precast concrete deck panels. The approach structures consist of single and multi-cell prestressed concrete box girders.

This paper focuses on the methodology and procedures used to analyze and load rate California’s first long-span signature cable stay bridge. The load rating underpins the structure’s 100-year design life through extensive construction stage analysis, integrating numerous construction documents throughout the life of the project, explicit modeling of locked-in construction effects and compatibility between the as-built cable stayed bridge and site survey information.

The concrete approaches also presented their own load rating challenges, using a MSS construction methodology with locked-in effects that affect the calculations. Lastly, this paper will focus on the non-conventional rating of complex structures, aspects not explicitly covered in the MBE, and rating of elements not typically covered on standard bridges. Understanding the bridge design intent, and interpreting code provisions made this a noteworthy challenge to the load rating team.

IBC 24-16: Construction engineering of the US 181 Harbor Bridge Replacement main spans

Quentin Marzari, P.E., S.E., Arup, San Francisco, CA ; Jonathan Aylwin, Arup, Corpus Christi, TX ; Manuel Contreras Pietri, CFC USA, Miami Beach, FL, ; Javier Campos, Arup, Los Angeles, CA, ; Luke Tarasuik, Arup, New York, NY,

The main spans of the US181 New Harbor Bridge currently under construction will replace the 66-year-old crossing over Corpus Christi, TX shipping channel. With a length of 3,289', a central span of 1,661', and a width under 149', once complete, it will be the longest cable-stayed bridge in the USA, the longest precast segmental span and widest delta frame bridge in the world.

The construction engineering of such a structure called for special attention, particularly when considering the geometry control of the bridge and the site-specific wind hazard.

Erection is performed with precast components hoisted near the towers and delivered by SPMTs to the cantilever front. A derrick crane then lifts the segments/delta frames into position with a manipulator fine-tuning the geometry.

The cable pretensions are carefully tuned to balance loading in different parts of the bridge with the objective of ensuring stresses are acceptable during construction and in-service, as well as limiting the sensitivity of the structure to uncertainties in creep behavior.

Geometry control includes matching the vertical profile to the roadway geometry, as well as correcting for twisting and other minor deformations inherent in the erection sequence.

With a relatively stiff superstructure, geometry adjustment for on-site variations through force is generally inefficient. Consequently, geometry control is mostly achieved using cast-in-place joints every 100' to 140'. This requires proper coordination between the erection engineering, survey, and construction teams to meet the targeted geometry.

Temporary works at closure locations provide moment fixity to protect the in-situ closure joints during curing.

IBC 24-17: Case Study of the Rehabilitation and Preservation of Two Ohio River Cable Stay Bridges

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The Kentucky Transportation Cabinet (KYTC) recognized significant deficiencies in two of their cable stay (CS) bridges across the Ohio River. They retained Burgess & Niple (B&N) to inspect, perform non-destructive testing (NDT), generate rehabilitation plans for extending the service life, provide construction oversite during rehabilitation, and preservation of the two structures. This is a case study of the interesting and pertinent details of the project. The William H. Natcher CS Bridge is 4,505 feet in length and 67 feet wide. It is supported by 96 stay cables connected to two identical diamond-shaped towers: each 374 feet tall. At the time of its construction in 2002, it was the ' longest stay cable-supported bridge over an inland waterway. The William H. Harsha Bridge is 2,420 feet in length, from abutment to abutment. The superstructure is supported by 80 stay cables connected to two identical H shaped towers. Project is on-going.

IBC 24-18: I-395 Signature Bridge - Construction Engineering of Precast Arches and Stayed Spans

Harry McElroy, P.E., McNary Bergeron and Johannesen, Broomfield, CO

The I-395 Signature Bridge consists of six precast segmental concrete arches radial to a center pier from which independent eastbound and westbound cast-in-place concrete superstructures are suspended. These are the first precast segmental arches done in the US since Natchez Trace 30 years ago. Unique details were developed for arch erection, including specialized precast molds, self-consolidating concrete, temporary tie-backs and towers, lifting details, and erection post-tensioning. A congested construction site in downtown Miami presented logistical constraints requiring staged arch and deck activities. Four of the arches will be constructed initially to suspend the westbound superstructure. Then traffic will shift from the old bridge to the new westbound, making way for construction of remaining arches and eastbound superstructure. Asymmetric alignment made no two suspenders alike in orientation. A full 4D non-linear staged construction analysis was used to determine the safest and most economical way to cast westbound and eastbound superstructures on falsework and hang them from the arches by engaging suspenders. In summer 2022 Archer Western de Moya began erecting arch segments.

Innovative Construction Techniques

IBC 24-19: Protection Level 3 application on Internal PT for large precast segmental bridge

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The deck is composed of 1000 No. precast concrete segments. The depth of each box girder varies between 3m and 6.7m, weighting from 60 to 140 tons, and the deck width is constant at 13.4m
Segments are cast following the match cast method, using 3 casting cells that can be adapted to different heights and to all types of segments, from typical and deviator segments to segments on piers and end segments.
Segments are installed following the balance cantilever method using a launching gantry.
The gantry measures 150 meters in length, 18 meters in height, and has a weight of 700 tons with a lifting capacity of 140 tons. It allows for the simultaneous assembly of a pair of segments using the balanced cantilever method. Wind tunnel tests on a scale model were conducted to justify its ability to withstand storm-induced wind loads.
The project's distinctive feature lies in the development and implementation of the prestressing system to meet the project's strict durability requirements, particularly at the joints between prefabricated elements. The internal post-tensioning system ensures the protection level 3 (PL3) with a sealed encapsulation of the cables.
This system establishes electrical isolation between the prestressing cables and the adjacent reinforcing cage, and it is the measurement of this electrical resistance that allows for the monitoring of the PT integrity at all stages of the structure's lifespan.
This is the first full application of a PL3 system with segmental coupler on such a large-scale structure.

IBC 24-20: Preliminary Fatigue Evaluation of a 100-Year-old Double Level Bridge

Richard Stevens, P.E., Hardesty & Hanover, New York, NY; Rasmin Kharva, P.E., Hardesty & Hanover, New York, NY

The Long Island Railroad (LIRR) Double Deck Bridge is multi-level structure carrying ten tracks over the Van Wyck Expressway – a busy corridor leading to JFK airport in Queens, New York. The superstructure system consists of riveted steel framed construction. Portions of the structure over the highway right-of-way are owned by New York State (NYS) DOT, while structure over railroad property is owned by LIRR.

The NYSDOT recently set out to construct two new multi-use lanes on the Van Wyck Expressway, requiring relocation of the lower portion of three column lines supporting this multi-level structure. A complex rehabilitation and load path reconfiguration scheme was developed, preserving much of the existing upper level of the structure to minimize long term impacts to commuter service.

A major fatigue assessment was conducted by NYSDOT and Hardesty & Hanover to compute the expended fatigue life of existing members and estimate the remaining fatigue life under future movements. The fatigue assessment calculations were conducted based on Miner's Rule, AREMA 2017 parameters, and live load stress ranges computed from the model. To further supplement the analysis, a comprehensive strain gage program was conducted where selected girders were instrumented. This paper/presentation will provide the results of the assessment, key factors that made the assessment successful, and lessons learned and recommendations for optimization of future fatigue evaluation.

IBC 24-21: Predicting Bridge Health: Machine Learning-Based Condition Rating from Element-Level Inspections

Zeinab Bandpey, Morgan State University, Baltimore, MD; Ruel Sabellano, Morgan State University, Baltimore, MD; Mehdi Shokouhian, Ph.D., Morgan State University, Baltimore, MD

Effectivity of transportation networks rely on the condition of bridge infrastructure. There are more than 617,000 bridges across the US and about 7.5% of these are considered to have structurally "poor" condition. The State Departments of Transportation (DOTs) have been collecting total quantities and quantities associated with condition states for the National Bridge Elements (NBEs), Bridge Management Elements (BMEs), and Agency Developed Elements, also known as element-level data since 2015.
The objective of this study is to develop a data-driven approach to evaluate conditions of small and medium span bridges and propose new prediction models based on the existing Element Level data and FHWA bridge inspection data.
Structure Inventory and Appraisal (SI&A), element level data, and NOAA weather data from 2015 to 2021 for 2,199 steel bridges were employed, and inconsistent or missing data were identified, cleaned, and processed. The processed data was used to carry out a preliminary analysis to identify the most influential variables on deteriorating a Steel bridge. Several Machine Learning models were examined to find the most suitable prediction model with the highest accuracy for bridge deterioration. This model is instrumental in aiding decision-makers to accurately predict bridge condition and effectively allocate funds for bridge management.

IBC 24-22: An Overview of the I-95 Bridge Collapse, Emergency Repairs, and Bridge Replacement

Joseph Sirignano, P.E., VMA, Benesch, Allentown, PA; Amelia Harris, Ph.D., P.E., Benesch, Cranberry Township, PA; Din Abazi, P.E>, Pennsylvania DOT, King of Prussia, PA

On Sunday June 11, 2023, a fiery truck crash led to the collapse of the northbound bridge carrying I-95 traffic over the ramp to Cottman Avenue in Philadelphia, PA. The southbound structure was compromised and eventually demolished, resulting in the complete closure of a critical corridor of I-95 that normally carries 160,000 vehicles per day. This presentation will review the design and construction of the temporary roadway, completed in 12 days, to partially reopen the interstate, and also focus on the design and construction of the permanent bridge replacement to restore the interstate to full capacity. The temporary roadway utilized Gravix barriers and a bifurcated median barrier, with wire walls and ultra-light weight foamed glass aggregate fill. The permanent bridge replacement consists of two single-span skewed steel bridges. Critical design decisions were made in the hours and days after the incident and influenced all phases of the project. Staging limits were set to minimize construction phases and complete the permanent structure as quickly as possible. The staging limits worked by inches and required unusual design considerations for the permanent structure, including non-ideal deck joint locations and large overhangs. Construction of the original steel structure was completed 6 years ago, and this talk will cover key design changes related to code modifications and material availability under a compressed schedule. This presentation will also cover the evaluation of fire damage to the existing substructure using concrete core samples, and the determination of concrete removal limits. Construction of both stages will be reviewed.

Suspension-Rehabilitation Design 2

IBC 24-23: Proposed Improvements to North American Main Cable Dehumidification Systems

Jonathan Morey, P.E., WSP USA, Edgewood, MD ; Stuart Rankin, WSP USA, New York, NY

Over the past 10 years, main cable dehumidification systems have been installed on select suspension bridges across North America. The performance of these systems in achieving the desired objective of maintaining exhaust readings less than 40% Relative Humidity has been inconsistent. As there is presently no code governing the application of dehumidification systems, WSP has compiled observations through involvement in the design, installation, operation, and maintenance of 8 suspension bridge cable dehumidification systems. By comparing variables across bridges, from resistance to flow within cables, to control and monitoring integration with mechanical equipment, and comparing these observations with systems elsewhere that have a proven history of performance, WSP has developed improvements that should be applied to future dehumidification systems and may be included on existing systems through retrofits. The most critical improvement to the main cable dehumidification system layout is the number of air changes per hour that will take place, which is predicated based on the distance between injection and exhaust locations. A target volume of air circulating through the main cable of 3.5 Air-Changes-per-Hour (ACH), at an injection pressure of 12"w.c., assuming reasonable Loss of Flow along the cable length and Cable Void Ratios, will overcome the non-homogeneous conditions, as well as variables associated with resistance to flow along the length of the cable. Additional improvements to mechanical equipment, locations of exhaust sensors to avoid outside interference from wind, purge valves at low points of dry air piping and the use of gate valves for balancing will be discussed.

IBC 24-24: Deck Replacement and Strengthening of the Throgs Neck Bridge

Roger Haight, P.E., ENV SP, WSP USA, New York, NY ; Courtney Clark, P.E., Thornton Tomasetti, New York, NY; Edmond Knightly, P.E., MTA Bridges & Tunnels, New York, NY; Yimin Chen, P.E., MTA Bridges & Tunnels, New York, NY

The Throgs Neck Bridge (TNB) in New York City is a steel suspension bridge with total length of 2,848 ft. The roadway deck was replaced, and the superstructure was strengthened.

The existing deck on the suspended span of TNB was a concrete-filled grid deck system supported on stringers that provided nearly 60 years of service. Project goals for the new deck included: a lighter system to reduced dead loads; staged construction; and providing a minimum of 75 years of service life. To meet these goals, a new steel orthotropic deck was designed to replace the existing deck. A life-cycle-cost-based approach was used to evaluate three deck alternates: one orthotropic deck alternate, and two filled-grid-deck alternates. The life cycle cost comparison accounted for both the longevity of the orthotropic deck components and the reduced maintenance for elements below the deck due to the jointless configuration. Also critical was for the deck alternative to accommodate staged construction.

For this heavily trafficked bridge, maintaining flow was a key requirement for the deck replacement project. In order to most effectively stage the construction and maintain traffic, multiple staging scenarios were considered to coordinate stage lines for consistent rib spacing and to match longitudinal splices for shop fabrication, along with considering the effects on the deck during the intermediate stages. Staging involved design of temporary median crossovers. Cast-in-place composite deck placed at the anchorage and tower spans used high-performance internally-cured (HPIC) concrete, now standard for roadway decks in New York State.

Since the new orthotropic deck is composite with the stiffening trusses, strengthening/ rehabilitation included addition of shear connectors between orthotropic deck and stiffening trusses and stiffening truss strengthening, all coordinated with the staged construction. New tower span stringers, new concrete-span bearings and pedestals, custom floor truss and stiffening truss gusset plate strengthening and repairs, new median and fascia barriers, new modular expansion joints, electrical and lighting upgrades, and new NFPA-compliant dry standpipe system were also included. Key site conditions included, among others, developing a successful, cost-effective, and constructible strategy among owner, contractor, and designer for addressing pack rust deformations in the existing stiffening truss bottom chord built-up section that caused challenges in installing strengthening plates.

IBC 24-25: Completion of First UHPC Deck Rehabilitation on Entire Suspension Bridge

Sam Boukaram, P.E., WSP USA, Lawrenceville, NJ ; Shekhar Scindia, DRBA, New Castle, DE ; Abate Tewelde, WSP USA, Lawrenceville, NJ, ; Michael McDonagh, WSP USA, Lawrenceville, NJ,

The Delaware River and Bay Authority (DRBA) now has a UHPC overlay on the entire deck of it's 2-mile-long Delaware Memorial Bridge first structure. The UHPC was installed as a replacement of the top layer of the deck to avoid increasing the weight. This is the first suspension bridge with a complete UHPC overlay in the and possibly in the world. Construction began in September 2022 and was carried out in three phases, with completion in November 2023. The UHPC overlay was placed on over 550,000 square feet of deck all while keeping traffic flowing in both directions across the twin bridges. This project was preceded by a small pilot project in 2020 which helped guide project decision-making.
The presentation will briefly review the benefits of UHPC overlays and the steps the design team took since 2018 that resulted in overlaying the entire deck with UHPC, and then present how the full overlay project transpired and discuss some of the challenges encountered and how they were resolved.

Construction Engineering 1

IBC 24-26: Construction of the US 60 Bridge over the Cumberland River

Taylor Perkins, Ph.D., P.E., S.E., Stantec, Lexington, KY; Austin Hart, Kentucky Transportation Cabinet, Paducah, KY

The existing Lucy Jefferson Lewis Memorial Bridge in Smithland, Kentucky carries US 60 traffic over the Cumberland River. This crossing serves as an essential connector for Livingston County and the narrow typical section and imposed weight restrictions of this 90 year-old structure were no longer satisfying the needs of the community. Consequently, in 2015, the Kentucky Transportation Cabinet awarded a contract to design a replacement.

The replacement structure consists of a 700-ft simple-span truss main unit, the third longest in North America, with PPC I-beam approach spans. This paper discusses the construction challenges of the project, which included installation of large foundations in this high seismic region and mitigation of high-water impacts in this floodplain of the Ohio and Cumberland Rivers. The highlight of the construction was the truss float-in. Located in a difficult s-curving stretch of the Cumberland River, the bridge site presented challenges to the erection of the truss. With temporary support restrictions from the USCG and nearby ROW and archeological constraints the Contractor was forced to seek a feasible erection location off-site. Fortunately, an agreement was struck between an under-utilized riverport facility in Paducah, KY and the Contractor to the mutual benefit of both parties. Although 15 miles downriver from the project site, the Riverport facility had the perfect infrastructure for staging and erecting the truss. In September of 2022, the 700-ft truss span was floated from the Riverport facility in Paducah to the project site in Smithland and lifted into place.

IBC 24-27: Brightline Trains Florida: Rail Structure and Construction Innovations over 160 miles of Railroad

Ryan Rapp, P.E., S.E., HNTB, Lake Mary, FL ; Kyle Ervin, P.E., HNTB, Lake Mary, FL ; Scott Dean, P.E., HNTB, Lake Mary, FL, ; Michael Leonard, P.E., Collins Engineering & Design, Jacksonville, FL

Brightline Trains Florida, LLC built a $4.5B rail system to connect the large metropolitan areas of Central Florida (Orlando) and South Florida (Miami) via a high-speed rail corridor. Forty (40) miles of the corridor is new, greenfield railway connecting Orlando International Airport to the existing Florida East Coast Railway (FECR) corridor in Cocoa. Another 120 miles of existing FECR corridor was improved and double-tracked from Cocoa to West Palm Beach.

The 65 structures built utilized a variety of structure types including steel plate girders, steel through-girders, rolled steel beams, prestressed concrete deck beams, prestressed box beams, cellular concrete tunnels built off-alignment and hydraulically jacked into place under live traffic, a cut-and-cover concrete tunnel, and cast-in-place below-grade concrete trenches. The bridges were designed in accordance with AREMA, with additional serviceability requirements for passenger service that were adopted from the Eurocode. Construction within the active FECR rail corridor required phasing to maintain freight traffic at all times. The concrete deck beams incorporated the first-ever U.S. railroad use of Ultra High Performance Concrete (UHPC), and the off-line jacked structures were among the earliest usage of that technology in the U.S.

The submitted paper will provide an overview of all structure types used, the challenges of constructing bridges in an active freight corridor, the design and detailing process and lessons learned from the use of prestressed concrete deck beams and UHPC for a rail bridge application. Brightline's decision to accept the Contractor's alternate technical concept of jacked cellular concrete tunnels will also be discussed.

IBC 24-28: High-Load Jacking for Truss Bearing Replacement at the Pulaski Skyway

Qi Ye, P.E., CHI Consulting Engineers, Summit, NJ; Steven Htet, CHI Consulting Engineers, Summit, NJ; Yujan (Albert) Zhang, CHI Consulting Engineers, Summit, NJ; Liwei Han, CHI Consulting Engineers, Summit, NJ

Under Contract 8B, the steel bearings on Piers 44 to 56 of the Pulaski Skyway are slated for replacement with new HLMR bearings, totaling 34 bearing replacements. Each of these bearings is designed to support substantial dead and live loads, with the peak load reactions for a single bearing reaching around 1,100 tons for dead loads and 290 tons for live loads.

To ensure a seamless and safe replacement of the steel bearings, CHI Consulting Engineers introduced cutting-edge jacking frames and temporary supports. These include temporary diagonal members incorporated within the existing trusses and triangular frames positioned atop the existing concrete steps at the pinnacle of pile caps. For expansion piers, the design integrates temporary sliding bearings.

By October 2023, 12 of the existing bearings have been successfully elevated and replaced. Notably, the most challenging lift was at Pier 43, where an astounding 4.6 million lbs of jacking force was applied to hoist the two trusses from the pier. This achievement underscores the strength and effectiveness of the support systems developed by CHI.

Design & Analysis-Innovation

IBC 24-29: Triple I-Girder, Integral Steel Straddle Bent Application for I-10/US69 Beaumont Eastex

Ahmed Rageh, Ph.D., P.E., Volkert, Tallahassee, FL; Christopher White, P.E., HNTB, Houston, TX; Feifei Bai, Volkert, Houston, TX, HNTB

The authors were recently involved in the design of $720-million reconstruction and expansion projects for two I-10/US69 Interchanges in Beaumont, Texas. Geometric challenges arose in accommodating multi-directional, elevated structures crossing multiple lanes of interstate highway within restricted right-of-way. One particularly challenging location required the use of 149-ft, skewed straddle bents to carry three lanes of traffic over six lanes of divided I-10 NB and SB mainlanes on a 2.75º curve. The unusually long span and vertical clearance requirements prohibited the use of a post-tensioned concrete cap or a "stacked" girder/cap arrangement. Therefore, the authors utilized integral steel bent caps at the two interior pier locations supporting the 61-ft-wide, three-span steel I-girder superstructure.
This paper presents the planning, design, and redundancy analyses of the proposed steel straddle bents. Steel straddle bents are one if the most critical substructure systems since its failure could cause a progressive collapse of the bridge. To ensure the redundancy of the proposed straddle bents, TxDOT's preferred steel non-fracture three I-girder integral straddle bent is employed. The integral girder section developed by the authors was designed: (1) Overall section design using a 3-D FEM beam model to size members satisfying the requirements of AASHTO "LRFD BDS" Section 6; and (2) 3-D shell FEM models by SAP2000 and CSIBridge to design girder/cap connections and verify system redundancy requirements of AASHTO/NSBA "Guide Specification GSFCM-1-UL". Possible fatigue crack locations were investigated and implemented in the three-dimensional modelling of the straddle bent. The analyses and integral steel connection details are presented.

IBC 24-30: Pocket Track Viaduct Pier Strengthening and Rehabilitation

Bradford Shaffer, P.E., S.E., AECOM, Seattle, WA ; Mark Henry, P.E., WMATA ; Elliott Mandel, P.E., AECOM, Arlington, VA, ; Thomas Trapnell, P.E., AECOM, Arlington, VA, ; Rez Lotfi, Ph.D., P.E., AECOM, Arlington, VA,

Three piers along the WMATA D&G Junction viaduct were issued a change order to accommodate the future extension of the center pocket track. This extension is improve rail operations by allowing an 8 car train to wait before crossing between the Orange and Blue Lines. The retrofit was based on providing a redundancy of the anchor bolts, already at Fatigue Life, at the top of the column by providing a post-tensioned concrete cap. For the extension, these caps at each of these 3 piers were increased in size to accommodate an additional steel box girder. The strengthening involved short post-tensioned tendons coupled with steel plates and post-tensioned bars to contain the splitting forces around the existing columns. Finite element MIDAS models were developed along with emphasis on constructability detailing to help facilitate the implementation by the contractor. Direct work with the contractor on RFIs have improved the intended final product.

IBC 24-31: Data-Driven Preventive Maintenance and Service Life Increase of the Sunshine Skyway Bridge – Tampa FL, USA.

Ivan Gualtero, P.E., TYLin, Tampa, FL; Vincent Collie, P.E., Florida DOT, Tampa, FL; Atiq Alvi, TYLin, Tampa, FL; Steve Womble, TYLin, Tampa, FL

The Sunshine Skyway Bridge was opened to traffic in 1987. This remarkable structure is a cable-stayed structure with a Main Span Length of 1,200 ft and a 4,000 ft Main unit with a total of 11 spans. The bridge is now reaching half of its design service life and its owner (the Florida Department of Transportation) is putting a lot of effort into extending the service life of the bridge. This paper describes the Data-Driven Preventive Maintenance and Service Life Increase approach that is being applied to this bridge. This innovative approach implemented by T.Y. Lin includes Structural Monitoring with almost 100 sensors, composed of a balanced mix of conventional SHM sensors combined with custom-built sensors tailor-made for the specific monitoring needs of this structure. Parallel to monitoring, we are implementing a Finite Element Model that will be an accurate representation of the as-built structure and will be calibrated with sensor data creating a true Digital Twin of the structure. The Digital Twin will help to better understand the structural behavior of the bridge and will provide vital data for determining the remaining service life of a very critical component like the stay cables and the stay cable dampers. The data obtained from the sensors is post-processed using the latest techniques in "Big Data" processing and is currently being used to train a Machine Learning model that soon will help accurately predict in real-time structural parameters allowing the identification in real-time any parameter that is outside its normal limits.

Design & Analysis

IBC 24-32: Existing Pier Evaluation using Non-Linear Composite Concrete Modeling

Tony Shkurti, Ph.D., P.E., S.E., HNTB Corporation, Woodridge, IL; Angela Kingsley, P.E., HNTB, Minneapolis, MN

MnDOT contracted with HNTB in 2020 to provide advanced analyses for pier evaluation and repair design at Bridge 9217 carrying T.H. 494 over the Minnesota River. The hammerhead piers were designed prior to the use of modern detailing practices and the introduction of code provisions such as the general method for shear design or the strut-and-tie method for D-regions. Leaking joints over much of the bridge's service life had resulted in long periods of drainage on the piers below, causing widespread deterioration. Assessment of remaining pier capacity was needed to define strengthening needs.

HNTB used a specialty nonlinear finite element analysis program to accurately assess pier behavior and capacity. Based on Modified Compression Field Theory (MCFT) and the Disturbed Stress Field Model (DSFM), the analysis is capable of capturing concrete cracking and stress redistribution between concrete and rebars, capturing nonlinear behavior of the materials such as compression softening due to transverse cracking, tension stiffening, shear slip along the cracked surfaces and consideration of the deterioration effects and repair such as material nonlinear expansion, confinement and clamping effects, rebar bond slip, and cover spalling.

Nonlinear pier analyses were performed using 2D elements incorporating both smeared and discrete bar elements for reinforcement modeling. Force-based analyses were run starting with loading determined by a refined superstructure model and loads were increased in 5-10% increments until the pier could not carry any additional loading. The analysis results showed all possible failure modes and captured the

IBC 24-33: Rehabilitation of the LA 47 over Intracoastal Waterway Gulf Outlet

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TRC was responsible for the development of preliminary and final plans to address the repair and rehabilitation of all substructure and superstructure elements of this historically designated bridge consisting of 1,248 feet of steel main spans with cantilevered arms and a tied arch (main span); 3,304 feet of welded steel girder approaches; 1,590 feet of prestressed girder approach spans; and 480 feet of concrete slab spans for a total bridge length of 6,622 feet.

Work items associated with the rehabilitation and cleaning and painting of the structure were initially defined using previous NBIS inspection reports, non-destructive testing reports, load rating reports, and as-built and widening plans. During the final design, TRC conducting a focused inspection and bridge washing to verify and quantify repair locations. 3D laser scanning was also conducted during the final design to determine which pier(s) translatedr movements to cause excessive finger joint movements at the main spans. Rehabilitation items included cleaning and painting all structural metalwork, safety cable installation, MMA deck sealer, FRP concrete repair, LMC inlay deck repair, heat straitening impacted truss members and retrofitting the truss to accommodating pier movements.

IBC 24-34: Design of the Main Span for the Bogota MRT Line Viaduct

Rajan Chaurasia, P.Eng., WSP Canada, Mississaugua, ON Canada; Max Nie, WSP Canada, Burlington, ON Canada

The Bogota metropolitan area suffers from the world's most severe rush-hour traffic congestion, surpassing major cities like Manila, Mumbai, and Tokyo. The planned first Metro Line is a 24km long elevated Mass Rapid Transit (MRT) line featuring 16 stations, along with a depot. The WSP Global teams are awarded as the project's lead consulting, while WSP Canada teams have been tasked with designing the viaduct structures. The entire elevated viaduct consisting of 750 spans would be built using span-by-span segmental construction. This paper presents the challenges encountered in the design of the main span (215m) long viaduct taking into consideration a range of design codes.

The three-span (57.5m + 100m +57.5m) viaduct carrying 2 pairs of LRT (Light Rail Train) tracks was designed using a balanced cantilever construction method. The primary design code was Colombian Bridge Design Standard - LRFD (CCP 14), which is heavily based on AASHTO LRFD Bridge Design Specifications – 2012. However, several other design codes, such as the latest AASHTO, ACI, and Eurocode, were also incorporated to address other load cases like train live load and associated load cases like hunting, longitudinal, and rolling forces, including train derailment, broken rail, and rail structure interaction. As the design advanced, the design criteria underwent changes to reconcile conflicts arising from the incompatibility of these design codes.

Rehabilitation Design 1

IBC 24-35: Suspended Truss Span Rehabilitation of Wind Shear Devices

Greg Roby, P.E., Stantec, Baltimore, MD; Ruel Sabellano, Maryland Transportation Authority, Baltimore, MD

The Millard E. Tydings Bridge (I-95 over Susquehanna River in Maryland) was built in 1962. It's an
87-foot wide by 5,061-foot-long steel deck truss consisting of anchor spans and suspended spans. The suspended spans are 245 feet long and are hung by vertical members from the cantilevered anchored spans. Wind shear devices keep the suspended spans aligned. This project involved an innovative way to rehabilitate and restore these devices with minimal impact to traffic. The original 1962 wind shear device consisted of steel-on-steel wear plates carrying the vertical weight of the devices and longitudinal wear plates to keep the spans aligned. After 20 years of wear and deterioration, in 1984 the original devices were retrofitted with new devices atop of the original devices. This allowed the original devices to perform while the retrofits were installed. The 1984 retrofits utilized elastomeric pads on the vertical and horizontal wearing surfaces. The elastomeric pads eventually fell out, transferring the extra dead weight to the original device, along with the original device now performing the full function of a wind shear device. This accelerated deterioration of the original devices which resulted in the need to completely rehabilitate all the bridge's wind shear devices. Stantec developed an innovative approach to rehabilitate both the original and 1984 retrofit wind shear devices with minimal impacts to traffic. Now the Tydings Bridge has an original and backup wind shear device at each of these critical locations. Various other truss and substructure repairs were completed at the same time.

IBC 24-36: Rehabilitation of the Historic Union Bridge over the Ottawa River

Amer Hammoud, M.A.Sc., P.Eng., Parsons, Ottawa, ON Canada; Patrick Mergel, Parsons, Ottawa, ON Canada; Peter Harvey, Parsons, Ottawa, ON, Canada; Thierry Tremblay Prebinski, Public Services and Procurement Canada, Gatineau, QC, Canada; Paul Lebrun, Public Services and Procurement Canada, Canada

The Union Bridge, built in 1919 and owned by Public Services and Procurement Canada, is a 71.5 m long single-span riveted steel through truss bridge spanning the main channel of the Ottawa River downstream of the Chaudière Falls. The Union Bridge serves as a vital transportation link along the Chaudière Crossing, the oldest crossing over the Ottawa River in Canada's National Capital Region, linking the City of Ottawa in the Province of Ontario with the City of Gatineau in the Province of Quebec. The inspection and evaluation of the 100-year-old structure identified multiple components that are in critical need for repair or replacement. Active transportation improvements including construction of new raised concrete cycle tracks were also required. Rehabilitation work included concrete deck replacement, stringer replacement, floor beam strengthening, truss members strengthening, structure jacking, bearing replacement, structural steel recoating, approach slabs replacement, new waterproofing and asphalt wearing surface, new fibre-reinforced polymer sidewalk, new parapet wall and railing, and substructure rehabilitation. Since the bridge serves as an important route for vehicles and transit between the two cities, a minimum of one open traffic lane was required to be maintained throughout construction. Restrictions and considerations due to the staged construction, limited access and the extensive rehabilitation of the structure's main components presented numerous challenges that required detailed analysis, planning and sequencing of work.

IBC 24-37: Bringing New Life to an Old Bridge through Effective Teamwork

Andrew Goodrich, P.E., Burgess & Niple, Parkersburg, WV ; Dan McCaffrey, P.E., Modjeski and Masters, Mechanicsburg, PA ; Andrew Adams, Modjeski and Masters, Mechanicsburg, PA,

Previously owned by the City of Parkersburg, WV, a toll bridge locally known as "Parkersburg Memorial Bridge" serves as a key link between Parkersburg and the City of Belpre, OH. The 70-year-old steel structure was in serious need of rehabilitation to remain in service; however, the funds needed for such a project were above the means of the city.

In early 2021, after a Request for Proposal process, the City of Parkersburg entered a Public-Private Partnership with United Bridge Partners (UBP), a company whose mission is to offer solutions to state and local governments to replace or repair bridges in need. Under this partnership, UBP would acquire the bridge and provide 100% of the funding to rehabilitate the bridge. UBP formed a local subsidiary, Parkersburg Bridge Partners, which will provide long-term operation and maintenance.

Using the Construction Manager/General Contractor (CM/GC) Method for this project, UBP teamed with Modjeski and Masters as the design engineer, Kokosing Construction Company as the General Contractor, and Burgess & Niple as the Owner's Engineer/Field Representative during construction. This $50+ million project included extensive repairs and replacements of steel components including pin & hanger-to-splice retrofits in the multi-girder approach spans, strengthening of steel truss members, deck replacement using fiber-reinforced concrete and galvanized rebar, patching and coating of all concrete substructures, complete blast & painting, installation of an upgraded roadway & decorative lighting system, and implementation of an all-electronic tolling system.

The presentation will focus on the rehabilitation scope and the effective partnering among the entire team.

Construction Engineering 2

IBC 24-38: Falls Creek Bridge: Design For a Mountainous Site Washed Out by Atmospheric River

Borja Alverez, P.Eng., Stantec, Victoria, BC Canada; John Philip, P.Eng, MICE, C.Eng., Stantec

This case study describes the challenges and structural solutions analyzed and adopted for the permanent reinstatement of a bridge crossing on the Trans-Canada Highway 1 at Falls Creek in British Columbia, Canada, where an existing embankment and culvert was washed out by the atmospheric river event of November 2021. Initially the highway was reopened with a temporary 80 m single-span Acrow bridge carrying a single lane of traffic operating under an extended length of SLAT (Single Lane Alternating Traffic) to maintain traffic flow over the wide steep gulley that resulted after the washout. The main objective was the rapid restoration of two-way traffic allowing removal of the costly SLAT and ultimate completion of a three lane structure. The presentation will describe how the design of the permanent works was influenced by the site constraints, schedule requirements and location as well as the effect such constraints had on choosing the erection method. The construction of the bridge, a 79 m curved steel plate girder span involving precast components, girder launching, and lateral sliding is described in a second paper and presentation at the conference. The project is being delivered under an Alliance Contracting model, which involves an integrated team of Owner, Contractor, and Designer.

IBC 24-39: Falls Creek Bridge: Accelerated Bridge Construction With Precast, Launching and Lateral Sliding

Murray Johnson, P.Eng., Stantec, Victoria, BC Canada; Vikram Verma, P.Eng., BC Ministry of Transportation and Infrastructure

The Trans-Canada Highway at the Falls Creek site had been operating under single-lane alternating traffic ever since an atmospheric river event washed it out in November 2021, with an urgent need to reopen it to three-lane traffic. Working under the Alliance Contracting model, the project team employed a variety of accelerated bridge construction methods to construct the 79 m curved steel plate girder span while maintaining traffic on the single-lane emergency bridge that occupied part of the permanent bridge alignment. Construction techniques included innovative partial-shell precast abutment elements, launching of curved steel girders in pairs, offline opening of the permanent bridge to traffic while the temporary bridge was removed, and lateral sliding of the completed bridge into the permanent alignment during a short traffic closure. The steep mountainous terrain in a semi-remote area provided a highly constrained construction site with multiple challenges overcome by the integrated Alliance team who worked together on all elements of design and construction. The design of the permanent structure including the impacts on design resulting from the intended construction techniques is described in a second paper and presentation at the conference.

IBC 24-40: Walk Bridge Project : The design journey of replacing a historic movable rail bridge in a busy Northeast Corridor, from bridge type selections to creating an aesthetic structure reflecting the community of Norwalk, Connecticut

Jesse Miguel, AIA, NCARB, ENV SP, HNTB, Kan, MO; Christian Brown, HNTB, Kans, MO; Jeffrey Portal, Connecticut DOT, Newington, CT

The Walk Bridge, is a 127-year old swing span railroad bridge over the Norwalk River, listed on the National Register of History Places, and part of Metro-North Railroad's New Haven Line and serving as the link to the nation's busiest rail corridor, the Northeast Corridor. Listed on the National Register of Historic Places, the Walk Bridge has reached the end of its useful life, failing to operate properly disrupting rail service, and requiring several emergency repairs. In 2011 the constant pattern of failures became apparent, and after failing twice within a 2-week week in 2014, the ConnDOT Commissioner signed an Emergency Declaration, resulting the need to replace the bridge. The final design chosen is a vertical lift bridge, selected for allowing the least disruption to rail service while under construction.

The design process consisted of studying various bridge type options, primarily movable bridges but also some fixed high bridges, required to maintain the navigational channel as required by the US Coast Guard. These options were reviewed and evaluated and initially a twin bascule option was selected. But that required having to construct a temporary run around bridge carry two tracks to allow construction, which led to the final selection of the vertical lift span bridge, construction started in Spring 2023.

The new Walk Bridge will be aesthetically designed per the City of Norwalk with review by their Design Advisory Committee, due to its location in a historic South of Norwalk district and becoming the symbol of the area.

Design & Analysis-Urban Interaction

IBC 24-41: Jane Byrne Interchange: Complex Interchange in Historic Urban Environment

Matthew Santeford, P.E., S.E., TranSystems, Schaumburg, IL

The Jane Byrne Interchange (Circle Interchange) is the hub of the Chicago Expressway System: the convergence of the Kennedy, Dan Ryan, and Eisenhower Expressways (I-90/94 and I-290) in downtown Chicago, accommodating 400,000 vehicles per day (25% trucks). In 2012, the interchange was rated by the American Transportation Research Institute and the FHWA as the #1 freight bottleneck in the country, a distinction the Illinois Department of Transportation was motivated to address.

This $640M reconstruction project was a massive undertaking. It was a complex, challenging exercise to essentially rebuild the interchange within, and on top of, the existing interchange. The project involved the reconstruction of 19 bridges (including 7 curved steel girder ramp bridges, two of which were tri-level flyovers), nearly 50 retaining walls, and over 32 miles of expressway lanes.

Adding to the complexity were ten service interchanges within the project area. Two of these service interchanges, at Adams Street and Jackson Boulevard, required complex steel framing to accommodate the entrance ramps that "T" into the side of the crossroad bridges. Each of these structures are also adjacent to sensitive, historic structures, making construction vibration a serious concern.

This presentation will provide an overview of the Jane Byrne Interchange project, as well as focus in on the details of the complexity of the Adams Street and Jackson Boulevard service interchanges. The bridge design as well as the design of 20' tall retaining walls founded in soft clay material will also be discussed.

IBC 24-42: Bridge Rehabilitation in the Heart of Our Nation's Capital

Ahmad Faqiri, HDR, Vienna, VA; Jeffrey Hollands, P.E., HDR, Washington, DC

Over half a mile of an elevated portion of the I-695 Freeway in Washington, DC is comprised of three main bridges and 10 ramp bridges. Bridge 1103 and its ramps, approximately 800 feet long, are a series of simple prestressed bulb-tee spans ranging from 50 to 150 feet long supported on reinforced concrete pier bents. Bridges 1104 and 1109, approximately 550 feet and 1500 feet long respectively, are primarily a series of simple steel plate girder spans ranging from 50 feet to 260 feet long supported on steel cross-girders and reinforced concrete columns. Several of the steel plate girder spans include pin and hanger connections. Theses bridges span over parking lots, local roads, and CSX facilities, resulting in complex bridge shapes. Built in the 1960s and rehabilitated in 1990s, these bridges are in poor condition, needing deck repair, joint replacement, beam repair, pin and hanger retrofit, bearing repair, pier/cross girder repair, and column/abutment repair. Due to the highly urbanized location of this project and the importance of the freeway to the transportation network of the US capital city, MOT is a major component of the project. To mitigate the risk and reduce the construction duration, the design team has proposed accelerated bridge construction methods such as use of ultra-high-performance concrete for the bridge deck overlay and some of the other repairs such as link slabs and joint replacements. Additional innovative rehabilitation techniques, to enhance bridge preservation, include metalizing of concrete and catcher beams at pin-and-hanger locations.

IBC 24-43: Pittsburgh International Airport Terminal Modernization - Construction overview and opening preview

Kevin O'Connor, HDR, Pittsburgh, PA, PA

The Pittsburgh International Airport Terminal Modernization Program (PIT-TMP) will be approximately 90% complete at the time of the IBC in 2024. When the 2025 IBC comes back to Pittsburgh the Airport will be completed and open, and many of the conference attendees will pass through the new facility. The PIT-TMP is a terminal and roadway project that includes architectural and art elements as part of the Terminal Front Bridge and retaining walls. This presentation will show construction photos of the nearly complete facility and compare to renderings and mockups that were produced in design to illustrate the successful execution of the project vision. The PIT-TMP was designed using an overarching concept of Nature, Technology, and Community (NaTeCo). This concept is evident in the design of the Terminal, the bridge and retaining walls, and the terminal curbs on the bridge. The bridge design team also paid special attention to the user experience at the terminal curbs on the bridge, which is an area that is often neglected in airport design.

Foundation Design & Analysis

IBC 24-44: Widening an Interprovincial Bridge over the Ottawa River

Ryan O'Connell, P.Eng., Parsons, Ottawa, ON Canada; Jack Ajrab, P.ENG., Parsons, Ottawa, ON Canada; Paul Lebrun, P.Eng., Public Services and Procurement Canada, Gatineau, QC, Canada; Thierry Tremblay, P.Eng,, Public Services and Procurement Canada, Gatineau, QC, Canada

The Hull Causeway is an existing three-span, two-lane steel girder bridge, part of the Chaudière Crossing, connecting Ottawa, Ontario to Gatineau, Quebec over the Ottawa River. This paper will focus on widening the structure and the design challenges associated with it. Widening the structure required the addition of a new plate girder, widening of the abutments and introduction of an approach span and associated substructure and foundation. The north end of the structure spans across the Devil’s Hole, a karst feature which has existed for a period of time dating back to the 1800’s. The presence of hole presented challenges for widening as the new steel girder required widening of the abutments. At the south end of the structure, mircopiles were capable of supporting the structure. Supporting the north end of the structure, which is located directly next to the Devil’s Hole, with new caissons, would require a design based on a total length of approximately 50m and unsupported length of almost 45m. As a result of the caisson required, and its associated cost and potential construction impact on the existing structure, an alternative design was completed. The existing abutment would be widened and supported by a series of rock anchors tied in to the solid bedrock under the existing abutment. The new north approach span abutment was required to be in an area whose stability is controlled by a crown pillar along with sliding of a fault feature. To stabilize the foundation, a series of rock anchors were installed.

IBC 24-45: New River Draw Bridge Design and Analysis for Cooper E80 Locomotive Loads

Aravinda Ramakrishna, P.E., Hardesty & Hanover, Hamilton Township, NJ; Brian Mileo, P.E., Hardesty & Hanover, Hoboken, NJ; Kevin Gurski, P.E., Hardesty & Hanover, Hamilton Township, NJ

This paper presents the foundation design aspects for the new River Draw Bridge project in New Jersey. The new bridge piers are founded on clusters of 8.0 ft diameter drilled shafts with shaft tip elevations varying from 180 ft to 230 ft below water line to satisfy the American Railway Engineering and Maintenance-of-Way (AREMA) Manual requirements, which requires bridge foundations to safely withstand Cooper E80 locomotive live loads. This paper also discusses the results of the static load test program implemented to verify the as-built drilled shafts achieved the assumptions made during the design phase. The objective of this paper is to present the different aspects of the bridge foundation design to safety withstand Cooper E80 locomotive live loads.

IBC 24-46: The Value of Value Engineering

Austin Spencer, P.E., Pennoni, Newark, DE; Michael Alestra, P.E., Newark, DE

Pennoni was retained by the contractor, RE Pierson Construction Company to redesign the foundation for a proposed moveable bridge replacement to accelerate the project schedule as a value engineering alternative. The proposed bridge replaces an existing 10 span twin leaf bascule bridge and consists of 67.5 feet wide, 664 feet long, six span bridge with a 105-feet long bascule center span crossing the Shrewsbury River from Rumson to Sea Bright, New Jersey. The original replacement design proposed founding the abutments and piers on five-foot diameter drilled shafts ranging in length from approximately 90 to 126 feet. As part of this alternate foundation design, the contractor sought to replace the drilled shaft piles with 42-inch concrete filled steel pipe piles, ranging in length from approximately 90 to 140 feet.
The geotechnical design consisted of determining geotechnical axial and lateral capacities as well as vertical and lateral pile displacements. The structural design consisted of steel pipe pile structural capacity, and the bridge foundation reinforcement was redesigned for the revised pile layout.
Extensive coordination was required with Pierson, Monmouth County, NJDOT and the original design consultant throughout the fast-tracked design development process with project design criteria that included maintaining the pier foundations/pile caps footprint, minimizing noise and vibration during installation, as well as limiting lateral deflections to 0.5 inches longitudinal/0.25 inches transverse for bascule piers and 1 inch for the remaining piers and abutments. Additionally, scour depths of up to 33 feet needed to be considered.

Movable Bridges

IBC 24-47: High Rise Bridge Grid Deck Replacement and Structural Repairs

Deanna Nevling, HDR, Virginia Beach, VA; Brianna Binowski, HDR, Virginia Beach, VA; Christopher Dean, HDR, Virginia Beach, VA

High Rise Bridge (HRB) is a double leaf trunnion bascule bridge located in Chesapeake, Virginia on Interstate I-64 with over 80,000 vehicles a day crossing the bridge. The existing open and concrete filled grid deck had reached the end of its service life and needed to be replaced. Several stringers and floorbeams exhibited deterioration requiring repairs to extend the service life of the structure. An expedited design, fabrication, and construction schedule was necessary to complete the repairs in sequence with the adjacent new High Rise Bridge opening to ensure hot lanes and tolling revenue could be generated through the corridor. VDOT accelerated the design schedule and procured the new grid deck directly from the fabricator concurrently with the selection of a contractor for the project. Stringer and floorbeam repairs included replacing all continuity plates, replacing severely deteriorated stringers, repairing locations of floorbeams and stringers that could only be accessed with the grid deck removed. Numerous challenges were overcome during construction due to undocumented as-built changes and fabrication tolerances. For example, grid deck channel support holes did not align with the existing holes in the stringers and bascule girders, existing railing attachments were misaligned with the new grid deck panels, and new grid deck panels did not fit longitudinally or transversely. VDOT, the fabricator, contractor, and the designer all collaborated as a team to overcome numerous obstacles to ensure the gird deck replacement and repairs were completed on time.

IBC 24-48: Vehicle Collision Repairs to an Overhead Counterweight Rolling Lift Bridge

Jonathan Eberle, AECOM, Mechanicsburg, PA; Jason Hastings, Delaware Department of Transportation, Dover, DE; Neil Shemo, AECOM, Mechanicsburg, PA

On December 28, 2021 DelDOT’s bridge 2-021A was impacted by an over height vehicle travelling on the structure. The structure, originally constructed in 1929, consists of steel girder approach spans on either side of the 55’ – 10 ½” overhead counterweight rolling lift main span and carries Rehoboth Blvd over the Mispillion River in Milford, DE. This waterway provides access for boats upstream to the Delaware Bay and the movable span operates a few dozen times a year for pleasure watercraft.
The impact sustained to the bridge occurred when the arm of an excavator being trailered north on the roadway directly impacted the portal frame above the roadway leading to significant damage to the machinery platform. AECOM was tasked with the inspection and repair design for the damage sustained. Repair drawings were prepared and the construction was awarded under an on-call contract. As construction was about to begin, the bridge was impacted a second time in a similar fashion which caused additional damage to the structure. Inspection was performed and the scope of work was modified to include additional repairs. Construction was completed under a full vehicular detour of the roadway and the bridge was reopened to navigation and vehicular traffic on August 11, 2023. This paper will discuss the findings of the inspection, the repair design and issues encountered during construction including the second impact. It will also discuss unique methods used for construction, lessons learned from the project and DelDOT’s plans to prevent future impacts to the bridge.

IBC 24-49: Collaboration to address Construction Challenges – The Loxahatchee River Bridge Rehabilitation

Steven Shaup, P.E., TranSystems, Fort Lauderdale, FL; John Williams, Wiss, Janney, Elstner Associates, Inc., Doylestown, PA

The Loxahatchee River Bridge, a simple trunnion bascule bridge in Jupiter, FL, required rehabilitation to restore it to double track service after decades of single track use. The project was initially let using design-bid-build procurement to perform superstructure replacement of the bascule and approach spans with a single extended duration rail outage. The Contractor proposed an alternate plan to reduce the rail outages to one 24-hour and one 48-hour outage. However, this required the Designer to collaborate with the Contractor and agree to alter some of the structural and mechanical details to suit the Contractor’s means and methods. During the early stages of construction, it was decided to increase the scope of the rehabilitation work to include substructure replacement for the approach spans. This work was delivered as a CMGC-type procurement working collaboratively and performing redesign on the fly, as needed.

The paper will provide background information on the design of the replacement bascule span superstructure, the alternate plan for construction proposed by the Contractor, the design collaboration process that was followed to develop the structural and mechanical design details to suit the Contractors’ plan, the process followed in the shop and in the field to install the bascule span superstructure within a short duration outage without sacrificing quality, and the design and construction process used to deliver the replacement of the approach span substructure.

Construction Engineering 3

IBC 24-50: Shop Assembly and Steel Erection on the New Nice/Middleton Bridge

Ronnie Medlock, High Steel Structures, LLC, Lancaster, PA ; Tom O'Rourke, Skanska USA Civil, East Elmhurst, NY ; Brian Wolfe, Maryland Transportation Authority, Nottingham, MD,

The main span superstructure of this new bridge is a steel unit with field-bolted plate girders, cross-frames and lateral bracing. For successful progress of construction in the field, these shop-fabricated steel components must fit well such that erection progresses on schedule, without fit-up problems at field connections. Historically, fabricators have used shop assembly to produce and check field connections, but as fabrication has modernized, fabricators have reduced production of connections in assembly, accelerating fabrication. However, even with this reduction, some level of shop assembly is still used for checking the fit of connections. This paper describes how High Steel produced the field connections for this bridge, how much shop assembly was used to check the field connections, and, subsequently, how fit of the steel went in the field.

IBC 24-51: Complex Steel Erection Procedure for Curved Girders and Substantial Simple Spans

Sean Kennedy, EIC Group LLC, Fairfield, NJ ; Michael Marks, EIC Group LLC, Fairfield, NJ

The revitalization of interchanges between Interstate I-95 and the Betsy Ross Bridge is being implemented by two separate project designations BSR and BRI within the city of Philadelphia. Section BRI is split into five contracts and is currently under construction with an anticipated completion date of 2028.

Contract BR2 was completed in 2023 by the prime contractor Buckley and Company and steel erector Structural Services, Inc. The contract consisted of the reconstruction of four ramps, NB I-95 over the Frankford Creek (Ramp A), Betsy Ross Bridge to SB I-95 (Ramp B), Betsy Ross Bridge to NB I-95 (Ramp H), and Aramingo Avenue to SB I-95 (Ramp D). EIC Group LLC provided the erection engineering and recommended procedures for Structural Services, Inc.

In particular, the erection procedures for Ramp B over Conrail and Ramp D over Conrail were challenging due to the proximity of existing structures, energized overhead electrical wires, and the design features of the steel girders. Ramp B over Conrail consists of five curved steel girders with a simple span length of approximately 147 feet which utilizes a unique top flange of a structural tube. Ramp D over Conrail consists of five steel girders with a simple span length of approximately 195 feet.

To overcome the challenges of the project, several innovative techniques were developed including a custom truss spreader, unique temporary support and bracing systems utilizing the proposed substructures and adjacent bridge structures, and complex crane analysis to maintain the necessary clearances.

IBC 24-52: Innovative Construction for a Complex Site

Kevin Heffern, P.E., S.E., Burns & McDonnell, Chesterfield, MO; Tom Ringelstetter, Kraemer North America, Plain, WI; Dennis Boll, Geotechnology, Saint Louis, MO; Joe Knapp, Genesis Structures, Kansas City, MO

The Houbolt Road Bridge was a privately funded design/build project to construct an 1880-foot major river bridge over the Des Plaines River – connecting I-80 to the nation’s largest inland port. The presence of two transcontinental BNSF tracks along the south bank required all materials for construction at the south bank to be barged across the river. Thirty-five thousand cubic yards of peat and organic muck were dredged down to a clean sand layer 20 feet below the waterline. This dredging allowed construction of an engineered-fill causeway designed to support critical crane lifts. Shallow bedrock at the north bank prevented the construction of a sheet pile dock wall that could support crane-loading the girders onto barges to ship across the river. Instead, an innovative steel loading ramp system enabled 150-foot-long trucks to be driven directly onto two barges lashed end-to-end and deliver the girders to the south bank. The multi-girder system for the 460-foot main span was assembled on a custom-designed barge system at the north riverbank and erected with strand jacks to minimize maritime disruptions. The assembly and erection were performed for the four upstream girder lines and repeated for the four downstream girder lines. Each 750-ton lift was accomplished in less than four hours.

Design & Analysis-Ped Bridge

IBC 24-53: An S-Curved Tied Arch – An Overnight Success: Design and Construction of the Northaven Trail Pedestrian Bridge

Gregor Wollmann, HNTB, Blacksburg, VA; Kira Larson, HNTB; Ted Zoli, HNTB; Nathan Petter, Texas DOT

The Northaven Trail Pedestrian Bridge will carry bicycle and pedestrian traffic across US 75, Central Expressway, in north Dallas, connecting three highly-used trails in the region for the first time. Its signature element is a 201-ft span network tied arch across the freeway. The arch sits on skewed piers, has a basket handle arrangement, and features an S-curved deck. These features created unique challenges that had to be addressed during the design and construction of the structure.

Central Expressway carries 250,000 vehicles a day. Full closures of the 8-lane highway and frontage roads were not an option and it was imperative to minimize impacts to traffic during construction. This challenge was solved by fabricating the steel arch in its entirety, including the concrete deck, in a parking lot located about 1,000 feet from the bridge site. The completed 800,000 lb arch was then moved into its final position using self-propelled modular transporters (SPMTs) and a lateral launching system during a single overnight traffic closure.

The presentation will present both design and accelerated bridge construction (ABC) considerations for the Northaven Trail arch span.

IBC 24-54: The Nancy Pauw timber shallow-arch footbridge

Leon Treder, P.E., StructureCraft, Abbotsford, BC Canada; Gerald Epp, StructureCraft, Abbotsford, BC Canada

The Nancy Pauw timber shallow-arch footbridge was completed September 2022 in the town of Banff, Alberta, one of the most picturesque locations of Canada's first national park. StructureCraft responded to the challenging brief with a low profile clear span solution using natural materials, and creating minimal environmental impact.

The bridge spans 80m across the Bow River, and with an approximate rise-to-span ratio of 1:20, the structure invites all the challenges of a shallow arch structure. These include nonlinear behavior, potential for snap-through buckling, significant abutment thrusts, susceptibility to unsymmetrical loading, and vulnerability to vibration.

StructureCraft as design-builder was responsible for the concept, design, fabrication, and erection of the superstructure, as well as turnkey delivery of the entire bridge project. Vibration and soil-structure interaction analysis were critical to success.

The curved glulam girders with a special layup were fabricated in long sections and assembled on-site. The erection procedure involved two mobile cranes simultaneously lowering the halves of the bridge assembly into place, with only millimeters of tolerance to activate the arch thrust.

Once the final midspan elevation was confirmed by real-time survey, the crew fastened the final fixed connections. After the installation of the deck, dynamic testing took place, and the necessity of a planned custom-made tuned mass damper was confirmed to mitigate accelerations.

The unique challenges of a timber shallow-arch bridge demanded holistic engineering and erection design and greatly benefited from the design-build model to achieve a beautiful, natural solution, while ensuring both constructability and economy.

IBC 24-55: Curved, Variable Depth, Propped Cantilever, Post-Tensioned Bridge

Dean Van Landuyt, P.E., AEC, A TYLin Company, Austin, TX ; Nick Koontz, P.E., AEC, A TYLin Company, Austin, TX ; Logan Golla, AEC, A TYLin Company, Austin, TX,

The Cypress Grove pedestrian bridge crosses Waller Creek at the edge of the new $66M Waterloo Greenway park project in downtown Austin, Texas. The available profile was extremely limited due to the high floodwater elevation and restricted ADA path. Structural difficulties were compounded by a 68' path radius, 87' span, and prohibition against columns in the creek. Engineers were also challenged with creating an attractive structure in this 1.5-mile long creek-side path coursing thru the heart of the new entertainment and convention center district.

The result is a curved, torsionally-stiff, variable depth, post-tensioned concrete bridge that arcs nearly a quarter-circle without support. The propped cantilever requires a full-moment connection between the span and drilled shaft foundation on the western bank. The foundation consists of three 36" diameter compression shafts near the bank and three 24" diameter tension shafts 7' behind. The lightly loaded east end is supported on two neoprene bearing pads located on a small, simple abutment ensconced in a wrap-around mechanically stabilized rock abutment. The span depth varies from 6' to 2' and is post-tensioned with five 19-strand 0.6" diameter tendons.

Foundation construction commenced in July 2023. Span casting is scheduled for late October 2023.

Asset Management

IBC 24-56: City of Pittsburgh Comprehensive Bridge Asset Management Program Overview

Louis Ruzzi, P.E., CBSI, NCTI, WSP USA, Pittsburgh, PA; Eric Setzler, P.E., City of Pittsburgh Department of Mobility and Infrastructure, Pittsburgh, PA; Alexandra Beyer, WSP USA, Lawrenceville, NJ

This paper will give an overview of City of Pittsburgh Comprehensive Bridge Asset Management Program for the City of Pittsburgh's 146 bridges. This project was advertised in response to the January 28, 2022 Fern Hollow Bridge collapse and to ensure that the City was maintaining its bridge inventory in a structurally safe and serviceable condition. The project will recommend maintenance/preservation and rehabilitation activities and time frames for each type of activity to invest the City's resources wisely by minimizing life cycle costs. The plan will also make recommendations optimal internal staffing levels for the City's Maintenance and Bridges/Structures staffs. This is so the City will be able to cost effectively perform maintenance and repair activities, and to develop/implement effective asset management policies and design and deliver capital improvement projects quicker.

IBC 24-57: An Investigative Study on Extensive Transverse Deck Cracking – Two Twin Bridges

George Zimmer P.E., ENV SP, WSP USA, Lawrenceville, NJ; Alexandra Beyer, P.E., WSP USA, Lawrenceville, NJ; Rama Krishnagiri, P.E., WSP USA, Lawrenceville, NJ; Jason Hastings, MCE, P.E., Delaware DOT, Dover, DE; Kevin Lindell, P.E., Delaware DOT, Dover, DE

This case study investigates two parallel multi-span skewed prestressed concrete bridges that exhibited extensive full depth transverse and acute corner deck cracking observed soon after re-decking. The rehabilitation altered the original structural configuration which utilized a suspended span with joints and expansion bearings. These joints and expansion bearings were eliminated or modified during the re-decking. The skewed spans thermal demands are bi-directional and the new configuration, which limited transverse movement resulted in cracking and damage to the bridge. Our investigation considered the most likely causes of the cracking and considered several phased rehabilitation options to preserve the expected service life of the structures. An extensive literature review, overview of the analytical studies performed and an in-depth discussion on the many contributing factors which led to the deck cracking will be presented. Deck concrete mix, additives, pour sequence, construction records, temperatures during pour, curing methods, bearing type, response to live load demand and skew effects were considered in detail and will be discussed. Elimination of the original joints, their relocation off the bridge and the link slab design utilized for the same will be presented. An independent Finite Element Analysis to verify thermal movements, their directions and magnitude was performed, and results validated by a simple approach for reasonableness. By the time of presentation, the Phase 1 rehabilitation program should be completed with Phase 2 design underway. Results of the Phase 1 rehabilitation and ongoing monthly drone inspections to verify that cracking has subsided will be shared as well.

IBC 24-58: Inspection, Evaluation, and Rehabilitation of the Taylor Bridge Gusset Plates

Kai Marder, P.Eng., TYLin, Vancouver, BC Canada; Brook Robazza, TYLin, Vancouver, BC Canada; Dusan Radojevic, TY Lin International, Vancouver, BC, Canada

The Taylor Bridge is a two-lane six-span 712 m (2336 ft) steel truss bridge that was constructed in 1960 and crosses the Peace River in northern British Columbia, Canada. During a recent inspection of the bridge, advanced corrosion was identified on numerous gusset plates along the interface with the truss bottom chords. The British Columbia Ministry of Transportation and Infrastructure contracted the Taylor Bridge Owner's Engineer team (Hatch Ltd., Charter Project Delivery Inc., and T.Y. Lin International Canada Inc.) to conduct a targeted inspection and load evaluation of the gusset plates.

A triage method was developed to identify a subset of 23 potentially vulnerable truss nodes. Ultrasonic thickness measurements were taken on this subset of gusset plates, providing detailed information on the variation in section loss along the length of each plate. A load evaluation that accounted for the measured section loss was performed based on the AASHTO Manual for Bridge Evaluation, with a project-specific methodology being developed to consider the significant asymmetry in the measured corrosion. A 3D non-linear finite element model that explicitly included the measured section loss in the geometry was used to validate the evaluation methodology.

A strengthening system for the deficient nodes was designed that involved installation of additional doubler plates in targeted locations. A construction procedure that temporarily relied on drift pins in place of existing rivets and bolts permitted the works to be conducted with the bridge open to traffic, with no need for temporary bracing or bypass of the affected gusset plate.

Digital Delivery

IBC 24-59: Pennsylvania Turnpike Commission: Pilot 3D Bridge Model Project

Dan Rogers, P.E., RETTEW Associates, Inc., Lancaster, PA; Ryan Rago, P.E., Pennsylvania Turnpike Commission, Middletown, PA

In 2015 the Pennsylvania Turnpike Commission began the initial research towards the goal of implementing digital delivery by 2023. In January 2021, the Commission awarded RETTEW Associates, Inc. the engineering contract for the replacement of Bridge No. NB-550 at Milepost A-83.88, carrying Hatchery Road (SR 1001) over the Northeast Extension in Penn Forest Township, Carbon County, Pennsylvania. The Commission selected the project as the pilot bridge replacement project for digital delivery and 3D modeling. Over the next two and a half years, RETTEW coordinated with the Commission, PennDOT, and outside consultants to develop construction documents that included a 3D bridge model as the legal document.

The project was advertised for construction in August 2023 and completion of construction is due by November 2024. The final deliverables for the proposed two-span prestressed composite spread box beam bridge included 2D plan sets for Roadway, Erosion & Sediment Pollution Control, Maintenance and Protection of Traffic, Signing and Pavement Marking, and Cross Sections. The 3D bridge model was paired with an abbreviated Structure plan set. Challenges included selecting and optimizing software, rebar modeling, developing the abbreviated structure plan set, quality control and assurance, deciding on the extent of annotated sheets in the 3D model, and preparing construction inspection and management staff. At the time of the presentation, the project will be in construction and lessons learned to date during construction will be included.

IBC 24-60: The Digital Puzzle: Working Together to Implement BIM Standards

Joseph Brenner, P.E., Michael Baker International, Harrisburg, PA; Eric Weber, P.E., Pennsylvania DOT, South Williamsport, PA; Alex Mabrich, Bentley Systems, Sunrise, FL

PennDOT is committed to bridging the digital divide with its Digital Delivery Directive 2025, or 3D2025, to modernize PennDOT's project delivery processes and contract document media to incorporate digital data. For bridge projects, this includes developing software environments and digital workflows that can efficiently and effectively produce products that comply with the standards PennDOT has had in place for decades. This takes collaboration and communication from multiple stakeholders including owners, consultants, and software companies all working together to fit the necessary pieces in place.
Using a collaborative team of PennDOT representatives, consultants and a software vendor's team for PennDOT's OpenBridge Modeler development as an example, this presentation will outline the necessary puzzle pieces and the steps required to put them together that a large should consider for a successful BIM implementation.

IBC 24-61: Transitioning the Nation's largest bridge inventory to Digital Delivery

Daniel Jensen, Michael Baker International, Salt Lake City, Utah ; Courtney Holle, P.E., Texas DOT, Austin, TX

TxDOT is currently in the planning stages of transitioning the nations largest bridge structure inventory from traditional project delivery to a digital delivery system. This will involve using 3D design processes which will ultimately allow for a model as the contractual document allowing for better presentation of data and a deeper understanding from all parties. This presentation will give you an understanding of how TxDOT expects to achieve this process and what types of groundwork has been put in place to ensure a successful transition. A perspective of the current challenges as well as the expectations of the Bridge Division throughout the next few years will help your organization to learn from the success of others.

IBC 24-62: Parameter-Driven Creation of 2D Traditional Style Drawings, 3D Models, and Analytical Models: A Quantum Leap in Efficiency

Douglas Dunrud, P.E., WSP USA, Sacramento, CA ; Douglas Dunrud, WSP, Sacramento, CA

As the bridge industry grapples with implementing 3D models, many senior experts are struggling to use the 3D model to validate the underlying data and prefer traditional 2D drawings for detailed information while embracing the models as visualization tools. The Interstate Bridge Replacement (IBR) Project utilizes the OpenBrIM software platform to generate 2D drawings that meet the client's CAD standards that are indistinguishable from those produced by traditional methods, along with high definition 3D models and sofisticated analytical models, all based solely on bridge parameters. This makes it possible for delivery teams to perform the same quality review process even though the underlying data is all in the 3D model.
This is essentially equivalent to creating automated bridge detailers that know how to take information from the model to create 2D bridge plans and quantities. These automated bridge detailers know the CAD standards of different clients and create drawings that match their preferences. The drawings are not mere “viewports” into the model but genuine 2D algorithms that replicate what has been done traditionally by CAD detailers. The 2D drawings can be “red-lined” by senior personnel and the entire 3D data set can be modified at once.

Construction Engineering 4

IBC 24-63: The Replacement of the Park Avenue Viaduct: Micropile Foundations and Innovative Construction Techniques

Arsanious Guirguis, P.E., H&H, New York, NY; David DeLuca, P.E., DBIA, H&H, New York, NY; Michael Sheehan, MTA; Chelsie Scarafile, H&H, New York, NY

The proposed project, situated in Manhattan's Harlem neighborhood, addresses the replacement of a vital transportation link – the Park Avenue Viaduct – between East 115th and East 123rd Streets, serving as an essential route for approximately 750 daily Metro-North Railroad (MNR) trains from Harlem, Hudson, and New Haven lines to Grand Central Terminal servicing hundreds of thousands of commuters per day. The existing Viaduct, constructed in 1893 and last rehabilitated in 1993, requires replacement, presenting unique challenges due to the site's history. The project involves the replacement of this viaduct segment with a rapid construction approach while maintaining service on the existing structure. Innovative rock-socketed drilled micropile foundations using innovative construction techniques were implemented that were installed in low overhead conditions while minimizing disturbances to surrounding structures. The project's quality assurance program included a comprehensive testing program comprised of verification testing on sacrificial micropiles, proof tests at substructure locations, and rock socket video inspections. To ensure safety and structural integrity during construction, a geotechnical instrumentation and construction monitoring plan has been implemented, including monitoring for vibrations, accelerations, vertical settlement, and lateral movement of adjacent structures and utilities. In summary, the proposed project combines urban construction with innovative construction techniques, aiming to provide a sustainable and reliable transportation infrastructure that meets the demands of MNR commuters and travelers.

IBC 24-64: Value Engineered Solution for the Replacement of a Highly Skewed Heavily Traveled Urban Bridge

Zhuo Wen (Zeus) Wu, EIC Group LLC, Fairfield, NJ; Haiwen (Helen) He, P.E., EIC Group LLC, Fairfield, NJ; Michael Marks, P.E., EIC Group LLC, Fairfield, NJ

The Astoria Boulevard Bridge, constructed circa 1940’s, was a single span deck girder-floorbeam highly skewed structure with a span of approximately 86’-0”. The bridge is in Queens, NY and provides access to LaGuardia airport along with local businesses for both vehicles and pedestrians.

Routine inspections revealed the bridge had severe corrosion of the steel and deck deterioration. Construction to replace the bridge commenced in December 2020 to remedy the structural deficiencies and to meet geometric requirements for this heavily traveled urban roadway. The existing bridge superstructure was replaced by a new multi-girder-slab structure.

J. D’Annunzio & Sons, Inc. retained EIC Group to perform value engineering services to re-design the bridge to minimize impacts to the public and reduce construction duration and cost. The original Contract proposed to utilize a 30’-6” wide, temporary ACROW bridge adjacent to the existing bridge to carry vehicular traffic allowing the bridge to be reconstructed in a single stage. However, this scenario resulted in an extended construction duration and significant impact to vehicular traffic.

The value engineered solution eliminated the vehicular temporary ACROW bridge and used a temporary pedestrian bridge adjacent to the existing bridge to maintain pedestrian access. A stageline strongback girder was utilized so the bridge could be completed in two stages and maintain traffic on the existing structure. Pre-cast deck panels were utilized to accelerate the construction process. The result was a one-month construction time reduction and approximately $1,000,000 in cost savings to the NYSDOT. The project was completed in June 2022.

IBC 24-65: Don't Judge a Bridge by Its Span Length: West Montgomery Avenue Bridge Replacement Project

Adam Bagriacik, P.E., Modjeski and Masters, Mechanicsburg, PA ; Chris Smith, Modjeski and Masters, Mechanicsburg, Pennsylvania ; Ryan Sen, City of Philadelphia Department of Streets, Philadelphia, PA,

The existing five-span bridge was built in the 1910's and carries vehicular and pedestrian traffic over five railroad tracks of the Northeast Corridor (four operated by Amtrak and one operated by Conrail). The proposed bridge is a 126-foot single span steel multi-girder bridge. The design presented numerous challenges, however, two were key: the bridge skew is 40 degrees and there are numerous existing obstacles within the project.

To capture all force effects caused by heavy skews, the bridge was designed using a combination of three-dimensional modeling and one-dimensional line girder analyses.

The bridge is surrounded by 100-year-old masonry walls, residential homes, and businesses, and the legal right-of-way is a few feet outside the bridge footprint. There were several underground utilities that ran perpendicular and parallel to the bridge, including a 4'-6" diameter brick sewer pipe that crossed perpendicular directly beneath a proposed abutment. The final major challenge is the rail traffic frequency through the bridge site.

Modjeski and Masters (M&M) collaborated with the City of Philadelphia Department of Streets to develop innovative design solutions such as a discontinuous pile cap to avoid the existing brick sewer, ultra-lightweight foamed glass aggregate backfill, shallow, wide-flanged plate girders, and prefabricated modular wingwalls (TWalls). The concrete end diaphragms were also designed to be used for future jacking due to the desire to eliminate the need for towers adjacent to the busy tracks. The goal of this paper is to explore the design challenges and document M&M's solutions to overcome them.

IBC 24-66: Constructability Reviews - an invaluable part of the process.

Gary M. Dinmore, P.E., Dinmore Engineering, Upper Black Eddy, PA

Most young engineers can design a beam to support the loads given, some can even develop the loads, however, most young engineers will not consider how that same beam gets made, delivered, and erected. These are all factors that should be considered early-on in the process and designed accordingly. Access is one of the most important factors when it comes to building a bridge, especially in heavily populated areas like New York & Philadelphia, but there are many other factors to consider of which some will be presented along with alternate means & methods (i.e. gantry cranes, spincasting, stay-in-place- fascia-forms, hydraulically driven (self-propelled) heavy-duty shoring equipment, etc.) that could be implemented instead of conventional construction. In general, constructability reviews are intended to identify potential issues that could arise in the field before time & monies are lost on a project; value engineering is similar, it looks more at how time & monies can be saved on a project. This presentation will explore both constructability and value engineering and introduce some innovations that can open minds to proven alternatives available today that can improve projects.

Design & Analysis-Arch

IBC 24-67: Innovative Hanger Replacement for the Sherman Minton Bridge

Blaise Blabac, P.E., Modjeski and Masters, Poughkeepsie, NY; Sean Casey, P.E., Modjeski and Masters, Poughkeepsie, NY

The Sherman Minton Bridge Renewal is a $137M public-private partnership (P3) project involving the comprehensive rehabilitation of this critical bridge carrying I-64 over the Ohio River between Louisville, KY and New Albany, IN. The main span of the bridge consists of two 800 ft. span double-deck tied arches carrying 3 lanes of traffic on each level (westbound on the upper level; eastbound on the lower). One component of the rehabilitation project is the replacement of all 136 hanger cables, which are original to the bridge and are now over 60 years old (opened in 1962). Modjeski and Masters, as a member of the Kokosing Construction Co. team, developed an innovative method to replace the existing hangers without the need for costly temporary hangers. The new hangers utilize Type 6 sockets with threaded rods to allow for load transfer and adjustment of hanger length to match the original geometry. In order to meet the required the strength and durability requirements of the project specifications, the new hangers (consisting of 2-9/16" dia. ASTM A586 structural strand) utilize a unique hybrid wire configuration with Grade 2, Class A inner wires and Grade 1, Class C outer wires to provide a minimum Factor of Safety of 3.0. This paper will illustrate the key components of the hanger replacement system and the methods employed during construction to transfer the 120-ton reaction from each of the existing hangers to the new hangers, all while maintaining full traffic and matching the original geometry of the structure.

IBC 24-68: Engineering for Bridge Demolition – Recommended Best Practices

Samantha Kevern, P.E., S.E., Foothills Bridge Co., Boulder, CO; Josh Crain, P.E., S.E., Genesis Structures, Kansas City, MO

Engineering for Bridge Demolition – Recommended Best Practices is a new manual of practice from ASCE, with publication set for Spring of 2024. While there are guidelines and recommendations for bridge construction, there is little documented guidance for bridge demolition.
Most engineers and owners acknowledge that additional considerations are required to analyze a structure as it is being constructed. During partial stages of erection, there are unique and potentially governing load cases that need to be considered beyond the final design of the permanent structure. Bridge demolition has similar challenges and complexities as a structure is being removed, while simultaneously having a finite service life. The need for properly engineered bridge demolition plans becomes apparent when you combine the technical complexity of bridge demolition with increasing project constraints due to population, economic impact, and environmental concerns.
This presentation provides an overview of the recommended best practices for bridge demolition engineering, including the purpose and need for the document, the history of its development, qualifications of the contributors, and an overview of the content.

IBC 24-69: Design of the Hawk Falls Arch Bridge

Thomas Murphy, Ph.D., P.E., S.E., Modjeski and Masters, Mechanicsburg, PA; Wally Wimer, The Pennsylvania Turnpike Commission, Middletown, PA; Daniel McCaffrey, Modjeski and Masters, Mechanicsburg, PA; Andrew Adams, Modjeski and Masters, Mechanicsburg, PA; Nohemy Galindez, Modjeski and Masters, Mechanicsburg, PA

The new Hawk Falls bridge will carry the Pennsylvania Turnpike's Northeast Extension over a scenic, steep-sided gorge in the Hickory Run State Park. Due to increases in traffic over the years and the deteriorating condition of the existing crossing, a replacement structure consisting of a 465' span steel deck arch and 720' total length was developed to keep the traffic moving while harmonizing with the dramatic geography of the park setting. The bridge is designed to carry 4 traffic lanes plus full outside shoulders and reduced width inside shoulders. In addition, the design of the structural components incorporates a future widened condition with two additional travel lanes added to the bridge. Three arch ribs are used to carry the multi-girder cross section, which is supported on columns with a longitudinal spacing of 60'. The use of a multi-girder cross section supported on the arch rib allows for a significant amount of system redundancy such that the floor beams can be classified as System Redundant Members. The design of the arches incorporates HPS 70W steel, as well as strategic use of the highly corrosion resistant A709 grade 50CR steel in the bearing regions. All other steel is weathering grade, with the interior of the box section arches painted for enhanced durability and to allow for easy inspection. The arches are supported on stainless steel pins at the skewbacks, and feature a low rise-to-span ratio. This presentation will cover the design, fabrication, and construction of the structure to date.

IBC 24-70: New Tricks Used to Rehabilitate an Old Arch Bridge

Steve Olson, Ph.D., P.E., Olson & Nesvold Engineers, PSC, Edina, MN ; Mark Maves, Short Elliot Hendrickson Inc., St. Paul, MN ; Steve Eads, Genesis Structures, Kansas City, MO,

Several innovations or "tricks" were used as part of the rehabilitation project. Tower cranes were supported off of the main river piers to facilitate construction activity. To retain and utilize spandrel columns with existing reinforcement that didn't meet today's code requirements an external post-tensioning system called the YOWman system was developed. This significantly improved the load rating for the bridge and reduced construction costs by limiting the number of spandrel columns to be replaced and the complexity of the detail between the arch rib and the existing or new spandrel columns. A passive cathodic protection was deployed with a thermally sprayed metal anode on the arch ribs. This was supplemented with concrete repairs that utilized galvanized rebar anchored with a cement based grout. To expedite the measurement of concrete surface repairs a system using a handheld laser scanner was developed. This readily allowed the contractor to be paid extra for "deeper" repair locations. With complicated curved geometry, hand measurements are tedious and time consuming. The handheld laser scanner minimized time in the field, minimized impact to the contractors operations and produced a digital record of where the repairs were performed.

Rail

IBC 24-71: Streamlining Infrastructure: Box Jacking for Trenchless Underpasses in North America

Alex Belenguer, P.E., McNary Bergeron & Associates, Broomfield, CO

Box jacking is an advanced bridge construction technique enabling the trenchless installation of underpasses. This method combines hydraulic pushing of the structure with simultaneous excavation at the tunnel's leading edge.

There are several advantages associated with this approach. First, it can be engineered to maintain live traffic during the underpass installation, minimizing disruptions to existing infrastructure. Second, the precast construction of the underpass separates the timing of the push, making it easier to schedule for minimal user impacts. Furthermore, it can be employed under both road and railroad traffic by designing temporary structures tailored to each project's needs.

Despite its widespread use in Europe, this technique is just beginning to gain traction in construction projects in North America. This paper provides a comprehensive overview of various design and construction alternatives, along with examples of successful applications in projects such as the Long Island Rail Road Expansion, the Brightline High-Speed passenger train system, and the Hurontario Light Rail Train.

IBC 24-72: 120 Year Old Truss Replacement with 187' TPG Span

Zach McKinley, E.I., PCL Construction, Inc., Tempe, AZ; Nabil Hamadani, P.E., HDR, Cincinnati, OH; Austin Holub, P.E., PCL Constructionn, Inc., Tampa, FL; Andrew Cestaro, PCL Construction, Inc.

The Norfolk Southern, 120-year-old 209' truss, main span over Leaf River in Hattiesburg, Mississippi required replacement due to concerns with the condition of the structure. A 187' through girder span with 13' tall girders supported on multiple 6' diameter large diameter piles was selected as the replacement for the main span. For replacing the truss which was constructed in 1904, the project team faced several challenges to complete the in-line replacement while allowing the safe passage of trains across the river. The construction and span change-out had to be performed with minimal disruption to the 12 trains that travel over the bridge every 24 hours, and was required to maintain a safe passage for pedestrians using both Chain Park and Petal River Park on either side of the Leaf River. This paper will go over the design and environmental permitting for the replacement structure and examine the measures required in the face of the challenges to replace a major structure on a critical route over which goods are transported throughout the region to and from one of the largest ports in the United States. Emphasis will be on the strategies employed for successful execution of the project, including the importance of a constructable lateral slide design, planning and sequencing of construction activities (including providing a safe access to the congested site), and minimizing disruptions to rail traffic and park users. These strategies were a core part of the project from development through completion and were integral to the project's success.

IBC 24-73: Valley of the Dons – Utilizing Long Span Segmental Bridges over the Environmentally Sensitive Terrain of the Don River Valley

Nickolas Hatinger, P.E., S.E., P. Eng., HDR, Olympia, WA, WA ; Jason Stauffer, P.E., S.E., P.Eng., HDR, Tallahassee, FL

As part of the Ontario Line Technical Advisor contract with Metrolinx in Toronto, Canada, HDR is providing final design services for the Don Valley Crossings including two long-span segmental bridges used to cross the Don River Valley. Each of these two bridges contain main spans exceeding 136 meters with columns as tall as 32 meters and are part of the Ontario Line's North Civil transit program. The structures support 2 tracks of commuter rail and will provide residents of Thorncliffe Park neighborhood direct access to downtown Toronto. Strategic planning and extensive coordination with stakeholders is necessary to overcome the project's many challenges. Design and construction challenges include high voltage lines, gas pipelines, public spaces, freeways, residential communities, and environmentally sensitive terrain. The presentation will cover a brief overview of the project and highlight challenges overcome for the design of the Don Valley Crossings.

IBC 24-74: Replacement of Norfolk Southern Bridge N-680.20 over North Court Street in Circleville, Ohio

Edward Baznik, P.E., Michael Baker International, North Royalton, OH; Kimberly Guice, P.E., Michael Baker International, Shaker Heights, OH; Nicholas Bayer, P.E., Norfolk Southern Railway, Atlanta, GA

Norfolk Southern's Bridge at Milepost N-680.20 carried two mainline tracks over North Court Street in Circleville, OH. It was comprised of a 164'-2½'' out-to-out three-span open deck through girder bridge skewed 70 degrees to the substructure and founded on a concrete gravity abutment, steel columns and a concrete end pier integral to a 100+ year old reinforced concrete tunnel. Michael Baker International (MBI) performed a type study to investigate solutions for the structure, including replacements that would reduce the high skew, as well as options that would maintain that skew, all while replacing the structure with a ballasted deck. The preferred alternative included a new 90' long, highly skewed, ballasted deck double track steel through plate girder span and installing new precast box beam spans over the existing tunnel. The change from an open deck to a ballasted deck would require raising the track by 3-feet to maintain the existing vertical clearance over North Court Street. Pre-outage work included the construction of a new full height concrete abutment in front of the existing abutment required the installation of four rows of micropiles under the existing, in-service, structure. The existing tunnel was modeled, analyzed and strengthened with the addition of micropiles and pile cap on the pier side. During a 40-hour track outage, the existing steel superstructure was removed and the new plate girder span was installed using a Liebherr LR-1750 crane. The track bed raise drove the outage schedule and required significant planning and coordination between the crews.

Rehabilitation Design 2

IBC 24-75: Deck Removal for the I-75 Bridge over the Rouge River

John Boschert, P.E., S.E., Genesis Structures, Kansas City, MO; Clay Malloure, CA Hull Co., Inc., Walled Lake, MI

The I-75 over the Rouge River Bridge carries eight lanes in Detroit, Michigan. I-75 in this area is a critical highway connecting to Canada and is very heavily used by the traveling public.
Based on length and surface area, the I-75 over the Rouge River Bridge is the largest bridge in Michigan and was originally built in the 1960s. The bridge consists of 106 steel plate girder spans and is 1.63 miles long, including five spans over railroads and three spans situated high over the Rouge River.
A major deck replacement project for the entire bridge was undertaken starting in 2017 which was planned and performed over a two-year period. The deck removal and replacement operations were performed in phases with the southbound bridge replaced first followed by the northbound bridge while maintaining three lanes of traffic during the entire project. Deck removal operations required large-scale operational planning to remove existing deck from the composite steel plate girder system in safe and efficient manner.
This paper and presentation will focus on the planning and demolition engineering that were performed by the project team to perform this landmark project, including the following:
•Coordination and planning for the extensive and complex construction operations required
•Discussion of engineering methods utilized to address field conditions and equipment loading
•Evaluation of the existing bridge for deck removal operations, specifically considering the composite steel plate girder system and strength reductions during deck removal
•Discussion of special conditions to address temporary stability and

IBC 24-76: Rigid-Frame Bridge Seismic Retrofits on TransCanada Highway

Kai Marder, P.Eng., TYLin, Vancouver, BC Canada; Kai Marder, TYLin, Vancouver, BC Canada; Dusan Radojevic, TY Lin International, Vancouver, BC, Canada; Terrence Davies, TYLin, Vancouver, BC, Canada

The British Columbia Ministry of Transportation and Infrastructure (BC MoTI) identified three underpass bridges along the TransCanada Highway in West Vancouver, BC for potential seismic retrofit as part of its Bridge Seismic Retrofit Program. Constructed circa 1973, the bridges are steel rigid-frame configurations with inclined pier legs founded on soils with average shear velocities ranging from 180 to 1500 m/s. The BC MoTI retained T.Y. Lin International Inc. (TYLin) to assess the vulnerability of the existing structures using Canada's new 6th Generation seismic hazard model demands, which were found to be significantly higher than the previous 5th Generation demands. TYLin developed detailed finite element models to analyze the seismic demands and designed retrofit solutions to address the vulnerabilities of each bridge. Key criteria for the retrofit designs included minimizing pier foundation modifications and managing traffic throughout construction. The required retrofits for two of the bridges were isolated to their abutment and pier bearing connections, whereas the third bridge required extensive retrofit improvements, including deadman anchors, link slabs, bearing restrainers, and a fluid viscous damper system. The retrofits provide a life-safety service level and a probable-replacement damage level in accordance with the Canadian Highway Bridge Design Code (CSA S6:19) requirements for the 975-year return period seismic event. This seismic performance level permits safe highway traffic flow below the bridges while retaining limited live load capacity for traffic crossing the bridges. This paper provides a discussion of the seismic hazards and vulnerabilities affecting each of the bridges and descriptions of the retrofits.

IBC 24-77: A Case Study on Retrofitting of a Box Girder Bridge with CFRP and External Tendons

Chun-Chung Chen, Ph.D., S.E., National Center for Research on Earthquake Engineering, Taipei, Taiwan; Chi-Rung Jiang, National Center for Research on Earthquake Engineering, Taipei Taiwan

This paper describes a retrofit case study of a field bridge that uses Carbon Fiber Reinforced Polymer (CFRP) and external tendons. The project has three stages: on-site structural investigation, laboratory experiments, and field long-term monitoring. The first stage involves field investigation and experimental tests to understand the existing condition of the bridge and prepare for the design and planning of retrofitting work. The second stage involves laboratory specimen tests, including CFRP patch anchorage performance testing and scaled-down specimen experiments, to ensure the expected structural behavior of the engineering design and to reasonably understand and explore the performance of CFRP retrofitting specimens, providing feedback for the evaluation and valuable references for the authorities and the design company. The third stage is the construction of a field long-term bridge monitoring system which is used to observe the stability of the retrofitted structure, confirm the structural behavior of the bridge, and collect long-term monitoring data to explore and propose maintenance management reference suggestions. The long-term monitoring system is about to start running, and the results of the first two stages have been fed back to the design company to verify the design assumptions and confirm that the retrofit result was effectively achieved.

Construction Engineering-Demolition

IBC 24-78: Demolition Challenges of the Harry W Nice/Thomas "Mac" Middleton Bridge

Nikkolas Edgmond, E.I., Genesis Structures, Kansas City, MO; Brian Clark, United Demolition, Charleston, SC

The Harry W Nice/Thomas "Mac" Middleton Bridge was a uniquely designed and constructed structure from its birth in 1940 and posed some very unique challenges during its removal nearly 100 years later. With superstructure types ranging from simple span precast bridge units, to deep plate girder spans, to continuous deck trusses, to the main channel consisting of a 3-span continuous arched support truss; each structure type required specialized demolition analysis and processes to safely remove the aging structure. Moreover, the structure was supported primarily on 2D steel towers that framed into the superstructure through a rhomboidal detail. The unique design of the rhomboidal regions developed interesting load distribution within the system when subjected to irregular loading coinciding with demolition operations. This presentation will highlight the various demolition methods considered for these different structure types and the decision process that led to the selected removal methods. The presentation will conclude with review of the demolition activities on the bridge, including large demolition equipment, precision structural element removal, and explosive demolition, including a lesson in expecting the unexpected when bridges decide to defy the laws of physics.

IBC 24-79: Engineering and Execution of the I-74 Mississippi River Bridge Removal

Thomas Schebler, EIT, Helm Civil, Freeport, IL; Zachary Bardot, Genesis Structures, Kansas City, MO; Lisa Briggs, Genesis Structures

When we talk about a bridge project, the focus is typically on the new bridge being constructed. But often, the safe and efficient removal of the existing bridge contributes equally to the project's success. In the case of the existing I-74 Bridge spanning the Mississippi River between Moline, IL and Bettendorf, IA, Genesis Structures and Helm Civil collaborated to engineer and execute a complex staged removal sequence. The demolition involved a deviation from the suggested plan of blasting the suspension spans in their entirety to a piece-by-piece removal of the existing superstructure. By limiting the amount of required recovery time from the river, this method proved to be more cost effective and reduced the required navigational closure time of the waterway. Additional challenges associated with the demolition included the proximity to the new bridge, crane access limitations near the existing lateral dam, and the presence of endangered mussels which prohibited the use of temporary structures on a portion of the job site and necessitated the use of barges with shoring towers to support the approach trusses during removal.

IBC 24-80: Sequenced Removal of the Non-Redundant I-30 Bridge

Steve Eads, Genesis Structures, Kansas City, MO ; James Caster, Kiewit Massman Construction Co., Little Rock, AR ; Logan McInvale, Kiewit Massman Construction Co., Little Rock, AR, ,

The I-30 Bridge over the Arkansas River in Little Rock, Arkansas, was originally built in the late 1950s. The main river crossing consisted of eight spans with span lengths ranging from 160' to 210'. The existing bridge consisted of a reinforced concrete deck supported by steel stringers and floor beams that were in-turn supported by two nonredundant plate girders. The replacement bridge has a similar alignment as the existing bridge. The first phase replacement bridge was constructed along the east side before the demolition of the existing bridge began. A joint venture between Kiewit & Massman performed the new bridge construction and required demolition operations. The bridge deck was removed with excavators operating on the structure and debris collected on barges operating below. The main super structure steel was removed with land-based cranes and a water-based, barge-mounted, ringer crane. Specialized sequential removal analysis was performed to safely dismantle the continuous nonredundant structure while maintaining stability of the remaining pieces. Genesis Structures performed the required demolition engineering. The multi-phase project required various demolition activities and engineered components that included pier brackets, post-installed supporting concrete corbels attached to the face of the existing substructure, strongbacks for temporary support of the discontinuous girders, custom lifting lugs, longitudinal bearing lock-up devices, false-work towers, and girder-flange lateral torsional buckling restraints.

Design & Analysis-Steel

IBC 24-81: Record Setting I-64 Kanawha River Bridge

Jason Fuller, HDR, Pittsburgh, PA; Anthony Ream, HDR, Pittsburgh, PA

HDR teamed with Brayman/Trumbull, a Joint Venture (BTJV), to deliver this $224 million WVDOH design-build project, which widened four miles of Interstate I-64 near Charleston, WV from four to six lanes. The project consisted of a new tri-level interchange with two curved steel ramp structures, replacement of three sets of dual mainline structures, an overhead crossing, and dual bridges crossing the Kanawha River west of Charleston, WV. The 562'-6" main span of the dual river bridges is the longest steel multi-girder bridge span in the United States.

The team investigated rehabilitation and replacement options for the existing river truss structure, choosing to replace the existing bridge with two new dual structures. BTJV constructed a westbound (WB) steel I-girder bridge on new drilled shaft river piers and deep pile foundation abutments adjacent to the existing structure. After shifting traffic to the WB bridge, BTJV demolished the existing truss, making room for a second dual eastbound (EB) steel I-girder bridge.

The new river bridges utilized unique details and analyses. These included adaptive reuse of the exiting truss piers for the EB bridge; strand-jacking the central 400'-portion of the main span girders from barges below; haunched girders with optional longitudinal field splices and minimal longitudinal stiffeners to allow fabrication and shipping flexibility; and complex analyses including nonlinear buckling, live load time history, thermal gradient, and other load considerations required for a record setting span.

IBC 24-82: Efficient Design of Modern Steel Highway Bridges

Francesco Russo, Russo Structural Services LLC, Havertown, PA; Michael Grubb, M A Grubb & Associates; Donald White, Georgia Institute of Technology; Melanie Hay, University of Delaware

The design of steel bridges includes consideration of traditional dead and live loads, but also newer requirements related to wind loads, stability during construction, and various practical considerations related to girder sizes, weights, practical span layouts, and other factors, all of which are interrelated.
This paper discusses observations and conclusions from the design of over 200 modern steel plate girder bridges designed to meet AASHTO requirements and at the same time meet various fabrication and erection preferences for safe and economical construction. Engineers will be able to understand the relationship between various competing AASHTO design provisions that are important in the design of the completed bridge as well as have a role in construction and erection engineering.
1 - Overview of new AISC standard plans
2 - Influence of various AASHTO provisions on bridge design i.e. design of non-composite bridge for wind, deck casting, new stability design provisions, etc.
3 - Observations on stability and strength implications of newer AASHTO provisions
4 - Conclusions and observations from several hundred recently completed standard designs

IBC 24-83: Standard Designs and Plans for Modern Steel Highway Bridges

Francesco Russo, Russo Structural Services LLC, Havertown, PA; Michael Grubb, M A Grubb & Associates; Melanie Hay, University of Delaware

New AISC standard plans have been developed to simplify the design of hundreds of routine steel bridges. These standards cover bridges with 1, 2, 3, and 4-spans with individual spans ranging from 80 - 300 ft. Beam spacings of 8, 10, 12, and 14 ft are included. Link-slab options for simple spans built continuous are included. The designs are in accordance with the new AASHTO LRFD 10th edition requirements for stability, include modern wind load considerations, and have been developed with nationwide fabricator input for fabrication and erection efficiency and safety. The paper and presentation will review the development of these standards, including many details like bracing and splices that are also provided, and provide a walk-through for engineers on how to use these standards to quickly design many short, medium, and long-span steel bridges. The engineering workflow to satisfy the many AASHTO requirements will be highlighted as integral to a safe and economical design.

Segmental

IBC 24-84: Waxed Tendons for Fort Walton Beach Bridge Replacement Project

Christopher Vanek, P.E., WSP USA, Seattle, WA; Victor Ryzhikov, WSP USA, Tampa, FL; Matthew Durshimer, WSP USA, Tampa, FL

Serving as the major East-West corridor across the panhandle of Florida, the US98 corridor is a major arterial route serving the coastal tourist communities. A popular destination of the Destin/Fort Walton area is connected by the Brooks Bridge crossing over the Santa Rosa Sound along the Intracoastal Waterway. The replacement project requires replacement of the existing structure with two parallel structures each carrying three travel lanes and a shared used pedestrian path. The new high level 13 span structure stretching approximately 2110 feet long is constructed with a skewed 275' post-tensioned concrete spliced girder main span. Apart of Florida Department of Transportation initiative to combat corrosion contamination the design introduces one of the nation's first unbonded flexible filler internal tendons spliced girder system. This paper will outline the modeling, design approach and details of the bonded/unbonded spliced girder system, mockup and construction requirements and a unique detailing required for the 30-degree skewed interior piers.

IBC 24-85: Evaluation, Design and Implemantation of a Holistic Repair Strategy to Extend the Service Life of the Post-Tensioned I-526 Wando River Bridge

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Post-tension (PT) tendons have been used for many years in bridge construction. Generally, these structures have performed well except where PT tendons have had issues due to grouting deficiencies. These deficiencies can result in voids, chloride contamination, and soft or segregated grout which can lead to corrosion and failure of the PT tendon.
This presentation will describe evaluation techniques which can be used to identify the presence of voids and corrosion, engineering and construction considerations, as well as methods which have been developed to mitigate corrosion of PT tendons.
The I-526, post-tensioned segmental box girder bridge over the Wando River in Charleston, SC was experiencing PT tendon corrosion and failures resulting from these conditions. SC DOT and engineering consultant HDR were proactive in evaluating the structure and developed a repair and maintenance strategy to mitigate corrosion and extend the service life of the structure.
The Wando River Bridge case study will be presented to demonstrate how proper evaluation, engineering analysis and implementation of a holistic repair strategy can be used to preserve and maintain critical transportation assets.

IBC 24-86: Brim Based Geometry Control in Cable Stayed Bridge Construction

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The Kruunuvuori Bridge, slated for completion in 2025, stands as a forthcoming landmark in Helsinki, Finland. As a cable-stayed bridge, it boasts a single tower soaring to 135 meters and spans two main spans of 260 meters each, with a total length of 1160 meters. Currently under construction, the bridge is exclusively designed for public transportation (tram) and pedestrians. Its superstructure, a steel-concrete composite, features a subtle curvature in plan, a unique characteristic for cable-stayed bridges.
The project embraces full information modeling, a standard practice in Helsinki's public infrastructure construction. Notably, the geometry control of the cable-stayed bridge is wholly model-based, marking an unprecedented implementation of Building Information Modeling (BIM) in major bridge construction globally. The curved superstructure is assembled in segments, lifted onto temporary supports, and cast before the stays are stressed. The incorporation of both vertical and plan camber, essential for accommodating the superstructure's curvature, further distinguishes this endeavor.
Throughout the construction process, the structure's geometry is meticulously provided in open format (IFC) models, directly usable for on-site surveys with total stations. These models, based on staged construction analysis using Finite Element Method (FEM), are continuously updated to reflect the as-built conditions. By automating the production of geometry models from the analysis, the workflow has proven to be rapid, flexible, and highly visual.
This paper elucidates the workflow of full model-based erection control, shedding light on the innovative methodologies employed in realizing the ambitious vision of the Kruunuvuori Bridge.