Proprietary Session

IBC 23-01: Cast Steel Nodes for Bridge Structures Designed and Built with HSS

Jennifer Anna Pazdon, P.E., CAST CONNEX, New York, NY ; Carlos de Oliveira, CAST CONNEX, Toronto, ON Canada

Bridge designers and stakeholders are increasingly taking advantage of the significant efficiency and serviceability benefits the use of tubular members (Hollow Structural Sections and pipe) offer in the design and construction of truss bridges. The proposed addition of welded joint details for tubular members in the Bridge Welding Code (AASHTO/AWS D1.5) would further accelerate that trend. Globally, tubular members are very often leveraged in the design of highway, rail, and pedestrian bridges, and in most of these cases, cast steel nodes are leveraged at the key intersections of the tubular elements.
The proposed paper and presentation will discuss the advantages tubular members offer in bridge design, will discuss some of the issues and challenges around connection design and performance in tubular connections in bridge structures, and will discuss how cast steel nodes can be used to address all of the challenges associated with connections between tubular members in bridges. Specific focus will be on how cast steel nodes enhance the stiffness, strength, and fatigue performance and simplify the fabrication of tubular connections, and thus it will be shown how the use of cast steel nodes improve the overall structural efficiency, reduce deflections, improve vibration performance, and improve coating system performance and longevity of bridge structures. The paper and presentation will then present several examples of highway, rail, and pedestrian bridges incorporating tubular members and cast steel nodes from around the world and in the United States.

IBC 23-02: Use of ASTM A1035-CS Corrosion Resistant and High Strength Reinforcement in the New Nice Middleton Bridge Project for Sustainable Bridge Construction

Hans Geber, Commercial Metals Company, Cayce, SC

ASTM A1035-CS reinforcing steel used in the New Nice Middleton Bridge Project is not only corrosion-resistant but also high strength. The A1035-CS reinforcement is shown to have a positive effect on carbon footprint and global warming potential. Examples of use within bridge elements include utilizing reinforcement for flexural and shear applications. The use of A1035 reinforcement can be applied to various structural components of a bridge, including super- and sub-structural elements, including but not limited to, end zone design and detailing of post-tensioned members, pier cap design, and the design of cast-in-place bridge decks. When a bridge deck is designed using the strip method, it can be shown that the bar high strength considerably allows for a significant reduction of steel quantities and concrete cover. The usage of A1035 also allows for increased durability of the bridge deck due to its high corrosion resistance, thus increasing the service life of the bridge. Another application found to be suitable with ASTM A1035 steel is to use it in the negative moment zones bridges made continuous for live loading. With the use of A1035 bars, bar congestion is greatly reduced in critical area of the deck and girders.

IBC 23-03: How Geophysics Contributes to Rebuilding the U.S. Infrastructure: A Case Study Involving Seismic Tomography

Siavash Mahvelati, Vibra-Tech Engineers, Hazleton, PA; Douglas Rudenko, PG, Vibra-Tech Engineers, Hazleton, PA; Stephen Munoz, Vibra-Tech Engineers, Hazleton, PA; Sebastian Lobo-Guerrero, American Geotechnical & Environmental Services, Inc., Canonsburg, PA; Scott Kelley, Erdman Anthony, Mechanicsburg, PA

Reusing existing bridge foundations is one way of expediting the rebuilding of U.S. infrastructure. A challenge to foundation reuse is the difficulty of assessing the structural integrity of existing foundations. In the absence of a priori information, direct methods such as concrete coring run the risk of only looking at competent concrete and missing problematic zones. This issue can be mitigated by employing geophysical methods that can offer a greater spatial coverage. In this project, Pennsylvania Department of Transportation plans to replace the superstructure of the SR75 Market Street Bridge in Port Royal, PA. A seismic tomography survey was performed to measure the compressional wave velocity (VP) of the bridge abutments, which subsequently points to zones of compromised concrete. Three vertical boreholes were drilled in a triangular pattern through each abutment. At each abutment, seismic measurements were made at various depths in two of the boreholes while the third borehole housed a seismic source. An array of receivers was also installed along the exposed face of abutments. Travel-time information of seismic waves was inverted using a tomographic inversion scheme which yielded a three-dimensional velocity model of the abutments. Four low velocity zones were identified in the abutments. Confirmation drilling encountered small zones of honeycombed concrete at depths that agreed with the identified anomalous features from the tomography survey. Further laboratory testing revealed that despite having a low velocity, zones of concern have compressive strengths of 5,000+ psi making it possible to reuse the existing abutment for the new superstructure.

IBC 23-04: Seismic Isolation for Achieving Functionality of Critical Bridge Structures

Anoop Mokha, S.E., Earthquake Protection Systems, Vallejo, CA; Victor Zayas, Earthquake Protection Systems, Vallejo, CA; Stanley Low, Earthquake Protection Systems, Vallejo, CA

Functionality is an important consideration while designing critical bridge structures in earthquake prone regions of the world. This is necessary for minimizing post-earthquake disruption to society. Major earthquakes that have occurred every year in the world are a constant reminder that critical structures must remain operational post-earthquake, so that community needs are met. Bridges classified as lifeline structures also need to remain functional so that rescue and recovery operations can be performed.

Code provisions (ductility based) for seismic design of structures all over the world have focused primarily on achieving “Collapse Prevention” or “Life Safety” within acceptable limits, at the expense of inflicting damage to structural, non-structural, architectural elements, and contents. After a major earthquake this results in loss of use and function, as observed in recent Japan, New Zealand and Chile earthquakes. One of the approach to achieve functionality is through continued functionality design objectives for minimizing damage in structures by absorbing seismic displacement in isolation bearings, maintaining an elastic structure, and minimizing in-structure accelerations and drifts.

Bridges designed and built to current AASHTO minimum design requirements to provide “life safety” using a ductile design approach will not provide a resilient, sustainable, and functioning bridge. A ductile design approach has resulted in costly post-earthquake damage that has been disruptive to roadway systems. Decisions made forty years ago in formulating a ductile design approach to achieve “life safety” are reviewed in light of seismic isolation designs for “continued functionality” criteria. Seismic design methodology and criteria are presented for increasing reliably

IBC 23-05: Il De Re Testing & Instrumentation

Stephen Schorn, Sixense, Inc., Reston, VA; Stephen Joye, Sixense Monitoring, Nanterre France

The Ile de Re viaduct located in France was built in 1988 and has 29 spans over 2930m in total length. It has 218 external post-tensioned cables to support the bridge. In 2018 one of the external cables suddenly failed and was identified to have broken about 1 meter from the anchorage head. Sixense has inspected 85 anchorages using ultrasonic testing to assess their condition and support future rehabilitation efforts on the bridge. It was decided to also install about 280 acoustic sensors to monitor the bridge (for the first third so far) . This presentation would detail the UScan tests and results, as well as the SHMS installed on the bridge.

Rehab/Maintenance, Part 1 Session

IBC 23-06: Rehabilitation of a 1930's Steel Crescent Truss Arch

Nicholas Cervo, P.E., HDR, Pittsburgh, PA; Eric Liebmann, P.E., HDR, Pittsburgh, PA

The Jerome Street Bridge, located outside of Pittsburgh, was built in 1937. It has a 455’ main span composed of a steel crescent truss arch, with a “floorbeam-stringer-grid deck” floor system, that spans over the Youghiogheny River. The east and west approach spans are composed of a “girder-floorbeam-stringer-grid deck” structural system, and span over local roads, a bike trail, and a railroad. Due to over 80 years of deterioration, the main span, as well as the approaches, required an extensive rehabilitation. This rehabilitation included a full redecking (using lightweight concrete), steel floor system member replacements, lateral bracing reconfiguration, numerous steel repairs (including the historic sidewalk railing), bearing and expansion joint replacement, a new PPC (polyester polymer concrete) overlay, and painting. Note that the redecking occurred under phased construction to maintain traffic in one direction during construction. To accomplish these design goals, a combination of line girder analysis (floor system) and 3D finite element analysis with staged construction and wind loading (arch and lateral bracing) was utilized. Various advantages of the 3D analysis (versus a simplified 2D truss analysis) are discussed. Also to be explored are various final design details that were employed to simplify the construction efforts and minimize field issues. Additionally, the future permit rating procedure for a complex structure will also be examined. HDR also provided construction services throughout the construction, which included shop drawing reviews as well as responses to RFI’s and other submittals. The response to various complications in the field will be discussed.

IBC 23-07: Hidden Lake Bridge Restoration

Andy Lohan, P.E., S.E., , Chicago, IL; Robert Hong, P.E., S.E., Lochner

Hidden Lake Bridge is a 50-foot-long historic cast and wrought iron bowstring pony truss that spans over the East Branch DuPage River in Hidden Lake Forest Preserve in DuPage County, Illinois. The precise age of the structure is unknown, however it can be identified as a bridge constructed by the King Iron Bridge Company which dates from the 1870’s. Cast and wrought iron bowstring truss bridges are among the nation's oldest surviving metal bridges and are also among the rarest types of historic bridge in the country. Each surviving bridge is an essential part of our nation's transportation heritage and should receive the highest preservation priority. Built during a period of experimentation, these bridges display unusual construction details that were often the patented designs of the company that built them.
The existing bridge was in critical condition with severe section loss and its load path had been modified by the addition of a center pier. The challenge with this project was to economically preserve this historic bridge and restore it as a working bowstring pony truss capable of carrying pedestrians and maintenance vehicles. The design team first researched the history of the existing bridge construction and materials. Next, they performed structural analysis to determine where strengthening was required and developed unique details to recreate or strengthen existing structural elements while consulting closely with historic bridge preservationists. This balanced approach allows this historically significant bridge to continue to serve the Chicago region for many years to come!

IBC 23-08: Innovative Project Delivery Methods and Technical Solutions on the Emergency Repairs of the Roosevelt Bridge

Eric Sommer, P.E., Structural Technologies, Fort Worth, TX

When the Florida Department of Transportation closed portions of the Roosevelt Bridge to address emergent repair needs identified during a routine inspection, it had to quickly identify a collaborative and efficient process to ensure rapid restoration of the mobility for pedestrians, vehicles, vessels and rail. The two parallel 4,600' long precast post-tensioned segmental 41 span bridges (41 spans each) were constructed in balanced cantilever. Cracking had been discovered in the bottom slab of Southbound Span 1 over Dixie Highway. The technical difficulty of the work combined with the importance of restoring traffic to downtown Stuart, FL and minimizing the duration of a 20+ mile detour for a major state highway led FDOT, for the first time in their history, to select the CMGC (Construction Manager/General Contractor) method of project delivery. This contracting method leverages early contractor involvement to provide assistance with design and repair methods, expediting project completion and reopening of the structure. Major elements of the work included emergency structural evaluation, the final design and construction repairs, and incorporation of strengthening and long-term preservation systems, all on a streamlined schedule. An innovative strengthening solution was implemented involving installation of flexible filled external multi-strand post-tension tendons inside the box to replace the failed and corroded existing tendons. The project restored traffic to full capacity within 130 days and made additional improvements to enhance future reliability through preventative maintenance and hardening measures. These measures will serve to extend the functional life of the bridge while maintaining its original, appealing aesthetic.

IBC 23-09: Comprehensive Restoration of a Century Old Suspension Bridge (Wurts Street Bridge over the Rondout Creek, Kingston, NY)

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

Exactly 100 years after the Wurts Street bridge opened to traffic in 1922, construction began on the structure's first major rehabilitation in nearly 50 years. This paper will focus on the comprehensive restoration of this historic suspension bridge. Because of the bridge's age and condition, numerous complex construction operations were required to repair primary components of the suspension main cable system, stiffening truss and floor system. Sequencing the deck replacement operation required careful consideration of dead load removal and the corresponding stresses in the stiffening truss and stability of the suspension system. Another major component and design aspect involves installation of a supplemental main cable anchorage which relieves a portion of the dead load carried by the original anchorage eyebars. This project also includes the replacement of the sidewalk, pedestrian and vehicular railing systems, all 114 suspenders, links between the continuous stiffening trusses and towers and all 120 bottom chord gusset plates of the stiffening truss. The goal of this project is to make the bridge safe for pedestrian and vehicular traffic, while preserving historic features important to the surrounding communities for decades to come.

IBC 23-10: PA Turnpike Bridge Milepost A098.11 (I-476 over Lehigh River) – Tie-Plate Crack Investigation and Emergency Repairs

Bradley Degnan, P.E., TranSystems, Morristown, NJ; Margaret Sherman, P.E., TranSystems Corporation, Philadelphia, PA; James Hibbs, P.E., Pennsylvania Turnpike Commission, Middeltown, PA

Built in 1955 and rehabilitated in 1989, Pennsylvania Turnpike Commission Bridge NB-635 at Milepost A098.11, carrying I-476 (the Northeast Extension) over the Lehigh River, is a steel two-girder bridge with floorbeam overhangs attached over the girders with tie-plates. These tie-plates are in tension and considered fracture critical members. For over 10 years there has been a known crack in the West Girder tie-plate at the North Abutment end floorbeam. During the September 2021 routine inspection, the crack was noted to have propagated beyond the first rivet. The tie-plate was subsequently scheduled for monthly special inspections through the winter to monitor for further crack propagation while repairs were designed and mobilized.

While performing a monthly special inspection, the inspection team discovered a previously unidentified crack at a similar tie-plate connection in the East Girder. Additional inspections were then conducted at the South Abutment floorbeams, and the remainder of the structure, where three additional cracked tie-plates at the East Girder at the piers were discovered, leading to temporary lane restrictions on the bridge. Unlike the cracks observed at the North Abutment, the cracks encountered at the piers were almost fully propagated thru the tie-plate width. A team of engineers and contractors were immediately mobilized to design, fabricate, and install tie plate retrofits. The emergency retrofits, consisting of rivet removal and installation of supplemental plates, were performed over the course of four days, and the lane restrictions were removed within a week of finding cracked tie-plates at the piers.

Construction Special Session

IBC 23-SS01: UHPC- Construction Methods/Equipment

Michael McDonagh, P.E., P.Eng., WSP USA, Lawrenceville, NJ; Zach Haber, University of South Florida, Tampa, FL; Nick Dean, Delaware DOT; Dave Czachorowski, Zack Excavating, Smyrna, DE

This session will provide an overview of the UHPC overlay construction market in the United States, the basic construction steps and equipment required, the technical guidance available, and current and needed research. Additionally, the Delaware Department of Transportation (DelDOT) will share their experiences with UHPC overlays and why they use them. Finally, a contractor who installed a UHPC overlay on a DelDOT bridge will share their experience including successes, challenges, and lessons learned.

IBC 23-SS02: Wind on Bridges During Construction: An Erection Engineer's Perspective

Brian Witte, P.Eng., P.E., Parsons, Westminster, MD

Wind loads on bridges can be higher during construction than throughout its entire service life. Although the erection engineer is tasked with developing safe and constructible erection procedures, decisions made during bridge design may significantly impact the erection engineer's ability to carry out these duties. Bridge owners and designers will benefit from increased awareness of the impacts of wind loads on partially erected bridges to reduce potential issues and challenges during construction.

IBC 23-SS03: Mobile River Bridge and Bayway - Progressive Design Build

John Dietrick, P.E., S.E., Michael Baker International, Cleveland, OH; Edwin Perry, Alabama DOT

The Mobile River Bridge and Bayway Project is a $2.7B construction project which will add capacity to approximately 11 miles of I-10 through downtown Mobile, AL and across the Mobile Bay. This corridor, which currently utilizes a four-lane tunnel under the Mobile River, is one of the most congested interstate corridors in the country. The project will include a new cable-stayed bridge with a main span of 1380 ft. over the Mobile River, the replacement of approximately 7 miles of Bayway structure over Mobile Bay, and the reconstruction of seven interchanges. The Alabama Department of Transportation is using a Progressive Design Build model to procure two separate design-build teams to deliver the largest transportation project in the history of the state. This presentation will include a discussion of the decision making process that led to the selection of the Progressive Design Build procurement method and challenges associated with procurement process.

New Technologies Special Session

IBC 23-SS04: Drones City of Pittsburgh Bridge Asset Management Program

Seth Zora, Aerdia, ,

In this presentation, we'll discuss the role of drones in AEC, specifically in bridge inspections. AerdiA's experience in providing high-resolution media for inspections on some of Pittsburgh's largest and most challenging bridges will serve as a case study. Drone equipment specifically used for this project will be discussed. With the rapid advancement of drone technology, it's crucial to know how to choose the right hardware and software for effective bridge inspections.

IBC 23-SS05: Enhancing Bridge Inspection and Analysis with Drones, Artificial Intelligence, and Other Advanced Technology

Michael Giacco, AI Engineers, Middletown, CT

AI Engineers, Inc. (AIE) is pairing the latest AEC innovations with their over 30 years of conventional services experience. Unmanned aerial systems (UAS/drones), light detection and ranging (LiDAR) scanning, wireless monitoring sensors, and more perform or supplement their traditional bridge inspection and evaluation tasks as well as create reality capture models and digital twins. AIE now implements artificial intelligence (AI) to safely monitor infrastructure assets, minimize the risk of failure, prioritize repairs, and optimize infrastructure spending. Leveraging these technologies gives AIE the ability to improve safety, quality, and value for their clients and staff.

IBC 23-SS06: Resiliency Research and PennDOT Policy Changes

Nick Vivian, P.E., Pennsylvania DOT, Harrisburg, PA; Timothy Carre, Pennsylvania DOT nvivian@pa.gov

IBC 23-SS07: BIM/Digital Delivery

Allen Melley, P.E., Pennsylvania DOT, Harrisburg, PA

Emergency Response Special Session

IBC 23-SS08: Emergency Response to Hurricane Ian including Pine Island and Sanibel Island Bridge Repairs

Christina Freeman, P.E., Florida DOT, Tallahassee, FL; Natalie Rodriguez, P.E., TranSystems, Fort Lauderdale, FL; James Phillips, P.E., Hardesty and Hanover, Tampa, FL

The damage from Hurricane Ian will continue to be felt in Southwest Florida for some time – yet the FDOT team and partners helped reconnect communities in unprecedented time. Pre-storm preparations allowed immediate response. Industry partners successfully worked in tandem to restore access to Pine Island in less than three days and rebuild the Sanibel Causeway in just 15 days.

IBC 23-SS09: SR 51/I 70 Bridge Hit

Jeremy Hughes, Pennsylvania DOT, Uniontown, PA

IBC 23-SS10: PennDOT Emergencies

Jason Zang, P.E., Pennsylvania DOT, Pittsburgh, PA

Young Attendees Special Session

IBC 23-SS11: Scudder Falls Bridge Project

Ryan Opel, Trumbull Corporation, Pittsburgh, PA

IBC 23-SS12: Rehabilitating the Historic Wheeling Suspension Bridge

Kody Oliver, P.E., HDR, Charleston, WV

Spanning 1008.5-ft across the Ohio River, the Wheeling Suspension Bridge opened in 1849 as the longest suspension bridge in the world. During its more than 170 years in service, this bridge experienced numerous rehabilitations but inspection findings over the last decade prompted major repairs including the replacement of stay cables and a retrofit to a main suspension cable anchorage. This presentation will cover a brief history of the bridge and the design challenges faced during its recent rehabilitation to implement modern solutions into a National Historic Landmark.

IBC 23-SS13: The Sky's the Limit: Turning Bridge Engineers into Drone Pilots

Kevin A. Wilson, EIT, Pennoni, Newark, DE

This presentation will introduce you to the possibilities and benefits of using a drone to supplement your workflow. This will be balanced with important limitations to consider before investing in a drone and pilot. We will then cover the pilot certification process, as well as the wide range of deliverables drones can unlock. My goal is to provide you with key factors for deciding if you should pursue an in-house drone pilot and supply a guide for certification to help you take off.

IBC 23-SS14: Planning and Managing a Large Bridge Inspection Project

Binh Pham, P.E., TranSystems, Philadelphia, PA; Jason Booty, P.E., TranSystems, Cherry Hill, NJ

Bridge inspection management is a complex and challenging task with many factors to consider. It is important to have a clear understanding of the goals of the project, to develop a well-thought-out plan, and to communicate effectively with everyone who is involved. This presentation will discuss the key elements of bridge inspection management from every stage of the project: starting with planning the inspections, to ending with delivering the final reports.

Design, Part 1 Session

IBC 23-11: The Architecture of the new Frederick Douglass Memorial Bridge

James Marks, RIBA RIAS Int’l Assoc. AIA, BEAM Architects, Dorset, Bridport United Kingdom; Keith Brownlie, RIBA AIA Intl' Assoc., BEAM Architects, Dorset, Bridport United Kingdom

The monumental new Frederick Douglass Memorial Bridge is Washington DC’s largest capital infrastructure project to date and forms a bold new intervention on DC’s iconic skyline. Spanning over the Anacostia River between Anacostia and the Navy Yards, the bridge provides a direct route to South Capitol Street and the United States Capitol, replacing the adjacent structurally obsolete South Capitol Street Bridge. Like the structure that it replaces, the new bridge is a tribute to Frederick Douglass, the celebrated social reformer, abolitionist and statesman.

The new 1200ft bridge deck is supported from three pairs of tall steel arches that bear onto concrete V-shaped piers to describe a fluid serpentine line of structure. The through-arch arrangement provides a dynamic gateway to the monumental core of the city and provides a rare and significant alteration to the DC skyline that mediates between urban development on the Capitol side and parkland setting on the Anacostia side. The project includes two landscaped traffic ovals that mediate between the orientation of the bridge and the city street grid and generous pedestrian overlooks that cantilever out from the NMU paths between the arches to form external rooms over the river as social gathering spaces for the City.

The paper is written by the Bridge Architect. It will focus on aesthetic aspects of the proposals, including evolution of the concept, integration of the new structure into Washington’s L’Enfant Plan, visual impact, component shaping and provision of high-quality public realm on the bridge.

IBC 23-12: Computational Design of Complex Structures with Faster Finite Element Analysis Programs

Jeff Svatora, P.E., HDR, Prior Lake, MN

HDR has developed in-house finite element analysis programs that offers substantial speed increases over commercial programs. The approaches used by HDR to achieve these speed improvements will be discussed. The program is being used to analyze variations of Tied Arches in preliminary design with highly refined floor systems and influence surfaces in under 10 seconds. HDR has paired this dramatic reduction in analysis runtimes with computational design routines to size various members and geometric aspects of the arch. The resulting tool can rigorously analyze several hundred variations and rib, cable, and tie girder size and geometry an hour. Optimization techniques have been used to search for the “optimal” structure. Variations of this program that have been applied to cable stayed bridge and steel I-girder examples will briefly be discussed.

IBC 23-13: A State-of-the-Art Analysis and Design of a Continuous Seven Spans Post-Tensioned Bridge with Innovative Seismic Isolation Bearings

Sameh Salib, Ph.D., P.Eng., BDS, P.E., WSP Canada, Thornhill, Ontario Canada; Maged Ibrahim, M.A.Sc., P.Eng., P.E., FEC, WSP Canada, Thornhill, Ontario Canada

A continuous post-tensioned bridge over seven spans, 27m each, was constructed in Quito, Ecuador. Located in one of the most active seismic/volcanic regions of South America, several challenges were faced during the bridge design. The superstructure is supported on piers with two separate circular columns/caissons without a pier-cap or framing into the deck. This substructure system was adopted to satisfy the required vertical clearance for the arrival level below. Consequently, the post-yield behaviour of pier reinforcement could not be allowed as a hysteretic energy dissipation system since the formation of plastic hinges at such piers impairs the control over deck displacement and the stability of the bridge deck. A non-linear time history analysis accompanied by a parametric study was carried out considering different types of base isolation bearings. To achieve an optimum seismic performance, an innovative seismic isolation system was developed along with a full-scale testing of the proposed bearings at the University of New York at Buffalo. Further, the limits on the bridge movement due to adjacent terminal buildings and having no expansion joints within the bridge length exposed the need to minimize the overall longitudinal movement of the bridge due to creep and shrinkage. Therefore, the proposed construction stages and bearings conditions at each stage were designed and executed to satisfy the desired behaviour. The bridge has been serving for 10 years with satisfactory performance under various seismic events. Herein, the developed three-dimensional finite element model (3D-FEM), seismic analysis, staged construction and the bearings experimental program are presented.

IBC 23-14: Perquimans River S Bridge Replacement

Timothy Noles, Hardesty & Hanover, LLC, Raleigh, NC ; Nathan Wiggins, P.E., Hardesty & Hanover, LLC, Raleigh, NC ; David Peterson, Rummel, Klepper, & Kahl, Raleigh, NC,

Stretching over the Perquimans River as it drains into the Albemarle Sound in northeastern North Carolina an historic bridge connected the towns of Hertford and Winfall. Built in 1929, the previous structure carried a 0.6 mile long causeway of US17/NC37 on poor compressible soils including a 650 feet long bridge structure with a 161 feet Warren Truss Swing Span. Continued settlement of the causeway, flooding during severe weather, and deterioration of the structurally deficient Swing Span necessitated the replacement of the entire structure.

To replace the structure, NCDOT has embarked on its first movable bridge replacement through Design-Build procurement. McLean Contracting teamed with RK&K and Hardesty & Hanover to replace the existing structure with a new pile supported bridge including 27 concrete approach spans and a new Steel Swing Span over the existing navigation channels for an overall length of 2700 feet. The approach spans consist of precast deck panel forms with a cast-in-place concrete deck pour, Florida I-beams, 30in. prestressed concrete piles and integral abutments. The Steel Swing Span consist of a stringer-floorbeam floor system with a lightweight concrete deck, and a Warren Truss.

Technical design requirements included strict adherence to durability requirements for concrete approach spans and concrete substructure, enhanced aesthetics of Swing Span and Control house, protection to turtle species, a new formulation for metallizing the Swing span structural steel, minimizing long-term machinery and electrical costs, and capabilities for remote operation of the bridge.

The paper will present the design-build procurement process, design challenges and construction progress.

Inspection and Evaluation, Part 1 Session

IBC 23-15: Seismic Strengthening of Bridge Columns with FRP In Lieu Of Steel Jacketing

Clyde Ellis, Structural Technologies, San Francisco, CA; Tarek Alkhrdaji, Structural Technologies, Columbia, MD

Needs related to the repair and improvement of our Transportation infrastructure continue to increase. Seismic strengthening of bridge columns to enhance load capacity and flexural and confinement performance have become an important focus. Many in the engineering and construction communities are familiar with steel jacketing as an approach to address this need. Concerns and challenges associated with this approach are schedule duration, placement concerns, ability to address geometry of the existing condition and retrofit service life.

This paper uses the case study of Caltrans' design-build project on US 50 corridor which included seismic upgrade of 4 and 5-foot diameter flared bridge columns. Column heights for the South Park and 15-16th Street Viaducts ranged from 19' to 29'. Design-build project delivery leverages process creativity and optimization. Teams are motivated to "think outside the box" and thus, Alternative Technical Concepts (ATC's) are born.

Complex analysis led to a value engineering option using externally bonded Carbon Fiber Reinforced Polymer (CFRP) wrap in lieu of 1/2" thick Steel Casing due to ready availability, ease of placement, conformability and long-term performance. The shift to use of the CFRP system yielded schedule reduction and cost savings over the steel casing alternative. The ATC proved particularly suitable and superior for the complex geometry of the flared columns. All stakeholders benefitted from this project innovation. The paper will demonstrate how the design-build team was able to leverage innovative collaboration to provide schedule and cost benefits, and long-term value to the Owner.

IBC 23-16: Nondestructive Evaluation of Post Tensioned Ducts of the Eltham Bridge

Shane Boone, Ph.D., Bridge Diagnostics, Inc., Louisville, CO; Annette Adams, Virginia DOT, Fredericksburg, VA; Jeffrey Cohen, Bridge Diagnostics, Inc., Louisville, CO

Over the course of 18 months in 2021 and 2022, BDI inspected over 5 miles of post tensioned (PT) ducts on the bridge Carrying US-33 over the Pamunkey River west of West Point, VA (Eltham Bridge) utilizing a multi-technology approach of nondestructive evaluation (NDE). With a permanent lane closure established, the AASHTO bulb tee girders were accessed with under bridge inspection trucks (UBIT). Ground penetrating Radar (GPR) was utilized to locate the harped PT ducts and Impact Echo (IE) and ultrasonic tomography (MIRA) were used to identify potential voids in the ducts utilizing a combined acoustic analysis technique. Specific locations were identified to validate testing results, and multiple ducts were excavated to confirm void locations as well as collect grout samples for chemical testing (Chloride, Sulfate, pH, and carbonation). The data will be utilized by the Virginia Department of Transportation (VDOT) to determine preservation activities for the structure.

IBC 23-17: Detection of Post-Tension Grout Defects in Bridges

Brian Pailes, Ph.D., P.E., NACE CP Specialist, Vector Corrosion Services, Tampa, FL ; Ben Armitage, NDT Corporation, Sterling, MA ; Natallia Shanahan, Vector Corrosion Services, Tampa, FL,

The Varina-Enon (VE) Bridge located near Richmond, Virginia carries I-295 over the James River. The VE Bridge is a cable stay bridge that implements post-tensioned (PT) in the super- and sub-structure. There is vertical internal PT in the piers, external longitudinal PT in the superstructure, and internal transverse PT in the deck. Throughout the world, it has been discovered that the grouting of PT has been plagued with defects like voids and soft grout. These issues can cause serious and very accelerated corrosion deterioration of the PT strands. What makes the issue even more challenging is that voids and soft grout defects in PT are impossible to detect through standard inspection methods. Therefore they are often not discovered until serious damage to the structure has occurred, often tendon failure. VDOT hired VCS and wholly owned subsidiary NDT Corporation (VCS/NDT Corp.) to survey the PT of the VE Bridge to locate and quantity any grout defects. VCS/NDT Corp. have developed an effective tool that uses both impact echo and pulse velocity (IE/PV) to non-destructively test both internal and external PT tendons to identify the location and extent of voids and soft grout issues. This method has been proven to work on many previous PT bridge structures and this paper will present how this approach works and show actual results from the VE bridge. VCS/NDT Corp. was able to accurately survey the PT elements and determine the location of the grouting defects so that the owner could remediate these issues.

Foundations Session

IBC 23-18: Structural Design Challenges for an Architecturally Constrained Bridge

Ryan Jenkins, Ph.D., P.E., HDR, Pittsburgh, Pennsylvania; Melissa Werner, HDR, Pittsburgh, Pennsylvania; Kevin O'Connor, HDR, Pittsburgh, Pennsylvania

Designing a bridge is always a challenge, but when it services a marquee, $1.4 billion airport terminal and is built on top of an existing airport taxiway, it adds an entirely new set of design and analysis challenges. The new Pittsburgh International Airport terminal, currently under construction, consists of three stories, and the approach roadway is required to split and weave into three, vertically stacked roadway sections. This culminates in a two-level, 1300’ bridge structure facilitating four travel lanes and a 32’ sidewalk area adjacent to the terminal building.

Practical challenges to design include addressing drainage on a bridge with a level profile grade and designing trapezoidal box-girder field splices at in-plane rectangular straddle cross girders, which are also at the maximum negative moment regions. Structural analysis challenges include a curved-to-tangent simple span, with one end on a straddle cross girder, and the effects of a two-level bridge.

The sharp curve-to-tangent alignment on a simple span bridge causes service and fatigue uplift at a disc bearing, and the end straddle cross girder required nonlinear analysis to evaluate stability during construction. The most challenging analysis challenge is caused by the two levels. Because of their interaction, especially for thermal effects, the substructure and foundation required detailed, refined analysis. In addition to analyzing the entire structure in a single, comprehensive finite element model, a detailed soil-structure interaction was considered. This included calibrating the modeled foundation stiffness by iterating between the global analysis model and foundation analysis model.

IBC 23-19: Alternative Approach to Design for High Shear Demands in Rock Sockets

Lawrence Rolwes, Jr., HNTB, Arlington, VA

It is common strategy to “socket” drilled shafts into rock to develop lateral or axial capacity where overburden soils are shallow and or relatively weak compared with the underlying rock formation. Where drilled shaft foundations are incorporated with the substructure units to resist lateral loads such as seismic or vessel collision forces through frame action, large moment demands develop at the base of the shafts. Current methods of numerically modeling soil structure interaction using p-y techniques often result in shear forces near the top of the rock sockets that are significantly larger than the applied lateral forces. These demand forces are typically addressed from a capacity perspective by increasing concrete strength, increasing shear reinforcement, and/or increasing the shaft and socket diameters. All these approaches have cost and constructability implications.

Shear capacity within rock sockets has traditionally been evaluated using beam theory methods. Considering the mechanics and geometric characteristics of load transfer through the socket and into the supporting material, it is apparent these elements are better characterized as D-Regions for which a strut-and-tie approach is an appropriate tool for assessing the socket capacity. Such a solution results in slightly more longitudinal steel but much less transverse reinforcement leading to a more cost effective and constructible solution.

IBC 23-20: Delivering Value and Resiliency in Bridge and Foundation River Construction

Gregory Ricks, P.E., HNTB, Parsippany, NJ; Laura Spann, P.E., Haley & Aldrich, Parsippany, NJ; Henry Meyers, Anselmi & DeCicco, Inc., Maplewood, NJ; Steven Flormann, HNTB, Parsippany, NJ

The construction of this bridge utilized innovative value engineering and construction techniques to reduce construction duration, reduce overall cost, and provide improved performance. The Route 46 Eastbound bridge over the flood-prone Passaic River was being re-constructed while the existing adjacent Route 46 Westbound bridge was to remain in service. The Eastbound bridge was originally designed to have three piers in the river, even though the existing Westbound bridge has only two; this was done to maintain distance between new pier construction and existing Westbound shallow foundations, minimizing potential for settlement of the existing bridge. A value engineering process was undertaken to reduce the number of new Eastbound piers in the river from three to two. The elimination of the center pier in the river improved the hydraulic characteristics, minimized scour potential, and reduced the length of the temporary trestle, reducing environmental impacts and potential for delays. To mitigate settlement concerns when installing new deep foundations adjacent to the existing Westbound foundations, fully cased drilled shafts were utilized, minimizing vibrations and concerns related to hole stability and, thus, potential settlements. A pile dynamic load test was performed utilizing the APPLE test, which allowed for efficient testing of the shaft design with limited available skin friction resistance (no rock socket). The abutments, founded on drilled shafts, were detailed to be semi-integral.

IBC 23-21: I-895 over Herring Run – Erosion & Scour Mitigation

Laura Magoon, P.E., RK&K, LLP, Baltimore, MD; David Black, P.E., RK&K, LLP, Baltimore, MD; Ruel Sabellano, MDTA, Baltimore, MD; Peter Mattejat, MDTA, Baltimore, MD

The Maryland Transportation Authority's (MDTA) I-895 bridge crossing Herring Run suffered a severe scour event in November 2018 that endangered the southbound bridge's piers. Upon notice, MDTA immediately began corrective measures to mitigate the scour at the bridge. This included two-plus years of responding to multiple large storm events, increased stream bed/bridge monitoring, non-destructive testing, collection of soil borings, four separate authorizations from USACE and Maryland's Department of the Environment for waterway construction permitting, hydraulics modeling, scour countermeasure design, and several mobilizations for emergency scour mitigation construction.
The first of the three-span steel beam bridge was constructed in 1956 with piers founded on spread footings then other spans to widen bridge were constructed in 1968 and 2007 with pile supported foundations. The project location is in the Coastal Plain Physiographic Province where the riverbed is dominated by sand, small gravels and cobble stones. The river flow generally exceeds the riverbed's ability to resist movement. The fortunate accessibility to 100 years of aerial imagery, previous bridge construction plans, proximity of a USGS real-time gage, and 2-dimensional hydrodynamic modeling enabled the team to make informed decisions for immediate design needs and paths to protect the bridge infrastructure for years to come. The multi-disciplinary design team of structural/geotechnical/water resource engineers, environmental scientists, and construction specialists combined with MDTA's managers provided robust bridge infrastructure protection consisting of grout bags, a gabion wall, and relocating the upstream sand bar to reduce the angle of attack.

ABC Session

IBC 23-22: Accelerated Construction of Unbraced Network Arch Bridge Using SPMTs

Mike LaViolette, HDR, Omaha, NE; John Belcher, Michigan DOT, Lansing, MI; Matt Longfield, HDR, Lansing, MI

The 2nd Avenue Bridge consists of a 245 ft long, unbraced, network tied arch span which will carry vehicular traffic, bicycles and pedestrians in separate dedicated lanes over I-94 in Detroit, MI.

Assembly of the steel-concrete hybrid bridge skeleton was performed in a staging area approximately 500 feet from the final bridge location. Installation of the bridge skeleton required the use of three separate accelerated bridge construction (ABC) operations in a single project:

•SPMTs were to transport the bridge skeleton from the staging area to the rear of the south abutment
•A skidrail system was used to launch the bridge skeleton over the south abutment abutment
•SPMTs were once again used to transport the bridge across the freeway
Following the bridge move and prior to re-opening traffic on I-94, the tied arch span was then lowered approximately 16 feet onto the permanent abutments.

This presentation will discuss the assembly of the bridge skeleton in the staging area and ABC installation of the bridge which was completed during a short closure of I-94 in July 2022.

IBC 23-23: ABC Widening of I-376 Westbound Bridge using Precast Elements

Jason DeFlitch, P.E., SAI Consulting Engineers, Pittsburgh, PA; Brian Rampulla, P.E., Pennsylvania DOT, Bridgeville, PA; Keith Michael, P.E., SAI Consulting Engineers, Pittsburgh, PA

The projected increase in traffic on the ramp from I-376 WB to Bates Street leading to a nearby proposed brownfield development in Pittsburgh necessitated widening the adjacent I-376 WB bridge to provide a deceleration lane for stopped vehicles on the structure. The existing exit ramp form I-376 WB to Bates Street did not have a deceleration lane and traffic often queued onto the right thru lane of I-376. Maintaining vehicular and pedestrian traffic in this congested urban area during construction was a paramount objective. To accomplish this, ABC techniques utilizing precast substructure and superstructure elements were utilized to minimize traffic restrictions during construction. These included precast foundations supported by drilled micropiles, precast substructure stem/backwall elements, and precast deck panels. Installation of micropiles and precast substructure elements occurred during several weekend closures of Bates Street and various ramps to/from I-376. Superstructure widening included partial removal of the existing deck, erection of a new girder and placement of precast deck panels matching the existing deck and connected to the existing deck with a longitudinal UHPC closure pour. Transverse UHPC pours were placed between adjacent precast deck panels. The superstructure widening activities occurred during a 15-day restriction of traffic on I-376 WB that reduced the existing three lanes of traffic to two lanes. The use of precast deck panels reduced the duration of the lane restriction on I-376 WB compared to the use of a cast-in-place concrete deck.

IBC 23-24: A Very Rapid Bridge Replacement

Yen Wu, P.E., MASc., Arup, Toronto, Ontario Canada; Shahzal Nisar, Moot MacDonald Canada; Ken Bontius, Arup, Toronto, Ontario, Canada

The conventional methods of construction are the dominant techniques for today's bridge construction practice. However, such methods may impose significant disruptions to traffic. The industry professionals, in collaboration with the owners are adopting innovative construction techniques to reduce the timeline of traffic disruption from several years to just a few weekends. One of these innovative techniques, the Rapid Bridge Replacement (RBR), was used for the superstructure replacement of the overpass at Highway 400 & Finch Avenue West as part of the Finch West LRT (FWLRT) project. While the project was procured by Metrolinx in a Public-Private Partnership (PPP), the structure is owned and retained by the Ontario Ministry of Transportation (MTO). The existing northbound and southbound superstructures were removed and replaced using the RBR method during two full-weekend closures of Highway 400 and Finch Avenue West. Each twin superstructure, consisting of a two-span continuous slab-on-girder system, was constructed in nearby areas on falsework, completed with a semi-integral conversion, barrier walls, and a new waterproofing system. During the full weekend closures, the superstructures were transported and erected in place by a self-propelled modular transporter (SPMT) and finished with new precast approach slabs, asphalt pavement, and lane markings. This safe and efficient method saved two years of staged construction, including highway widening to accommodate the traffic staging, reducing the impact to traffic and the community, and ultimately contributing to a smaller environmental footprint for the project. On June 22, 2020, at 5 a.m., the new bridge opened to unrestricted traffic.

Pedestrian/Special Purpose Bridges Sessi

IBC 23-25: Making Connections at Phoenix Sky Harbor International Airport

Jennifer Whiteside, P.E., Gannett Fleming, Greenwood Village, CO ; Pouya Banibayat, Gannett Fleming, Los Angeles, CA ; Andrew Ward, P.E., Gannett Fleming, Toronto, Ontario,

Bridges supporting taxiways and runways that carry commercial aircraft remain relatively rare. Due to increased air travel demand, combined with increased development around airports limiting airport expansion, the necessity of these bridges is escalating. Phoenix Sky Harbor International Airport, which services more than 400,000 takeoffs and landings per year, is in the midst of a paramount project to expand access between the north and south field runways through the construction of Taxiway “U”. The new taxiway will pass over several of the airport’s main access roadways and the existing PHX Sky Train® automated people mover.
This alternative delivery project will include two new bridges for the taxiway, which are designed for Federal Aviation Administration (FAA) Group VI loading, generally controlled by the Airbus A380 airplane. Current FAA guidance on the design of bridges carrying aircraft loading is limited to a few bullet points and a reference to AASHTO’s Load and Resistance Factor Design 7th Edition. In addition to these two documents, the American Concrete Institute (ACI) has published ACI 343R-95: Analysis and Design of Reinforced Concrete Bridge Structures, which includes a section on runway bridge loads. This document was last updated in 2004. This leaves much of the application of live load up to the designer. This presentation will explore these challenges and discuss our team’s solutions.

IBC 23-26: An Engineered Timber Bridge for the Seven First Nations

Vanessa Wan, P.Eng., M.Eng., Stantec, Montréal, Quebec Canada

More than 10,000 people living north of the Berens River in Ontario live in isolation and without essential services. Currently, the winter roads last only 2 to 6 weeks a year and is a critical for the transport of people, goods and materials to these communities. The Government of Canada and the Seven First Nations communities wants to build an all-season road access to their communities and the Berens River Bridge is the gateway to this new road development. They wanted a bridge, but they have let us determine the best solution for them. This did not mean that we had a "carte blanche". After a first stage of solutions and location studies, the Seven First Nations chose a two-lane engineered wooden bridge with a sidewalk. The second stage has put us in the middle of the challenges: some anticipated and others that turned out to be in the process of design. Being in a remote region, it was necessary to think about prefabrication, simplified connections, easy maintenance and the opportunities for First Nations to ensure the sustainability of the structure themselves. The 90-m engineered timber arch with cross hangers was chosen for its possibility of being assemble off-site and then transported to its final position. These are some of the many criterias we had to consider into our bridge design and analysis.

IBC 23-27: Park Union Bridge - Complex Pedestrian Bridge Design and Analysis

Lana Potapova, B.Eng., M.Eng., P.E., Arup, New York, NY ; Matt Carter, Arup ,

Arup is the Engineer of Record for the Park Union Bridge, opened to pedestrians in July 2021, connecting the U.S. Olympic & Paralympic Museum to America the Beautiful Park and Downtown Colorado Springs.

Called the rip curl for its cresting design, the footbridge spans 250ft over active rail lines. The 300 ton steel superstructure is designed to both integrate with the aesthetic vision for the
museum and to minimize impact on rail operations during construction. From bridge inception, we leveraged our parametric 3D work environment to communicate visually and explain crucial aspects of the bridge behavior with key collaborators including Diller Scofdio + Renfro and Anderson Mason Dale architectural team; City of Colorado Springs client; Union Pacific railroad; Kiewit general contractor; and, King Fabrication steel fabricator. This communication style continuously supported the architectural vision for the bridge, and allowed to preserve the sculptural “floating” nature of the bridge while presenting a pragmatic and sensible design.

IBC 23-28: A People-First Approach to a Modular FRP Pedestrian Bridge

Thomas Osborne, RIBA, Knight Architects, London, United Kingdom

The ‘Flow’ bridge is an innovative new standard footbridge designed by Knight Architects for Network Rail (the UK Rail Operator) as part of their nationwide drive to improve safety at level crossings. The brief sought to find an alternative to the heavy steel standard footbridge commonly used across the railway network.
The project challenged the design team to deliver a user-focused footbridge that was cheaper and quicker to produce than a steel equivalent, and adaptable to a wide range of locations. The unique properties of modern composites resulted in a concept design which is lightweight, strong, and cost-effective. This in turn allowed the use of concrete free foundations.

Improvements to the bridge geometry and parapets create a radically enhanced user experience, when compared to the standard through-girder. A modular concept design was developed in fibre-reinforced polymers (FRP) using parametric modelling tools, which allowed for a highly collaborative process and real-time design evolution. The result is a standardised product which accurately reflects the concept, whilst offering a variety of configurations to respond to different site characteristics.
The innovative procurement process meant concept to completion of full-size prototype took less than a year and was achieved largely remotely.

Digital Delivery/BIM/3D Modeling Session

IBC 23-29: Bridging the Digital Divide

Joe Brenner, P.E., Michael Baker International, Harrisburg, PA ; Brad Wagner, Michigan DOT, Lansing, MI ; Marcia Yockey, P.E., Michigan DOT, Lansing, MI,

Michigan DOT (MDOT) is moving forward with Digital Delivery and let its first pilot delivering the digital bridge model as the contract document in August 2022. This paper will cover the development of this industry leading pilot including reimagining how design information is presented, engagements, and training.

In place of the typical 2D plan set, a 3D model enhanced with annotations, model attributions, saved views, 2D details, and links to supplemental documents is accessible from a computer or tablet. The model was created using a combination of OpenBridge Modeler, ProStructures, and OpenRoads Designer and will be viewed in the field using Bentley Synchro.

Developing the new format required evaluating the purpose of each detail in a conventional plan set. Throughout the project, the team worked directly with contractors, consultants, and MDOT to determine what information the legal documents ultimately need. Additional engagements with the contractors and fabricators focused on how they could use the digital information in the field and in their native software.

Successful use of the model depends on training and communication. Project scope contains extensive training for all disciplines from design through construction including live sessions, on-demand videos, and guides demonstrating the differences between traditional and Digital Delivery workflows.

MDOT is investing in Digital Delivery to create a more efficient process that better communicates design information to the contractor. Directly sharing design data will minimize mistakes in the field leading to fewer claims and improved relationships between clients, consultants, and contractors – valuable returns for any organization.

IBC 23-30: 3D Modeling: Complex Bridge Construction and Emergency Repairs

Zacharie Stonestreet, E.I.T., Michael Baker International, New Brighton, PA

Complex bridge types like tied-arches and cable-stayed bridges present many geometrical challenges to both the design teams in the office and the contractors in the field. These challenges often don't present themselves until the construction or the repair of these bridges, and they are potentially catastrophic when the condition of the bridge is on the brink of failure. 3D modeling is very beneficial as it assists engineers in the geometric design of components and creating drawings for fabrication and construction, while providing other benefits, such as detecting interferences prior to construction and conveying design methods with the renderings produced from the model. 2 case studies will be presented to illustrate how the 3D models have proven to be an integral part in the design process. The first case study is a 3D construction phasing model that was developed for one of several complex bridge alternatives for the US-51 Bridge Replacement project, which is a concrete superstructure cable-stayed bridge spanning the Ohio River from Kentucky to Illinois. The second case study is the 3D model that was developed and utilized to design the temporary and permanent repairs of the Hernando de Soto Bridge emergency repair.

IBC 23-31: Database driven design of a large-scale bridge

Sean LeCoultre, P.E., Ramboll Finland Oy, , Finland; Ilkka Ojala; Eero Särkkä; Augustin Ceillier

Computational design has gained traction in the infrastructure industry in recent years. The link between parametric tools, FEM, and BIM software allows integration of parametric design practices directly into the structural and fabrication design. By linking the project design processes, many tasks can then be automated. Even though creating a bridge model from a script is not new, the detailing of these models usually stays a labor intensive and time-consuming process. The detailing hence stays on the critical path of a project delivery schedule. Similarly, keeping the dataflow consistent between the different models can become a challenge on tight schedules.

The Kruunuvuori Bridge is a 1,2km long cable stay bridge that will be built in the heart of the Helsinki metropolitan area. Once completed, it will be the longest bridge in Finland and one of the longest bridges in the world built only for public transport and pedestrian traffic.

The project has been an opportunity to push design automation further by having a holistic workflow integrating analysis and detailing. The development of a series of processes and tools allowed generation of a fully detailed BIM model in a few seconds: from a common database driving both the analysis and BIM models, a precambered model of the bridge is generated that can be used directly for fabrication without any labor intensive and timely hand detailing. The automated approach allows more tasks to be treated in parallel, hence shortening the delivery schedule. Similarly, changes in the design can be implemented "instantly."

Construction/Erection, Part 1 Session

IBC 23-32: Unique Girder Erection Techniques for Difficult Site Conditions in Kicking Horse Canyon

Brian Witte, P.Eng., P.E., Parsons, Westminster, MD ; Justin Ramer, Parsons, Westminster, CO ; Chris Koop, Parsons, Golden, BC,

The Kicking Horse Canyon - Phase 4 project includes widening and realignment of approximately 5 km of Trans-Canada Highway 1 approximately 4 km East of Golden, BC. The project is situated in rugged mountainous terrain adjacent to the narrow existing roadway which created significant challenges to all phases of construction including maintenance of traffic through all phases of construction.

The design-build team worked closely together to ensure the final design would be constructible. The steep and varying terrain required bridge span lengths up to 70m, horizontal curves, longitudinal slopes, and transverse slopes (each up to 6%). In addition, traffic staging required some structures to be constructed in multiple phases.

While these span lengths, horizontal curves, and steep slopes are typical for steel bridges, the location they had to be built on the Kicking Horse Canyon project was very atypical. A wide variety of creative techniques were required to construct each bridge since it was not feasible to position cranes to erect girders onto their final bearings using conventional methods. Solutions to overcome challenges included temporary crane trestles perched off the side of the mountain, steel trusses used to temporarily extend permanent pier caps, and hydraulic jacks and rollers system to launch girders transversely across the piers.

IBC 23-33: Strand Jacking of the I-64 Westbound Steel Girder Bridge over the Kanawha River

Peter Quinn, P.E., Tunstall Engineering Group, Cranberry Twp, PA ; Jarid Antonio, P.E., Tunstall Engineering Group, Cranberry Twp, PA ; Shawn Tunstall, P.E., Tunstall Engineering Group, Cranberry Twp, PA, ; Thomas Hesmond, P.E., Brayman Construction Corporation, Saxonburg, PA, ; Jeff Slezak, P.E., Trumbull Corporation, Pittsburgh, PA,

The US35/I-64 Nitro Interchange Project consists of the demolition and construction of six (6) bridges to reconfigure a portion of the interchange and replace the main river crossing. The existing main truss bridge crossing over US35, Kanawha River, and CSX railroad will be replaced with twin 1344'-6" three-span steel haunched girder bridges with main spans of 563'-6". The girder webs vary in depth from 10'-11" to 15'-5" and the flanges are up to 54" wide and 3" thick for a total max pick of 330,000 lbs. Spans 1 and 3 were erected using conventional construction methods erecting the girders using barge and land-based cranes, with falsework towers, pier brackets, and bracing supporting the girders. The center span was constructed on barges, floated into place, and strand-jacked up until the splices with the previously erected girders could be made. The total weight of the portion lifted into place was almost 3 million pounds. Span 3 was longitudinally jacked to close the gaps at the splices. The contractor and contractor's construction engineer will provide details associated with the construction and construction engineering required to erect the new Westbound bridge. Strand Jacking, Longitudinal Jacking, and other construction details will be discussed.

IBC 23-34: Transportation and Erection of Four Steel Arch Bridges

Thomas McNutt, P.E., P.Eng., Harbourside Engineering Consultants, Dartmouth, Nova Scotia Canada; Robbie Fraser, Harbourside Engineering Consultants, Dartmouth, Nova Scotia Canada; Stuart Herlt, Cherubini Bridges and Structures, Dartmouth, NS, Canada

Waterfront Toronto has taken on the ambitious project to reinstate a natural river channel for the Don River where it empties into Lake Ontario to provide flood protection for the Port Lands area and surrounding neighborhoods. This project also converts a large industrial area to park land and mixed-use development close to downtown Toronto. The new river channel required the construction of four new bridges to provide access to the newly developed area.

To achieve the desired appearance, coupled with the need to accelerate bridge construction due to extensive Civil works undertaken across the entire site, it was determined that the best way to build the bridges, while minimizing visible field joints and producing high quality coatings, was to fabricate, assemble and paint large fully assembled segments at the fabrication shop and transport large completed steel superstructure segments to site. The bridges were fabricated and coated in Dartmouth, NS before each segment was loaded onto a barge. HEC developed the innovative solution for all aspects of fabrication, transportation and erection for each of the Port Land Bridges.

This paper will explore the challenges and design considerations required to transport and erect the two 56.1 m long fully fabricated steel arch bridges at Cherry Street from Dartmouth to Toronto. Harbourside developed the accelerated bridge construction procedures and designed the temporary works to load the bridge onto the barge, secure the bridge during transit, rotate the bridge on the barge after arriving in Toronto and finally lower the steel superstructure the bearings.

IBC 23-35: Innovative Construction of the Gambo Creek Bridge through Engineering and Contractor Collaboration

Michael Izzo, P.E., Whitney, Bailey, Cox & Magnani, LLC, Baltimore, MD ; Marcus Gursky, P.E., Whitney, Bailey, Cos & Magnani, LLC, Baltimore, MD ; Ren Persaud, Kokosing Construction Company, Inc., Annapolis Junction, MD,

Built in 1940, the bridge over Gambo Creek at the Naval Support Facility (NSF) had long exceeded its life and was structurally deficient. Due to the 18-foot width and 10-ton weight restriction, many vehicles serving the base could not cross the bridge, which connected major areas of the NSF. Vehicles able to cross were confined by 9-foot lanes, which created hazardous conditions for passing motorists. As a vital link to NSF missions, replacing the bridge was critical to maintaining operations.
Whitney, Bailey, Cox & Magnani, LLC (WBCM), as Engineer of Record, teamed with contractors CER, Inc. and Kokosing Construction Company, Inc. on this design-build bridge project, which faced multiple complexities, including a dense matrix of utilities, environmental constraints, culturally significant archeological sites, unexploded ordinances, and bridge alignment constraints, and required virtual communication throughout the COVID-19 pandemic.
As environmentally-sensitive wetlands prevented traditional construction methods, the design-build team proposed directional drilling below the marshland to relocate utilities prior to bridge demolition. This allowed the new bridge to be constructed within its existing footprint, which the design-build team showed to be possible using sequential span-by-span demolition and construction. This innovative method, which impressed NAVFAC and received approval, consisted of using the new bridge to support the crane and advancing on new foundations and a temporary superstructure to construct each subsequent span, thus, avoiding a costly temporary trestle. The new 520-foot-long bridge significantly improves roadway width and load-carrying capacity, eliminating safety concerns and restoring full access for all vehicles necessary to support NSF operations.

IBC 23-36: Construction Innovation on India's Longest Sea-crossing Mumbai Trans Harbour Link (MTHL)

Hohsing Lee, P.E., S.E., AECOM, Sacramento, CA; Robin Sham, AECOM Asia, Hong Kong Hong Kong; Sunil Wandhekar, MMRDA, Mumbai, Maharashtra, India

The Mumbai Trans Harbour Link (MTHL), a new 22 km sea crossing bridge across Mumbai Bay, will be composed of a dual three-lane expressway bridge connecting Sewri on the Mumbai side with Chirle on the Navi Mumbai side in Maharashtra. Of the total length, approximately 16.5 km will be over the sea and 5.5 km will be viaducts on land on either side. The MTHL project is developed by Mumbai Metropolitan Region Development Authority (MMRDA), which will provide a critical link between the two urban areas and quick access to the southern part of Navi Mumbai. The project has been divided into 3 civil packages and 1 system package. MMRDA awarded the design-build civil construction contracts in November 2017 with a 54-month deadline. The sea crossing is scheduled to open to traffic on the end of year 2023. When completed, MTHL would be the longest bridge / sea link in India.

The MTHL superstructure consists of mostly match-cast segmental precast prestressed continuous box girder for main lines, a typical span length of 60m, and several spans of orthotropic steel superstructure in the obligatory spans with a maximum span of 180m. In the ramps, cast-in-situ prestressed continuous box girder superstructure is provided. This paper highlights the construction innovation for the large diameter bored piles utilizing reverse circulation drilling machines, launching gantries erections on the large amount precast segments, fabrication of large block assembly in overseas, the lifting and erection of OSD spans, and other construction methods.

IBC 23-37: Keep Traffic Moving on the Benjamin Franklin Bridge

Qi Ye, P.E., CHI Consulting Engineers, LLC, Summit, NJ; Steven Htet, EIT, CHI Consulting Engineers, LLC, Summit, NJ; Kyunghwa Cha, CHI Consulting Engineers, LLC, Summit, NJ; Michael Rakowski, P.E., Delaware River Port Authority, Camden, NJ; Michael Venuto, P.E., Delaware River Port Authority, Camden, NJ

The Benjamin Franklin Bridge owned by DRPA is a suspension bridge with a 1,750-ft main span and two 752-ft side spans. It serves more than 100,000 vehicles and 200 trains per day. After over ninety-years' service, the existing pins, end laterals and rocker links at both anchorages have experienced significant deterioration requiring replacement. The construction project was awarded to Skanska, who retained CHI to design alternate supports for the replacement work.

Limited space and access inside anchorages and high design loads posed major challenges for design and construction of alternate supports. Additionally, an overarching design objective was to minimize impacts on traffic operation during construction and improve contractor efficiency by eliminating restrictive track outage requirements. Innovative designs were required to achieve the project goals.

After extensive investigation, a compressive and coherent system of alternate supports was developed. It includes four parts: longitudinal struts; wind tongues and diagonal bracing; truss end diagonal reinforcement; and rocker links. The longitudinal struts pass through the openings in the concrete walls at anchorages behind the stiffening trusses. Each wind tongue consists of a longitudinal box beam passing through the openings in the first interior floorbeam, the end floorbeam and the concrete wall. The temporary rocker links are sandwiched in the tight space between the concrete walls and the existing rocker links.

It is scheduled that the retrofits in the Pennsylvania Anchorage will be completed at the beginning of 2023, and those for the New Jersey Anchorage will be completed in the fall of 2023.

Design, Part 2 Session

IBC 23-38: Final Design and Uplift Mitigation for a 300' radius Steel Curved Girder Bridge

Daniel Baxter, P.E., S.E., Michael Baker International, Minneapolis, MN; Alexandra Willloughby, Michael Baker International, Minneapolis, MN

This presentation will provide a case study of final design and uplift mitigation for a new horizontally-curved steel curved plate girder bridge with a 300' minimum radius, located in Duluth, MN. Site constraints required that the structure, Bridge 69905, fit a specific span length configuration, which resulted in permanent uplift under dead load at the structure's north abutment. The design methods chosen to minimize this uplift will be described, including the use of staged installation of select cross-frames and counterweight design. The use of refined analysis methods and provision of lateral bracing to minimize girder differential cambers will be described as well. The bridge was completed in Fall 2022.

IBC 23-39: Bridge over Fossvogur

Keith Brownlie, RIBA AIA Intl' Assoc., BEAM Architects, Bridport, Dorset United Kingdom; James Marks, RIBA AIA Intl' Assoc., BEAM Architects, Bridport, Dorset United Kingdom; Magnus Arason, EFLA, Reykjavík, Reykjavík, Iceland; Kristjan Uni Oskarsson, EFLA, Reykjavík, Reykjavík, Iceland

This paper discusses the engineering and architectural design of an important new bridge in the Icelandic capital Reykjavík, crossing the Fossvog inlet. Fossvog bridge is the key element of a new Bus Rapid Transit system and is configured for use by pedestrians and cyclists as well as the BRT. EFLA Engineers and BEAM Architects were awarded the design contract for the bridge following an international competition in December 2021.

The 270m long bridge is a curved steel girder structure with 5-spans of 45+60+60+60+45m. The primary structure is a pair of closed, airtight steel edge box-girders with transverse girders between them supporting a composite concrete deck. The edge girders are curved in plan and elevation and a shared-use path following a serpentine route shapes the structure into a dynamic architectural form.

Stainless steel is the chosen material for the primary structural elements based on Life Cycle Costing and the need for minimized in-service disruptions, making this the first stainless steel bridge to be constructed in Iceland. The design is following a CEEQUAL process – the bridge first in the country to do so.

The superstructure is supported on a series of transversely arranged V-piers. Piers, pile caps and abutments are cast in-situ, constructed within cofferdams on the seabed. The foundations rest on groups of hollow steel section tubes with reinforced concrete infill, rammed down to bedrock.

The paper outlines the above design features, focusing on the bridge form as well as parametric design of the superstructure and the proposed erection method.

IBC 23-40: The Good, The Bad, & The Ugly: Long, Phased & Highly Skewed Steel Bridge

Eric Dues, P.E., S.E., Gannett Fleming, Columbus, OH

While planning a deck replacement of a highly skewed bridge, unforeseen conditions necessitated a full replacement. The bridge site is confined by ramp geometry, phased demolition of failing substructures, and a flyover bridge. The site, hydraulics, maintenance of traffic, varying alignments and superelevation, slope stability, adjoining walls, and substructure stability dictated the final bridge geometrics and phasing. The bridge was designed and built in three phases, with the closure pour tying the bridge together atop an exposed girder near the median. Ultimately, the bridge is a two-span (190'-293'),) structure, with a 65.5-degree skew, and is 90.2' wide, constructed in three phases. The 210' long semi-integral diaphragms have all passive pressure relieved from them contained 710 cubic yards of concrete. The girders, analyzed in Leap Steel, CSI Bridge, and rated in AASHTOWare BrR, consist of 10 lines of 110" deep webs with 28"-34" flanges ranging in thickness from 1.5"-2.75".
The Ohio Department of Transportation (ODOT) and designer often agreed that there are details that are not optimal, but time was not on our side. This paper and presentation present some of the unique details and decisions required to allow this structure (and a much larger $60 million project) to progress from concept to final plans in 12 months after a multi-year delay due to subsurface issues. Details to be discussed include bearings, self-supporting backfill, closure pour details, steel fit-up, semi-integral embedded steel diaphragms, a single hybrid section, cross frames, and a deck extension to facilitate geometrics.

IBC 23-41: Design and Construction of the New Harry W. Nice / Thomas "Mac" Middleton Bridge

Stephen Matty, AECOM, Hunt Valley, MD ; Edwin Salcedo Rueda, AECOM, Glen Allen, VA

The Harry W. Nice / Thomas "Mac" Middleton Bridge over the Potomac River replaces an existing 1.9-mile, two-lane undivided bridge with a new 61-foot-wide bridge, with four 12-foot-wide lanes, and a center median to increase traffic capacity, improve safety and facilitate access for maintenance and wide-load vehicles.
The new bridge was designed and constructed to cost effectively balance the number of spans against the number of the supporting piers. The design leveraged a combination of prestressed concrete girders in the low- and high-level approach spans with long-span, haunched steel girders over the main channel. The substructure and foundations vary from pile bents to concrete columns and caps on waterline footings. The deep foundations are 36 and 66-inch prestressed concrete piles with lengths up to 190 feet. The design approach provided a simple and repetitive structure, which increased construction efficiency, allowing the design and construction to be completed within 24 months from notice of award.
The bridge incorporated many firsts for the Maryland Transportation Authority, such as cylinder piles with carbon-fiber prestressing strands, ChromX reinforcing steel in the bridge deck, and precast concrete drainage troughs beneath the modular expansion joints. Given the size of the piles, innovative equipment was used to drive the piles, along with the permanent design incorporating temporary elements to facilitate pile installation. Steel erection of the long spans was performed using one crane and angel wings to stabilize the haunched girders, allowing field sections to be slid horizontally to complete the closure in the main span.

IBC 23-42: Overview of the new FHWA Bridge Geometry Manual

Thomas Eberhardt Jr., P.E., HDR, Columbus, OH

HDR, along with subconsultant Markosky Engineering Group, authored the Bridge Geometry Manual (FHWA-HIF-22-034) for the Federal Highway Administration. The manual documents and discusses numerous bridge geometric topics and parameters, as well as certain geometry behaviors of different bridge structure types. The document is intended to provide geometric basics to new engineers, as well as seasoned engineers. From the foreword to the manual:

"Documenting a bridge's geometry accurately on bridge layouts and detailed drawings during the design process is fundamental to successful bridge construction. Detailed bridge geometry provides the information necessary to establish analytical models for bridge superstructures and substructures. Geometric constraints often dictate the type of bridge to be built at a specific site. As such, determining bridge geometry is central to the work of bridge engineers and technicians."

The 30-minute presentation will be broken up into two primary parts. The first part of the presentation will provide an overall synopsis and summarization of the entire Bridge Geometry Manual document and touch on some of the overarching general topics for bridges in general. The second part will dive deeper into both the concrete and steel bridge topics discussed in the manual. The concrete topics include geometry related to precast prestressed concrete I-beams, concrete U-girders, and segmental concrete box beam superstructures. The steel bridge topics will center on steel I-girder bridges and will include the structural behavior and geometry changes under load, geometry and bridge fit conditions, geometry considerations for bridge modeling, thermal changes for different steel bridge geometries.

IBC 23-43: Design and Construction of the Ravensdale Road Bridge

Matthew Cochran, P.E., H.W. Lochner, Inc. , Pittsburgh, PA; Kevin McCloskey, H.W. Lochner, Inc. , Pittsburgh, PA

The Ravensdale Road Bridge, located in Hastings-on-Hudson, NY, approximately 12 miles north of Yankee Stadium, carries Ravensdale Road (~9,200 vpd) over the Saw Mill River Parkway (~50,000 vpd) and the South County Trailway. The existing structure, constructed in 1946, was a two-span steel girder bridge with substructures supported by closely spaced timber piles. Lochner, under agreement with New York State Department of Transportation (NYSDOT) Region 8, provided design services for a 203' long single-span steel girder replacement structure. Pile-supported, semi-integral, full height abutments were located to avoid the existing timber piles eliminating concerns with extraction and to accommodate future Saw Mill River Parkway widening. A pier could not be introduced due to geometry of the Parkway (no median), small stream, and the location of the existing pier and timber piles.

Traffic volumes on Ravensdale Road dictated utilizing a temporary run-around with a temporary two-span ACROW bridge on GRS abutments to maintain traffic during construction. To minimize the project footprint, the temporary approach roadway was supported by temporary GRSS walls. The location of the temporary roadway and existing timber piles required construction of the southeast wingwall in phases after removal of the temporary run-around.

A high-voltage electric duct bank, which was not located/surveyed during design, was determined to be in conflict with the northwest wingwall during construction. The duct bank could not be relocated or de-energized, requiring extensive coordination between all involved parties to develop temporary shoring details and wingwall revisions to avoid delays to the project.

Rehab/Maintenance, Part 2 Session

IBC 23-44: Successful Rehabilitation of the Fatigue Cracking Problems developed in the I-64 Delta Frames over the Maury River in Virginia.

Loai El-Gazairly, Ph.D., P.E., Whitman, Requardt and Associates, Richmond, VA ; Rex Pearce, P.E., Virginia DOT, Staunton, VA

The twin delta frame bridges carrying I-64 over the Maury River within the Virginia Department of Transportation (VDOT) Staunton District have experienced fatigue cracking problems that caused structural deterioration and a deficiency in the bridges' inventory ratings. These cracks started in 1991 and continued to propagate till 2009. Analytical investigation by researchers at Virginia Polytechnic Institute and State University (Virginia Tech) showed that the bridges could be retrofitted to achieve essentially infinite fatigue life. A fatigue retrofit approach, recommended by VA Tech, has been implemented and a 3-D finite element computer model was developed to examine the stress levels within the structures and its global stability through the retrofit process. In addition, different retrofits of the bridge connections were implemented to increase their fatigue resistance by improving their fatigue category for the load-induced fatigue based on the AASHTO-LRFD Bridge Design Specifications. The bridges' structural behavior was also monitored through a structural health monitoring program aimed at correlating the actual response with that of the analytical model. This paper discusses the comprehensive structural retrofit program designed to control the fatigue cracks to attain infinite fatigue life. Rehabilitation was completed in 2017 and the bridges were opened to traffic. The retrofitted cracks and the areas of potential cracking are being scrutinized through stringent bridge inspection and maintenance programs. The bridge structural steel received a new coat of paint in 2021and after five years of continuous monitoring, no new fatigue cracks or retrofitted crack propagation have been observed.

IBC 23-45: Design and Construction of Fatigue-Prone Detail Retrofits and Corrosion Repairs for Interstate 79 Neville Island Bridge

Jason DeFlitch, P.E., SAI Consulting Engineers, Pittsburgh, PA; Brian Rampulla, P.E., Pennsylvania DOT, Bridgeville, PA; David Miller, P.E., SAI Consulting Engineers, Pittsburgh, PA

The Neville Island Bridge carrying I-79, located north of Pittsburgh, Pennsylvania consists of a tied through arch main span and 26 dual parallel approach spans. These dual approach spans are continuous units comprised of two welded steel plate girders, welded steel plate floorbeams, and rolled continuous steel wide-flange stringers. The tied arch span is composed of welded plate box tie girders and arch ribs, both welded plate and box floorbeams, and rolled continuous steel wide-flange stringers. All spans are considered fracture-critical and have many fatigue-prone details along with numerous areas that are experiencing section losses due to corrosion. Presented is the design, fabrication, and construction procedures for fatigue prone detail retrofits, replacement of rocker bearings and girder field splice plates, bolts, expansion dam seals, and total painting. The coordination effort involved with the various repair type locations to develop a traffic control scheme to minimize impacts to the interstate, local roads, railroads, and the Peregrine Falcon's nesting season will be discussed, Also presented are lessons learned during construction and effectiveness and performance of the previously retrofitted fatigue type retrofits.

IBC 23-46: The Safe Harbor Trestle Bridge Rehabilitation Project

David Hoglund, P.E., RETTEW Associates, Lancaster, PA

Manor Township, Pennsylvania recognized the importance of protecting an abandoned rail line, a once-in-a-lifetime historical resource, and sought RETTEW's services to assist with acquiring, evaluating, and converting it into today's Enola Low Grade Trail. The Enola Low Grade Trail has become a targeted destination for rail trail enthusiasts from far and wide. This approximately 6-mile section of the Enola Low Grade Trail, located along the scenic Susquehanna River in Manor Township, includes spectacular views of the river and its wooded hillsides, a bird's eye view of the Safe Harbor Dam and Hydroelectric Station, and the trail's crown jewel, the Safe Harbor Trestle Bridge.

In 2015, Manor Township asked RETTEW to develop a long-term rehabilitation plan for the Safe Harbor Trestle Bridge. RETTEW started by exposing the tower bases and performing anchorage and substructure rehabilitation. In 2016, RETTEW assisted the Township in removing the ballast and catwalks from the structure. In 2018, The Township was successful in acquiring the funding to undertake the estimated $8 million design and construction project to make the bridge operational once again as a recreational destination along the Enola Low Grade Trail. Nearly 30 miles of continuous trail is now available across southern Lancaster County with the opening of the Safe Harbor Trestle Bridge in June 2022.

IBC 23-47: Rehabilitation and lifetime extension deteriorated bascule bridge by Digital Enabled Asset Management

Torben Bilgrav Bangsgaard, Rambøll Danmark A/S, , Denmark; Henrik Gjelstrup, Rambøll Danmark A/S Denmark; Claus Pedersen, Rambøll Danmark A/S, Denmark; Bjørn Lassen, Rambøll Danmark A/S, Denmark; Thor Meyer

This contribution demonstrates how integration of different Digital Enabled Asset Management services including Structural Health Monitoring (SHM) have been critical to the rehabilitation and lifetime extension of the Langebro bascule bridge in Copenhagen. Langebro opened in 1953 is a 3+3 lane road and light railway bridge spanning 252 m across the inner harbor of Copenhagen, with a central bascule steel span of 35 m. Since its inauguration the bridge has been critical to the traffic in central Copenhagen, however, insufficient maintenance has caused the bridge to deteriorate, with the mobile counterweights and tracks in critical need of rehabilitation. This paper provides an overview of the suite of digital services (including LiDAR, photogrammetry, BIM, SHM) implemented as part of a special inspection program initiated in 2019 to assess the state of the bridge and develop the necessary basis for rehabilitation and lifetime extension of the bridge. The aim of the activities is to explain the causes of the anomalies and prescribe the necessary re-alignment and rehabilitation works that can ensure continued operation for the decades to come. Specifically, it is presented how the SHM, based on continuous monitoring of vibrations, movements, and stresses, provides insight to the constantly changing alignment and global balance of the bascule bridge during operation and openings, which are coupled with operational and environmental parameters to assess both structural wear and operational safety. Benefits of improvements of the monitoring system and analyses with respect to the further value it brings for the asset managers are finally discussed.

IBC 23-48: Bryn Mawr Avenue Bridges - Rehabilitating Small & Unique Historic Structures

Margaret Sherman, P.E., TranSystems, Philadelphia, PA; Michael Cuddy, P.E., TranSystems, Philadelphia, PA; Din Abazi, P.E., Pennsylvania DOT, District 6, King of Prussia, PA; Monica Harrower, P.E., Pennsylvania DOT, King of Prussia, PA

Recently bestowed the 2022 Ralph Modjeski Award for Excellence in Transportation Design, Preservation and Archaeology by Preservation Pennsylvania, this trio of bridges is easily overlooked on a straight stretch of Bryn Mawr Avenue. The bridges were built as gifts to Radnor Township (Delaware County, PA) by George W.C. Drexel with decorative parapets constructed out of brick, stone block, and molded concrete blocks. They are unusual features to find on a state route in Pennsylvania and the largest of the three is listed on the National Register of Historic Places. Suffering severe deterioration from being in-service over 100 years, and subjected to unsympathetic repairs, these bridges were in desperate need of rehabilitation.

PennDOT Engineering District 6-0, known for sensitively rehabilitating historic bridges, undertook the rehabilitation of these bridges and completed construction in summer of 2020. The scope of work included construction of new moment slabs with reinforced concrete cores faced with brick and stone to exactly replicate the ornamental brick and stone parapets. The large stone and molded concrete blocks were salvaged and delicately reset in the new parapets. The end result was the successful rehabilitation of a trio of small and unique bridges that preserved their character while upgrading the structures to serve modern transportation needs.

IBC 23-49: Accelerated Rehabilitation of a Masonry Arch Bridge

William Goulet, STV Incorporated, Boston, MA ; Michael Scott, P.E., STV Incorporated, Boston, MA

The Connecticut River Mainline Bridge 47.90 is a masonry arch bridge that supports one track of freight and passenger rail service. The bridge was constructed in 1848 and had no existing plans available. All dimensions and details needed to be determined during field investigations. The arch span is 17'-9" with a total structure length of 71' with approach retaining wall structures included. The existing structure consisted of timber ties supported by masonry with concrete infill between the ties. Existing detailing allowed water infiltration through the structure. An evaluation of the structure identified it as candidate for rehabilitation to extend its service life. The rehabilitation consisted of replacing the track and the top course of masonry with a precast deck section and ballasted track section. A drainage system and safety walk were included as part of the rehabilitation best practices. The precast was sized to allow the ability to raise the ballast for future potential track realignments. The deck replacement was performed over an extended weekend shutdown and included rapid set concrete for closure pours, waterproofing, and restoring the track and ballast. Installation of the safety walk and drainage system was later performed along with repointing and crack repairs to the masonry structure.

Design, Part 3 Session

IBC 23-50: Urban Infrastructure Improvement Focused on the Community

Matthew Adams, P.E., Hardesty & Hanover, Tallahassee, FL

The I-395 Segmental Bridges are part of an $840 million dollar Design-Build Project with Archer Western-De Moya Joint Venture for the FDOT to replace and upgrade the existing Interstate 395 in Miami, FL. The segmental bridges provide elevated viaducts between Interstate 95 and the MacArthur Causeway. The Project is provided to improve capacity, revitalize the historic Overtown district, and improve safety and mobility within the community. Hardesty & Hanover provided the final design and construction documents, served as the contractor's construction engineer, and created the shop drawings for over 2,000 precast and cast-in-place closure segments.
The project provides 700,000 square feet of bridge deck area comprised of 89 spans constructed utilizing precast balanced crane and mobile segment lifter erected cantilevers supported by stability props. Some of the unique design features include individual bridge units transversely connected and post-tensioned to conform to complex roadway geometric requirements, phased construction and temporary traffic conditions on partially completed structures, and the use of flexible filler to accommodate future tendon replacement.
A major focal point of the design was to increase accessibility within the corridor using increased span lengths, elevated profiles, and a reduced footprint for the structures to alleviate divisions. Design features further incorporate improved lighting, architectural enhancements, and a planned 55-acre linear park beneath the structures. Providing community gathering and activity spaces, the park includes the I-395 Heritage Trail, a contiguous path connecting the surrounding areas while celebrating the vibrant history of the area with commemorative monuments incorporated into the structure.

IBC 23-51: Rebuilding an Urban Viaduct at the Speed of Segmental

Eric Johnson, Corven Engineering, a H&H Company, Tallahassee, FL

The I-59/20 Central Business District Bridges carry heavily traveled Interstates 59 and 20 through downtown Birmingham, Alabama. The original structures (opened in 1973) were designed for 80,000 vehicles per day, but current traffic exceeds 160,000 and the original bridges exhibited signs of deterioration due to age and use. ALDOT's decision to replace the original bridges allowed for I-59/20 to be closed for only 14-months for both demolition and construction of the new bridges. A precast segmental concrete box-girder bridge was the only option that could be erected within the 14-month closure. This option allowed for offsite precasting of the bridges prior to the Interstate closures and offered other benefits to ALDOT including increased span lengths, improved durability, and aesthetics.

The new bridges feature separate eastbound and westbound structures, each approximately 6,500-ft long, and carry traffic along as many as six travel lanes. Each bridge is comprised of two precast segmental concrete box-girders joined by a longitudinal closure strip. In total, this includes 172 spans, 2,316 superstructure segments and, over 1-million square-feet of elevated bridge.

With an understanding of the short construction duration, and large scale of the project, the design featured elements that could be produced repeatedly and erected quickly. By standardizing many of the common elements the Contractor was able to work efficiently in "assembly-like" fashion.

The Contractor utilized a unique technique for span-by-span construction, erecting each span on falsework towers. This method proved to be successful, with all 2,316 segments (172 spans) erected in only 217 days.

IBC 23-52: Balanced Cantilever Construction in Alberta

Myles Lewis, P.Eng., Stantec, Calgary, AB Canada

The twinning of the Bow River Bridge on Northwest Stoney Trail in Calgary Alberta required large spans exceeding 100 m to be aesthetically and hydraulically compatible with the existing structure. While the existing structure was constructed by incrementally launching the superstructure, early discussions with contractors indicated that cast-in-place segmental balanced cantilever construction was their preferred method to construct the new concrete box girder superstructure. As a result of this feedback and preliminary design investigation, the new bridge was designed for and is currently being constructed with this balanced cantilever construction method, which presented unique design and constructability challenges to overcome.

For example, key design and constructability challenges included choosing the appropriate design criteria, designing for cantilever alignment correction forces, monitoring geometry control, and accommodating safe accessibility.

This paper will showcase the lessons learned from detailed design and construction challenges of the cast-in-place segmental balanced cantilever construction method used on the Bow River Bridge on Northwest Stoney Trail in Calgary Alberta.

IBC 23-53: SR 0095 over Tacony and Bridge Street: Curved Girder viaduct with Integral Post-tensioned Concrete Cross-Girder

Tyler Kerstetter, CDM Smith, Harrisburg, PA ; Hasan Alqennah, CDM Smith, Pittsburgh, PA ; Avi Hawver, P.E., CDM Smith, Philadelphia, PA, ; Robin Dominick, CDM Smith, Philadelphia, PA

The Tacony Viaduct is part of the SR 0095 (I-95) Section BS2 in the City of Philadelphia, PA. The Section BS2 project will improve and widen the I-95 mainline by over 50 feet, to carry an additional lane in each direction and widen the shoulders. The Proposed Tacony Viaduct is a dual structure carrying I-95 Traffic over the NB Maintenance Ramp, Tacony Street, and Bridge Street. The proposed structures are both 5-span continuous curved hybrid steel girders with total lengths of 995 feet (each) supported by integral post-tensioned concrete cross-girders. The southbound span arrangement is 160'-230'-230'-200'-175' and the northbound span arrangement is 200'-250'-170'-200'-175'. Each structure is 75-foot-wide.

Due to a combination of community requirements, geometrical constraints, and numerous underground and overhead utilities in this dense urban area, standard hammerhead or multi-column bents were not feasible in all locations. Therefore, approximately 100-foot-long cross - girders (straddle bents) were required to span over Tacony Street at two locations. Steel and Concrete post tensioned cross-girders were both considered and examined as alternatives. Integral post-tensioned concrete cross-girders were recommended alternative and ultimately accepted by the client, PennDOT.

The design and detailing of the integral post-tensioned concrete cross-girder presented its own challenges. When the post-tensioned concrete cross-girder becomes integral with the steel girder superstructure, it adds many challenges to the design, detail, and construction of the cross-girder. The final design provides the basis to provide design and detail guidelines that results in more application and use of the integral post-tension concrete cross-girders on future projects.

IBC 23-54: History Matters: Compatible Bridge Design in Historic Districts

Michael Cuddy, P.E., TranSystems, Philadelphia, PA

Today, history has standing, and the consideration of adverse effects and potential mitigation measures are woven throughout the design process when working with historic resources. Too often, engineers, stakeholders and even SHPO officials feel compelled to “decorate” a new bridge being built in an historic district. However, is the need to include aesthetics in bridge design guiding our decisions well? This paper will focus on a review of the federal regulations that permit alterations and additions to historic properties and treatments to be considered which allow a new bridge to successfully blend in with the historic setting and context. Should we consider more new bridge designs that are simple and quiet, that permit history to make the statement and not the new bridge? The paper will also explore how the aesthetic aspect of bridge design is confused with developing compatible designs in historic districts.

Alternative Delivery Session

IBC 23-55: Fern Hollow Bridge Emergency Replacement Design-Build

Jason Fuller, P.E., HDR, Pittsburgh, PA ; Kevin O'Connor, P.E., HDR, Pittsburgh, PA ; Michael Szurley, P.E., Pennsylvania DOT, Bridgeville, PA, ; Eric Setzler, P.E., City of Pittsburgh, Pittsburgh, PA, ; Chad Basinger, P.E., Swank Construction Company, LLC, New Kensington, PA,

On January 28th, 2022, the Fern Hollow Bridge in Pittsburgh, PA collapsed. Although there were some injuries, no lives were lost. The Governor immediately signed an Emergency Proclamation that allowed PennDOT and the City of Pittsburgh (the bridge owner) to partner and utilize all available powers, resources, and personnel deemed necessary to cope with the magnitude and severity of the bridge collapse. A Sole-Source Design/Build Construction Contract allowed Swank Construction Company and HDR to team and immediately begin design and construction of the new Fern Hollow Bridge.

The Fern Hollow Bridge Carries Forbes Avenue (an NHS route with an ADT over 21,000) over Frick Park and is a diversion route for Interstate 376 at the Squirrel Hill Tunnels. As design began in February of 2022, it was clear that speed and cost of construction were critical to a successful replacement of this important structure. Immediately conceptual design decisions had to account for the existing bridge location, ROW limitations, environmental/historical impacts, and requirements from traffic volumes and pedestrian/bicycle users. The structure width was unchanged, but width to accommodate pedestrian/bicycle was increased by 50%. Various structure types, material types, span arrangements, and methods of construction were investigated to come to an informed decision on the best option to advance. Based on all the information being assessed, it quickly became clear that a ~460' long, 3-span prestressed concrete beam bridge would be the most effective solution to provide the accelerated delivery needs of this emergency project.

IBC 23-56: Alternative Technical Concept for the Chicago Transit Authority's Red and Purple Modernization Phase One Project

Emily Hereford, P.E., Stantec, New York, NY ; David Depp, P.E., S.E., Stantec, Lexington, KY ; Miles Gentsch, Walsh Construction, Chicago, IL,

The Red and Purple Modernization (RPM) Phase One Project is the largest capital improvement project in Chicago Transit Authority (CTA) history. The goal is to replace, reconstruct, and modernize 10 miles of elevated track and support structures along Chicago's busiest transit corridor to increase train speeds and add capacity to CTA's system with a 100-year service life.

Design and construction features of this project include an alternative technical concept (ATC) to use precast prestressed concrete (PPC) beams which lowers cost, shortens construction schedule, reduces foundations, and minimizes maintenance; CTA transit operations maintained throughout construction; advanced analyses including rail-structure interaction and vehicular-structure interaction; and noise studies/abatement for community integration in design.

The proposed structure improvements for the four North Mainline tracks include new closed-deck structure and rehabilitation of the existing open deck steel structure. The closed-deck superstructure consists of a concrete deck supported on PPC or steel stringers including spans with "hybrid" framing of both PPC beams and steel stringers to accommodate the flared layout for connection between the North Mainline and Ravenswood tracks. Steel rehabilitation includes inspecting and updating a 100+ year old structure to meet new track alignment and revised framing.

Also included in the new structures were grounding, isolation, and corrosion protection via bridge deck expansion joints to isolate steel framed spans from PPC beam spans, and GRFP rebar in hybrid spans.

IBC 23-57: Technical Challenges in Design of the Kingston Third Crossing Signature Span

Edouard Renneville, Eng., SYSTRA IBT, Laval, Quebec Canada; Zac McGain, SYSTRA IBT, Laval, Quebec Canada

The Kingston Third Crossing bridge is a signature structure located in Kingston, Ontario. It is being delivered using the Integrated Project Delivery (IPD) model for the first time on a bridge project in North America. This project model creates a more cohesive partnership while motivating every member to create value by identifying cost-saving ideas through all phases of the validation, detailed design and construction phases. This includes numerous improvements to the reference design that directly increase constructability and reduce project costs while maintaining the project's visual quality requirements. The 1.2 km long bridge consists of 19 precast girder spans of 43-48 m, and 3 steel below-deck arch spans of 62-95m. The deck is comprised of partial depth precast panels with a cast-in-place concrete deck topping. The precast concrete girders are the longest and tallest ever constructed in the province of Ontario, and provide a strong visual contrast with the weathering steel girder main span. The main span variable depth I-beam girders form an arch shape that presents as delta frames over the central piers. This paper presents the various technical solutions and innovations developed to tackle the construction, geometric and climatic challenges for the design of the signature span of the bridge while meeting the expectations of all IPD partners.

Rail Bridges Session

IBC 23-58: Design and Construction Challenges of the Main Span and East Approach Replacement/Retrofit of TRRA Merchants Bridge over Mississippi River

Nick Staroski, P.E., S.E., TranSystems, Kansas City, MO

The Merchants Bridge spans the Mississippi River and has been identified as the top priority for improving freight movement through the St. Louis region. The 130-year-old bridge's current capacity had been limited the existing double track bridge to allowing only one train to pass at a time causing significant delays in freight movement.

This presentation will focus on the engineering and construction challenges related to (1) replacing the three 523' main river truss spans, (2) seismically retrofitting the four existing river piers and (3) improving the east approach by filling the spans with light-weight cellular fill. The main span replacements included track (10-day per span) and navigation channel closure windows. The significant weight of the existing truss span (3.8M lbs.) and new ballasted truss span (9.0M lbs.) required the use of a robust gantry system with strand jacks to lift the spans and a slide system for translation. The new bridge spans opened to double track capacity in October 2022.

IBC 23-59: AREMA/NSBA Collaboration Steel Railroad Bridge Constructability Design Guide

Brandon Chavel, Ph.D., P.E., Michael Baker International, Cleveland, OH ; Jaclyn Whelan, Consolidated Rail Corporation, Mount Laurel, NJ ; Ronnie Medlock, High Steel Structures LLC, Lancaster, PA,

Steel railroad bridges are designed in accordance with Chapter 15 of the American Railway Engineering and Maintenance of Way (AREMA) Manual. Having satisfied the manual and owner requirements there are many other choices that impact the cost, schedule, and constructability of the bridge. The AREMA/NSBA Steel Bridge Collaboration Guideline provides a supplementary resource for project teams that elaborate on design, fabrication, and construction of steel railroad bridges. The Guide discusses alternatives such as cross section types, corrosion protection measures, and construction techniques to facilitate constructability of bridges. This presentation focuses on recommendations developed by the joint AREMA / NSBA task force on best practices in steel railroad bridge design.

IBC 23-60: Utilizing Innovative Construction Access Design to Minimize Rail Traffic Disruptions

Austin Holub, P.E., PCL Civil Constructors, Inc., Tampa, FL; Neil Greenlee, P.E., G&A Consulting Engineers, PLLC, Marietta, GA; Patrick Weldon, Norfolk Southern Railway, Irondale, AL; Andrew Cestaro, PCL Civil Constructors, Inc.,, Tampa, FL

The project team for Norfolk Southern bridge crossing the East Pearl River in Louisiana was faced with a challenge to replace a nearly 120-year-old structure entirely within the same footprint of the existing span, while allowing the safe passage of locomotives across the river on a busy route that connects from the Port of New Orleans, LA with much of the country. The work had to be performed without delaying any of the rail traffic that uses the line daily.
This paper will shed light on the background of replacing a critical structure on a valuable route that allows the movement of goods throughout the region to and from one of the largest ports in the United States. The NS Pearl River project has come away with several take-aways throughout the execution of the project including the importance of a constructible design, planning and sequencing of construction, managing material supply chain issues throughout a pandemic, and minimizing disruptions to a busy rail line. These objectives have been a core part of the project from development and throughout the completion of the replacement and are integral to the project's success.

IBC 23-61: State of the Art and Current Practice on Rail-Structure Interaction in North America

Ying Tan, Ph.D., P.E., HDR, Raleigh, NC; John Lobo, HDR, Denver, CO

This paper examines the current methods for performing rail-structure interaction (RSI) analysis and the acceptance criteria prescribed through various transit agencies and national guidelines in the United States and Canada. It also compares these methods and criteria to European code. A numerical analysis compares the results of two different methods for a simplified structure. The results show that the method is deeply entwined with the design philosophy and acceptance criteria and that acceptance criteria must be chosen strictly based on the methods adopted for analysis. A large number of transit agencies in the United States and Canada provide inadequate guidelines on how rail-structure interaction analysis should be performed, or provide a mix of requirements from both European and North American methods, which can result in overly conservative structure design. This paper highlights the need for a clear national guideline that prescribes the methods of analysis and corresponding acceptance criteria and recommends an approach to address the gap in current methods in the United States and Canada.

IBC 23-62: Accelerated Design for Accelerated Construction: Emergency Superstructure Replacement in Tallahassee, Florida

Richard Schoedel, P.E., Michael Baker International, Moon Twp, PA; Lisa Hoekenga, P.E., S.E., Michael Baker International, Cleveland, OH; Johann Aakre, Michael Baker International, Chicago, IL; Hank Schneider, Michael Baker International, Tampa, FL

On January 3rd 2022, Bridge 550940 over SR 20 (US 27), Apalachee Parkway in Tallahassee Florida was struck for the third time in three years by vehicles taller than the posted 14'-0" vertical clearance. During prior bridge strikes in 2019 and 2021, the existing 4 girder deck plate girder bridge was repaired and heat-straightened in discrete locations. The damage from the third and most recent strike was much more significant. The strike fractured the web of the girder, caused significant roll and completely dislodged it from the concrete deck. With the sensitivity to railroad and local traffic operations, FDOT understood that an accelerated approach would be required to complete the repairs.

Within the initial 48 hours following the collision, Michael Baker had personnel on site to inspect the bridge, developed temporary shoring plans, performed a load rating, and prepared repair alternatives and cost estimates for solutions ranging from girder replacement to superstructure replacement. FDOT and Michael Baker weighed the merits of repair versus complete superstructure replacement. FDOT ultimately decided to move forward with a superstructure replacement of the spans over the roadway utilizing a low profile through plate girder structure type that would increase the vertical clearance from 14 feet to 16 feet and greatly improving the safety at the bridge for over height vehicles. The entire spans were replaced in a short duration closure to minimize disruption to rail and commuter traffic.

Inspection and Evaluation, Part 2 Session

IBC 23-63: Load Rating of A CIP Open Spandrel Arch Bridge with Curved Widening and Offset Traffic Pattern Using Refined Method of Analysis in Virginia

Soroush Fakhri Yazdi, P.E., WSP USA, Herndon, VA ; Charles Kruger, WSP USA, Herndon, VA ; Shiwei Luo, WSP USA, Herndon, VA,

Load rating of 11 span spandrel arch bridge with a major widening that shifted the traffic pattern, which could not be analyzed without using 3D refined model. Arches traditionally perform well by reducing the bending moment caused by vertical load and converting it into load into the axial load. This feature is most effective when the arch is loaded evenly.

The open spandrel arch bridge carrying Rte. 58 over Smith river was built in 1927. In 1961 the deck was widened on one half of the arch to create a curved roadway alignment. The design engineers at the time added counterweight to the opposite side of the bridge for balancing the force flow through the supporting arch. The offset portion of the roadway was supported by a cantilever structure extended from the original spandrel arch.

This paper investigates the behavior of the bridge superstructure under standard AASHTO vehicles using 3D FEM, which proves to be a cost effective and precise analysis for load rating such sophisticated structure. Certain assumptions are made in modeling such complex system to simplify the process. This work will appraise these assumptions and different boundary conditions used in the model to determine what assumptions will lead to most realistic results. The results from 3D model showed that the counterweight added did not help balance the distribution of internal forces. In this paper traditional methods of calculation are used to better understand why the design engineers used such counterweight.

IBC 23-64: Development of MDTA Software Tool – the Bridge Asset Management Program (BAMP)

Y. Edward Zhou, AECOM, Germantown, MD ; Ilya Batychenko, AECOM, Pittsburgh, PA ; Ruel Sabellano, Maryland Transportation Authority, Baltimore, MD, ; Tekeste Amare, Maryland Transportation Authority, Baltimore, MD,

The Bridge Asset Management Program (BAMP) of Maryland Transportation Authority (MDTA) is an advanced Excel tool for intelligent management of MDTA's six signature bridges and over 320 workhorse bridges. As a result of close collaboration between the bridge owner and the consultant, BAMP facilitates data driven decisions in bridge preservation, rehabilitation, and replacement, as well as lifecycle based budgetary planning. After continuous development and enhancement, BAMP has the following key features: (1) calculating a bridge priority score for each asset considering current condition, risk and performance history; (2) conversion from the Condition States (CS) per the AASHTO Manual for Bridge Element Inspection (MBEI) to the Condition Ratings (CR) per the FHWA National Bridge Inventory (NBI) standards; (3) risk assessment considering bridge functions, capacities, and vulnerabilities based on the available Structural Adequacy Functionality and Exposure (SAFE) ratings; (4) deterioration modeling of bridge components based on historical inspection data using the Weibull analysis method; (5) identification and prioritization of bridge improvement work needs for achieving a user specified condition target (NBI CR ≥ 6 for all elements); (6) development of construction projects, estimated costs, and yearly cash flows for a 25-year budget plan; (7) predictions of future bridge conditions and construction costs for different scenarios of projects and budgets; (8) providing guidance for MDTA's annual Bridge and Paint Tour programs; (9) generating information needed for the MDOT TAMP report required by FHWA, including asset values, 2/4/10-year performance targets, etc.; and (10) display of key BAMP results in ASIR (MDTA's bridge management software).

IBC 23-65: Program Management of the Chesapeake Bay Bridge

Jonathan Morey, P.E., WSP USA, Edgewood, MD ; Ruel Sabellano, MDTA, Dundalk, MD

As part of a continuous effort to preserve the condition and working order of the Chesapeake Bay Bridges while reducing impacts on traveling public, the Maryland Transportation Authority (MDTA) has taken a proactive approach to routinely perform repairs on both of the four-mile-long structures crossing the Chesapeake Bay. The Bay Bridge is a twin bridge crossing that connects Annapolis to Maryland's eastern shore. The two-lane Eastbound Bridge, opened in 1952, and the three-lane Westbound Bridge, opened in 1973, receive Biennial Hands-On Inspections with Risk Based Inspections in off-cycle years. The results of these intensive inspections are processed to prioritize areas in need of repair and make the most efficient use of available funds. Design-Bid-Build contracts are utilized to perform any number of repair types, while alternative contract methods, including Design-Build and CMAR, are considered for complex rehabilitation to the bridge structures, which utilize Suspension Spans, Cantilever Deck and Through Truss Spans, Built-up Steel Girder and Prestressed Concrete Girder Spans, and a variety of concrete substructures founded on piles in up to 60 feet of water. Repairs consider available Daytime and Nighttime Lane closures and Alternative Access methods to perform repairs that range from Complex Projects to Standardized Priority Repairs, in a concerted effort to maximize efficiency. Consideration of Long-Range Needs with revenue cash flow is proactively considered, as is the implementation of Preventative Maintenance, to keep these structures well into the foreseeable future.

Research Session

IBC 23-66: Long-Term Field Response of Skewed Steel I-Girder Bridge Superstructures

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Two continuous two-span steel I-girder bridges, one skewed 45˚ with integral abutments and the other skewed 41˚ with seat-type abutments, have been instrumented for long-term static and dynamic (20 Hz) field monitoring since construction. The bridges are closely located and subjected to similar traffic volume and thermal variation, around 100 to 0 ºF (38 to -18 ºC). Girders and cross-frames were instrumented with strain gauges, and girder end rotations and overall bridge movements were monitored; temperature was recorded at each sensor. Progression of superstructure response under thermal and live load over more than two years of data collection has been recorded, including for the in-service full bridges and first-stage half bridges (temporarily for six months). Response of half and full bridges with different types of abutment is compared based on field measurements and numerical simulation – 3D finite element analyses were conducted to provide enhanced understanding of bridge behavior. Girder cross-sections and cross-frames experienced cyclic movement and periodic strain variation under thermal loading; several members exhibited increasing stress over time, at girder bottom flanges and webs and at cross-frames. The unexpected responses initially presented during the first cold-weather period, and some of the stress development continued regardless of thermal cycles. Bridge response under daily traffic loading is also assessed and compared with predictions from computational studies. Evolution of bridge dynamic properties and structural load paths was evaluated throughout the long-term monitoring, including a case study where an initially-loose connection of a cross-frame was tightened after the bridge was in service.

IBC 23-67: A Case Study on Curved Fully Integral Abutment Bridge Thermal Deformation: I-390 over I-490

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The awarding-winning I-390 southbound bridge over I-490 eastbound is a 525-feet long and 45-feet wide curved fully integral abutment bridge, which is the longest fully integral abutment bridge in New York State by the project completion time in 2021. The bridge superstructure consists of three-continuous span multi-steel I-plate girders on a horizontal curve with a 2000-feet radius, and the span lengths are 185-feet, 155-feet and 185-feet, respectively. The fully integral abutments are supported by HP-driven piles with the pile web orientation parallel to the bridge longitudinal direction. The refined analysis method is required for the bridge based on the curvature exceeding 0.06 and the total bridge length exceeding 400-feet according to the limits specified in AASHTO and NYSDOT bridge design criteria. In this paper, the thermal deformations in the curved bridge are simulated by 3D finite element modeling. The longitudinal and radial displacements at the expansion joints are analyzed and compared with the field data and observations. The soil-pile-structure interaction mechanism is investigated to understand the behavior of the curved fully integral abutment bridge subjected to thermal expansion and shrinkage. According to the results, design recommendations for curved fully integral abutment bridges will be proposed to facilitate further adoption of the cost-effective and low-maintenance integral abutment construction in horizontally curved bridge practices.

IBC 23-68: Noncontact Lap Splices of Large Hooked Reinforcing Bars

Zachary Coleman, Virginia Tech, Blacksburg, VA ; Johnathan Kerchner, Virginia Tech, Blacksburg, VA ; Eric Jacques, Ph.D., P.Eng., Virginia Tech, Blacksburg, VA, ; Carin Roberts-Wollmann, Ph.D., P.E., Virginia Tech, Blacksburg, VA,

Within accelerated bridge construction practices, adjacent precast concrete elements may need to be connected, such as in wide bent caps. Connections permissible by AASHTO LRFD provisions are generally lengthy Class B lap splices of straight bars, requiring large closure pours of cast-in-place concrete, especially if large bars are used. To create shorter closure pours and optimize the benefits of using accelerated bridge construction practices, some transportation authorities have utilized noncontact lap splices of hooked reinforcing bars to connect precast elements. However, tests of such lap splices have not been performed to validate their satisfactory performance. Therefore, seven 13 ft long beams predominantly containing lap splices of No. 11 hooked bars were tested under four-point loading. Splice spacing, hook shape, and the quantity of confining reinforcement in the splice region were varied among the beams. Two unique phenomena termed hook prying and hook side bulging were found to result in splice failure along with splitting. By comparing the hook stresses to the calculated stresses using AASHTO LRFD provisions for the development length of hooked bars, it was found that the code provisions significantly overestimated the anchorage strength of hooked bar lap splices.

IBC 23-69: John Lewis Memorial Bridge, A Case Study in Alternative Delivery Methods

Eric Birkhauser, Donald MacDonald Bridge Architects LLP, San Francisco, CA

The path towards a successful completed bridge is never straightforward, such is the case with the John Lewis Memorial Bridge (JLMB). After the initial design team developed a concept that did not fit the budget, the client, the Seattle Department of Transportation, acted as the prime consultant to arrange a team to develop a solution that both fit the budget and achieved the community's vision for the connection. This unconventional hands on approach created a nimble problem-solving team devoid of affiliation beset on leveraging skillsets in an outcome oriented iterative process. One that in turn met these goals and achieved an award-winning project celebrated and beloved by its users.

The JLMB creates new, safe routes for people biking, walking, rolling, and taking transit in Northgate. Spanning Interstate-5 in Seattle's Northgate neighborhood, this bridge links the newly opened Northgate Light Rail Station and bustling Northgate urban center to the North Seattle College campus, a UW medical satellite campus, and the residential neighborhoods beyond. In connecting to light rail, this growing community has expanded safe, affordable, and accessible options to travel across the region. The community focus, elegant design, and streamlined project delivery manifest the equitable development priorities of SDOT, WSDOT, Sound Transit, and the surrounding community together into this elegant and transformative piece of urban infrastructure.

IBC 23-70: Dynamic Amplification of Light Rail Vehicle Derailment Impact on Bridge

Nicholas Catella, Simpson Gumpertz & Heger, Inc., Waltham, MA ; Robert MacNeill, Simpson Gumpertz & Heger, Inc., Waltham, MA ; John Lobo, HDR, Denver, CO, ; Glenn Gough, Siemens Mobility Inc., Sacramento, CA,

This work presents the results of a study on the amplification of bridge live load in the vertical direction due to derailment of a light rail vehicle, i.e., derailment impact. This work builds on earlier research investigating the effects of impact from derailment of single-level and bi-level commuter train cars. The study was performed using a numerical model consisting of a detailed model of a light transit rail vehicle—accounting for all geometry, stiffness, and damping of the car body and suspension system - and a single span precast prestressed concrete girder bridge, idealized as a spring-supported rigid surface with a range of typical stiffness values. The analysis was performed in LS-DYNA. The model simulated the condition of the vehicle derailing and falling vertically through the height of the rail and supporting plinth to impact the bridge's deck. Two different drops were considered, representing the rail height only and rail height plus plinth structure. The results showed that the peak amplification of bridge live load due to LRV derailment varied from 320% to 620% over the range of stiffness and vertical train drop. These results are consistent with previous research on single-level and bi-level commuter train cars. The results are also consistent with simplified calculations based on rigid body kinematics. The results are high enough to warrant a more detailed examination of and approach to the derailment forces currently used in North American bridge design codes to determine more accurate loads.

Cable Supported Bridges Session

IBC 23-71: The Design and Construction of the New Storstrøm Bridge

Luca Cargnino, M.Sc. Eng, Ramboll, , Denmark; Peter Curran, Ramboll, Southampton United Kingdom; Marco Raimondi, SBJV, Vordingborg, Denmark

The New Storstrøm Bridge is a 3.8km long combined rail and road bridge currently under construction. It will be Denmark's third longest bridge. It comprises two approach viaducts with 44 spans, typically 80m long, and a cable-stayed bridge located centrally within the strait crossing, with two 160m navigational spans and a single, architecturally shaped pylon. The 25m wide deck is a prestressed concrete box-girder with a unique asymmetric cross section and wide cantilevers. It carries a two-track, high-speed railway and a carriageway comprising a two-lane road and a combined pedestrian-cycle path.
The tight construction schedule imposed to the Design & Build Contract requires a construction method based on onshore large-scale prefabrication of the majority of the bridge components, such as foundation caissons, piers and box girders. This method not only ensures enhanced construction speed but also quality. The 2500tons heavy pad foundation caissons and lower pier stem are sunk into position. A precast segmental solution is used for the remaining part of the piers, ranging from 18 to 35m high and comprising multi-faceted stem segments and prestressed in-situ pier heads. A span-by-span construction method based on the erection of typically 73m-long and 4000tons heavy precast segments is adopted for the superstructure.
This paper presents the peculiarity of this construction method and the main design challenges due to its constraints, such as the capacity limits of the lifting equipment, requiring a careful optimization of the material distribution. Changes to the early-phase concept to optimize and accelerate the erection are also presented.

IBC 23-72: Preliminary Design of the New Ile d'Orleans Bridge

Simon Gren, M.Sc.Eng., Ramboll, Copenhagan, Denmark; Steve Thompson, Ramboll, Southampton United Kingdom; Philippe Provost, Stantec, Quebec City, Quebec, Canada

The existing Ile d'Orleans suspension bridge is to be replaced with a new cable-stayed bridge. The Groupement Origine Orleans (GOO) won the architectural competition and was awarded the advanced preliminary design of the new bridge, the only link spanning the Saint Lawrence River to the Ile d'Orleans.
The 2.1km long bridge will consist of 18 spans; the main cable-stayed bridge has a main span of 430m; the approach spans are typically 90m. The superstructure consists of a composite deck comprising a steel trapezoidal box with a concrete deck slab.
Concept design and an extensive preliminary design of the bridge was performed by the GOO This considered the development of a construction scheme which reflected the limited amount of time available for working in and from the river due to ice. It also considered the extreme environmental loads the bridge could be exposed to, such as earthquakes and extreme snow and ice loads. Wind tunnel testing was performed, and wind induced vibrations of the bridge was assessed with and without accretion of ice on the dissuasive barriers.
The result is an elegant yet robust and durable structure befitting of the landscape, with an enhanced user experience.

IBC 23-73: Galecopperbridge - Stay Cable Replacement in Traffic

Dimitri Tuinstra, Arup, New York, NY ; Janwillem Breider, Arup, New York, NY ; Charlotte Murphy, Arup, New York, NY,

The Galecopperbridge is a cable stayed highway bridge with a total length of 326m and 6 traffic lanes. The bridge was built in 1970 and suffers from corrosion problems in the locked coil stay cables. After a major refurbishment where the bridge was strengthened and prepared for widening, the stay cables will be replaced. As the bridge is positioned in the hart of the congested highways network in the Netherlands, the bridge can not be closed for traffic or diverted for a long time. The method in this article describes a stay cable replacement of a bridge in traffic. It will discuss issues that were encountered during design and construction of the replacement and associated strengthening works in the structure.

Inspection and Evaluation, Part 3 Session

IBC 23-74: Structural Health Monitoring of the Great Belt Suspension Bridge and the Benefits for Operation and Maintenance

Tobias Friis, Rambøll Danmark A/S, , Denmark; Silja Tea Nielsen, Rambøll Danmark A/S Denmark; Martin Lollesgård, Rambøll Danmark A/S, Denmark; Torben Bilgrav Bangsgaard, Rambøll Danmark A/S, Denmark; Martin Duus Havelykke, Sund & Bælt Holding A/S, Denmark

This contribution demonstrates how operation and maintenance of one of the largest suspension bridges worldwide have significantly benefitted from a structural health monitoring (SHM) setup with +400 sensors developed in a unique collaboration between consultants at Ramboll, contractors and the owners from Sund & Bælt. The Great Belt Fixed Link in Denmark opened in 1998 and consists of an 18 km road and railway link composed of a tunnel, a continuous multi-span beam-type bridge, and a suspension road bridge with a main span of 1624m, the current 6th longest worldwide. The aim of the tailormade SHM setup is to provide knowledge of structural performance, deterioration and remaining lifetime to the asset managers that can accordingly plan maintenance and actions for mitigation of undesirable structural performance to ensure economical and sustainable asset management and safe operation. The paper provides an overview of the SHM system followed by case studies showing SHM outputs and how these are used in the operation and maintenance. Specifically, it is presented how the SHM provides insight into the vibration phenomena and fatigue lifetime of the hangers, insight into fatigue lifetime of the main girder including influences of operational and environmental parameters, and insight into wear and lifetime of the bearings. It is revealed how this valuable information are used in decision making of the operation and maintenance of the suspension bridge. Lastly, further improvements of the monitoring system and subsequent analyses are discussed with respect to the further value it brings for the asset managers.

IBC 23-75: Load Rating the Denison Harvard Bridge: A Hybrid Approach for Complex Superstructures

Aaron Englehart, P.E., Michael Baker International, Columbus, OH; Ed Baznik, P.E., Michael Baker International, Cleveland, OH; Shane Weiss, P.E., Michael Baker International, Cleveland, OH

Michael Baker International was tasked to perform a LRFR load rating of the Denison Harvard bridge in Cuyahoga County. This 3,000 foot long bridge superstructure is composed of four girder lines and three sub-stringers supported by K-Frame floorbeams. The girders in one unit of the bridge are kinked at splice points to follow the horizontally curved bridge deck geometry.

This presentation will include a discussion of how the girders and sub-stringers, which are supported by trussed K-Frame floorbeams, were load rated using a combination of Midas Civil 3D & AASHTOWare BrR. Michael Baker utilized the strengths of each program to effectively and efficiently rate the girders, sub-stringers, and floorbeams. This approach used limited modeling of the structure in Midas Civil 3D to rate the trussed floorbeams and to evaluate the girder and sub-stringer ratings. A large difference in stiffnesses of the sub-stringers relative to the girders greatly influenced the stringer forces and rating factors. Midas was used to confirm the girder ratings from BrR and to develop a calibrated BrR stringer model, which allows for future load ratings, including permit evaluation, to be completed with the simplified BrR analysis.

IBC 23-76: NJDOT's approach to Risk-based Asset Management and Prioritization

Rama Krishnagiri, WSP USA, Lawrenceville, NJ; Harjit Bal, New Jersey DOT, Ewing, NJ; Megan Ortiz, WSP USA, Lawrenceville, NJ; Juan Diego Porras-Alvarado, WSP USA, New York, NY; Travis Gilbert, E.I.T., WSP USA, Lawrenceville, NJ

NJDOT has set performance targets and has in parallel developed a Risk framework, utilizing the vast array of data available in ComBis, NJDOT's bridge asset database and external sources (e.g. FEMA, FHWA) and will integrate the framework into AASHTOWare™ Bridge Management software (BrM).. Presently, the risk framework covers typical National Highway System and State Highway System bridges, and future enhancements include other assets such as sign structures, complex/movable bridges, minor bridges, arches, and County/municipality owned bridges, private/ Toll agency bridges. WSP and NJDOT staff closely collaborated via technical workshops to develop this framework. NJDOT Risk framework covers seven risk categories, including Fatigue, Flooding, Scour, Overload, Seismic Events, Vehicle Collision (Superstructure and Substructure), and Marine Vessel Collision, each category considered individually. For each risk category, the likelihood of occurrence and its consequence is considered.. Likelihood of occurrence is further broken down into each asset's exposure to a given hazard (demand) and the magnitude of exposure to it. Filters were applied to verify that the asset is even exposed to a given hazard, whether mitigation strategies are in place and a consideration of the magnitude of the exposure. Consequence is evaluated by considering the asset's capability to sustain the same (vulnerability) and loss as a result (agency cost, user inconvenience, etc.,).The Risk Score Is taken as the product of Likelihood and Consequence. For each asset, various failure modes for each risk category were identified in an Excel spreadsheet, linking data from ComBiS. Future enhancements will gather additional data to supplement Combis.

Construction/Erection, Part 2 Session

IBC 23-77: Erection Procedure of the Mile Long Bridge

Michael Haas, P.E., S.E., Collins Engineers, Inc., Chicago, IL ; Sean Doumas, P.E., Collins Engineers, Inc., Chicago, IL

The Mile Long Bridge was originally constructed in 1957 and consisted of 16 steel spans and 38 precast spans with a total length of 4,852 feet carrying I-294 Northbound and Southbound traffic over the Des Plaines River, The Chicago Sanitary and Ship Canal, multiple rail lines, and utilities. After multiple widenings over a 60 year life span, the twin structures were replaced beginning with the Northbound structure in 2019-2020 and concluding with the Southbound structure in 2021-2022. The new structures reduced the number of spans from 54 to 27, consisting of 5 steel spans and 22 precast spans. Collins Engineers was hired by the general contractor/steel erector and demolition subcontractor to provide construction engineering for the proposed structure.

Due to site access constraints, a system of three gantries spanning between the partially demolished original NB structure and new NB structure was utilized for the erection of the three-span steel unit over the Sanitary and Ship Canal. Collins analyzed the existing structures for stability and strength to support the gantry system, and designed the anchorage needed to resist thrust from the gantry legs. Collins verified the proposed erection procedure including the use of a stiffening truss to facilitate erection of a long single girder segment, and designed a longitudinal jacking system with a fixed bearing sliding surface for closure of the steel spans.

IBC 23-78: Old Champlain Bridge Deconstruction

Wade Pottie, P.E., P.Eng., Harbourside Engineering Consultants, Dartmouth, Nova Scotia Canada; Greg MacDonald, Harbourside Engineering Consultants, Stratford, Prince Edward Island Canada

The Old Champlain Bridge, in Montréal, Quebec, was open from 1962 to 2019 and crosses the Saint Lawrence Seaway Main shipping channel. The bridge contained six travel lanes and was one of the busiest vehicular bridges in Canada. The bridge consisted of 50-54m long+/- concrete girder approach spans, 4-78m structural steel approach spans and a 450m+/- main steel span consisting of two anchor spans and a suspended span.

Harbourside were responsible for all sequencing/phasing, means & methods and temporary works design for the project.

The main steel spans of the bridge, consisting of three variable depth steel trusses, spanned over the St. Lawrence Seaway Navigation Channel, making its removal particularly challenging. The center suspended span was successfully lowered to a pair of interconnected barges, using six large strand jacks. The lowering was completed within a 48-hour operational weather window, in the cold temperatures of January to coincide with the winter closure of the Navigation Channel.

The steel anchor spans are deconstructed by installing and jacking load into two 100ft tall steel temporary towers, installing jacking/locking collars to control dynamics on main truss elements, disengaging the span near its centerline, and deconstructing the cantilevers in piece-by-piece methodology.

The concrete approach spans over water were dismantled by lifting and removal of the span via barge with jacking tower and then demolition of the span on the barge platform.

This paper will explore the main methods, constraints, challenges and design considerations required to deconstruct the various spans types of the structure

IBC 23-79: New Champlain Bridge over the Saint Lawrence river in Montreal. Design of the temporary works for the construction of the cable-stayed bridge

Alejandro Pérez Caldentey, P.E., FHECOR North America, Houston, TX; Hugo Corres, Universidad Politécnica de Madrid, Madrid, Madrid Spain; Javier Milián Mateos, MSc, FHECOR Consulting Engineers, Madrid, Madrid, Spain; Alejandro Abel Núñez, FHECOR Ingenieros Consultores, Madrid, Madrid, Spain

This communication summarizes the design of the temporary structures used for the construction of the New Champlan Bridge in Montreal (Canadá). The complexity of the structure of the cable-stayed bridge, with a total width of 60 m and a strong asymmetry in elevation and in cross section, has been a real challenge for the design of the temporary works and assembly operations. The singularity of the of the assembly and bolting operation of the Main Span segments, comprised of three composite box girders joined together by transverse girders is explained at length. The alternatives for the bridge contruction are also dealt with.

IBC 23-80: Construction of the Wekiva Parkway Section 6

Robert Bennett, P.E., RS&H, Sanford, FL

The Wekiva Parkway section 6 project was 6.1 miles in length and was a complex portion of the overall 25- mile parkway around Orlando, Florida. This multi-lane limited access roadway provides more access for motorists as an alternative to traveling I-4 through central Florida. This project included 18 new bridges. Three of these bridges crossed the Wekiva River. This River is designated as a national wild and scenic River and the bridges required a 360' main span to span the River. As a result, these bridges were constructed as cast in place concrete box segmental using balance cantilever erection method. The segmental portion of these 3 bridges allowed the work to proceed without encroaching on the environmentally sensitive river footprint.

IBC 23-81: I-84 Twin Bridges Project

Benjamin Martz, P.E., CDR Maguire, Allentown, PA; Timothy Benner, CDR Maguire, Allentown, PA

PennDOT District 4-0 is undertaking a critical replacement of two deteriorated structures located on I-84 over Roaring Brook and the active DL&W Railroad in Lackawanna County, Pennsylvania. The project includes replacement of two long span steel mainline bridges as well as reconfiguration of an adjacent interchange. The mainline structures are being replaced with dual 1,200-foot-long steel plate girder bridges consisting of spans up to 330 feet long that are elevated 125 feet above Roaring Brook.

The difficult project site includes an active railroad, Roaring Brook, and steep terrain requiring the construction of several access roads, staging areas, crane pads, and temporary stream crossings for access, erection, and demolition activities. Early action pier construction under the existing bridges as well as staging of the new I-84 EB superstructure are critical elements of traffic control and pose constructability challenges related to tight clearances and global stability. The project also includes innovative use of an abandoned circa 1883 railroad bridge that once carried the former E&WV railroad over DL&W Railroad and Roaring Brook. Serving as an important crossing during construction, the abandoned railroad bridge is to be rehabilitated as part of the I-84 project and converted to a pedestrian bridge for future use carrying the planned Lackawanna County Trail.

The project was delivered 9 months ahead of schedule and was awarded to contractor JD Eckman at a bid price of $113,000,000. Construction began in Spring of 2020 and the new I-84 EB bridge is expected to be complete during the Summer of 2023.

Rehab/Maintenance, Part 3 Session

IBC 23-82: Infrastructure for People and Planet – Bridging the LA River | Taylor Yard Bikeway and Pedestrian Bridge Design and Construction

Scott Lenz, Arup, Los Angeles, CA ; Jennifer Sudario, Arup, Los Angeles, CA

The completion of the Taylor Yard Bikeway and Pedestrian Bridge marks the beginning of a new era of bridge crossings over the Los Angeles River. With the design provided by Studio Pali Fekete: architects and construction work from Ortiz Construction, Arup provided civil engineering expertise and bridge structural design services to fulfill the City of Los Angeles' goal to revitalize the river. The eye-catching 400-ft orange truss structure connects the Elysian Valley neighborhood to the Cypress Park community. This bridge is one of the first new generation river crossings in accordance with the LA River Revitalization Plan (LARRMP) which aims to bring residents back to the river.

Acknowledging the waterway's complex ecosystem, Arup implemented sustainable construction strategies to minimize disruption to the river and the various living habitats it contains. Our focus on mitigation guided the design decision to preassemble segments of the steel box truss bridge at the adjacent fabrication yard before driving it down to the river and splicing it. This method allowed the bridge superstructure to be built within one dry season, ensuring continued protection of the river's natural environment.

The project was initiated with an extensive constructability study conducted in partnership with the City of Los Angeles and Caltrans. The findings of this study informed all aspects of the project including the modified construction schedule and an overall design that ensured the structure remains safe and above water in a 100-year flood event.

The project was awarded the Institute for Sustainable Infrastructure's Envision Bronze certification.

IBC 23-83: Emergency Repairs and Road Diet at the Rt.71/Shark River bridge

Rama Krishnagiri, WSP USA, Lawrenceville, NJ; Gerald Oliveto, New Jersey DOT, Ewing, NJ; Rishi Rishindran, WSP USA, Lawrenceville, NJ; Alex Kluka, WSP USA, Lawrenceville, NJ; Andrew Foote, WSP USA, Lawrenceville, NJ

At the Rt 71 bridge over Shark River double-leaf Bascule bridge, the oldest drawbridge in NJ, with the highest demand for openings, an accidental failure of the center lock severely damaged the lock-bar, receiver socket and toe floorbeam, closing off the roadway to vehicular traffic. The incident occurred while large boats were still out at sea, scheduled to return later. Immediately NJDOT and WSP evaluated the field conditions, and maintenance cut away the lock bar to fully close the leaves. Fortunately, the two exterior locks were intact. The bridge carried three lanes (two southbound and one northbound), but the approaches only two. An immediate interim solution was required to reopen the span and bring the boats back safely. Immediately modifying the Finite Element Analysis on file at WSP, engineers quickly verified the deformed member capacity and the outer locks' ability to carry live loads, tested the safety interlocking and verified that the span could safely open.

As a longer-term solution, a Road Diet was implemented, eliminating the center lane off the bascule span, thus reducing Live load to the outer two lanes and also utilize the improved shoulders to safely accommodate bicycle traffic. Pre-Emergency repairs, bicyclists walked their bikes across the open steel grid deck. WSP designed a Fiber Reinforced Polymer bike path on the bascule span, roadway was restriped, and provided safe continuous bike paths to the approaches. The re-configured lanes relieved Live load off the center lock, now non-functional, and improved the bike access, all achieved very economically.NJ

IBC 23-84: Rehabilitation of the Detroit-Superior Bridge, Cleveland, Ohio

William Vermes, This Old Bridge, Strongsville, OH; Andrew Kustec, P.E., Pennoni, Independence, OH

The Detroit-Superior Bridge (aka the Veterans Memorial Bridge), opened in 1917, is Cleveland's signature bridge, and one of the city's most prominent icons. With creative urban planning, reuse of the abandoned lower deck, underground streetcar stations and subway tunnels are being viewed as future public spaces to compliment the upcoming development of park spaces below the bridge.

To properly restore the stations and tunnels, the rehabilitation required a different repair strategy from those used in earlier rehabilitations. The design team incorporated institutional knowledge (i.e. the successes and shortcomings of the previous rehabilitations) along with a detailed review of the original construction drawing and previous rehabilitation plans that addressed long neglected elements of this complex structure. This included incorporating specific dimensions and jack arch radii in the station repair directly supporting the busy city arterial above. This information was used by the contactor to use geofoam molds for exact replication of the unique jack arches and column capitals. To prevent further corrosion of the reinforcing steel, passive cathodic protection was added in the form of embedded zinc anodes within the newly placed concrete. "Insightful notes" and "negative notes" were used to guide the contractor and resident engineer to not perform unnecessary repairs. Additionally, deteriorated concrete over public areas below the concrete superstructure were patched using passive cathodic protection followed with discrete application of protective carbon fiber warp to the lower sections of the arch ribs, lower deck floor beams and structural floor beam corbels.

IBC 23-85: Rt. 30 over Beach Thorofare – Rehabilitation of an Historic Complex Single Leaf Bascule Bridge

George Zimmer, P.E., ENV SP, WSP USA, Lawrenceville, NJ; Rama Krishnagiri, P.E., WSP USA; Brianna Rela, WSP USA; Georgio Mavrakis, P.E., New Jersey DOT; Muhammad Akhtar, P.E., New Jersey DOT

The rehabilitation of the Historic Rt. 30 over Beach Thorofare single leaf bascule bridge in Atlantic City, NJ, currently under construction, will address a major mechanical/electrical rehabilitation, structural deficiencies, and upgrade outdated safety features. Throughout the project, the WSP team had to balance fulfilling the project need, safety, and cost while maintaining the movable span balance, ensuring continuous use of a coastal evacuation route and preserving the NJHPO deemed historic features of the bridge. The paper will focus on the bascule span deck replacement, partial bascule span superstructure replacement, movable bridge safety, custom resistance barrier gates, and use of innovative materials such as FRP and aluminum to retain leaf weight. The project is scheduled to be completed in late 2023.