REHABILITATION OF THE BEN SAWYER BRIDGE

“OUT WITH THE OLD IN WITH THE NEW”
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Existing Swing Span Bridge - Constructed in 1943

Swing Span

- Pratt Truss
- Center bearing type with balance wheels
- End & Center wedge supports
- Span- 247 Feet
- Width-34- c-c Trusses
- 2 Lanes of Traffic - 1’-6” safety walks
- Designed for H-20 Truck Loading as per 1941 AASHO
- Spans over ICWW 94’ navigation channel
- Vertical clearance- 35’
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Approach Spans
- 12 spans (6 per side) in 3 span continuous units
- 2 Non-redundant riveted steel plate girders supports:
  - Floor beam/ stringer framing
  - 7” concrete deck
  - Concrete post and steel railing
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Substructure

- Reinforced concrete piers founded on timber piles
- Substructure is in good condition
- Existing concrete compression tests range from 5,300 to 10,060 psi
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Design Criteria

- AASHTO LRFD Code & Including Seismic Criteria
- SCDOT Design Criteria & Memorandums
- RFP Technical Specifications

New Superstructure to Match Existing EXCEPT:

- Bridge Roadway Width increased - 26 feet to 28 feet
- Provide 5’ 6” sidewalk on west side of Bridge
- Increase vehicular vertical clearance to 16 feet at Truss Portal
- Provide TL-3 capacity for identical bridge rail
- Provide seismic isolation bearings at approach span piers
- Provide Pivot bearing that resists seismic forces
- Maintain octagonal shape control house
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Goals of the Rehabilitation Project

- Maintain Similar Aesthetic Appearance
- New Structure to meet New Design Code including existing substructure
- Maintain Existing Profile
- Communicate with local citizens during construction
- Sensitive to the wetlands during construction
- Adhere to construction schedule
  - 540  Total Days (Including Design)
  - 10   Bridge Closure Days
  - (Required 11 due to adverse weather)

- Design/Build Contract Bid $33.5 million
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Approach Spans

In kind replacement with following modifications

- Lightweight concrete deck (115 lb /ft3; f’c = 5,000 psi)
- TL-3 design bridge rail vs unrated bridge rail
- 5’ 6” sidewalk vs no sidewalk
- 2 – 14 foot lanes vs 2 -13 foot lanes
- A709 Gr 50 steel vs A7
- Welded steel plate girders vs riveted
- LFRD design code vs allowable stress design
- Replace rocker bearings with isolation bearing
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Substructure Analysis

- Substructure Service Load Analysis
  - Check to determine if existing foundations meets LRFD Code with heavier dead load (increase 15%)
  - Individual Pile Analysis required using original boring logs and pile driving data

- Seismic Analysis
  - SAP 2000 software
  - Response spectron analysis
  - Time history analysis
  - For 500 year return period event
  - Isolation bearings installed on new approach span superstructure
  - Pivot bearing designed for seismic load

- Results - Seismic Capacity/Demand
  - Range 1.04 (Rest Pier)
    - 1.47 (End Bents)
    - 1.18 – 1.42 (Intermediate Piers)

- Results – Non-Seismic LRFD Analysis
  - Resistance Factor Range
    - [0.26 – 0.36 (Piers)]
    - [0.41 – 0.44 (Abutments)]
  - AASHTO LRFD Requires 0.4 Resistance Factor or 2.5 Factor of Safety
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Approach Spans
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Isolation Bearing
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Approach Spans
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Swing Span

In kind replacement with following modifications
- Rolled truss members in lieu of built up lattice members
- Exodermic lightweight concrete deck vs concrete filled grating
- TL-3 bridge rail vs unrated bridge rail
- 5’ 6” sidewalk vs no sidewalk
- 2 – 14 foot lanes vs 2 -13 foot lanes
- A709 Gr 50 steel vs A7 (Fy=36 ksi)
- LFRD design code vs allowable stress design
- Bolted connections in lieu of riveted
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Swing Span

Typical Section

Steel Railing
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Truss in Lay Down
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Swing Span
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Swing Span
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Control House

- Match appearance of existing octagonal shaped house
- House enlarged for improved view corridors, electrical equipment, bathroom
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Control House

- Floor Plan layout allowed views from all windows from the control desk
- Bathroom provides working plumbing system
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Control House
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Mechanical Systems

- Span drive machinery
  - 2 independent motors drive span mounted pinion
  - 1 motor capable of operating swing span
  - manual drive available w/ capstan through deck
  - disk brakes provided for motor and machinery
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Span Drive Machinery
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Span Drive Machinery
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Center Pivot Bearing

- Designed for seismic event lateral load (360k)
- Bronze/Steel Pivot bearing
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Center Pivot Bearing

Existing

New
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

End Lifters

- Used in lieu of end wedges to minimize machinery weight and better access
- Eccentric roller system lifts span to meet approach roadway
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

End Lifters
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Mechanical Systems

- Center Rollers
  - used in lieu of mechanically driven center wedges
  - used to resist live load on pivot girder
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Center Rollers
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Balance Wheels

- Eight provided for counter over turning moments induced by wind
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Span Lock Machinery

- New to AASHTO LRFD
- Hold swing span in closed position
- Designed to resist full opening force of machinery
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Fender System

- Fender system replaced and realigned
- Realigned north rest pier fender system to north due to wider swing span
- Pivot pier fender remains in same location
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Construction
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Construction

- Temporary Crane Trestles: North & South Approaches
- Approach Spans: Temporary Erection Bents
- Swing Span: Float-in Barge
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Approach Span Construction

Crane Trestle under construction
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Approach Span Construction

Crane Trestle & Temporary Bents
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Approach Span Construction
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Approach Span Construction

Temporary Approach Span Bent adjacent to existing substructure
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Approach Span Construction

Temporary Bent for Displaced Existing Bridge

Tension Jack & Pull Rods

Hillman Roller Supports & Guides
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Approach Span Construction
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Approach Span Construction

Approach Span Pulling System
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Approach Span Construction

New Approach Spans in Place
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Swing Span Construction

- Pre-assembled at fabricators shop
- Erected at Port of Charleston
- All machinery installed at erection site
- Control House erected and installed
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Swing Span Construction

Swing Span in lay-down at Florida Structural Steel Fabrication Plant
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Swing Span Construction

Swing Span Erection at Fabrication Plant
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Swing Span Construction

Swing Span Framing and Exodermic Deck
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Swing Span Construction

Swing Span near completion at the Port
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Swing Span Construction
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Closure
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Closure

Swing Span  Float-in
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Closure

Swing Span Barge lifting existing Swing Span
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Closure

Anchor Bolt templates for Pivot Pier
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Closure

Swing span and approach span are demolished at joints to clear for removal
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Closure

Pivot Pier being cleared
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Closure

Barge turned around 180° to place new span in position
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Closure

Swing Span barge moving into position
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Closure
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Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Machinery Installation
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

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Machinery Installation

Temporary Pivot Bearing Struts for Rack & Track
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Machinery Installation

New machinery in place during Float-in
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Machinery Installation

Machinery in place ready for Grouting
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
Machinery Installation

[Image: Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW Machinery Installation]
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Machinery Installation

Temporary shims for final Grouting
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW

Adverse weather during Float-in and Approach Span Transition
Sub Freezing Temperatures
Snow/Rain
30+ MPH Winds
Rehabilitation of the Ben Sawyer Bridge (SR703) over the ICWW
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Construction Project Teams

- FHWA
- SCDOT
- Parsons Brinkerhoff (PB Americas Inc.)
  Owner's Representative
  Construction Management & CEI
- PCL Civil Constructors, Inc.
  Contractor
  Project & Construction Management
  Construction Engineering
- Hardesty & Hanover, LLP
  Design Management
  Bridge Design
  Seismic Design
- Florence & Hutcheson
  Roadway Design
  Environmental Services
  Design Surveys
  Existing Bridge Assessment
  Bridge Design Support
- STV/Ralph Whitehead Associates
  Utility Coordination
- S&ME, Inc.
  Geotechnical Design
- Civic Communications
  Public Information and Community Outreach
- Edwards Electric
  Electrical Subcontractor
- Electrohydraulic Machinery
  Electrical Control System Subcontractor
- Florida Structural Steel
  Structural Steel Fabricator
- Steward Machine Co., Inc.
  Bridge Machinery Supplier