Bayonne Bridge “Raise the Roadway” Project

RAISING THE NAVIGATIONAL CLEARANCE OF THE BAYONNE BRIDGE

Chester Werts, PE SE
Sr. Bridge Engineer/Professional Associate

Western Bridge Engineers’ Seminar
September 2013
HDR/PB, A Joint Venture

- HDR Engineering / Parsons Brinckerhoff Joint Venture
  - Joint Venture
    - HDR Engineering
    - Parsons Brinckerhoff
  - Subconsultants
    - Arora Associates
    - Arora Engineers
    - Barbara Thayer Associates
    - ECI
    - Gilmore
    - Hartgen Associates
    - HNTB
    - Huie Services
    - IH Engineers
    - Illumination Arts
    - Karl Frank
    - Khaled Mahmoud
    - KPFF
    - Pennoni
    - Purdue University
    - RWDI
    - Sam Schwartz Engineers
    - VJ Associates
    - Weidlinger Associates
Project Background: Port Authority Bridges
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HDR/PB, A Joint Venture
Project Background: Existing Facility
Project Background: Existing Facility
Project Background: Existing Facility

- Opened to traffic on November 15, 1931
- Third longest steel arch bridge in the world
- Longest in the world at the time of completion
- Connects Bayonne, New Jersey with Staten Island, New York - spanning the Kill Van Kull
- Arch span of 1,652 feet from pin to pin
- Height of the arch above the water at the crown is 325 feet
- Original bridge designed by Othmar Ammann
Project Background: Existing Facility

Existing Facility: 6,974’
INCREASE NAVIGATIONAL CLEARANCE

- +35’  185’ Clearance
- +50’  200’ Clearance
- +65’  215’ Clearance

BY

- Raise the Roadway
- Jacking the Arch Vertically
- New Replacement Bridge
- Tunnel under Kill Van Kull
Project Background: 2008 Feasibility Study

INCREASE NAVIGATIONAL CLEARANCE

- +35’  185’ Clearance
- +50’  200’ Clearance
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BY

- Raise the Roadway
- Jacking the Arch Vertically
- New Replacement Bridge
- Tunnel under Kill Van Kull
Project Background: Container Ships

TEU: Twenty-foot equivalent unit
A measure of volume or capacity based on the standard dimensions of a 20-foot cargo-carrying container; a 40-foot container provides for the same volume or capacity as two 20-foot containers (2 TEUs).

“Post-Panamax” refers to ships that are too large to navigate the Panama Canal. But they will fit through after 2014, when the expansion of the canal is expected to be completed.

New level: 215 feet

New generation TEUs: 12,000+

Channel depths required by newer generations of container ships that are approaching 50 feet.

U.S. Army Corp of Engineers; Maher Terminals; The Port Authority of N.Y. and N.J.; Pictonomy

FRANK CECALA and ANDRE MALOK/THE STAR-LEDGER
Project Background: Container Ships

Current

TEU: Twenty-foot equivalent unit
A measure of volume or capacity based on the standard dimensions of a 20-foot cargo-carrying container; a 40-foot container provides for the same volume or capacity as two 20-foot containers (2 TEUs).

Bayonne Bridge air draft: 151 feet at high tide

Panamax
TEUs: 4,100-5,000

Post-Panamax
TEUs: 4,500-9,000

Super Post-Panamax
TEUs: 9,600

“Post-Panamax” refers to ships that are too large to navigate the Panama Canal. But they will fit through after 2014, when the expansion of the canal is expected to be completed.

New level: 215 feet

Channel depths required by newer generations of container ships that are approaching 50 feet.

1st generation
TEUs: 1,700

2nd generation
TEUs: 2,305

U.S. Army Corp of Engineers; Maher Terminals; The Port Authority of N.Y. and N.J.; Pictonomy

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HDR/PB, A Joint Venture
**Project Background: Container Ships**

**Current**

- **TEU:** Twenty-foot equivalent unit
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  - Bayonne Bridge air draft: 151 feet at high tide
  - 1st generation: TEUs: 1,700
  - 2nd generation: TEUs: 2,305

**Future**

- **Post-Panamax** refers to ships that are too large to navigate the Panama Canal. But they will fit through after 2014, when the expansion of the canal is expected to be completed.
  - New level: 215 feet
  - TEUs: 12,000+

**Note:** Channel depths required by newer generations of container ships that are approaching 50 feet.

**Graphical Representation:**

- **Panamax:** TEUs: 4,100-9,000
- **Super Post-Panamax:** TEUs: 9,600

**Sources:**

- U.S. Army Corp of Engineers; Maher Terminals; The Port Authority of N.Y. and N.J.; Pictonexmetry

**Acknowledgments:**

- FRANK CECALA and ANDRE MALOK/THE STAR-LEDGER

**HDR/PB, A Joint Venture**
“Raise the Roadway”
Rehabilitate, Retrofit, and Reuse – Arch

- Rehabilitate: Strengthening the Existing Arch
- Retrofit: Relocation of the Arch Portals
- Reuse: Raising the Roadway within Existing Arch
Wider Roadway – Arch

Existing Arch Section

New Arch Section
Construction Overview: Arch Construction
“Raise the Roadway”
Replacement – Approach Structures
Approach Structure: New Precast Concrete Box Girders
Construction Overview: Approaches
Design Criteria: Live Loads – Future BRT/LRT

- **BASE**
  - 32'-0"
  - 70'-0"
  - 2 Lanes @ 12'-0"
  - 6'-0"
  - 12'-0"

- **BRT**
  - 66'-8"
  - 5 Lanes @ 12'-0"
  - 3'-4"

- **LRT**
  - 17'-0"
  - 24'-4"
  - 24'-4"
Design Criteria: Live Loads – Future BRT/LRT

- **BASE**

- **BRT**
  - Dedicated BRT Lane

- **LRT**
Design Criteria: Live Loads – Future BRT/LRT

- **BASE**
  - 32'-0"
  - 70'-0"
  - 2 Lanes @ 12'-0"
  - 6'-0"

- **BRT**
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- **LRT**
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Design Criteria: Wind Tunnel Tests

- Arch Model Wind Tests performed by RWDI
# Design Criteria: Wind Speeds

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<tr>
<th>Wind Speed Applicable for</th>
<th>Return Period (years)</th>
<th>Mean Wind Speed (mph) at Deck Level 215 ft and Averaging Time</th>
<th>Corresponding 3-sec Gust Speed (mph) at 33 ft Open Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design during construction</td>
<td>20</td>
<td>78.5</td>
<td>95.5</td>
</tr>
<tr>
<td>Design of completed bridge</td>
<td>100</td>
<td>90.0</td>
<td>110.7</td>
</tr>
<tr>
<td>Stability during construction</td>
<td>1,000</td>
<td>110.0</td>
<td>140.8</td>
</tr>
<tr>
<td>Stability of completed bridge</td>
<td>10,000</td>
<td>133.0</td>
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**Arch:**

**Approaches:**

![Graph showing Fastest-Mile Wind Speed vs Elevation](image-url)
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Arch:

Approaches:

Fastest-Mile Wind Speed

- 100-yr
- 20-yr
Design Criteria: Site Specific Seismic

BAYONNE BRIDGE NY & NJ APPROACHES
DESIGN RESPONSE SPECTRA W/5% DAMPING

Acceleration (g)

Period (sec)

1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0

1500-Year Design Spectrum
2500-Year Design Spectrum
Design Criteria: Site Specific Seismic
Approach Structures: Foundation Types

6’ Dia. Drilled Shaft

12” Micro-Pile
Approach Structures: Pier Types

- Single Pier
- Combined Pier
- Tall Pier
Approach Structures: Pier Types

- Single Pier
- Combined Pier
- Tall Pier
Approach Structures: Articulation/Pier Fixity

New York

New Jersey

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Approach Structures: Box Geometry

Typical 36’ Rdwy

Wide 48’ Rdwy
Approach Structures: Pier Diaphragms

Typical Haunched Girder

Typical Cross Section
Approach Structures: Pier Diaphragms

Typical Constant Depth Girder

TYPICAL CROSS SECTION

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THE PORT AUTHORITY
OF NY & NJ
Approach Structures: Section Design

Typical Constant Depth Section
Approach Structures: Section Design

Typical Constant Depth Section

Transverse PT

TYPICAL CROSS SECTION
Approach Structures: Section Design

Typical Constant Depth Section

Vertical PT Bar

TYPICAL CROSS SECTION
Approach Structures: Exp. Piers – Construction
Approach Structures: Exp. Piers – Construction
Approach Superstructures – End Diaphragms

Typical End Diaphragm Segment
Approach Superstructures – End Diaphragms

Typical End Diaphragm Segment

- EXP. JOINT FACE
- Ø NB BOX
- PLAN TOP SLAB
- PLAN BOTTOM SLAB
- SECTION BULKHEAD FACE
- ELEVATION

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Typical End Diaphragm Segment

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THE PORT AUTHORITY
OF NY & NJ
Approach Superstructures – End Diaphragms

Typical End Diaphragm Segment

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Approach Structures: End Span – Construction

- Third Truss Support as Required
- Closure Joint
- Span S2
- Span S1
- Pinned Pier S2E
- Pinned Pier S3E
- Exp. Tower S1E

HDR/PB, A Joint Venture
Approach Structures: End Span – Construction

Third Truss Support As Required
Closure Joint
Span S2
Span S1
Pinned Pier S3E
Pinned Pier S2E
Exp. Tower S1E
Approach Structures: Top Continuity PT

- AASHTO LRFD Thermal Gradient
- Wide Deck Produces Large Loads
- Combination of TG- with Zero LL at Opening Day
- Controlled Top Continuity PT
Approach Structures: Top Continuity PT

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Approach Structures: Utilities

- **Northbound Approach**
  - 24 Utility Conduits inside Box Girder
  - 8” Fire Standpipe
  - Drainage in Typical Box Section

- **Southbound Approach**
  - 15 Utility Conduits
Approach Structures: Utilities

- **Northbound Approach**
  - 24 Utility Conduits inside Box Girder
  - 8” Fire Standpipe
  - Drainage in Typical Box Section

- **Southbound Approach**
  - 15 Utility Conduits
Construction Milestones

- Bids Received: April 2013
- Project Awarded: April 2013
  - Skanska-Koch/Kiewit $743 Million
- Construction Notice to Proceed: May 2013
- Foundation Construction: 4th Quarter 2013
- Main Span Arch Strengthening: 1st Quarter 2014
- New Arch Roadway: 1st Quarter 2014
- Approach Pier Construction: 1st Quarter 2014
- NB Approach Superstructure: 2nd Quarter 2014
- Existing Arch Deck Removal: 4th Quarter 2015
Thank you