Open Spandrel Concrete Arches
New and Old
Introduction

• William M. (Bill) Davidge IV, P.E.
• Vice President - Wiley & Wilson, Inc.
• Education
  – B.S. Civil Engineering - 1973
    University of Virginia
  – M.S. Structural Engineering - 1977
    George Washington University
• Professional Registration
  – Professional Engineer
    • VA, MD, CA, NC
• Professional Organizations
  – American Society of Civil Engineers
  – National Society of Professional Engineers
  – Virginia Society of Professional Engineers
  – Joint ASCE/ACI Committee on Concrete Bridge Design
  – Virginia Section - Institute of Transportation Engineers
Agenda

- Purpose & Need
- Project Constraints
- The Original Luten Bridge
- The General Design Solution
- The Bridge Design Solution
- Aesthetics
- Project Status/Conclusion
- Questions and Answers
Project Purpose & Need

• Condition of Bridge Structure
Project Purpose & Need

- Destructive Testing Program
  - 34 Compression Test Cores Taken in Arches & Piers
  - 6 Splitting Tensile Strength Tests for Arches & Piers
  - 54 Chloride Tests in Arches & Piers
  - Petrographic Analysis
Project Purpose & Need

- Traffic
  - TRAFNETSIM Model
  - Main Street/Riverside Drive Intersection
  - Main St. Is Downtown Thoroughfare
  - Riverside Dr. (Rte. 58) Is Main East-West Corridor for Southside Virginia
  - Requires 2-Thru + Left and Right Turn Lanes on Each of 4 Legs
• Surrounding Historic Resources

Project Constraints
Project Constraints

• Existing Grid of City Streets
The Original Luten Bridge
The Original Luten Bridge

- Backdrop of Historic Danville
  - Cotton Milling Industry
    - Began 1820’s
    - 7 Mills Established Here in late 1800’s
  - Mill Housing
  - Tail Races Here Served Other Businesses
  - Canals Here Used for Transport

- Other Bridges on this Site
  - Wood Covered Bridge Built 1851, Replaced 1887
  - Theodore Cooper “Iron” Truss (Fireproof) Built 1887, Burned 1927
The Original Luten Bridge

- Daniel B. Luten, Bridge Designer
  - Indianapolis, Indiana
  - Prolific & Well Known Engineer
  - Held 50 Patents, First Dated 1912
  - Pioneered Open Spandrel Arch Construction
  - Marketed to Municipalities
  - Marketed to Replace Metal/Timber Structures (Fire, Wear & Flood Resistant)
  - Built Bridges in 45 States + Overseas
The Original Luten Bridge

- Construction of the Bridge
  - 1927
  - Concrete Steel Bridge Company
    Clarksville, West Virginia
  - Concrete Design Selected for
    Fire and Flood Resistance
  - High-Profile Designer Selected in
    Line With Danville’s Image
    (Notable Others Included
     Concrete Building Designers
     Julius Kahn & Claude A.P.
     Turner)
The Original Luten Bridge

- 7 Spans
- 840 Feet Long
The Original Luten Bridge - Function

- Cross Section
  - 2 Arches
  - 4 Spandrel Columns
  - 44.5 Feet Curb-To-Curb
  - 2 – 5 Foot Sidewalks
  - Trolley Tracks
The Original Luten Bridge-Function

- Existing Configuration
The Original Luten Bridge - Structure

- Piers & Foundations
  - Founded on Granite Bedrock
The Original Luten Bridge - Structure

- Abutments
  - Incorporate Old Mill Race Walls
The Original Luten Bridge - Structure

• Arches – 3 Radii
The Original Luten Bridge - Structure

• Arches
  – Pairs
  – Variable Thickness
The Original Luten Bridge - Structure

• Arches
The Original Luten Bridge
-Structure

- Spandrel Columns
  12” X 18”
The Original Luten Bridge - Structure

- Floor Framing
  - Continuous, Cantilevered Cross-Beams
  - Deck Spanning Parallel to the Direction of Traffic
The Original Luten Bridge - Structure

- Deck, Overlay & Sidewalk
The Original Luten Bridge - Structure

• Railings & Lighting
The Design Solution
• Location Alternatives

The General Design Solution
• Design Configuration
• Maintenance of Traffic During Construction
The Bridge Design Solution
-Renovation of the Original Bridge
• Rehabilitation of Arches and Piers

The Bridge Design Solution
-Renovation of the Original Bridge
• Replacement Above Arches
  – Cast-In-Place Concrete

The Bridge Design Solution
-Renovation of the Original Bridge
• Floor System – Beams and Deck

The Bridge Design Solution
-Renovation of the Original Bridge
• Floor System – Concrete Formwork

The Bridge Design Solution
-Renovation of the Original Bridge
• Temperature Considerations/Deck Joints

The Bridge Design Solution
-Renovation of the Original Bridge
• Deck Drainage

The Bridge Design Solution
-Renovation of the Original Bridge
The Bridge Design Solution
-Renovation of the Original Bridge

• Railings & Sidewalk
  – Texas Design With Alterations
  – Crash Tested
• Lighting
  – Period Lighting Fixtures
    Consistent with City Standard

The Bridge Design Solution
-Renovation of the Original Bridge
The Bridge Design Solution

-New Bridge
• Foundations & Substructure

The Bridge Design Solution
- New Bridge
• Arches
  – Uniform Radius
  – 2-Piece
  – Precast Channels
  – Post Tensioned at Crown

The Bridge Design Solution
-New Bridge
• Arches
  – Staged Construction

The Bridge Design Solution
-New Bridge
• Arches - Staged Construction

The Bridge Design Solution
- New Bridge

Stage I Construction

2. Construct abutment A, pier 1, pier 2, and pier 3 to the construction joints, 2” below spring line.
3. Connect arch ribs at crown in spans a, b, and c in succession.
4. Infill arch ribs in spans a, b, and c in succession.
5. Complete abutment A, pier 1, and pier 2 construction.
6. Construct superstructure in spans a and b in succession.
The Bridge Design Solution
-New Bridge

- Floor System
  - AASHTO Type III Girders
  - Utility Supports
• Above Deck Items

The Bridge Design Solution
-New Bridge
Aesthetics
Aesthetics
-Elements in Common

• Arch Spans
• Span Arrangement
Aesthetics - Elements in Common

- Railing
- Lighting
Aesthetics
-Elements in Contrast

• Arch Shape
Aesthetics
-Elements in Contrast

• Spandrels
Aesthetics
- Elements in Contrast

• Concrete Color
  – Davis “Mesa Buff” Color No. 5447
  – Dosage Rate: 3/8# per Bag

-- Done in combination With Concrete Cleaning (No Chemicals, Limited Nozzle Velocity)
Aesthetics
- Elements in Contrast

• Concrete Detailing
  – Fascia
Aesthetics
- Elements in Contrast

• Concrete Detailing
  – Pier Faces
Project Status/Conclusion

- Entire Project Opened to Traffic During Winter 2005/06
• June S. Baldwin, VDOT Overall Project Manager
• James M. Fariss, VDOT Bridge Project Manager
• S. Babu Nallamala, New Bridge Designer
• Karl Kratzer & Others from H. W. Lochner and JMA, Authors of the EA
• Claude Napier & Rudy Maruri, FHWA Bridge Engineers
• Les Daniel & Pettis Bond, Bridge Construction Engineers for VDOT
• A. L. Simpson & His VDOT/ Consultant Inspection Crew
• Jeff Beatty, Project Manager for GC Glade East
• Leonard Pharr, Superintendent for GC Glade East
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Questions & Answers