Aluminum Bridge Decking
Advancements & Applications

Overview

- Introduction to Aluminum Bridge Decking
- Features & Benefits
- Deck Systems
- Bridges in Service
- Case Study
- Recent Project Examples
- Future Projects
- Q&A

Aluminum Bridge Decking

- First deck of this type installed in 1996
- Earlier versions date back to the 1930s
- Structural aluminum extrusions are an ideal bridge rehabilitation solution for:
  - Structurally deficient bridges
  - Functionally obsolete bridges
  - Moveable bridges
  - Historic bridges

Benefits of Aluminum Bridge Decking

- Lightweight structural aluminum to reduce dead-load
- Prefabricated for accelerated bridge construction
  - Minimizes traffic interruptions and need for expensive traffic control
- Lower lifecycle costs
- Advantages over existing deck alternatives
  - Corrosion resistant with minimal maintenance…*no painting!*
  - Better skid resistance and less road surface noise compared to grid decks
  - Capable of a 3.5’ cantilever on each side of bridge to widen roadway
    - Can utilize existing superstructure
  - Simple mechanical connections for fast installation and easy inspection
  - Damaged deck panels can be quickly fabricated and replaced

Aluminum Deck Features

- Weight: 21 - 23 lbs./sq. ft. (depending upon deck depth and wearing surface)
- Structural Efficiency
  - Composite or non-composite behavior with steel beams
  - Similar to monolithic concrete deck
  - 90% as strong transversely as longitudinally
  - Designed for infinite fatigue life using AASHTO Specifications
  - Polymer concrete wearing surface performs well on highways
  - Impacts from pneumatic tires not a concern
  - Meets LRFD code
  - Chemical and UV resistant

Aluminum Deck Features

- Maintenance Requirements
  - No corroded surfaces to repair
  - Wearing surface can be removed and applied in field (indefinitely sustainable)
- Constructability
  - Meets goals for Accelerated Bridge Construction (ABC)
  - Rapid deployment of lightweight panels
- Adaptability
  - Decks in service with beam spacing up to 9’
  - Potential to reuse beams
  - Addresses functionally obsolete bridges (too narrow) with cantilever

Aluminum Deck Features

- Wearing Surface
  - 2-part epoxy wearing surface
  - Variety of aggregate colors and textures
- Functionality and Safety
  - Improved skid resistance (0.8 to 0.9 friction coefficient)

Aluminum Deck Features

- Experience and Performance
  - Decades of aluminum bridge applications and evolution
  - 100-year deck technology may have been deployed 20 years ago
- Specifications
  - AASHTO LRFD Section 7 Code incorporates aluminum
    - Revisions ratified on July 9, 2012 by T-14 Steel Design Committee
  - AWS D1.2 includes friction stir welding as of June 2014
  - Meets Canadian Highway Bridge Design Code S6-06

FDOT Study

Aluminum Decking to Replace Steel Open Grid

BASCULE BRIDGE LIGHTWEIGHT SOLID DECK
RETROFIT RESEARCH PROJECT

DECK ALTERNATIVE SCREENING REPORT
FINAL

FPID 419497-1-B2-01

Prepared for:

STATE OF FLORIDA • DEPARTMENT OF TRANSPORTATION

Florida Department of Transportation
Structures Design Office

Prepared by:

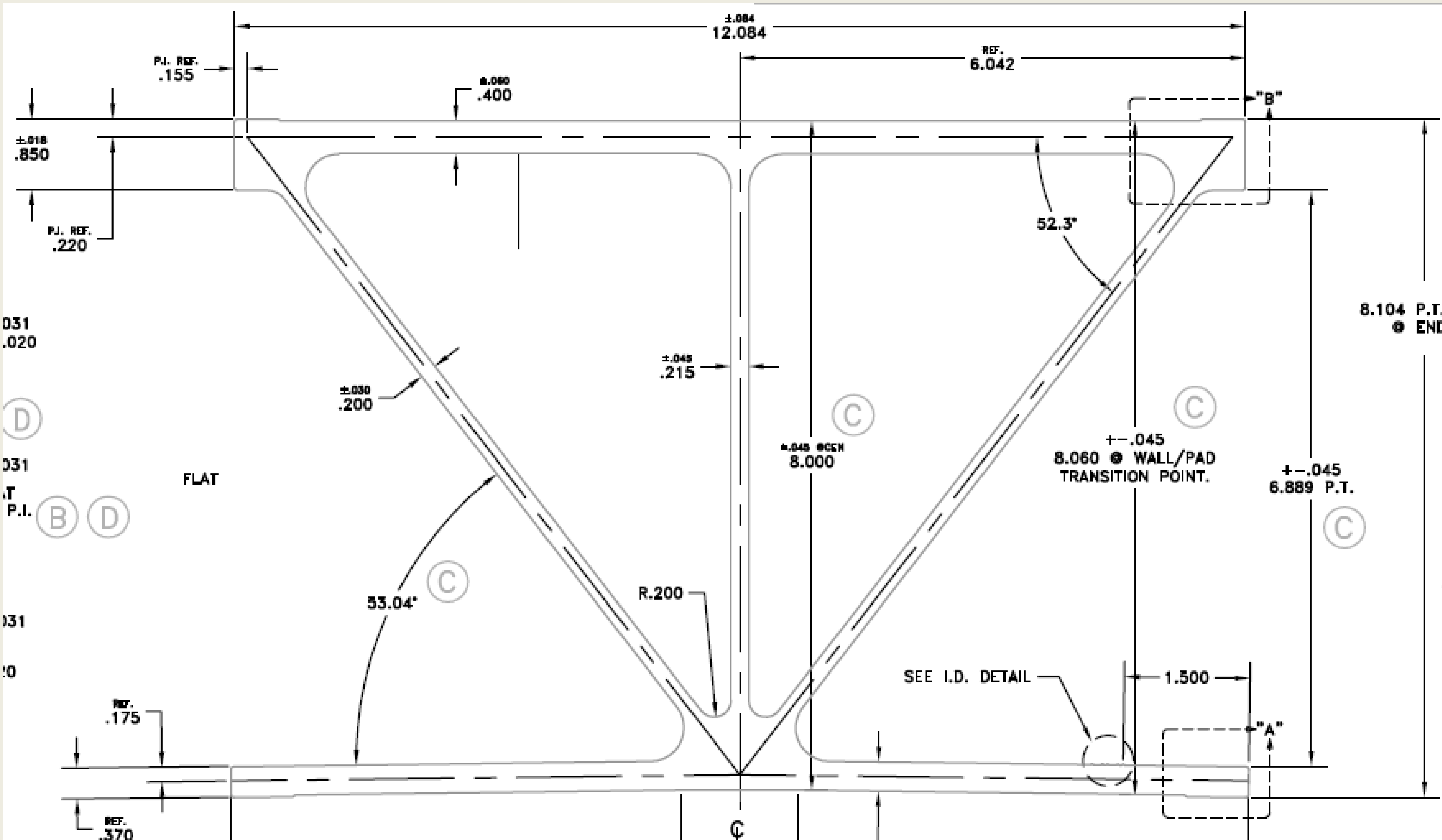
URS

URS Corporation, Inc.
7650 West Courtney Campbell Causeway, Suite 700
Tampa, Florida 33607

May 14, 2012

8” Deep Deck Profile

Replaces Concrete or Timber on Steel Beams



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8" Deep Bridge Deck

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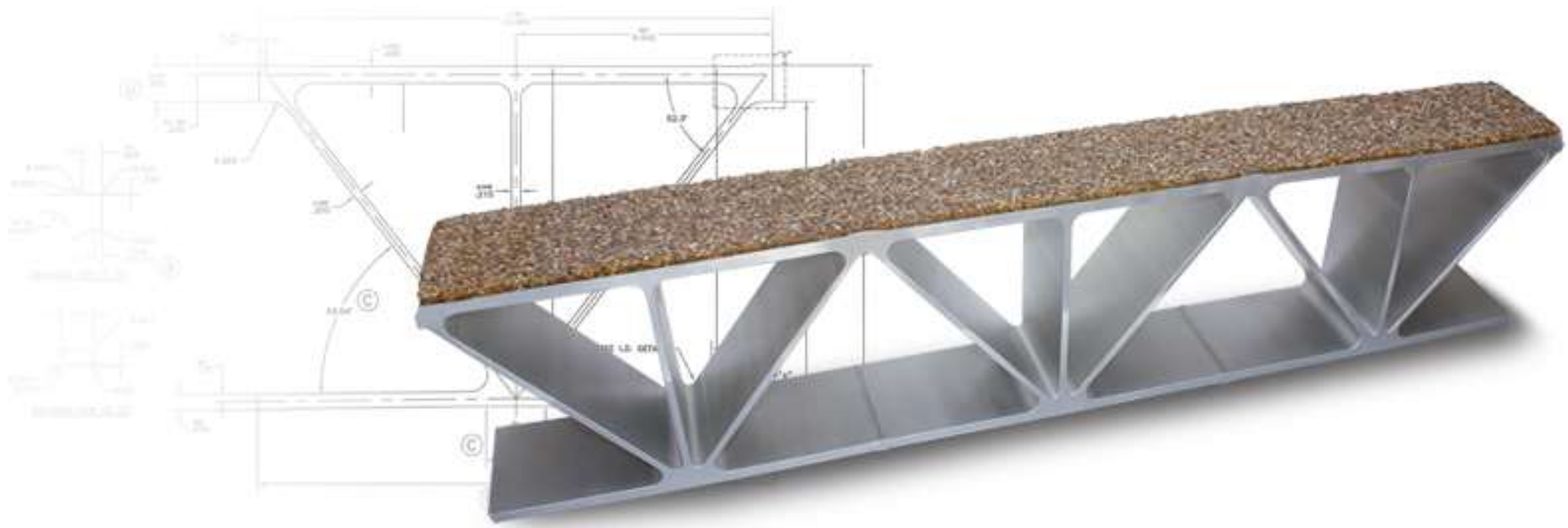

Corbin Bridge

Huntingdon, PA

Case Study

- Aluminum deck installed on the Corbin Bridge in Huntingdon, PA
- A historic bridge, so reconstruction was not an option
- Bridge posted for 7 tons before rehab
- Over 80,000 pounds of dead-load removed
- Load rated for 24 tons after rehab
- Performing well after 20 years of service

Before

After


U.S. Route 58 – Virginia
- Bridge was functionally obsolete
- Bridge was widened using existing substructure

Sandisfield, MA Bridge

Completion & Shipment

Sandisfield, MA Bridge
Lifting & Positioning: 15 minutes

Sandisfield, MA Bridge

Placement on Bearings: 15 minutes

"From crane to bearings in 30 minutes!"

Sandisfield, MA Bridge

April 21, 2015

St. Ambroise River Bridge
Quebec, Canada

- Deck Design Requirements:
  - 8” (203.2 mm) deep deck
  - Non-composite
  - 2 large panels with a longitudinal splice joint
    - Each panel 32.9’ (10,040 mm) x 12.3.’ (3,750 mm)
  - Need method to attach guard railings to deck
  - *Cannot bolt deck to beams*
    - Need non-mechanical connection at base of longitudinal splice joint
    - 4 unique extrusion dies had to be made

St. Ambroise River Bridge

- December 10, 2014: Panels ship from fabrication facility in Rapid City, SD
- January 15, 2015: Independent inspection completed in Quebec
  - Friction stir weld and leak proof tests
- January 20, 2015: Ministry of Transportation – Quebec (MTQ) issues acceptance

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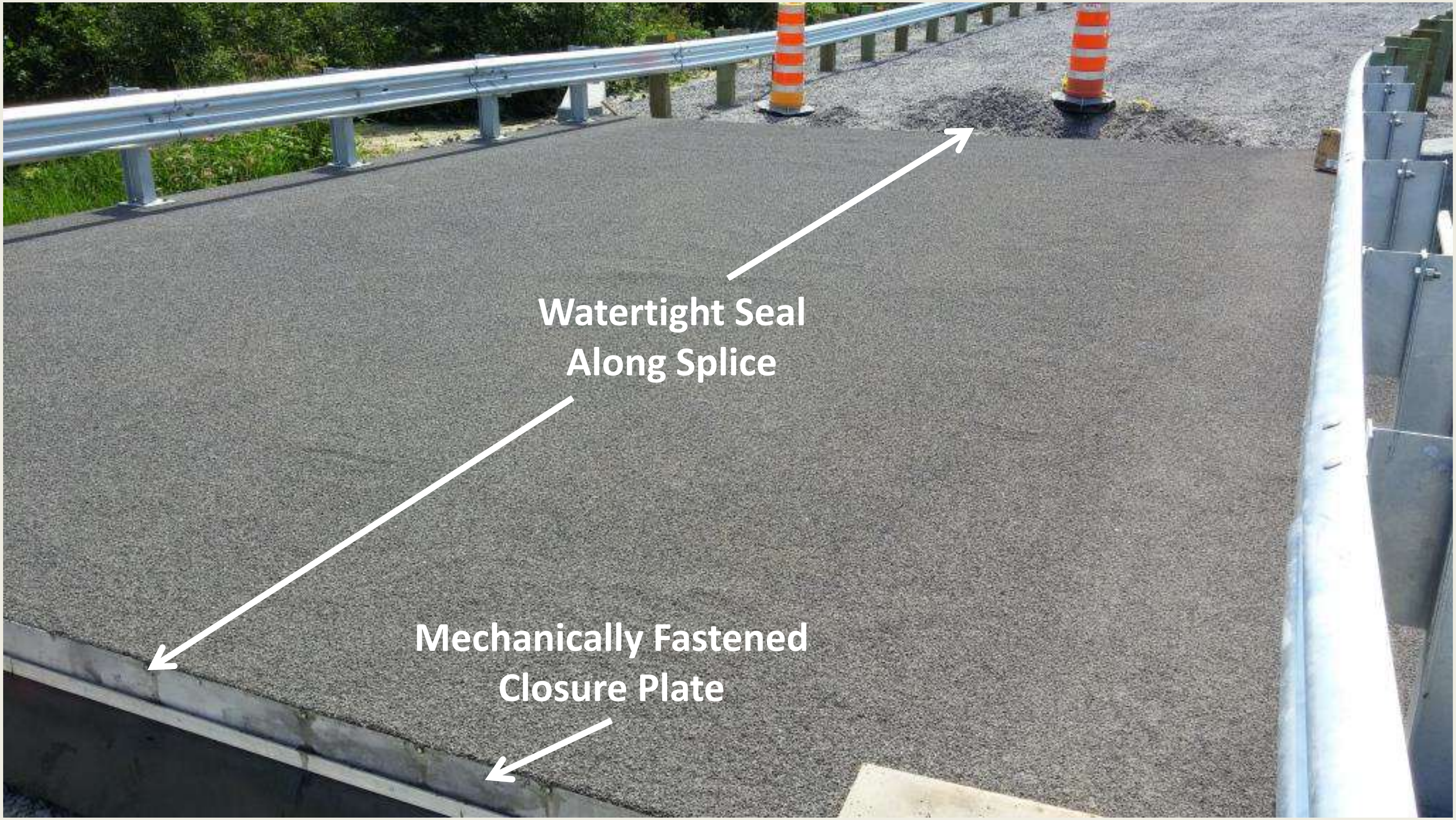
St. Ambroise River Bridge

- 32.9’ (10,040 mm) x 24.6’ (7,500 mm) deck assembly (all within tolerance)
  - Flatness Avg.: 0.37” (9.4 mm)
  - Straightness: 0.21” (5.4 mm)
  - Squareness: 0.167” (4.2 mm)
  - Width: 0.125” (3.2 mm)

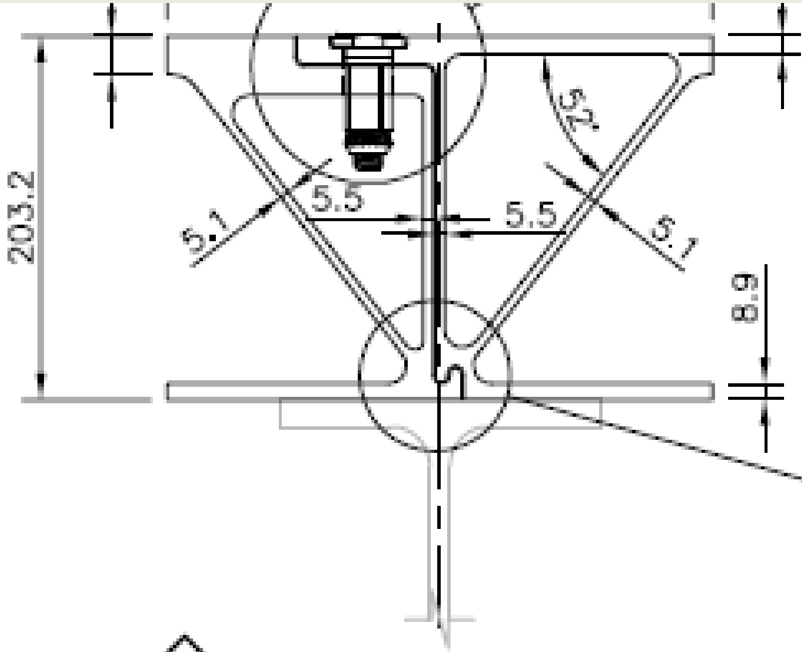
St. Ambroise River Bridge

Wearing Surface & Closure Plates

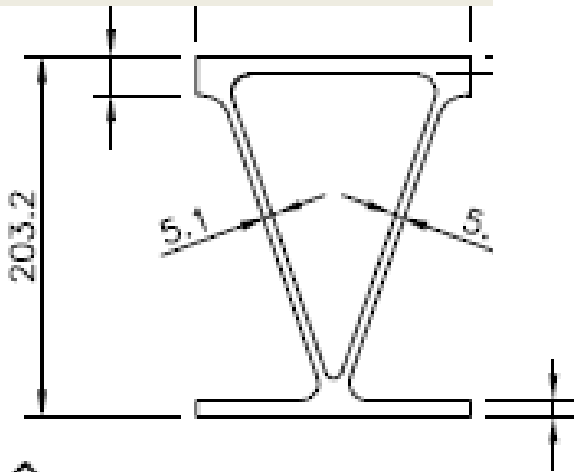


St. Ambroise River Bridge

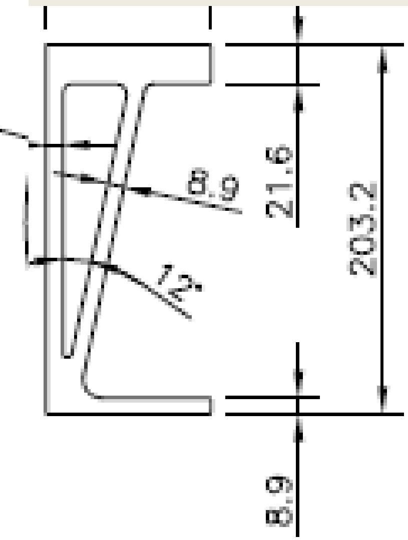
New 8” Deck Extrusion Profiles



C DECK SPLICE



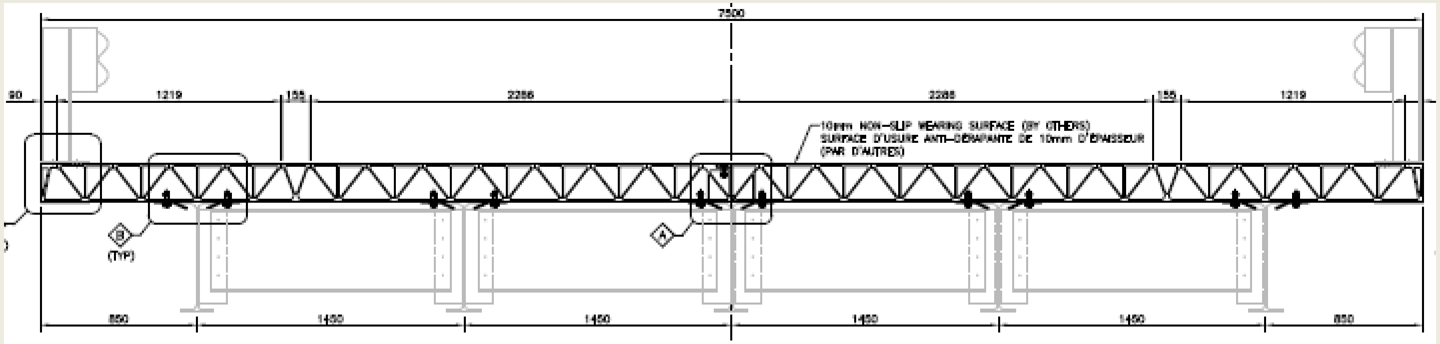
B HALF EXTRUSION

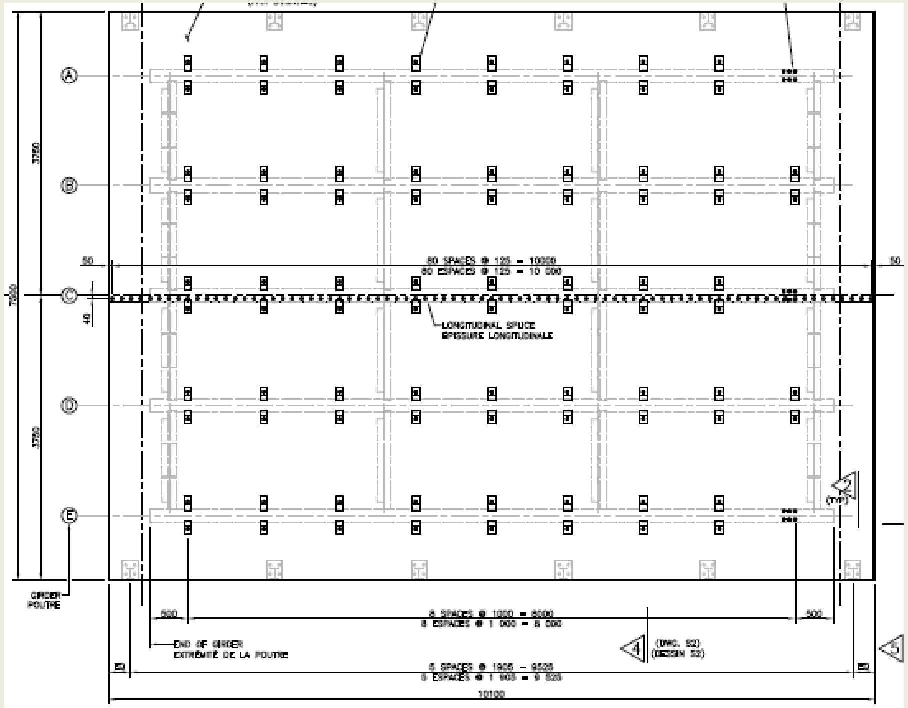


G END EXTRUSION

LBFoster

St. Ambroise River Bridge Shop Drawings





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St. Ambroise River Bridge

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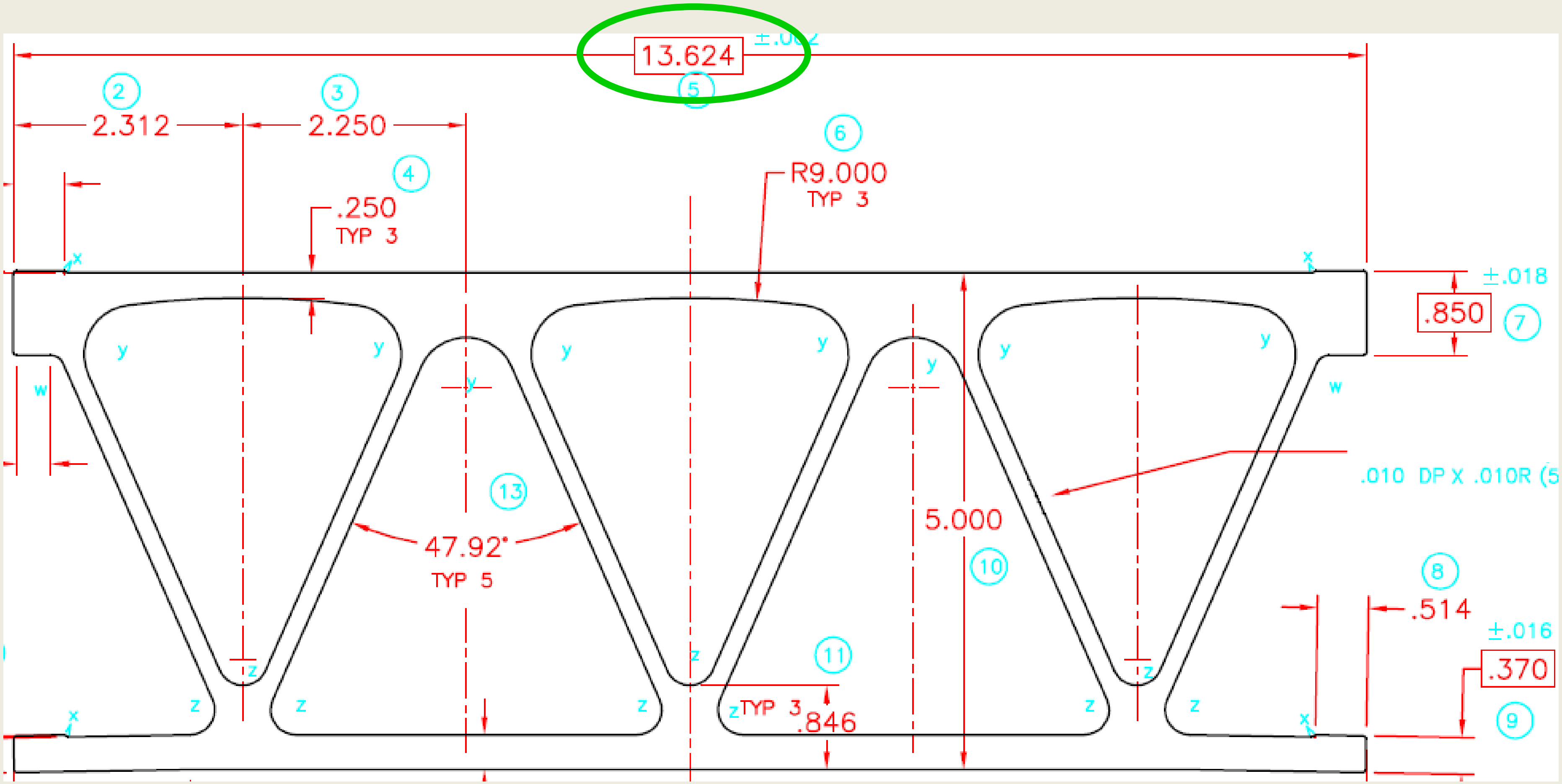
St. Ambroise River Bridge

Gen I 5” (127 mm) Deep Deck Profile

Replaces Grid Decks



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5″ Deep Bridge Deck

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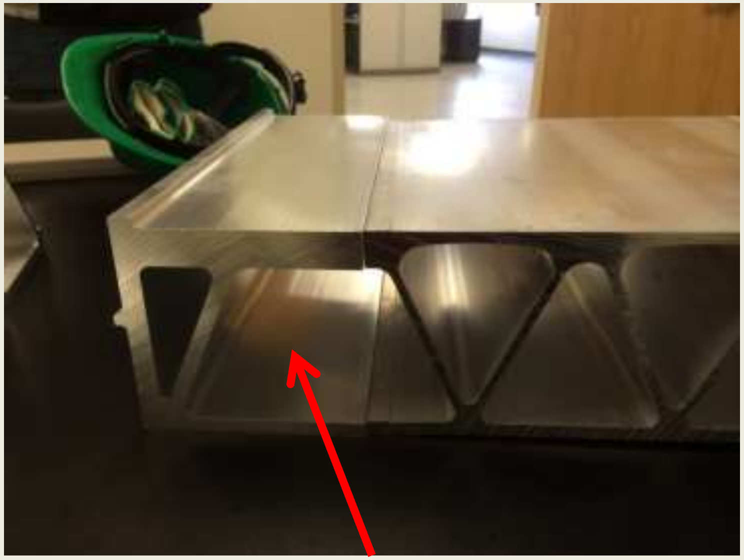
Movable Bridge Applications

- Improved safety
  - Better skid resistance
  - No ‘see through’ decks
  - No car steering influences
  - Quick installation
- Rehabilitation potential
- Reduced maintenance
- Enhanced longevity

5” Deep Deck

Gen I

5” Deep Deck - Base Extrusion Profile



5” Deep Deck - End Extrusion Profile

- New 6063-T6 alloy chemical composition offers improved ductility and fatigue resistance
- End extrusion offers structural panel closure and width adjustability
  - End extrusion legs can be trimmed back for panel width variance
- Three primary FSW tests for quality assurance (Ultrasonic testing can also be performed)
  - Macro Analysis: Cut, polish and analyze weld core during pre-production trials
  - Tensile Tests at start and stop of weld seams
  - Force Analysis: Compares forces of welder for acceptable welds in trials to production welds

Extrusion Production



- Extrusion trials confirm 44’ maximum length for 5” deep deck
- Extrusion trials confirm 33’ length required for 8” deep deck
- Potential for longer lengths with transverse FSW or splice joints

FDOT Panel Fabrication

Gen I 5” Deep Deck

- Maximum panel length: 44’
- Maximum panel width: 13.5’
  - Longer and wider available with transverse FSW or splice joints

Wearing Surface Application

Gen I 5" Deep Deck

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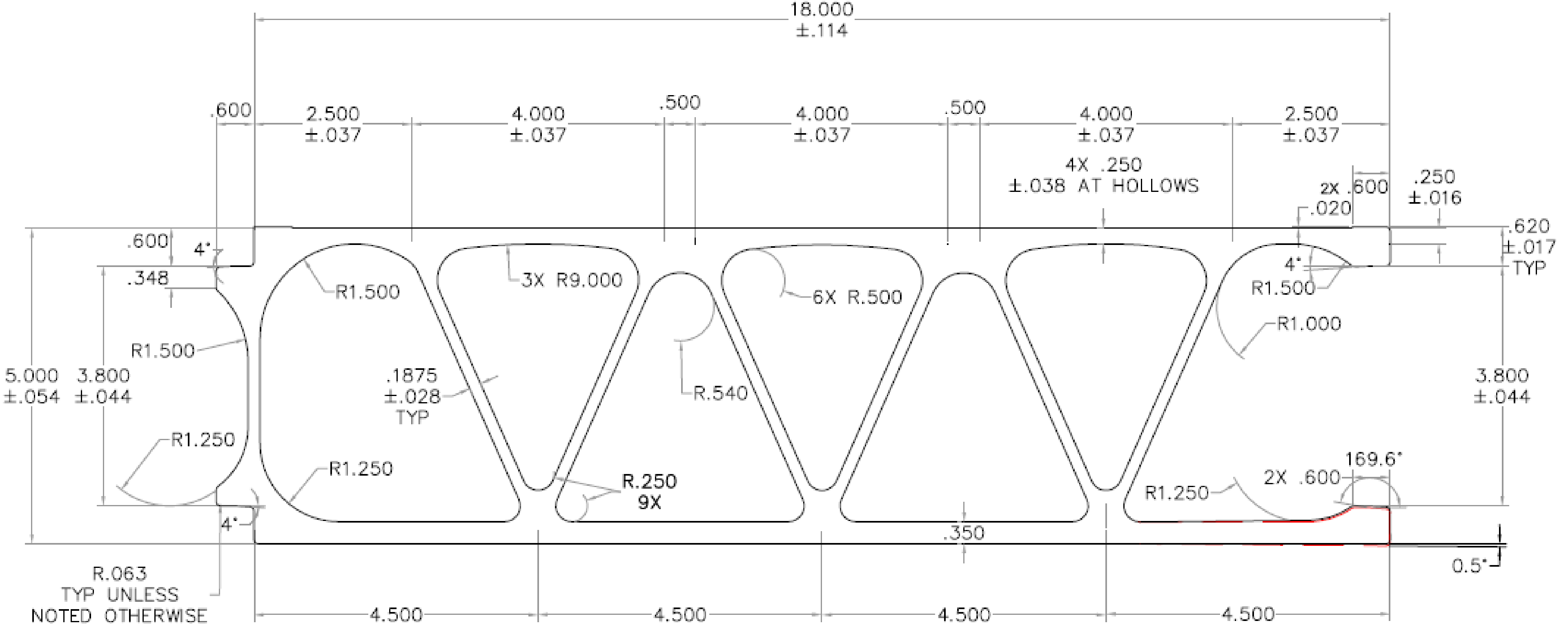
5” Deep Deck
Gen I

5” Deep Deck
Gen I

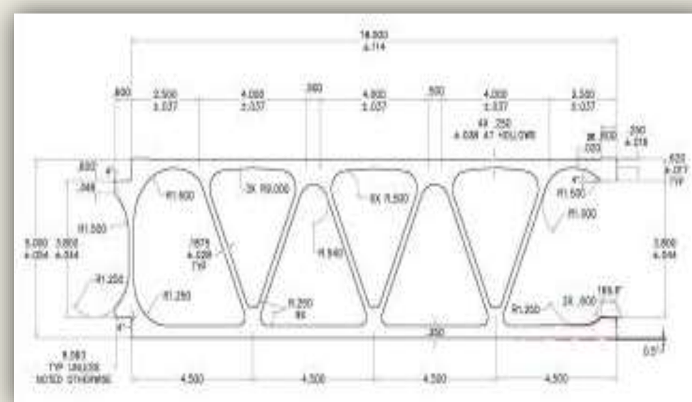
Gen II 5” Deep Deck (18”-Wide Profiles)

Optimized for Friction Stir Welding Efficiency

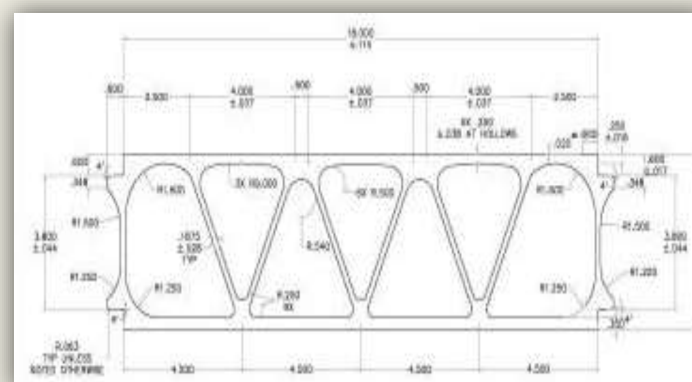


Gen II 5” Deep Deck (18”-Wide Profiles)

- Deck Enhancements
  - Wider extrusions
    - Fewer welded joints
  - Single-sided FSW
    - More efficient than self-reacting (2-sided FSW)
    - Over 2x to 3x the welding speed with no weld flash
    - Faster setup times
  - Matched top and bottom flange thicknesses
    - Greater weld shrinkage control with 20% less heat
- Verification of Refinements
  - Structurally equivalent to original deck product
  - Performance of new profiles
    - Manual calculations (section properties) – System 2
      - Transverse forces from loading between stringers
    - Finite element analysis – System 3
      - Localized flexure from wheel patch loading



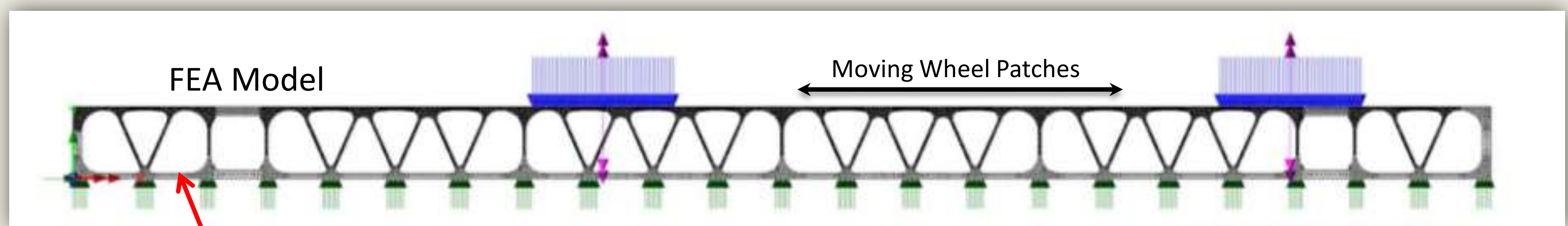
Male - Female



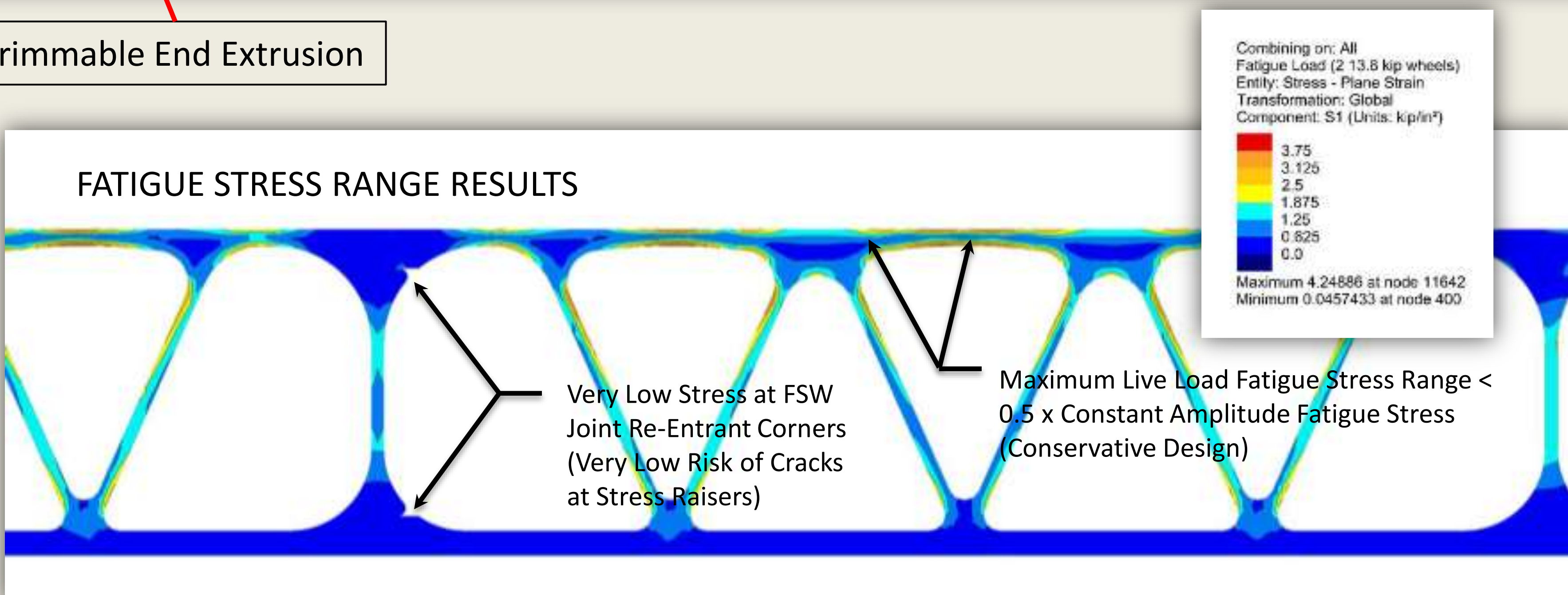
Male - Male

Gen II Finite Element Analysis Results

Conducted by Hardesty & Hanover



Trimmable End Extrusion



Gen II 5” Deep Deck
FDOT Panel Fabrication

Gen II 5” Deep Deck
FDOT Panel Fabrication

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FDOT Panel Fabrication

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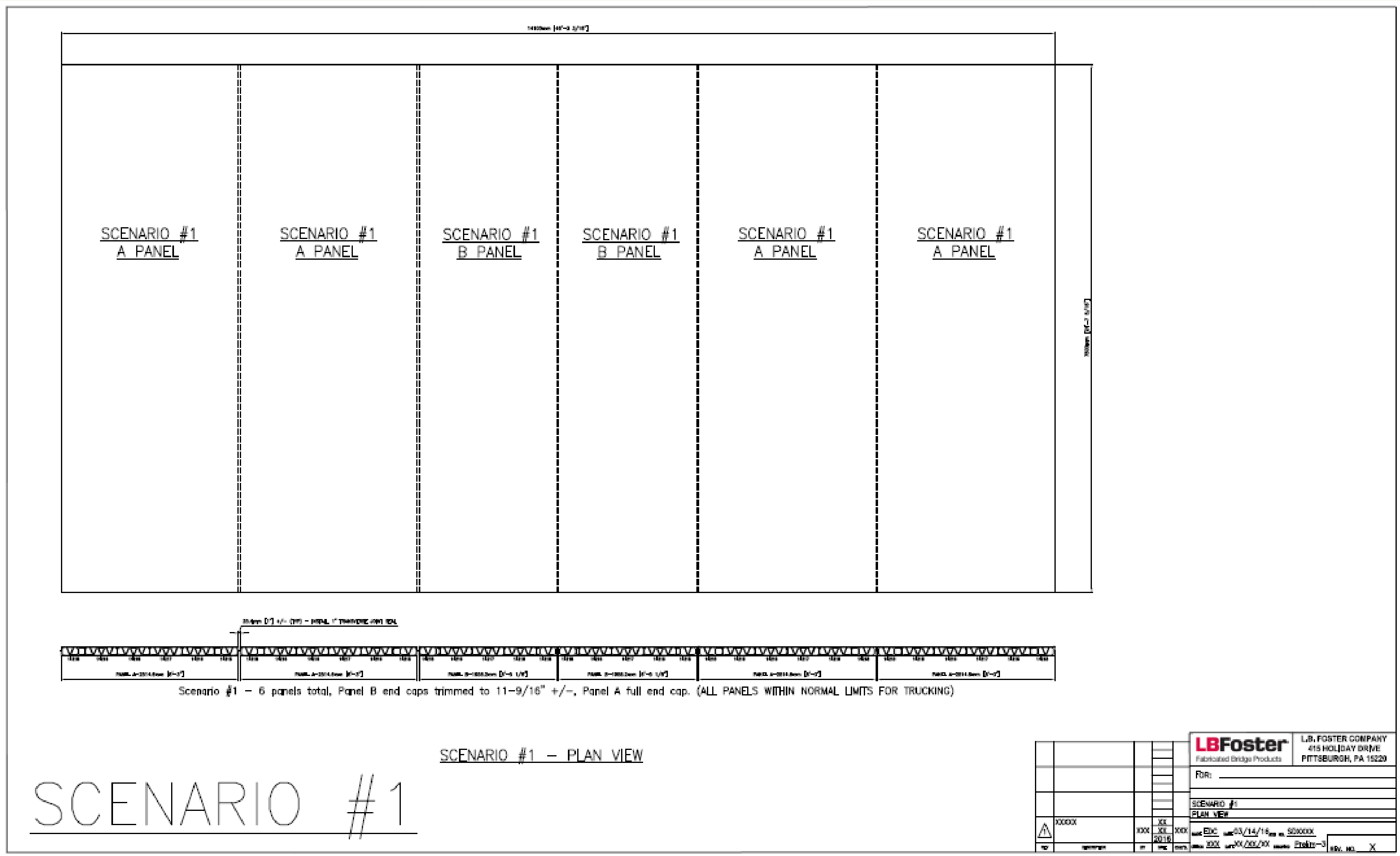
FDOT Panel Fabrication

Next MTQ Aluminum Deck Project

Metabetchouan Bridge



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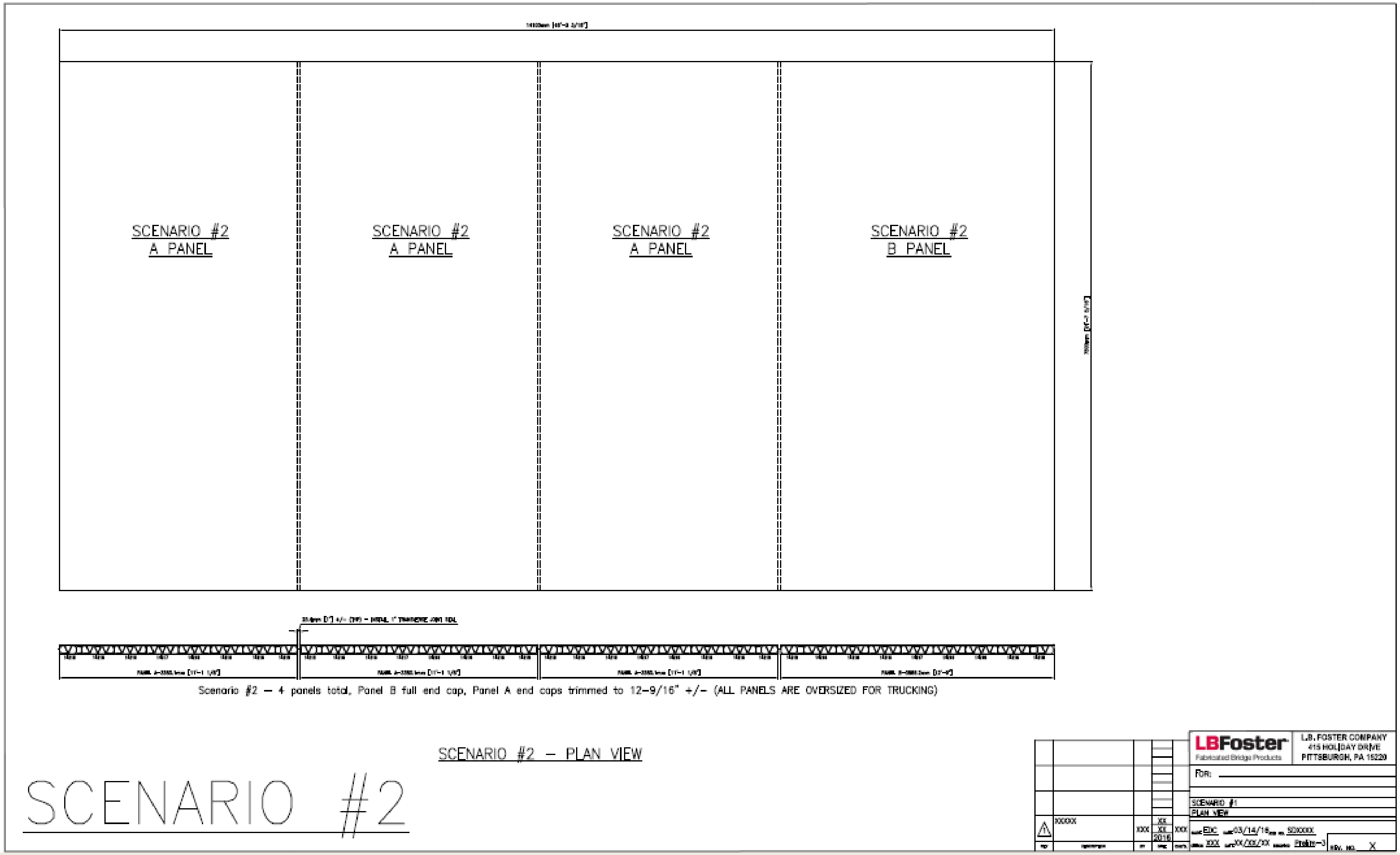
Next MTQ Aluminum Deck Project

Metabetchouan Bridge



Marine Parkway Bridge

Test Panel - MTA - NYC (5")

Ed Koch Queensboro Bridge
NYC DOT (5")

Aluminum-to-Steel with Zinc Coating

Electrical Potential

Metal or alloy	Potential (mV)
silver	-130
titanium	-150
nickel	-200
bronze	-360
copper	-360
steel	-610
cadmium	-700
aluminum (6063)	-740
zinc	-1130
magnesium	-1600

Because the difference between aluminum's potential (-740) and steel's potential (-610) exceeds 100 mV, galvanic corrosion is possible when they are in contact. Since aluminum's potential is less than steel's, aluminum can be corroded by this contact, while the steel is protected.

Corrosion Resistance

54-Year Aluminum-to-Steel Connection

Lightweight Bridge Deck RFP Template

- Performance-based bid template
  - No mention of aluminum
  - Similar templates for Roadway Asset Management already in use
  - Works well with design/build projects
- Avoids ‘sole-source’ concerns with proprietary/patented products
- Delivers ‘best value’ for bridge owners (technical proposal + price)
- Bid model reviewed and supported by FHWA


CONTRACT NUMBER
LIGHTWEIGHT PREFABRICATED BRIDGE DECK SCOPE OF SERVICES
(REV. 7-22-11)

PROJECT BACKGROUND AND CONSIDERATIONS

OBJECTIVES

Technical Proposal Criteria	Maximum Value
1. Contractor Experience and Capabilities	10
2. Service Life Expectancy	10
3. Live Load Carrying Capability	10
4. Structure Dead Load Characteristics	10
5. Initial and Long Term Quality	10
6. Corrosion	10
7. Ease of Maintenance	10
8. Speed of Construction	10
9. Skid Resistance/Rideability	10
10. Safety	10
Maximum Technical Raw Score	100

FHWA & VTRC Sponsored Evaluations

- http://www.fhwa.dot.gov/publications/publicroads/97spring/alum.cfm
  – FHWA article written by Bill Wright and published in *Public Roads Magazine*,1997 Spring Edition.
- http://www.virginiadot.org/vtrc/main/online_reports/pdf/99-r22.pdf
  – Article written by the Virginia Transportation Research Council regarding tests performed on Little Buffalo Creek Bridge.
- http://www.virginiadot.org/VTRC/main/online_reports/pdf/00-r5.pdf
  – Article on aluminum bridge deck built by Reynolds Metals Co. and written by VTRC.

Contact Info

www.alumabridge.com

AlumaBridge Video:

http://www.alumabridge.com/alumabridge_video.htm