Bridge Replacement Using Buried Bridges

SSSBA Learning by Example Webinar Series

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Presentation Outline

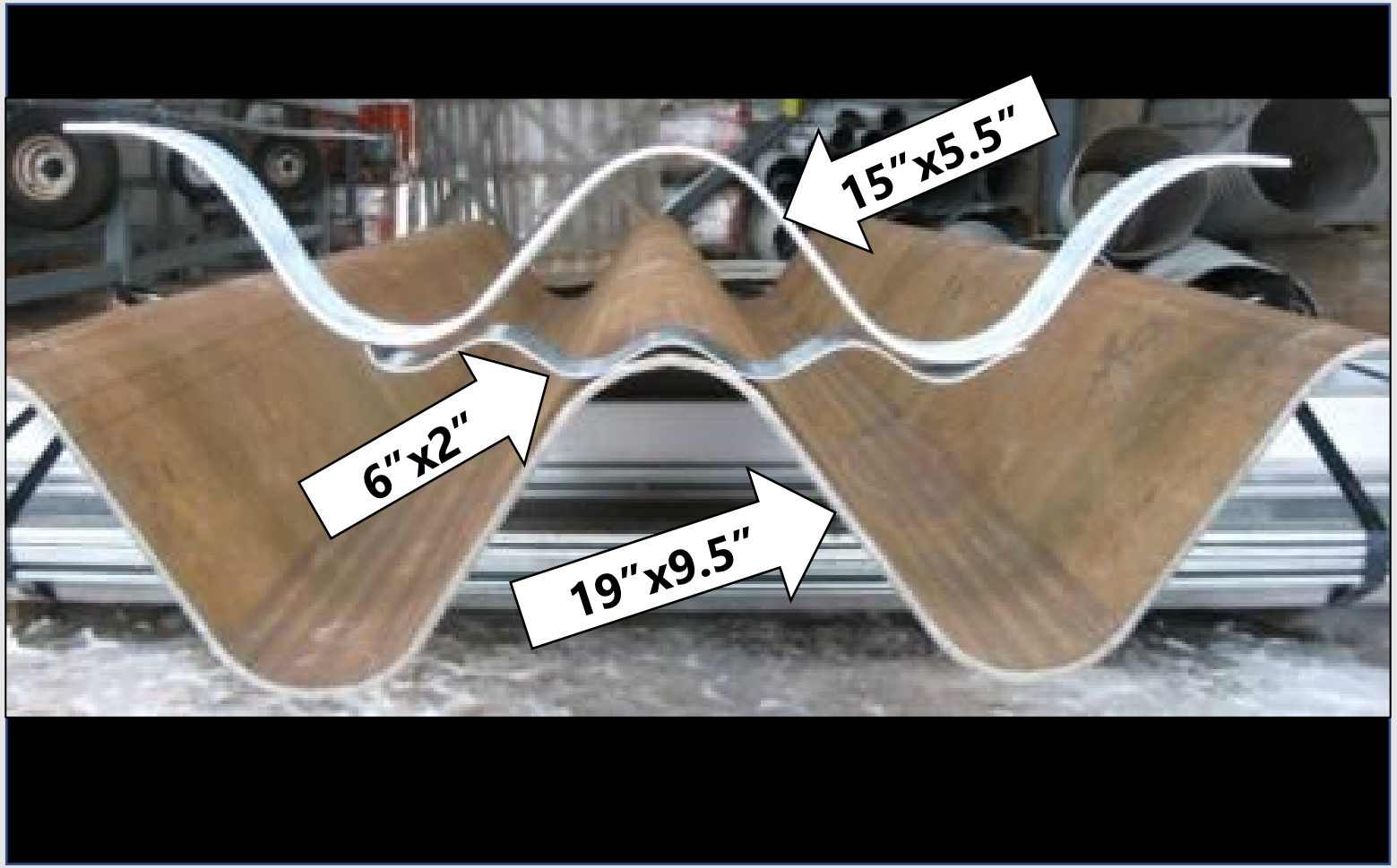
- Buried Bridges Introduction
  - Definition, materials, applications & advantages
  - Evaluation as alternative to conventional bridge
- Case Studies
  - Lawrence Road Bridge Replacement – Gray, Maine
  - St Johnsbury Bridge – St Johnsbury, Vermont
  - Project Snapshots

Buried Bridge Introduction

- >20’ span buried structure that works with granular backfill to support loads through soil-structure interaction
- Flexible & able to accommodate differential movement
- Subject of TRB, NACE, SSSBA, DOT webinars, conference sessions, & workshops – design, ABC, resilience, durability / service life, large span applications, load rating, low volume roads
- Meets all AASHTO LRFD materials, design, construction, and load rating requirements and is not proprietary. Analyzed using FEA.

Flexible Buried Bridge Materials

- Shallow Corrugated Steel Structural Plate (6” x 2” profile)
- Aluminum Structural Plate (9” x 2.5” profile)
- Deep Corrugated Steel Structural Plate (**15” x 5.5”** & 19” x 9.5” profiles)
- Deep Corrugated is ~9x stiffer than shallow corrugated & 6.25x stiffer than aluminum
- Deep Corrugated is ~33% stronger than shallow corrugated & ~100% stronger than aluminum.
- Differential settlement tolerance of ~6” over 50 ft.

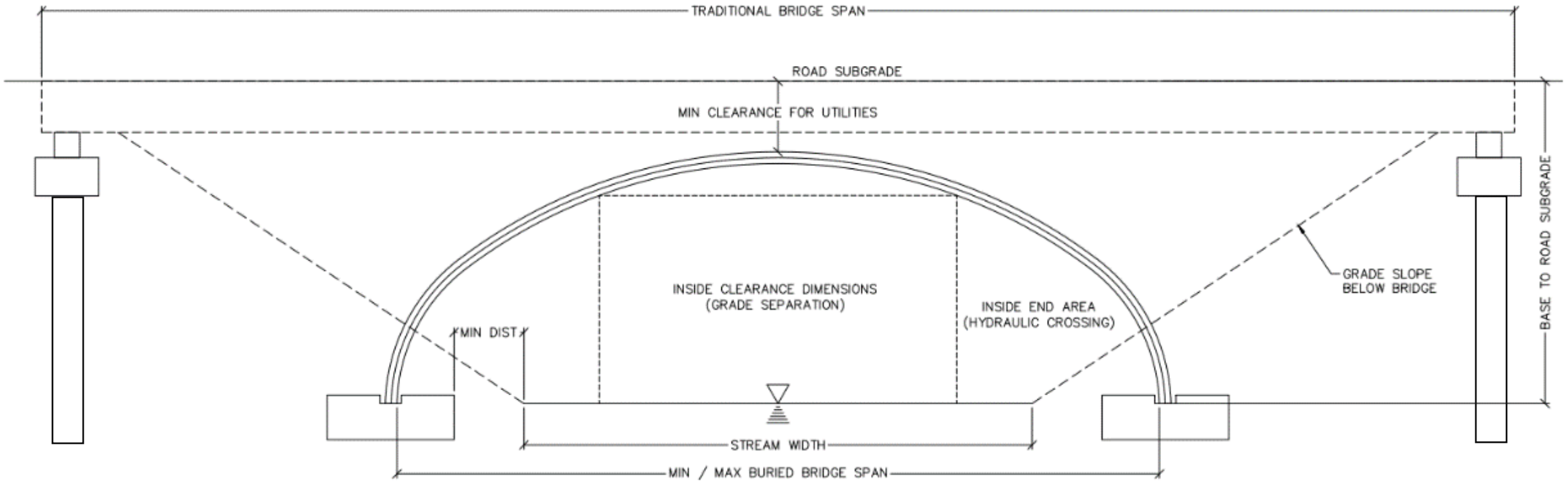


Advantages & Applications

- Wildlife Crossings / AOP
- Value Engineered Solutions
- Grade Separation
- Challenging Geotechnical Conditions
- Bridge Replacement / Rehabilitation
- Structurally Redundant / Resilient
- Single Span Alternative to Multi-Cell Crossings

- Lower Cost Foundations
- Emergency / Temp / Detour Bridges
- No “Bump at the end of the bridge”
- Reuse Bridge Foundations
- Staged Construction
- Low Maintenance Cost & Easy to Inspect
- Able to Carry Heavy Loads

Evaluation as a Conventional Bridge Alternative



SITE CONDITIONS & CONSTRAINTS

https://www.shortspansteelbridges.org/flexible-buried-bridges-part-1/

Case Studies

- Lawrence Rd Bridge Replacement – Gray, Maine
- St Johnsbury Bridge Replacement – St Johnsbury, Vermont
- Additional Projects

Lawrence Rd. Bridge Replacement
Gray, Maine

Custom Box Structure
28’1½ ” span x 6’ 3½ ” rise

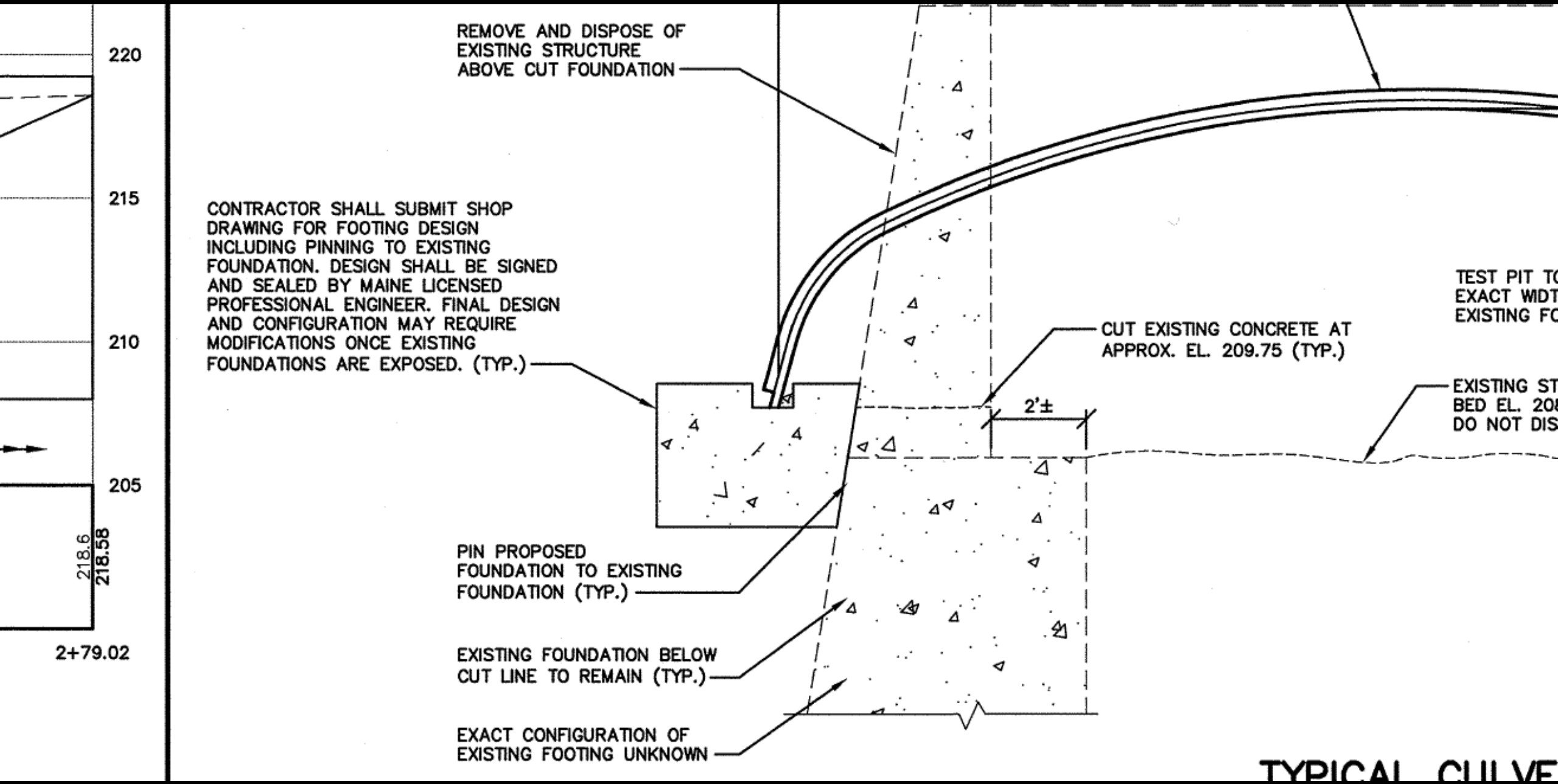
Design Considerations:

- **Short span bridge replacement**
- **Height limitations**
- **Bridge foundations to remain**
- **New headwall configuration**

Existing Bridge


Existing Bridge

Foundation Detail



Getting Started


MATSU


Backfilling & Headwalls


KOMATSU
MACK
DEERE
No Walers or Deadmen

VT Route 2B Bridge Replacement
St. Johnsbury, Vermont

47’11” span x 26’9” rise Arch

- **Replacement for 139 ft 3-span steel & concrete bridge built in 1936**
- **Sized for AREMA clearance**
- **28 day max. trail closure / 50 day road closure for all work**
- **1.5 days for assembly by first time contractor, open to public in 45 days**
- **Incorporated MSE precast panel headwalls on curve.**
- **Used precast footings – sized to match anticipated settlement of approach embankments.**


CAT
Genie S-40
Genie S-40
CAT
336E


CAT
8050

Thank You!

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Case Study Slides:
https://www.shortspansteelbridges.org/wp-content/uploads/2022/09/I44-Missouri-Buried-Bridge-Joel-Hahm-Contech.pdf

Case Study Video:
https://www.youtube.com/watch?v=FmGANs1Wqz0&t=4s

Bonus Material that didn’t make the cut


Findlay, Ohio 48’ x 21’
I-75 Bridge Replacement, Staged Construction
Genie

Randolph, Nebraska 50’ x 17’
Grade Separation with E80 Loading

Houston, Texas
Phased Construction
Recycled Concrete Backfill
Architectural Requirements


LaCygne, Kansas 53’ x 25’
Grade Separation


Topeka, Kansas
Reline of 40’ span x 200’ long concrete arch under I-70

Laguna Niguel, California
Twin 39.7’ span x 13.2’ rise Buried Bridges
Hydraulic Improvements & Signature Entrance to City Park


Skagway, Alaska 75’x25’
75’ cover with RCC


Knox County, Indiana 53’ x 24’
E80 Loading
JEPX
243


Irvine, California
Pedestrian Crossing, Sustainable Construction


Greensboro, South Carolina 53’ x 25’
Significant Settlement of Backfill

Durability & Service Life

- **Buried bridges typically have no invert**
- **50% more galvanizing than CSP and are available in much higher steel thicknesses**
- **Electrochemical requirements apply for soil & water *in contact with* the structure – not necessarily site soil conditions.**
- **Use same backfill electrochemical requirements as those in AASHTO LRFD Design Section 11.10.6.4.2 for MSE walls:**

  - pH = 5 to 10
  - Resistivity ≥3000 ohm-cm
  - Chlorides ≤100 ppm
  - Sulfates ≤200 ppm
  - Organic Content ≤1 percent

- **Added features/detailing like splash walls, secondary coatings, barriers, etc. can limit exposure.**
- **Design considerations (site conditions, foundations, grading, proper hydraulic design, etc.) & quality of construction can have a significant impact on service life.**
- ***Service life primarily depends on proper design & installation, maintenance, and what structure is exposed to. End user (owner) has greatest impact on and control over service life.***

Material & Design Properties

- **Material properties provided in AASHTO M167 / ASTM A761**
- **Design properties provided in AASHTO LRFD Section 12 (Appendix A12)**
- **Construction specifications in AASHTO LRFD Section 26**
- **Thicknesses up to 0.380” thick.**
- **Hot dipped galvanized with 3.0 oz/ft^2 coating weight (50% more than CSP)**
- **¾” or ⅞” diameter high strength steel bolts (ASTM A449)**

Property	Aluminum (ALSP)	Shallow Corrugated Steel	Deep Corrugated Steel
Geometry Types	Small arch, box, closed shapes	Arches, closed shapes	Arch, box, pipe, multi-radius arches
Corrugation Profile	9” x 2.5”	6” x 2”	15” x 5.5”
Design Yield Strength	24 ksi	33 ksi	44 ksi
Relative Stiffness	~1.5 x shallow	1 (baseline)	~9 x shallow ~6.25 x ALSP