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A QUIKRETE® COMPANY

Structural Plate North Dakota

Tim Miller

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Presentation Agenda

- Structural Plate History
- Structural Plate
  - Design Life
  - Installation
- Inspect/Assess
- Fix
  - Invert Repairs
  - Extensions
  - Buried Bridge
  - Reline/rehabilition

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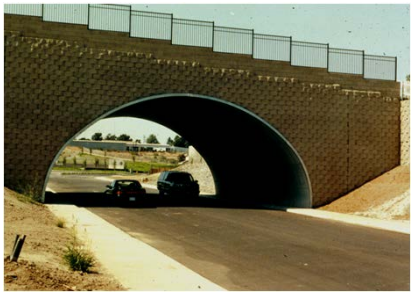
Structural Plate

85 years of use in critical highway applications



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Structural Plate

STEEL

BRIDGECOR / MULTI-PLATE / SUPERSPAN

Railroad Rehabilitation

Alaska DOT

ALUMINUM

ALUMINUM STRUCTURAL PLATE
ALUMINUM BOX CULVERT

Residential Development

Golf Course Community

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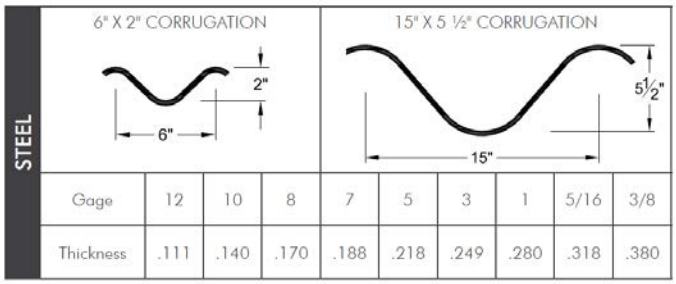
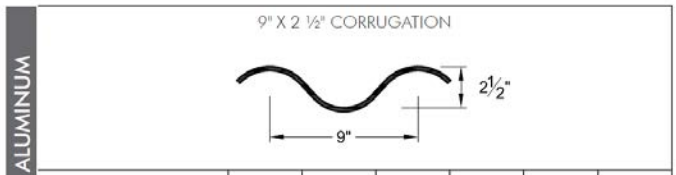
Plate Corrugations

STEEL



Gage	12	10	8	7	5	3	1	5/16	3/8
Thickness	.111	.140	.170	.188	.218	.249	.280	.318	.380

ALUMINUM



Thickness	.125	.150	.175	.200	.225	.250

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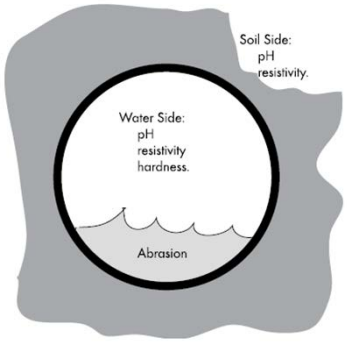
Structural Plate Durability



Controlling Factors
- pH
- Resistivity
- Hardness

When to Use Steel or Aluminum?

STEEL (50 Year Life):
6.0 ≤ pH ≤ 10.0
Resistivity > 2,500 ohm-cm
Hardness > 300 mg/L

ALUMINUM (75 Year Life):
4.0 ≤ pH ≤ 9.0
Resistivity > 500 ohm-cm
Hardness < 300 mg/L

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Structural Plate Durability – Galvanized Steel

NCSPA STEEL: PROVEN 100-YEARS STRONG

SERVICE LIFE CALCULATOR

Service Life Calculator (Plate) – Beta Version

Gage: 12	N/A
Gage: 10	N/A
Gage: 8	N/A
Gage: 7	89 Years
Gage: 5	99 Years
Gage: 3	100 Years
Gage: 1	100 Years
Gage: 5/16	100 Years
Gage: 3/8	100 Years

Desired Service Life (Years): 75

Resistivity (Ohm-cm): 2000

pH: 6

Abrasion Level: Level 3: Moderate Abrasion

Plate and CSP estimator on website

Based on CALTRANS/AISI studies of CSP

Buried bridges designed without inverts
- Improves overall durability
- Eliminates potential invert corrosion
- Quality backfill aids in durability

Steel structural plate – 50% more galvanized coating

Post applied coatings aid in extending service life
- Polymers, Asphalt, Concrete Paving, etc.

Impermeable membranes over structure
- Minimize water migration
- Shed de-icing chemicals

NCSPA.org for Service Life Calculator

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Durability - Hot Dip Galvanizing Steel PLATE

Galvanized Steel MULTI-PLATE requires a pH between 6 – 10 and resistivity between 2000 – 8000 ohm-cm for a minimum 50 year design life.

There are many technics used to increase the service life of Hot-Dip Galvanized Structures
1) Design an open bottom arch on concrete footings.
2) Increase the steel thickness of the invert plates
3) Field Poured concrete paved inverts add 30 + years of service life
4) Clean, free draining aggregate backfill if soil side corrosion is a concern
5) Membranes above the crown in heavy salted road with minimum cover

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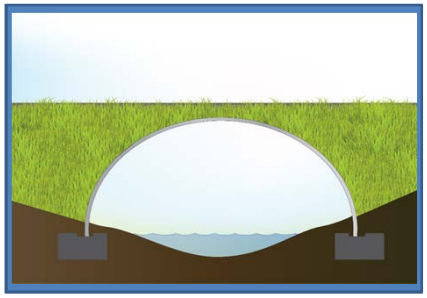
Durability Benefits of Clear Span



Improves Long Term Durability

- No Invert - Keep normal flows away from structure
- Exposure to high flows for short duration
- Free draining backfill
- Clear span sensitive wetlands

BridgeCor

- Deep corrugated metal structures
  Spans up to 80'
  AASHTO approved
  9X stiffer than MULTI-PLATE
  Accelerated construction methods

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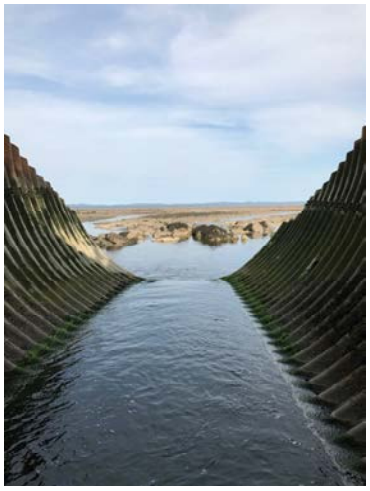
Structural Plate Durability – Aluminum



- **Metal oxide film**
  - Pit rate can be estimated at 1 mil/yr.
  - Ex.: 0.100" thick plate/ 0.001"/yr = 100 year design life
- **Excellent abrasion resistance**
  - Metal oxide film is not a coating
- **Excellent saltwater performance**

Bay of Fundy US Rte 1 Robbinston, ME

- 1966 install
- Saltwater environment
- No metal loss

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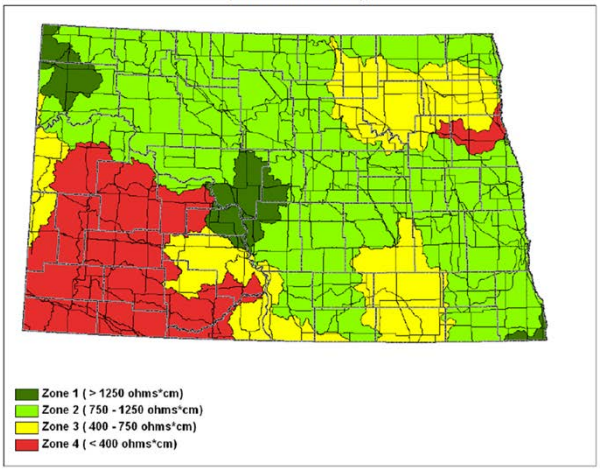
SECTION V-05 Pipe Material Selection
Page 12 Revised 1/26/16

Corrosion Zone Map & Tables

North Dakota Corrosion Zones (Map 1)
(Based on Soil Resistivity)



Data Source: United States Environmental Protection Agency's (EPA) Environmental Monitoring Assessment Program.

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Corrosion Table: 4a

- Mainline Drainage -
(Design Service Life - 75 Years)

Pipe Material		Corrosion Zone Zone 1	Zone 2	Zone 3	Zone 4
Concrete Pipe (Section 830.01)		Y	Y	Y	Y
Metal Pipe (Section 830.02)	Gauge				
Zinc Coated Corrugated Steel	16 ga.				
	14 ga.				
	12 ga.				
	10 ga.	Y			
	8 ga.	Y	Y		
Aluminum Coated Corrugated Steel (Type 2)	16 ga.				
	14 ga.				
	12 ga.	Y			
	10 ga.	Y	Y		
	8 ga.	Y	Y	Y	
Polymeric Coated Steel (over Zinc or Aluminum Coated Steel)	16 ga.	Y	Y	Y	Y
	14 ga.	Y	Y	Y	Y
	12 ga.	Y	Y	Y	Y
	10 ga.	Y	Y	Y	Y
	8 ga.	Y	Y	Y	Y
Structural Steel Plate Pipe (Zinc Coated)	16 ga.				
	14 ga.				
	12 ga.				
	10 ga.	Y			
	8 ga.	Y	Y		
Aluminum Alloy Structural Plate Pipe	16 ga.	Y	Y		
	14 ga.	Y	Y		
	12 ga.	Y	Y		
	10 ga.	Y	Y		
	8 ga.	Y	Y		

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Structural Plate Shapes

Shapes		Sizes=Span x Rise
Round		5' to 50'-6"
Vertical Ellipse		4'-8" x 5'-2" to 25' x 27'-8"
Underpass		12'-2" x 11'-0" to 20'-4" x 17'-9"
Pipe-Arch		6'-1" x 4'-7" to 20'-7" x 13'-2"
Horizontal Ellipse		7'-4" x 5'-6" to 14'-11" x 11'-2"
Arch (single radius)		6' x 1'-10" to 54'-4" x 27'-2"
Arch (2-radius)		18'-5" x 8'-4" to 50'-7" x 19'-11"
Low-Profile Arch*		19'-5" x 6'-9" to 45'-0" x 18'-8"

High-Profile *		20'-1" x 9'-1" to 35'-4" x 20'-0"
Horizontal Ellipse		19'-4" x 12'-9" to 37'-2" x 22'-2"
Pear- Arch		23'-11" x 23'-4" to 30'-4" x 25'-10"
Pear		23'-8" x 25'-5" to 29'-11" x 31'-3"
Box Culvert		8'-9" x 2'-6" to 35'-3" x 13'-7"
Elliptical/Circular Arch **		12' to 102'
H-20 Bridge ** Pedestrian **		spans up to 300' spans up to 300'

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Freight Economy

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Multiplate Installation

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Aluminum Installation

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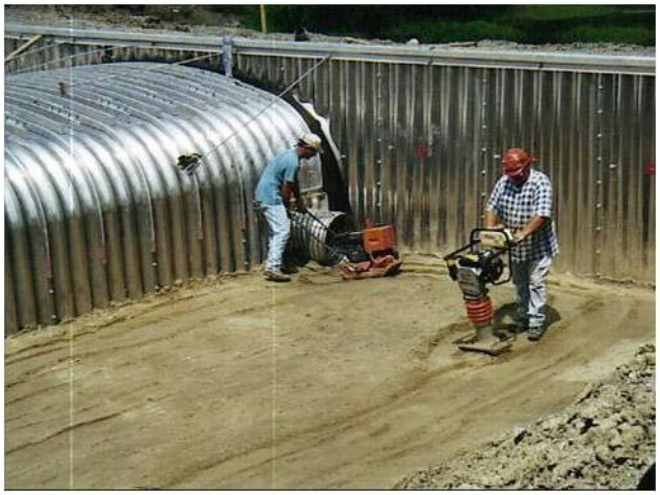
Preassemble In Shop or Out of Stream

Backfill with aggregate to proper density

AASHTO A-1, A-2-4, A-2-5, A-3 aggregate.
Compact symmetrically on each side. 8” – 10” loose lifts
compacted to a minimum 90% density per AASHTO T180.



Inspection

1. Get access to culvert
2. Check dimensions and shape
3. Location of issues (Corrosion at invert or other locations)
4. Deformation
5. Count number of plates and bolt holes circumferential
6. Take pictures

1960's plate install Grand Forks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Assessment and Issue

1. Abrasion Invert
2. Soil side corrosion
3. Water Corrosion
4. Improper Backfill Used or Compaction

1961 Install Near Dickinson


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Fix

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1. Invert Concrete Paving per FHWA Standards
2. Allowable Deflection
3. Reline or Rehabilitation Option
4. Open Cut Replacement

Invert Paving

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1961 Plate Installed

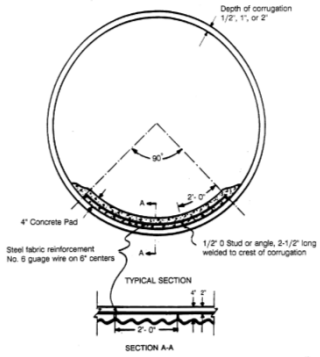

Plate Extensions

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Bid Alternates

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Bid Alternates - Multi Plate and RCB

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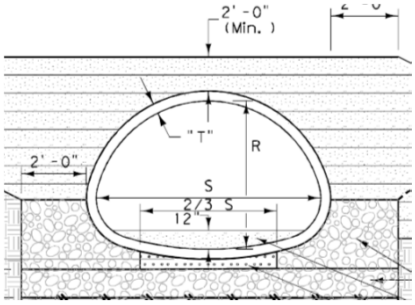
MDT Bid Alternates

Design Requirements:

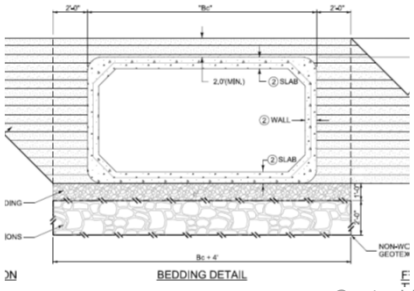
- Both meeting same design life per MDT
- Same hydraulic capacity and load requirements (HL93)

Bid Options for 106' Structure:

- 12' x 6' RCB
- 13'-3" span 9'-4" rise Multi Plate Pipe Arch



FRONT ELEVATION



BEDDING DETAIL

Aluminum Box Structures

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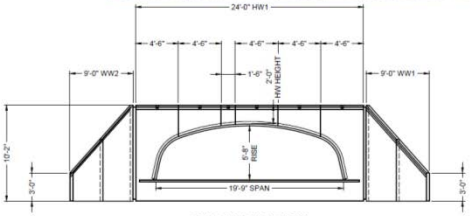
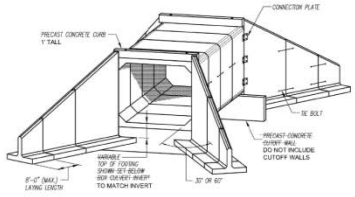
Bid Alternates – RCB vs ALBC



END ELEVATION

SINGLE CELL FLARED END



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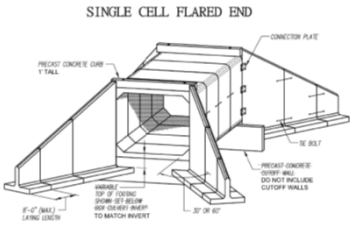
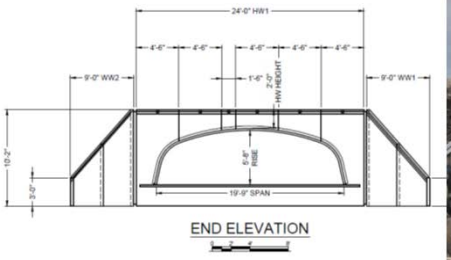
Project Case Study – Bid Alternates

Fremont County RCB vs ALBC

- 100 Year Life Expectancy (PH 5-9 and Resistivity > 500 Ohm-cm
- 210 LF 18x5 RCB Headwall and Wingwalls
- **ALBC Bid $75k less than concrete box**
- **Low bid came in $377k and the engineers estimate was $671k**
- **$294k under engineers estimate (44%)**





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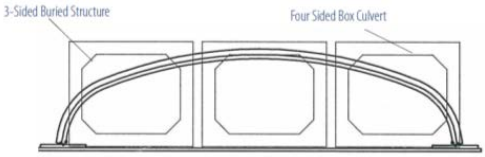
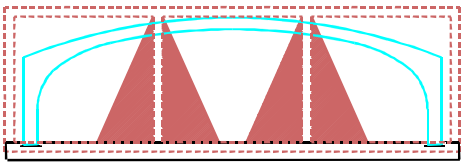
Buried Bridge vs. Culverts



CULVERTS CONVERT TO BURIED BRIDGES

- Complete system with headwalls, wingwalls and foundations
- Bottomless structure promotes natural aquatic habitat and fish/wildlife passage
- Maintenance-free structure lowers overall life cycle cost
- Project specific design to handle all loading requirements
- Long clear spans promote improved hydraulics while minimizing pier blockage



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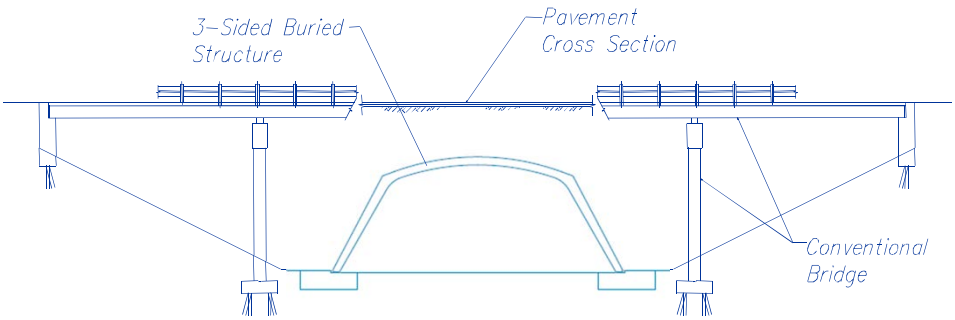
Buried Bridge vs. Bridge At-Grade



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Reline, Rehab, Liner Plate

PLATE PRECAST TUNNEL LINER PLATE

Bridge Reline

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3

Bridge Reline

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Reline

SR-10 – Emery County, UT
Owner – UDOT

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Bid Alternates – Bridge or Culvert

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Plate Strength 120’ cover

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Aluminum Box Structures – Williston ND

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Buried Bridge

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Working with Contech

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Questions?

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