


Basic Structural Considerations

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## Culverts - Basic Structural Considerations

<https://m.youtube.com/watch?v=NTbhyHNA1Vc>

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## Introduction

- ~ 6000 bridge size culverts in Alberta
- Two types of culverts:
  - Rigid Structures (concrete or timber)
  - Flexible Structures (corrugated metal)

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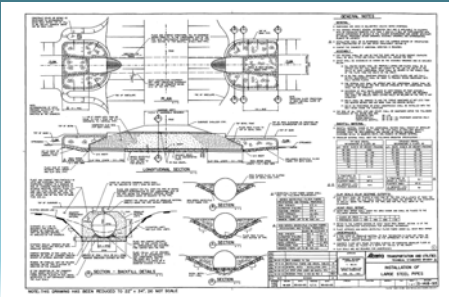


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[Std. Drawing S1418](#)



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## Rigid Structures

- Concrete (5%) – either box or pipe
- Timber (1%) - no longer being built
- No noticeable deflection under loads
- Concrete is a durable material
- Concrete is relatively expensive

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## Rigid Structures

The diagram illustrates a rigid structure under various forces. A truck is shown on the road surface above the structure. Vertical forces from the earth and truck act downwards on the top of the structure. Horizontal forces from the earth act from the sides. Vertical forces from the foundation pressure act upwards at the base. A 'ZONE OF HIGH STRESS' is indicated at the base of the structure, where 'STRONG FOUNDATION SUPPORT REQUIRED'. A note states 'QUALITY OF BACKFILL NOT ESSENTIAL TO INTEGRITY OF THE STRUCTURE'. Other labels include 'ROAD SURFACE', 'COVER', and 'RIGID STRUCTURE'.

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## Flexible Structures

- Metal Culverts comprise 94%
- Fabricate to almost any shape
- Relatively cheap
- Backfill & Installation CRITICAL
- Susceptible to structural problems
- Prone to corrosion, abrasion

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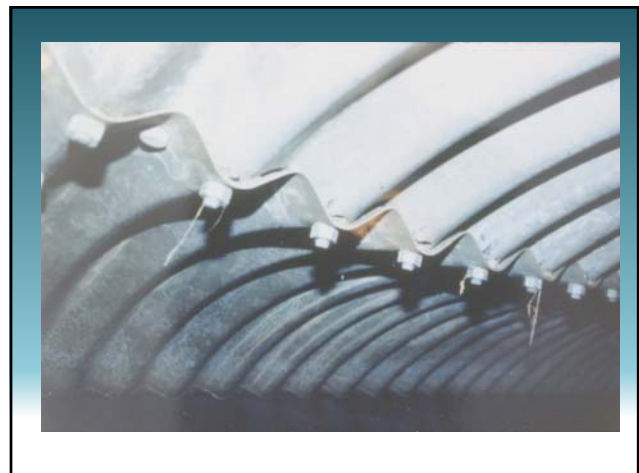
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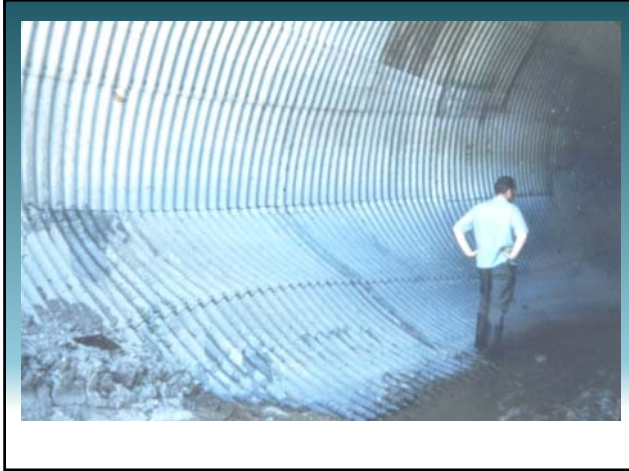
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## Flexible Structures

The diagram shows a 'SECTION THROUGH ROUND METAL CULVERT'. It illustrates how a flexible structure deforms under load, creating a 'SOIL ARCH' above it. This arching provides 'PASSIVE RESISTANCE' and reduces the load on the structure. The 'ZONE OF HIGHEST STRESS' is shown at the top of the structure. Other labels include 'ROAD SURFACE', 'COVER', 'VERTICAL FORCES (EARTH & TRUCK)', 'HORIZONTAL FORCES (EARTH)', 'RIGID STRUCTURE', 'ZONE OF HIGH STRESS', 'STRONG FOUNDATION SUPPORT REQUIRED', and 'COMPETENT FOUNDATION REQUIRED'. A note states 'SOIL ARCH (GOOD QUALITY WELL COMPACTED GRANULAR MATERIAL) IS ESSENTIAL TO THE INTEGRITY OF THE STRUCTURE'. Other labels include 'ROAD SURFACE', 'COVER', 'VERTICAL FORCES (EARTH & TRUCK)', 'HORIZONTAL FORCES (EARTH)', 'RIGID STRUCTURE', 'ZONE OF HIGHEST STRESS', 'STRONG FOUNDATION SUPPORT REQUIRED', and 'COMPETENT FOUNDATION REQUIRED'.

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### CSP (field jointing)

The diagram illustrates the field jointing of Corrugated Spiral Pipe (CSP). It shows two cross-sections of the pipe. The top section shows a single ring with labels for 'Re-rolled End', 'Spiral Corrugation', and 'Ring Length'. The bottom section shows two rings joined together with a 'Coupler' and a 'Circumferential Seam'. The 'Ring Length' is also labeled for the second ring.

Alberta  
Transportation

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Bridge Inspection and Maintenance

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## Flexible Culverts

- Two Types:
  - Corrugated Steel Pipe (CSP)
  - Structural Plate Corrugated Steel Pipe (SPCSP)



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## Basic Structural Considerations

## Corrugated Steel Pipe (CSP)

- Complete rings fabricated in plant
- Rolled helical sections, re-rolled ends
- Joined by couplers
- Bridge sizes range from 1500 to 3600
- Common sizes 1800 to 3000 (in 200mm increments)
- Length to suit transportation (2.5 to 15.0m)



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## CSP Properties

- Common Thickness
  - 2.8mm, 3.5mm, 4.2mm
- Common Profiles
  - 68mm (Pitch) x 13mm (depth)
  - 76mm X 25mm, and 125mm X 26mm



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## Structural Plate Corrugated Steel Pipe (SPCSP)

- Flat plate is corrugated & punched
- HD galv. then curved to shape
- Five thickness – 3, 4, 5, 6, and 7mm
- Profiles - pitch x depth
  - 152 x 51
  - 380 x 140
  - 400 x 150
- Plates bolted together



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## SPCSP (cont.)


- Plate lengths
  - 3050mm (10 ft)
  - 3670mm (12 ft)
- Plate width 5N, 6N, and 9N
 

N is the circumferential bolt spacing  
 $N = 3\pi$  (244mm or 9.6")  
 $N/\text{ring} = 4(\text{dia. in feet})$   
 (i.e. 10ft dia = 40N)

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## SPCSP - some recent products

- Atlantic Industry's 'Bolt-a-Plate'  
width 1067, length 3N to 16N
- Twister Pipe's 'MP 200'  
pitch 200, depth 55mm
- SuperCor, and Bridge Plate  
(pitch 380, depth 140)
- New coating systems

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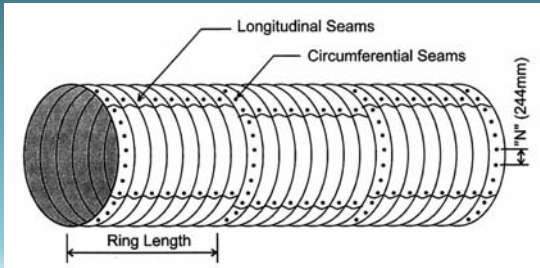
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## SPCSP (field bolting)




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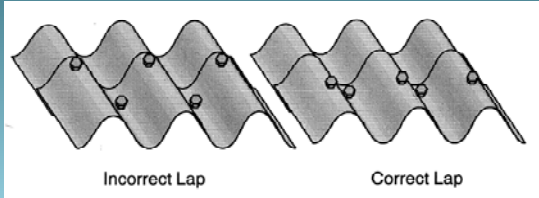
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## SPCSP (longitudinal lapping)




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## Properly Lapped Seam

Bolt in valley is nearest visible edge





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## Improperly Lapped Seam

Bolt in valley is farthest from visible edge





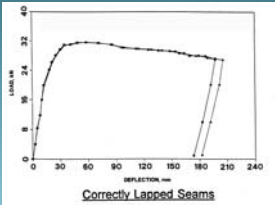
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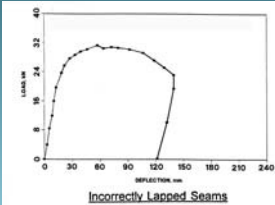
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## SPCSP (seam strength tests)




Correctly Lapped Seams




Incorrectly Lapped Seams

Both types of laps can carry about the same load  
Correctly lapped seams are more ductile - don't normally develop cracks




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# Questions??



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