A New FRP Solution for Reconstruction of Deteriorated Pipes and Culverts

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PipeMedic by QuakeWrap
Introduction

➢ Tomorrow (12:30) presentation about FRP Wet-Layup
➢ A new type of fully-structural liner
  ➢ Pre-manufactured pipe used in slip-lining
  ➢ Applied directly on the host pipe
Genesis of Invention

➢ Wet-Layup:
  ➢ Carbon FRP applied for hoop strength
  ➢ Usually 1-3 layers is enough
  ➢ Costs about $300/m²/layer >> $300-$900/m² of pipe surface

➢ Some clients are asking for fully structural liner
  ➢ Buckling or ring stiffness controls the design
  ➢ Increase thickness and moment of inertia of cross section
  ➢ Adding many layers of carbon >> Cost prohibitive

➢ Develop a sandwich construction pipe
Composite Sandwich Construction

Steel I-beam

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Stiffness</td>
<td>1</td>
</tr>
<tr>
<td>Weight (Pounds/ft²)</td>
<td>0.910</td>
</tr>
</tbody>
</table>
Ring Stiffness (**ASTM D2412**)

![Image of test equipment and graph showing Load Vs Deflection for Specimens 1 to 5.](image-url)
Charpy Impact Test *(ASTM D2444)*

Avg. absorbed energy = 162 N-m 
(for annealed steel = 161.3 N-m)
Over Burden Pressure Test

Deflection Vs Applied Over Burden Load

- LVDT1-12:00
- LVDT2-3:00
- LVDT3-6:00
- LVDT4-9:00

Deflection, mm

0.00  0.50  1.00  1.50  2.00  2.50  3.00  3.50  4.00  4.50  5.00  5.50  6.00  6.50  7.00  7.50  8.00  8.50  9.00  9.50  10.00

Applied Over Burden Load, MPa

psf 0.0  1000  2000  3000

0.00  0.04  0.08  0.12  0.16  0.18
Awards

ASCE 2016 Innovation Award
American Society of Civil Engineers

StifPipe™: winner of 2016 ASCE Innovation in the category “Green Engineering”
StifPipe® Construction

- Walls of this pipe are made with a lightweight honeycomb core that is sandwiched between carbon or glass fabric.
- Internal fabric layers (usually carbon) are designed to take the internal pressure of pipe.
- Honeycomb and outer glass fabric provide rigidity for pipe.
- Can be easily made to any shape and size.

Used for:
- Slip-lining deteriorated pipes.
- As a wet layup system built directly on deteriorated pipes using the existing pipe as the mold.
Gillies Road Culvert
Cairns, QLD
Gillies Road Culvert
Cairns, QLD
Gillies Road Culvert
Cairns, QLD
Non Circular Shapes

➢ Egg-Shaped
➢ Oval-Shaped
➢ ........
Aguirre Power Plant, PR

- Pipe network 24-60 in. (600-1500mm)
- Operating P= 150-200 psi (1-1.4 MPa)
- Pipe risers throughout
- 2015: One lid dislodged – 100-ft (30 m) away
Structural Design Criteria

- Class IV Structural Liner
- External pressure from traffic & soil
- Internal design pressure of 400 psi (2.8 MPa)
- 35” OD pipes to fit into 36” ID host pipes
- 3’-10½” long to cover 4’-0” section
- 1 Layer of chopped strand mat
- 2 Layers of TU27C
- 1 0.31-inch spacer sheet
- 2 Layers of VB26G
Aguirre Power Plant, PR
Field-Applied StifPipe®

Recent Project in Minneapolis:
➢ Tunnel Dia. 3.6 m (12-ft)
➢ Buried 46 m (150-ft)
➢ Access through shaft
➢ 1200 m (4000-ft) Distance
   ➢ 2 layers of glass
   ➢ 20mm core
   ➢ 4 layers of CFRP
Onsite-Manufactured InfinitPipe®
Questions?

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