SUCCESSFUL INSTALLATION OF CFRP AND GFRP ON PIPE BRIDGES IN SCOTLAND, UK

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OUTLINE

Project Background

Introduction to FRP

Engineered Solution

Installation

Inspection

Conclusion

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Client: Scottish Water
Alliance Partner: Amey Black & Veatch
Contractor: Environmental Techniques

The site is located within Calderbraes Golf Club, located just off Roundknowe Road, 2km northwest of Uddingston, South Lanarkshire.

- 900mm OD Steel Pipe
- 235m overall length
- 4 Nr. Manholes
- 11 Nr. Piers
- 2Nr. River crossings
- Signs of corrosion
- Alongside a golf course
Reasons for Strengthening

- Corrosion
- Structural Failure
- Leaks

- Pollution
- Environmental Issues
- Poor image
Traditional Replacement

- Flows of 850l/s
- 20 Weeks of Overpumping
- 500m of hoses
- £500k for temporary pumping station
- High Risk of Environmental incident occurring
• Fiber Reinforced Polymers (FRP)
  o Reinforced fiber (carbon or glass)
  o Epoxy Resin

• FRP Rehabilitation
  o Pipes
  o Buildings
  o Bridges
INTRODUCTION TO FRP SYSTEMS

CFRP: Close Up
Comparison of Mechanical Properties
Advantages of an External Repair

1. Pipe diameter is not an issue
2. Pipeline can remain in service during installation
3. Design can be a fully structural solution
4. No impact to flow
5. Emergency repairs can be accommodated
6. Repair length can be varied based on requirements (local or continuous repairs)
7. Installation time is typically 25 percent less
• **Hoop Direction**

- Burst Pressure
- Pipe Deflection
- Constrained Buckling

• **Longitudinal Direction**

- Poisson’s Effect
- Temperature Change
- Thrust Loading
- Beam Bending
ENGINEERED SOLUTION – SPECIAL DETAILING

Flange Connections

Legend
- CFRP Wrap
- CIPP
- P01 Pier
- J01 Joint
- FC01 Flange Connection
- REP01 Repair
- FC REP Flexoax Coupler

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Flange Connections

Expansion Joint

Steel Straps

4:1 Slope of Epoxy Mortar

CFRP System

(E) Steel Clamp

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• Requirement to maintain golfers access to the 7th green – throughout the installation
• Due to remote location of the pipeline, safe access needed to be created whilst minimizing the environmental impact
• Set-up of external scaffolding
• Encapsulation of the pipe during the installation
  o Due to lead in the existing paint coating
  o Ensure proper cure of CFRP
  o Environmental protection during the installation
Step 1: Surface Preparation

Step 2: Installation of GFRP/CFRP System

Step 3: Finish System applied
Shore D Hardness Testing

- Measures Cure of FRP System

Witness Panels

- One layer of the GFRP and CFRP System
- Preparation of panels spread throughout construction
- Testing per ASTM D3039
- Confirms design assumptions
235 meters of pipe rehabbed
25% less time compared to traditional
Extended Life by 60 years
10% Cheaper
QA/QC Program
Saltire Civil Engineering Awards 2019

Roundknowe Overland Sewer Rehabilitation Entry for Scottish Civil Engineering Award 2019

WINNER – 2019 SALTIRE CIVIL ENGINEERING AWARD