Glass-Polymer Composite High Pressure Pipes and Joints - Design, Manufacture & Characterize

Ben Imes, Hota V. S. GangaRao, Udaya B. Halabe
Constructed Facilities Center
Department of Civil and Environmental Engineering
West Virginia University

Main Objective

This project was awarded to West Virginia University in order to investigate advanced composite pipes made of pultruded and filament wound Glass Fiber Reinforced Polymers (GFRP) as a viable alternative/complementary material to steel for high pressure transmission lines. Investigation of burst pressures of GFRP pipes will be done through experimental methods.

Figure 1. Fiber wound GFRP pipe.

Figure 2. Burst pressure testing of fiber wound pipe.

Project Approach/Scope

Major tasks to achieve the objective of the project are:

- ❖ Hydrostatic Burst Pressure Testing of GFRP pipe and joints
- ❖ Analysis of GFRP pipe and joint behavior
- ❖ Prediction of mechanical behavior and failure mechanisms
- ❖ Characterization of GFRP pipes and joints

Manufacturing

Process of making GFRP wound pipes are:

- ❖ Fibers are wetted by running through a resin bath
- ❖ Wet fibers are wound around a mandrel
- ❖ Curing is activated by applying heat to the pipe
- ❖ Shrink wrap is wrapped around pipe to insure a void free surface

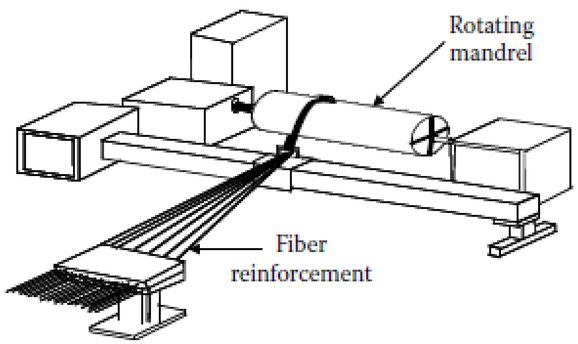

Figure 3. Fiber wound pipe manufacturing process.

Results to Date

i. Pultruded pipes burst at a lower pressure than the fiber wound pipes.

ii. Three fiber wound pipes of 3/8” wall thickness were tested and yielded an average burst pressure of 2,957 psi, while three 3/4” thick pipes yielded an average burst pressure of 4,814 psi.
   - Failure of wound pipes were due to local delaminations on the interior barrier layer.
   - Failure stress was within 10% of analytical prediction

iii. Two GFRP wrapped butt joints were tested and failed at 50% of pipe pressure.
   - Joint failures were due to a delamination of the external GFRP wrap and a leak on the edge of the external wrap.

Figure 4. Damage of the interior barrier layer in the 3/8” fiber wound pipe.

Figure 5. Delamination of the external wrap on the butt joint.

Acknowledgments

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References

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GangaRao, H. V. S., Halabe, U. B., Zondlo, J., Imes, B., Kavi, J., Pacifico, A., & Cvetnick, A. (2018). Glass-Polymer Composite High Pressure Pipes and Joints - Design, Manufacture & Characterize.

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