HydroFoamer

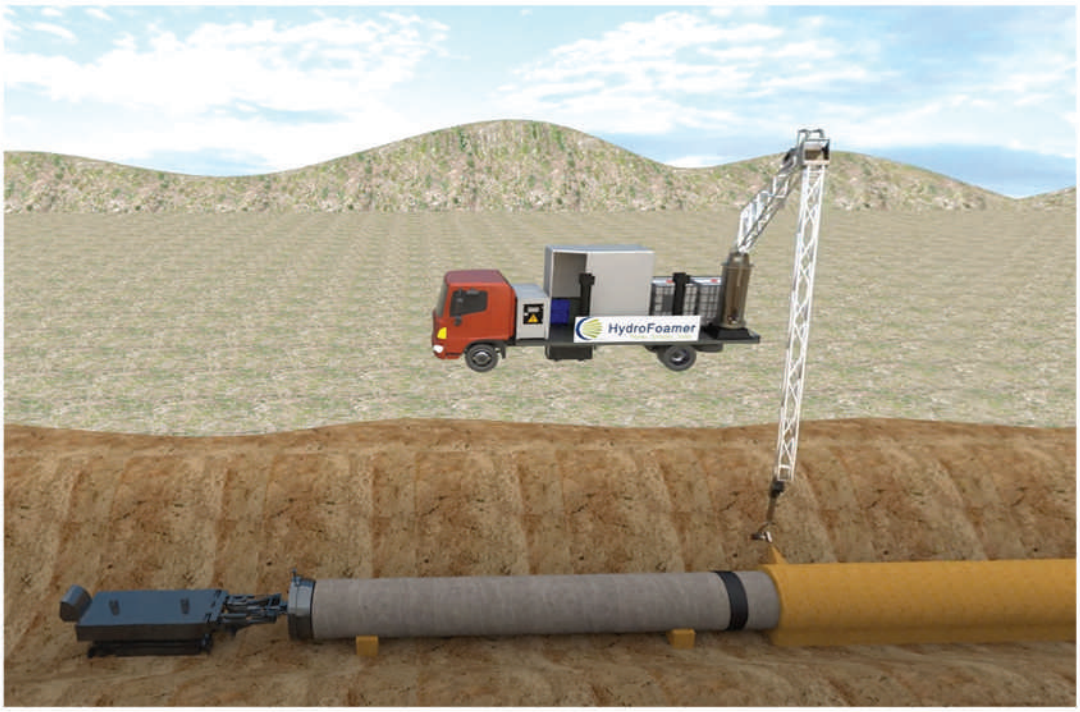
Simpler, Faster, Safer

Product Guide

RIGID, CLOSED CELL PU FOAM BASED PIPELINE BACKFILL REPLACEMENT & BEND STABILISATION SYSTEMS

Self-contained, automated spray system

www.hydrofoamer.com



For a 3D video of the application:

https://www.youtube.com/watch?v=X6f8wue56AI

- Self-contained, automated robotic spray platform
- Standard 20’ shipping container
- 20m / 66’ per cycle
- Average installation tempo > 1m / 3’ per minute
- Compensates for trench roughness of 300mm / 1’
- Ultra-safe component storage solution
- Additional manual spray capability




ABOUT THE COMPANY

HydroFoamer is a company that has grown from the intellectual property created by Guy Harris, a hydropower engineer who in 2015 patented the use of polyurethane foam to replace granular backfill and thus stabilise buried pressure pipes. One of the lessons learned from the first implementation project in Finnmark in Norway was that automation would multiply the geotechnical advantages that the use of polyurethane foam as replacement for granular backfill offers. We established the company to develop an automated spray system, specifically to service the pipeline market, by providing maximum installation tempo through the use of a self-contained robotic platform that can be mounted on multiple construction site vehicles, such as flat bed trucks, trench crawlers and towed trailers.

The working prototype has been brought to TRL7, and should be in production in Norway in Q3 2021, installing pipes in the 500-1500mm (20-60”) range for various Norwegian small-scale hydropower developers.

PRODUCT APPLICATION

HydroFoamer can install PU foam on any pipe or pipe-like system. The Hydrofoamer method gives at least 7 times greater geotechnical stability than compacted granular backfill.

From a logistics, engineering & environmental viewpoint, it is most applicable to situations where granular backfill is difficult to move to the pipeline site and where it is advantageous to avoid the use of concrete thrust block anchors. In addition, the load-spreading characteristics of PU foam make it particularly applicable to situations where dynamic loading may cause ovalisation or complete pipe failure. PU adheres strongly, either mechanically or chemically, to most typical substrates in the pipeline environment: polymers, metals, coatings.

From a project and financial perspective, HydroFoamer cuts installation times by ±90% compared to classic granular backfill-based methods and this, combined with the the reduction in logistical bandwidth and infrastucture, means that HydroFoamer reduces expenditure on project finance, absolute installation and risk costs.

In addition to axial stability benefits, HydroFoamer avoids almost all need for thrust block anchors.



POLYURETHANE FOAM CHARACTERISTICS

Polyurethane is an organic, thermosetting polymer, consisting of two components: polyol and isocyanate, which themselves are organic compounds. The polyurethane foam system is produced by mixing the components, together with small quantities of additives, such as extenders, linkers and most importantly fire retardants. Modern blowing agents use water, which reacts with MDI to form foam bubbles. HydroFoamer uses a rigid, closed-cell PU foam that is totally inert when fully-reacted and effectively impermeable. There are no known biological agents that can attack or degrade PU foam in the natural environment. Polyurethane may only be degraded by mechanical process, extreme heat and very high levels of UV light. Great care must of course be taken when producing PU foam & handling the liquid components, particularly the use of respiratory PPE during spraying operations. However, research has shown that the danger to the environment from component spillage is relatively low*; MDI (isocyanate) reacts with water to produce non-toxic crystals that rapidly break down naturally; polyol resins are 90% polyols, which are very large alcohol-type molecules & relatively non-toxic.

** WHO Concise International Chemical Assessment Document 27 DIPHENYLMETHANE DIISOCYANATE (MDI) ISBN 92 4 153027 8*

The PU foam used by HydroFoamer is extremely robust. A cupcake sized piece of foam will support the weight of a grown man and a 30x30cm (1SqFt) surface is enough to support an SUV. The cellular foam structure gives the foam extremely high and useful load-spreading capacity. The mechanical properties give foam very high resistance to impact or penetration by soil or backfill, such that in explaining the performance of the system, we often use the term 'concrete light'. Similarly, with good substrate preparation, adhesion may far exceed tensile, compressive and shear strength.

Property	Metric	Imperial
Pre-Mix Specific Gravity @ 21°C	1.23 (isocyanate) / 1.07 (polyol)	
Post-Reaction Density EN 1602	45 kg/m^3	2.8 lbs / ft^3
Compressive strength EN 826	269 kPa	39 psi
Tensile Strength EN1607	353 kPa	51.2 psi
Elasticity modulus (tensile) EN 1607	10.1 MPa	1,464 psi
Elasticity modulus (compressive) EN 826	7.2 MPa	1,044 psi
Adhesion to GRP (Glass Reinforced Polyester) pipe	170 kPa	24.7 psi
Global Warming & Ozone Depletion Potential	Zero	

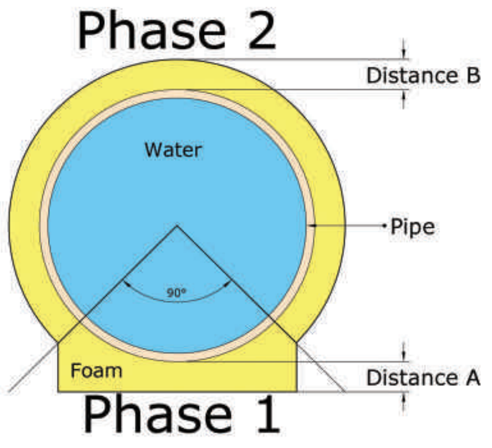
Exact parameters of the foam are adjusted according to individual project requirements.

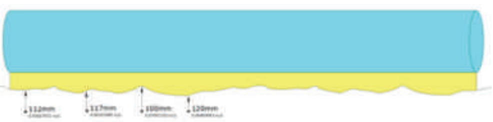
SYSTEM CHARACTERISTICS

The HydroFoamer applies PU foam in two phases, surrounding the pipe completely to a depth calculated to achieve the stated design requirements, which differ according to geotechnical, mechanical and production circumstances and objectives.

The system is designed to work with either an entirely pre-laid pipe, suspended on PU foam pillows that are sprayed into place during the first of the two phases, or with a 'pipe head' strategy, which involves jacking and holding the pipe section during spraying.

Although the system has a manual spray backup, it is designed to work automatically. The two production phases relate approximately to the lower middle quadrant (Phase 1) and the three upper quadrants (Phase 2).





The objective of Phase 1 is to provide the support foundation of the pipe, with a typical distance of at least 100mm / 4" between the lowest part of the pipe surface and the trench bottom (Distance A). In operational conditions, the excavated trench bottom is not even; in classic backfill systems, the trench must be made flat with backfill or other material such as tunnel stone. The HydroFoamer has the advantage of being able to fill practically any void, negating the need to prepare a very flat trench bottom to receive the pipe.

The initial process in Phase 1 is a full scan of the trench bottom (figure to left) and pipe position by a simple laser distance system, mounted in the spray head. This provides 3D data to the robotic system, which compensates for the varying depth under the pipe by varying the travel speed of the robot along the pipe during the spraying process.

In a 'pipe head' installation, the foam is solid enough to support the weight of the pipe within 2 - 3 minutes, during which Phase 2 takes place.

The upper three quadrants present a simpler use case for the system, as the pipe surface is regular and foamed to a standard depth (Distance B).

The duration of each 2-phase cycle is between 0.5 and 1 minute per metre or yard length, depending on pipe diameter and foam depth requirements.

HydroFoamer & Pipe Bends

The tensile and compressive strengths of PU foam are so high that the HydroFoamer can apply a sufficient depth of foam to absorb deformation from resultant bend forces by transferring them to the surrounding soil masses. The HydroFoamer system thus recreates the behaviour of a restrained system or thrust anchor, at a fraction of the weight and cost. The first installed and instrumented system was academically validated by NTNU in Trondheim, where a 15° 4BAR bend showed less than 0.1mm of deformation in any axis during operation, over course of the last 3 years