

Engineering Solutions – Summary

In 2016, the revolutionary PU foam pipe laying technology, using patented IP owned by HydroFoamer BV was installed by contractors working for Statkraft, the Norwegian state renewables giant. The Adamselv project in North Norway is a 1.1km, DN800/900 hydropower pipeline, pumping water from a lower water source, to supplement the hydropower installation.

Key Figures & System Profile

The properties of PU Foam can be manipulated by temperature, pressure and the addition of accelerants.

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	

Geotechnical Stability

The normal solution to provide axial stabilisation for unrestrained buried pressure pipes is the use of granular material, usually graded aggregate, which surrounds the pipe and uses friction, augmented by compaction, to stop the pipe sliding in an axial direction. In general, native extracted soils may not be used for this purpose, as they do not hold compaction. The HydroFoamer Ltd method provides the effect of a restrained system, by adhering strongly (300kPa / 43 psi) to the pipe surface, before, after and across the joint. Furthermore, when the trench is backfilled, the uneven surface of the foam, especially on the trench floor, and the tendency of objects in the backfill to push into and deform the surface layer, leads to massively increased axial stability: the system no longer relies on friction, but on the shear strength of the surrounding masses. This effectively increases the axial stability by up to 50 times. The same mechanism is also evident in resisting vertical forces, such as buckling and buoyancy.

Thrust Forces / Anchor Blocks

Pressured pipelines must be restrained against the resultant hydraulic, hydrostatic thrust forces that attempt to deform the pipe in the direction of the apex of a bend or a deflected pipe joint. Failure to restrain the system leads to separation of the joint in an unrestrained joint system or shoulder failure in flanges. The typical solution is to engage the use of an anchor block which bears the thrust forces and transmits them to undisturbed soil, utilising earth pressure. These anchors often require steel reinforcement and ground stabilisation work to ensure that they remain static. Because the foam is a solid mass, the HydroFoamer method distributes forces from the pipe surface throughout the entire mass of foam to the surrounding soil mass; this supporting length is much greater than is the case for anchor blocks and due to the low density and high compressive and tensile strengths of PU foam, there is no need to provide foundations. The process is also extremely quick. A typical 30°, 30 BAR / 435 psi bend can be installed in less than an hour and movement in the joints either end of the bend piece will be less 3.26mm or 1/8th of an inch.

Corrosion Protection and Mechanical Pipe Surface Protection

Metallic pipes suffer from differing forms of corrosion: chemical and electrical. Polymer pipe coatings are often inadequate and become damaged by soil and backfill, leading to coating holidays, corrosion and failure. Closed cell PU foam is chemically inert, an electrical insulator and effectively watertight. This provides triple protection for metallic pipes, by interrupting the electrical potential between pipe and soil, stopping water getting to the surface to provide an electrolyte, and stopping mechanical damage of the pipe surface or its coating where appropriate.

Ovalisation & Washout

Ovalisation of pipes occurs when topsoil / backfill exerts pressure on the crown of a pipe, and is exacerbated by loss of resistance and support from backfill materials in the lower quadrants of the pipe, which can be caused by incorrect backfilling or washout. PU foam fills the shoulder voids perfectly and cannot be washed away. Additionally, the cellular structure of the foam gives excellent load spreading properties, at 50% per cell layer, helping to disperse both dynamic and static loads around the pipe and providing direct support. In the event of total washout, the foam-pipe system acts as a beam, helping to suspend the pipe above the void, preventing separation of the joint and pipe failure. The pipe-foam beam effect is stronger than intuition would indicate, due to the high mechanical strength and load dispersal properties of the PU foam. This effect also allows the use of cheaper materials, such as HDPE and other thermoplastic pipe materials.

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