Elimination of Trench Drainage in PU Foam-Backfilled Pipeline Installations

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16th September 2025

Introduction

Trench drainage has long been considered a necessary element of buried pipeline design, particularly in hydropower and water conveyance projects constructed in challenging geotechnical environments. Conventional practice relies on granular bedding and backfill, which, while providing immediate mechanical stability, also create a preferential pathway for groundwater. Drainage measures are therefore required to prevent uplift, erosion, or long-term seepage along the trench, as documented in CIRIA C688 Guidance on Embedded Pipelines in Wet Ground (CIRIA, 2010) and the ASCE Pipeline Design Manual (ASCE, 2015).

With the introduction of polyurethane (PU) foam as a stabilisation and backfilling medium, the assumptions underlying this requirement must be reconsidered. In consultancy conversations in 2016 between Guy Harris of HydroFoamer and Håkon Bergsodden of Norconsult, a leading Norwegian hydropower engineering consultancy, Bergsodden observed that PU foam fundamentally changes trench hydraulics and geotechnical performance, to the extent that dedicated trench drainage is no longer always required.

1 Rationale for Eliminating Trench Drainage

Absence of a Permeable Migration Pathway

Granular backfill creates a continuous, highly permeable medium, allowing groundwater to collect and migrate along the trench. PU foam eliminates this mechanism. Once cured, the foam forms a continuous, relatively impermeable mass that bonds tightly to both the pipe surface and the surrounding native soil. The trench therefore ceases to function as a preferential flow path. This directly addresses the concern in EN 805 Water Supply Systems (CEN, 2000), which identifies control of water migration along service trenches as a key design requirement.

Hydrostatic Pressure Management

Pipelines embedded in permeable bedding can be subject to uplift forces if water accumulates beneath or beside the pipe. PU foam locks the pipe in place and distributes hydrostatic loads into the surrounding soil mass. Even in saturated ground conditions, displacement is effectively prevented. This resolves a problem highlighted in ASCE Pipeline Design for Installation in Difficult Ground Conditions (ASCE, 2015), which warns of buoyancy risks in high water table areas.

Frost Protection

In cold-climate installations, frost penetration and frost heave are critical concerns. The closed-cell structure of PU foam offers significant thermal insulation, reducing the risk of frost-related damage and obviating the need for drainage as a frost-protection measure. This aligns with mitigation strategies described in CIRIA C688 (2010), which recommends drainage to control frost heave where permeable backfill is used.

Integration of Communication Cables in Conduits

In conventional pipeline trenches, communication cables are often installed in separate conduits, typically surrounded by sand or granular backfill. This arrangement provides basic protection but can create additional interfaces for water ingress, differential settlement, and frost heave, as well as extra costs.

PU foam backfilling offers an improved solution. By embedding the conduits directly into the foam matrix alongside the pipeline, the cables gain the same mechanical and environmental protection as the pipe itself. The closed-cell structure of the foam cushions the cables against impact, prevents displacement or floating under groundwater pressure, and provides effective insulation against frost penetration.

From a construction standpoint, placing both the pipe and communication conduits within the same trench simplifies logistics and reduces the need for additional protective materials. The foam effectively locks all elements into position, creating a stable and durable composite system. This multifunctional use of the trench demonstrates an additional advantage of the PU foam concept: enabling integrated utility corridors with enhanced protection and reduced environmental footprint.

Construction and Environmental Benefits

Trench drainage systems add cost, complexity, and environmental impact to pipeline projects. By eliminating the drainage requirement, PU foam enables narrower construction corridors, reduced use of quarried aggregates, and simpler logistics, while delivering long-term stability. This benefit is consistent with the sustainability principles emphasised in EN 805 (CEN, 2000), which encourages minimising environmental impact and construction footprint.

2 Conclusion

Håkon Bergsodden’s early assessment highlighted a fundamental advantage of the PU foam method: by eliminating the continuous permeable medium associated with granular backfill, PU foam removes the primary driver for trench drainage systems. The result is a more stable, efficient, and environmentally sound pipeline installation. This conclusion, drawn from hydropower engineering practice in Norway, continues to shape how PU foam is viewed as a disruptive alternative to traditional trenching and backfill techniques.

References

- CIRIA C688. *Guidance on Embedded Pipelines in Wet Ground*. London: Construction Industry Research and Information Association, 2010.
- American Society of Civil Engineers (ASCE). *Pipeline Design for Installation in Difficult Ground Conditions*. ASCE Manuals and Reports on Engineering Practice No. 128, 2015.
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