Pipes designed for generations

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stream

The greenest pipe is the one you don't have to replace

GRP projects around the globe that have been in service for many decades

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stream

Intro


Dr. Alexander Frech, CEO Amiblu Group

Environmental activist Annie Leonard said it best: "Recycling is what we do when we're out of options to avoid, repair, or reuse the product." In the reduce, repair, reuse, recycle mantra, recycling comes last.

If you want to reduce your environmental impact, make pipes that last for generations. There's no need to recycle what never should have been produced in the first place.

We've set up the most comprehensive LCA (life-cycle assessment) platform in the pipe industry. This allows us to carefully evaluate and choose the most environmentally friendly raw materials, designs, and production processes for our products. We can quickly compare the Carbon Footprint of various products from all Amiblu plants in a cradle-to-gate scenario. Furthermore, we can educate stakeholders on the impact of raw material selection and steer product choice towards greener and more responsible options.

No one under fifty has lived a year without an Earth Day and every company faces questions from skeptical customers who have a keen sense of what they consider environmentally acceptable.

We need to radically change our thinking. We're not just making pipes. We're making long-lasting water infrastructure that protects one of the most precious elements.

Because the greenest product is the one you don't have to replace.

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From dye works to Switzerland's first hydropower pipeline in 1961

Innovations that occur by chance are often the most successful. Such was definitely the case in Switzerland in the 1950s.

At that time, the Basle dye works were looking for an alternative to the wooden cylinders used for winding round the fabric during the dyeing process. As the wood splintered and became discolored, it damaged the expensive textiles making a replacement urgently needed.

Hoping to find a solution, the owners staged an in-house ideas competition. The rules were that the new material had to allow cylinders of a certain length and specified circular outside diameter to be made, it had to be corrosion resistant, low weight and have a smooth surface in order to ensure uniform dyeing results and also had to be cost effective. It was by no means an easy undertaking, but the employees at the dye works proved that they could think outside the box. The mechanical engineers in the plastics department built a centrifuge and produced a roller made of glass fiber and polyester resin. Although these materials had previously only been used in the automotive, aircraft and shipbuilding industries, their resistance to corrosion and chemicals also made them ideal for other applications. The innovative centrifugal casting process enabled them to meet the specifications for the outside diameter, as the inside diameter of the casting mold was determined in advance - the new roller for dyeing textiles was found.

Just for dyeing fabrics?

The Swiss, renowned worldwide for their vision and inventiveness, soon discovered that not only the outer surface of the rollers had special properties but also the inner layer displayed unique characteristics.

One thing led to another and the first centrifugally cast pipe made of glassfiber-reinforced plastic (GRP) was produced in 1957. The Swiss initially manufactured rollers for their own use at the dye works and patented the production process shortly after.

It was not long before the first external application in the form of pipes followed in 1961. In the Binn Valley in the Swiss canton of Valais, Gommerkraftwerke AG was seeking a suitable material for a pressure pipeline to their hydropower plant. When they heard about the excellent features and low weight of the centrifugally cast GRP pipes bearing the company name at that time, Armaverit, it was soon clear what material they wanted for the three-kilometer-long, very steep sloping DN 1000 pipeline. The pipes were green inside and joined with bell sleeves.

Today plant director Bernhard Truffer is still highly satisfied with the Hobas products, "especially when you take into consideration the very low wall thickness of 7 mm for a diameter of 1000 mm. What's more, the pipes neither had ideal bedding nor were they installed or grounded properly", adds Truffer extremely pleased with the experience that the company has had with the pipes over the past 50 years. And Hobas can justifiably be proud of producing quality for generations.

PROJECT DATA

Country	Switzerland
Year of construction	1961
Application	Hydropower
Installation	Open cut
Technology	Hobas
Total length of pipe	> 3 km
Nominal diameters	DN 1000
Pipe specifics	Pressure pipeline, wall thickness 7 mm
Client	Gommerkraftwerke AG

30-year-old glass fiber pipeline appears as brand new

GRP pipes have withstood the forces of nature for 30 years at the power plant north of Lillehammer. The pipeline is emerging as resistant as when it was installed in 1982. A smooth and glossy inner surface implies that the pipe characteristics are maintained over time and that the tubes have very long life.

Due to a planned shutdown of the plant, the pipeline suppliers, APS Norway AS and Flowtite Technology, required an inspection of the pipeline. As a part of the follow-up of projects and quality assurance, this was a good opportunity to confirm some of the pipe properties.

A significant upgrade of the Vinkelfallet power plant in Lillehammer, Norway, was conducted in 1982, including replacement of pipeline steel in favour of GRP (Glass Reinforced Plastic). "We had no experience with GRP as it was installed in 1982. The offer was reasonable in light of the many aspects, not least economy and ease of operation. Installation was carried out in an easy way, and after 30 years of operation, we can conclude a smooth operation phase. Our lifetime perspective on pipelines is set to 60 years", says production manager at Gudbrandsdal Energy, Stein Kotheim.

No visible signs of wear-out

In long-term tests carried out in Flowtite Technology's laboratories, the pipes are exposed to large overloads. The results from these tests are then extrapolated to 50 years. Thus, the pipes are designed with spacious safety margins. If we correlate this to tests and inspections of facilities, this indicates that the pipes will keep very long.

On the inside, the pipeline was covered with a thin layer of humus that was easily washed away with water to ascertain that the pipeline emerged new with a smooth and polished surface. Through visual inspection, it was concluded that the surface had no visible signs of wear or any other negative impact after 30 years of operation.

Low headloss

A glossy and smooth surface after 30 years of operation confirms that the pipes' hydraulic properties are maintained over time. This has great significance for headloss and the plant's ability to maintain efficient production. This matches well with the manufacturer's expectations and is also in line with the literature, where plastic pipes are expected to retain excellent hydraulic properties over time.

Ivar Elstad at Norconsult has worked on headloss issues for many years and has also been involved in tests and measurements. "As far as we have been able to document through tests and measurements, we assume that the roughness of GRP pipes is of about 0.1 millimetres. This includes the effect of joints and humus", he says.

State-of-the-art GRP technology for almost 50 years

For nearly 50 years, Flowtite Technology has been manufacturing GRP pipes and marketing them globally. The tubes are currently installed in thousands of facilities throughout the world, and GRP has been dominant as a pipe material for projects in hydropower, water, sewage and industrial applications, many of these among the largest of their kind in the world.

The pipes were a contender in the market when they were launched in the late 60's. Competitors had been on the market for a long time; steel and concrete were well established. Moreover, the market was wary of a new material – especially glass fiber. Was it strong enough? Would it live up to its claims?

The task of establishing Flowtite on the market was challenging. But with faith in a good product and pains-taking work over the years, focusing on quality and continuous investment in research and development, Flowtite pipes have taken a solid share of the market. Today, the pipes are always considered a good option for hydropower projects, water, sewage and industrial applications.

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- Alexander Frech, CEO Amiblu Group

Pipeline withstands highly abrasive glacial sediment

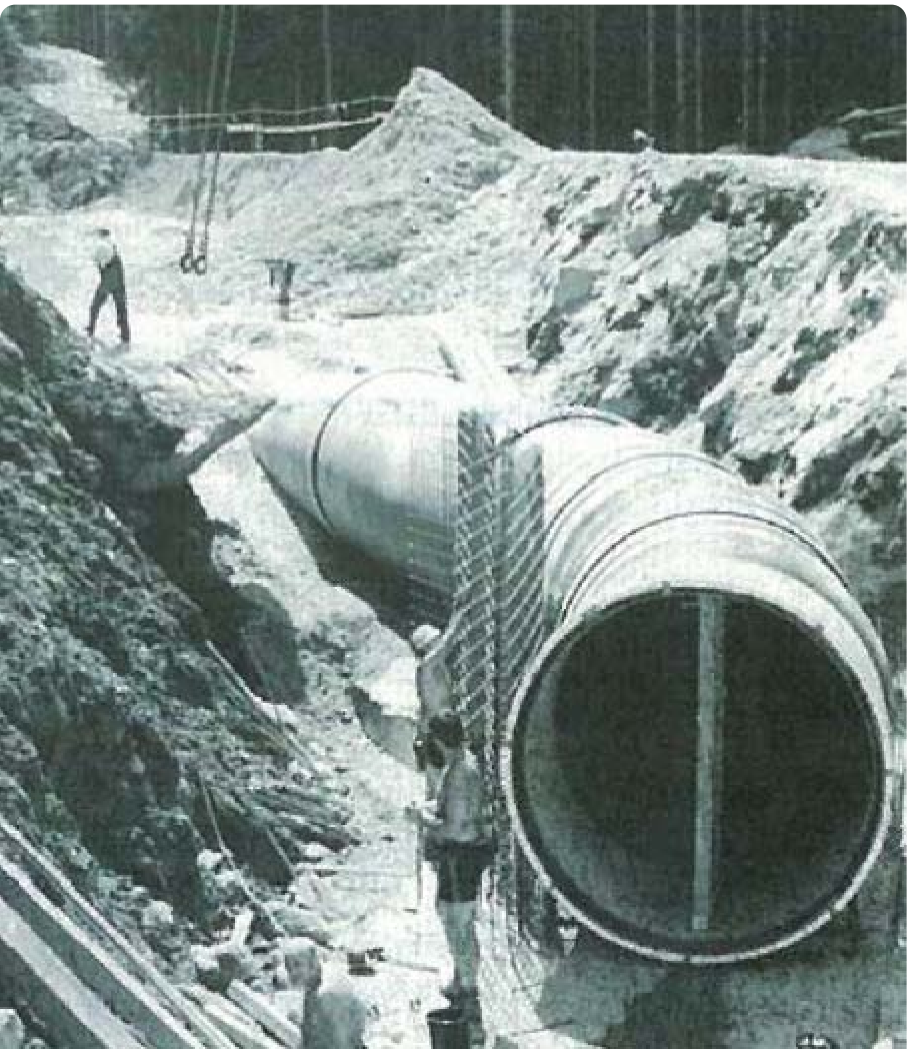
The Wald hydropower plant enjoys a picturesque setting at the edge of the Hohe Tauern National Park and takes advantage of the considerable difference in elevation between the villages of Krimml and Wald. Built by Salzburg AG in the 1980s, it has been in operation since fall 1988 to meet the rising energy demand in the surrounding area.

Top priority when planning this project were environmental protection and nature conservation. As the national park is such a sensitive area, extreme care was also taken both during construction of the power station and installation of the pipeline to comply with the stringent legislation. The powerhouse is situated in Wald, while the water intake was built around 200 meters higher up in the village of Krimml not far from the famous waterfalls. A daily storage reservoir with a capacity of 65,000 cubic meters and a dam body were integrated in the existing terrain, landscaped and planted. The water intake is an inconspicuous structure and has a very well designed fish ladder that looks virtually like a natural creek. Strict regulations were observed during installation of the Hobas pipeline to prevent flora and fauna from being disturbed.

Like most parts of the hydropower pipeline, the penstock between the daily storage reservoir and headrace tunnel was buried. A DN 2200, PN 4 - 6 pressure pipeline measuring 840 meters in length constituted the first part of the penstock. It is encased in concrete in the area of the storage dam and the Krimmler Ache river crossing.

PROJECT DATA

Country | Municipality	Austria | Wald
Year of construction	1987
Application	Hydropower
Installation	Open cut
Technology	Hobas
Total length of pipe	1143 m
Nominal diameter	DN 1200 - DN 2200
Nominal pressure	PN 1 - 8.5
Nominal stiffness	SN 2500 - SN 10000
Client / investor	Salzburg AG
Contractor	ARGE Polensky & Zöller



After 18 years in operation, the sand flushing pipeline in the hydropower plant consisting of DN 2200, PN 1 Hobas pipes underwent inspection by the owner and Hobas experts in March 2006. The engineers were delighted to find that even after having been in service for nearly two decades, the pipeline showed hardly any signs of wear. Despite the highly abrasive medium –water with sand and glacial sediment– the inner pure resin layer that is also responsible for the unique hydraulic properties of Hobas pipes was neither pitted nor worn away and also in the invert area of the pipes the liner was completely intact. Just how aggressive glacial sediment is on most materials can be seen from the fact that the power plant’s turbine had to be replaced several times over the same period – the Hobas pipeline however shone like new against the light. Even the original installation numbering on the pipes was largely still visible and only slight signs of mechanical abrasion could be detected on the markings.

The management at Salzburg AG has every reason to be more than happy with this project and many following generations can rely on the quality of Hobas pipes.

GRP pipes in excellent condition after 33 years in seawater

In 1975, 1500 m of Flowtite pipes were installed as subaqueous marine outfall of the Enga wastewater treatment plant in the Norwegian town of Sandefjord. In 2008, one pipe section was brought ashore to evaluate its condition. The result: A fully functional pipe with very good mechanical properties.

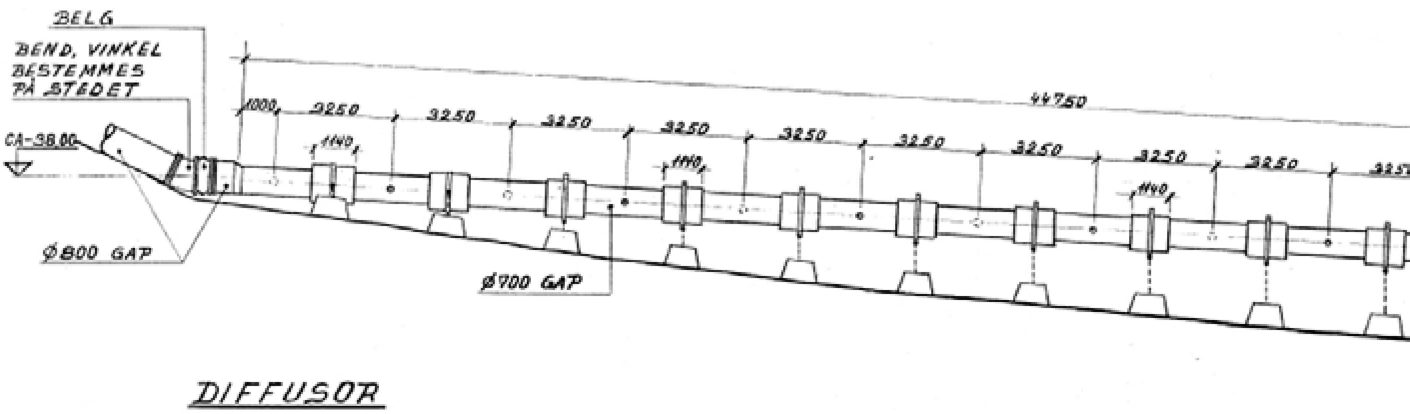
The outfall of the Enga wastewater treatment plant in Sandefjord was installed and commissioned in 1975. Built of Flowtite GRP pipes, the outfall is entirely installed underwater and consists of three different parts:

- The first part is 400 m long and consists of pipes DN 800, buried in the seabed at an average depth of 2 to 2.5 m.
- The next 1055 m of GRP pipes DN 800 are laid directly on the seabed. Flowtite GRP pipes do not float as they have a specific gravity of approximately 2. Horse-shoe anchors are used for additional stability.
- The 67 m long suspended GRP diffusor, DN 700 and DN 500, was installed floating at an elevation of up to 3 m above the seabed and 38 to 42 m below sea level. The diffuser consists of a 45 m long initial section DN 700 and a 22 m long final section DN 500. Both sections are fitted with 180 mm circular ports every 3.25 m along the diffuser's spring lines. The sections are joined with a DN 700/500 eccentric reducer, and all parts connected with GRP butt-wrap joints. A DN 800/700 eccentric reducer joins the diffuser with the main outfall line DN 800 with a rubber bellow. For floatation, the GRP diffuser is fitted with foam-filled buoyancy elements. The buoyancy elements are moored to concrete anchors resting at the seabed.

The outfall was constructed by joining GRP pipes to 50-100 m long pipe strings using GRP butt-wrap joints. The strings were fitted with GRP collars and steel loose flanges at the ends, installed by means of a float-sink procedure, and joined on site using the flanges.

In 2008, a section of the DN 500 diffuser was brought ashore for analysis of its condition and mechanical properties after 33 years of exposure to treated sewage and seawater. Even though there was no chlorination, the pipes showed only very limited biological growth. Samples were cut from the pipe and cleaned. A visual inspection did not reveal any signs of ageing, the internal surface of the samples was as shiny as of a new pipe. →

Above: After 33 years of service in seawater, a section of the GRP diffuser was brought ashore to have its mechanical properties tested.
Below: A drawing of the complete 67 m long diffuser.



The key mechanical properties of the 33-year-old pipe were measured at the Amiblu laboratory in Sandefjord and compared to the design requirements from 1975. The results are listed below:

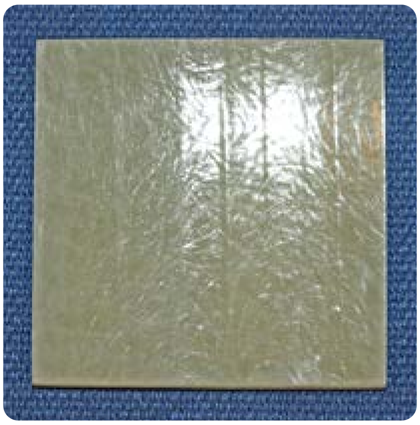
In addition, a pipe section was pressure tested to burst. The pipe busted at 25 bar, which is a very good performance for a PN 2.5 pipe.

Mechanical properties	**Design requirement 1975**	**Measured result 2008**
Specific initial tangential stiffness	1280 Pa	1377 Pa
Axial tensile strength	70 MPa	95.4 MPa
Hoop flexural strength	140 MPa	168.3 MPa

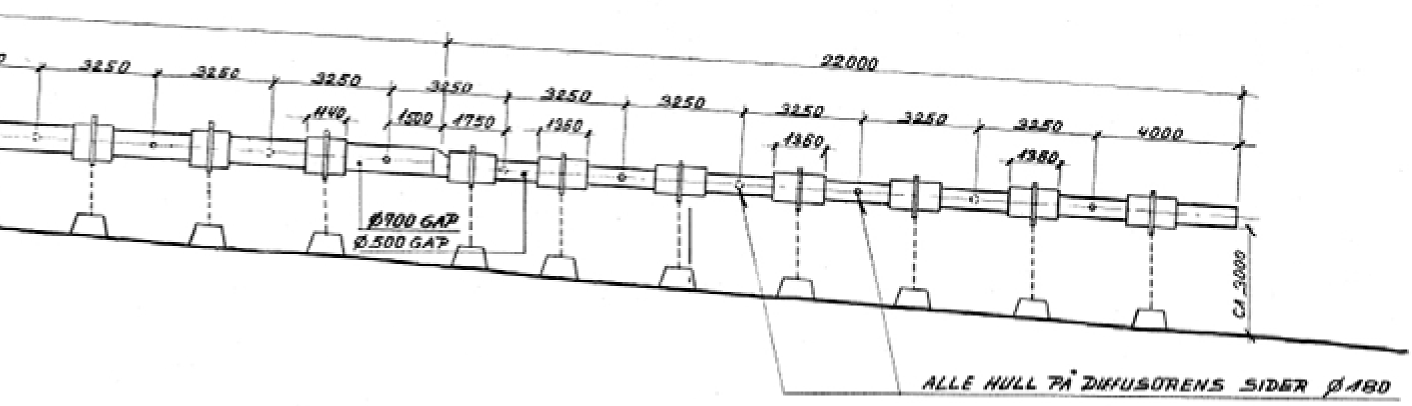
Bottom line: The GRP pipes have proven to be totally resistant to corrosion and had retained the mechanical properties that applied to the products when they were initially manufactured.

PROJECT DATA

Country | Municipality	Norway | Sandefjord
Year of construction	1975
Application	Seawater outfall for WWTP
Installation	Subaqueous
Technology	Flowtite FW
Total length of pipe	1500 m
Nominal diameter	DN 500, DN 700, DN 800
Nominal pressure	PN 2.5
Nominal stiffness	SN 1280
Client / investor	Sandefjord Municipality
Designer	Vlak AS



Left: After cleaning the pipe with soap and water, it looked brandnew. There were no signs of ageing. The test results confirmed the excellent condition also with regard to the pipe's performance.



GRP pipes are designed for generations. Here's the proof.

A generations-long, low-maintenance service life: It's a promising claim that Amiblu makes about their GRP products. A promise that is not just based on the company's 60 years of age and experience – there's quite a bit of meticulous scientific research involved. We talked to Amiblu Product Development Manager Högni Jónsson who let us in on some interesting research.

The test results demonstrate the product performance and reveal a product service life of many generations, including a remarkably high safety margin.

– Högni Jónsson
Head of Product Development and Support
Amiblu Group

Amiblu promises an operational lifetime of many generations for their GRP products. Where's the proof?
Jónsson: To answer this question, we first need to look at the reasons why most pipes do *not* reach such a mature age. These reasons carry names such as thiobacillus concretivorus and thiobacillus ferrooxidans – tiny bacteria that decompose sewage and form hydrogen sulphide gas (H_2S). When combined with moist air, the gas forms sulphuric acid (H_2SO_4) which is highly corrosive to materials like concrete, steel, and cast iron. This "microbially induced corrosion" can cause significant damage over time. Corrosion is also a major problem in seawater applications, where the contained sodium chloride eats away at e.g. metals and causes them to fall apart. With GRP products, the situation is quite different.

You're saying that GRP pipes are not affected by corrosion?
Jónsson: Exactly. Plastics are inherently more robust than both concrete and metals in acidic environments. To prove this, we literally put our pipes to the acid test: Several pipe samples are exposed to sulphuric acid (H_2SO_4) for a considerable time, while being subjected to artificially high tensile strains (see Fig. 1). The idea is to simulate the chemical conditions in aggressive sewage, but under an excessive strain in order to cause failure within a reasonable time frame. To determine the pipes' long-term properties, the measured data is analysed statistically and extrapolated into the unknown to predict a limiting strain for use in pipe design.

Did Amiblu invent this test method?
Jónsson: No. The acid test for GRP pipes was first standardized by the American Society for Testing and Materials in 1978 (test method ASTM D3681) and has been in use ever since. The same procedure is also specified in EN 1120 and ISO 10952. The test method calls for minimum 10,000 hours of testing with at least 18 samples. However, since the test is relatively simple to conduct and does not require much space, a great number of samples have been left exposed to acid for much longer time periods. We studied the results from over 40 years of continuous testing of Flowtite and Hobas GRP pipes, involving more than 1800 test samples.

***Fig. 1**: Strain corrosion tests according to ASTM D3681 in the Amiblu R&D center in Norway.*

This sounds very comprehensive. Please tell us a little more about these samples and the test setting.
Jónsson: Our tests cover a variety of pipe designs which have been in continuous use. The samples, most of them DN 600, were taken from a number of Flowtite and Hobas manufacturing plants. According to ASTM D3681, we subjected each 300 mm long pipe sample to a vertical force causing tensile bending strain in the pipe invert, while exposing it to a 5 % concentration of sulphuric acid. →

A typical test series consists of 18-25 samples, usually from a single production batch, at various strain levels. The strain is measured after the load has been applied and then the sample is stored under controlled conditions until failure occurs, detectable as leakage through the pipe wall.
With at least one data point exceeding 10,000 hours and the rest relatively evenly spread over the time range, and with an appropriate coefficient of correlation, the data can be safely used and extrapolated with classic statistical methods.

How about the results?
Jónsson: The shortest measured time to failure is 0.3 hours at 1.35 % strain; the longest is 28 years and 78 days at 1.05 % strain. The longest, still running test was set up on October 4th 1978. The sample has now been exposed to the acid test for almost 45 years at 0.91 % strain. What's really interesting here is the bilinear behavior: up to strains of about 1.6 %, most samples fail within relatively short time periods. At strains between 0.9 % and 1.3 %, the time to failure is much longer. Only a handful of data points fall below this range, meaning that below a certain "threshold strain", the samples simply do not fail. For this set of data, the threshold appears to be around 0.9 % strain. A classic regression analysis of the data points up to 1000 hours results in a line with a mild slope. On the other hand, regression analysis of data points after 1000 hours through to over 350,000 hours show an almost horizontal line. By extrapolating this line by only ½ of a decade, which is less than one third of what classical statistics allows, we reached a long-term strain value of 0.93 %.

Is this a typical strain in sewer or similar applications?
Jónsson: No, and that's the fantastic conclusion: The typical long-term operating strain of such a pipe is merely 0.27 %. This means that, in real-life applications, we even reach an excellent safety margin of 3.4.

This sounds really impressive! Any project examples that prove this durability?
Jónsson: In 2004, a pipe DN 1800 that had been in continuous use in aggressive environment since 1980 was unearthed and inspected. The pipe came from the sewage treatment plant belonging to the Water and Sewerage Department in Riyadh. After almost 25 years in service, the pipe showed no signs of degradation or deterioration, only a slight change in stiffness. Another sample taken from a pipe in Norway that had been submerged in sea water for more than 33 years showed no signs of corrosion or visible aging either. The mechanical properties were also well within the initial design requirements.

Bottom line: TThe extraordinary lifetime of Amiblu GRP pipes is a matter of fact!
Jónsson: Indeed. The data shows that, if the strain is below a certain threshold level, the pipes will serve several future generations.

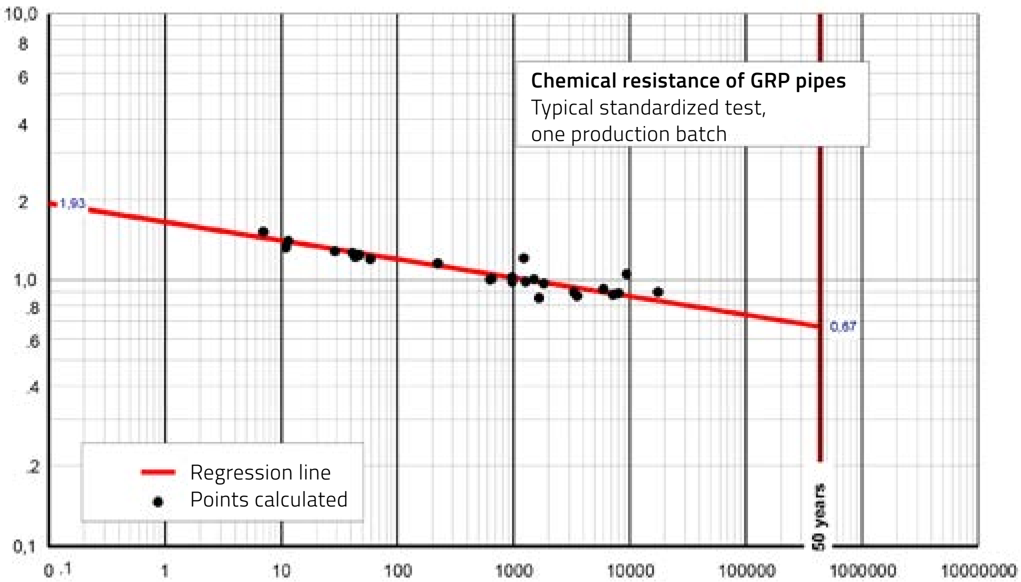


***Fig. 2**: A typical test series with 25 Flowtite pipe samples. The horizontal axis is the time-to-failure, the vertical axis shows the bending strain at the pipe invert, both on a logarithm scale. Each point on the graph represents a pipe sample that has been subjected to the recorded strain until failure occurred. Having fulfilled the statistical requirements, a straight line that fits the data is computed, using covariance regression analysis. In this case, the extrapolated strain value at 438,000 hours (i.e. 50 years) is 0.67 %. With typical long-term deflection of 3 % (yielding a strain of 0.27 % for current pipe designs), the calculated safety margin is approximately 2.5.*

Premiere in Hamburg in 1982

The first large-scale and technically demanding GRP jacking project in the world, DE

Hobas made its debut with centrifugally cast GRP jacking pipes in 1982. Before then, the pipes had only been used on some test construction sites in northern Germany for pushes of up to 50 meters. The world's first large and technically highly demanding jacking project with GRP products was undertaken at Hamburg's customs port.

A sewer was to be installed under a very busy part of the port in the north of Germany. The specifications were challenging: a fire service exit, port railway and federal railway lines were not to be disrupted under any circumstances and settling had to be prevented over the entire length of the pipeline. Given the fact that trenchless construction saves space and is highly accurate, jacking was truly predestined for this application. The Hobas products' corrosion resistance also to aggressive wastewater, their smooth outer surface and easy handling persuaded the clients and they ordered jacking pipes with an outside diameter of 752 mm and wall thickness of 50 mm. The pipes were installed six meters under the groundwater table in two drives over a length of 165 meters without any intermediate jacking stations.

Although their outer surface is very smooth, the Hobas pipes were lubricated with bentonite every 30 meters to reduce friction and speed up the jacking work. It is hardly surprising therefore that the greatest jacking force used was only 1700 kN, which is far less than the limit for the pipes. What is also remarkable is the great precision with which the Hobas pipes were jacked through the silt and clay soil under the groundwater table at that time: the pipeline only deviated 15 mm from the planned route over a length of more than 100 meters, thus remaining well below the specified tolerance.

The facts sounded spectacular then but are now exceeded many times over. In 2009, Hobas supplied De 3000 jacking pipes that were installed without using the intermediate jacking stations in sections of almost a kilometer. And in 2021, Amiblu delivered GRP jacking pipes De 2047 for a spectacular project in Rome that–with a thrust section of 1,235 meters–marked a new trechless record.

PROJECT DATA

Country | City	Germany | Hamburg
Year of construction	1982
Application	Sewer
Installation	Jacking
Technology	Hobas
Total length of pipe	165 m
Diameter	De 752