

IN FOCUS: Hydropower



PIONEERING POLYMER TECHNOLOGY

Within the Hydropower industry, polymer technology can offer a plethora of benefits including resistance to cavitation, excellent resistance to erosion and corrosion and efficiency enhancement. These developments offer a cost and time-saving alternative to traditional methods.

Traditional repair challenges

One of the most conventional repair methods is welding. In this situation, lost material is replaced with more of the same material, a like for like repair. Reintroducing the same base material simply allows the problem to reoccur and does not address the root cause of the issue. Continued metal loss will result in continued shutdowns.

Another drawback of replacement of lost metal using hot work is the procedures involved in implementing the repair. From the United States Bureau of Reclamation Turbine Repair manual (Volume 2-5, 1989 p. 7);

“Extensive weld repairs can result in runner Blade distortion, acceleration of further cavitation damage, and possible reduction of turbine efficiency. Also, extensive repair can cause residual stressing in the runner resulting in structural cracking at areas of high stress”.



Fig 1: Cavitation damage on a stay vane

Hot work is carried out gradually, heating up the entire part first prior to application of the repair technique. This incurs lengthy cool down times between application of the repair to avoid excessive heat distortion.

Care is also required when selecting the repair metal (plates or welding rods) as dissimilar materials can introduce local galvanic corrosion, initiating even more repair requirements.

Advanced polymer technologies- coatings and repair composites

With the myriad of problems that can arise from traditional repair techniques, cold applied protective coatings and repair composites offer a welcome alternative. The Belzona paste grade rebuilds the substrate while the coating grade provides a layer of protection. This method completely halts corrosion and ensures long-term equipment protection.

Areas deteriorated from erosion-corrosion and cavitation (see Fig 1 and 2) can be rebuilt using Belzona’s two component repair composites. This method bypasses the need to replace the damaged material with the same material, a like for like repair, which would otherwise leave ▶▶



Fig 2: Deteriorated turbine runner

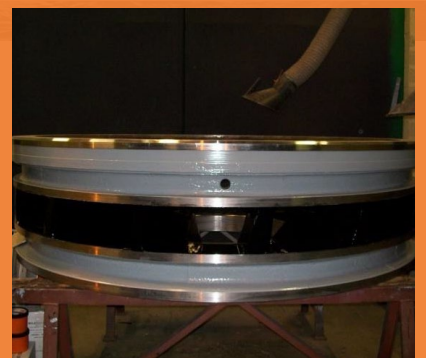
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BELZONA 2141 (ACR-FLUID ELASTOMER)



A two-part polyurethane resin designed for the coating of metal and rubber components. This flexible elastomeric material is appropriate for coating extremely high localised pressure areas where abrasion, cavitation, erosion and corrosion resistance are required. This fluid material is easy to mix and apply without the need for specialist tools and it cures at room temperature eliminating the need for hot work.

- » Long-term adhesion retention on immersion
- » High resilience, high tear strength, elongation at break typically 530% (ASTM D412)
- » Meets requirements of the ASTM D3623 (90 day immersed) cathodic disbondment test
- » Independent tests show performance 297% better than stainless steel and 1,394% better than E-grade steel in the ASTM G32 cavitation erosion ultrasonic vibration test method



Application

[Belzona 2141 \(ACR-Fluid Elastomer\)](#) can be injected/formed or applied as either a one or two coat system by brush or applicator to most common surfaces such as metals, alloys, natural and synthetic rubbers, fibreglass and composites.

» the substrate susceptible to further damage. Not only does this technique avoid the need to use specialist tools and equipment, it simultaneously avoids the need of lengthy downtimes as application can be carried out quickly and easily by hand or spray. Coatings and composites are applied and cure at ambient temperatures, eliminating the need for hot work.

Extending Asset Life

Another way in which polymer technology provides a more beneficial alternative to traditional methods is the way in which it increases asset life and efficiency performance. Belzona achieves this through the application of coatings which reduce resistance to flow caused by friction with the substrate surface. [Belzona 1341 \(Supermetalglide\)](#) is an epoxy coating with a low electronic affinity with water molecules (a hydrophobic or, 'water repelling' material) and rheological properties. Once simply applied by brush or heated airless spray, it forms an extremely smooth surface which reduces the friction boundary layer of the pumped fluid and the internal turbulences, creating a more laminar flow, thus increasing hydraulic efficiency. [Belzona 2141 \(ACR-Fluid Elastomer\)](#) can be used in conjunction with Belzona erosion-corrosion coatings to allow localised protection where cavitation resistance is required.

Cavitation

The use of hard materials and specialist alloys is a common practice in areas exposed to cavitation, but these measures are often very expensive and will eventually also fail under constant attack. In order to resist the effects of cavitation, Belzona specially developed [Belzona 2141 \(ACR-Fluid Elastomer\)](#). This two-part elastomeric polyurethane is applied using a brush as a coating specifically to areas subject to cavitation damage. Being an elastomer, the elasticity of this product provides resistance against impact damage.

[Belzona 2141 \(ACR-Fluid Elastomer\)](#) was formulated following a lengthy development and research process to determine the key conditions present in cavitation areas on fluid handling equipment. Exceptional bond strength and the elasticity to absorb and dissipate the extreme impact pressures from the micro jetting were all requirements fulfilled by this Belzona elastomeric polyurethane material.

Over a decade of field applications still providing excellent performance are testament to the material's longevity.

Proven protection from erosion, corrosion and cavitation

Advanced application techniques and constantly evolving technology have allowed polymeric solutions to become a consistent choice for the maintenance and protection of the fluid handling equipment. These coatings and composites have been proven to reduce cavitation, halt corrosion and slow the effects of erosion on critical equipment for decades within the Hydropower industry.

Following stringent laboratory testing, Belzona applications are carried out by experienced and trained personnel to ensure the highest possible quality and standards. ■



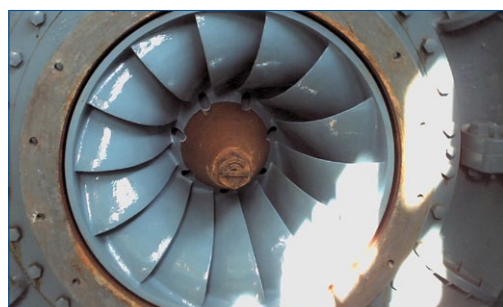
Francis turbine following preparation by grit blasting



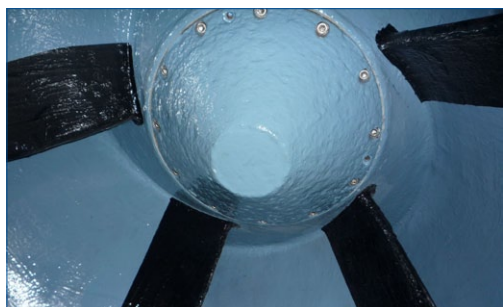
Application of [Belzona 1341 \(Supermetalglide\)](#) in progress to runner



Turbine following rebuild using a paste grade material to in-fill areas of erosion damage



Completed runner installed and ready to return to service



[Belzona 2141 \(ACR-Fluid Elastomer\)](#) can be used in conjunction with Belzona erosion-corrosion coatings to allow localised protection where cavitation resistance is required

BELZONA QUICKLY RESTORES & UPGRADES TURBINE

Belzona successfully repairs and protects Francis turbine in hydropower plant

A Belzona application was carried out on a Francis turbine runner which had been previously coated 15 years ago. The original coating was found to be in good condition with the exception of the areas subjected to extensive cavitation damage. When the original application took place [Belzona 2141 \(ACR-Fluid Elastomer\)](#) was not yet formulated. The client was satisfied with the performance of the Belzona coating and wished to renew it to maintain erosion-corrosion protection.

[Belzona 5811 \(Immersion Grade\)](#), a high performance barrier coating was applied to the bottom and top parts of the turbine, as these areas required only corrosion protection. [Belzona 2141 \(ACR-Fluid Elastomer\)](#) and [Belzona 1341 \(Supermetalglide\)](#) were used on the middle

part of the turbine where cavitation damage had previously occurred. With the elastomer addressing the cavitation problems and the smooth hydrophobic coating protecting the metal from erosion and corrosion, the system provided the ideal solution for the long-term protection of the turbine.

In this case downtime would have been very costly for the client, therefore maintenance work had to be completed quickly. The Belzona solution provided not only a time but also a cost-effective solution as the equipment was coated on time and put back into service with minimal delay. The previous Belzona application lasted for 15 years with no remedial work required. The new specification now includes a cavitation resistant elastomer and is expected to last even longer. ■



Blasted runner prior to the application



Completed application

BELZONA 1341 (SUPERMETALGLIDE)

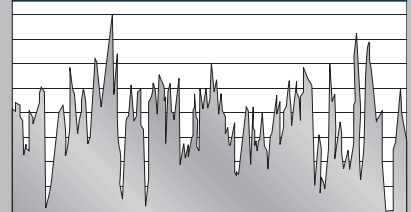


[Belzona 1341 \(Supermetalglide\)](#) was first formulated in 1989 in response to a market demand for a coating that increases the service life of the fluid handling equipment, while at the same time reducing the need for routine maintenance.

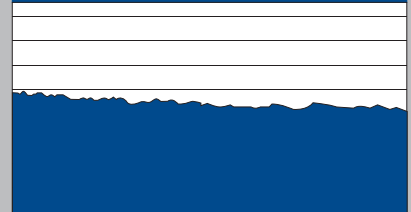
As a result, a hydrophobic coating was designed that inhibits corrosion, slows down erosion and improves the fluid flow.

When compared to polished stainless steel, it was found that [Belzona 1341 \(Supermetalglide\)](#) was 15 times smoother. Incorporation of ceramic fillers also allows this material to resist erosion and protect the equipment for long service periods.

Polished Stainless Steel (Ra 1.19 um)



Belzona Polymeric Efficiency Coating (Ra 0.078 um)



Roughness comparison between polished stainless steel and Belzona 1341 (Supermetalglide). (Surface Inspection, Leeds University, 1989)

Specialised filler materials such as ceramics and aluminium oxide allow this epoxy coating to achieve incredible wear resistance.

SYSTEM SELECTOR

TYPE	BELZONA MATERIAL	DESCRIPTION
Metal repair/ rebuilding composite	Belzona 1111 (Super Metal)	Fully machinable repair composite based on a ceramic steel reinforced polymer system
	Belzona 1121 (Super XL-Metal)	A slow curing composite, intended for large repair areas
	Belzona 1311 (Ceramic R-Metal)	Repair composite for the rebuilding and protection of metal components damaged by erosion-corrosion
Erosion-corrosion protective coating	Belzona 1321 (Ceramic S-Metal)	High strength coating for the protection of metal surfaces subject to erosion-corrosion
	Belzona 1341 (Supermetalglide)	Hydrophobic smooth coating system for improving the efficiency of the fluid handling equipment
	Belzona 2141 (ACR-Fluid Elastomer)	Elastomeric polyurethane coating system designed for protecting areas subject to cavitation erosion
	Belzona 5811 (Immersion Grade)	Barrier coating for the protection of metallic and non-metallic surfaces operating under immersion conditions in contact with aqueous solutions

MAIN APPLICATION
AREAS WITHIN
HYDROPOWER INDUSTRY

Belzona materials offer solutions to equipment and structures:

- » Deteriorated penstock and draft tube
- » Corroded spiral casing
- » Turbines subjected to erosion, corrosion and cavitation
- » Transformer oil leaks
- » Roof leaks
- » Slippery surfaces
- » Spalled concrete
- » Damaged floors
- » Deteriorating walls
- » Pipework leaks



Belzona is not just a product manufacturer but strives to provide a complete supply and apply package through its Global Distribution network. This network was specifically created to provide clients with direct access to Belzona quality products, specialist application services, inspection services and supervision. It is Belzona's mission to meet specialist repair and maintenance needs in its target industries and markets worldwide.



IRREPARABLE? - BELZONA TAKES ON THE CHALLENGE!

Belzona polymer technology bypasses need to replace expensive equipment on Francis turbine

A Francis turbine in a hydroelectric power plant was left in a terrible state of repair following impact from debris in the water in conjunction with erosion and corrosion. As Francis turbines are subject to high pressure flows, the client required a solution that would provide long-term, durable protection against erosion corrosion and impact damage from objects in the water.

Instead of replacing the turbine which would have incurred not only lengthy shutdowns for repair work but also expensive equipment replacement costs, the Belzona system was specified and applied.

The wicket gates and stay vanes were grit blasted and rebuilt using a durable, corrosion resistant composite, [Belzona 1111 \(Super Metal\)](#). A hydrophobic smooth epoxy coating [Belzona 1341 \(Supermetalglide\)](#) was used to protect the runner from erosion-corrosion and create a smooth surface improving flow. After the overhaul and coating of both the wicket gates and the runner the client saw an increase in output of 10-15%. After three years in service minor damage was repaired due to impact with objects in the water. Some remedial work was also carried out following a flood in 2006. The client expressed himself happy with the application. ■



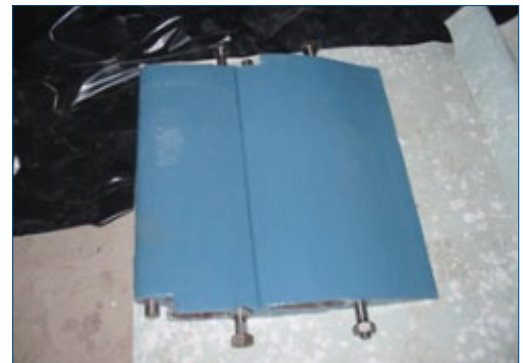
Damaged wicket gate blade



Blade after grit blasting



Blade after rebuilding with [Belzona 1111 \(Super Metal\)](#)



Blade after coating with [Belzona 1341 \(Supermetalglide\)](#)



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