

## Superior Composite Technology Developed for Pipe and Tank Repair and Protection

Already with a 100% application success rate, Belzona's high-tech pipe wrap repair system has undergone a major reformulation and enhancement.

Belzona Research and Development Manager, Jevon Pugh said, "Following the success and popularity of Belzona SuperWrap over the course of seven years, our R&D team has been busy developing and redesigning numerous aspects of the technology to create a superior composite repair and protection system, Belzona SuperWrap II."

Belzona SuperWrap II has achieved compliance with industry standards; ISO 24817 (Composite Repairs for Pipework) and ASME PCC-2 Article 4.1 (Nonmetallic Composite repair systems: high risk applications).



[Application of SuperWrap II on pipe spool]

### 100% Application Success Rate for Belzona SuperWrap II Predecessor

With no recorded failures to date, Belzona SuperWrap is already a major player in the repair and maintenance of pipework and tanks. This compliant composite repair method restores strength to weakened or holed metallic substrates without the need for hot work or lengthy downtime.

Specially developed for use on a variety of geometries including bends, straights and tees, it can also be applied as a patch repair to large diameter pipes (over 600mm) and tank walls. Due to its versatility and up to 20 year design life (in accordance with ISO 24817), Belzona SuperWrap has proven highly popular amongst pipework and pipeline maintenance engineers.

### A Simple, Two-part Epoxy Resin System

Driven by SuperWrap's success and popularity, the Belzona R&D Department conducted a rigorous series of independent and in-house tests to determine ways in which the system could be enhanced. These tests include Young's modulus, Poisson's Ratio, Shear Modulus, Thermal expansion, Glass Transition Temperature, Shore D Hardness and Lap Shear

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testing, 1000 hour survival tests for through wall and thin wall defects, physical testing to validate that the repair system strength meets the values generated by the independent laboratory testing. Following this careful and painstaking process, SuperWrap II was born.

The new wrap system comprises of two Belzona products; a cold curing fluid grade epoxy resin and a hybrid reinforcement sheet consisting of glass fibre and carbon fibres, which have been woven together to give an optimised balance of strength and flexibility.

In order to achieve a versatile product, SuperWrap II is now available with two different resin grades, Belzona 1981 and Belzona 1982. The main difference between these resin grades is the end service temperature and working life of the resin. Belzona 1981 has been developed for cool ambient temperatures above 5°C and has a maximum service temperature of up to 60°C, while Belzona 1982 has been designed for warm ambient temperatures above 20°C and has a maximum service temperature of up to 80°C.

Both grades use the same Belzona 9381 Reinforcement Sheet and Belzona 9382 Release Film. Belzona 9381 reinforcement sheet is a bespoke hybrid fabric combining glass fibre and carbon fibres. The glass fibre gives the sheet flexibility and acts as a wet out indicator, whereas the carbon fibre gives the applied composite the strength it needs to withstand high pressures and mechanical loading.

### **Superior Composite Technology Four Times Stronger than Predecessor**

Three key areas of SuperWrap II have been enhanced, these include:

- Young's Modulus (higher)
- Poisson's Ratio (lower)
- Thermal Expansion Coefficient (to align with steel)

A common problem encountered by maintenance engineers when repairing pipework is pressure from the pipe acting on the defect area which can cause the repair material to bend. To address this, SuperWrap II exhibits a high Young's modulus, approximately 38000 MPa, meaning the material will retain an extremely high level of stiffness and resist bending forces.

The new formulation also exhibits a low Poisson's ratio, 0.26. This relates to the negative ratio of transverse to axial strain which occurs when a material is elongated in one direction, it usually tends to thin in the other two directions perpendicular to the direction of expansion. This means that with a low Poisson's ratio, once the repair is put under stress, it will resist changes to its original profile.

The Thermal Expansion Coefficient of the system is a key value, this is the rate in which the repair will expand or contract with temperature change. If this coefficient is significantly different to that of the substrate material, changes in temperature will induce stresses, which can be detrimental to the repair. To combat this, SuperWrap II exhibits very similar thermal expansion coefficient to steel, approximately 0.00001 mm/mm°C, which means both the system and the substrate will expand and contract at a similar rate, thus minimising this problem.

The result of all these improved properties is a repair system that is four times stronger than its predecessor. This means a thinner repair can be engineered whilst still withstanding

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similar pressures, allowing for reduced downtime, material and labour costs, due to the shorter application time and lower volume of material required.

### Testing Performed- Wrap Outlasts Steel

During the Annex C test (ISO 24817) and Appendix III (ASME PCC-2 Article 4.1), a test designed to rebuild the damaged section of pipe back to its original yield strength, the repair withstood the calculated yield pressure of the substrate, whilst the original steel profile showed signs of yielding.

The test involved machining a 125mm x 62.5mm rectangular defect into a 250mm diameter pipe (2000mm in length). The original wall thickness of the pipe was 10mm, and in the defect area this was reduced to 2mm. The yield pressure of the undamaged spool was calculated to be 39.2MPa, a repair was engineered to restore the pipe to this original pressure.

The repair was applied to specification and the pipe was then pressurised up to 39.2MPa, without failure, demonstrating that the Belzona SuperWrap II had performed as designed. Pressure was then increased to determine where a yielding would occur – in the repair or in the original pipe. At around 42MPa, the pipe clearly yielded, outside of the repair area. This demonstrated that not only had the wrap returned the pipe to its original strength, it had also made the defect area stronger than the original pipe section.



[Pressurised to target pressure of 39.2MPa, pressure taken 5% over, no failure seen, but substrate began to yield]

### Quick and Easy Application Procedure

The fluid grade product and simple wet out procedure enables quick application times along with wet on wet application procedure.

- 1) First apply the selected resin grade product, Belzona 1981 or Belzona 1982, to the blasted substrate.
- 2) On to this, the Belzona 9381 reinforcement sheet, wetted with the selected low density resin (Belzona 1981 or Belzona 1982), is spiral wound onto the repair area, adding strength.

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- 3) When all wraps have been applied to specification, further resin grade product is then applied on top of the reinforcement layers if required.
- 4) The repair is then consolidated by tightly wrapping the Belzona 9382 Release Film over the repair area, ensuring a high quality laminate, with no air entrapment or voids.

Because this system uses higher density carbon and glass reinforcement than most, typically only three or four spirals or wraps are required, significantly cutting application time when compared to other systems.

The following video shows application of Belzona SuperWrap II:

Resin Grade	Resin Colour	Cure Temperature	Minimum Cure Time [Return to Service]
Belzona 1981	Blue	5°C >10°C	48 Hours 24 Hours
Belzona 1982	Green	>20°C	24 Hours

### Fully Compliant with Industry Standards

Where once maintenance engineers had doubts regarding composite technology, this repair system now sits at the forefront of pipework repair and maintenance.

Although composite technology was widely used and understood by sectors including automotive and aerospace, and was well established in the glass reinforced plastic (GRP) pipe industry, its use for the repair of steel pipes had been based upon experimentation rather than mathematical design. This, compounded by inconsistent application standards, led to composite repairs historically operating with varying degrees of success.

However, the publication of two international standards in 2007 has changed all of this and this technology sector is growing rapidly. These standards are:

- ISO/TS 24817- Composite repairs for pipework- qualification and design, installation, testing and inspection
- ASME PCC-2 Article 4.1- Non-metallic composite repair systems for pipelines and pipework: high risk applications

Now all aspects of composite pipe repairs are governed by these standards, from the prequalification of materials and repair systems, the design of a repair specific and 'fit for purpose' for the individual pipe defect, to the training and validation of applicators. Application quality forms a major part of these standards because, as with welding, even the best material in the world incorrectly applied will not perform as required.

The standards recognise that repairs must be applied to the required standard, stipulated in the design, i.e. the same manner as the compliance testing from which much of the performance data used in design is derived. They also require that all installers be validated

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through training and consequently pressure tests are carried out to confirm that an installer can produce work to the required standard.

### Theoretical and Practical Training

In addition to improving the material's characteristics, Belzona has also perfected the theoretical and practical training courses to ensure Belzona SuperWrap II designers, installers and supervisors are fully trained and proficient in the use of the system. These improvements include an online training module that covers the majority of the theoretical aspects which is required to be completed before attending the SuperWrap II practical training course.

This allows for more hands on time in an extended practical session, further improving the skills of the installer. The installer training course is a pass or fail course, so only the highest skilled installers are allowed to apply Belzona SuperWrap II, ensuring the product is applied in the way it was intended thus maintaining our high standards of application.



[Belzona SuperWrap II can be used in a variety of application areas]  
[Theoretical and practical training available at Belzona head offices]

### Belzona SuperWrap II- The Complete Package

Quick and simple to apply, this compliant composite repair system, consisting of a resin, reinforcement sheet, and release film, restores strength to weakened or holed metallic substrates without the need for hot work or lengthy downtime. Other benefits include:

- Suitable for service temperatures 5°C to 80°C
- 24 hour back in service (48 hour back in service at <10°C)
- Long usable life in hot climates (30 minutes at 30°C)
- Convenient mixing ratio
- Easy to apply (minimal downtime, simple techniques, ease of wetting out)
- Thermal expansion coefficient close to steel
- High Young's modulus
- Low Poisson's ratio

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For further information on this application or to book an appointment with your local Belzona representative visit [www.belzona.com](http://www.belzona.com)

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**Notes to Editor;**

**About Belzona:**

- Established in 1952, Belzona has pioneered innovative polymer technology that has revolutionised industrial repair and maintenance procedures.
- Belzona is a leading company in the design and manufacture of polymer repair composites and industrial protective coatings for the repair, protection and improvement of machinery, equipment, buildings and structures.
- At Harrogate, the full Belzona product range is manufactured to stringent quality and environmental control guidelines complying with the requirements of ISO 9001:2008 and ISO 14001:2004.
- Belzona has over 140 Distributors in more than 120 countries ensuring not only the availability of Belzona materials, but also specification support, project management, application and supervision services. Distributorships and their teams are supported by Belzona Corporate offices in Europe, North America and Asia.

**About this article:**

- High resolution images, if not supplied with the email, are available on request.
- The article can be altered, lengthened or shortened upon request.
- Can we contribute to the article you are writing? We can provide images, technical data, case studies or an interview with one of our technical service representatives. Please let us know if this would be of interest.
- Do you have an upcoming topic that we could contribute an editorial on? Please let us know the topic, preferable length and the material submission deadline.

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