# The Use Of GRP
## In The Mine Site
# Environment

How the use of fibre reinforced plastics for containment, handling and treatment of corrosive industrial chemicals and gases can be used in the mine site.

FGS COMPOSITES

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# Application of GRP

Design engineers have traditionally selected metallic pipe materials for large-diameter water conveyance projects such as mining operations. Materials used have typically been steel or ductile iron, with an internal cement mortar lining to protect against corrosion from poor water quality. Although plastic pipes such as High Density Polyethylene (HDPE) and PVC are hydraulically smoother than metallic pipes, the primary reason for their exclusion in large diameter applications is that they are not cost-competitive with metallic pipes.

- GRP pipe is highly resistant to internal and external corrosion from the aggressive (hyper-saline and moderately acidic) groundwater, which removed the need to apply protective coatings or sleeving;
- GRP pipe is non-conductive, and given the proximity of the transfer pipeline to a high- voltage powerline along much of its alignment, this removed the need for earthing;
- Multiple fittings may be cast monolithically into a single length of GRP pipe, thereby reducing the number of individual fittings and flange connections required. This reduced supply costs, as well as the cost and time associated with installation of the pipeline;
- The modulus of elasticity for GRP is significantly lower than for DICL pipe, resulting in lower transient wave speeds during water hammer events. This meant that expensive water hammer mitigation infrastructure was no longer required, resulting in significant cost savings;
- GRP pipe has a smoother internal surface than DICL pipe, resulting in fewer friction losses along the transfer pipeline. This in turn reduced the required pumping head by approximately 10 metres, lowering the capital costs
- GRP pipe can be supplied in lengths of 12 metres, which is double the standard length of metallic pipes. Consequently fewer pipe connections were required, resulting in faster installation time and associated cost savings;
- GRP pipe is approximately half the weight of metallic pipe per unit length, which results in faster transportation (as more pipe can be transported in a single load) and pipe installation;
- GRP pipe can be stored outdoors in aggressive environments indefinitely without any effect on performance.

# Non-corrositivity

Testing has shown that GRP pipe can withstand long-term exposure to aggressive internal and external environments. An investigation was conducted by Norwegian manufacturer, *Amiantit Fibreglass Industries* who excavated a 25-year-old GRP pipe from salt-laden soils immediately downstream of a sewerage discharge tank. This pipe was subjected to a series of tests, after which it was found that the physical and chemical integrity of the pipe had not diminished (Amiantit 2005).

The non-corrositivity of GRP negates the need for additional protection measures against internal and external corrosion, such as inert coatings and sleeving.

# Modulus of elasticity

As for the majority of plastic pipes, GRP pipe has a modulus of elasticity that is much lower than for metallic pipe materials such as DICL or steel (24,000 MPa for GRP compared to 165,000 MPa for DICL). This property has a direct effect on the transient wave speed (celerity) propagating through the fluid medium during water hammer events. The lower modulus of elasticity associated with GRP considerably reduces the celerity and therefore the impact on the water supply infrastructure associated with water hammer effects. The calculated celerity in a DN600, PN20 GRP pipe is approximately 610 m/s, compared to approximately 955 m/s for the equivalent size and pressure rating in DICL.

# Smooth internal surface

The most significant advantage of GRP with regard to operational efficiency is the smooth internal surface that is characteristic of plastic pipes. GRP pipes have a roughness height of approximately 0.035 mm (Iplex Pipelines Australia 2008) whilst DICL pipes have a roughness height of approximately 0.15 mm (Tyco Flow Control 2000). GRP pipe will maintain its smooth surface for a number of years whilst DICL is prone to pitting and scaling of the internal concrete surface over time.

The smooth internal surface of GRP pipe results in significantly lower frictional head-loss during operation. Consequently, a lower pressure head is required to pump the water through the transfer pipeline during the life of the mine. This will create cost benefits through the selection of a smaller pump, leading to a reduction in power consumption during operation, as well as the immediate savings in terms of capital cost.

# Storage requirements

GRP pipe can be stored outdoors and unsheltered for an indefinite period with no impact to the integrity of the pipe, even in arid environmental conditions. The only effect is some weathering to the outer layer manifest by increased external roughness and discolouration of the pipe. This has no effect on the structural or chemical integrity of the pipeline.

# Rubber-ring jointing system

The standard jointing system for GRP consists of a spigot and rubber-ring coupling. This is a flexible jointing system which allows for a maximum deflection of 3° per joint for a DN600 PN20 pipe.

Although the standard jointing system for GRP pipes is spigot-coupling, it is possible to incorporate flanged connections as required. However, the cost of manufacturing flanged GRP pipes is high compared with DICL pipe, and as such the production of these is limited. As an alternative, GRP flange-spigot couplings can be fitted to the end of regular spigot-end GRP pipes. This allows for greater design flexibility, as the flanged coupling can be placed at any location along the pipeline by cutting the pipe as required.

# Method of Manufacture

Fibreglass-reinforced plastic is constructed by weaving together individual strands of fine glass fibre to form a flexible fabric, which is then placed in a mould and combined with resin. This process is then repeated in order to create many layers of the fibreglass and resin, which then becomes a high performance material of exceptional strength and versatility. The resin most commonly used in GRP is unsaturated polyesters dissolved in styrene.

Polyesters can be tailor-made to specific industry requirements.
Owing to its strength, durability and non-corrosive properties, GRP pipe systems have a longer life expectancy when compared to a variety of construction materials, making it massively economical over the long run.

Furthermore, glass reinforced plastic pipes are considerably less expensive than those manufactured from materials such as stainless steel or more exotic materials that are required in the metallurgical processing industry.

Due to its unique physical properties, glass-reinforced plastic can be easily moulded and manufactured to meet almost any industry specifications. With GRP, there are few constraints on size, shape, colour or finish.

Pound for pound, GRP is stronger than steel and sheet metals, has a high resistance to environmental extremes, and is resistant to ultra violet light, extreme temperatures, salt air, and a variety of chemicals including most acids.

Different types of resins used for manufacturing GRP, GRV and GRE pipes are Isophthalic resin, Vinylester resin and Epoxy resin respectively that are selected according to the required properties like chemical resistance, temperature resistance and mechanical properties. The resins provide thermal and chemical properties such as glass transition temperature, resistance to heat, chemical resistance, etc. required for finished product.

The properties of GRP pipes can be varied by changing the ratio of raw materials as well as the winding angle. These pipes consist of three layers adherent to each having different characteristics in relation to functional requirement.
*Inner Liner – Veil (Glass), Resin: CSM (Glass), Resin*
*Structural wall - Roving (Glass), Resin*
*External Liner- Veil (Glass), Resin*

*Inner Liner – Veil (Glass), Resin: CSM (Glass), Resin*
Inner Liner one is chemical resistant being in direct contact with fluid and therefore, responsible to resist chemical corrosion as well as permeability.

*Structural wall - Roving (Glass), Resin*
Glass Reinforced layers guarantee the mechanical resistance of the whole pipe against stresses due to internal and external pressure, external loads as well as thermal loads. For GRP / GRV pipes, the layer is obtained by applying on the previous partly cured liner continuous riving of glass wetted with resin under controlled tension. For GRE pipes, the structural wall is wound directly on a wet liner. The layer can contain aggregates like silica sand if allowed by specifications while thickness depends on design conditions.

*External Liner- Veil (Glass), Resin*
Topcoat or external liner is the outer layer of pipe consisting of pure resin. UV protectors may be added if so required to protect the pipe from solar exposure. In case of severe exposure condition like aggressive soils or very

corrosive environment, the external liner can be reinforced with a surfing veil or added with filters or pigments.

Fibreglass composites consist of glass fibre reinforcements, thermosetting resins and additives designed and processed to meet specific functional performance criteria.

Amount, type and orientation of glass fibres in pipe provides mechanical strength. C Glass, E glass and ECR / Advantex glass are used commonly depending on pipe application. Various forms of glass reinforcements are surface veil, chopped strand mat (CSM), chopped roving, filament roving and woven roving (WR).

Raw materials like catalyst, accelerators, inhibitors, aggregates and pigments are used together with resin and glass reinforcements to achieve desired properties of Fibreglass products. Catalyst is an organic compound which when added to resin in presence of an accelerator, determines the polymerisation reaction at ambient temperature. Acceletor is a chemical compound used together with a catalyst to shorten the polymerisation time. Inhibitor is added to the resin to reduce reactivity at ambient temperature. There are two manufacturing processes; Dual helical filament winding process and the other being Continuous winding process (Drostholm)

# Pipe Repair Bandage

Pipe repair bandage is an instant emergency pipe repair system that is simple to use with no mixing or measuring required.  Bandages have a woven fibreglass substrate impregnated with a water-activated polyurethane resin.

The repair bandage's ability to perform effectively in emergency situations greatly reduces costly downtime and production loss. Because of the product's ease of use, it can be applied by practically any applicator as long as they follow the application instructions from the bandage manufacturer.

Repair bandage is used for your temporary emergency pipe repair needs. It is simple to use, with no mixing or measuring required. A successful pipe repair can be achieved in only 30 minutes.

The bandage includes a woven Fibreglass bandage impregnated with a water-activated polyurethane resin. Used along with a putty which is hand-mixable it can be moulded into any shape to fill cavities, cracks or holes for a more successful repair.

The Bandage method can be used on all types of pipes including stainless steel, copper, PVC, steel, rubber, concrete, metal, galvanised, Fibreglass, and polypropylene. It can be applied on cracked, fractured, corroded, damaged and leaking pipes, around difficult shapes, straight lengths, tee and elbow joints, couplings and clamps. It is suitable for use on wet or dry pipes. It can even be applied underwater, in fresh or saltwater.

The bandage bonds to most pipe substrates, including copper, metal, PVC and polyurethane.

The bandage is resistant to most chemicals, including harsh solvents such as MEK, hydrochloric acid and gasoline. These chemicals do not cause any softening of the bandage. Its heat resistance is 150° Celsius; anything over this could cause toxic fumes.

# FRP (Fibre Reinforced Plastic) Pipes

Fibre-reinforced polymers/plastics is a recently developed material for strengthening of RC and masonry structure. This is an advanced material and most of the development in its application in structural retrofitting has taken place in the last two decades. It has been found to be a replacement of steel plate bonding and is very effective in strengthening of columns by exterior wrapping.

The main advantage of FRP is its high strength to weight ratio and high corrosion resistance. FRP plates can be 2 to 10 times stronger than steel plates, while their weight is just 20% of that of steel. However, at present, their cost is high.

FRP composites are formed by embedding a continuous fibre matrix in a resin matrix. The resin matrix binds the fibre together and also provides bond between concrete and FRP. The commonly used fibres are Carbon fibres, Glass fibres and Aramid fibres and the commonly used resins are polyester, vinyl ester and epoxy. FRP is named after the fibre used, e.g. Carbon Fibre Reinforced Polymer (CFRP), Glass Fibre Reinforced Polymer (GFRP), and Aramid Fibre Reinforced Polymer (AFRP).

The fibres are available in two forms

(i) Unidirectional tow sheet, and
(ii) Woven fabric.

The application of resin can be in-situ or in the form of prefabrication of FRP plates and other shapes by pultrusion. The in-situ application is by wet lay-up of a woven fabric or tow plate immersed in resin. This method is more versatile as it can be used on any shape. On the other hand, prefabrication results in better quality control. The manufacturers supply these materials as a package and each brand has a specific method of application, which is to be followed carefully. Specialised firms have developed in India also, which take up the complete execution work and supply of material. It is important to note the difference between the properties of steel and FRP and it should be understood that **FRP cannot be treated as reinforcement in conventional RC design methods**.

RTRP stands for reinforced thermosetting resin pipe, a composite material consisting of a thermosetting polymer, a type of polyester reinforced with glass or other fibres that provide strength and stiffness to a composite material.

# Basalt Fibre

Basalt Fibre is a material made from extremely fine fibres of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. It is similar to Fibreglass, having better physicomechanical properties than fibreglass, but being significantly cheaper than carbon fibre.

Basalt Fibre is made from a single material, crushed basalt, from a carefully chosen quarry source. Basalt of high acidity (over 46% silica content) and low iron content is considered desirable for fibre production. Unlike other materials, such as glass fibre, essentially no materials are added. The basalt is simply washed and then melted.

The manufacture of basalt fibre requires the melting of the quarried basalt rock at about 1,400° C (2,550° F). The molten rock is then extruded through small nozzles to produce continuous filaments of basalt fibre. There are three main manufacturing techniques, which are centrifugal-blowing, centrifugal-multiroll and die-blowing. The fibres typically have a filament diameter of between 9 and 13 µm, which is far enough above the respiratory limit of 5 µm to make basalt fibre a suitable replacement for asbestos. They also have a high elastic modulus, resulting in excellent specific strength—three times that of steel.

Basalt fibre is used more and more in the fabrication of concrete reinforcing, bridge building, tanking, piping, etc. It is very cost competitive, exhibits greater strength than glass, has much better abrasion, heat and chemical resistance and is extremely impact resistant.

The corrosion resistance of fibreglass has resulted in extensive use in the mining industry. Saline cooling water and wet gas streams containing hydrogen sulphide at temperatures up to 130° C are corrosive to many materials but GRP offers longevity and strength in these applications. Subsea cooling water intakes and outfall pipelines and diffusers are also manufactured from GRP, which offers longevity in the saltwater environment.

“FGS Composites have completed circulating and cooling water pipe projects in remote locations like Papua New Guinea.”

**<u>Newcrest Mining (Lihir, PNG)</u>**
*– Refurbish and replacement of FRP pipelines, scrubbers, grating and other miscellaneous components. Undertaking innovative procedures to maximise time efficiency during short shutdown timeframes. Fabrication of conveyor stacker structural support and conveyor belt tensioners.*

Today the company continues to be a market leader in the use of fibreglass for containment, handling and treatment of corrosive industrial chemicals and gases. In order to provide high performance cost competitive solutions to the diverse needs of industry we draw upon international expertise, where required, which complements our internal skills and proven experience. The result is a unique organisation - one capable of the design, production, supply and installation of equipment which handles corrosive and polluting materials for the needs of the mining industry today, and into the future.

# To Get More Information About OUR SERVICE

The most discriminating mine maintenance managers rely on FGS to take care of their fibreglass and composite solutions.
We offer:

- ✓ Engineering
- ✓ Analysis
- ✓ Design assistance
- ✓ Process development
- ✓ Tooling fabrication
- ✓ Composite plastics
- ✓ Emergency FRP Pipe Repair
- ✓ Metal fabrication
- ✓ Assembly
- ✓ Project management

We are a unique company capable of the design, production, supply and installation of equipment, which handles corrosive and polluting materials for the needs of the mining industry today, and into the future.
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