BluGeo GRP Ground Systems
GRP CONTINUOUSLY THREADED BAR SYSTEMS

WHAT IS IT?
BluGeo GRP Ground Systems are a Glass-Fibre Reinforced Plastic (GRP) continuously threaded bar system (Powerthread, Spinset, Spinmax & Powermesh), suited to applications in ground stabilisation and civil engineering projects.
BluGeo GRP Ground Systems offer high tensile strength, ability to carry high loads and long term corrosion resistance for anchoring and soil nailing projects.

WHERE DO WE USE BLUGEO GRP GROUND SYSTEMS?
BluGeo GRP Ground Systems is an economical alternative to steel and offers advantages for numerous applications.
- Face stabilisation
- Slope stabilisation
- Ground support
- Systematic rock bolting

WHY BLUGEO GRP GROUND SYSTEMS?
Available for left or right hand drilling
- High corrosion resistance
- Permanent and temporary application
- Cuttability
- High tensile strength
- Flexibility
- Low weight and easy handling
- Non conductive material
- Economical versus steel
BluGeo GRP Ground Systems

PRODUCT SUPPORT

RESEARCH, EXPERIENCE, PRODUCT, SUPPORT

BluGeo GRP Ground Systems is manufactured and supported by Minova International Ltd, a company with 50 years of accumulated experience in providing products for the mining industry.

Minova’s range of products includes resin capsules for rock bolting, high volume output grouts for strata support, ventilation control devices and specialised strata support coatings.

BluGeo GRP Ground Systems is a system of Glass-Fibre Reinforced Plastic (GRP) solid continuous thread bar and self drilling anchors (SDA) with advanced strength and head load. It was developed for strata support in mining and tunnelling as well as for slope and face stabilisation.

BACKED BY ORICA

Minova is part of the Orica Group (www.orica.com) which provides products and services to the mining, manufacturing and construction and consumer markets. Orica, with a market capitalisation of approximately AU$7 billion, is one of the top 50 companies listed on the Australian Stock Exchange, and has over 13,000 employees in approximately 50 countries and services customers in 98 different countries around the world.
BluGeo GRP Ground Systems

PRODUCT APPLICATIONS

Suitable where additional durability or ease of application is required over traditional anchoring systems.

APPLICATIONS:

Ground Stabilisation
Tunnelling
Soil nailing
Ground anchors
Rock bolting
# BluGeo GRP Ground Systems

## PRODUCT FEATURES & BENEFITS

<table>
<thead>
<tr>
<th>KEY FEATURES</th>
<th>KEY BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Corrosion Resistance</td>
<td>BluGeo GRP Ground System bars have durability exceeding 100 year life expectations. The bars are resistant against acid attack as well as against alkaline attack and provide long service life in aggressive soil conditions. It offers an environmentally friendly solution and significant repair and maintenance cost reduction. Supply cost is reduced with less layers of corrosion protection.</td>
</tr>
<tr>
<td>Cuttability</td>
<td>The cuttability of BluGeo GRP Ground System bar protects machinery and equipment and prevents damage to machinery while drifting and enlarging tunnels.</td>
</tr>
<tr>
<td>All-Thread Bar</td>
<td>Due to its continuous thread profile, BluGeo GRP Ground System bar can be trimmed if needed. The bar has a high ultimate strength and due to its profile it offers maximum bondage with all grouting material and also concrete.</td>
</tr>
<tr>
<td>High tensile strength</td>
<td>BluGeo GRP Ground System bar has double the strength of normal steel, but the weight is only a quarter of steel.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>The high flexibility of BluGeo GRP Ground System bar is well suited for applications without couplings in confined locations.</td>
</tr>
<tr>
<td>Light weight</td>
<td>Due to the low density of glass and resin, BluGeo GRP Ground System bars show a density, which reaches just 30% of the density of steel. The low weight facilitates handling and reduces risk of injury to installers where manual handling is necessary. This feature minimises the transportation cost and can reduce dead loads of structures.</td>
</tr>
</tbody>
</table>
Bluey Technologies recognised that there was a need in the industry for a more efficient, economical and durable method for anchoring and soil nailing.
Benefits versus steel

**BENEFITS VERSUS STEEL**
- Lighter one man operation
- No need for Double Corrosion Protection (DCP)
- No risk of broken sheathing
- More economical than steel
- Quicker to install than steel
- Eliminates chance of corrosion - long term durability
- Non conductive material

**BLU G E O  P O W E R T H R E A D K 6 0**

<table>
<thead>
<tr>
<th></th>
<th>K60-25</th>
<th>K60-32</th>
<th>K60-38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer diameter</td>
<td>mm</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>Tensile stress area</td>
<td>mm²</td>
<td>346</td>
<td>580</td>
</tr>
<tr>
<td>Ultimate load</td>
<td>kN</td>
<td>350</td>
<td>560</td>
</tr>
<tr>
<td>Breaking load thread Steel Nut</td>
<td>kN</td>
<td>180</td>
<td>320</td>
</tr>
<tr>
<td>Breaking load thread FRP Nut</td>
<td>kN</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Breaking load thread Power Nut</td>
<td>kN</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Ultimate strength</td>
<td>MPa</td>
<td>1000</td>
<td>960</td>
</tr>
<tr>
<td>Torsion resistance</td>
<td>Nm</td>
<td>120</td>
<td>230</td>
</tr>
<tr>
<td>Shear resistance</td>
<td>MPa</td>
<td>460</td>
<td>430</td>
</tr>
<tr>
<td>Tensile E-Modulus</td>
<td>GPa</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Strain at failure</td>
<td>%</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Weight</td>
<td>kg/m</td>
<td>0.90</td>
<td>1.50</td>
</tr>
</tbody>
</table>
BluGeo GRP Ground Systems

PRODUCT COMPARISON

MATERIAL COST COMPARISON
Typical by component for 6.0 metre BluGeo Powerthread GRP and Steel soil nails

INSTALLED COST COMPARISON
Typical installed comparison for 6.0 metre BluGeo Powerthread GRP and Steel soil nails
**BluGeo GRP Ground Systems**

**ONSITE INSTALLATION**

BULK EXCAVATION TO FORM BENCHES AND FACE FOR ROW OF BLUGEO GRP GROUND SYSTEMS TO BE INSTALLED

Local trimming of face to achieve agreed tolerance prior to installation of BluGeo Powerthread K60

Bulk excavation to proposed formation

Existing ground

Installed BluGeo Powerthread K60

To be installed BluGeo Powerthread K60

**EXAMPLES OF FACING SYSTEMS USED IN A SOIL NAIL STRUCTURE**

**HARD FACING**

The combination of soil nails and facing has to fulfil the function of stabilising the slope between the nails, and shall therefore be dimensioned to sustain the expected maximum destabilising forces.

**FLEXIBLE FACING**

Flexible facings are designed to provide the necessary restraint to the areas of slope face between the bearing plates, as well as erosion control.

The common flexible facings include geogrids.

**SOFTWARE FACING**

The primary function of soft facing is erosion control and protection against surface ravelling. In many cases, the soft facing has to reinforce the vegetation layer, either in the temporary or the permanent situation. In some instances, nails serve only to retain the facing and not to stabilise the slope.

**WITHOUT FACINGS**

Nailing in case of critically inclined sliding surfaces (e.g. rock strata with reduced shear resistance), however with a stable surface.
BluGeo GRP Ground Systems

TEST DATA

Composite reinforcement manufacturing

BluGeo GRP Ground Systems are manufactured from the highest quality raw materials to produce the most durable finished products.

BluGeo GRP Ground Systems are manufactured in a special, open pulwinding process, based on modified pultrusion process.

Direct Rovings made of Glassfibres similar to EC-glass quality are impregnated in a matrix of vinyl ester resin (VE). This vinyl ester resin is based on a bisphenol-A-epoxy material with following properties:

- Insoluble - inert against strong chemical attack, being completely stable under exposed conditions once cured.
- Impermeable - water vapour diffusion resistant, means contaminated water or free ions cannot migrate through the resin and onto the surface of fibres.
- Heat resistant - safe for constant temperatures up to 80°C.

<table>
<thead>
<tr>
<th></th>
<th>GRP</th>
<th>Steel</th>
<th>Aluminium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific weight (kg/m³)</td>
<td>1900</td>
<td>7800</td>
<td>2700</td>
</tr>
<tr>
<td>Tensile strength (MPa)</td>
<td>1000</td>
<td>600</td>
<td>350</td>
</tr>
<tr>
<td>E-Modulus (GPa)</td>
<td>60</td>
<td>207</td>
<td>69</td>
</tr>
</tbody>
</table>

![Graph showing comparison of GRP Rod and Steel](image)
BluGeo GRP Ground Systems

TEST DATA

Tensile test with GRP bolts

Test Report No 456496:
EMPA, Swiss Federal Laboratories for Materials Science and Technology

TEST PIECE

Geometry of the test piece. The free GRP length was 1000mm. Both ends of the 2000mm long GRP bolt were glued into steel sleeves in the factory.

![Test Piece Diagram]

TEST SET UP

The cross head displacement and the force were measured. The measurement of the cross head displacement is subsequently designated as, ‘test machine displacement reading’. The strain was measured contactless with an image correlation system within a field with a length of $L_m=300$mm. The image correlation system took pictures with a frequency of 0.4Hz. The software calculated the surface profile and the displacements was $\pm 0.005$mm. The strain was calculated using the relative displacement between two selected points along the bolt axis.

![Test Setup Diagram]
**TEST RESULTS**

The table shows the results of the tensile tests and the Young's moduli. The maximum stress and the Young's modulus were calculated using the stress area shown.

<table>
<thead>
<tr>
<th>Name</th>
<th>Stress Area $A_s$ (mm²)</th>
<th>Maximum Force $F_u$ (kN)</th>
<th>Maximum Stress $F_u$ (MPa)</th>
<th>Strain @ 20%$F_u$ (%)</th>
<th>Strain @ 50%$F_u$ (%)</th>
<th>Strain @ 50%$F_u$ (%)</th>
<th>Young's modulus (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K60-32 GPR Bolt 1</td>
<td>580</td>
<td>633.0</td>
<td>1091</td>
<td>2.00</td>
<td>0.33</td>
<td>0.91</td>
<td>56.411</td>
</tr>
<tr>
<td>K60-32 GPR Bolt 2</td>
<td>580</td>
<td>732.9</td>
<td>1264</td>
<td>2.18</td>
<td>0.38</td>
<td>1.04</td>
<td>57.438</td>
</tr>
<tr>
<td>K60-32 GPR Bolt 3</td>
<td>580</td>
<td>688.5</td>
<td>1187</td>
<td>2.13</td>
<td>0.37</td>
<td>1.01</td>
<td>55.468</td>
</tr>
<tr>
<td>K60-32 GPR Bolt 4</td>
<td>580</td>
<td>694.9</td>
<td>1198</td>
<td>2.14</td>
<td>0.37</td>
<td>1.02</td>
<td>55.385</td>
</tr>
<tr>
<td>K60-32 GPR Bolt 5</td>
<td>580</td>
<td>698.5</td>
<td>1204</td>
<td>2.17</td>
<td>0.38</td>
<td>1.03</td>
<td>55.794</td>
</tr>
<tr>
<td>Mean value</td>
<td></td>
<td><strong>698.6</strong></td>
<td><strong>1189</strong></td>
<td>2.12</td>
<td>0.37</td>
<td>1.00</td>
<td><strong>56.099</strong></td>
</tr>
<tr>
<td>Standard deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>32.2</td>
</tr>
</tbody>
</table>

**Specimens 1-5**

- K60-32 GPR Bolt
- K60-32 GPR Bolt
- K60-32 GPR Bolt
- K60-32 GPR Bolt
- K60-32 GPR Bolt
Tensile test with GRP & Steel Nuts & Steel Couplings

TEST PIECE

The figures show the geometry of the test pieces for the tests with the nuts and coupling. One end of the test piece was glued into a steel sleeve in the factory and the other end was equipped with (1) a GRP nut plus a GRP plate or a steel nut. 2 sizes of steel nuts were tested - 150mm and 200mm. The free end of the bolt had a length of 40mm.

For the coupler test, one end was equipped with an over-the-bolt glued steel sleeve and the other end with a steel nut. The free end of the GRP bolt had a length of 110mm. The two GRP bolts were joined together with the Steel Coupler, which was centrically attached to both bolt ends with the ends touching each other.
**TEST SET UP**

To prevent eccentric loads from acting on the test pieces a steel plate with a hole diameter of 34mm was placed underneath the nuts. This plate was protected by a washer in the case where steel nuts were tested. The steel sleeve at the other end was clamped.

**TEST DATA**

<table>
<thead>
<tr>
<th>Name</th>
<th>Breaking Load GRP Nut &amp; Plate (kN)</th>
<th>Breaking Load Steel Nut 150mm (kN)</th>
<th>Breaking Load Steel Nut 200mm (kN)</th>
<th>Breaking Load Steel Coupling (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K60-32 - 1</td>
<td>131.2</td>
<td>435.2</td>
<td>534.7</td>
<td>334.8</td>
</tr>
<tr>
<td>K60-32 - 2</td>
<td>125.8</td>
<td>419.4</td>
<td>401.6</td>
<td>338.8</td>
</tr>
<tr>
<td>K60-32 - 3</td>
<td>145.2</td>
<td>507.4</td>
<td>468.0</td>
<td>327.3</td>
</tr>
<tr>
<td>K60-32 - 4</td>
<td>132.1</td>
<td>363.8</td>
<td>487.0</td>
<td>342.3</td>
</tr>
<tr>
<td>K60-32 - 5</td>
<td>127.0</td>
<td>413.2</td>
<td>517.7</td>
<td>297.6</td>
</tr>
<tr>
<td>Mean value</td>
<td>132.3</td>
<td>427.8</td>
<td>481.8</td>
<td>328.1</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>6.9</td>
<td>46.4</td>
<td>46.3</td>
<td>16.1</td>
</tr>
</tbody>
</table>

**TEST RESULTS**

The table shows the force - test machine displacement relationships for the test with GRP nuts, steel nuts and Steel Couplers.
TEST RESULTS

Displacement relationships for the tests with normal GRP nuts and Bolts, steel nuts 150mm, steel nuts 200mm and steel couplers.

<table>
<thead>
<tr>
<th>Component</th>
<th>Mean breaking load (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powerthread K60-32</td>
<td>690</td>
</tr>
<tr>
<td>GRP Nut &amp; Plate</td>
<td>132</td>
</tr>
<tr>
<td>Steel Nut L = 150mm</td>
<td>428</td>
</tr>
<tr>
<td>Steel Nut L = 200mm</td>
<td>482</td>
</tr>
<tr>
<td>Steel Coupler L = 250mm</td>
<td>328</td>
</tr>
</tbody>
</table>
BluCeM HS200 is a high fluidity, low bleed and high compressive strength structural grout, approved for use with the BluGeo GRP Ground System.

WHERE DO WE USE BLUCEM HS200?
BluCeM HS200 has been specifically designed and tested to meet the onerous specification requirements demanded by road authorities for use in grouting of post tensioned cables in bridges and other structures and for use in grouting of ground anchors and soil nails.

WHY BLUCEM HS200?
The product meets road authority specification requirements with regard to:
- Constant high fluidity for 45 minutes to ensure flow, penetration and encapsulation throughout the pumping and placement cycle
- Very low bleed for absolute engagement of cables and anchors for load transfer
- High early strength for early loading of cables and anchors
- High ultimate strength to provide a dense, low permeability grout medium for long term durability
- Limited volume change provides a stable grout matrix within the filled void.
BluGeo GRP Ground Systems

PACKAGING

PRE BLENDED BULK BAGS

BluCem HS200 can be delivered in a range of packaging formats to suit site requirements. This includes both additive and pre-blended formats.

Contact your local Bluey representative for further advice.
Bluey Technologies

PRODUCT RANGE

- **bluCem**
  - BluCem AP10
  - BluCem RF20
  - BluCem FC
  - BluCem HB range
  - BluCem HE10
  - BluCem HE80
  - BluCem HE80AG
  - BluCem HE80HT
  - BluCem HS100 range
  - BluCem HS200 range
  - BluCem EA02
  - BluCem GP60
  - BluCem UF40
  - BluCem UW range

- **bluGeo**
  - BluGeo Powerthread range
  - BluGeo SD Anchors range
  - BluGeo ST Rock Bolts range
  - BluGeo Swellex range
  - BluGeo Tekflex

- **bluRez**
  - BluRez Crackseal 111
  - BluRez Crack Seal 150
  - BluRez Crackseal NV
  - BluRez Carbostop
  - BluRez Carbostop 42D
  - BluRez Epoxy 225
  - BluRez Epoxy 480
  - BluRez Epoxy 480UT
  - BluRez Epoxy 575 CG
  - BluRez Epoxy 655

- **bluSeal**
  - BluSeal Anchor Knob Sheet
  - BluSeal Britdex Membrane
  - BluSeal Moulding Putty
  - BluSeal Dust Control 10
  - BluSeal Road Sealer 10
  - BluSeal Containment Liner
  - BluSeal PVC Tunnel Liner
  - BluSeal Injection Kit
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