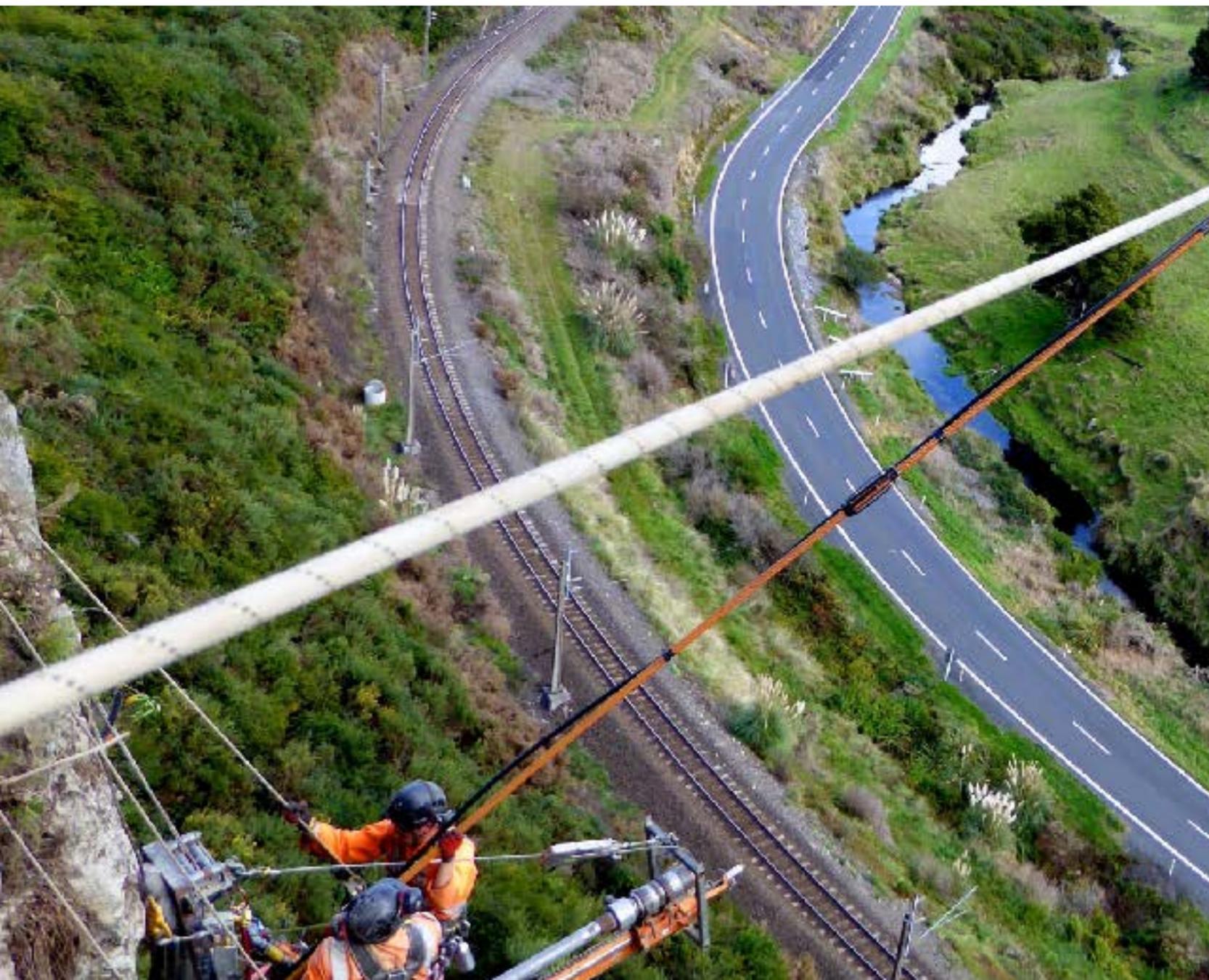






Bluey Technologies

BluGeo GRP Soil nails and anchors

An aerial photograph showing a construction site for a major infrastructure project. A large, light-colored cable is being laid across a valley. Below the cable, a winding road and a railway track are visible, along with a small stream. Two workers in orange safety gear are positioned on a platform or structure in the foreground, working on the cable. The surrounding landscape is green and hilly.

Bluey Technologies is a supplier of construction products for major civil engineering infrastructure works.

Our operations now span Australia & New Zealand, Asia, Europe and the UK.



BluCem

Flowable Grout

Deep Pour Grouts

Fast Setting Grouts

PT Grouts

Repair Mortars

Shotcretes

Floor levelling

Recycled glass products





BluGeo

GRP Soil Nails

GRP Mesh

DCP Rock Bolts

DCP Cable Bolts

Removable Ground Anchors

Permanent Ground Anchors





BluSeal

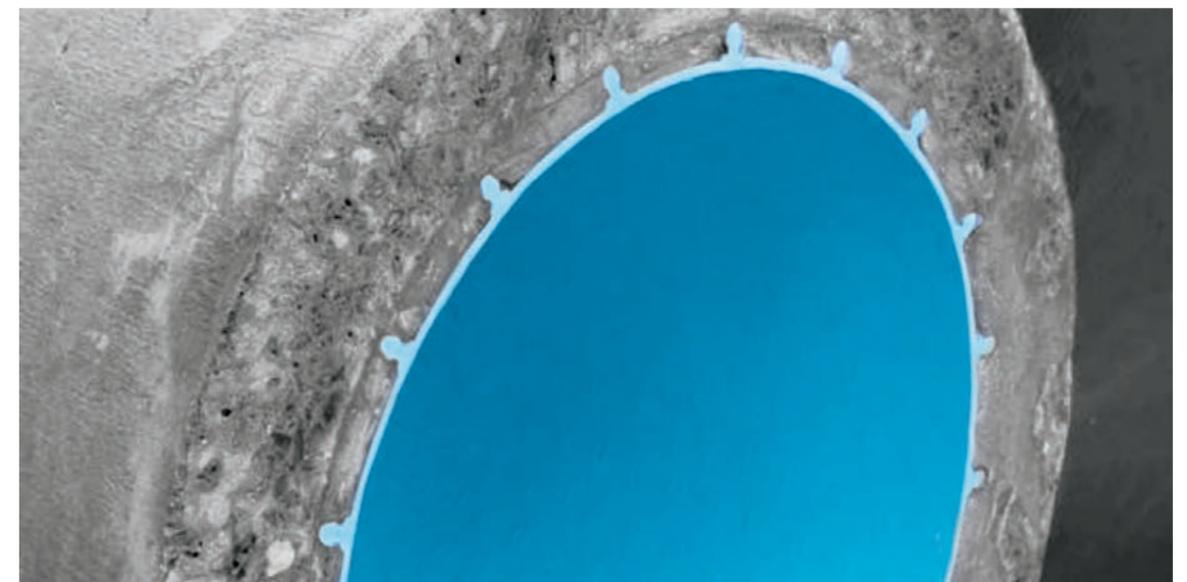
Cast-in Linings

Sheet Tunnel Linings

Spray Tunnel Linings

Dam Linings

Strata Support





BluRez

Structural Epoxies

Epoxy Coatings

Injection Resins

Ground Stabilisation





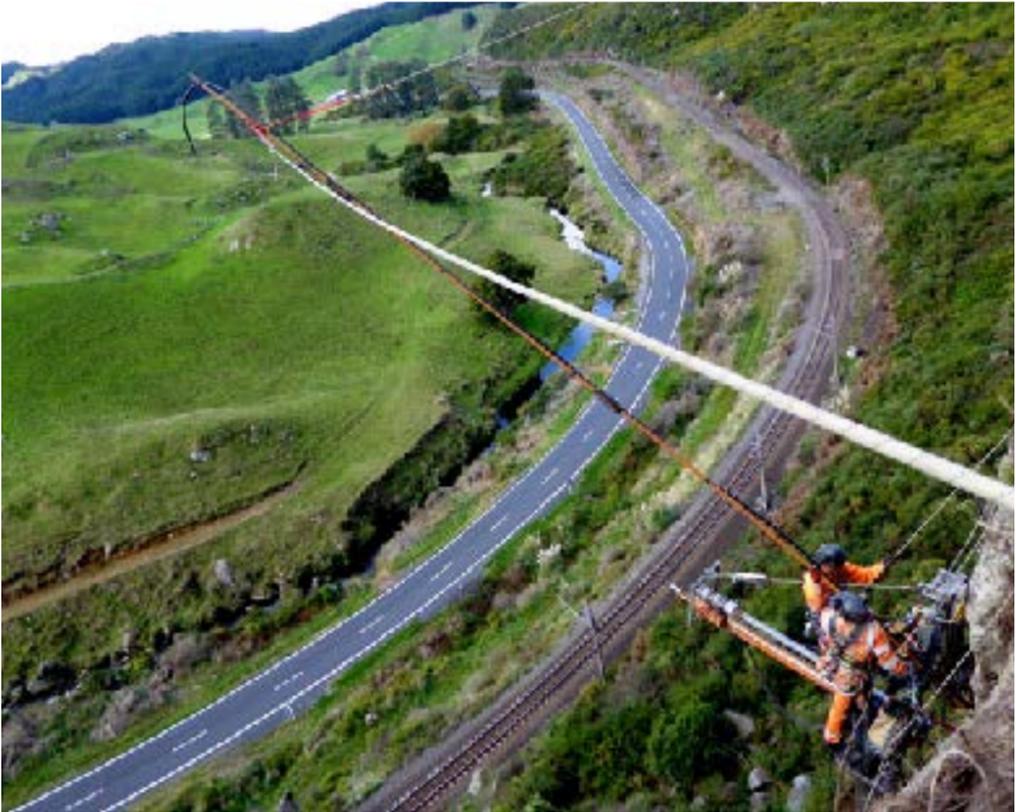
AIRPORT UPGRADE PROJECTS





GROUND
STABILISATION





SLOPE
STABILISATION



MARINE AND PORT UPGRADES





ROAD PROJECTS



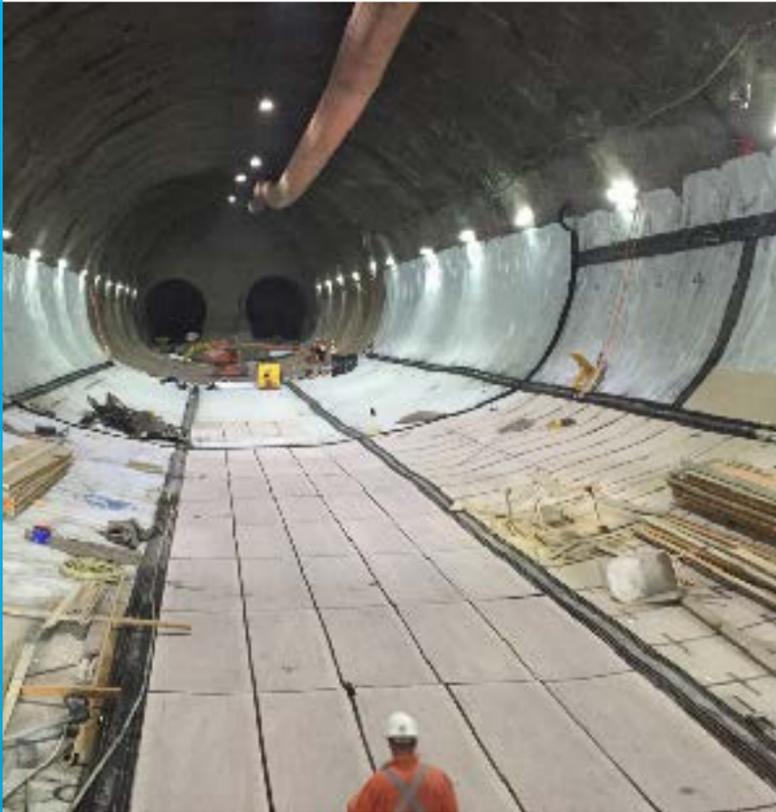


WASTE WATER PROJECTS





TUNNEL
PROJECTS





BLUGEO GRP BASICS



WHAT IS GRP?

Glass-Fibre Reinforced Plastic
GRP, FRP, GFRP

For the purpose of this presentation - The GRP is continuously threaded bar.



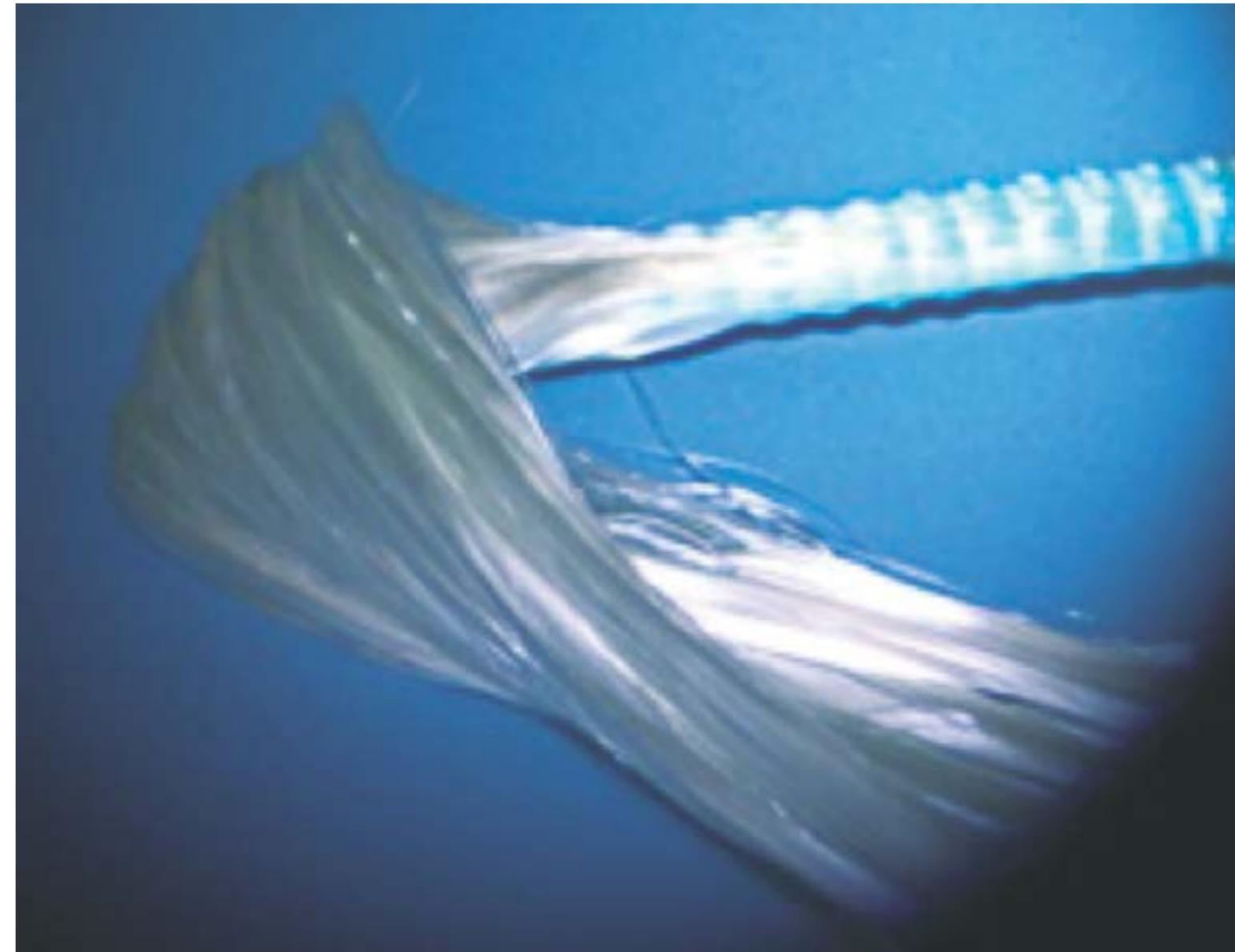


COMPOSITE REINFORCEMENT / MANUFACTURING

Composite - manufacturing process and used input material influences final characteristics:

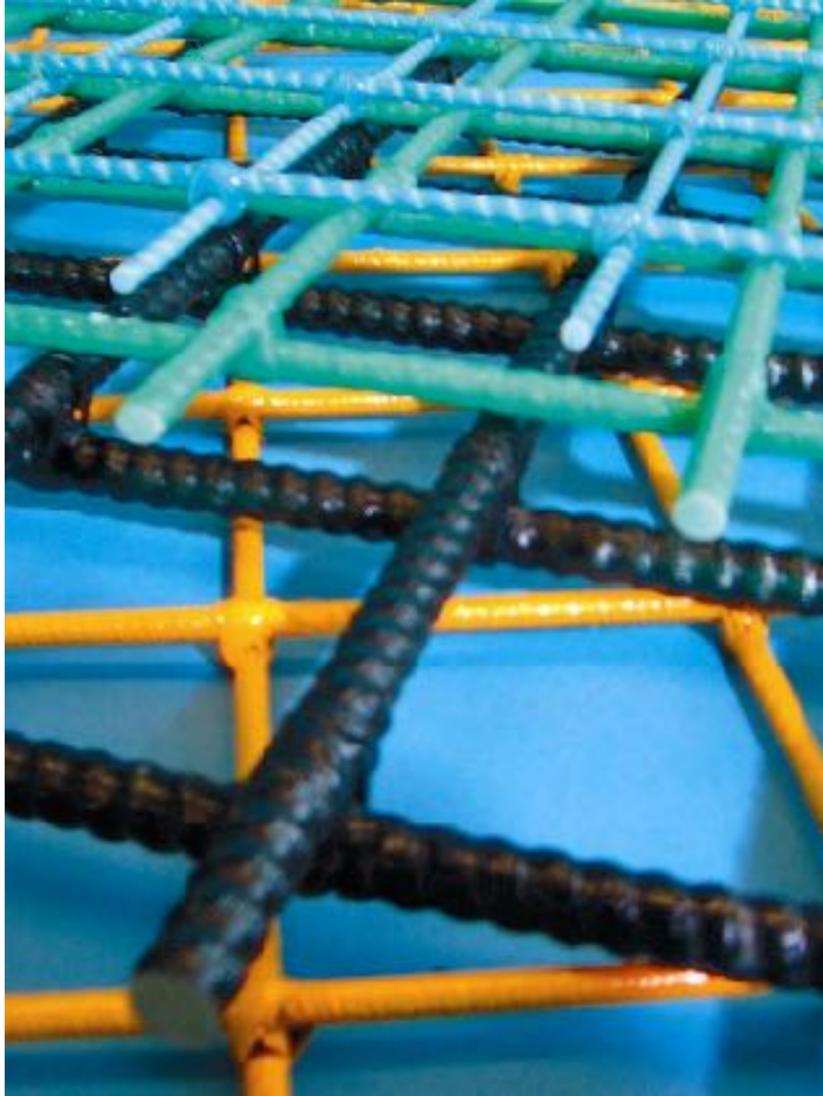
FIBRES Glass fibres / 1000MPa (standard)
Carbon Fibres / 2200MPa

RESIN Vinylester (permanent application)
Poly Ester (temporary application)
Epoxy





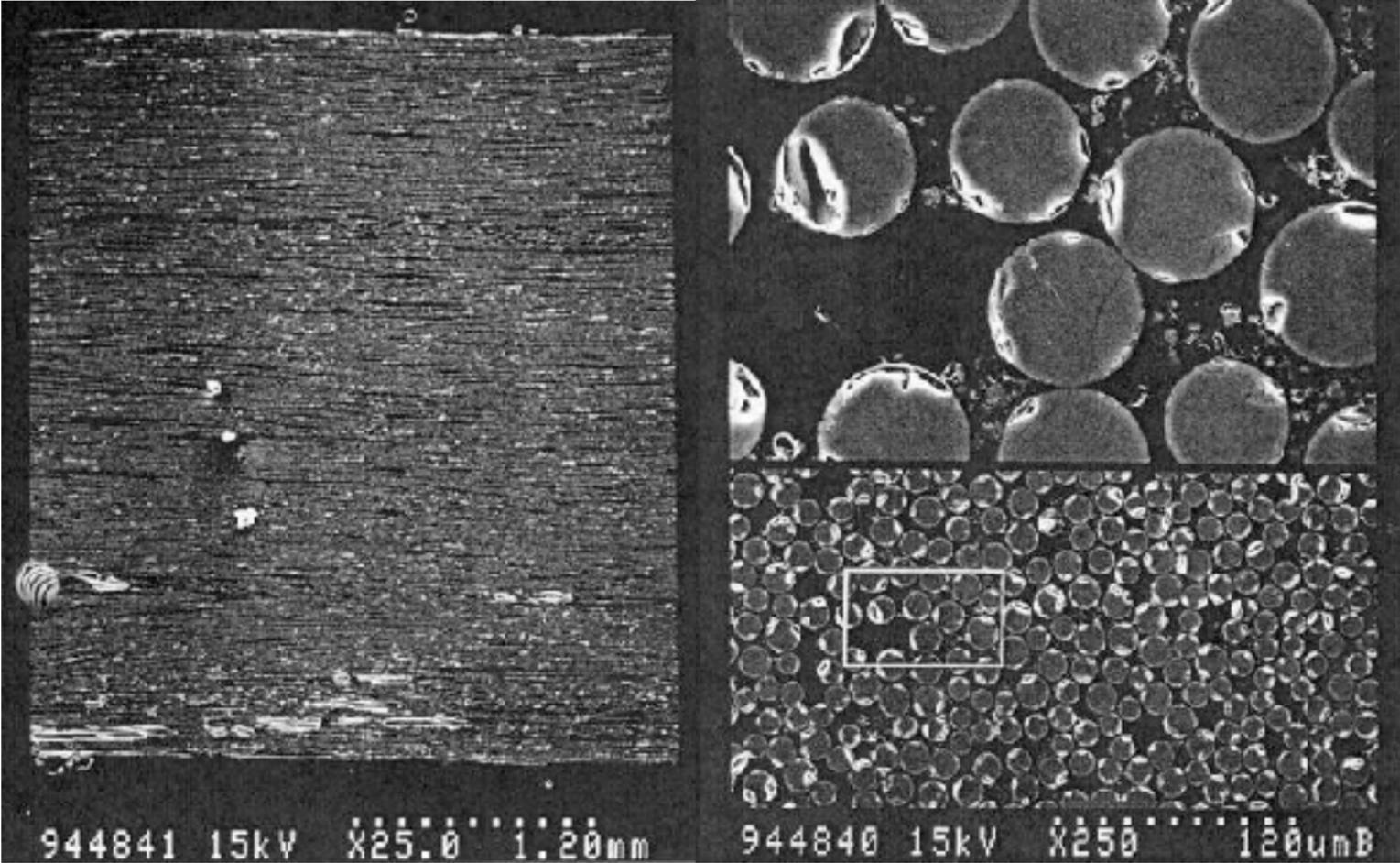
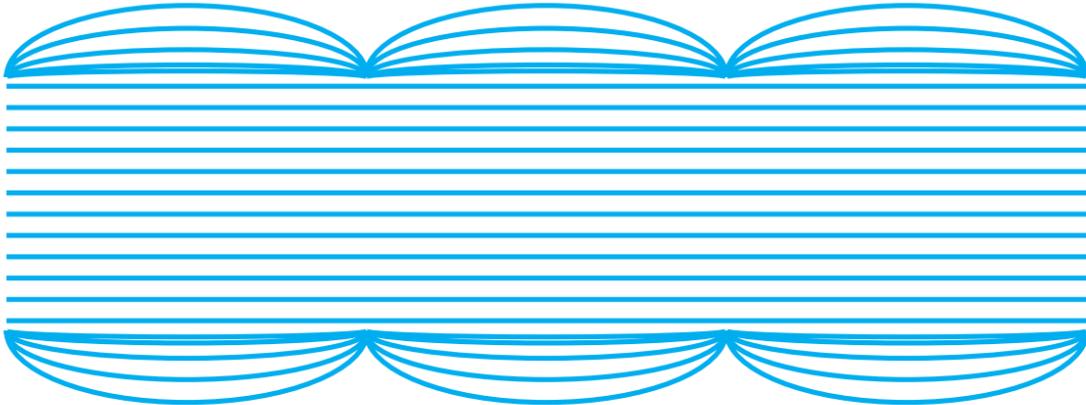
GRP BARS





COMPOSITE REINFORCEMENT / MANUFACTURING

LONGITUDINAL SECTION





GRP APPLICATIONS AND BENEFITS



WHERE CAN GRP REPLACE STEEL

- Face and slope stabilisation
- Ground support
- Rock bolts
- Reinforcement
- Tunnelling, mining, marine, bridges
- Permanent and temporary applications





WHY DO WE USE GRP

- Durability - 100 year design life
- High Strength - Tensile and Shear
- Non Conductive - No stray currents
- Lightweight - Less equipment for installation





SAFER INSTALLATION

- 12m bar can be lifted safely by 1 person
- Simple installation operation

Description	12m
24mm steel	47kg
32mm GRP	18kg



MATERIAL PROPERTIES

- Tensile strength greater than steel
- High shear strength
- Bond stress to grout greater than steel





DURABILITY

- No reliance on galvanising or sheathing for corrosion protection
- No risk of damage to complex DCP system during installation
- No minimum cover requirements in accordance with AS3600





RELIABLE INSTALLATION

- Single grouting operation with no sheathing required for GRP60
- Full encapsulation and engagement of the bar with approved grout
- More reliable than DCP





NON CONDUCTIVE

- GRP is a non-conductive element
- Resistivity $> 1000k\Omega.cm$ (immeasurable)
- Eliminates stray current corrosion
- Reduces occurrence of accelerated corrosion





ECONOMICAL

BluGeo GRP60 offers cost reductions on:

- Material supply
- Installation and site storage
- Whole of life cost





GRP PRODUCT TESTING



INTERNATIONAL STANDARDS

Manufacture

■ ACI440.6

■ CSA S807

Testing

■ ACI440.3

■ CSA S806





INTERNATIONAL STANDARDS

- BS8006 - Code of practice for strengthened/reinforced soils
- BS8081 - Code of practice for grouted anchors
- VicRoads Section 683 - Soil nail walls
- US FHWA - Geotechnical engineering
- EuroCode 7 - Geotechnical Design
- RMS R64 - Soil nails
- B114 - Ground Anchors



Testing Required

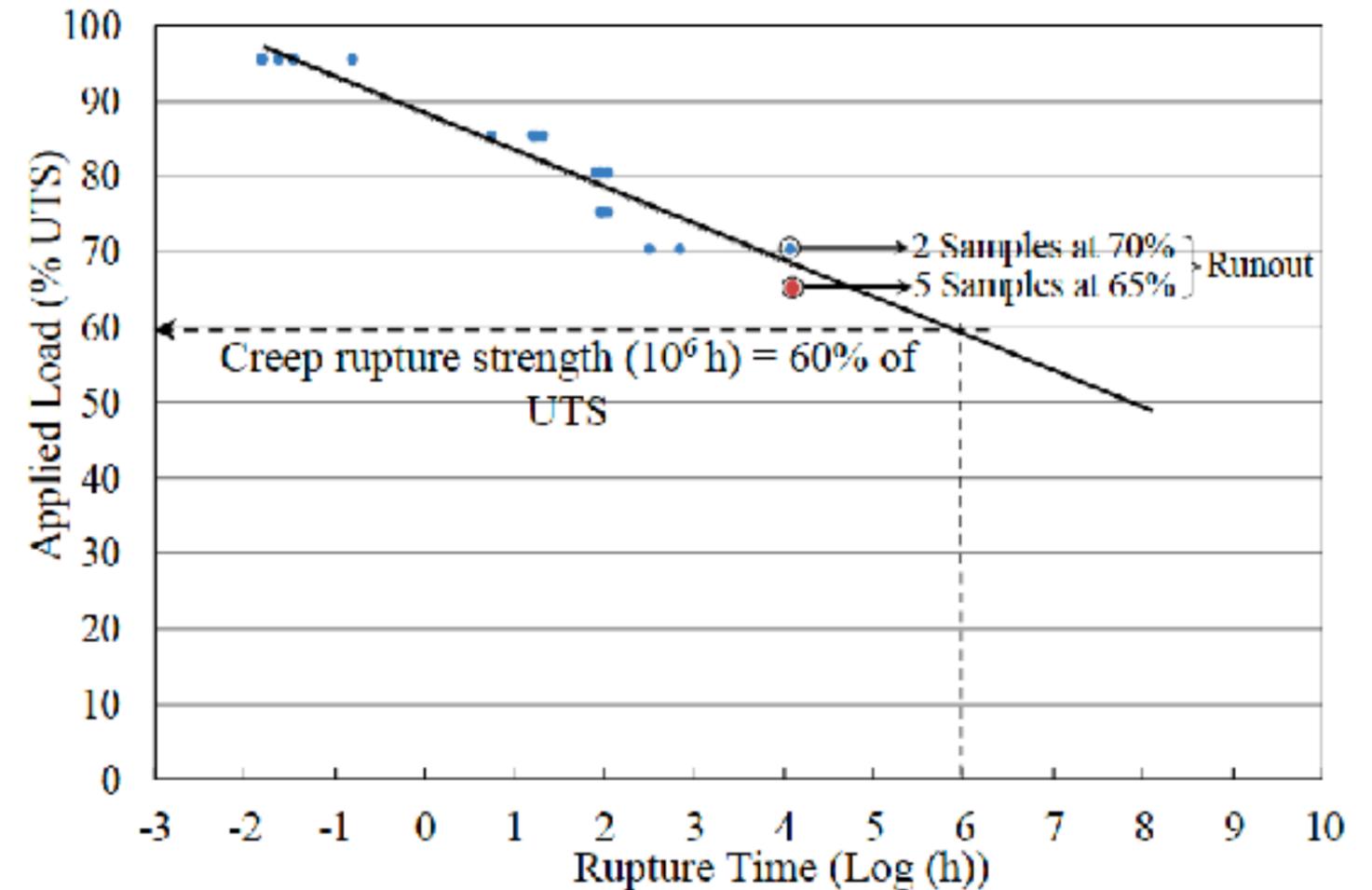
- Creep Rupture
- Creep Deformation
- Durability - Alkali Resistance
- Tensile Strength
- Bond Strength
- Shear
- Flexural strength





Creep Rupture

- Measures the maximum long term load that can be applied
- Min 5 test loads of UTS
- % of UTS - 95,85,80,75,70,65
- Test until rupture or min 10,000hrs





Creep Deformation

- Measures the long term deformation under working loads
- % of UTS - 20% and 40%
- Strain levels out at approximately 28 days
- 5-10% creep observed

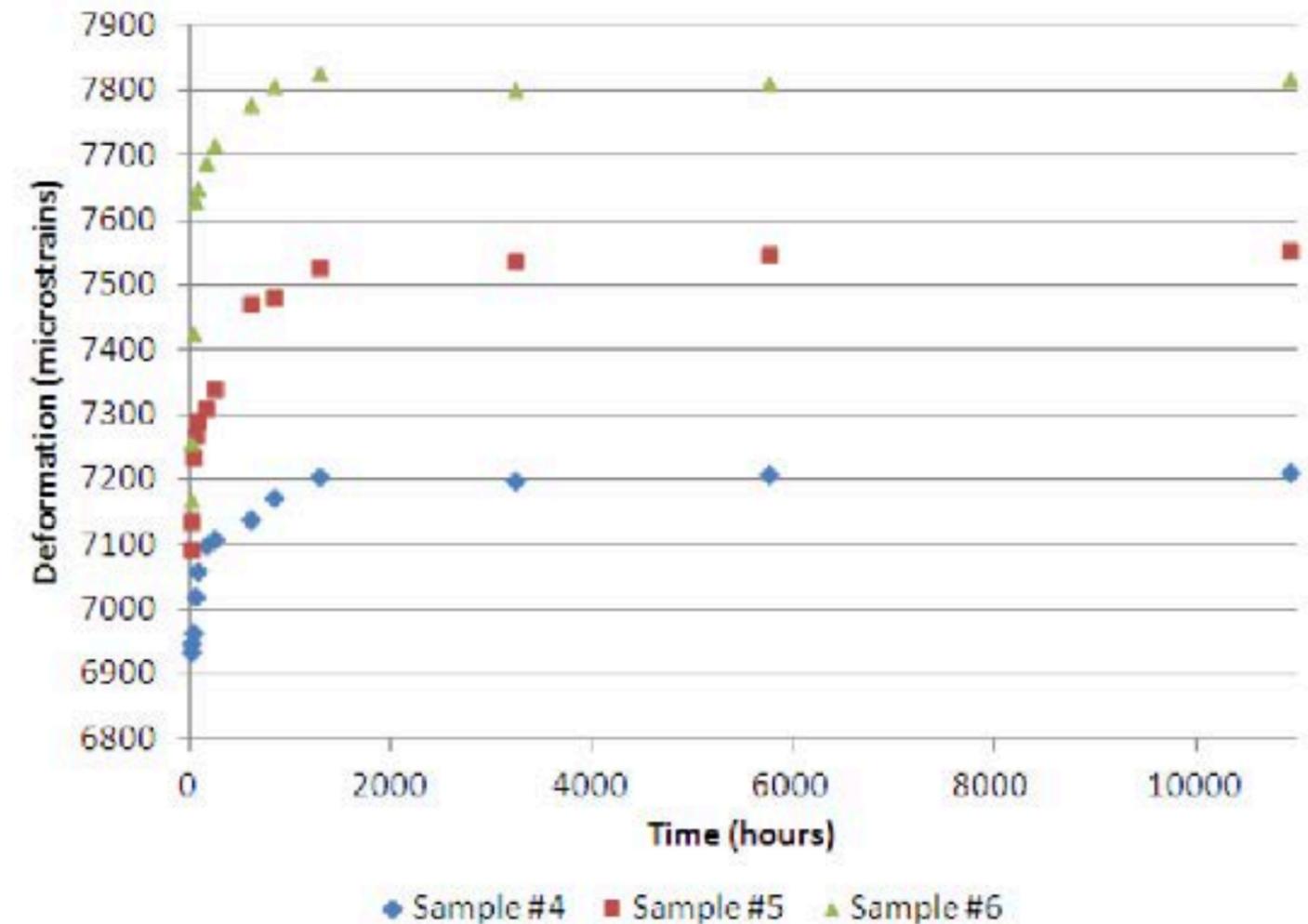


Figure 6: Creep evolution for each individual sample exhibiting 40% $f_{u,ave}$



Alkali Resistance

- Accelerated age test for GRP encased in alkaline grout environment
- 16 test pieces (8 control)
- Alkali bath @ 13.5pH 60°C
- 3 months soaking
- > 80% retention of UTS and modulus required





Tensile Strength

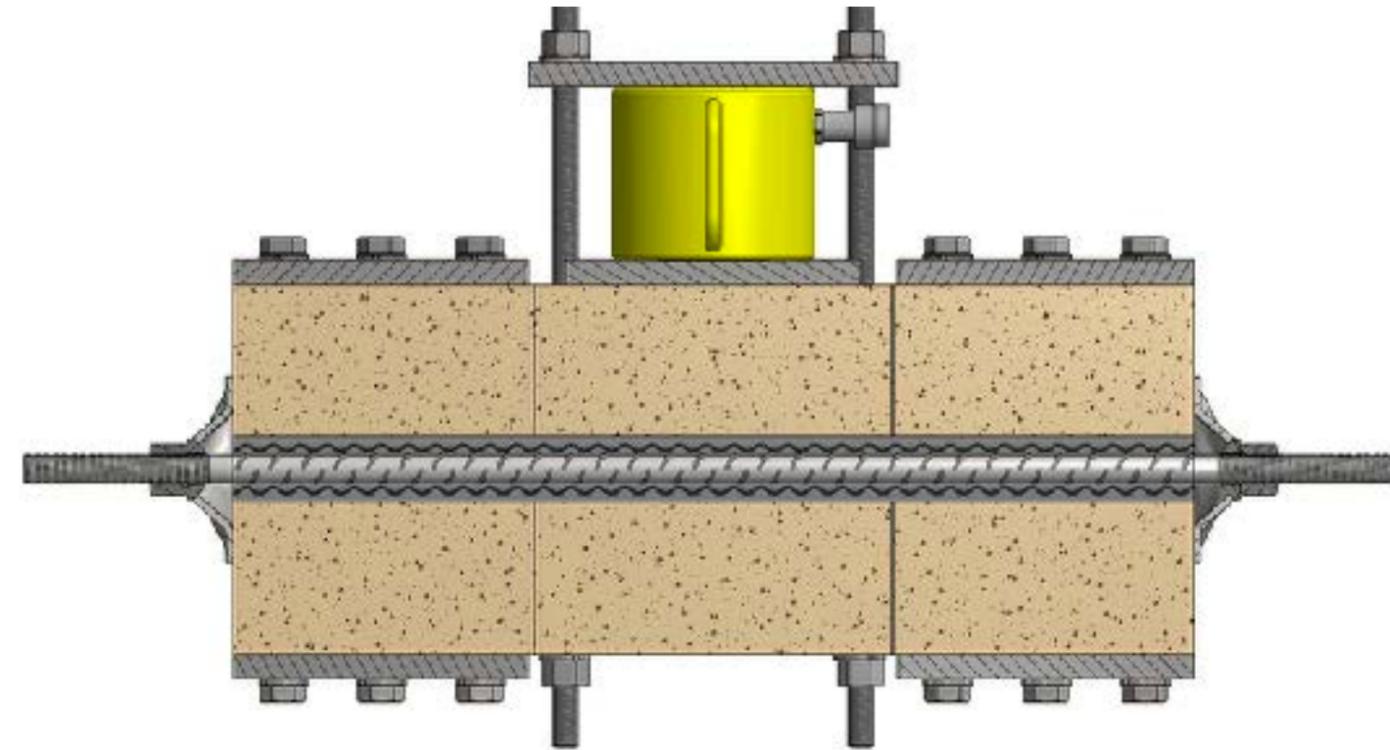
- Standard tensile testing completed to determine:
 - Ultimate Tensile strength (f_u)
 - Tensile Modulus (E_L)
 - Ultimate tensile strain
 - Batch testing in factory and local NATA testing





Shear Strength

- Testing completed to determine performance under various types of shear load
- Three types of shear test completed
- GRP can perform as well as steel bar in shear depending upon manufacturing process





Shear Strength

- Test Type I - Transverse Shear
- In accordance with ACI and CSA standards
- Direct double shear till failure
- 20mm bar = 130kN





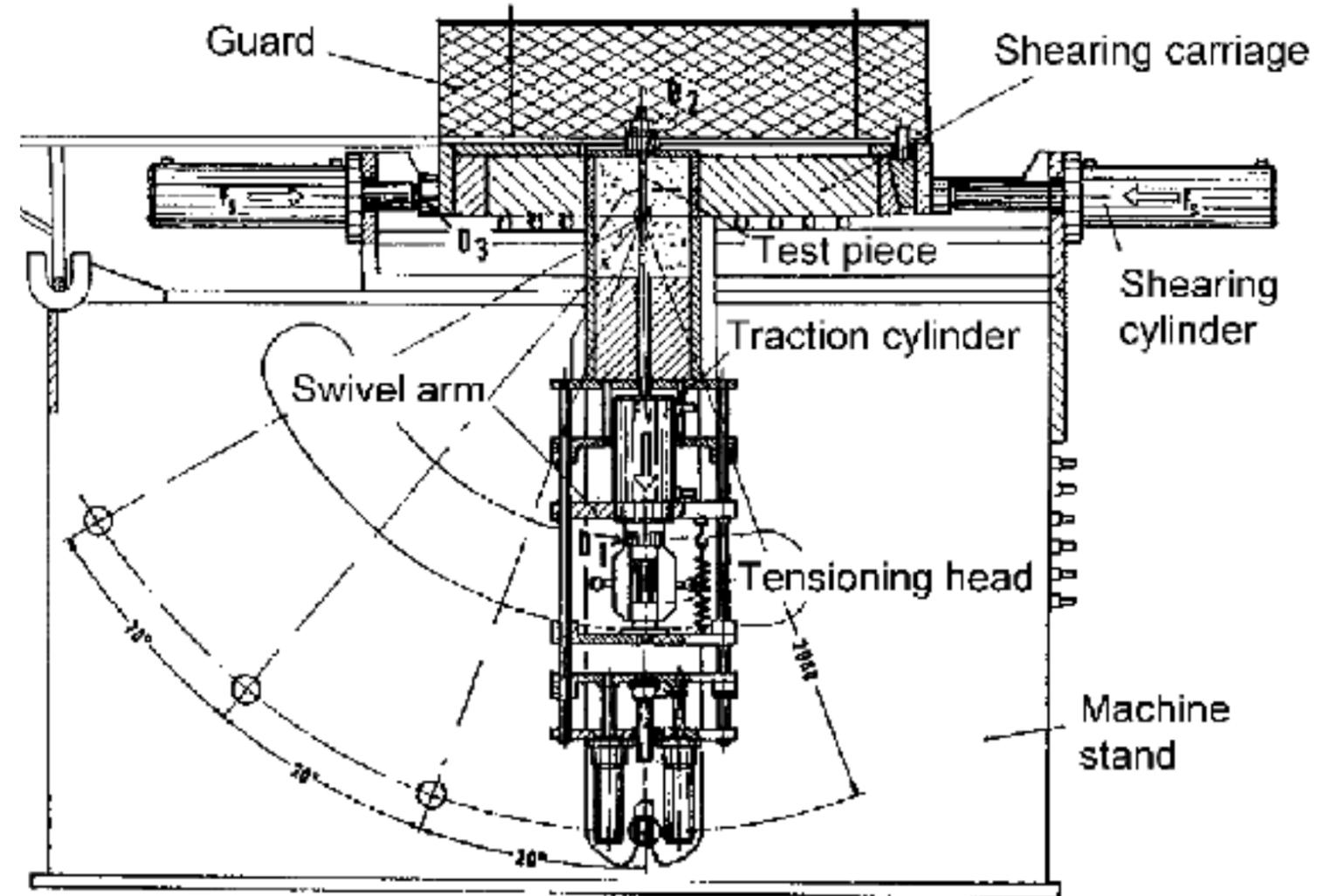
Shear Strength

■ Test Type 2 - 90° Shear Load Bearing in Rock

■ In accordance with DIN 21521

■ 25mm @ 90° - 170kN

■ 32mm @ 90° - 248kN





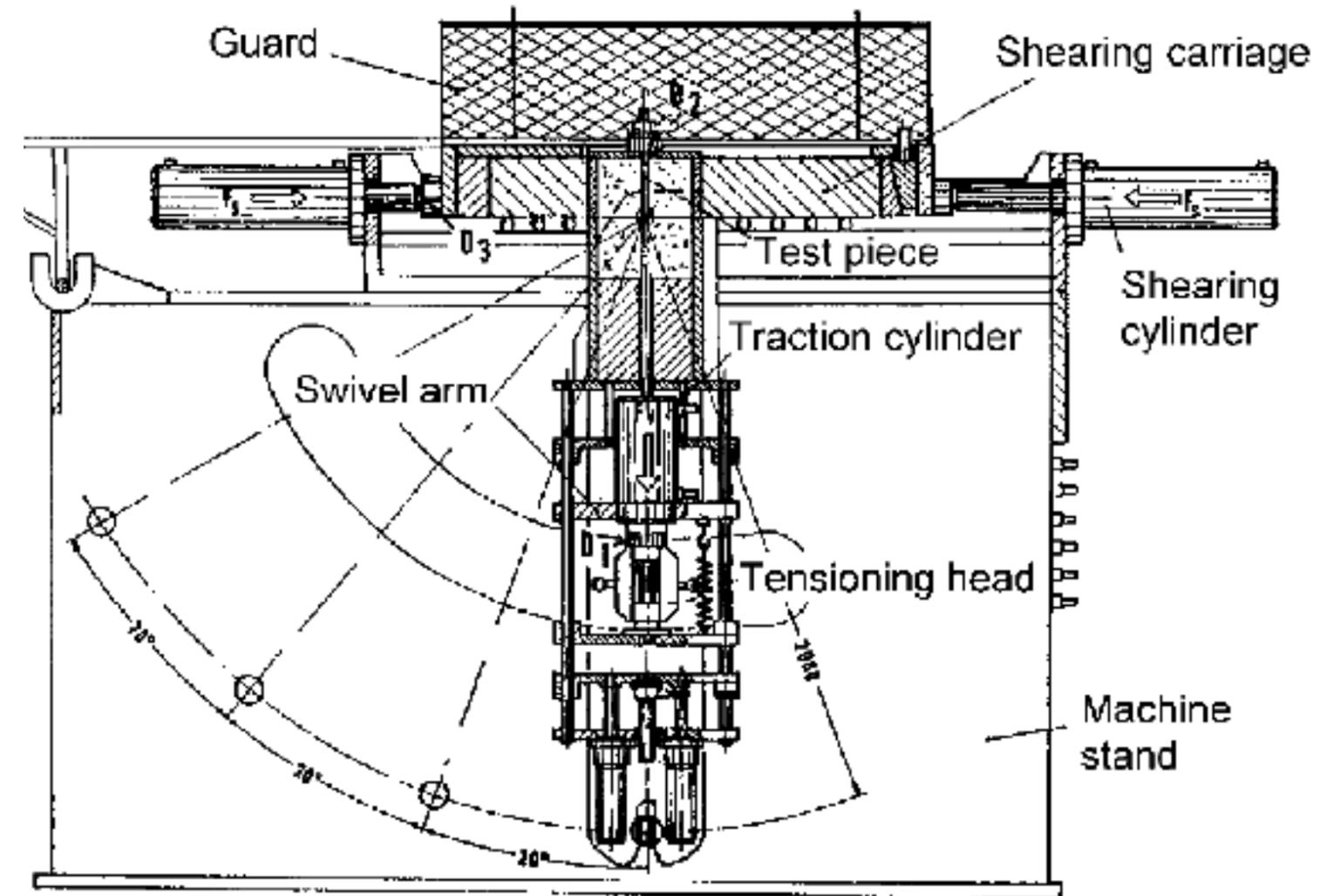
Shear Strength

■ Test Type 3 50° Shear Load Bearing in Rock

■ In accordance with DIN 21521

■ 25mm @ 50° - 347kN

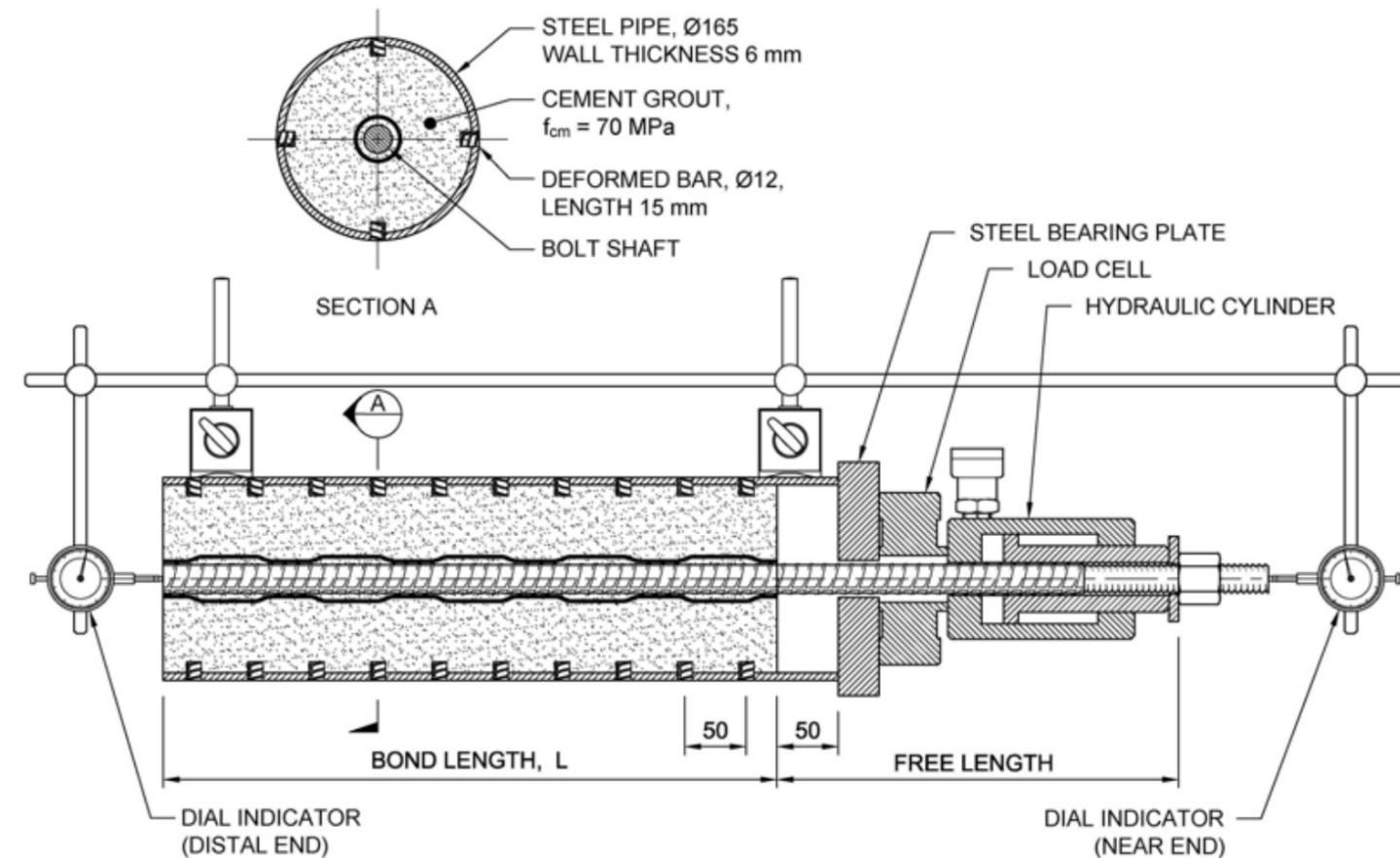
■ 32mm @ 50° - 495kN





Bond Strength

- Pullout testing in accordance with the ACI and CSA standards
- Determines the the bond stress between the bar and the grout
- Bond Stress is equal to and/or greater than a steel bar





GRP STRUCTURAL ASSESSMENT



STRUCTURAL ASSESSMENT

Design in accordance with following:

- Refer to BS8006, CIRIA guide

637 Reduction Factors:

- Creep Rupture Strength $\Phi_{rc} = 0.60$

- Durability $\Phi_{ud} 0.65$

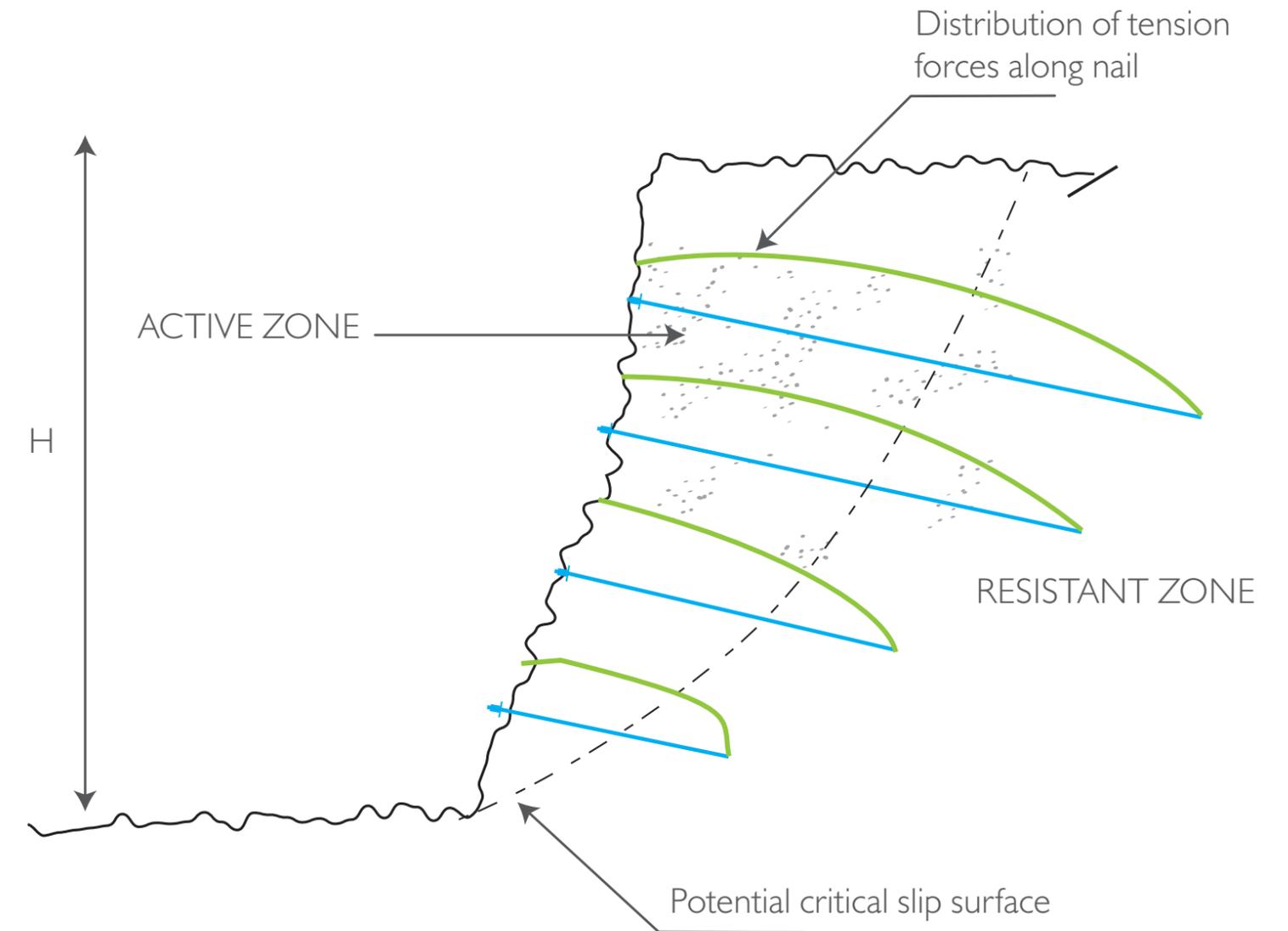




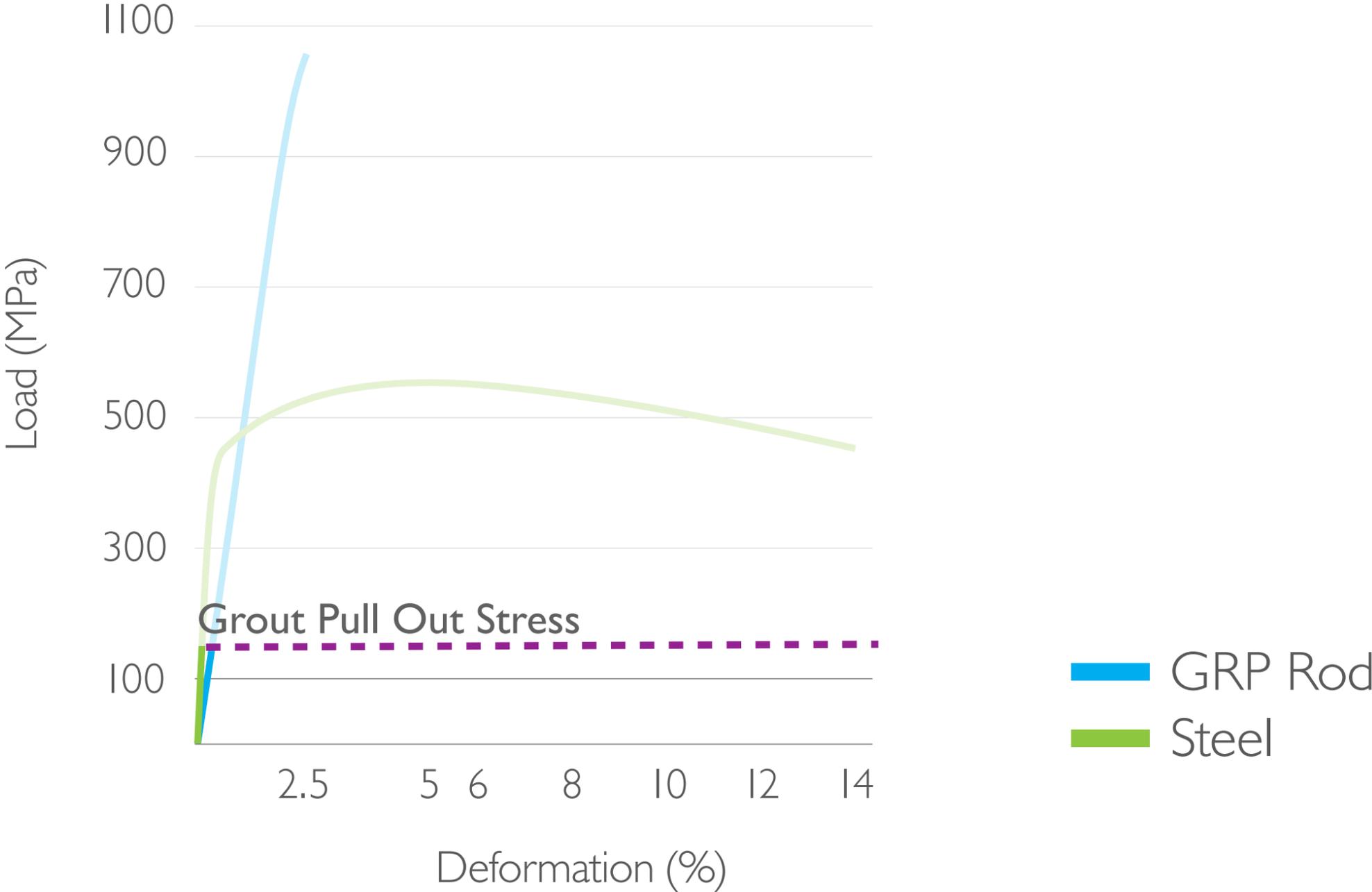
STRUCTURAL ASSESSMENT

GRP Tensile Strength

- Design to ensure that ductile failure occurs through soil/grout interface
- Tendon generally works at less than 10% of capacity in soil nail applications



Location of maximum tension force in each nail occurs at interface between active and resistant zones. However this interface is not necessarily the critical slip surface.

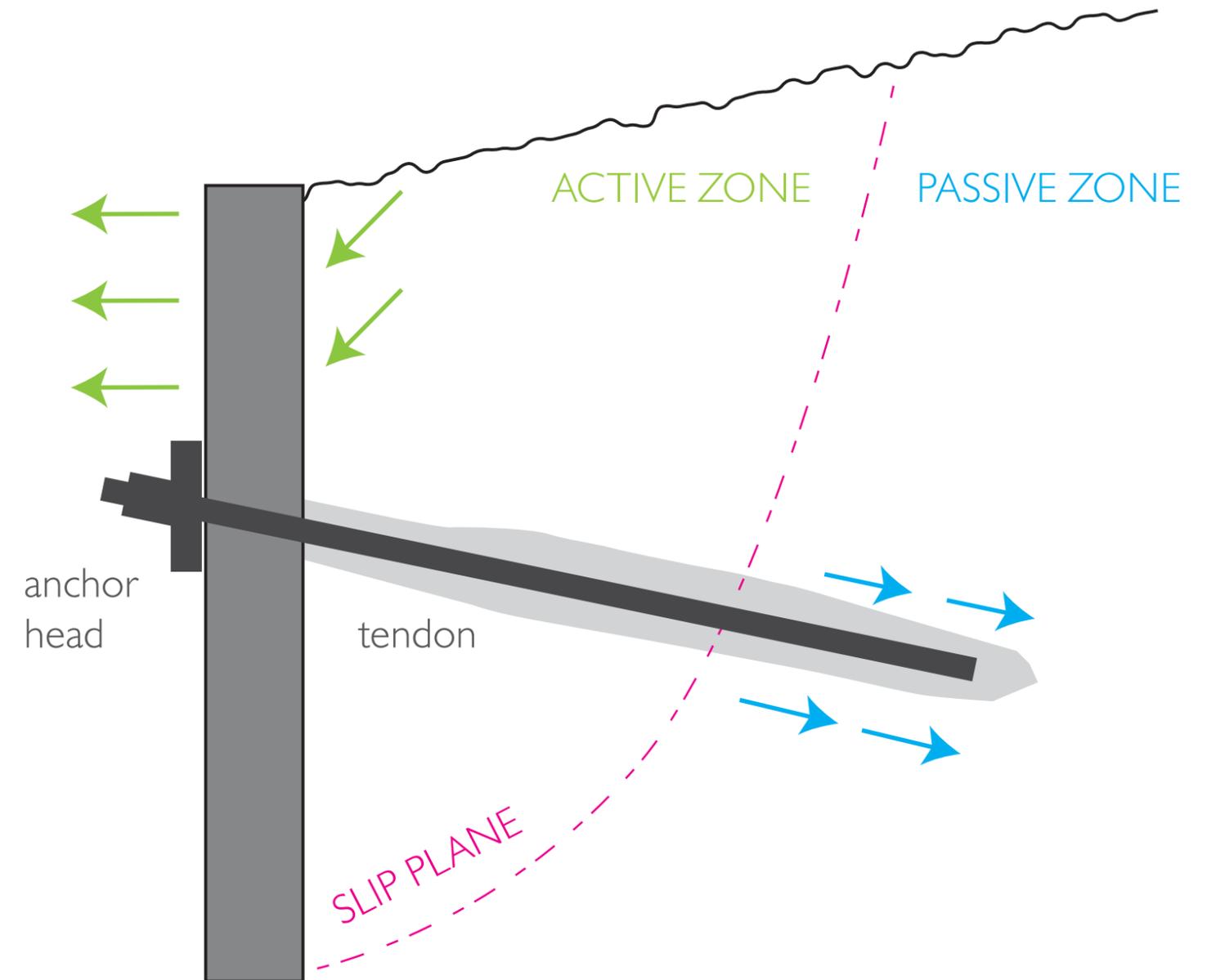




STRUCTURAL ASSESSMENT

GRP Tensile Stiffness

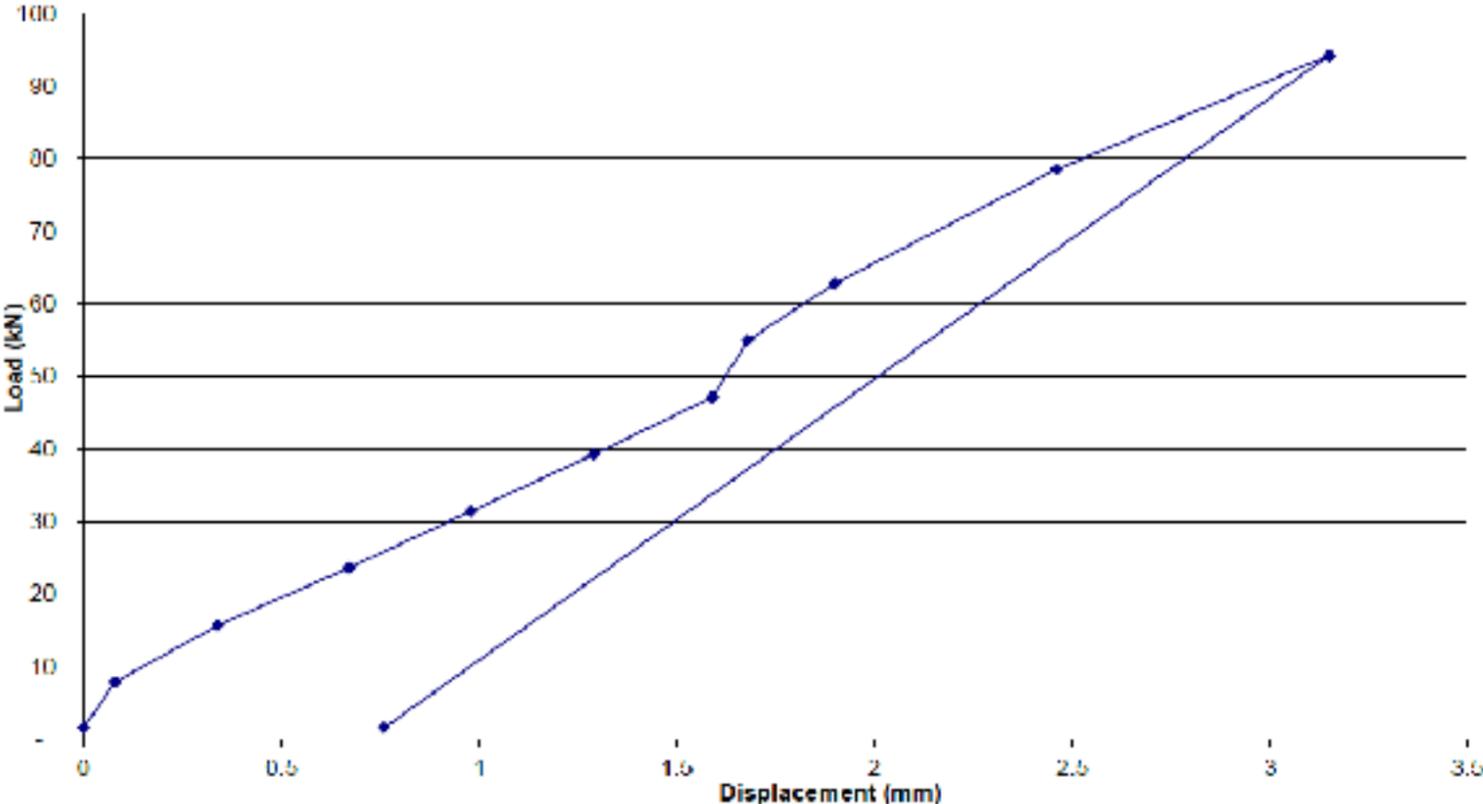
- GRP E-modulus of 60GPa
- Deformation mostly due to ground reaction
- In-situ testing demonstrates similar reaction under land between steel and GRP



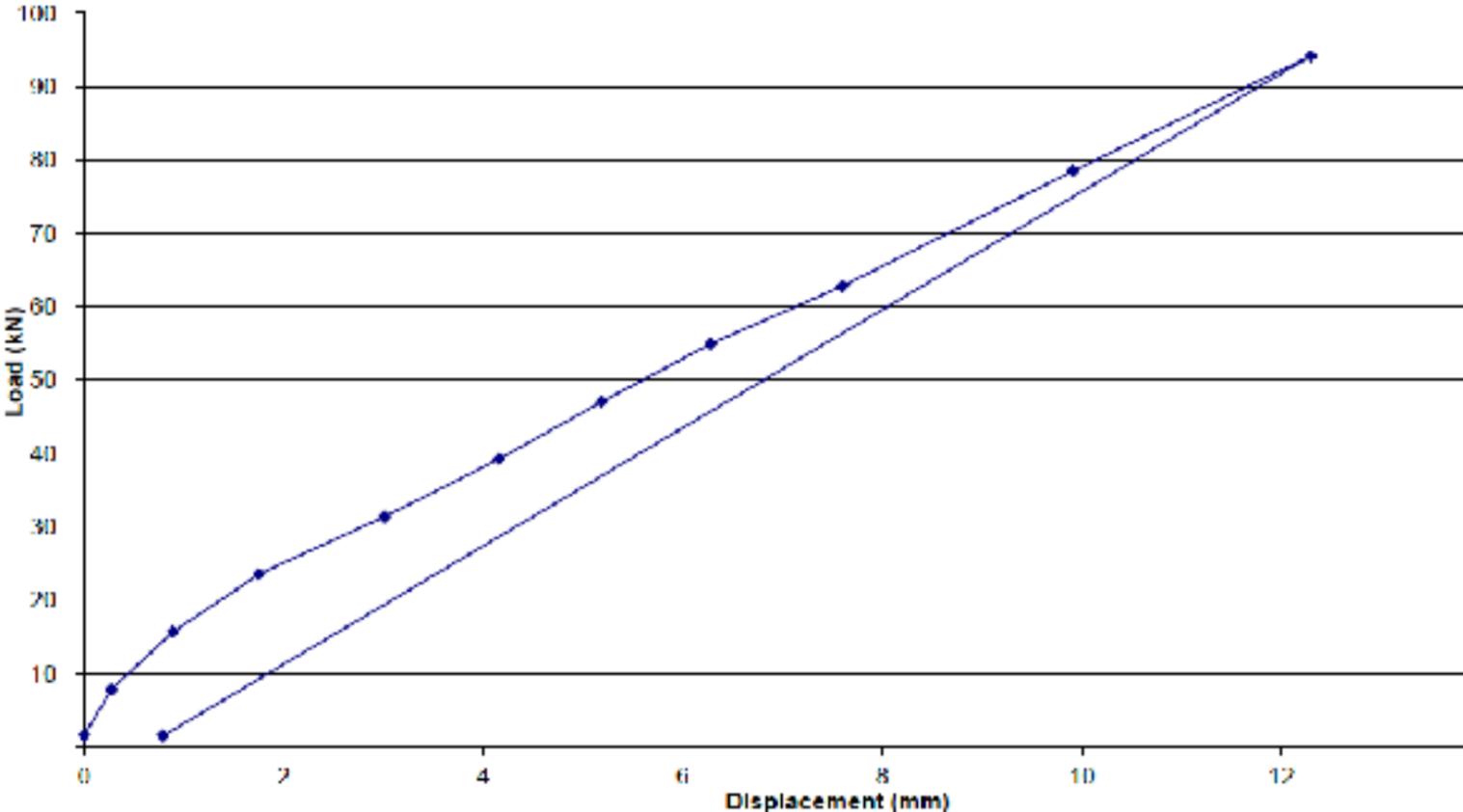


IN SITU DISPLACEMENT STEEL v GRP

Load vs displacement — Test Nail # 1



Load vs displacement — Test Nail # 2





GRP APPROVALS



APPROVALS

- BS8006 (2011)
- VicRoads Section 683 (2012)
- Metro Trains Vic Type Approved (2017)
- TMR (2014), DPTI,
- NZTA (2013), SCIRT (2015)
- Christchurch City Council (2015)
- Eurocode 7

METRO **Type Approval Certificate**

Certificate No.: MTM-FTA-00317 **Issue No.:** 1
Issue Date: 25/07/2017
Expiry Date: -

*This Certifies That the Product Detailed Below
Has Satisfied The Requirements For
Metro Trains Melbourne Type Approval*

Product:	Bluey GRP Soil Nails
Type/Model:	BluGeo GRP60
Manufacturer:	Bluey Technologies P/L
Place of Manufacture:	China
Description:	Soil Nails for stabilising cuttings.
Application(s):	BluGeo GRP60 is a Glass-Fibre Reinforced Plastic continuously threaded solid bar which forms a high load carrying capacity ground anchor and soil nail.
Specified Standards (Specifications):	VicRoads Section 683 Soil Nail Walls

Certificate valid without page 2.

Approved By Chief Engineer
Phil Willingworth

Disclaimer
This certificate is issued based on submittal documentation and MTM Type Approval Mechanism (TA 00317, issued 25/07/2017). The certificate remains valid until the date specified above, unless cancelled or revoked, provided the service restrictions indicated are complied with and the product remains satisfactory in service. It will be null and void if the manufacturer is changed or if any changes or amendments are made to the product without notification and approval in writing from MTM. MTM reserves the right to require any changes to the product.



Thank you

greg.sieders@bluey.com.au