BarChip Fibre Concrete Reinforcement For 21st Century Railway Design

At BarChip, we believe the future of concrete reinforcement exists in materials;

- That eliminate corrosion.
- Are environmentally friendly.
- Reduce construction time.
- Are safe and easy to use.
- Enable 100+ year design life.

We're making this vision possible with our BarChip synthetic fibre concrete reinforcement.

The time of expensive, high maintenance steel reinforcement is over. Join thousands of companies already using the macro synthetic fibre concrete reinforcement system and make the change to a better reinforcement today.

BarChip
Synthetic Reinforcing Fibre

Replacing Steel
Reinforcement in Concrete.

BarChip Inc.
The Synthetic Fibre Experts

When performance matters, choose BarChip fibre concrete.

www.barchip.com

BarChip Fibre Reinforced Track Slab

21st Century Railway Design

High performance BarChip synthetic fibre eliminates the need for steel reinforcing bars in modern concrete track slab, decreasing construction times and long term maintenance costs.

Traditionally, track has been laid on ballast material which provides a relatively stiff bearing surface which is able to transfer the train loads through to the ground below. However, as train loads get larger, and speeds increase, maintaining the durability of ballast material becomes more challenging. At high speeds, or with heavy loads, this ballast can be pulverised, causing the track levels to shift, which can jeopardize ride quality and safety.

Concrete track slabs have been increasingly used as an alternative to ballasted track systems, particularly for high speed rail, to overcome these issues. They have also become commonplace in metro light rail construction, where the rail corridor is shared by road traffic, and the rail is embedded into the concrete track slab. Concrete track slabs are used as they enable faster construction times, provide a longer design life and require less maintenance than traditional ballast systems.

Traditional steel reinforcement presents a number of drawbacks to concrete track slab. Laying and tying steel reinforcement is a huge time consumer during the construction process and the logistical problems from placing bars at close centres can severely slow construction times. Steel bar can also cause unwanted conductivity from the rail potentially causing corrosion of steel infrastructure.

BarChip structural synthetic fibre reinforcement used in concrete track slab eliminates steel related problems. The benefits of BarChip synthetic fibre include;

- Significant reduction in construction time - no placing of steel
- Increased durability - no corrosion of reinforcement
- Reduced maintenance costs
- Reduced current leakage between the AC and DC systems
- The fibre reinforces the full depth of the concrete slab - unlike steel bar
- No need to box out or predesignate areas in order to avoid the steel reinforcing
- Crack inducers are easily installed - no set up delays
- Reduced crack penetration and propagation through the section

BarChip Inc.

The Synthetic Fibre Experts

DECREASE MAINTENANCE COSTS
AND
INCREASE THE SERVICE LIFE
OF YOUR CONCRETE TRACK SLAB

- Embedded Rail
- Floating Slabs
- Direct Fixing and Resilient Baseplates
- Precast Track Slab
- Cast in Sleepers
- Booted Sleepers

Docklands Light Railway, UK

REINFORCED WITH BarChip®

BarChip 48

Performance Testing

Flexural Performance - ASTM C 1609 / C 1609 M

Residual Strength at 0.75 mm Displacement f^{150}_{600} [MPa]

	Dosage Rate [kg/m³]					
f'c [MPa]	2.5	3	3.5	4	5	6
25	1.10	1.35	1.60	1.85	2.35	2.85
32	1.30	1.55	1.80	2.10	2.60	3.15
40	1.50	1.80	2.05	2.35	2.90	3.50

Residual Strength at 3.0 mm Displacement f^{150}_{150} [MPa]

	Dosage Rate [kg/m³]					
f'c [MPa]	2.5	3	3.5	4	5	6
25	0.75	0.95	1.15	1.35	1.75	2.20
32	0.90	1.10	1.30	1.50	1.95	2.40
40	1.05	1.25	1.45	1.65	2.10	2.60

Flexural Performance - EN 14651, RILEM

Residual Strength at CMOD 0.5 mm f_{R1} [MPa]

	Dosage Rate [kg/m³]				
Concrete Class	2.5	3	4	5	6
C25/30	1.30	1.55	1.90	2.20	2.60
C30/37	1.35	1.55	1.95	2.30	2.70
C35/45	1.40	1.60	2.05	2.35	2.80
C40/50	1.50	1.70	2.10	2.45	2.90

Residual Strength at CMOD 1.5 mm f_{R2} [MPa]

	Dosage Rate [kg/m³]				
Concrete Class	2.5	3	4	5	6
C25/30	1.35	1.60	2.05	2.55	3.15
C30/37	1.35	1.60	2.15	2.80	3.40
C35/45	1.40	1.65	2.20	3.00	3.50
C40/50	1.45	1.75	2.30	3.05	3.60

Residual Strength at CMOD 2.5 mm f_{R3} [MPa]

	Dosage Rate [kg/m³]				
Concrete Class	2.5	3	4	5	6
C25/30	1.45	1.65	2.10	2.70	3.55
C30/37	1.45	1.65	2.35	3.15	3.70
C35/45	1.50	1.70	2.40	3.20	3.80
C40/50	1.50	1.80	2.55	3.30	3.90

Residual Strength at CMOD 3.5 mm f_{R4} [MPa]

	Dosage Rate [kg/m³]				
Concrete Class	2.5	3	4	5	6
C25/30	1.30	1.50	2.05	2.65	3.20
C30/37	1.30	1.55	2.15	2.80	3.45
C35/45	1.35	1.60	2.25	2.95	3.50
C40/50	1.35	1.70	2.40	3.05	3.75

BarChip 60

Performance Testing

Flexural Performance - ASTM C 1609 / C 1609 M

Residual Strength at 0.75 mm Displacement f^{150}_{600} [MPa]

	Dosage Rate [kg/m³]				
f'c [MPa]	4	5	6	7	8
32	2.00	2.30	2.60	2.90	3.20
40	2.25	2.60	2.95	3.30	3.65
50	2.45	2.80	3.20	3.55	3.90

Residual Strength at 3.0 mm Displacement f^{150}_{150} [MPa]

	Dosage Rate [kg/m³]				
f'c [MPa]	4	5	6	7	8
32	2.00	2.35	2.70	3.10	3.45
40	2.30	2.70	3.05	3.45	3.80
50	2.55	2.95	3.35	3.75	4.15

Design Optimisation with Finite Element Analysis

BarChip Inc.
The Synthetic Fibre Experts

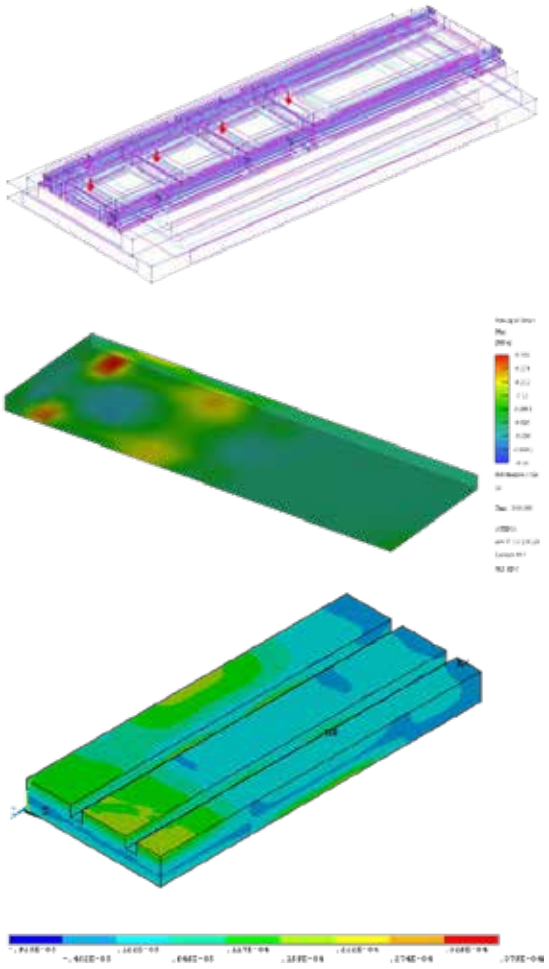
BarChip is more than just a fibre reinforcement provider. Our field experts can guide you through every aspect of synthetic fibre reinforcement, from the fibre's technical characteristics to the concrete mix design to on-site work processes.

Our design services team can create virtual 3D FEA modelling of any concrete asset which show in real time the effects of structural loads. When combined with the performance requirements, service limit loads and ultimate limit loads expected, BarChip is able to accurately determine the performance over the entire life of the asset.

Benefits of FEA include;

- Optimisation of dose rates
- Life of asset modelling
- Exact stress point modelling
- Virtual load simulation
- Simulated testing across the entire structure
- Surety and confidence delivered to the asset owner

This combination of world leading product and application experience combined with world first design practice ensures you get the best possible outcome when you partner with BarChip.



FEA design output shows in full transparency the performance of BarChip fibre track slab

St Petersburg Tramlines, Russia

Bukit Berapit High Speed Rail, Malaysia

Proven Performance in Concrete Track Slab

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Docklands Light Railway, UK. Elasto Ballast Track Slab with BarChip fibre was incorporated into London's Docklands Light Railway (DLR) extension from Canning Town to London City Airport in 2004 and again in 2008. This second project required the laying of concrete track slab through twin bore tunnels underneath the River Thames. Some project facts include;

- Dosage of 6 kg/m^3 of BarChip Shogun fibre
- Approximately 20 tonnes used over the entire project
- Slab Thickness 150 mm to 200 mm
- Poured in 2 - 3 linear metre bays
- Total track length just over 6 km

Szeged Tramway, Hungary.

In August 2008 the Hungarian Government approved the 100 M Euro upgrade to the Szeged electric tram public transport network. Upgrades included the rehabilitation of 18.3 km of tram track and the construction of 4.8 km of new tram track.

The tram lines were originally designed with a traditional rail pad tram system, however concerns over durability, costs, stray current and construction time resulted in the contractor (SzKT) ordering the designs changed to a synthetic fibre reinforced track slab system, making it the first project of it's kind in Europe.

Fibre testing at the University of Budapest showed that BarChip fibre was the highest performing synthetic fibre available, and that the performance of 5 kg m^3 of BarChip 48 was equivalent to 55 kg m^3 of steel fibre.

Oita Elevated Railway, Japan. Analysis of Japan's high speed rail network showed that maintenance amounted to as much as one third of the total operating budget. As a consequence Japan's Railway Technical Research Institute (RTRI) experimented with various track slab alternatives.

The RTRI research showed that ballastless designs, like Elasto Ballast Track, offer significant benefits over steel reinforced track slab and traditional track designs.

Japan's railway now incorporates a host of ballastless track systems, like the 2010 construction of the Oita Elevated Railway (pictured right).

Sanki Construction Company chose Elasto Ballast Track Slab, using 9kg/m^3 of BarChip structural fibre for the Oita railway line. The reinforced concrete block, containing BarChip fibre, supports pre - stressed concrete sleepers which are supported underneath by shock absorbing rubber.

Innovative Track Slab Systems Using BarChip Fibre Reinforcement

PreCast Advanced Track (PCAT) - 21st Century SMART Railway Track Structure.

PCAT (PreCast Advanced Track) is a new concept in railway construction which challenges the traditional engineering method of supporting railway tracks on ballast. PCAT is designed with a 120 year design life and represents a step change in design technology.

The PCAT slab design is based on a Channel Beam upper profile which provides a high modulus slab monocoque structure, this maximises the slab strength and minimises the stiffness needed for the track foundation. This allows PCAT tracks to be constructed quicker than conventioal track.

Independent studies on PCAT light rail and heavy rail systems were completed by AECOM, Mott Macdonald and Viaduct in 2015 and funded by SBRI, Innovate UK, Dft and UK National Rail. The studies showed that;

- PCAT-LRT saved 70% in construction time
- PCAT-LRT delivered a 52% saving in capital cost
- PCAT-LRT delivered a 38% reduction in service life maintenance
- PCAT-HR was similar in cost to traditional ballast but faster to install
- PCAT-HR delivered a 59% reduction in service life maintenance
- PCAT HR and LRT increased track capacity and availability

PCAT is reinforced solely with BarChip macro synthetic fibre reinforcement.

Innotrax Slip Form Track Slab

Innotrax is an innovative new slip formed construction method for concrete track slab. The principles of the innovation are based on slip forming a slabtrack with a surface that has a plus tolerance. In other words, the slabtrack after production is too high in relation to the exact height that is required, but never lower than the ideal height. Once hardened, the concrete is profiled to the exact height. This has been done before, but the existing methods were slow and expensive.

Innotrax has succeeded in developing a method with which the concrete can be economically profiled with great precision and at high speed. This can be done with both hand poured or slip formed concrete, but preferably slip formed to have a consistent compaction of the slab. The Innotrax system is designed to complete 250-m to 400-m per day and can be profiled to a precision of 1 to 2 mm.

To compliment this process, Innotrax has designed and tested a system to pre- install dowels for the rail fasteners, before the concrete is slip formed. The concrete is slip formed over the sealed dowels and when the concrete is profiled the dowels come free, ready for the rail fasteners to be mounted.

Another big advantage when the slabtrack is constructed by slip forming, is the use of BarChip macro synthetic fibres, which can completely eliminate the use of steel reinforcement. Besides saving a lot of money on steel reinforcement, labor and logistics, macro synthetic fibres are not conductive and corrosion free, which is a big advantage in the railway world. The logistics of concrete, especially in single tunnels will be less complex when using synthetic fibres.

Eliminate Corrosion of Reinforcement and Stop Concrete Cancer

Corrosion of Steel Fibres

Spalling From Concrete Cancer

In-Situ Corrosion of Steel Reinforcement

BarChip synthetic fibre eliminates corrosion of reinforcement and is the preferred choice of concrete reinforcement in corrosive environments.

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