Rail Design Support Manual

protexia®

Tracktex™

GEOfabrics®

Mechanical Strength

Quality

High Performance

Construction Cost Savings

Easy Installation

Extended Maintenance Interval
About Us

GEOfabrics Limited is a UK manufacturing company established in 1992. From the outset the objective has been to manufacture high-performance products tailored for use within the demanding environment of a global rail industry.

The company’s ethos is to continually exceed the expectations of both existing and future customers with innovative and effective products supported by an established technical service. Successful product development is achieved by understanding the customer’s problem, determining the necessary properties and functions that are required, manufacturing the solution and then rigorous quality testing to demonstrate that the product meets those requirements. GEOfabrics has a dedicated and experienced team of personnel that cover both commercial and technical departments and that work in unison to provide the necessary attributes to meet our global challenges.
Protexia RK Geosynthetics for Railway Engineering

For many years GEOfabrics has developed and provided a broad spectrum of tailor engineered products that are specifically manufactured to address many of the problematic ground conditions that exist beneath railway track.

All GEOfabrics’ track products are Network Rail approved and specified for use across the world’s rail infrastructure, with a wide number of major rail operators.

Our established and proven Protexia RK range of materials for railways contains robust geotextiles manufactured from high quality, high tenacity, 100% virgin polypropylene fibres.

Oxidation tests indicate in excess of 150 years durability, as demonstrated on our product CE declarations.

GEOfabrics’ materials are manufactured to produce the highest level of mechanical performance and the long-term durability required in track bed engineering and construction.

RK geotextiles are used ‘independently’ and are also combined with other types of geosynthetics to produce a wider portfolio of product solutions.

Such examples include reinforcement geogrids, drainage geonets and other specialist components, to form specific multiple layer geocomposites that offer bespoke multi-functional solutions to many of the geotechnical problems identified by international track engineering consultants.

In a modern world under increasing pressure to provide construction cost savings and deliver ‘value engineering’, GEOfabrics’ rail products have been consistently proven to be a viable solution. Protexia provides a cost effective and preferential alternative to traditional engineering methods, often using granular aggregate based solutions, which are expensive and slow to install.

Through all of the above, the RK range is designed to offer immediate construction cost savings, increase the ease and speed of installation and extend the maintenance interval reducing further long-term costs.

Our extensive on site laboratories include a wide range of independently verified and UKAS accredited test procedures, which not only provide the tight levels of quality control our customers expect but underpin our ongoing investment into research and development. This is conducted in partnership with specialist rail consultants, government agencies, academic institutions and other skilled manufacturing partners.

This brochure is designed to provide detailed information on all of our existing product range and recent industry developments.
Protexia Rail Products

With a capability to manufacture up to a maximum width of 6m, GEOfabrics’ non-woven, needlepunched RK1 geotextiles are specified by engineers due to their robustness and proven ability to work in the most demanding installations. This is especially important when considering the difficult engineering conditions and aggressive environment at the ballast formation interface where RK1 is installed.

Protexia RK1

Protexia RK1 is GEOfabrics’ separation and filtration geotextile for use between the track ballast and a sand layer or granular subgrade. Extensive and continual testing and development has demonstrated its world class-leading mechanical strength and hydraulic properties and long service life under dynamic loading conditions. This is as a result of the products:

- High puncture resistance
- High elongation to break
- Superior abrasion resistance
- Excellent filtration characteristics at all strains
- UV resistance

Protexia RK1 features and benefits

Extensive testing has produced data which demonstrates needlepunched geotextiles outperform heat-bonded continuous fibre geotextiles beneath ballast.

Subject of Network Rail Certificate of Acceptance PA05/00059 and Prorail Approval SCP00252.

In excess of 20 years track record.

Preferred by contractors as it can handle rough treatment and be installed under difficult conditions.

Manufactured in suitable widths to minimise waste.
By utilising Protexia RK1 with the latest lamination technology and in house rail testing equipment we have been able to develop and manufacture a number of multi-functional Protexia products. Incorporating additional geosynthetic materials we provide effective and bespoke geocomposite solutions to a variety of problematic ground conditions that exist in rail across the world.

**Protexia RK2**

![Protexia RK2 Image]

Drainage enhancing and robust composite of two layer drainage geonet encapsulated between two geotextiles.

Protexia RK2 is a filtration and drainage geocomposite and has been developed to address existing track bed formation installations that have a significantly reduced natural ground drainage capability. This is a problem accentuated by years of active rail traffic use, including factors such as historic ash discharge from steam engines. In addition to providing improved drainage the product also acts as an enhanced robust separator over RK1, where formation stone size appears more aggressive. Protexia RK2 can provide additional CBR puncture strength, tensile strength and reduced cone drop through higher thickness.

**Protexia RK4**

![Protexia RK4 Image]

Reinforcing composite of geogrid and geotextile.

Protexia RK4 is a reinforcing geocomposite combining a RK1 separator and bi-axial reinforcing geogrid that addresses ground conditions with soft soils such as low CBR ground bearing capacity e.g. peat. Extensive research has indicated that the benefits of this reinforcement composite installed in track construction are greater than previously thought. Considerable improvements in track quality and extended maintenance intervals can be achieved by the use of reinforcing composites installed under ballast. RK4 provides a solution that offers higher ‘stiffness’ properties through interlock with the granular and angular ballast that will overcome soft ground conditions but without having to increase ballast thickness or use of other more expensive ground reinforcement techniques.
Protextia Tracktex

GEOfabrics’ Protextia Tracktex is a unique patented, engineering solution delivered through our calculated product development programme, in partnership with rail operators and track bed engineering specialists.

Tracktex has been created to address the extensive and expensive track and ballast deterioration problem caused by ‘Erosion Pumping Failure’. When installed at the ballast formation interface it prevents rain water penetrating through to the underlying deposits whilst under load, allowing a controlled upward movement of water through capillary action and also filtering and retaining any fine soil particles, in situ, during the process.

The ‘Pumping Problem’

‘Erosion Pumping Failure’ is a long-term and global problematic phenomenon that affects the longevity of track geometry through contamination of the ballast. This is a mechanism where fine grained particles in the formation layer beneath the ballast are mobilised upward into the ballast layer above. This is further augmented by the presence of either rainfall or ground water, which allows the washing of the particles through the interconnected void spaces between the ballast. This process of fines movement also softens and degrades the basal layer through erosional processes, so that depression of the ballast into the subgrade also occurs.

These factors lead to rail deflection with uneven settlement of the rail-line and also promotes lateral movement of the same nature. The consequence of erosion pumping is the loss of rail ‘line and level’, specifically its lateral and vertical position and regularity.

This is likely to directly cause the reduction of the line’s safe traffic speed for safety reasons, resulting in the removal of the line from service so that the line and level can be restored to prevent derailment.

Other issues to further aggravate and amplify the movement of ‘fines’ from the subgrade and base layers into the ballast layer are:

- The ingress of water and train effluent (spoil and diesel / oil / grease)
- Water ingress from below due to a rising water table or water table already above that of the subgrade
- Water ingress from either side of the track from the embankments that would form part of a railway cutting

In addition to the ‘wet contaminants’, stone damage also occurs due to the physical attrition and abrasion of the aggregate thereby generating ballast flour.

The movement of these fines and muddying of the separate layers in the rail bed leads to the uneven settlement of the track initiating further movement of the track away from its original ‘perfect position’. This whole phenomenon applies across all countries around the world with similar ground conditions and is well documented where the term ‘Erosion Pumping Failure’ has been applied.

Several studies have taken place to address the ‘Pumping Failure’ issue including previous research from the then nationalised UK railways that examined the use of varying membrane liners to prevent this problem. The conclusion was then, and since enforced, that the use of any form of impermeable membrane was neither a practical nor economic solution. Whilst ballast remained uncontaminated the subsidiary impact of such barriers was saturation of the overlying sub base construction and build up of a hydrostatic head beneath by interrupting natural hydraulic flow patterns.
The Development Process

More recently significant progress has been made in both ground investigation techniques and GEOfabrics’ development of more complex and high-performance geocomposites. Work to identify the solution to this pumping phenomenon has been readdressed successfully. A program supported by the Department of Trade and mainstream rail clients produced a design for a performance-based test rig that was tailor engineered and installed at GEOfabrics’ laboratories located in Leeds, UK. The equipment was developed to accommodate any realistic track bed construction in order to gain further data on both track and geosynthetic performance, in situ, so that we could improve our products and look to create bespoke materials that can extend track performance and maintenance intervals.

Real time rail loading is simultaneously and cyclically applied to the replicated track construction through three hydraulic powered ram actuators. The rams can be programmed to load the installed track dynamically to simulate anything from an empty passenger train to a fully loaded freight train, or an ultra-high-speed train of the future. Trafficking frequencies can be modelled to replicate customers’ specific requirements.

Once set up the test equipment could then be utilised effectively to evaluate the actual performances of any nominated track construction.

In addition to track evaluation, the rig incorporates the opportunity to utilise both existing and innovative geosynthetic materials within the construction. The development team closely monitor performance to create successful geosynthetic solutions to long-term and expensive ground engineering problems.

It is important to note that the test rig equipment also has the ability to support a water table and passively controls any further flows using spray head nozzles. The rail bed created for ‘Erosion Pumping Failure’ research simulates a live track scenario using 300 mm of fine London clay covered with 800 mm of rail ballast using a standard geotextile separator in each case, between the stone ballast and clay layers. All of which was tamped down to create slurry prior to each test programme.

A fully examined performance comparison of a significant number of alternative geosynthetic materials were carried out during the process, including:

- Various non-woven geotextiles
- Membrane liners sandwiched between non-woven geotextiles
- Non-woven geotextiles with membrane composite and the inclusion of a geonet

Each individual test in this program was carried out using a million cycles (5-8 years live track use) with mixtures of high-speed, local train and freight train loading profiles, which were established from research in the USA. Water was added to the equivalent of 5 years average rainfall during the test program and the depression and track integrity were monitored over the full test period.

This test facility is also available for hire externally to be utilised by other companies to test and evaluate any part of the track bed structure, using the realistic conditions and available loading programs. Any enquiries are to be made directly to GEOfabrics.
**Tracktex: The Anti Erosion Pumping Solution**

The Tracktex product was specifically manufactured to address ‘Erosion Pumping Failure’ and is a bespoke composite material consisting of a unique micro-porous filter, sandwiched between two high strength protection geotextiles. The product was developed following continual testing using the aforementioned equipment and was finally tested intensively to over 10 million cycles (140 million gross tonnes), successfully retaining functionality and performance, before being installed in live trial sites within the UK.

Tracktex is approved for use by Network Rail and has since developed a substantial well proven reference list having been extensively installed on sites across the UK, effectively solving the problem of ‘subgrade pumping erosion’. Information on Tracktex installed sites is available from GEOfabrics upon request.

Tracktex allows subgrade pore-water pressure to dissipate whilst still preventing fine soil particles migrating upwards to contaminate the ballast. In addition, the composite conforms to the formation profile and thus minimises the potential for pockets where slurry could accumulate.

### Tracktex features and benefits

- Pore water is relieved upwards through the composite under the cyclic loading.
- Rainfall cannot penetrate the micro-porous filter and is drained laterally to the sides of the track.
- Any residual slurry becomes dried as any pore water is dissipated.
- Conforms to surface depressions in the formation layer preventing the creation of slurry pockets.
- Faster installation rates reducing the construction costs and increasing the coverage for a given possession time.

- No requirement for specialist plant.
- Geogrids can be placed immediately on top of the composite.
- Predicted durability of greater than 100 years in soils with pH in the range 1.5 – 12.2.
- UKAS accredited laboratory testing.
- The compact 25m and 50m long rolls (3.5m and 3.9m wide) mean that difficult-to-access track becomes an easier proposition to manage.

### Environmental Benefits

The use of a Tracktex composite can reduce or totally remove the depth of excavation and the sub-ballast materials that would be required to construct a traditional ‘Erosion Pumping Barrier’. Tracktex promotes significant reduction in the number of vehicles delivering materials to site and the volume of spoil being taken away for disposal thus improving carbon footprint performance.
Installation Details

The standard specified and installed width of Tracktex is 3.9m laid directly onto a prepared formation avoiding any lapping up the sides of the excavation. This should be achieved wherever possible.

Where the above is not achievable typically because of width restrictions, a standard 3.9m roll can be lapped up one side of an excavation. This should only be conducted where work has been carried out to provide an adequate fall or suitable gradient that creates a clear drainage path to a suitable track drainage system installed on the opposite edge for runoff e.g. slotted or perforated pipe or a granular based drainage channel. Tracktex is then to be installed up to the edge of this drain. This procedure would also apply in tunnels and other structures where there is a restricted width on track.

Any further reduction in the specified width of Tracktex should be approved by the relevant Railway Design Engineer.

Tracktex was recently installed at Bradley Junction and used in conjunction with a reinforcing geogrid. The two materials have to endure extremely aggressive installation procedure and heavy loadings (see adjacent image). These installation activities are historically known to cause significant and permanent damage to geosynthetics. Tracktex has been specifically designed to withstand both installation damage and ongoing mainline service loading and activities.

It is a preferred option that plant does not drive directly on any installed geosynthetic and Tracktex remains no different. However it is possible to allow minimal movement of plant in one direction providing that the plant equipment has rubber tracks or tyres, but no 360° rotation of any vehicle should be carried out.

On no account should metal track or wheeled vehicles be utilised directly on Tracktex to maintain the integrity and functionality of the material.
Additional Products

In addition to Protexia rail specific products GEOfabrics also provide many other high-performance geosynthetic solutions to address additional geotechnical problems that regularly occur during the construction of rail projects across the world.

These materials offer complimentary solutions when constructing rail and other civil engineering projects. Functions include separation, filtration, drainage, protection and reinforcement demonstrated by our established HPS geotextile grades with puncture strengths between 2kN and 40kN (CBR). Examples include:

**Tamworth-Litchfield case study**
GEOfabrics’ GPT5 was used on the busy Tamworth-Litchfield line to accommodate a track widening program whilst addressing outstanding slip repairs and slope stabilisation.

The solution was achieved using GPT5 in conjunction with a soil nailing solution to provide drainage whilst retaining embankment soils. Upgrading the line also involved widening the cutting to accommodate new track. Progress included further excavation of the existing slope and stabilisation of the newly cut faces with a geogrid, GPT5 (a geotextile incorporating longitudinal band drains at 1m centres) and a galvanised steel mesh. The in situ GPT5 composite was fixed in place using the soil nails and mesh.

**Bessy Gill case study**
A rotational slip at Bessy Gill initiated subgrade deformation immediately below a main rail line with rail deflection indicating a 28mm vertical displacement from original track level.

Final stabilisation involved 319 concrete piles 9m long being bored mid slope and a significant number of soil nails being inserted into the upper slope. GEOfabrics’ HPS12 covered the complete slope with 82 concrete blocks (2.2t) placed along the toe of the embankment. The area was finally covered using stone filled gabions and placed rip-rap stone preventing further scour from the stream at the slope base which was thought to be a contributing factor to the initial problem.
Quality and Development

Geofabrics continue as one of the main geosynthetic innovators in the industry with our highly active Research and Development department.

Our continued success in new products is as a result of an experienced team and our ongoing relationships with an expanding list of professional clients who partner with us to produce bespoke geosynthetic solutions.

Geofabrics’ priority is to manufacture a high quality end product that provides the exact needs of our customers, in line with function, durability, value and in accordance with all current legislation and design standards.

Protexia: Long-Term Durability

Geofabrics manufacture from high density polyethylene, polyester and polypropylene polymer and fibres. Such polymers are generally considered chemically and biologically inert, in all but the most aggressive environmental applications.

Geofabrics’ composites are resistant to chemical and biological clogging, have UV stability to prevent degradation when exposed to sunlight and provide long-term strength without reduction in performance or function.

Geofabrics’ innovative products are produced using the latest manufacturing technology and UKAS accredited testing facilities.

Should you require any information or assistance in relation to this support service please contact us.

Approved by

Network Rail

ProRail

Accreditations

The ISO 9001 Management system uses customer feedback, continuous assessment and independent auditing to drive both improvement and the control required for a professional and quality based environment.

Accredited laboratories that operate in line with UKAS methodology, policy and audits to provide accurate performance information.

Geofabrics Limited manufactures CE Marked products that meet the construction products directive.
Global Supply Network

GEOfabrics Limited supply a world class range of engineering products for a diverse set of applications, across the UK and international markets. We pride ourselves on building strong, long-term and mutually beneficial partnerships with our agents and distributors, in order to provide a quality technical supply service to our clients.

UK       EUROPE      MIDDLE EAST      NORTH AMERICA      AFRICA      ASIA

Further literature, in the form of case studies, design guides, installation procedures, product data sheets and model specifications can be downloaded from www.geofabrics.com