

# Railways





# Geosynthetics in railways and related applications

## A geosynthetic provides one or more of four functions when used in track-bed construction:

**Separation** to maintain the integrity of adjacent soil types i.e. prevent intermixing.

**Filtration** to prevent leaching of soil particles.

**Drainage** to allow the free passage of water.

**Reinforcement** to provide additional strength.

The use of geosynthetics to reduce or replace traditional layers is now an accepted part of track-bed construction and renewals around the world. When correctly specified and installed, geotextiles and geogrids are proven to:

- enhance track performance.
- significantly extend design life.
- reduce the time required to renew a specific length of track (or allow more to be renewed in a fixed time).
- reduce overall material costs.

Innovation and the search for value-engineered solutions continues.

### Fiberweb Geosynthetics Ltd and TERRAM™ products

Fiberweb Geosynthetics Ltd was established in 2010 and is the UK's largest manufacturer of geotextiles. Its product portfolio includes the original, trusted and proven TERRAM geotextiles, geocells and geocomposites manufactured by TERRAM Ltd together with the geonets and pavers manufactured by Boddingtons Ltd (acquired 2011). The UK manufacturing capability has been expanded and centralised at Maldon in Essex.

Fiberweb Geosynthetics Ltd provides a unique range of value-engineered solutions for the construction of highways, railways, landfills, pipelines, coastal/waterways defences and in landscape engineering. With unrivalled expertise and experience in geosynthetics, accumulated over a 40 year period since the first TERRAM products were launched, the Company remains committed to the development of innovative and cost-effective geosynthetic solutions.

The Company intends to lead the market in the design and manufacture of geosynthetics, and continue to provide ground-breaking solutions - the next generation of TERRAM products.



# Extending track-bed life using geosynthetics

## Sub-grade erosion pumping over a clay or silty subgrade.

With ballast placed directly over a clay or silty subgrade there is the possibility of a slurry being formed at the ballast/subgrade interface; particularly if there are depressions or pockets at formation level.

Regular traffic causes the ballast to oscillate at the interface which disturbs the clay/silt, and the presence of water in the pockets causes the particles to form a slurry. As the ballast dilates, the slurry moves into the void. The slurry is pumped upwards as the ballast contracts. This rapid, cyclical effect causes the mobile clay/silt particles to be forced progressively up into the ballast.

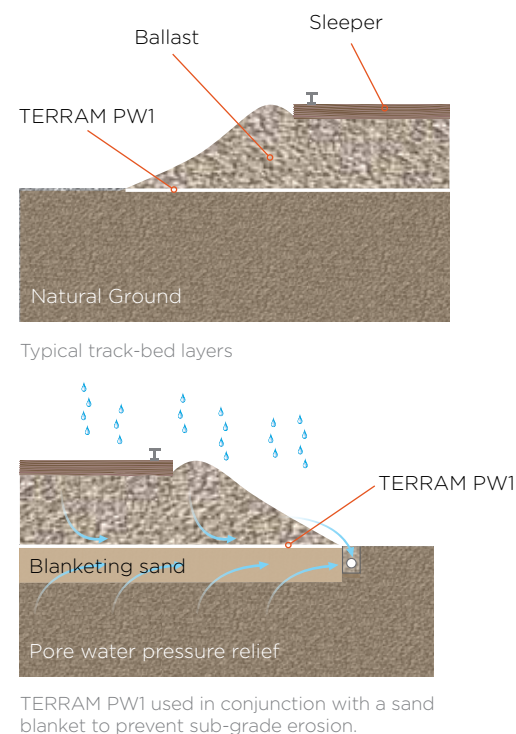
An alternative to using a graded sub-ballast in this situation is described in Railtrack's Line Code of Practice - Track Substructure Treatments 2 and 3 which describes a blanketing sand of specified grading is laid on the sub-grade to act as a fine soil filter/separator to prevent 'pumping'.

### Using a filter/separator to replace part of a sand blanket

One of the purposes for using a sub-ballast or a sand blanket is to filter any ground-water so that the ballast does not become contaminated with soil particles as a result of sub-grade erosion.

Contamination would cause loss of ballast friction and deformation due to reduced load-bearing capacity in the subgrade. The resulting effect on track alignment would mean a reduction in track speed and, ultimately, track renewal.

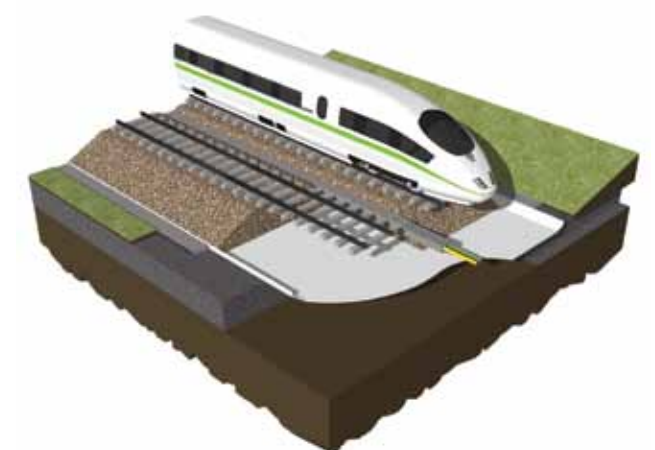
A 300mm deep layer of sand was originally introduced in the UK to prevent ballast contamination but it was later found that this could be reduced to 100mm if a geotextile filter/separator was used at the sand/ballast interface - TERRAM PW1. Although this geotextile allows downward movement of water coming via the ballast the relative change in permeability at this interface means this water drains laterally to track-side drains.



Sand does not contain the graded-gravel fraction of a sub-ballast and is thus prone to intermixing with the ballast. TERRAM PW1 also acts to prevent this.

Unlike sand, TERRAM PW1 is compact to transport and is rapidly laid ready for placement of the ballast. It has factory-controlled properties which do not rely on the need, unlike sand, for the correct thickness to be laid consistently across and along the track. In addition, excavation and the attendant disposal of fill is reduced when a geosynthetic is used to reduce the sand-blanket depth.

TERRAM PW1's ability to act as a filter over the design life is proven in countless projects around the world over the last twenty five years. Localised excavations along 8 to 10 year-old installations have revealed the TERRAM PW1 to be in good condition and visual inspection provided confidence that it would continue to do its job.





# Preventing Clay Pumping

Placement of a sand blanket is time consuming and time is of the essence when working against the possessions' clock.

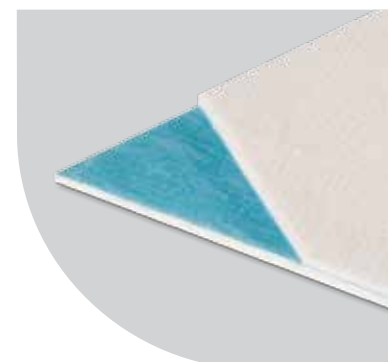
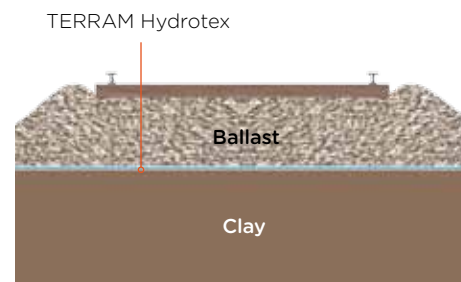
## Replacing a sand blanket entirely

Fiberweb have continued to develop and evaluate likely candidates for a sand-blanket replacement knowing that the ideal product would have to be:

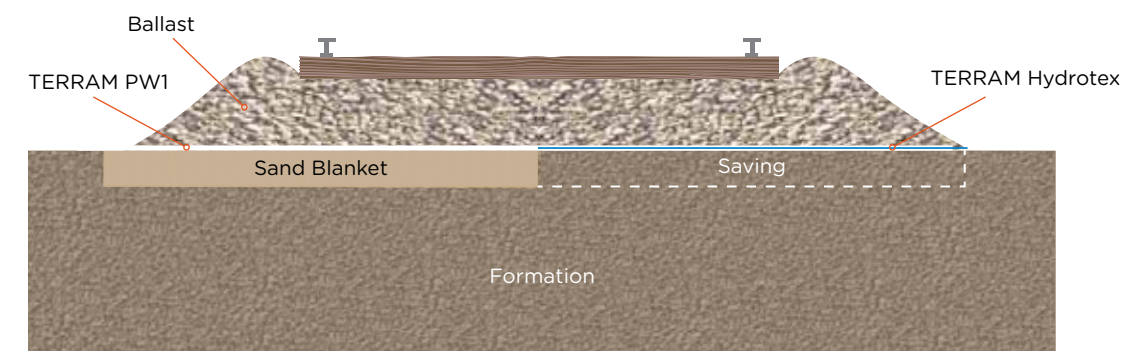
- Quicker to install
- Lower in (installed) cost
- More readily available
- More environmentally friendly

Fiberweb Geosynthetics recognised that its own development needed to be focused on the filter function as TERRAM PW1 alone is not capable of preventing the passage of the smallest clay/silt particles.

Fiberweb's innovation team have been developing filters for many industrial applications. The use of this expertise has been invaluable in designing a geosynthetic filter capable of preventing the passage of the smallest clay and silt particles. The solution was to sandwich a micro-porous filter at the centre of two robust layers of geotextile to protect it from potential damage. The result was the TERRAM Hydrotex range of geocomposites.



TERRAM Hydrotex composites allow pore-water pressure to dissipate whilst preventing fine clay and silt particles migrating to contaminate the ballast. In addition, an Hydrotex composite conforms to the formation profile to minimise the potential for ponding.



Replacing the whole of the sand blanket reduces the excavation that would normally be required to accommodate the sand and the attendant cost for disposing of the spoil.

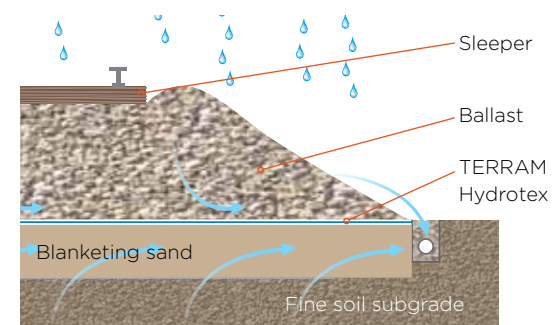


# Preventing sub-grade erosion

## Preventing sub-grade erosion with fine soils, coarse soils and granular soils i.e. sand and gravel

### Preventing sub-grade erosion with fine soils

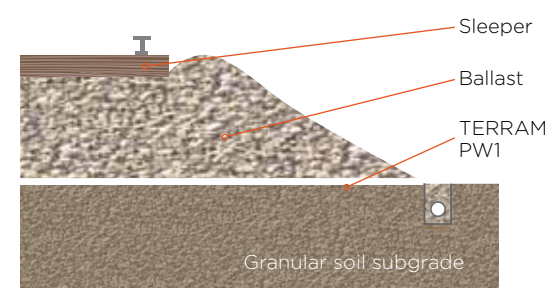
Fine soils are mixed soils, containing possibly all the grading sizes including clay silt, sand and gravel. The clay and silt fractions dominate its engineering properties/behaviour. Sub-grade erosion over fine soils can be prevented by the inclusion of a Hydrotex geocomposite at the ballast/subgrade interface.



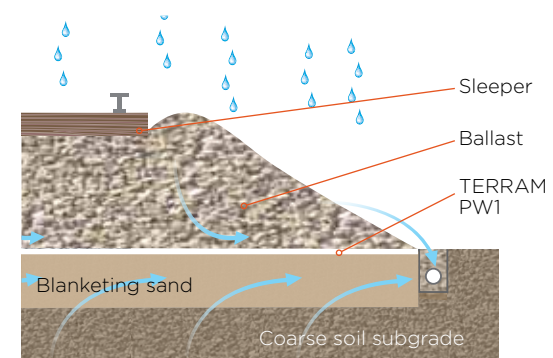
### Preventing sub-grade erosion with coarse soils

Coarse soils are mixed soils containing possibly all the grading sizes including sand, gravel, silt and clay. The sand and gravel fractions comprise over 65% of the soil and dominate its engineering properties/ behaviour.

One of the most common subgrades comprises worn ballast, silt from the degraded ballast, sand, ash, and perhaps some silt and clay contamination. This can fall in the category of coarse soil.



With subgrade erosion conditions, the silts and clays will have been washed out from the coarse soil immediately beneath the geotextile and been pumped through the geotextile to contaminate the lower ballast. Stable conditions will have been established when the washing out of the fines will have created a zone of granular particles immediately beneath the geotextile. Subsidence will have been minimal for a coarse soil dominated by sand and gravel because the fines can be washed out without the soil structure collapsing. A natural soil filter can then form below the granular zone thus preventing remaining fines being washed out.



This mechanism has been confirmed by reports of where silts and clays have contaminated the lower 25 to 50mm of the ballast at which point the contamination has ceased. The Engineer needs to decide if contamination of the lower ballast is acceptable. If not, a sand blanket augmented by TERRAM PW1 can be used.

If some contamination can be accepted, the use of PW1 directly on top of the coarse soil, without a sand blanket, may be considered appropriate. It is recommended that this solution is only adopted if the percentage of silt and clay fraction in the coarse soil is less than 15%.

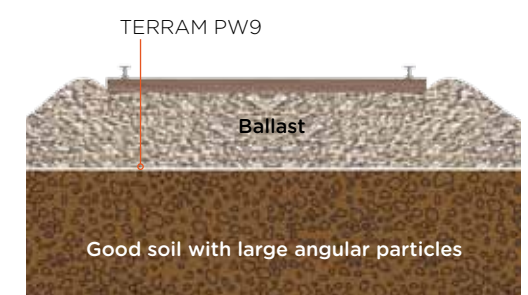
### Preventing sub-grade erosion with granular soils i.e. sand and gravel

If ballast is to be placed directly on a loose, slightly silty, fine to medium sand with occasional gravel, and there is a high water table, then TERRAM PW1 will aid the construction process over what would be difficult ground. In addition, TERRAM PW1's pores will prevent leaching of the sand whilst allowing easy passage for the ground water expelled when the line is trafficked.

**TERRAM PW1** Standard filter/separator should be used where there is an existing formation with a small percentage of coarse particles, i.e. <10% by weight <14mm.

**TERRAM PW9** Robust filter/separator should be used in an existing formation with a larger percentage of coarse particles i.e. >10% by weight >14mm.

Soil conditions can vary considerably along a length of track. In some circumstances PW engineers may consider it to be cost effective to lay a geotextile for the entire length as a precaution against localised subgrade variations. This approach is particularly relevant when using automatic, ballast-cleaning machines where the subgrade may never be seen.





# Ballast over weak subgrade

**It's accepted that a geogrid stiffens the ballast by providing reinforcement at its base, and that this is highly desirable when track is being constructed over a soft subgrade.**

## Ballast over weak subgrades

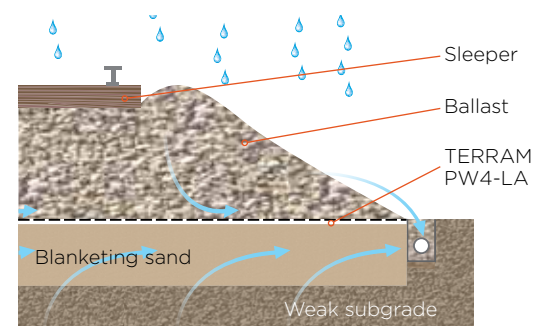
TERRAM PW4-LA is a composite of TERRAM PW1 and a geogrid which speeds up the installation time when both reinforcement and a filter/separator are both required.

An extensive, full-scale, independent research programme was carried out by British Rail and this clearly showed that the use of a geogrid beneath ballast over a soft sub-grade:

- Helps to extend maintenance intervals by minimising settlement.
- Enables the rate of settlement to approach that of tracks on firm foundations.
- Has a stiffening effect and will reduce the elastic deflections.
- Can limit the lateral creep of ballast, reducing settlement and, therefore, the rate of deterioration of the vertical track geometry.

## Other benefits of using TERRAM PW4-LA are:

- provides a genuine alternative to increasing ballast depth or chemical stabilisation.
- improves ballast performance and makes it more consistent.
- allows consistent high speeds to be achieved.
- avoids subgrade excavation and replacement with thick layers of imported fill.



**Low load-bearing capacity can exist with most soil types including organic soils.**

Susceptibility of the subgrade to erosion pumping may or may not be an issue. If it is then a suitable grade of Hydrotex or a sand blanket plus PW1 should be used in conjunction with the geogrid as required by the subgrade type.





# Earth Reinforcement for embankments

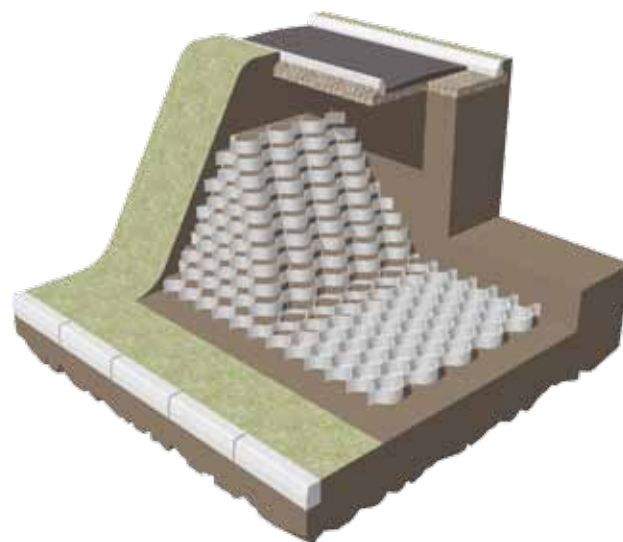
**TERRAM Geocell provides a cost-effective alternative to conventional earth retention structures due to its flexibility and suitability for use with a wide range of infill materials and foundation soils.**

The system eliminates the potential for cracking, spalling, splintering or corrosion that can affect concrete, steel and timber based systems.

It can be installed almost vertically to form an effective, economical earth retention structure. TERRAM Geocell is used in horizontal layers to form a wall structure. This can either be the panels themselves to form a gravity structure or as a facing system in a composite wall working in conjunction with an earth reinforcement system to form a mechanically stabilised earth structure. TERRAM Geocell can be used with a variety of reinforcement techniques such as geotextile or geogrid earth reinforcement, soil nails, rock bolts, helical anchors etc.

Typically installations will utilise a composite wall construction creating a totally confined wall facing that is directly connected to the backfill using one of the earth reinforcement systems outlined above. Where construction restrictions do not allow this methodology, a gravity wall construction may be considered.

In this construction the TERRAM Geocell is built as a layered wall capable of resisting the internal loads and pressures to maintain structural integrity. Utilising the TERRAM Geocell in this application creates horizontal terracing on the facia of the wall. In some circumstances these can be utilised to create a vegetated cover for the facia.



As with slope protection, the individual cells maximise water collection and minimise run-off, by allowing precipitation to infiltrate the exposed surface; creating a suitable environment for vegetation growth.

When used in these applications, TERRAM Geocell offers a solution that fulfils a broad range of design requirements and construction conditions. The unique nature of TERRAM Geocell structures offer flexibility and allow for infilling with a wide range of materials including site infill soils (if suitable), top soils, sand, aggregates and concrete.

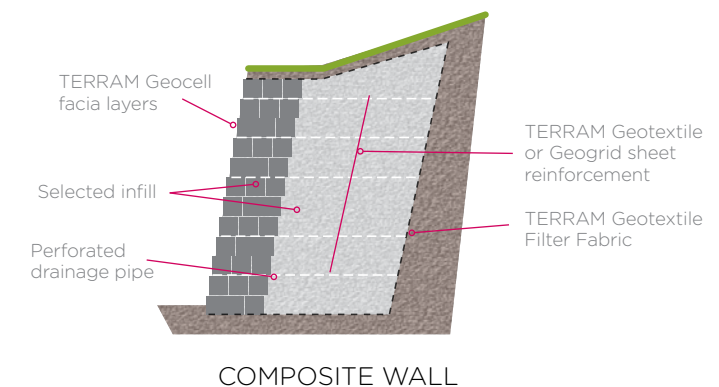
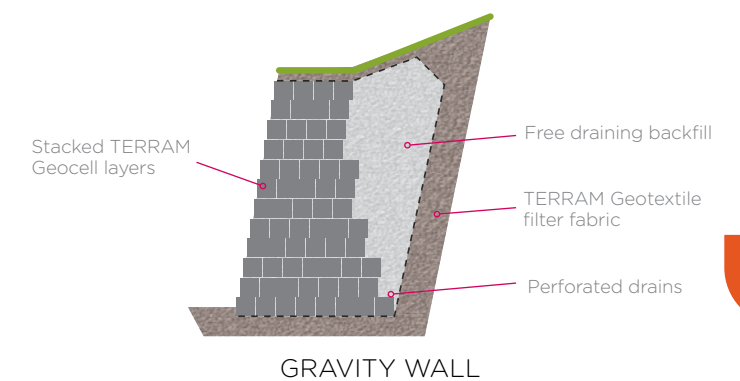
## Design Considerations

- Wall Height
- Facia Angle
- Surcharge load on the top of the wall
- Overturning Stability (the consideration of the turning moment around the toe of the structure)
- Sliding Stability (shear strength at the base of the gravity wall)
- Foundation Bearing Capacity (the substrate must be able to support the applied load of the wall structure).

TERRAM work with specialist partners to provide independently validated solutions in accordance with best practice guidelines.

## Typical Applications Include:

- Steepened Embankments
- Slope Stabilisation
- Green Walls
- Sound Barriers.



**A complete design service** including project design and on site technical support now available. Please contact us on 01621 874 200





# Controlling erosion on railway slopes

# Rail datums

**TERRAM Geocells are three-dimensional blankets of interconnected cells which are placed on slopes, secured in position using pins, and filled with friable topsoil.**

## Controlling erosion on railway slopes

Once installed, a TERRAM Geocell provides immediate stability by confining the fill and greatly improves resistance to wind and run-off.

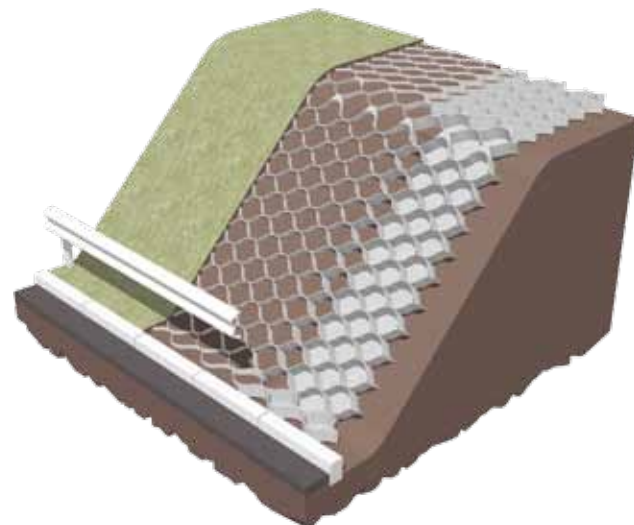
With a topsoil fill, the stability is further enhanced as vegetation becomes established and a geocell can be used to establish vegetation on slopes where establishing cover would otherwise have been a problem. The honeycomb of cells provides protection for the vegetation during the early, sensitive period of germination and growth.

The Geocells are formed from TERRAM Geotextile to confine the fill and the permeable walls allow drainage from cell to cell down the slope. Other geocells achieve this cell-to-cell drainage by perforating the walls but this process can lead to weaknesses. Geocells fabricated from impermeable materials suffer from weiring - water cascading down the slope from cell to cell - and this causes ongoing loss of soil from the cells.

Many variables affect the installation and performance of a slope-protection geocell, including slope angle, slope stability, the infill type, rainfall levels and irrigation (if included). It is important therefore that due consideration is given to all relevant criteria on a project by project basis.

## Typical applications include:

- Cuttings and embankments
- Noise-deflection and environmental bunds
- Abutments
- Steepened slopes
- Soil nailing cover
- Drainage ditches



A TERRAM Geocell with its distinctive array of interconnected cells.



TERRAM Geocells are anchored to slopes using U shaped - TERRAM Fixing Pins - these combined with the weight of the soil prevents slippage.

**Railway Datum Gauges are plastic marker sign plates used to mark the correct level or position of the rail track.**

The railway datum gauge sign plate is attached to a fixed object such as the railway platform or a bridge. Each datum plate is manufactured from a durable 'Luran S' plastic and is supplied with a red/green block & slider and spaces for security snap fit inserts.

- Plate size: 140mm x 200mm

- Colour through technology protects against vandalism and prolongs the product life

We can also provide steel, aluminium and plastic backing plates for secure fitting. Each plate requires 12 x Snap fit 25mm inserts and 4 x 10mm inserts which we can provide at an extra cost.





# TERRAM PW1

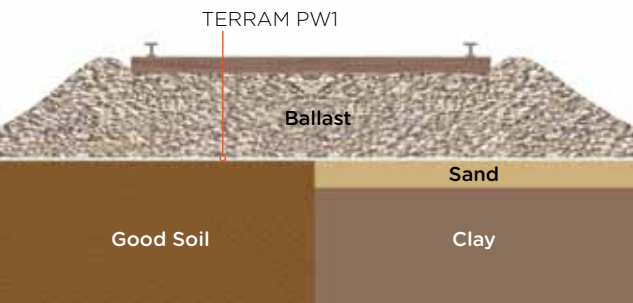


**TERRAM PW1 trackbed separator is designed to maintain separation between the adjacent sand/ballast layers within the trackbed construction, preventing the upward movement of fine sub-grade particles.**

TERRAM PW1 is suitable for where sub-grade soils are good, have sufficient strength and the particles are of even size.

TERRAM Geosynthetics provide solutions for permanent way applications where loss of rail track alignment caused by sub-grade erosion leads to costly maintenance and the complication caused by having to plan and temporarily close the track for its renewal.

- Features:**
- Engineered to provide high strength and high elongation at break.
  - Manufactured from high tenacity UV stabilised virgin polypropylene fibres to provide long term durability in all soil types.
  - Manufactured using a randomly orientated web to provide completely isotropic properties.
  - Excellent uniformity with high permeability and low pore size for soil filtration.
  - Network Rail approved PADS No. 057/100555.



**Scenario 1**  
Good soil subgrade

**Scenario 2**  
Clay subgrade and sand blanket

Physical Properties	PW1
Roll Width	4m
Roll Length	50m

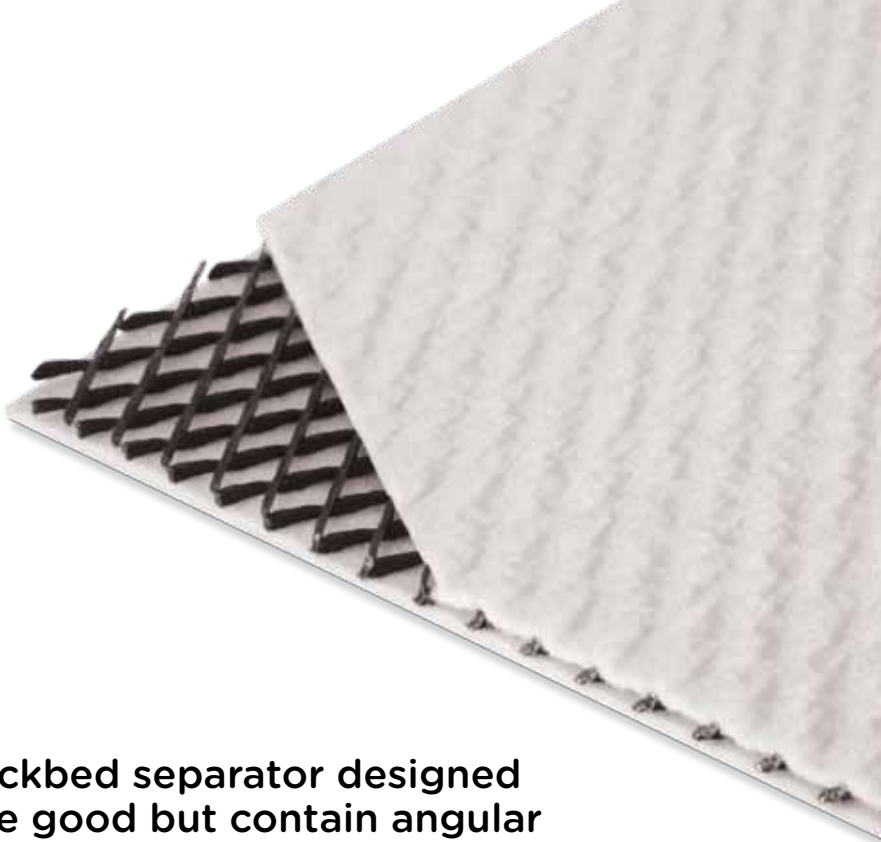
\* Other dimensions available

TERRAM product specifications can be downloaded freely from [www.terram.com](http://www.terram.com)





# TERRAM PW2

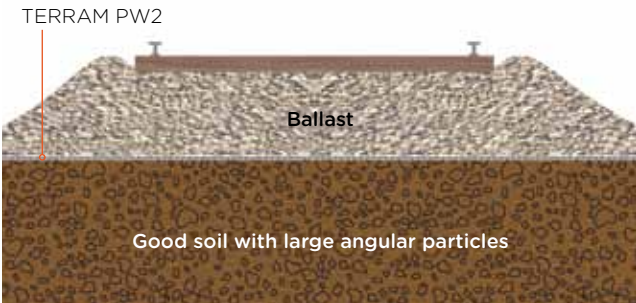


**TERRAM PW2 is a robust trackbed separator designed where the sub-grade soils are good but contain angular stone. This angular stone could damage a standard geotextile, so a robust geotextile that protects the separation geotextile.**

TERRAM PW2 is a geocomposite- a robust separator/filter incorporating a stiff net between two textile filter layers

TERRAM Geosynthetics provide solutions for permanent way applications where loss of rail track alignment caused by sub-grade erosion leads to costly maintenance and the complication caused by having to plan and temporarily close the track for its renewal.

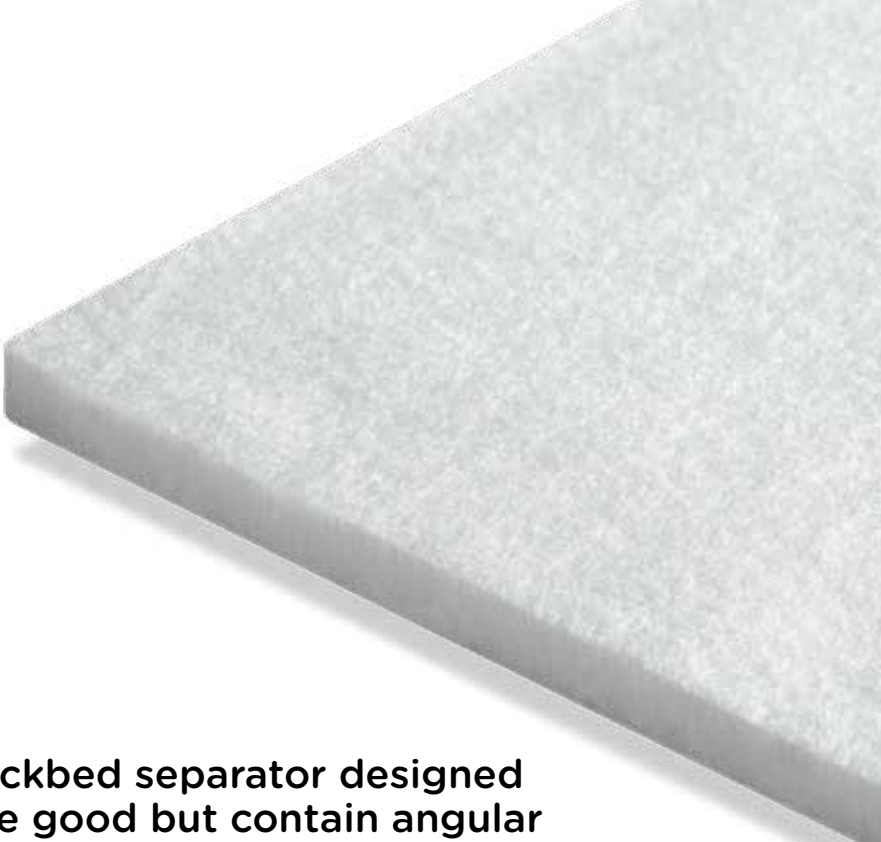
- Features:**
- Manufactured using HDPE geonet sandwiched between two layers of TERRAM PW1 to provide the necessary robustness when used with large angular soil particles.
  - Network Rail approved PADS No. 057/100777.



Physical Properties	PW2
Roll Width	4m
Roll Length	25m

\* Other dimensions available

# TERRAM PW9

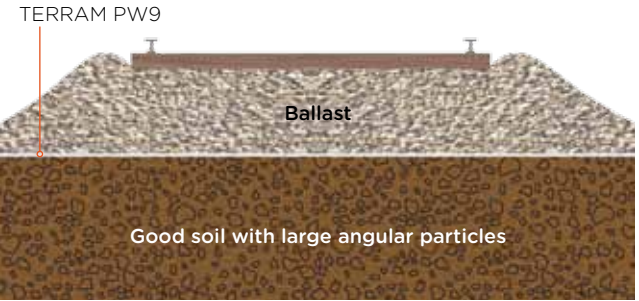


**TERRAM PW9 is a robust trackbed separator designed where the sub-grade soils are good but contain angular stone. This angular stone could damage a standard geotextile, so a robust geotextile that protects the separation function of the geotextile is essential.**

TERRAM PW9 is a mechanically entangled robust separator/filter that provides protection from angular stone damage.

TERRAM Geosynthetics provide solutions for permanent way applications where loss of rail track alignment caused by sub-grade erosion leads to costly maintenance and the complication caused by having to plan and temporarily close the track for its renewal.

- Features:**
- Engineered to provide additional strength to resist damage from large angular stone particles.
  - Manufactured from high tenacity UV stabilised virgin polypropylene fibres to provide long term durability in all soil types.
  - Manufactured using a randomly orientated web to provide completely isotropic properties.
  - Excellent uniformity with high permeability and low pore size for soil filtration.



Physical Properties	PW9
Roll Width	3.9m
Roll Length	25m

\* Other dimensions available



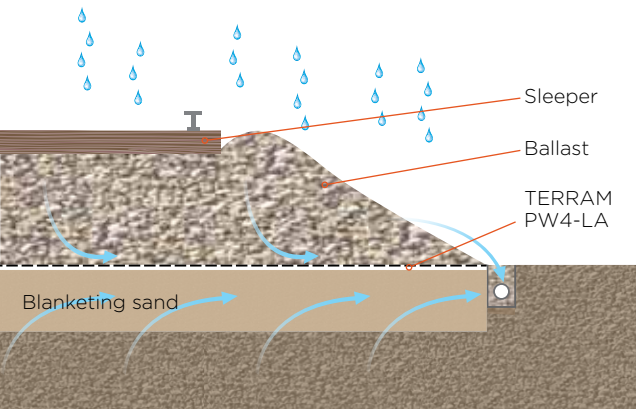
# TERRAM PW4-LA



**TERRAM PW4-LA is a reinforced trackbed separator designed where the sub-grade is weak, ie. Soft and boggy conditions.**

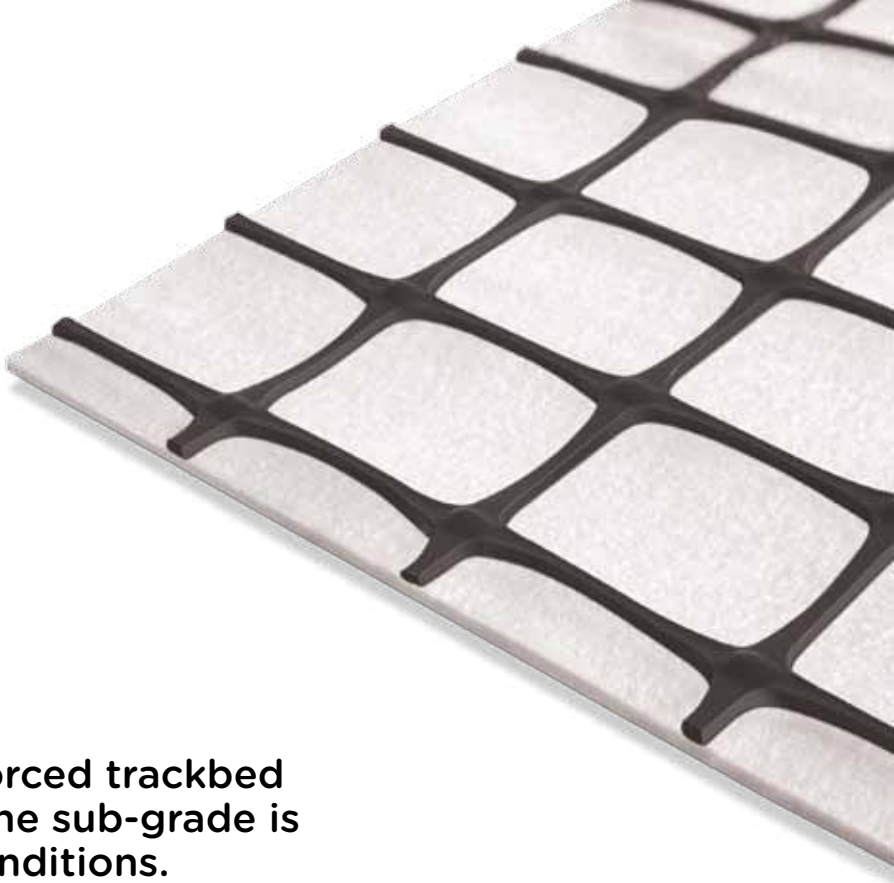
TERRAM PW4-LA is a composite formed from TERRAM PW1 and Tensar SSLA30 geogrid. Tensar SS40 improves track life and performance by stiffening ballast laid over weak ground. The advantage of TERRAM PW4-LA is the speed at which a geotextile filter and grid reinforcement can be laid in a single pass with the beneficial effect on construction costs.

TERRAM Geosynthetics provide solutions for permanent way applications where loss of rail track alignment caused by sub-grade erosion leads to costly maintenance and the complication caused by having to plan and temporarily close the track for its renewal.



Physical Properties	PW4-LA
Roll Width	4m
Roll Length	25m

\* Other dimensions available



- Features:**
- The structure and composition of PW4 provides a long term mechanical performance and chemical resistance, even when used in very aggressive conditions.
  - Improves the load bearing capacity of soil when placed at the base of ballast, constraining the aggregate by laterally confining it, providing the necessary support.
  - Manufactured using large aperture bi-axially orientated geogrid developed specifically for railway applications and use under ballast. PW4-LA provides the ideal dimensional characteristics for the effective interlocking of ballast within the geogrid apertures.
  - Network Rail approved PADS No. 057/100779.

# TERRAM Hydrotex



**TERRAM Hydrotex provides a permanent way solution for trackbed stability where clay pumping can cause loss of trackbed stability.**

TERRAM Hydrotex not only acts as a filter/ separator for fine soils, but also removes the requirement for a sand blanket, preventing the upward movement of fine clay particles.

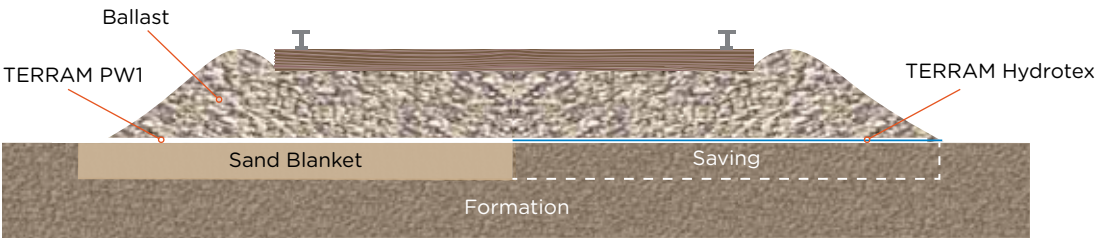
TERRAM Hydrotex nonwoven composite consists of a central filter media thermally bonded to two opposing mechanically entangled nonwoven robust filters to create a geocomposite with sufficient strength and protection to be durable to the abrasion and point loading of ballast.

The traditional use of a sand blanket in railway trackbed uses a sub-ballast and/or a graded-sand layer to prevent the upward movement of fine sub-grade particles, while allowing effective drainage and dissipation of pore water pressure. TERRAM Hydrotex offers this solution in one geocomposite.

- Features:**
- Prevents upwards particle passage smaller than 0.002mm.
  - Permeable filter, allowing upward and downward water transmission.
  - Replaces the requirement for a sand blanket.
  - Residual slurry becomes desiccated as any pore water is dissipated.
  - Network Rail approved PADS No. 057/100401.

**Environmental Benefits:**

TERRAM Hydrotex composite reduces the depth of excavation that would be required with a sand blanket. The result is a decrease in the amount of spoil being taken away for landfill and a reduction of vehicles required to deliver materials.



Physical Properties	Hydrotex
Roll Width	3.9m
Roll Length	25m

\* Other dimensions available





# TERRAM Geocell soil structures



**TERRAM Geocell Series 500 provides a cost-effective alternative to conventional earth retention structures.**

Its flexibility and it can be filled with a wide range of fill materials. The TERRAM Geocell is fabricated from geotextile which means that the 0.58m wide x 0.53m long x 250mm deep cells have permeable walls and there is no potential for cracking, spalling, splintering or corrosion associated with concrete, steel and timber facings.

The system is supplied as compact panels which are expanded on site to form a honeycomb area of cells measuring up to 10.6m x 5.5m. This, the largest panel, weighs 28kg.

TERRAM Geocell Series 500 can be installed almost vertically by placing one horizontal layer on top of a filled layer. The cellular panels can be used to form the face or they can be used to face a composite wall in conjunction with horizontal reinforcement elements such as geogrids or with soil nails, rock bolts, helical anchors, etc.

One further facing detail is to step subsequent layers to form horizontal terracing which allows vegetative cover to be cultivated in topsoil-filled cells.

The cells can be filled with site-won materials (if suitable), topsoil, sand, aggregates and concrete.

**Applications include:**

- Steep slopes.
- Dams and flood bunds.
- Retention bunds.
- Green walls.
- Culvert head walls.
- Sound bunds.

Panel Grade	20/04	20/06	20/08	20/10	20/12	20/14	20/16	20/18
Cell Nominal Diameter mm	500	500	500	500	500	500	500	500
Cell Length (L) mm	580	580	580	580	580	580	580	580
Cell Width (W) mm	530	530	530	530	530	530	530	530
Cell Depth mm	250	250	250	250	250	250	250	250
Panel Length mm	10606	10606	10606	10606	10606	10606	10606	10606
Panel Width mm	1450	2031	2611	3191	3772	4352	4932	5513
Cells per m <sup>2</sup> (nominal)	6	6	6	6	6	6	6	6

# TERRAM Geocell erosion control



**TERRAM Geocell is a relatively shallow cellular confinement system which is used to combat erosion on slopes up to 1:1.**

TERRAM Geocell is fabricated using a geotextile so it is permeable and allows water to flow between cells encouraging drainage and vegetation. It is supplied as compact man-handleable panels ready to be expanded on site to 5m x 7m or 6m x 3m areas with a honeycomb of diamond-shaped cells that are 100mm, 150mm or 200mm deep.

Once placed and secured on the slope, the geocell can be filled with soil or a mineral fill. The result is that the confined fill is able to better resist the erosive effects of wind and run-off. The expanded panels should be fixed at every perimeter cell and at 1m centres throughout using steel fixing pins.

The geocell is flexible enough to be formed around trees and other obstacles.

Seeded topsoil is the most suitable fill for less-exposed slopes, with small shrubs offering improved protection, whilst a granular material offers the highest protection.

**The TERRAM Geocell confinement system is suitable for:**

- Cut or fill embankments.
- Dams or spillways.
- Revetments.
- Abutment protection.
- Geomembrane protection.
- Soil-nailing cover.
- Landfill capping.

Panel Grade	22/20	25/10	25/15	35/10	35/15
Cell Nominal Diameter mm	220	250	250	350	350
Cell Length (L) mm	275	295	295	415	415
Cell Width (W) mm	230	250	250	370	370
Cell Depth mm	200	100	150	100	150
Panel Length mm	6176	5175	5175	5199	5199
Panel Width mm	3227	7300	7300	7438	7438
Cells per m <sup>2</sup> (nominal)	30	26	26	12	12





**Further market specific literature available:**

- Roads & Highways
- Grass & Ground Reinforcement
- Landfill
- Coastal & Waterways
- Pipelines / Utilities

Application specific literature, product data sheets, case studies and installation guides are available on request or can be freely downloaded from **www.terram.com**. Please contact our technical sales team for reference projects, to organise a CPD seminar and for further advice.

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