GEOfabrics®

TrackTex™

Anti-Pumping Geocomposite

User Guide

SUBSTRUCTURE DESIGN

The track sub-structure is the foundation that supports the track. When referring to ballasted track the substructure is constructed with the following layers:

- Ballast
- Sub-ballast
- Subgrade

Railroad Trackbed Components

SUBSTRUCTURE DESIGN

Ballast

Ballast is the granular material placed at the top of the substructure layer. Its three major functions are:

1) maintain track geometry by resisting vertical, lateral and longitudinal forces;

2) distribute train loads to a larger subgrade area, thereby limiting the stresses applied to the subgrade; and

3) facilitate drainage.

There are four recognised stages of ballast deterioration:

1. Clean ballast – uniform-sized particles that are free draining, with possibly a low level of fines within the voids.

2. Slightly dirty ballast – some fines that have accumulated within the voids, but the ballast section is still free-draining.

3. Dirty ballast – voids are filled with fines, but those fines are generally granular and permeable; the ballast section still drains, though slowly.

4. Very dirty ballast – voids are completely filled with fines and the ballast section is impermeable – it does not drain.

Sub-ballast

A well designed sub-ballast layer should be permanent, unlike the ballast layer which has a limited life and requires periodic replacement. A modern sub-ballast is well-graded, sandy and gravel-sized. Its function is to further distribute train loads to the subgrade, increase track stiffness, and provide a free-draining formation.

The grading is designed to form a dense layer that will not be subject to deformation once compacted. The sub-ballast layer should also provide a filter function when placed over fine graded subgrades, preventing the upwards migration of fine materials whilst allowing effective dispersion of pore water pressure.

Subgrade (Natural Ground)

Subgrade is native earth, and is the most inconsistent and potentially weakest of track components.

Ideally, the subgrade must function as a stable foundation layer, be structurally sound and consistent during any environmental change.

THE PROBLEM

In areas where the existing sub-ballast layer is inadequate to protect the underlying subgrade from erosion, or where the sub-ballast itself is of poor quality and breaks down under traffic, mud pumping can occur, particularly in areas with high rainfall and poor drainage.

Subgrade erosion occurs where fine-grain particles (silts and clays) are dislodged under dynamic loading by the ballast. The fine-grain material combines with water to produce a slurry, which is pumped upward under the high pressure generated by train loading. A suction force develops under the ties after the load has passed, causing the slurry to be pulled further up into the ballast section. Under these conditions there will be a tendency for water to be drawn out of the slurry, resulting in the slurry becoming thinner closer to the clay surface. Thus, in the presence of a suitable water supply, the process of subgrade erosion is self-perpetuating.

Mud pumping results in ballast failure, a weakening of the track modulus, and a consequential reduction in track structure bearing capacity. A small amount of slurry at the base of the ballast will have a minimal impact on track geometry. But when the slurry migrates upwards into the ballast voids, the load bearing capacity of the ballast can be significantly compromised. By this point, tamping is only a short-term fix to track surface problems.

The rate at which mud pumping develops will vary, dependent upon a number of factors. Where there is a fine-grained soil present at the ballast/sub-ballast interface, a slurry will develop. But if drainage is good or the line is lightly loaded, the slurry may remain at a low level and not significantly affect ballast performance. On the other hand, if the drainage is poor and the loading is significant, mud pumping can develop very quickly. Adding clean ballast may help in the short term, but it is not a long-term solution. A modification of the track structure may be needed.

The worst pumping problems often occur after undercutting, when the existing sub-ballast layer, which had provided adequate subgrade protection, is removed and the subgrade is exposed to direct ballast loading.

Mud pumping results in ballast failure, a weakening of the track modulus, and a consequential reduction in track structure bearing capacity

THE PROBLEM

Movement of slurry (fine-grain material and water) from subgrade to track level

Slurry is shown pumping its way up through the ballast

THE SOLUTION

TrackTex™
Anti-Pumping Geocomposite

TrackTex is a multilayer composite with a unique microporous filter media protected by specially engineered nonwoven geotextiles. The filter is an orientated microporous polymeric film with a series of microcells and interconnecting pores, characterised by its relative strength and ability to transmit vapour.

TrackTex allows the passage of liquid under pressure, but the pores prevent the passage of clay fines. Without pressure water cannot pass through the filter. Therefore over time the underlying formation will dry out.

Christiansburg District - USA

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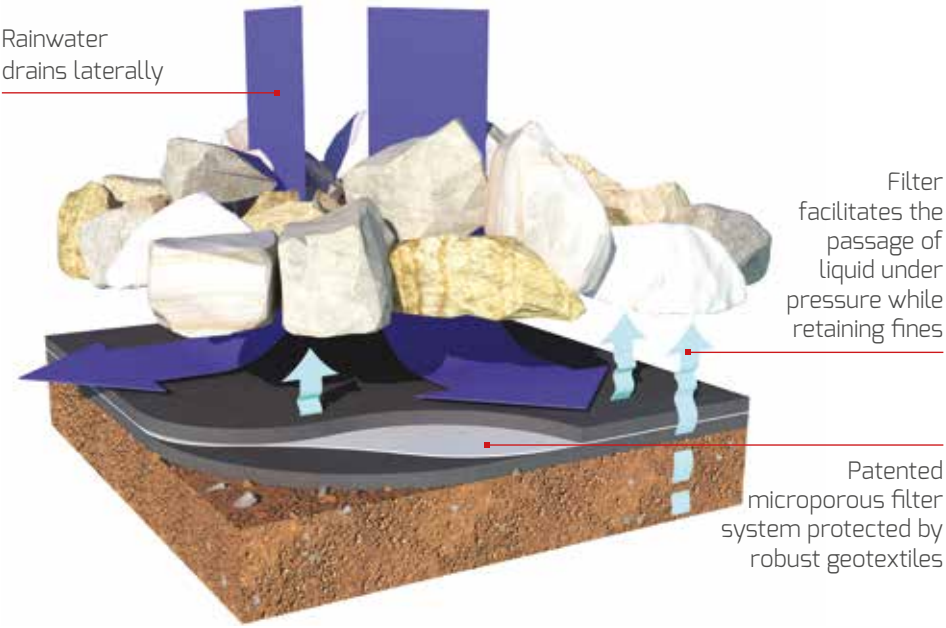
TrackTex advantages

- Prevents subgrade fines and slurry from migrating up into the ballast
- Facilitates drying of existing subgrade slurry by allowing pore pressures to dissipate under loading, while preventing re-saturation from above
- Is proven to be sufficiently robust to withstand the rigors of installation and train loading without damage
- Is flexible enough to conform to uneven subgrade formations such that no slurry-induced voids exist

THE SOLUTION



Significant performance benefits have been documented when TrackTex is used in new track construction or added to areas prone to subgrade pumping.

Some of the documented benefits include:

1. Increased interval between required maintenance by more than 25 times over re-ballasting alone
2. Faster installation rates than alternative remedies (such as installing new sub-ballast)
3. Improved track quality and geometry
4. Lightweight, easy to install (TrackTex is delivered in rolls)
5. Reduced excavation/undercutting required (up to 25% less than required by new sub-ballast)

SELECTION CRITERIA

The guidance in Table 1 can be used where a pumping location has been identified or where there is potential for pumping to occur as a result of geotechnical conditions.

TrackTex may be placed directly on the subgrade or on existing contaminated ballast. An engineering analysis of existing or proposed conditions is suggested to determine if TrackTex is suitable.

Table 1 – TrackTex Geotechnical Guidance

Ground Condition Under Existing Ballast Consists of:	Guidance for Use of Anti-Pumping Geocomposite
1a. Ballast (with no evidence of pumping subgrade)	
Clean to slightly fouled; Heavily fouled (non-cohesive)	A standard geotextile is suitable
Heavily fouled (cohesive); Slurried	**TrackTex is suitable**
1b. Ballast (with pumping subgrade)	
Slurried; Voids filled with clay	**TrackTex is suitable**
Voids filled with silt or sand	**TrackTex can be used**, however a standard geotextile may also be suitable with good drainage. (See note on drainage)
2. Sub-ballast	
Fine to medium sand (0.02mm ≤ D60 ≤ 0.20mm)	Normally not required
Coarse sand (0.20mm ≤ D60 ≤ 0.60mm); Sand and Gravel; Well graded crushed aggregate	Normally not required
Cohesive; Slurried	**TrackTex is suitable**
3a. Fill Soil (susceptible to erosion)	
Mixed fill - rockfill in clay/silt matrix;	**TrackTex is suitable**
Rockfill - weak fine grained rock	
3b. Fill Soil (not susceptible to erosion)	
Rockfill - weakly cemented coarse-grained rock; Rockfill - hard, durable, unlikely to degrade	Normally not required
4. Natural Ground	
Organic soil; Soft to firm Clay (Undrained Cohesion ≤ 75 kPa)	**TrackTex is suitable** Consideration should also be given to placing a Ballast Reinforcement Geogrid directly on top of the geocomposite in these conditions. (This can be provided as a laminated composite or as separate components)
Stiff to very stiff Clay; Hardpan/Mudstone	**TrackTex is suitable**
Interbedded rocks, including clay or silt layers; Weathered, or weakly cemented fine grained rock	**TrackTex is suitable**
Weathered, or weakly cemented coarse grained rock; Hard rock, unlikely to pump/degrade	Normally not required

Note 1: Drainage

The performance of a trackbed treatment can be affected by the level of drainage.

Poor drainage

A site which has pre-existing drainage problems, for example where standing water is frequently found within 3 ft. of the base of the sleeper;

Satisfactory drainage

A site where water is maintained at 3 ft. between the base of the sleeper or lower with the exception of heavy rainfall;

Good drainage

A site that rarely has a drainage problem, and where surcharging of the drainage does not occur more than once per decade.

Note 2: Trackbed Stiffness

Good quality track geometry necessitates a sufficient and uniform stiffness, which is determined largely by the depth and strength of the ballast, sub-ballast, and the natural ground/subgrade.

Note 3: Wet-spots occurring from ballast deterioration

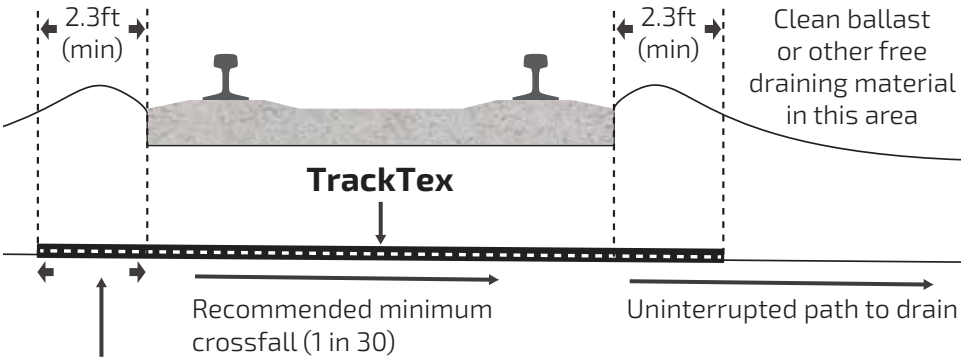
Ballast is subjected to repeated loading and mechanical maintenance which can break down the ballast particles until the voids become filled with fines. This fouling reduces the effectiveness of tamping and the ability of the ballast to drain. Track geometry is not significantly impacted until the fines reduce permeability to the point at which the pore water pressure is unable to dissipate under vehicle loading. TrackTex will not prevent ballast breakdown, but it will greatly reduce pumping caused by subgrade erosion.

Standard Cross Section

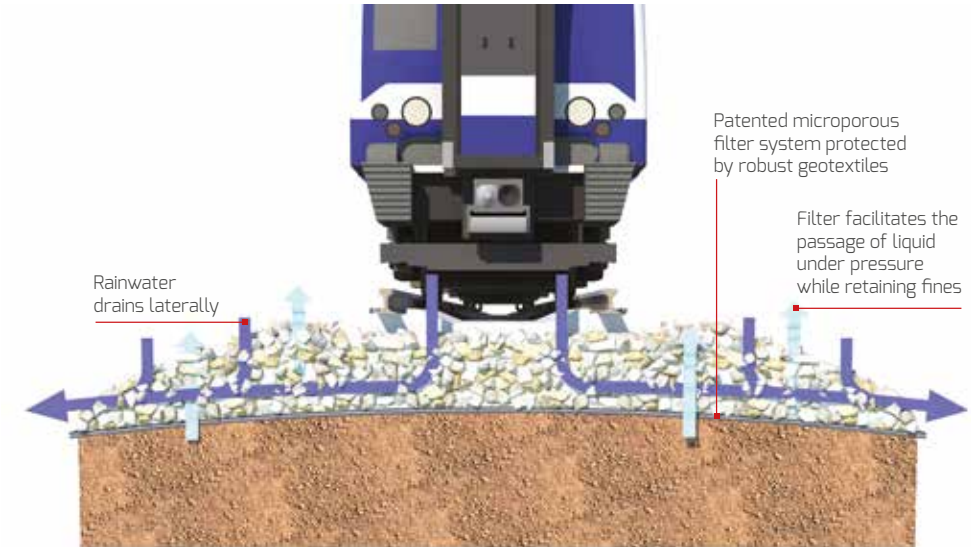
Criteria for use

- Well established sub-grade erosion problem
- Less than 3 inches of good blanketing material separating susceptible subgrade from the base of the ballast
- Typical excavation width shall be 13ft or greater

Where sufficient trackbed stiffness cannot be achieved, a geogrid composite (such as RK4, a combination of geogrid and geotextile)can be used to improve support.



Geotextile to extend at least 2.3ft beyond sleeper. If not possible the dig should be extended as far as possible with the excess being brought up to the side of the excavation



Shown to increase trackbed maintenance intervals due to pumping failure by more than 25 times, providing significant savings over any available alternative

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0338

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