Geosynthetics: What Are They and What is their Relevance in Rail Engineering?

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The challenges facing the rail network

Our Rail network is a key component of our transportation infrastructure and with the implementation of High Speed rail we are heading into a new rail era.

Unfortunately much of our existing rail infrastructure that new networks will tie into were built in the 19th century and many of the earthworks are not faring too well, embankments with saturated cohesive fill and cuttings with stability issues being commonplace.
What are geosynthetics?

• Geo: from Greek *geo*, that means "earth"

• Synthetics: from Greek *synthetikos* – etymology: "skilled in putting together" – commonly accepted definition: man-made, artificial products

• Geosynthetics: “(artificial) products/components that are skilfully added to earth”

• Typically talking about textiles, grids, mats, membranes, composites and lightweight fill materials manufactured from a range of polymers
The functions of geosynthetics:

- Separation
- Filtration
- Drainage
- Reinforcement
- Stabilisation
- Protection
- Barrier
- Erosion Control
Cyclic loading of the rail ballast during the passage of trains causes the upward passage of pore water along with fine particles from the saturated fill at the core of the embankment.

The loss of rail ballast into the embankment fill reduces the bearing capacity of the track bed and over time leads to deformation and the need for costly maintenance or the risk of line closures.
A textile layer beneath the ballast separates the ballast and embankment fill.

Prevents mixing of ballast and sub ballast materials.

 Allows pore pressure dissipation under dynamic loading but prevents the upward migration of fine particles.

Improves rail stability and reduces the need for maintenance.
Geosynthetic Applications in Rail Engineering
Radar detectable strips
The addition of a rigid geogrid at the base of the track ballast provides a reinforcement and stabilisation function. Interlock with the ballast prevents lateral spread of the particles under dynamic loading increasing the track bed stability and improving load distribution.
Whether widening existing rail corridors to increase capacity, stabilizing existing embankments in both cut and fill or creating new infrastructure, the need to minimize the land space needed for the works and reduce the need for removal of in situ materials and import new materials is key to delivering cost-effective and sustainable schemes.
Geosynthetic Applications in Rail Engineering
Reinforcement for retaining walls, steep slopes and bridge abutments
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Saturated cohesive ground not only has poor initial bearing capacities but is also prone to long term secondary settlement under new loadings such as embankments as the elevated pore pressures dissipate slowly. This consolidation settlement can take several decades to stabilize and any differential settlements can affect track stability and ultimately safety.

Wick drains/ PVDs can accelerate the consolidation ensuring the embankment is stable within months of construction.
Geosynthetic Applications in Rail Engineering
Drainage for earth retaining structures and bridge abutments

Water buildup behind conventional retaining structures and bridge abutments can increase the applied loading and movements on the rear of the structure and may require thicker structures to resist the loading.

Traditional stone drainage layers are costly and difficult to place without contaminating the drainage layer. Geosynthetic composite drains have the same drainage capacity but are far easier to install.
This ease of installation without the need to worry about segregation of drainage fill and backfill is especially noticeable around cut and cover tunnels, box culverts and when completed structures are to be jacked into place under short line closures.
In bored tunnels through both soil and rock there is a need for both membranes, drainage for pressure relief, protection layers for the membrane. This often leads to the requirement of a multi layered system between the rock face and tunnel lining.

In NATM tunnels the addition of a looped erosion control mat can act as a grip layer to receive the shotcrete.
The same drainage composites can be used to create an open air void adjacent to rail structures, beneath slab track or retrofitted to existing structures close to new lines. The void in addition to providing drainage, which slows the speed of vibrations in soil also dampens soil borne vibrations reducing damage and disruption to neighbouring structures.
Erosion of new and existing cutting and embankment slopes starts is best resisted by a vegetative surface that bonds the topsoil and reduces the infiltration of rainwater stopping small rill and gully erosion developing into full scale slope failures and reducing the risk of track blockage.

Open 3D geosynthetic mats are used to provide a permanent artificial root matrix to assist in the establishment of vegetation and prevent surface erosion in periods where the vegetation cannot. Pre filled mats can provide heavier duty protection in areas where embankment slopes encounter water at their toe.
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In steeper cuts combinations of drainage, anchors, reinforcement, erosion control mats and rock fall netting can be used to support slopes. The modular and lightweight nature of all the components makes installation from outside the train corridor possible reducing down time.
The benefits of geosynthetics

Geosynthetics are one of the tools within our geotechnical armoury that can help to improve the old network and ensure the same issues are not faced by the new.

Their proper application offer savings in both time and money and significantly reduce the embodied carbon content of projects helping the contractor to meet the more onerous targets necessary in modern construction.
Thank you for listening

• Any Questions?
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