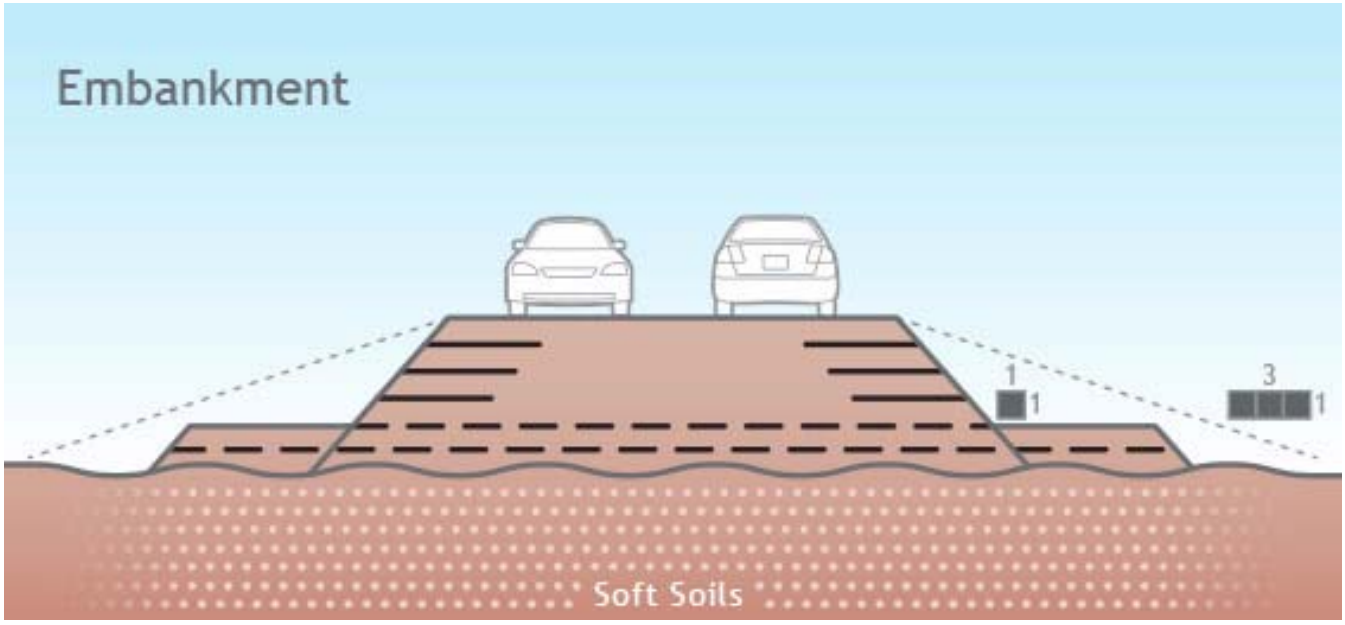
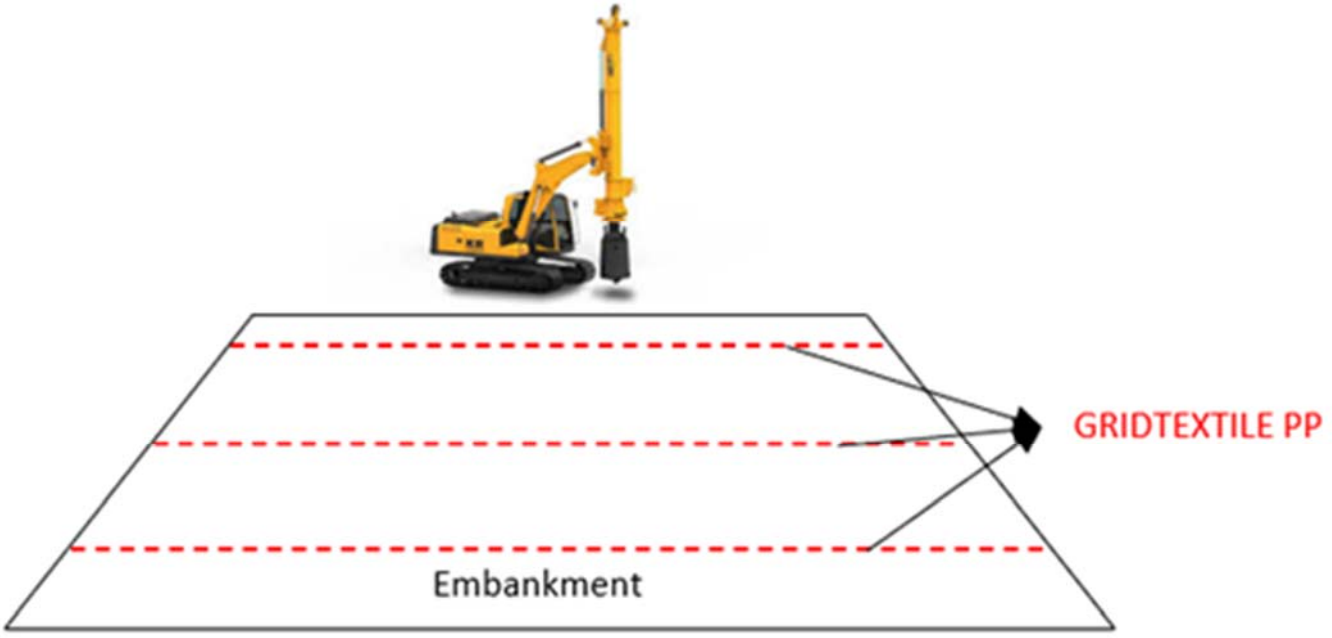
Embankment Fill Reinforcement

Most of the projects in the urban areas will not have sufficient place for the extended side slopes on an embankment. Therefore, GRIDTEXTILE PP geogrids can be used to increase the gradient and saving the space for embankment side slopes.



Also, wherever heavy machinery expected on top of the embankments during construction phase or after, a set of GRIDTEXTILE PP geogrids at 500mm max. vertical distance can be installed to distribute the heavy machinery load on to larger area and to achieve the overall stability of an embankment.



Overlay Stress Absorption and Asphalt Reinforcement

Road surfaces must be maintained regularly. Commonly, a paved road becomes a candidate for maintenance when its surface shows significant cracks and potholes. The rehabilitation of cracked roads by simple overlaying is rarely a durable solution. The cracks under the overlay rapidly propagate through to the new surface. This phenomenon is called reflective cracking. Cracks in the pavement surface cause numerous problems, including:

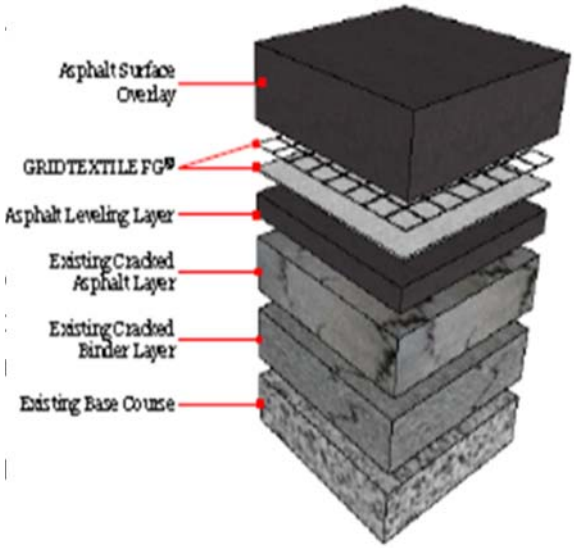
- Riding discomfort for the users
- Reduction of safety
- Infiltration of water and subsequent
- reduction of the bearing capacity of the subgrade
- Pumping of soil particles through the crack
- Degradation of the road structure in the vicinity of the cracks due to stress

Typical solutions: In-spite of reflective cracking, overlays are still the most viable option for extending the life of distressed pavement. To lengthen the lifetime of an overlay, special asphalt mixes can be specified. Also, the thicker the overlay the longer it will last. Depending on the cause of the problem, this can involve removing layers of pavement, improving subgrades, and repaving. This is extraordinarily expensive and time consuming.

Geosynthetic solution: An Asphalt reinforcement with GRIDTEXTILE FG geogrid composite is the solution which will be placed over the distressed pavement or within the overlay to create an overlay system. The GRIDTEXTILE FG interlayer contributes to the life of the overlay via stress relief and/or reinforcement and by providing a pavement moisture barrier.

Benefits due to the Asphalt reinforcement with GRIDTEXTILE FG interlayer:

- Acts as stress relieving interlayer and delays the development of reflective cracks by absorbing the stresses that arise from the damaged pavement.
- Their high tensile strength reinforces and lengthens the service life of the overlay system, parallelly reduces the maintenance cost in the long-term.
- The geotextile layer in the composite will bond effectively with asphalt coating of the overlay system and waterproofs pavements that allow 30 to 60% of precipitation to infiltrate and weaken the road structure.
- Improves resistance to fatigue cracking and saves up to 2 inches in overlay thickness.



Roadways Geocomposite under Drainage Systems

Water in pavement systems is one of the principal causes of pavement distress. It is well known that improved roadway drainage extends the life of a roadway system. Modern roadways incorporating good drainage are predicted to have a design life of up to two to three times over that of undrained pavement sections (Cedergren, 1987 and 1988). The benefits of good drainage are also recognized in many current roadway design methods (e.g. AASHTO, 1993 and US Army, 1992), which incorporate drainage factors that enable designers to take advantage of good versus poor drainage conditions. Many engineers are taking advantage of these benefits by incorporating free draining base with edge-drains into their designs (NCHRP 239).

The detrimental effects of water in the pavement system are significant. AASHTO (1993) reports:

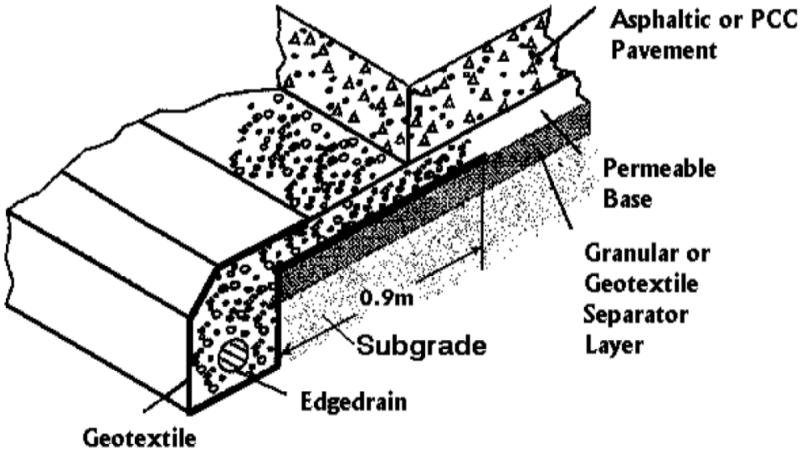
- Water in the asphalt surface can lead to moisture damage, modulus reduction and loss of tensile strength. Saturation can reduce the dry modulus of the asphalt by as much as 30% or more.
- Added moisture in unbound aggregate base and subbase is anticipated to result in a loss of stiffness on the order of 50% or more.
- Modulus reduction of up to 30% can be expected for asphalt-treated base and increase erosion susceptibility of cement or lime treated bases.
- Saturated fine -grain roadbed soil could experience modulus reductions of over 50%.

Quality of Drainage	Water Removed within
Excellent	2 hours
Good	1 day
Fair	1 week
Poor	1 month
Very Poor	Does not drain

Note: Table shows the AASHTO definitions for pavement drainage recommended for use in both flexible and rigid pavements design.

Roadways Geocomposite under Drainage Systems

Conventional Solution: Most of the water in a pavement section infiltrates through the pavement surface during rain events. The incorporation of open-graded, free draining base layer (OGDL) into the pavement section provides excellent drainage and extends service life. According to the FHWA (1987), the permeable base is recommended to have a minimum permeability of 1000 ft/day. This permeability will allow for drainage of the pavement within a few hours that qualifies as "excellent drainage" as defined by AASHTO (Table shown above). A dense graded subbase layer is usually placed below the OGDL as a separation/filter layer to prevent migration of subgrade fines into the open graded base and provide additional support. The aggregate layer(s) or cement treated base/subbase are part of the structural design.



- OGDL does not prevent the infiltrated moisture from moving into the subbase, which will reduce its as-built resilient modulus as well as that of the underlining subgrade.
- When a full depth OGDL is used, additional geotextile, layer is placed between the OGDL and subgrade to provide separation and filtration.
- Initial expense and constructability of OGDL are high.
- With an order of 5% fines in OGDL system, the permeability will be affected drastically resulting the drainage quality to "poor".

Geosynthetic Solution: An economical and best alternative for improved drainage of water in the pavement surface is to incorporate a Geocomposite drainage layer below the road layers (NETFLOW/CUPFLOW), and into roadway edge-drains (MATFLOW/CUPFLOW). This configuration dramatically shortens the drainage path.

Potential use of Horizontal Geocomposite Drainage Layers Includes:

a) Drainage of Roadway Base or Sub-base layers,

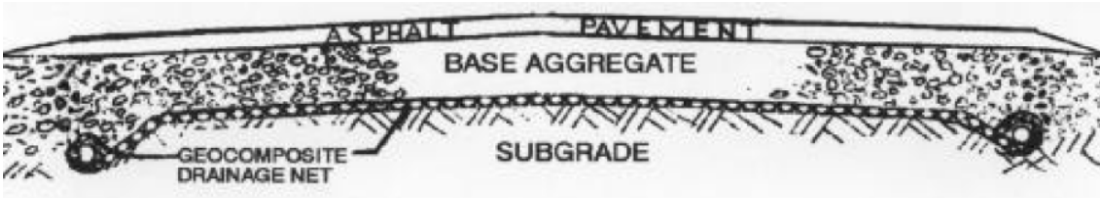
b) Drainage of Surface Asphalt or Concrete Pavement, and

c) Drainage of Subgrade to Form a Capillary Break Geocomposite Property Requirement.

In addition to the Roadways Geocomposite under drainage systems, drainage composites are also used in structural elements of the roads like retaining walls, bridge abutments, culverts, and other buried structures.

Drainage of Roadways Base / Sub-base layers

- By installing NETFLOW/CUPFLOW drainage composite below the roadway base and sub-base layers reduce the effective drainage length from the width of the road lane to the thickness of the base and sub-base layers. The shortened drainage path significantly decreases the time to drain and allows for the use of less select base materials (i.e with fines content >5%).

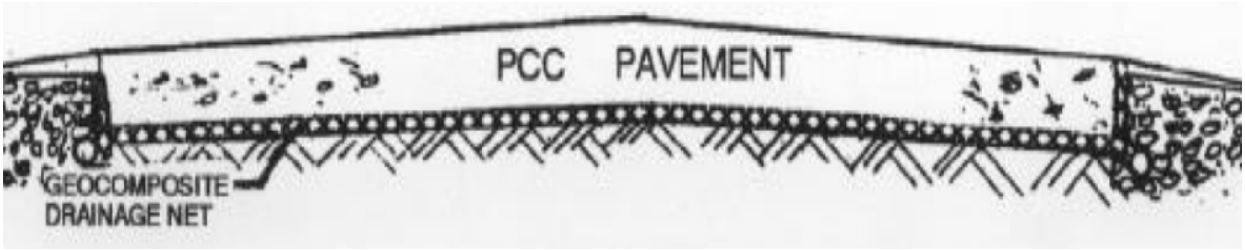


- Placement of the NETFLOW/CUPFLOW at this location may also help alleviate problems with capillary rise by preventing moisture from entering the pavement section during thermal events.
- The thickness of the base and sub-base layers can be reduced by considering a higher design modifier, because the time required for the base layer to drain is reduced. The pavement section can be designed at a higher structural capacity or the pavement section can be anticipated to have a longer service life.
- In addition to improved drainage and corresponding structural support, placement of the NETFLOW/CUPFLOW at the subgrade prevents subgrade fines from entering the base (i.e., separation with the geotextile layer component). Separation combined with drainage will allow for stabilization and improved foundation support for pavements constructed over soft foundation soils (i.e., CBR<3%). The improved drainage provided by the NETFLOW / CUPFLOW will also allow soft foundation soils to consolidate and improve over time.

Drainage of Surface Asphalt or Concrete Pavement

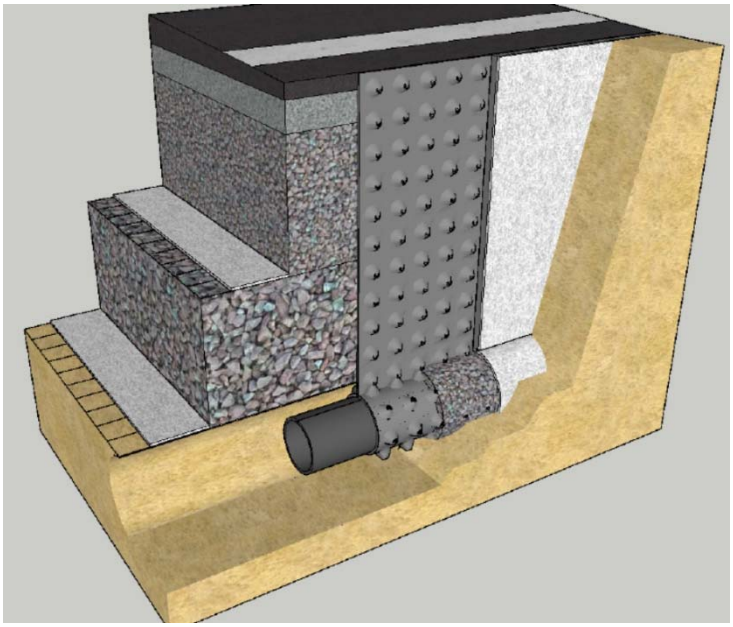
- NETFLOW drainage composite is placed directly beneath the base, to a limited extent the base-coarse aggregate can penetrate into the upper portion of the net. Thus, the geocomposite drainage net also has the potential to restrain the lateral movement of the base aggregate, and in this manner act like geogrid reinforcement.
- As the pavement ages and cracks are formed, most of the precipitation hitting the pavement surface will enter the pavement section. Thus, it is advisable to install the NETFLOW directly beneath the pavement surface as a substitution for drainable base. Here, the NETFLOW can drain infiltration water before it enters the underlying base/subbase layers.
- It is even possible to incorporate a membrane on the bottom side of the composite, NETLINER, as a moisture barrier to further and prevent water from infiltrating into the base (Elseifi et al., 2001). Additional benefit of this configuration may be more uniform concrete hydration. For both rigid and flexible pavement systems, this configuration is anticipated to extend the design life of the pavement section.

- In case of road to be constructed on swelling soil, placing of NETLINER directly beneath the base also helps to restrict the damages caused due to swelling soil. The moisture changes due to rainfall or frost precipitation in the subgrade swelling soil is restricted by the NETLINER.



Vertical Drains at Roadway Edges

- Roadway Edge drains has a MATFLOW / CUPFLOW Drainage Composites that collects and channels liquids and gases to a carrier pipe for transportation to a suitable discharge point. Geocomposite drainage is suitable for dealing with ground water and surface water.



- Traditional drains contain a filer stone, typically 300mm deep, will trap the silt and detritus and can be periodically excavated and replaced.
- On the other hand, MATFLOW/CUPFLOW drainage composites provides an ideal alternative for ‘traditional’ stone and constructions in the formation of surface and subsurface drainage systems saving time and money on construction projects. When high longitudinal flow capacity is required, edge drain geocomposite is combined with a perforated pipe, pipe diameter could be 100mm to over 1000mm.
- Modern roadway edge drains reduce excavation, reduce backfill quantities and reduce installation time. In-slope drainage increases geotechnical stability.
- The horizontal drainage systems at base and sub-base layers or drainage system immediately below the pavement surface are connected to the edge drains and then to discharge collection points.

Erosion Control of Roadways Slopes with APEC RECMs

- Natural slopes are critical to long-term performance. Disturbances due to man-made developments or nutrients loss in natural soils causes surface erosion in progressive manner and creates surface undulations. Since they are unprotected, the run-off flow concentrates and progress into deeper channels forming an eventual loss of stability.
- The natural solution to protect these slopes is by vegetation. However, the time until the seeds grow into plants and trees, the slopes are unprotected, and erosion can happen due to rains and heavy winds.
- Geosynthetically the issue can be tackled by the installation of Rolled Erosion Control Mats (RECMs) like EROMAT / EROGRID / CONCRETE MAT, reinforces to prevent soil from washing out of the slope face prior to the vegetation taking hold. Therefore, these reinforcements can withstand the rain drop impact energy, reduce surface runoff, and reduce total soil loss which ensures the growth of vegetation roots and provides additional mechanical strength to avoid slope failure. However, when no vegetation is planned on the slopes CONCRETE MAT is the best economical solution. Based on the flow velocities either of these materials are recommended.

  Flow velocity < 4.5 m/s – EROMAT is recommended

  Flow velocity 4.5 – 6.0 m/s – EROGRID is recommended

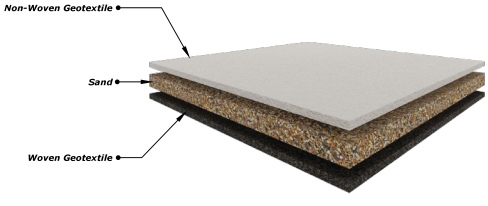
  Flow velocity > 5.0 - 10 m/s – CONCRETE MAT is recommended

EROMAT

EROGRID

CONCRETE MAT

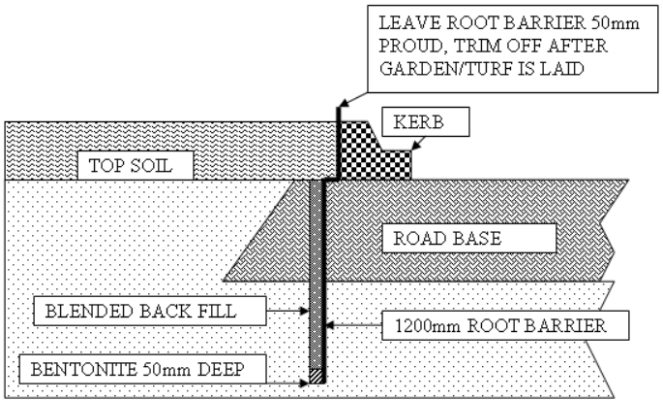
- In case of roadways near to coastal regions and other water sensitive environments SAND MAT is recommended to control erosion of road slope soils. It is an ideal solution for use in waterways where high filtration efficiency, revetment stability and abrasion resistance due to wave action is required. This can be installed under submerged condition without any dewatering and riprap or topsoil can be placed on it directly eliminating the protection layer in between.



SAND MAT

Root Barrier adjacent to Roadways

- ROOTDIVERT HD is a root barrier developed to protect highways, foundations, waterproofing, pipes, and other services, etc. from damage arising as a result of tree root penetration. It controls roots without damaging tree root structure.
- Tree roots predominantly grow in the upper surface of the soil and spread out extensively laterally from the trunk. A good root system is essential to sustain healthy tree growth, but the roots can be deflected to grow harmlessly.
- ROOTDIVERT HD is the best and economical composite product placed at back of kerb between the tree and road. The best practice in installing ROOTDIVERT HD is to place along, beside path of the road rather than surrounding the tree. ROOTDIVERT HD works as a waterproof seal protecting the structure from tree roots following the moisture coming through the seal and under the base of the kerb. If to stabilize the moisture in reactive clays under the road structure a deeper barrier may be required.



Salt Barrier below the Roads & Pavements and Landscapes

- Salt barriers are developed to prevent damage to sweet soil, top road layers, buried concrete structures to reduce frost heave effect and buried pipelines due to the capillary rise of saline groundwater (Capillary rise).
- The capillary action of the groundwater increases the stress carried by the soil. Thus, becoming less susceptible in carrying the load applied onto it. In areas where the underground water has high salt content, capillary rise causes problems not only in the effective stresses in the soil but also on vegetation and on buried structures.

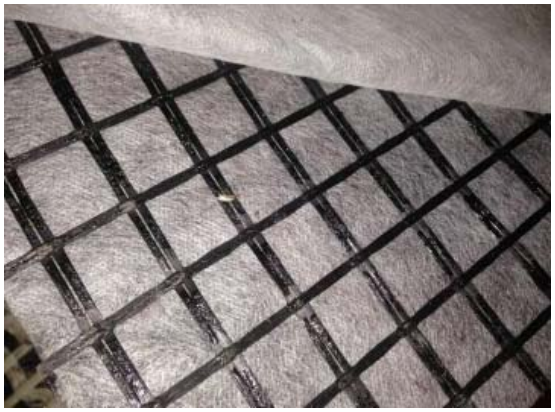
Conventional Solution: Crushed stone layers with at least 300mm thickness placed on top of the highest level the groundwater can be reached, was used conventionally. However, when subjected to different types of external loads and shaking (earthquakes), the void spaced in between the rocks will be filled with smaller soil particles thus providing spaces for capillary action to take place. This is a very costly and time-consuming process that does not really solve the issue in the long term.

Geosynthetic Solution: SALTSTOP is a salt barrier composite, on the other hand, are made up of geonets encapsulated with geotextiles at both sides. The void spaces formed in between the composite acts as the barrier to prevent the mixture of saline groundwater with the sweet soil. The geotextile at both sides of the composite acts as the filter to prevent the subsoil to enter directly in void spaced to prevent blocking or connection with the sweet and salt soils. The pervious nature of the geotextile allows water to pass through the material.

In the road applications the NETFLOW/CUPFLOW drainage composites used for drainage purposes will give the additional benefit of salt barrier.

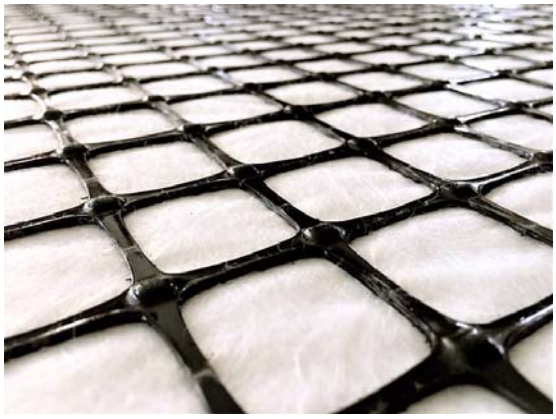
APEC Geosynthetic Composites in Roads & Pavements

GRIDTEXTILE PET



GRIDTEXTILE PET is a biaxial geogrid composite made from woven high tenacity multifilament polyester yarns and bonded with non-woven geotextile on one side. GRIDTEXTILE PET offers the needed reinforcement and stabilization of very soft saturated subgrades. It also provides filtration and separation between different soil layers. With the combination of geogrid and geotextile, GRIDTEXTILE PET ensures the stabilization and reinforcement in the structure throughout its service life. It provides higher tensile strength at low elongations. APEC offers a broad range of GRIDTEXTILE PET composites with various tensile strengths from 50/50 kN/m to 150/150 kN/m and different aperture sizes. Our roll widths are ranging from 1.8 m to 5.3 m and roll lengths of upto 100m.

GRIDTEXTILE PP



GRIDTEXTILE PP is a biaxial geogrid composite made from polypropylene core and bonded with non-woven geotextile in one side. GRIDTEXTILE PP offers the required reinforcement and stabilization of problematic soil all while providing filtration and separation in different layers of the soil layers. The high elongation capacity of geotextiles ensures that the inter-locking ability of the composite geogrid with the fill material is not reduced and stress is transferred to the geogrid.

Whenever soil reinforcement and separation are required for road construction and other civil engineering projects, GRIDTEXTILE PP is perfect is material. It lessens the required backfill material and is very easy and fast to install which in turn lessens project time and cost.

APEC offers GRIDTEXTILE PP geogrid composites with tensile strengths of 20/20 kN/m, 30/30 kN/m and 40/40 kN/m and various aperture size. Our standard role size is 4.0m width and to a max. length of 100m. It has higher tensile strengths at low elongation.

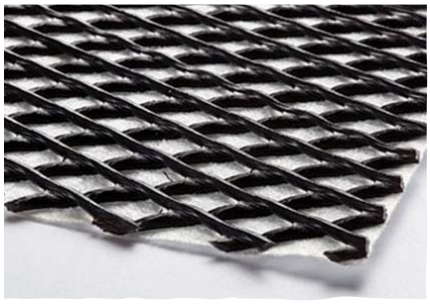
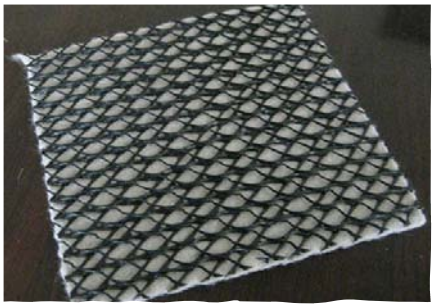
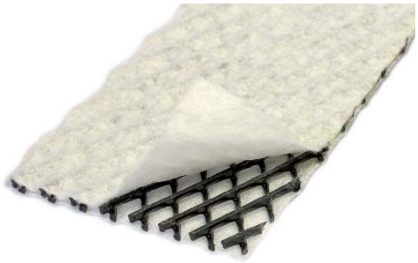
GRIDTEXTILE FG

GRIDTEXTILE FG is a woven biaxial geogrid composite made from glass fibre strands arranged in a grid pattern with bitumen polymeric coating and bonded with non-woven geotextile on one side.

GRIDTEXTILE FG has a strong tension in very low elongation that can largely increase the bearing capacity of the ground and extends the service life of roads and highways.

APEC offers GRIDTEXTILE PP geogrid composites with tensile strengths of 50/50 kN/m, 100/100 kN/m and 120/120 kN/m and various aperture size. Our standard role sizes are 2.0m, 4.0m and 5.0m width and to a max. length of 100m.

NETFLOW


NETFLOW drainage composite can be used as effective filters and drains in landfill capping, leachate collection and leak detection systems. It contains a bi-planar or tri-planar core extruded from HDPE and allows very large quantities of liquid to flow within its structure; it thus acts as a drainage core. The core will be protected by a geotextile, acting as a filter and separator, on one or both sides.

The emergence of such Geodrain composites, has all but eliminated traditional sand / stone / gravel drains with their better drainage capacity, effective mitigation of clogging, increases the friction characteristics and high compressive resistance. NETFLOW are cost effective, easier to apply, and are not limited by environmental legislations.

APEC offers a broad range of NETFLOW geonet drainage composites with various thicknesses fron 4.5mm to 8mm and with very high flow capacities. Our standard roll widths are 2m and 4m and ro lengths up to 100m. Customized roll dimensions are also available.

CUPFLOW

CUPFLOW drainage composite is a two-part prefabricated sheet drain consisting of a 3D polypropylene formed cuspated / dimple core covered with a non-woven polypropylene filter fabric on one side. The formed dimple core provides a void to relieve hydrostatic pressure and build up. The filter fabric allows liquids and gases to pass into the drainage core while restricting the passage of soil particles. The filter fabric is bonded to each dimple to minimize fabric intrusion into the core resulting from backfill pressure. The polypropylene core resists chemical attack and degradation in soil. CUPFLOW is a cost-effective alternative to gravel / sand drains and a solution to many drainage problems.

APEC offers a broad range of CUPFLOW drainage composites with various dimple heights varying from 6mm to 25mm and with very high compressive strengths and flow capacities. Our standard roll widths are 1m, 2m & 4m and roll lengths up to 100m. Customized roll dimensions are also available.

MATFLOW

MATFLOW is flexible, light weight, high compressive resistance, three dimensional GeoDrain composite, consists of W-shaped channel structure, drainage core made from Polypropylene extruded monofilaments, electro-mechanically bonded with non-woven filter fabrics on one or both sides.

MATFLOW has better long-term performance compared to sand / stone / gravel drains. They are more reliable in mitigation of clogging compared to conventional drains. Behind concrete structures they eliminate hydrostatic pressure build-up.

APEC offers a broad range of MATFLOW geomat drainage composites with various thicknesses from 5mm to 20mm and with very high flow capacities. Our standard roll widths are 2m and 4m and roll lengths up to 100m. Customized roll dimensions are also available.

NETLINER

NETLINER is a drainage composite that can be used as leak detection layer in the frack flowback water pond in oil & gas industry. Additionally, it has an ability of protection & waterproofing with the help of geomembrane laminated on one side. It contains the geonet core made with two over crossed strands at 60o, whose geometry create channels with a high flow capacity, also under pressure and at very low gradients. The core will be laminated by a non-woven polypropylene geotextile, acting as a filter and separator, on the other side.

EROMAT

EROMAT is a highly effective Erosion Control System designed and manufactured by APEC Industries. It is a lightweight, flexible 3D polyamide Geomat made with polymer monofilament yarns. It builds a less maintenance system in slopes, spillways and lakes with its high durability and high resistance to UV, chemicals, and biodegradation.

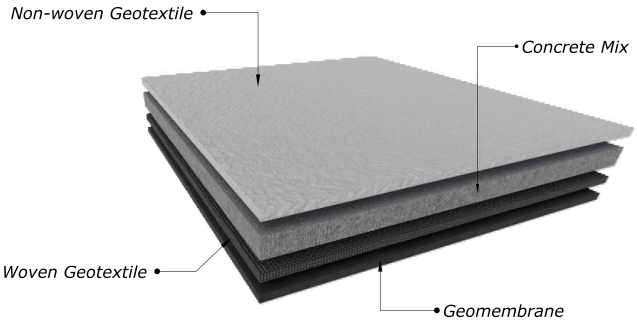
EROMAT can resist shear stresses up to 750 N/m^2 and flow velocities up to 4.5 m/s. EROMATs are available in various thicknesses ranging from 10-20mm, roll widths of 1.0 to 4.0m and roll lengths upto 150m.

EROGRID

EROGRID is APEC Industries another Erosion Control System. It also delivers maximum soil reinforcement and slope stabilization, thanks to its lightweight and flexible 3D polyamide Geomat composite made from polymer monofilaments with integrated high-tensile strength polyester geogrid.

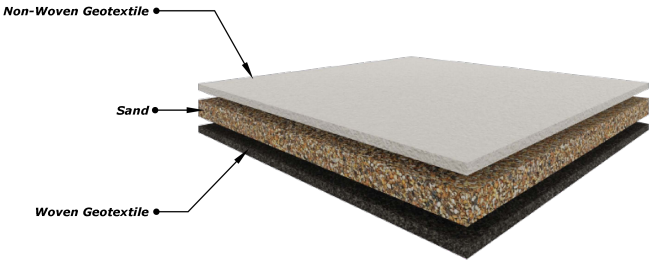
EROGRID can withstand higher shear stresses of 950 N/m^2 and is ideal for steeper slopes. It can resist flow velocities exceeding 6.0 m/s (2.5 times higher than just vegetation). Standard tensile strength of polyester geogrid is 40 kN/m. Dimensions similar to EROMAT.

CONCRETE MAT (Concrete in the form of roll)



When a greenery facing is of less important a concrete lining is used for permanent erosion control then an economical and unique alternative is Concrete Mat. It is a multi-layered composite material with non-woven geotextile as cap and woven geotextile as carrier layers followed by a PVC backing. The fabrics are needle punched and filled with unique mortar dry mix which is specially formulated. Once hydrated or fully immersed with water the dry mix will harden into impermeable concrete. The fibers reinforced concrete, preventing crack propagation absorbs energy from impacts and provides a stable failure mode. If properly anchored, it can withstand shear forces of 1.2kPa & flow rates of 10 m/s.

SAND MAT (GCL with Bentonite core replaced with quartz sand)



SAND MAT is a multi-layered needle-punched staple fibre nonwoven with a filling of quartz sand for application in hydraulic engineering. The product has been developed aiming for underwater installation. Geotextile functions are separation, filtration, and protection. It is mainly used in coastal and other sensitive environments. It is an ideal solution for use in waterways where high filtration efficiency, revetment stability and abrasion resistance due to wave action is required.

SALTSTOP

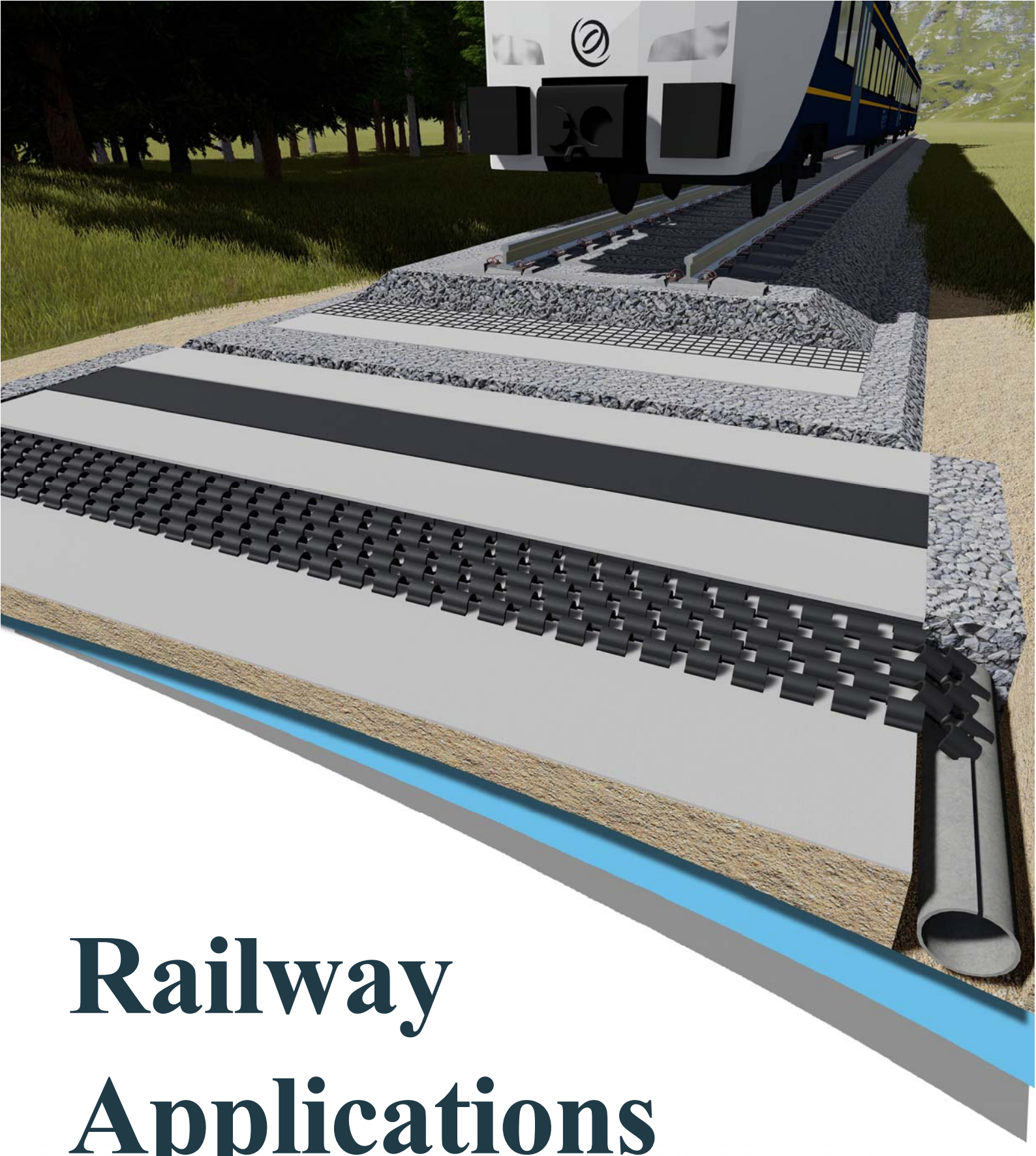
- SALTSTOP is a geosynthetic composite salt barrier / capillary breaker consisting of geonet core bonded with filter fabric on both sides. SALTSTOP prevent the movement of saline water by capillary rise into the top vegetative soils, imported soils, road base & sub-base layers, and foundations. It also acts as a drainage layer to collect & discharge rainwater and surface spillage.

- SALTSTOP replaces traditional capillary breaks made up of 300mm thick crushed stone layer making significant savings in construction cost and time. SALTSTOP maintains its drainage void throughout its service life providing a permanent solution to problems caused by capillary action and it can withstand differential settlements without loss of its performance.
- APEC offers a broad range of SALTSTOP composites with various flow capacities, thickness, and dimensions.

ROOTDIVERT HD

- ROOTDIVERT HD is a very durable and long-lasting root barrier system. Built to support long-term service life projects, this system creates an impenetrable geocomposite barrier between tree roots and project soil.
- ROOTDIVERT HD prevents root penetration from damaging concrete structures, foundations, road base layers and other buried structures. It prevents water seepage into buried structures as well and also protects concrete from soils and groundwater with high sulphate and chloride content.

- ROOTDIVERT HD is available in various options for membrane thickness, roll widths, and roll lengths.

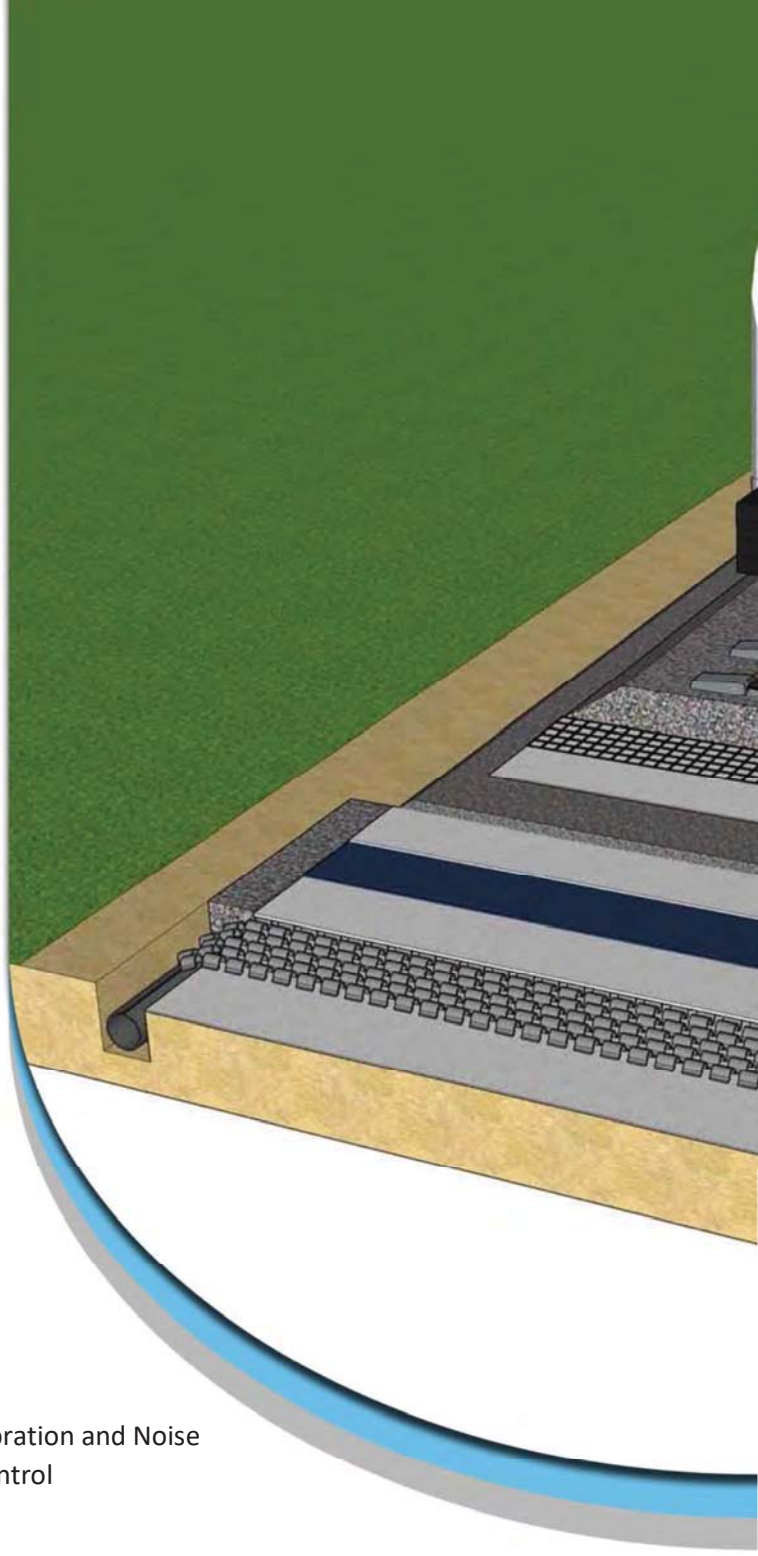


Railway Applications

Certified to ISO 9001:2015, ISO 14001:2015 & ISO 45001:2018

APEC Industries
Composite Polymeric Materials LLC

Tel no: +971 4 2222047
Email: info@apecindustries.com
Web: www.apecindustries.com

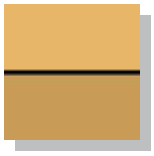


Railways play a big role in the development of a society. As people, goods and other necessities need to be transported from one location to the other. An economic and sustainable mode of transportation is needed to effectively cater the needs of society.

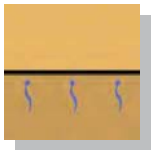
As the need of Railways increased, complex designs and performance demands created a need for a permanent material to enhance and supplement the engineering properties of natural soils.

We, at APEC Industries, provide a wide range of Geosynthetic Engineering Solutions to address the growing need of a sustainable, long lasting, and economical systems for the Railway industry.

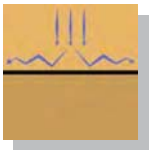
APEC Industries' Geosynthetic Composites used in different fields of transportation acts on the following functions:



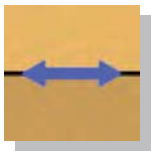
Separation



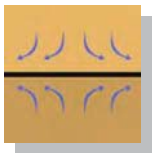
Filtration



Vibration and Noise Control



Reinforcement



Water Barrier

Drainage

Slope Reinforcement