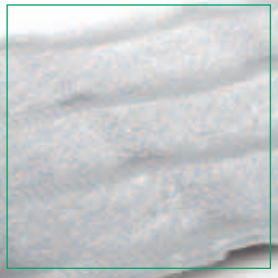
Advantages of PET/PP Combigrid®

- reinforcement, filtration, separation and drainage in just one product, reducing aggregate thickness
- firmly bonded composite product
- very high strength at low strains
- immediate interlocking with cover aggregate
- high resistance against installation damage
- nonwoven geotextile firmly bonded between uniformly extruded PP or PET bars
- high resistance against biological and chemical degradation
- 4.75 m wide rolls
- quick and easy to install
- ISO 9001 certified
- CE marked



NAUE

Combigrid®

Combigrid® geogrids are the next generation of geogrids produced with state of the art manufacturing technology, unlike any other geogrid on the marketplace today. The reinforcement element is a highly oriented polypropylene or polyester bar that is uniformly extruded and drawn to achieve a high modulus and strength at low elongations.

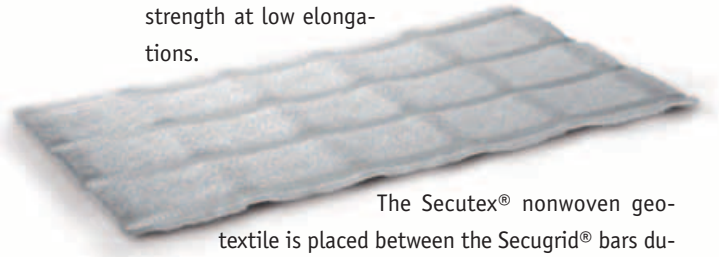


Fig. 1 Combigrid®

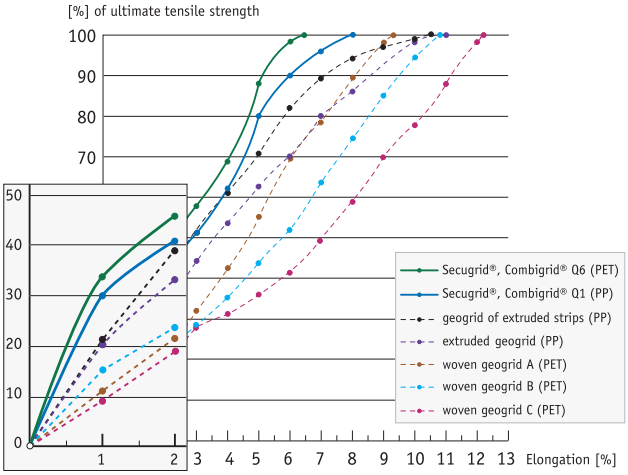
The Secutex® nonwoven geotextile is placed between the Secugrid® bars during the manufacturing process and is firmly bonded between the reinforcement bars with the NAUE patented welding technology to provide a structurally sound and stable geogrid. Combigrid® geogrids are mainly used in conjunction with soft and low CBR soils where soil reinforcement in combination with separation and filtration is needed, such as in base reinforcement, embankment reinforcement and pile cap platforms.

Advantage: Stress/strain behaviour

Geogrid composites like Combigrid® are used wherever a high strength is required at low elongation. The stress/strain behaviour (also known as strength/elongation) of the geogrid is important when selecting which type of geogrid is to be used or specified. Geogrids will typically have a maximum elongation at break of 6 % to 15 %. However, the internal angle of friction of medium to densely compacted soils, in realistic design conditions, is reduced when the soil is subjected to an elongation of less than 2 %. It is necessary to align the stress/strain behaviour of the installed geogrid to the elongation behaviour of the soil.

The performance of the geogrid at a stress/strain ratio in the range of 2 % is therefore important and here Combigrid® shows its strength. Combigrid® has excellent tensile strengths at low elongations (figure 2) and demonstrates its advantages in the critical required elongation ranges.

Fig. 2 Stress/strain curves of Combigrid® and selected geogrids. Enhanced view outlines realistic working strains (< 2 % elongation)

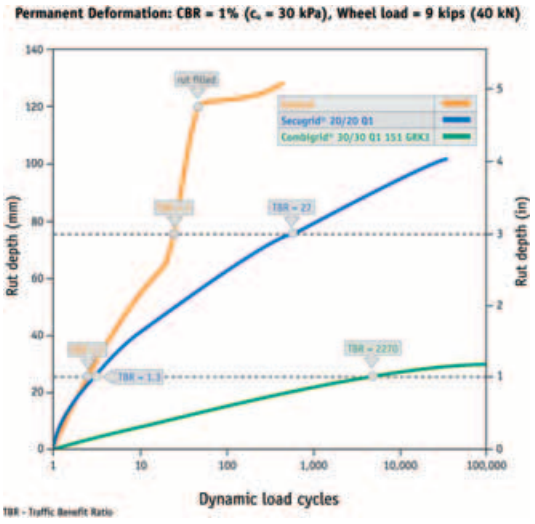


Advantage: Soil separation

The three dimensional fibre matrix of the needle-punched Secutex® nonwoven, that is firmly secured between the Secugrid® bars during the manufacturing process, acts as a separation layer between different grain size soils and ensures long-term separation and filter stability. Such a separation layer is typically recommended in base course applications for subsoils with a CBR less than 3 % or in applications where fines should be prevented from moving into the reinforced aggregate above.

Tests in the U.S. to simulate the traffic passages on an unreinforced base course resulted in 3 inch (75 mm) deep traffic ruts after 20 load cycles, and it took 540 load cycles when geogrid reinforcement (Secugrid® 20/20 Q1) was used. However, when Combigrid® (see picture) was used, the corresponding traffic rut depth was not reached even after 100,000(!) load cycles. Using a composite product of geogrids with a nonwoven geotextile firmly bonded between the long and cross bars in the boundary layer to less-portative, soft subsoils worked really well. Combigrid® - not just a geogrid - is the solution for all infrastructure projects to be carried out on less-portative subsoil.

Fig. 3 Combigrid® and Secugrid® traffic benefit ratio over a very weak subsoil, compared to an unreinforced design in a simulating test



APPLICATION

COMBIGRID® REINFORCED BYPASS

The implementation of the Kuestrin-Kietz roadway bypass project on federal road B1, east of Berlin, Germany, called for a grade-separated crossing combining an all-purpose rural road with the construction of the actual bypass. The project is in a classic low-lying area of the Oder river and the subsoil here is primarily peat. This presented the designers with the problem of providing a secure foundation for the up to 8 m high earthen ramps connecting the rural road to the overpass bridge. The foundation design had to minimise settling and be able to absorb expansion forces in the embankments base. A two-layer geosynthetic reinforcement was selected in the design in conjunction with preloading a layer of crushed stone over the subsoil to avoid much more costly foundation techniques, such as support pilings.

Fig. 4 Combigrid® installation over the soft subgrade (Kuestrin-Kietz, Germany)

About 7,000 m² of Combigrid® 60/60 Q1 251 GRK 4 were used as the bottom reinforcement layer. Combigrid® ensured the separation and filtration between the embankment's bulk material and the finely grained subsoil along with providing the first layer of soil reinforcement.

The second reinforcing layer consists of 6,000 m² of Secugrid® 40/40 Q1 geogrid and is positioned 500 mm above Combigrid®.

The advantages of Combigrid® are an immediate interlocking and transfer of stress into the reinforcement bars of the Combigrid® with an integrated filtration and separation layer against soft subsoils. And only one material needs to be handled versus two separate layers. The absence of larger overlaps as required for a single separation nonwoven geotextile layer also reduces costs and makes the installation faster, easier and cheaper. Additionally, with Secugrid® and Combigrid®, an edge wrap around the aggregate soil reinforcement material is not required.

REINFORCING THE SHIPPING INDUSTRY OF MERSIN, TURKEY

In southern Turkey, the city of Mersin has become an important trade center due to its strategically located port on the Mediterranean Sea. In addition to its key shipping access, Mersin possesses a large amount of land for cargo storage and rail and road access. As such, it has become particularly important for trade with the Middle East and for industrial and agricultural imports and exports.

Significant investment has gone into making Mersin a state-of-the-art port for the eastern Mediterranean region. The city (and province, also known as Mersin) has grown steadily and prospered.

But the soils upon which the stability of the container shipping port relies began to destabilize with the port's high-level of use and expansion needs. Deep grooves that had developed were significant enough to impair the safety of container cranes. Differential settlement of topsoil was responsible for the collapse of at least one container pile - a threat to the site's safety and, with the potential loss of goods or storage credibility, the port's economic security.

Fig. 5 Unrolling and overlapping of Combigrid® over the soft subgrade

Therefore officials called for the redevelopment of various container terminal sections.

Mersin's railway authorities are responsible for the port's activities, including its redevelopment. Perhaps influenced by the way reinforcement technologies are commonly used in railway construction, the port's reconstruction design team called for base course reinforcement. NAUE Combigrid® was chosen to improve the insufficient bearing capacity of the subgrade.

Combigrid® offered a number of advantages. Its composite technology uses three-dimensional needle-punched geotextiles between polypropylene geogrid bars with excellent stress-strain characteristics. This combination of strong geotextile and geogrid materials makes it the right choice for applications that require separation, drainage and reinforcement.

For the Mersin project, a test area was setup using 5,200 m² of Combigrid® geogrid. The results supported the design goals and led to the further installation of 34,000 m² of Combigrid®.

For the installation to be truly secure, the site's 20-year-old soil cover layer and gravel aggregate needed to be excavated to a depth of 1.4 m. A nonwoven geotextile firmly bonded between uniformly extruded geogrid bars, Combigrid® 30/30-201GRK-3, was placed on this base of soft soil.

Combigrid®, in this application, acts as a separation layer between the base course and the subsoil, so that fines do not mix with the reinforced aggregate. The geogrid reinforces the soil by transferring its stresses and by constraining the lateral movement of base course materials. Granular soils interlock with the geogrid apertures (the openings). The geotextile prevents vertical migration. Combigrid® protects the integrity of the reinforced installation in all directions, thus providing true long-term support.

Combigrid® is also easy to install, a characteristic that provides savings in time and labour without sacrificing quality. On the same day of the geogrid installation in Mersin, a 1 m layer of well-graded base course material was applied and compacted.

A 0.4 m thick cover layer of concrete completed the newly reinforced soil. The profit of the reinforcement with Combigrid® was realized quickly. Soil settlement has not been a problem and shipping activity continues to provide vital economic support and life to the region.

INSTALLATION

Loading of Combigrid®

On-site storage

Installed Combigrid® with overlaps

Cutting of Combigrid®

Placement of min. 200 mm aggregate

Soil compaction over Combigrid®

Aggregate interlocking

Final compaction

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