

ENGINEERING BULLETIN

GEOTEXTILE FUNCTIONS IN PAVED AND UNPAVED ROADS

FORWARD

The most common use of geotextiles is beneath paved and unpaved roadways, and this is referred to as the separation/stabilization application. Geotextiles used in paved and unpaved roadways actually provide several benefits through primarily four geotextile functions: Separation, Stabilization, Reinforcement, and Filtration.

The benefits derived from these four geotextile functions are most significant when subgrade soils are weak, i.e., $CBR < 3$. These benefits are well documented in the literature. However, long-term benefits (improved pavement performance over time) from separation in applications where the subgrade is competent, (i.e., $CBR > 3$), are just now beginning to surface, as roads 30 years old have been exhumed and have maintained their full structural section since they were built over a geotextile.

This Engineering Bulletin describes the functions of a geotextile beneath roadways. For design assistance using geotextiles beneath either paved or unpaved roads, the use of our free Roadways And Civil Engineering (R.A.C.E.) software is recommended.

SEPARATION

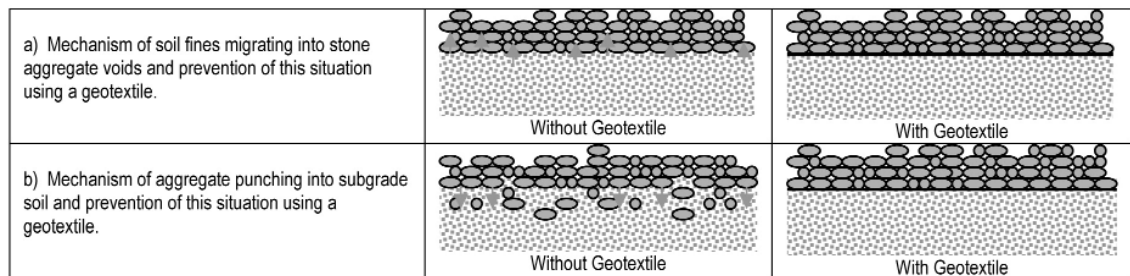
Geotextile separation is defined as the introduction of a flexible, porous textile placed between dissimilar materials so that the integrity and functioning of both materials can remain intact or be improved (Koerner, 1994).

In paved and unpaved roadways where granular aggregate is placed on fine-grained soils, two detrimental mechanisms occur over time without the use of a geotextile separator:

1. First, the fine-grained soils enter into the voids of the granular aggregate, preventing it from draining properly and the aggregate loses the required rock-to-rock contact, greatly diminishing the strength of the aggregate support layer and accelerating road failure (Figure 1).
2. Second, the granular aggregate punches into the fine-grained soil, thereby decreasing the effective thickness of the aggregate layer (Figure 1).

FIGURE 1.

From: FHWA Designing with Geosynthetics, Robert M. Koerner, 1994.



Properly selected woven and nonwoven geotextiles prevent these failure mechanisms from occurring, thereby greatly improving the performance of a road. For these reasons, separation is considered to be a very important geotextile function and is the key to the longevity of the road. Also, over the years, road builders have felt obligated to use a tight, well graded aggregate to help minimize subgrade soil migration upward. This proved to be only partially effective and, to the detriment of the road, these tight aggregates were weaker because they would not drain. The use of a separation geotextile allows the use of stronger, more free-draining aggregates with stronger AASHTO drainage coefficients. If a geogrid is used, there is no effective separation and a less cost effective tight aggregate must be used. The tight, well-graded aggregate recommended for use with geogrids, actually negates the structural benefit of using the geogrid.

STABILIZATION

Paved and unpaved roadway applications are long-term stabilized in two ways when a geotextile is placed at the subgrade/aggregate interface. First, when the aggregate is compacted over the top of a geotextile, the individual stones are "seated" making impressions in the geotextile and the subgrade. This interaction locks the bottom of the aggregate into a fixed position, thus stabilizing the aggregate layer indefinitely. An expensive geogrid is not needed to effect this interaction stabilization. Also, the subgrade soil is stabilized beneath the geotextile. This is because as the soil is loaded, from the top, the surrounding soil is held down in place, preventing a local punching, or shear failure. This change in the soil failure mode from local shear to general shear allows about 80% additional loading before the soils strength is exceeded. This mechanism allows for a reduced structural section over a subgrade stabilized with a geotextile. The use of less base aggregate and/or pavement section thickness over a geotextile saves the owner up front and, the permanent preservation of the entire structural section saves the owner down the road with additional years of maintenance-free service.

These first two functions, Separation and Stabilization, act together as the key reasons roads over geotextiles cost less and last longer. It is for this reason that the two terms are often used together to describe this application...a separation/stabilization geotextile.

REINFORCEMENT

Geotextile reinforcement is defined as the synergistic improvement of a total system's strength created by the introduction of a geotextile (good in tension) into a soil (good in compression but poor in tension) or other disjointed and separated material (Koerner, 1994).

In paved and unpaved roadway applications, geotextiles provide tensile reinforcement through frictional interaction with base course materials, thereby reducing applied stresses on the subgrade and preventing rutting caused by subgrade overstress.

Properly selected woven and nonwoven geotextiles provide reinforcement in roadways. However, woven geotextiles typically have a higher tensile modulus than a comparable nonwoven. By providing high tensile strength at low strains (i.e., high modulus) woven geotextiles generally are considered better reinforcement materials than nonwoven geotextiles which typically provide high strength at high elongations (low modulus). Therefore, benefits derived from the reinforcement function are dependent on the amount of system deformation allowed. In unpaved roads, a large amount of deformation is sometimes allowed and the reinforcement function of a geotextile can provide significant benefits. In paved roads, allowable system deformation is usually very low and, as a result, reinforcement is generally not considered to be applicable in most paved roadways but separation and stabilization are still key functions. Likewise, geogrids are rarely strained enough to provide a reinforcement function in roads. There is a misconception that geogrids are stronger than woven geotextiles. Much less expensive woven reinforcement geotextiles are available with much higher strengths and moduli than available geogrids.

FILTRATION

Geotextile filtration is defined as the equilibrium geotextile-to-soil system that allows for adequate liquid flow with limited soil loss across the plane of the geotextile over a service lifetime compatible with the application under consideration (Koerner, 1994).

In paved and unpaved roadway applications, geotextiles provide filtration through their defined openings that retain soil particles but allow the flow of water. This results in a free-draining pavement system. In paved and unpaved roadways, filtration is similar to separation. However a geotextile that is a good separator (a barrier) will not always be able to provide adequate filtration (retain particles and allow water flow). Properly selected, woven and nonwoven geotextiles can provide filtration in paved and unpaved roadway applications, thereby improving pavement performance. Depending on site conditions (e.g. if the subgrade is extremely wet) the filtration function may be as important as the other functions. This is because if water is trapped in the subgrade when a load is applied, pore pressures immediately build up and weaken the soil, even to the point of creating an unstable, "waterbed" effect, if severe. Propex supplies both woven and nonwoven geotextiles with greater ability to pass water than will ever be required beneath a road.

SUMMARY

All four of these geotextile functions are in effect to varying degrees when a geotextile is used in the separation/stabilization application beneath paved and unpaved roads. The life of a geotextile in this application is considered indefinite since the most harsh treatment the geotextile receives is during the actual construction, not in the long term use. Durability testing has shown that polypropylene geotextiles can last over 200 years in the ground.

For information on how to design both paved and unpaved roads, with and without the benefit of a separation/stabilization geotextile, please request a copy of our free design software, Roadways And Civil Engineering (R.A.C.E.). The software also helps you select the proper geotextile and allows you to quantify the significant cost savings associated with the use of a geotextile beneath your roads.

REFERENCES

Koerner, R.M. and Koerner, G.R, "Separation: Perhaps the Most Under-estimated Geotextile Function" Geotextile Fabrics Report, January 1994, pp. 4-10.



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