TECHNICAL NOTE

Geotextiles vs geogrids for separation

The importance of the function of geotextile separation

The GMA White Paper II, June 27, 2000, defines Separation as the prevention of subgrade soil intruding into aggregate base (or sub-base), and prevention of aggregate base (or sub-base) migrating into the subgrade. The simple separation of roadway construction materials from one another, as shown below in Figure 1, ensures that these materials function as they were initially designed and intended to perform, and to maintain the structural integrity of the roadway. Using geotextiles in roadway construction is the most basic and cost-effective way to accomplish separation of the roadway aggregate base course or subbase from the subgrade soils.

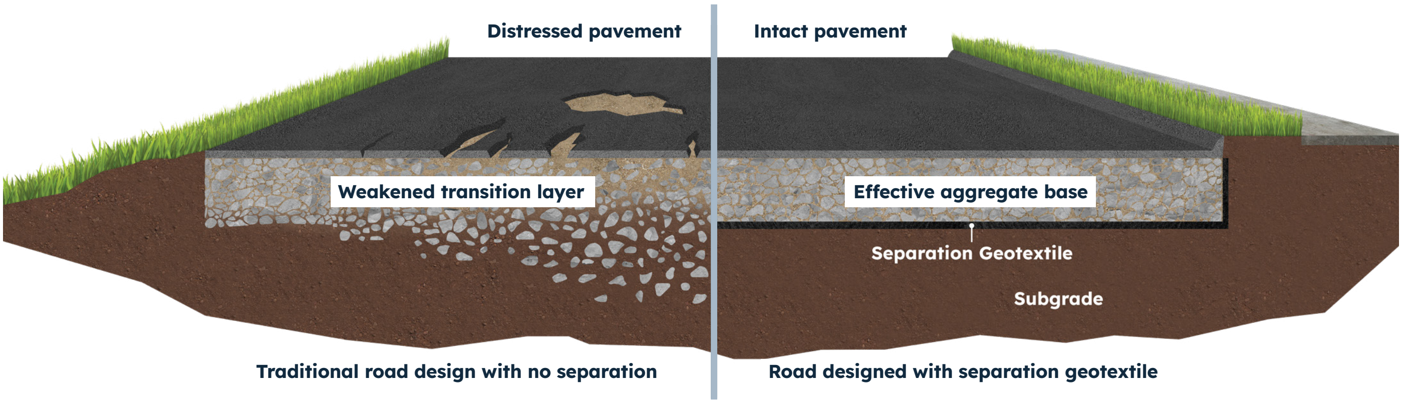


Figure 1: Separation effect of geotextile between soft subgrade and roadway aggregate

MIRAFI geotextiles increase a roadway's long-term strength, service life, and construction costs

Geotextiles provide separation between an aggregate layer in a road and the subgrade soils below by providing a durable, permeable membrane layer that keeps the aggregate from punching into the subgrade and keeps the subgrade fines from migrating upward (piping) into the aggregate layer. The geotextile can allow water to move freely from the soil into the aggregate layer, and vice versa. The ability of the geotextile to allow water to move freely across its plane while the materials are kept in place are called filtration and drainage functions. The separation function that a geotextile provides keeps the subgrade soils and aggregate layer intact, allowing the aggregate layer to maintain its designed thickness over the life of the roadway. So, geotextile separation can increase a roadway's long-term strength, service life, construction costs, and also reduces maintenance requirements and long-term costs. Figure 2 shows that as much as one hundred percent of the aggregate base can be lost into soft subgrade soils over time when a separation geotextile is not utilized.

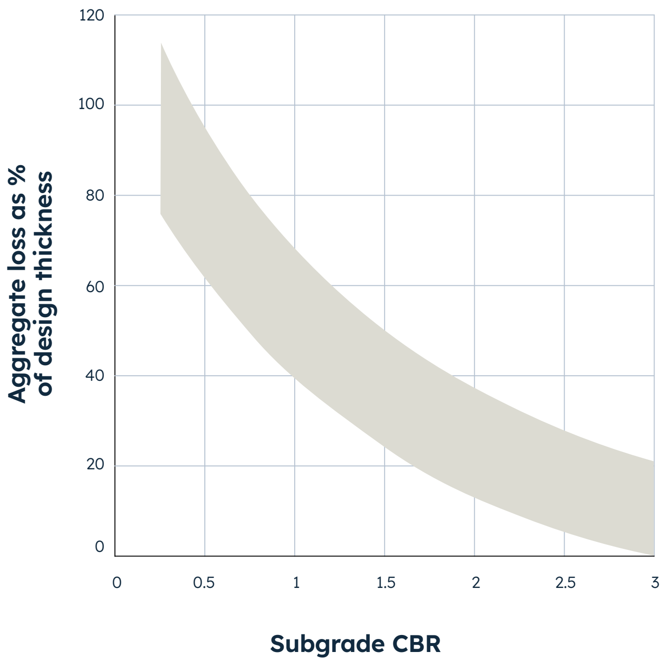


Figure 2: Range of typical aggregate thickness loss as a function of subgrade CBR strength (after Christopher and Holtz, 1989)

Common geotextile separation applications are:

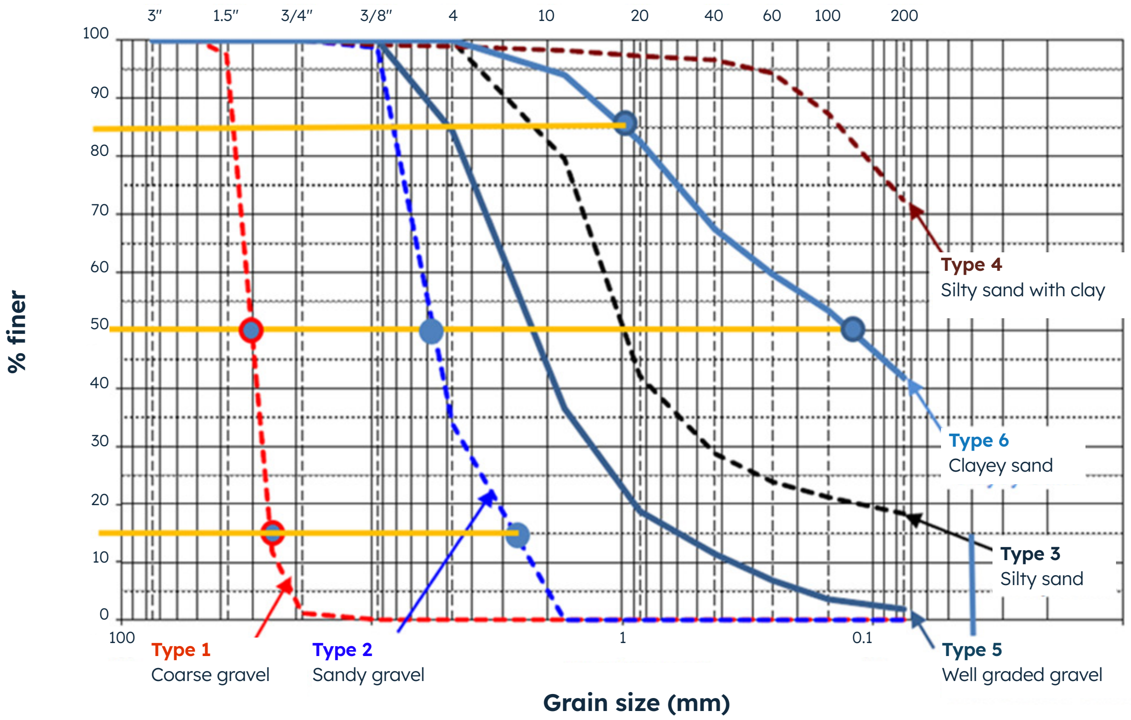
- Unsurfaced or flexible pavements for truck and vehicle traffic
- Flexible or rigid airfield pavements
- Railway alignments
- Container storage yards
- Moderate height embankments and fill pads
- Construction site access routes and working platforms
- Industrial waste lagoon or sludge pond caps.

One of the most commonly overlooked aspects in roadway design and construction is the type and quality of the subgrade soil that makes up the roadway's foundation. If the subgrade soils contain what geotechnical engineers call "fines" (soil particles smaller than the US No. 200 sieve, or 75 microns), then there is the opportunity for them to migrate under load into the base course aggregate when the subgrade becomes saturated after a rain or from groundwater recharge. Even subgrade soil with a very high California Bearing Ratio (CBR) or Resilient Modulus (MR) can lose its support when it becomes saturated and is subjected to dynamic traffic loads. We, therefore, recommend using a separation geotextile for subgrade soils containing more than ten to fifteen percent (10% – 15%) fines, especially low-plasticity fines or fine sands. These soil types have shown the greatest potential to lose strength, migrate or "pipe" under dynamic loading, and contaminate the lower portion of the aggregate base, reducing its strength and permeability. Some believe that geogrids can provide the same separation functions of a geotextile, even though their apertures are exponentially larger than the particle sizes found in a typical subgrade soil. Unfortunately, a geogrid is unable to separate any type of fill. As shown in the construction photo to the right, the subgrade soils, once saturated – easily flow through the geogrid apertures. The geogrid to the right does **not** offer any separation.

The NAVFAC Design Manual, DM 7.1 (1982) defines the particle size ratios required to create a filter bridge to prevent piping of soils between two dissimilar materials, called the "piping ratio". To meet the piping ratio criteria, the two soil gradations must meet the following equations:

$$\frac{\text{D15 base coarse}}{\text{D85 subgrade}} < 5 \qquad \frac{\text{D50 base coarse}}{\text{D50 subgrade}} < 25 \qquad \frac{\text{D15 base coarse}}{\text{D15 subgrade}} < 20$$

Many engineers believe that only the first criteria (D15/D85 < 5) of the piping criteria must be met to avoid using a separation geotextile, unfortunately all three of the above piping ratio criteria must be met to satisfy the requirements. Unfortunately, the gradations of most standard base coarse materials are too large compared to most subgrade materials to meet the piping ratio requirements. Figure 3 shows sieve plots of typical coarse gravel base, sandy gravel (fine base) and clayey sand (not too fine grained). Applying the NAVFAC piping ratio equations to the two gravels over the clayey sand, shows that these soil combinations require a separator geotextile. Note how the sandy gravel meets the first piping equation, but fails the 2nd equation. Type 4 silty sand with clay soil is even finer and if used with either gravel type, a separation geotextile would be required as well.



Type 1 gravel: D15 = 22 mm

Type 2 sandy gravel: D50 = 5.8 mm

Type 6 clayey sand: D50 = 0.13 mm, 85 mm = 1 mm

D15 coarse gravel = 22 mm / **D85** clayey sand = 1 mm **= 22** (not less than 5; no good)	**D50** sandy gravel = 5.8 mm / **D50** clayey sand = 0.13 mm **= 45** (not less than 25; no good)

Figure 3: Sieve plots of typical coarse gravel base, sandy gravel (fine base) and clayey sand (not too fine grained)

Many engineers mistakenly interpret a case study about a levee (exposed only to static loadings – no consistent traffic loadings on the levee) in New Orleans that highlights a paper titled, "*Geogrid Separation*", by R. P. Anderson, where a geogrid appears to separate a sand layer from a bayou mud subgrade after 13 years. What many fail to understand is that the sand layer alone is holding back the fine-grained soils of the bayou mud and that the two layers would remain separate regardless of the presence of a geogrid between them. In this case study, the NAVFAC piping ratio equations for static conditions were met, therefore a geogrid was not required and it should be no surprise that a sand layer held back fines from the subgrade.

It is important to note that the NAVFAC piping ratio equations were developed for subdrain/filtration applications in static conditions where water flows in one direction. Using the NAVFAC piping ratio allows engineers to design a graded aggregate filter by matching particle sizes of two dissimilar materials. Some engineers believe that a separation geotextile is not required in roadways, if the aggregate and subgrade soils meet the piping ratio values. Unfortunately, many engineers mistakenly try to apply the piping ratio to dynamic, non-static conditions found in roadways where water cycles from the subgrade through the base rock and then back into the subgrade again under repeated wheel loadings from traffic. In these dynamic cyclic loading conditions, a filter bridge can never be established and the piping ratio does **not** apply. In the case of a roadway, a geotextile for separation should always be utilized.

References

Berg, R.R., Christopher, B.R. and Perkins, S.W. (2000), Geosynthetic Reinforcement of the *Aggregate Base/Subbase Courses of Pavement Structures GMA White Paper II*, Geosynthetic Materials Association, Roseville, MN, 176 p.

Christopher, B.R. and Holtz, R.D. (1989), *Geotextile Design and Construction Guidelines, U.S. Department of Transportation*, Federal Highway Administration, Washington DC, Report No. HI-89-050, 265 p.

Anderson, R.P. (2006), *Geogrid Separation*," in Proceedings of International Conference on New Developments in Geoenvironmental and Geotechnical Engineering, Incheon, Republic of Korea. 472 p.