



Case Study

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| application | Haul Road |
| location | Iowa |
| product | Mirafi® HP570 |

TenCate develops and produces materials that function to increase performance, reduce costs and deliver measurable results by working with our customers to provide advanced solutions.

THE CHALLENGE

The roads on this project are proposed to be in the range of 16 ft wide with some for crane access at 32 ft wide. The geotechnical engineer on the project prepared a geotechnical report dated January 26, 2007. The borings showed topsoil over a stiff lean clay glacial till. The types of clays on this site are capable of getting soft when subjected to moisture. The report estimated a CBR of 2.3 for the clay, with a value less than 1.0 during wet weather conditions. The clay soils, especially in the low areas, lost their support capabilities after a few truck passes due to rutting. A pavement section needed to be developed to support construction traffic during these critical periods. Construction is to take place in early fall and completed by winter 2014.

THE DESIGN

Mirafi® HP570 woven geotextile has a tensile strength at 2% strain of approximately 15kN/m. The 2% strain number is preferred where the lock-up of the aggregate is important for stability. This strength value at 2% in both the machine and the cross direction is similar to biaxial geogrids. The geotextile is preferred over a geogrid because it can separate the soft material from the aggregate and thus maintain the full aggregate section placed with no intrusion, plus it is less expensive. A grid would let the mud right up through it. If road widths greater than 5 m are desired, multiple panels could be used. The 5.2 m wide panels of geotextile were deployed with a minimum overlap of 500 mm. The geotextile was immediately covered with larger sandstone aggregate in one lift so as to reduce the rutting of the subgrade, rolled and graded 1-3 times in order to affect the tensioned membrane effect of the high

strength geotextile and then topped with the smaller diameter capping aggregate. Deformation must occur for any geosynthetic to lock-up. The cap was graded and then sealed with a smooth drum roller.

A thinner section than the 1000 mm access road section recommended by the project engineer may be acceptable. We suggest that field trials be performed. We suggest an initial trial section include the geotextile, then a 450 mm sandstone aggregate and graded to effect the aggregate/geotextile "lockup" and then a 150 mm cap that is placed and sealed. If substantially wet and soft conditions persist during road building activity or if roads cross peat bogs, more aggregate may be required.

There was a 5% cement added and tilled in to the top soil at 8 to 12 inches in depth. Added to the surface was 2" of 3/4" minus limestone for construction uses and another 2" after construction for the final product. The mix design for the soil cement requirements varied depending on the objective. Soil cement bases generally have more stringent requirements than cement-modified soil subgrades. For soil cement bases, two types of testing have typically been used: durability tests and strength tests. The Portland Cement Association has developed requirements for AASHTO soils A-1 to A-7 that make it possible to determine the durability of cement on the basis of maximum weight losses under wet-dry (ASTM D559) and freeze-thaw (ASTM D560) tests. Many state departments of transportation (DOTs) currently require minimum unconfined compressive strength testing (ASTM D1633) in lieu of these durability tests.

This requirement is often based on many years of experience with soil cement. The advantage of using these strength tests is they can be conducted more rapidly than the durability tests (7 days vs. 1 month) and require less laboratory

equipment and technician training. However, achievement of a specified strength does not always ensure durability. The typical minimum strength varies from 200 to 750 pounds per square inch. For cement-modified soils, the engineer selected an objective and defined the cement requirements accordingly. Objectives may include one or more of the following: reducing the plasticity index (Atterberg limits, ASTM D4318); increasing the shrinkage limit; reducing the volume change of the soil (AASHTO T116); reducing clay/silt-sized particles (hydrometer analysis); meeting strength values/indexes such as the California Bearing Ratio (ASTM D1883) or triaxial test (ASTM D2850); and improving resilient modulus (ASTM D2434). Cement has been incorporated successfully into soils in the field with plasticity indexes ranging as high as 50.



Road construction looking north using soil cement and 4" of limestone after 5 years.



Road construction looking west using Mirafi® HP570 and 8" to 10" of limestone after 5 years.

THE CONSTRUCTION

It was recommended that the vegetation be pushed down with a smooth drum or sheepsfoot roller and leveled. If required, the surface vegetation can also be removed, however the surface should be sealed with a smooth drum roller, if possible.

A geosynthetic is preferred over a geogrid because it will keep the aggregate surface from penetrating into the silty soils, especially after a rain. Because geogrids have openings which allow contamination, they work best if confined within the aggregate section and not placed on a silty or clay base. Mirafi® HP570 geosynthetic was chosen because of its high water flow properties allowing it to work well in the high moisture, seepage prone areas of this project.

Soil cement: Construction of soil-cement and cement-modified soil is normally a fast, straightforward process. Cement can be incorporated into soil/aggregate in a number of ways. The most common method is to spread dry cement in measured amounts on a prepared soil/aggregate and blend it in with a transverse single-shaft mixer to a specified depth. Cement slurries in which water and cement are combined in a 50/50 blend with a slurry-jet mixer or in a water truck with a recirculation pump—have been used successfully to reduce dusting and improve mixing with heavy clays. Sometimes, central mixing plants are employed. Twinshaft continuous-flow pugmills are most common, although rotary-drum mixers have been used as well. Although construction procedures are similar for soil-cement and cement-modified soil, pulverization requirements need to be adjusted accordingly. The recommended pulverization for both granular and fine-grained soil (for soil material exclusive of gravel or stone) is as follows:

Sieve Size Soil-Cement Cement-Modified Soil
45 mm (1 3/4 in.) - 100
25 mm (1 in.) 100 -
4.75 mm (#4) 80 60

Compaction is normally a minimum of 95 percent of either standard or modified proctor density (ASTM D588 or ASTM D1557, respectively), with moisture content $\pm 2\%$ of optimum. Soil-cement shrinks as a result of hydration and moisture loss. Shrinkage cracks develop in the base, and can reflect through thin bituminous surfaces as thin (< 3 mm [$1/8$ in.]) cracks at a spacing of 2 m (6 ft) to 12 m (40 ft). If proper construction procedures are followed, shrinkage cracks may not reflect through, and if they do, they generally pose no performance problem. However, cracks can compromise performance if they become wide and admit significant moisture. A number of techniques have been used to minimize this problem, including compaction at a moisture content slightly drier than optimum; precracking through inducement of weakened planes or early load applications; delayed placement of surface hot mix; reduced cement content; and use of interlayers to absorb crack energy and prevent further propagation

There are four basic steps in construction and installation of subgrade chemical stabilization: delivery and distribution, mixing, compacting the subgrade after mixing, and proper curing with adequate moisture control

THE PERFORMANCE

As seen in the pictures, the roads that were constructed with Mirafi® HP570 are performing much better long and short term. Location one was installed in 2007 and has performed very well with no aggregate loss as of today.



Road where soil cement and geotextile were used. Construction was completed and reviewed after 6 months. Note stone loss and rutting.



Break down of soil cement after 6 months due to freeze-thaw cycle and moisture.

There were some soil cement concerns that needed to be considered regarding durability of a cement stabilized subgrade. Continuous exposure to water can adversely affect the performance of the chemically stabilized section. Lime and cement both have an affinity for water and will attract moisture if present. Abundant moisture could result in reducing the strength of the section. When chemically stabilized sections are exposed to freezing and thawing, the material's volume typically increases and the strength decreases. Several studies confirm that typical chemically stabilized soils will last for approximately 120 – 150 freeze/thaw cycles. The Midwest can easily experience 40-50, or more freeze/thaw cycles in one winter. Exposure to water could result in leaching of calcium which has a double effect; reducing the strength of the chemically stabilized section and possible environmental issues resulting from the leachate. In addition, the leachate could also affect the ability to grow crops if the treated areas are adjacent to farmland. The construction for this project was in late fall in northern Iowa where there was high ground water and above average moisture with limited drying hours/day.



Road where Mirafi® HP570 was used with no stone loss or rutting. Note the very high water table drain tile being installed in the fields.

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