

## Case Study

**application** Haul Roads (Wind Energy)  
**location** State of Oaxaca, Mexico  
**product** Mirafi® HP570 & BXG110

**job owner**  
**engineer**  
**contractor**

**Grupo Mexico**  
**Gamesa Spain**  
**Construtoral**

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 wind farm project for Gamesa required many kilometers of truck and crane access roads for construction be built. The access roads are approximately 8.5m wide at the road subbase with a road top of approximately 7m wide. Laboratory tests on the clay subgrade showed a CBR of 4-6% for a clay compacted to 95% of the maximum dry density at optimum moisture content. A rain soaked compacted clay will lose its strength especially when travelled over with vehicles and equipment so the CBR was estimated in the range of 0.5 to 1. The aggregate section desired was a 5cm base, a 30cm subbase and a lower 30cm subrasante layer. The performance criteria requested by the engineer was a rut of 2-4 cm or less during construction. The project location was very demanding, with extreme heat (40c) and rain - up to 300 cm annual rain fall.

### THE DESIGN

The tension-membrane effect created by the wheel loads resulted in deformation of the geotextile in combination with the aggregate. TenCate Mirafi® HP570 reinforcement geotextile has a minimum wide width tensile strength of 35 kN/m at 5% strain in both the machine and cross machine directions. (The ultimate strength is 70 KN/m and is well above the 30 KN/m strength for a biaxial geogrid). A high strength at 5% strain allowed the aggregate to lock up. Mirafi® HP570 has a relatively high water flow rate (permittivity of 0.35 sec-1) which is required when seepage or wet conditions are expected. A geotextile is preferred over a geogrid because it will keep the aggregate surface from penetrating into the clay/silt soils, especially after rain, while a geogrid has openings which allow contamination. That is

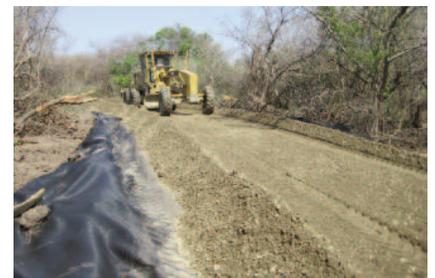
why geogrids work best if confined within the aggregate section and not placed on a clay subgrade. A biaxial geogrid sandwiched between the substrate aggregate and the subbase aggregate will likely enhance performance over that of just a high strength geotextile. A cement admixture into this clay/silt soil would require a high level of cement and a diligent mixing protocol. If the cement content is too low, breakdown over time could occur.

### THE CONSTRUCTION

It was recommended that Mirafi® HP570 geotextile be placed immediately on the subgrade, and then a subbase and a subrasante layer section with a combined aggregate thickness of 60cm be placed. The aggregate needed to be up to 60mm size with a diameter increased from a maximum aggregate size of 60mm to 75 mm, if the soil is soft (screened river rock). In order to develop the steep side slopes required at the edge of the road embankment, the aggregate needed to be compacted to 98% of the maximum standard proctor dry density per ASTM D698 at a moisture of  $\pm 2\%$  of optimum moisture. Geotextile reinforced embankment side slopes needed to be achieved to maintain an adequate road top section. Research and testing showed that the interface friction between Mirafi® HP570 and the aggregate material should be greater than 0.8 times of the friction angle of the aggregate material alone. A friction angle for a compacted aggregate of 45 degrees was estimated. The high friction of the aggregate and of the interface between the aggregate and the geotextile resulted in relatively steep side slopes of  $45 \times 0.8 = 36$  degrees during dry weather. However, the aggregate had fines in it which caused sloughing during rain. The on-site clay was compacted against the aggregate side slope to maintain an impermeable and erosion resistant material for the construction.



Existing conditions before construction.



Installation of Mirafi® HP570 and stone on a string road through the jungle.



Multiple trucks hauling stone to the site on Mirafi® HP570 without damage.



Installation of subbase on top of Mirafi® HP570.

Compaction was important during placement of the clay and it was recommend to be 98% of the maximum standard proctor dry density at a moisture content of  $\pm 2\%$  of optimum moisture. The clay allowed the side slope to be steeper than 36 degrees during construction without the requirement for the wrapping of the fabric at the edges. This compaction and clay (without wrapping) approach was recently used successfully at the Zopiloapan Wind Farm project in 2011 - 2012. The platforms were built the same way, with the placement of a layer of biaxial geogrid Mirafi® BXG110 after the placement of 40 cm of aggregate fill, with another 30 cm of aggregate fill on top of the upper layer of geogrid. Tensioning of the geotextile was required during the filling operations. Additionally, when ruts form as the fabric tensions, they should be filled in and regraded; not just simply regraded.

**THE PERFORMANCE**

Mirafi® HP570 was installed at the bottom of the stone base and on top of the existing vegetation, which allows no sub-base excavation in a very high water environment. This allowed construction to move forward much quicker during the dry seasons of southern Mexico. More importantly, Mirafi® HP570 geotextiles were selected based on past performance due to the separation and reinforcement requirements of the project. Using Mirafi® HP570 geotextiles made the construction much more economical because it prevented stone loss that would have occurred if no geotextile had been used.

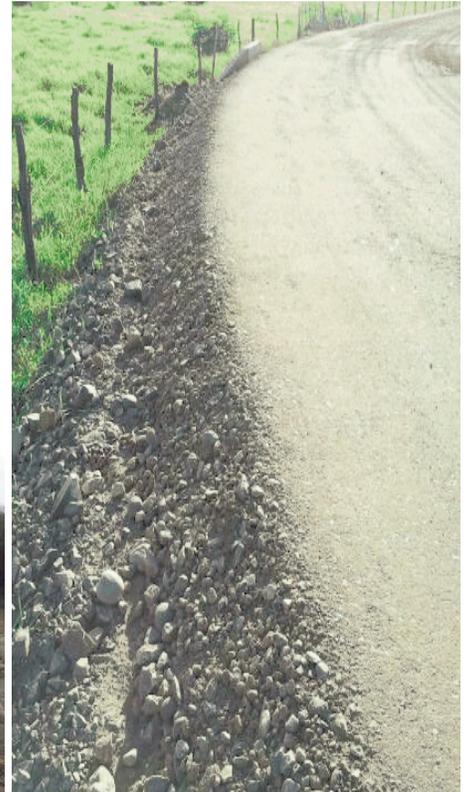
There is an increasing demand for wind energy projects throughout Mexico and the Americas. These projects require tandem and tri-axle heavy vehicles for hauling materials up to 90 KM one way to assess remote location over soft soil. Geosynthetics play a major role both short and long term in the road performance during and after construction.



Water being added to the subbase over Mirafi® HP570 for proper compaction.



Crane platform completed with a high water table during the dry season.



Road after construction was completed.



Completed road.

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