# WIND FARM

APPLICATION BULLETIN

Tensar®

FEATURED **PROJECT**

Tensar®

# Renaico Wind Farm

## Working with the Wind Energy Industry & Developing Integrated Construction Solutions

**APPLICATION:** In the Araucanía Region of Chile, forty-four 100 meter wind turbines were constructed to establish a new wind farm spreading over 2,965 acres in Renaico, located at about 8.08 miles (13 km) from the city of Angol. Access roads, internal roads, and working platforms were necessary for the construction of the wind farm, and foundation improvement was needed for the wind turbines.

**THE CHALLENGE:** All work was performed on a composite of soft clay and silty soils, in a limited time frame and with ground deformation restrictions. According to the European wind farm equipment suppliers, a subgrade with a shear strength of $C_u$ > 28.45 psi (2.0 Kg / cm$^2$) is required to support the wind farm turbines and equipment, but the natural subgrade had a $C_u$ = 3.56 psi (0.25 Kg / cm$^2$). In addition, temporary platforms to support the crane during the installation of the turbines required a $C_u$ > 35.56 psi (2.5Kg / cm$^2$).

**TENSAR® TRIAX® SOLUTION:** More than 17 km (10.56 miles) of internal roads were built between the turbines that make up the wind farm. In addition, 44 temporary working platforms were built to support the crane during the installation of the wind turbines. Tensar TriAx geogrids stabilized both the roads and crane pads, resulting in significant savings in costly imported granular fill.

**GEOPIER® SOLUTION:** Geopier Rammed Aggregate Pier® (RAP) elements were installed to increase the rotational stiffness and substantially decrease the differential settlement at the base of the foundations. The project management team evaluated an alternative solution based on concrete piles, which proved to be more expensive. The Geopier solution consisted of 79 RAP elements for each wind turbine, with effective lengths of 13.12-26.25 ft (4m to 8m) each, in order to reinforce the soft soil stratum underlying the foundations.

*Ground Improvement*


*Access Road Stabilization*


*Access Road Stabilization*

*Tensar Engineers perform DCP testing on behalf of the contractor.*

# TriAx® Solutions

**For more information:**
**800-TENSAR-1**
**www.TensarCorp.com**

## HAUL ROADS

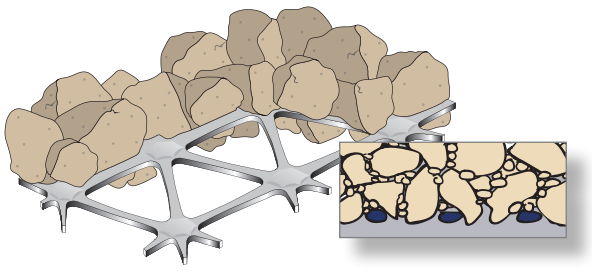
Tensar® TriAx® Geogrids are most commonly used to reduce the required aggregate thickness for the unpaved roads constructed to provide access to individual turbine locations. When geogrid is placed at the bottom of an aggregate layer, the aggregate particles partially penetrate through the apertures of the geogrid. This causes confinement of the aggregate and stiffening of the road structure.

By incorporating Tensar TriAx Geogrids, a mechanically stabilized layer is created for the haul/access roads and unpaved working areas. Construction cost savings of up to 50% can be realized in the amount of aggregate required. This results in less excavated material to be taken away from the site, and less aggregate to be imported, placed and compacted.

## CRANE PADS

In addition to road structures, geogrids can also be used to reduce the required aggregate thickness at crane platform locations. The locations where turbine components are unloaded and lifted into position often present the greatest challenge to avoiding subgrade failure. In these areas, multiple layers of Tensar TriAx Geogrids can be used to strengthen the aggregate section.

The stiffened aggregate results in an enhanced load distribution beneath the large static and dynamic loads imposed by the lifting equipment. This increases the factor of safety against a bearing capacity failure in the subgrade.



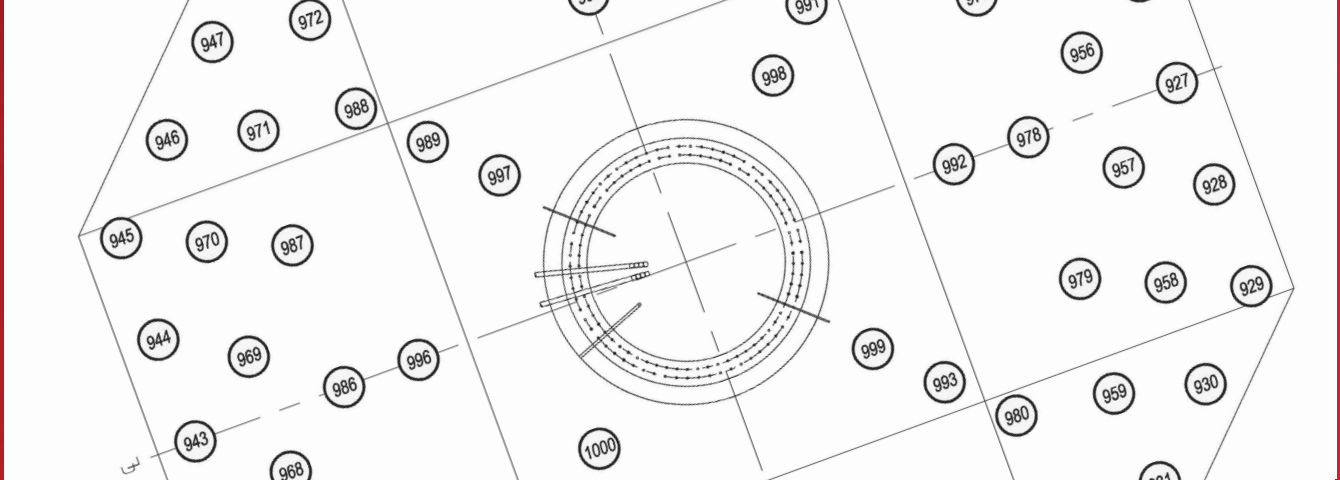
*The unique structure allows the grid to get a good "grip" on the aggregate particles and results in effective mechanical interlock.*

## TENSAR PROJECT SUPPORT

Tensar's team of professional engineers is available to provide free-of-charge support on wind farm projects. The ways that Tensar can bring value include the following:

- Initial assessment of soil conditions at the bidding stage of a project. If a geotechnical report is available, a review of this information can be made prior to submitting a bid. If information on soil quality is limited, Tensar engineers can arrange to visit the site and undertake dynamic cone penetrometer (DCP) or other testing in order to determine the quality of the sub-soil conditions. The goal is to provide our clients with the most accurate estimate of the aggregate thickness required for construction of the access roads and crane platforms.
- During the construction phase of a project, the soil conditions encountered are often significantly different than previously understood – perhaps due to a period of prolonged wet weather. When this occurs, Tensar engineers are available to visit the site and provide an accurate assessment of the requirements for the construction of the access roads and/or crane platforms.

*Spreading crane loads more widely enhances stability of the crane pad area.*




# GEOPIER® Tensar Solutions

**For more information:**
**800-371-7470**
**www.Geopier.com**

## UNIQUE FOUNDATION CHALLENGES

Wind turbine structures present unique design challenges, including high applied foundation bearing pressures resulting from significant overturning moments, minimum rotational/dynamic stiffness requirements, and total/differential settlement design tolerances. Geopier® ground improvement provides site-specific solutions to address these challenges.

## IMPROVED BEARING PRESSURE

Geopier ground improvement systems provide high internal friction angles and soil improvement to allow significantly improved design bearing pressures of 5 to 10 ksf, depending on soil conditions. The improved bearing pressure provides support for the large foundation edge pressures and may also reduce footing sizes, saving time and money on your project.

## SUPERIOR SETTLEMENT CONTROL

Geopier systems are engineered to provide you with a cost-effective approach that meets your specific project requirements. Geopier design-build engineers are experienced in providing superior settlement control for thousands of projects. In addition, site specific modulus testing provides an unmatched level of support and reliability.

*Rammed Aggregate Pier® Installation*

*Victory Wind Farm Caroll & Crawford Counties, Iowa*

## FOUNDATION STIFFNESS IMPROVEMENTS

The vertical energy imparted during construction results in piers with exceptional stiffness, delivering documented, proven settlement performance. The stiff Geopier elements improve the composite shear modulus beneath the tower foundation, increasing the rotational and dynamic stiffness to the reinforced soil for reliable foundation support. The Geopier design is specifically tailored to deliver the required rotational/dynamic stiffness values specified by tower designers.

## SOLUTIONS FOR ALL SOIL CONDITIONS

Subgrade conditions for wind turbine structures are usually the biggest variable in tower foundation design and construction. Whether your site is challenged by soft clays, loose sandy deposits, or even organic soils, Geopier design engineers have numerous Geopier ground improvement options to choose from to help satisfy your project's performance needs.

Tensar®

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