TriAx®

HEAVY-DUTY HAUL ROAD

APPLICATION BULLETIN

Tensar®

Haul Road Applications Like These – and Hundreds More

HAUL ROAD IN AMAZON RIVER BASIN RAINFOREST, REPUBLIC OF ECUADOR

Application: A haul-and-access corridor for personnel and heavy equipment, as well as a platform for the construction and maintenance of an oil pipeline, was built in 1993 to support the exploration, recovery and transport of a key export commodity.

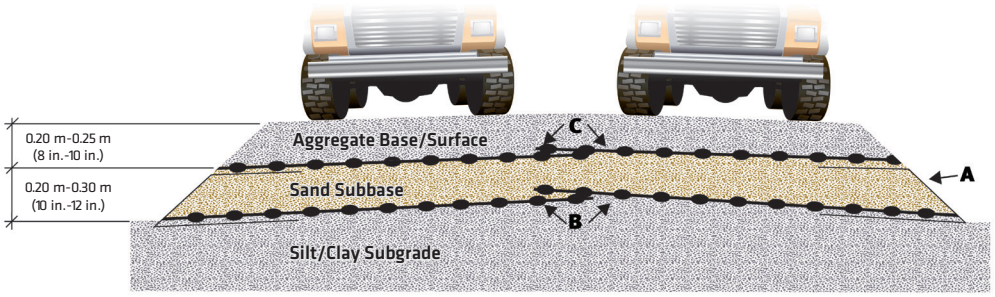
The Challenge: Heavily vegetated; the Amazon River Basin Rainforest is one of the most environmentally sensitive areas in the world. With an annual rainfall averaging 200 inches, it is also one of the wettest. Native soils are perpetually weak and saturated, and the availability and quality of native aggregates are extremely limited. In addition, the exploration site was located within an area protected for indigenous peoples. Concerns for the area's ecological vitality, as well as its protection from the threat of illegal clear-cutting, required road construction to be as unobtrusive and inconspicuous as possible.

The Solution: A 20-foot wide, 93-mile long gravel haul road using Tensar® Geogrid was successfully built and remains fully operational today. The road's subbase features a 12-inch layer of dredged river sand over a silt/clay subgrade, separated and stabilized by Tensar Geogrid. A non-woven geotextile confines the subbase along the road's shoulders. The base course features a 10-inch layer of unbound processed aggregate separated from the subbase by an additional layer of Tensar Geogrid.

The application of geosynthetics maximized the use of native materials, minimized material thicknesses and reduced borrow and haul requirements. The Republic of Ecuador now advocates geosynthetic stabilization procedures along the country's rainforest roadways. The performance of the products used on this haul road was cited in the Federal Highway Administration's (FHWA) *"Gravel Roads Maintenance and Design Manual,"* November 2000, the most comprehensive gravel road guidelines, *SD LTAP November 2000*.

Maxus Energy – Block 16 Haul and Access Road*
Republic of Ecuador

As featured in the FHWA Gravel Roads Maintenance and Design Manual**



A. Subbase fabric containment wrap, two 2.25-meter-wide rolls of non-woven geotextile (one each side)

B. Subbase reinforcement geogrid, one 3.5-meter-wide roll and one 4.0-meter-wide roll of Tensar Geogrid

C. Base reinforcement geogrid, two 3.5-meter-wide rolls of Tensar Geogrid

*This narrow two-lane road with 6.0-meter-wide surface requires 14.5 square meters of geogrid and 4.5 square meters of geotextile per meter of roadway length.

**FHWA *"Gravel Roads Maintenance and Design Manual,"* November 2000, pages 2, 26 and 32.

Tensar® TriAx® Geogrids: Proving Value on Haul Roads Across the World

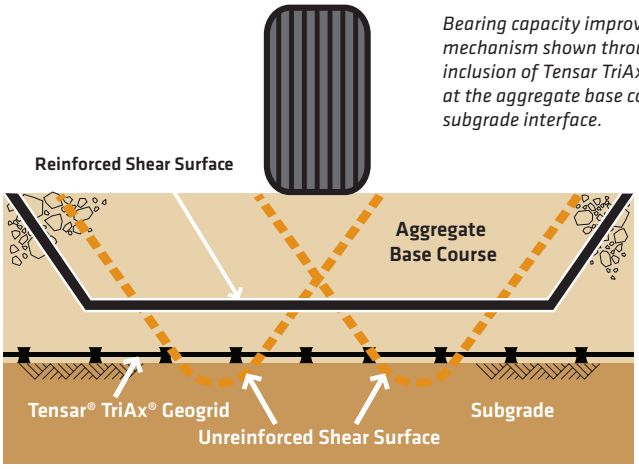
An estimated one-half of all roads in the United States, and an even higher percentage of roads throughout the world, are unpaved. Many of them serve as heavy-duty access and haul roads for a number of applications:

- Mining operations
- Highway construction
- Power generation and water treatment plants
- Wind farms
- Oil drilling, refining and storage sites
- Logging operations
- Residential, commercial and industrial site development
- Landfills
- Ethanol production plants

Growing haul road applications, diminishing and costly aggregate supplies, tightening construction budgets and heavier wheel loads have forced engineers, contractors and owners to explore lower cost alternatives to traditional methods of construction. One cost-effective, proven alternative has successfully stabilized thousands of miles of haul roads across the world: Tensar TriAx Geogrids.

In project after project, Tensar TriAx Geogrids have:

- Maintained road surface quality – increasing operating speeds
- Reduced the frequency of costly and disruptive surface maintenance
- Reduced aggregate requirements up to 60%
- Increased construction speeds
- Reduced labor and equipment needs
- Improved internal drainage properties
- Eliminated the need for costly overexcavation and disposal of poor quality soil
- Avoided issues associated with chemical stabilization including weather and climatic restrictions, curing, uniformity, chemical solubility and environmental and personnel safety
- Reduced tire rolling resistance resulting in reduced maintenance cost
- Provided an easily installed, environmentally superior solution that reduces construction truck traffic, minimizing disturbance to the terrain and the surrounding area



Bearing capacity improvement mechanism shown through the inclusion of Tensar TriAx Geogrid at the aggregate base course-subgrade interface.

THE HAUL ROAD CHALLENGE

Weak subgrades pose the greatest challenge to the performance of an unpaved access or haul road. Left untreated, a weak subgrade subjected to continuous heavy traffic will quickly deform, causing the road surface to rut, pothole, "washboard" and ultimately deteriorate beyond use.

Tensar TriAx Geogrids are designed to reduce construction induced or in-service stresses applied to weak subgrades. Geogrid and aggregate interlock to create a mechanically stabilized layer (MSL) to evenly distribute the load, increasing bearing capacity and ensuring longer-term stability and performance. The use of geogrids has also demonstrated effective separation and filtration properties, inhibiting movement to confine the subgrade when properly graded aggregate fill is used. While geotextiles provide separation and filtration functions, their abilities to confine aggregate are inferior to geogrids.*

**Department of the Army, U.S. Army Corps. of Engineers. 2003. Use of Geogrids in Pavement Construction, Engineering Technical Letter 1110-1-189.*

A NEW ERA IN UNPAVED ROADWAY DESIGN

The performance quantification of geosynthetics in haul road construction is performed through several models, depending on the project needs and loading. One of these is the Giroud-Han Design Methodology, the most significant advancement in unpaved road design over the past 25 years. Developed by Dr. J.P. Giroud and Dr. Jie Han, the "Design Method for Geogrid-Reinforced Unpaved Roads" was published in 2004 by the *ASCE*. The Giroud-Han Design Method determines the aggregate layer thickness required depending on whether the aggregate is stabilized with geogrid, a geotextile or simply unstabilized.

In particular, this performance-based methodology has redefined how unpaved roads are designed. Tensar has incorporated the Giroud-Han Design Methodology into all of its applications utilizing Tensar TriAx Geogrids in unpaved haul and access road construction. This has resulted in a more cost-effective use of materials whereby construction cost savings as much as 60% can be realized.

Tensar's SpectraPave is an industry-leading design tool that leverages over two decades of full-scale research and practical experience.

Tensar Design Resources for Haul Roads

SPECTRAPAVE™ SOFTWARE

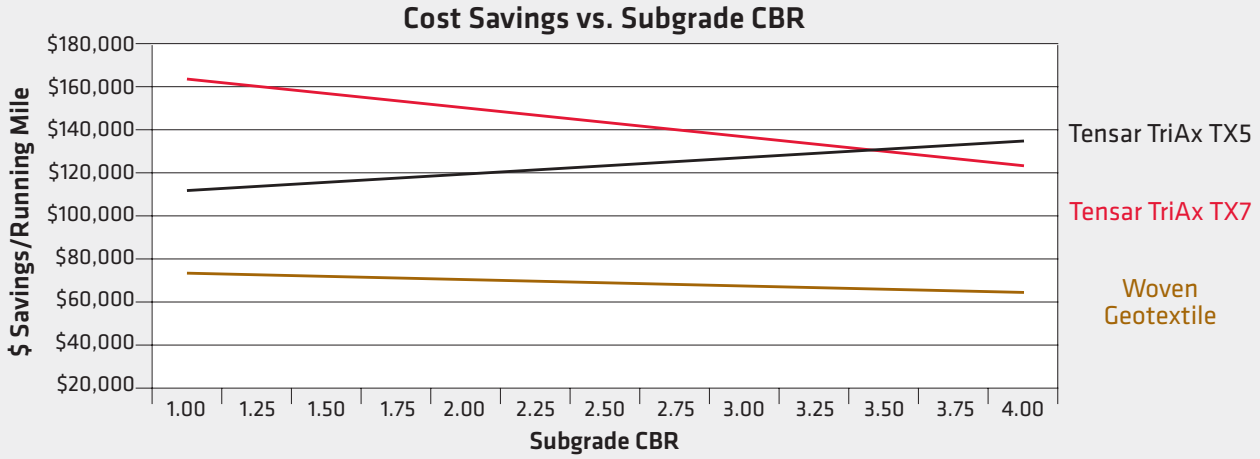
SpectraPave™ Software is the industry's leading design and analysis tool for roadway structures. Incorporating the Giroud-Han Design Methodology, it enables engineers, contractors and owners to accurately predict the performance (i.e., service life) of geogrid-stabilized and unstabilized paved and unpaved roads. SpectraPave's Paved and Unpaved Applications Modules calculate aggregate thickness requirements and the resulting cost savings. With SpectraPave Software, designers are able to create cost-effective structures that last longer and are easier to maintain.

PERFORMANCE SPECIFICATIONS

A key component to Tensar's solution for haul road stabilization is the ability to incorporate performance specifications. As advocated by the FHWA, performance specifications allow engineers to maintain the integrity of their design through the utilization of design output as the basis of acceptance rather than material geometric and mechanical properties. SpectraPave Software offers an easy means of generating performance specifications using a TriAx stabilized MSL.

DESIGN AND SUPPORT SERVICES

From site assessment and general consultation to stamped drawings and design calculations, Tensar maintains an in-house professional engineering staff to support our clients' design needs. Our engineers possess many years of experience in the design and construction of geogrid-stabilized haul road structures. In addition, a network of regional sales managers and technical support staff are available to provide local assistance and on-site support. Tensar is more than just geogrid, let us show you how.



Typical cost savings per running mile of a 25 ft wide permanent haul road. Aggregate Cost = $18.00/ton in-place.

For more information on Tensar TriAx Geogrids, as well as our full line of roadway improvement solutions, visit **TensarCorp.com**, call **800-TENSAR-1**, or email **info@TensarCorp.com**.

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