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# Track support for railways

## AREMA-approved geogrids benefit bed design in soft soils.

By Bryan Gee

By using Tensar Geogrid, the Utah Transit Authority had significant reduction in material and labor costs.

The support of rail line, whether for new or existing track, is an essential aspect of railroad construction and maintenance. This can be an expensive and lengthy procedure involving the mitigation of soft or variable soil conditions, frequent ballast maintenance, and in some cases, track realignment. However, advances in technology can provide quantifiable financial and time-reduction benefits.

Geogrids are one technology that has had a significant impact on rail line construction. As an example, Tensar's Spectra Rail Railway Improvement System, incorporating Tensar geogrids, has established an efficient and cost-effective solution for the mechanical stabilization of rail ballast and sub-ballast layers. This allows for the construction of rail lines with longer life or reduced roadbed thickness with no loss of performance. It also cuts down on track settlement and general wear and tear, which reduces maintenance costs, thus providing both short- and long-term financial benefits.

Geogrids are used throughout the world on rail line projects and recently were approved for track bed design by the American Railway Engineering and Maintenance-of-Way Association (AREMA).

"We've been including geogrids in our rail system designs for many years," said John Bolton, director of marketing for Tensar. "Our own research and experience has shown that the Spectra Rail Railway Improvement System is a very cost-effective option for reinforcing track ballast and bridging over soils with variable strength characteristics. Having this reinforcement benefit now recognized by AREMA is truly exciting news."

The growing recognition of the benefits of geogrids and their recent approval by AREMA have provided a significant boost toward their acceptance as a best practice for the industry.

### The only option

Geogrids recently were used successfully as part of a rail spur project in Clanton, Ala., where bridging an area of very weak subgrade soils was necessary. The narrowness of the spur corridor next to an existing line ruled out traditional removal techniques. Initially, the contractor tried using riprap to create a construction platform and base, but the structure was inadequate to prevent construction equipment from sinking into the boggy soil.

"We had completed a geotechnical study of the site and reported CBR values of approximately 0.5 or less," said Richard Brown, P.E., of Building and Earth Sciences Inc., who was a consultant for the project. "When the contractor's workers tried to clear the site for the embankment, their trackhoe sank up to its axles. At that point, it was obvious that we didn't have a conventional option. I suggested using geogrids to create a working platform to support the embankment."

It was agreed that geogrids would be the most effective solution to create a working platform to support the embankment. The general contractor was not familiar with geogrids, so Tensar provided a design recommendation that was verified by a test strip in the soft soil area.

As a result of the simple installation process, the contractor's crew was able to bridge the section immediately with its equipment, complete the platform quickly, and resume construction of the embankment. Fully loaded off-road trucks were able to cross the working platform without any difficulty.

In this situation, geogrid provided the only option for crossing some very challenging soil conditions.

### Ballast boost

The New Orleans Regional Transit Authority used geogrids on a 14-mile section of the historic St. Charles Avenue streetcar line, which had not been renovated in almost 80 years. Installation of the system significantly reduced construction time and renovation costs, improved subgrade performance and durability, and minimized excavation, which led to faster, easier, and less expensive installation than traditional methods.

The project was part of a $47 million effort that included installing new tracks, ties, and ballast. The challenge was to reduce the ballast thickness while limiting vertical stress on the subgrade to 20 psi, as recommended by AREMA. The existing light-rail bed included more than 2 feet of ballast placed on top of a cypress plank foundation. Soft conditions were a challenge because of a high water table throughout the rail corridor.

A geogrid-reinforced section was the solution selected for this project as a lower-cost alternative to traditional strategies of increasing ballast thickness. Reinforcing the new ballast with geogrids would produce a strong construction platform with less need for excavating the existing subgrade or importing new aggregate material.

Design calculations indicated that using a single layer of geogrid along the main line segments and two layers at each road crossing would decrease the effective stress at the bottom of the trackbed by as much as 65 percent, thus offering longer life and less maintenance compared with an unreinforced section. The geogrid also would reduce the total ballast profile from 26 inches to 12 inches, while improving the line's long-term load-carrying capacity.

The St. Charles Avenue track bed was prepared by removing the old rails and ties, and then excavating the existing ballast to the top of the cypress plank foundation or to a maximum depth of 26 inches. In areas where the cypress planks were exposed, a 1-inch-thick layer of sand was placed and compacted.

A layer of filter fabric was installed to help maintain free drainage, followed by 4 inches of rock ballast and a layer of geogrid. The ends of each roll were overlapped by 12 inches before being covered with an additional 8 inches of compacted railroad ballast.

After geogrid installation, crews were able to bridge immediately a section of weak subgrade soils.

The use of geogrids substantially reduced the construction time and costs associated with renovating the track. It also improved subgrade performance and durability by reducing the pressure and more evenly distributing the load imposed on the subgrade. These advantages were gained while reducing the required ballast thickness. The project required less excavation and the installation was simpler, faster, and less expensive than traditional solutions. As an added benefit, work could continue even when the installers encountered difficult working conditions such as inclement weather.

### A stabilizing solution

The same system was used to stabilize a 1.25-mile-long section of Class 1 rail line near Milstead, Ala., where poor soil conditions were causing excessive ballast settlement and soil pumping issues for CSX Transportation.

The track condition had deteriorated so greatly that CSX was required to maintain and surface the track every two to four weeks. Even with this regular maintenance, the track was subject to a 5-mph speed restriction.

The rail line runs parallel to the Tallapoosa River at an elevation above the high-water mark. The alignment is situated in a wide, deep, cut-through about 25 feet below the original phreatic surface, interbedded with sand and weak clay layers. The cut has 2:1 side slopes with benches at vertical intervals of approximately 25 feet. Erosion of the cut slopes and benches filled the section's drainage ditches. Lack of drainage saturated the subgrade soil and reduced its shear strength. Heavy rail traffic caused excessive settlement, pumping of fines through the ballast, and progressive failure of the railway embankment and shoulders.

Three design alternatives to restore the track to normal operation were considered:

- relocating the alignment of the track, which would have been a significant expense;
- stabilizing the subgrade using a geotextile installed over the existing sub-ballast; and
- reinforcing the ballast using a combina tion of geotextiles and Tensar Geogrids.

The ballast reinforcement solution with geogrids was selected by the client as the best option for improving the corridor and mitigating maintenance costs. Research demonstrated that a ballast section reinforced with geogrids would be able to carry as much as 10 times the rail traffic as an unreinforced section of equal thickness.

The system design called for raising the track and undercutting and removing the existing ballast. A filter fabric was installed over the exposed sub-ballast, followed by a single layer of geogrid. The track was lowered and a minimum of 12 inches of new ballast was placed using hopper cars. The track was then raised through the ballast, and vibrating tines compacted the ballast in place.

As a result of the successful project, CSX was able to restore normal operations at a fraction of the cost of relocating the line. After three months of operation with no track stability issues, the section's maximum speed was raised to 35 miles per hour, and subsequently all speed restrictions have been lifted.

Once again, the use of geogrids substantially reduced the traditional construction time and costs associated with renovation. Subgrade performance and durability were improved while the required ballast thickness was reduced.

## Solving soft subsoil

More recently, geogrids were used by the Utah Transit Authority to reinforce large sections of the 44-mile FrontRunner commuter rail line. Extensive soft soil conditions were overcome by using geogrids to create a strong construction platform with a reduced sub-ballast thickness.

The rail line is located on an existing right-of-way that runs parallel with the Wasatch Mountains. The area is part of a natural drainage basin that includes abundant soft soils and shallow groundwater. The subgrade consists of low-to-medium-strength cohesive soils and loose to dense sand.

A traditional design would have used thick sections of sharp stone, sub-ballast, and ballast to help bridge the soft soils. Given the extensive soft-soil conditions and costs associated with importing high-quality stone, this approach would have increased the construction budget considerably. Tensar and Terracon Consultants Inc., the project's geotechnical engineering firm, recommended using geogrids to reduce the thickness of the sub-ballast.

Terracon's project engineer, Rick Chesnut, developed the project design. Following his specifications, the contractor's crew graded and proof-rolled the subgrade, and covered it with filter fabric followed by geogrid. Where the stabilization zone needed to be wider, the geogrid rolls were installed side by side and overlapped by 18 inches.

Work on the line proceeded quickly and with a significant reduction in material and labor costs.

"Going with Tensar Geogrids allowed us to stay out of the soft subsoil conditions," Chesnut said. "It prevented having to dig down deeper and helped us avoid groundwater. In one case, it also allowed the general contractor to avoid moving over 900 feet of buried utilities. That was a huge saving all on its own."

"We were able to show that geogrids could provide a strong construction platform with a thinner section," said Branden Reall, Tensar Mountain West regional manager. "It has provided the reinforcement needed to carry rail traffic while reducing the sub-ballast layer from 12 inches to 8 inches." ▼

### Projects

- Rail spur in Clanton, Ala.
- St. Charles Avenue streetcar line renovation, New Orleans
- CSX rail line restoration, Milstead, Ala.
- Utah Transit Authority FrontRunner commuter rail line

### Participants

Building and Earth Sciences Inc.
New Orleans Regional Transit Authority
CSX Transportation
Utah Transit Authority
Terracon Consultants Inc.

### Product application

Tensar's Spectra Rail Railway Improvement System incorporating Tensar geogrids stabilizes rail ballast and sub-ballast layers, reducing track settlement and maintenance costs.

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