Since its introduction in the 1980s, geosynthetic reinforcement grid designed for road construction projects has been exclusively biaxial—with rectangular apertures. Now all that’s changed with the rollout of a triangular structure geogrid product from an early developer of geosynthetic solutions for civil engineering applications. It is a product with the promise of lower cost, durability, easy construction and more reliable trafficked surfaces.

Following a successful launch in Europe in 2007, Atlanta, Ga.-based Tensar International Corp. has introduced Tensar TriAx Geogrid in North and South America. This new geosynthetic results from more than six years of design research, laboratory trafficking trials and field applications by engineers in Tensar International’s United Kingdom business unit. The product quickly demonstrated improved performance over biaxial geogrid, with reductions in excavation depths and pavement component thicknesses as it extended the service life of both paved and unpaved surfaces. Its key features are the reasons why.

A new angle on performance

Through extensive research on biaxial geogrid, engineers identified five properties critical to a grid’s performance:

- In-plane stiffness;
- Rib profile;
- Rib thickness;
- Junction efficiency; and
- Aperture size.

This new geogrid leverages triangular geometry, an intrinsically stable and sturdy form, to enhance in-plane, radial stiffness, distributing radial stresses (loads) from aggregate to grid throughout a full 360°. The grid’s ribs—square-edged, concave and deeper than their biaxial counterparts—have proved to interlock with and confine aggregate more efficiently, stabilizing composite layers more securely. Modeling techniques in particular have confirmed the thicker ribs’ effect on confinement and load dissipation. In addition, the grid’s hexagonal junction shape and uniform manufacture ensure high junction strength and stiffness.

These properties yield a more effective mechanically stabilized layer, reducing materials excavation and removal costs as well as required aggregate layer thicknesses and their associated costs. In fact, triangular-aperture geogrid optimizes component thicknesses of aggregate and asphalt in paved applications as well as thicknesses of granular fill in unpaved applications. Additional
research has demonstrated that the grid can reduce asphalt quantities 15-30% and aggregate base/sub-base requirements 25-50%. It also can extend maintenance and rehabilitation intervals, directly affecting life-cycle costs as it supports more sustainable road design.

Tested and retested

To support these claims, triangular structure geogrid has been extensively tested on both sides of the Atlantic. Studies have included large-scale bearing capacity and trafficking trials to help qualify design features, measure sub-base performance, assess potential installation damage, measure multidirectional trafficking performance and determine bearing capacity. In addition, a number of installation field trials have been conducted.

“The need for innovation to optimize construction budgets is at an all-time high in the Americas,” remarked Stephen Archer, P.E., Tensar International roadway solutions marketing director. “TriAx Geogrid offers owners, engineers and contractors both short- and long-term cost savings for paved and unpaved applications through this significant advancement in geogrid technology.”

Three sides of applications

Triangular aperture geogrid improves the performance of low- and high-volume surfaces traditionally reinforced by biaxial products—roadways, parking lots, runways/ taxiways/aprons, intermodal facility platforms in paved applications as well as haul roads, staging areas, construction platforms and other unpaved applications. Its geometry is key to a greater reduction of subgrade stresses as it enhances the load-spreading capability of an overlying base or sub-base course.

Three recent installations, including two on interstate segments with soft, saturated soils plus a third on a municipal thoroughfare over a network of shallow utilities, demonstrate the grid’s reinforcement capabilities.

New York, N.Y.

Earlier this year, contractors working on the widening of two high-speed passing lanes on the New York State Thruway (I-87), about 40 miles northwest of New York City, encountered extremely saturated soils—gray and red clays characterized as “pudding.” Conditions were so saturated that dug test holes failed to reveal more stable soils below. Engineers were faced with the prospect of over-excavation up to 10 ft and the importation of select fill, an option described as “enormously expensive.”

“We had to find a solution that would be acceptable to the client and that could be adopted without causing significant project delays,” remarked Fred Staz, chief of field operations with New Jersey-based Boswell Engineering. The company initially considered using a filter fabric but opted for geogrid instead.
“It had more of a strength characteristic than the geotextiles. We were concerned with the traffic loads the roads would have to support,” Staz continued.

The company ultimately recommended excavation to an 18 in. depth and the installation of a 12-in. sub-base. TriAx 160 Geogrid was installed over the sub-base and covered with a 2½-in. binder layer, topped with a 1½-in. asphalt base.

“That part of the project worked out really well,” Staz added. “Before using the grid, there was a lot of pumping in areas with equipment traffic... You get a platform for construction as soon as the geogrid is covered with rock. If we had used removal [over-excavation], we would have had to remove a 36- to 40-ft-wide section down 10 to 12 ft for hundreds of feet.”

“In most ways this was a fairly straightforward project,” said Tom Whelahan, project manager with Yonkers Contracting Co. “There wasn’t much out of the ordinary... But the geogrid did help us to stay on schedule. There would have been more effort to over-excavate the soft areas, so it did save us time and dollars. If I had to calculate, it was probably one-third the cost to install the geogrid.”

“Since TriAx’s rib has a higher profile, and the product has a unique triangular grid shape with 360° load distribution, these properties provide base confinement and strength in wet soil conditions,” added David Lipomi, Tensar International regional sales manager.

TriAx reinforcement greatly reduced the amount of imported fill and provided the construction platform needed to support aggregate and asphalt trucks. Contractors were able to pave the segment just two weeks after its installation.

Casa Grande, Ariz.

Thousands of miles to the west, on I-10 near Casa Grande, Ariz., state DOT officials conducted a test installation of TriAx Geogrid along a 3-mile segment with a similarly weak subgrade. There, on a road-widening project, contractors were excavating up to 3 ft of saturated, silty soils, drying the material and reinstalling it with additional, more stable fill and an aggregate base. The procedure quickly created problems with respect to adequate staging areas and concerns over construction delays (already one month and counting) plus labor expenses surfaced as well.

ADOT was “anticipating a lot of saturated soils with no bearing pressure,” according to Carter McKune, senior resident engineer, leading the department “to look at alternatives to over-excavation.”

On a test section, contractors removed 20 in. of soil and placed a single layer of TriAx 160 Geogrid over the leveled and rolled subgrade. They then placed 12 in. of aggregate base, topped with 8 in. of asphalt concrete.
Minimizing time-consuming excavation requirements is a key benefit of Tensar International’s Spectra Roadway Improvement System with TriAx Geogrid, claimed Lars Nelson, the company’s regional manager. “Testing shows it has better strength properties than standard geogrid, providing enhanced base confinement and strength.”

Chula Vista, Calif.

First Avenue is a Class III collector roadway that also serves single-family residences in Chula Vista, Calif., a city of 225,000 located in southern San Diego County. Like many of the city’s older streets, First Avenue was constructed with a thinner profile. So when city engineers wanted to schedule a much-needed rehabilitation, they were faced with a choice of approaches.

“We considered the cost benefit of excavating and exporting material vs. using geogrid,” said Kirk Ammerman, Chula Vista principal civil engineer. “To improve [our roads’] performance, we have to go thicker or find a way to improve the subgrade under the pavement.”

Engineers opted to maintain a relatively shallow base and asphalt pavement section; traditional design methods would have required deeper excavation work and the relocation of many more utility connections.

TriAx Geogrid proved to be the most effective option for improving long-term pavement performance while minimizing excavation. The subgrade consisted of silty clay soils with extremely low shear strength. The geogrid design enabled the city to use a uniform profile overlay with just 5 in. each of crushed aggregate base (CAB) and asphalt concrete. The thinner profiles reduced over-excavation, removal costs and material costs by 113 truckloads (CAB alone was reduced by half). Altogether, project costs were reduced approximately $35,000 over conventional rehabilitation.

Jimenez Construction Inc., general contractor, excavated the roadway, then leveled and rolled the subgrade. The company next installed 12,000 sq yd of TriAx 160 Geogrid, overlapping each section by 18 in. for optimal reinforcement. The project was completed with the thinner layers of CAB and asphalt concrete overlay.

“Installation was pretty cut-and-dry,” said Jimenez Construction Vice President Javier Jimenez Jr. “There were tons of shallow utilities. With a deeper excavation, we would have needed to take up 60% of the lines, and that would have probably doubled our time on the job.”

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