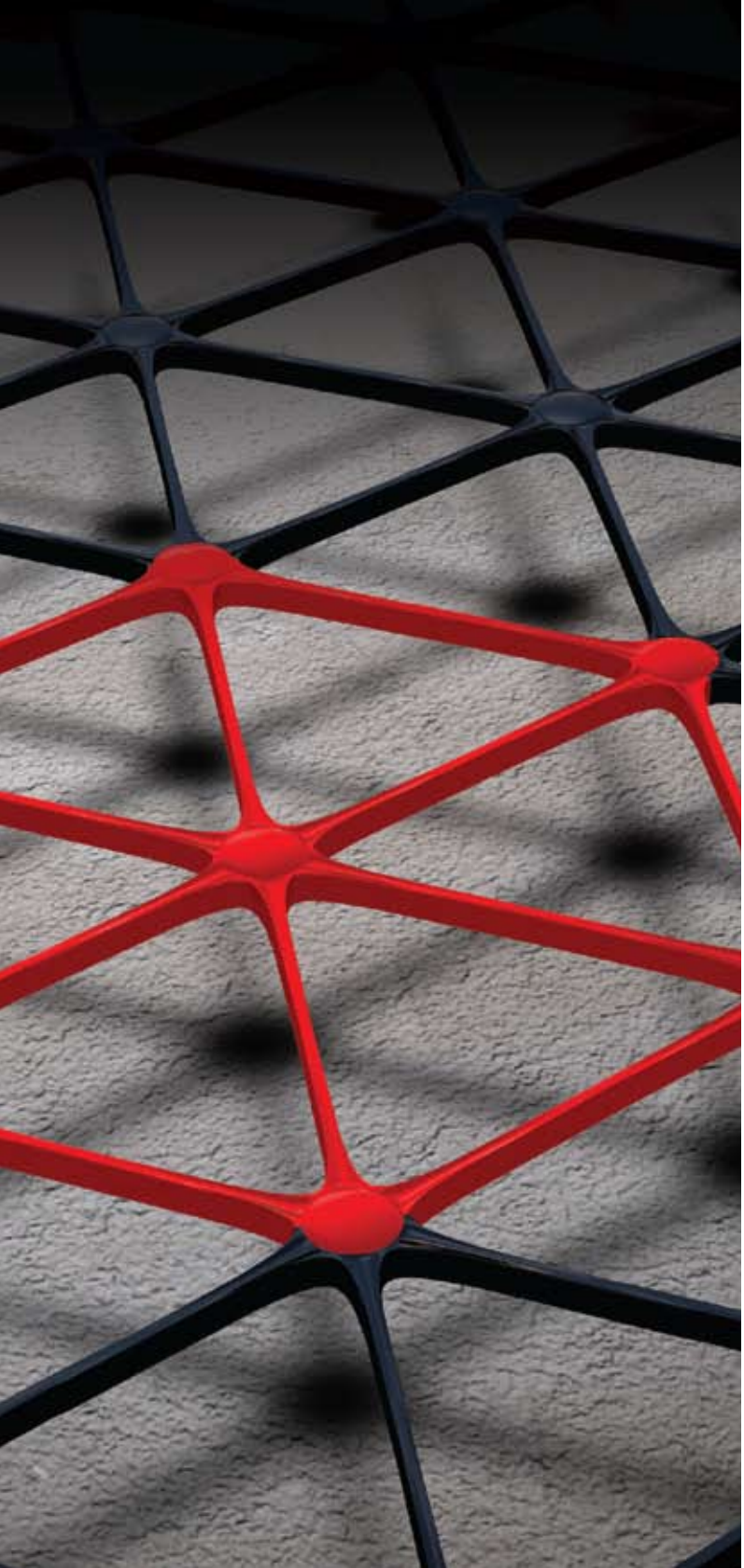
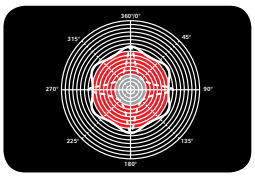
TriAx™

A REVOLUTION
IN GEOGRID TECHNOLOGY





The properties and performance advantages of Tensar **TriAx™** geogrids

Tensar®
INTERNATIONAL

TriAx™

A REVOLUTION IN GEOGRID TECHNOLOGY

Tensar International has almost 30 years of experience in analysing and optimising the performance of geogrids. Drawing on this technical knowledge and expertise, Tensar has radically re-engineered the fundamental structure of geogrids to create a revolutionary new product. The TriAx geogrid is the culmination of this research and represents the future of geogrid technology, using one of the most stable forms – the triangular structure.

BORN FROM TENSAR TECHNOLOGY

TriAx gives improved aggregate confinement and interaction, leading to improved structural performance of the mechanical stabilised layer.

Tensar invented and pioneered the original biaxial form of geogrid - until now the geogrid with the best performance in trafficked applications.

Through Tensar's policy of continual product development and innovation, the challenge for the Tensar development team was to improve on their biaxial geogrid and achieve even greater, long-term performance benefits.

By examining all the design characteristics of the biaxial geogrid, through testing and research, the development team was able to identify the key areas that affect its performance. These are the profile of the rib section, rib thickness, junction efficiency, aperture size and, of particular importance, in-plane stiffness. This research evolved into a revolutionary change from a rectangular to a triangular grid aperture. This fundamental change to the grid structure, coupled with an increase in rib thickness and junction efficiency, gives greatly improved aggregate confinement and interaction, leading to improved structural performance of the mechanically stabilised layer.

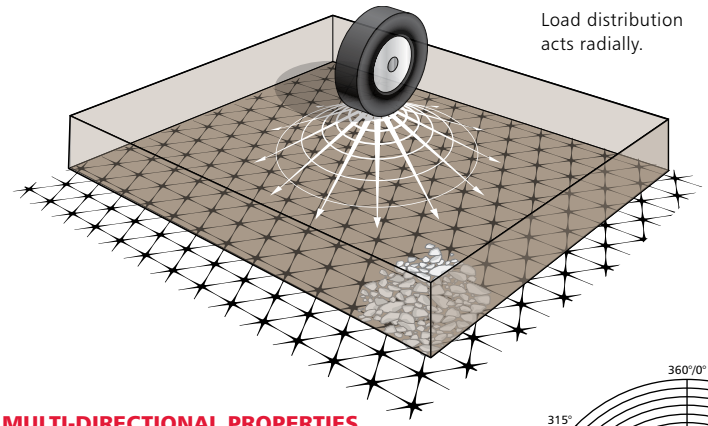
This was a revolution in geogrid technology with significant, new and improved benefits over the biaxial geogrid. A series of rigorous tests followed comparing the functional performance of TriAx with Tensar biaxial grids. These tests confirmed the research effort and demonstrated that TriAx functionally out-performed Tensar's best performing biaxial geogrids.

THE ADVANTAGES
OF TRIAX GEOGRIDS COMPARED WITH BIAXIAL

The unique TriAx structure incorporates several characteristics which combine to create an optimised structure that out-performs Tensar biaxial geogrids in trafficking applications. When combined with a suitable aggregate TriAx produces a mechanically stabilised layer with exceptional performance.

LOAD DISTRIBUTION

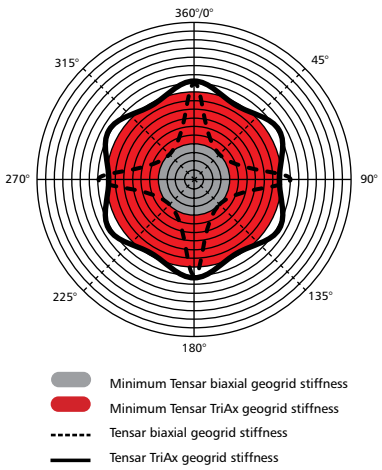
Load distribution is 3-dimensional in nature and acts radially at all levels in the aggregate. For a stabilised layer to be effective it must have the ability to distribute load through 360 degrees. To ensure optimum performance, the geogrid reinforcement in a mechanically stabilised layer should have a high radial stiffness throughout the full 360 degrees.



MULTI-DIRECTIONAL PROPERTIES

Biaxial geogrids have tensile stiffness predominantly in two directions. TriAx geogrids have three principal directions of stiffness, which is further enhanced by their rigid triangular geometry. This produces a significantly different structure than any other geogrid and provides near-uniform stiffness through 360 degrees. A truly multi-directional product with near isotropic properties.

The minimum radial stiffness for each product can be obtained from the relevant Tensar product technical note.



The polar diagram shows the shape of tensile stiffness plots for Tensar biaxial and TriAx geogrids manufactured from the same sheet thickness, with TriAx exhibiting near-isotropic properties.

JUNCTION INTEGRITY

TriAx is produced from an extruded sheet of polypropylene. This is then punched with an array of holes and stretched to create the unique TriAx structure. This Tensar process, coupled with the design of the junctions, results in a product with high junction strength and stiffness.

JUNCTION EFFICIENCY

Rigorous testing has been conducted in line with each of the three rib directions. In each direction tested, the TriAx geogrid was found to have high strength junctions and stiff ribs providing effective mechanical interlock of aggregate particles into the aperture.

Node structure providing high junction efficiency.

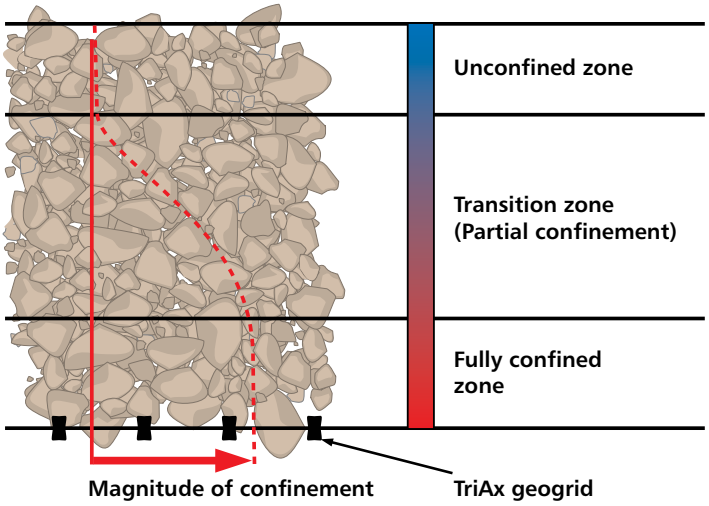
GEOGRIDS

GREATER INTERLOCK AND CONFINEMENT

In a mechanically stabilised layer, aggregate particles interlock within the geogrid and are confined within the apertures, creating an enhanced composite material with improved performance characteristics. The structural properties of the mechanically stabilised layer are influenced by the magnitude and depth of the confined zones.

The shape and thickness of the geogrid ribs and the overall structure of TriAx has a direct influence on the degree of confinement and efficiency of the stabilised layer.

Aggregate confinement within a mechanically stabilised layer. Compared with Tensar biaxial geogrid, TriAx increases the magnitude of confinement and increases the depth of the confined zones.



TriAx rib structure directly influences the efficiency of the stabilised layer.

PROVING THE IMPORTANCE OF RIB PROFILE

Compared with Tensar biaxial geogrid, TriAx geogrid has a more efficient rib profile. Trafficking tests and analytical modelling were undertaken to investigate the influence of rib profile on performance. The results were conclusive in confirming the importance of a combination of the depth and shape of the rib profile. Deep profile ribs are more effective than thin profile ribs and a rectangular profile is more effective than a rounded profile. TriAx has been engineered to provide the most efficient use of material. The ribs have an optimised, high depth to width ratio and a rectangular, slightly concave edge profile.

TriAx Tensar biaxial

Compared with Tensar biaxial geogrid, TriAx geogrid has a more efficient rib profile.

SUSTAINABLE DESIGN

The improved performance of TriAx geogrid enables greater reductions in aggregate layer thickness, further reducing the quantities of natural aggregates used and the volume of material to be excavated. These additional savings in materials and transport will help engineers to meet their sustainability objectives.

SCIENTIFICALLY PROVEN

TRIAX OUTPERFORMS EVEN TENSAR BIAXIAL GEOGRIDS

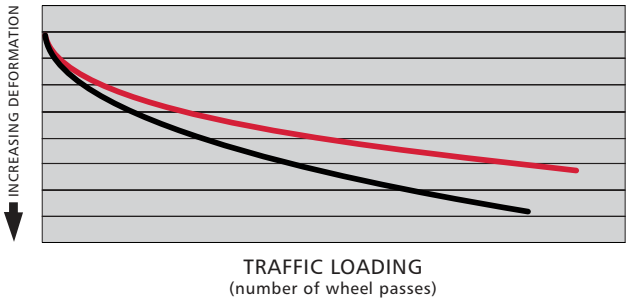
A number of tests and trials have been conducted to prove the performance benefits of the TriAx geogrid compared with Tensar biaxial geogrids. Tests included trafficking trials at the University of Nottingham and, on a large scale, at the Transport Research Laboratory (TRL). Installation damage assessment, bearing capacity and field tests were also conducted as part of the comprehensive and rigorous testing programme.

THE UNIVERSITY OF NOTTINGHAM TRAFFICKING TEST FACILITY

Facilities at the Nottingham Transportation Engineering Centre (NTEC) at the University of Nottingham were used to identify the design features required for improved performance and to help shape and define the TriAx geogrid. The trafficking test facility at NTEC was used to produce a large quantity of trafficking data across both TriAx and Tensar biaxial geogrids, confirming the much improved performance benefits of the TriAx geogrids compared with Tensar biaxial geogrids.

Testing at NTEC produced a large quantity of trafficking data, confirming the much improved performance of the TriAx geogrid.

TRL TRAFFICKING TRIALS



The performance advantage of TriAx compared with Tensar biaxial geogrids has been tested and proven in trafficking trials at TRL.

Trafficking trials were conducted on a much larger scale at the Transport Research Laboratory in the UK. A large number of TriAx and Tensar biaxial geogrids were tested across varying aggregate depths – each up to 10,000 passes. The results showed that wheel track deformations were consistently smaller for TriAx geogrids and proved conclusively the structural benefits of TriAx, which include:

- Improved confinement of aggregate and enhanced performance of a mechanically stabilised layer
- An increase in traffic life for a given sub-base thickness
- A reduction in sub-base thickness for a given traffic load

The effect of geogrid aperture size, shape and rib depth was extensively researched at NTEC.

Trafficking trials by TRL proved the performance benefits of the TriAx geogrid compared with Tensar biaxial geogrids.

INSTALLATION DAMAGE ASSESSMENT

Additional tests conducted at the TRL were to establish how the TriAx geogrid would withstand a typical installation procedure and full compaction. TriAx geogrid proved tough enough to cope without loss of integrity to the overall structure.

MULTI-DIRECTIONAL TRAFFICKING PERFORMANCE

The near isotropic stiffness properties of TriAx geogrid suggests that the product will perform consistently well, regardless of the wheel path direction. This has been confirmed by multi-directional trafficking tests in the NTEC slab test facility comparing TriAx with Tensar biaxial geogrids.

Deformation measurements showed that TriAx geogrid performed equally well in all trafficking directions. This is in contrast with Tensar biaxial geogrids, which showed a reduced effectiveness when trafficked at an orientation of 45 degrees to the rib direction, against comparable trafficking parallel to the rib direction.

Excavation of TriAx for installation damage assessment at TRL.

BEARING CAPACITY IMPROVEMENT

Large scale bearing capacity tests conducted by the UK Building Research Establishment (BRE) have shown that the increased stiffness and confinement provided by TriAx results in even greater load distribution capacity than Tensar biaxial geogrids.

Bearing capacity tests at BRE confirm TriAx geogrids increase load distribution.

INSTALLATION AND HANDLING

The final aspect of performance is handling on-site. Extensive use in projects covering a range of applications have now proved that TriAx is easy to handle and is robust and tough enough to be installed over weak sub-grades.

TriAx geogrid can be handled by machine or carried manually.

TriAx geogrid unrolled on site.

Aggregate placed over TriAx geogrid prior to full compaction.

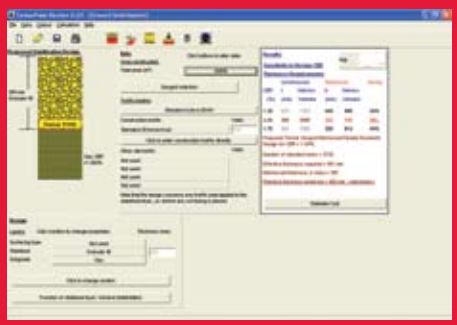
TriAx™

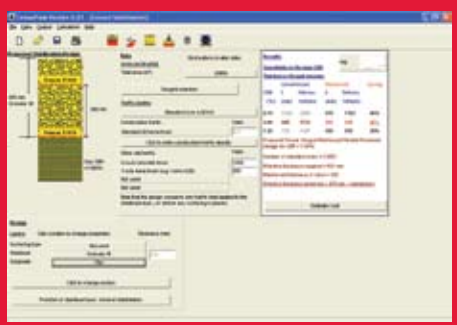
ADVANCED TECHNOLOGY

SUPERIOR TECHNICAL SUPPORT

Even the most technologically superior products are unlikely to perform to their maximum potential without the accompaniment of expertise and experienced support.

Tensar TriAx geogrids are supplied with the support of Tensar Technology - high performance products backed up by the knowledge and know-how to get optimum results. The Technical team at Tensar are world-renowned for unrivalled knowledge and expertise, providing engineers and contractors on request with the reassurance of design, technical and installation guidance on all projects.





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TENSARPAVE™ DESIGN SOFTWARE

TensarPave™ is a software package developed by Tensar International, incorporating TriAx design parameters for the most economical ground stabilisation and pavement design solutions.

DESIGNING WITH TRIAX GEOGRIDS

To get the best from TriAx and arrive at the most cost-effective designs for your client, TensarPave™ software is available free of charge with specific user training from Tensar International.

TENSAR PROVIDES

SUPERIOR SUPPORT FOR...

...DESIGN ENGINEERS

Tensar International's design team can offer free applications suggestions and indemnified designs, with full working drawings, offering increased support to design engineers.

...CONTRACTORS

The additional aggregate reductions made possible by TriAx geogrid may be the saving you need to give you a competitive edge and win that contract. Working to tight deadlines, Tensar engineers can provide a fully costed, alternative design. For projects on-site, our engineers are available on request to advise on solutions for problems with construction over weak or variable ground. TriAx geogrids are available from a network of distributors able to deliver locally from stock.

...HOUSEBUILDERS

TriAx geogrid is on hand to increase your opportunities to minimise costs and maximise profits. Upon encountering soft ground problems or brownfield sites subject to differential settlement, Tensar's experienced engineers are available to offer solutions on-site and identify further opportunities to save you time and money. Our engineers can provide alternative options, whether it is through applications suggestions or indemnified designs, complete with working drawings and support to obtain any necessary approval.

...GROUNDWORK SPECIALISTS

Initial installation advice and specialist advice on dealing with difficult ground conditions are available from our experienced technical support team. In cases involving extreme soil conditions, it is often the method of working that is the difference between a profitable project and a poor outcome. Our support team offers the knowledge to make the difference.

...PILING CONTRACTORS

Working platforms for piling or crane access are an essential but costly item for access over poor ground. Tensar International can provide an indemnified design and supply solution, subject to conditions, for working platforms that take full advantage of TriAx geogrids to minimise platform thickness and costs.

Tensar are world-renowned for unrivalled knowledge and expertise.

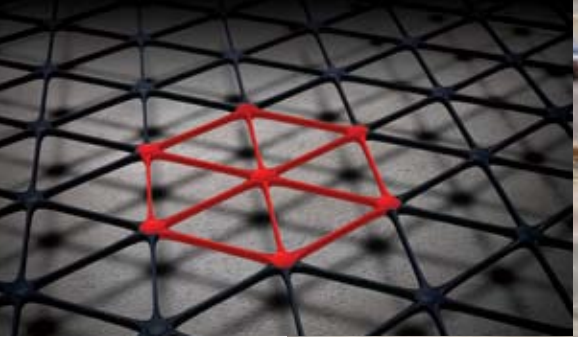
TriAx geogrids are available from stock.

TriAx geogrid represents the future of geogrid technology.

TriAx geogrid is easy to handle.

Delivering the best performance in trafficked applications.

Tensar provides contractors with design, technical and installation guidance.



APPLICATIONS

TriAx™ geogrids from Tensar International offer exceptional performance in ground stabilisation and sub-base reinforcement. Combined with the technical support and expertise offered by the Tensar team, TriAx™ represents the future of geogrid technology and, with its proven performance, will replace conventional biaxial geogrids.

ROADS AND TRAFFICKED AREAS

With TriAx™ geogrid and its structural performance benefits, there is an opportunity to make considerable savings on unpaved roads and permanent road construction.

Less aggregate is required with TriAx™ geogrid, which can also reduce installation time and further helps to reduce ground stabilisation costs. The reduction in aggregate materials and transport also helps engineers meet sustainability objectives. For thin surfaced pavements, TriAx™ geogrids can provide longer-term benefits, with an increase in pavement life and reduction in whole life costs.

HOUSING

Increasingly, housing developments are being built on weak or marginal land. This means that the sub-grade conditions can be variable, which leads to differential settlement.

By providing a reinforced sub-structure to a road pavement, TriAx™ geogrids can be used to help control differential settlement and offer cost savings of up to 75% compared with conventional solutions.

All geogrid applications require appropriate engineering analysis by Tensar Design Engineers or other qualified professional engineers.

Many millions of square metres of Tensar TriAx™ geogrid are in use around the world and have been installed on a wide variety of projects.

CASE STUDY 1 Arecleoch Wind Farm, Scotland

Tensar TriAx™ geogrids were the answer for a new Scottish wind farm built in a rural area. Existing tracks had to be widened and new access roads built over the site which had low ground strength with CBR values between 0.5% and 1%. Using thick stone layers to accommodate site traffic would have involved large numbers of vehicle movements and excessive road settlement. Instead, multiple Tensar TriAx™ geogrid layers were installed and combined with site-won stone. Although the stone quality was less than ideal, this solution delivered excellent trafficking performance and achieved a 15% carbon emissions saving over an unreinforced solution.

ONLINE CARBON CALCULATOR

Check your carbon footprint and realize the environmental benefits with cost savings for your project, online at **www.tensarsustain.co.uk**

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CASE STUDY 2 Green Point Stadium, Cape Town, South Africa

TriAx™ helped create significant time and cost savings for the new Cape Town World Cup stadium, where extensive earthworks had generated large quantities of variable quality loose fill. In one area this fill was used as a temporary haul road ramp. This needed converting into a permanent heavy-duty road, but was showing signs of deformation. With no time to excavate and re-compact the fill material, two layers of Tensar TriAx™ were added to the sub- base. This stabilised the ramp and minimised any differential settlement. TriAx™ was used to reinforce the haul road, the surface of which would later be trimmed to form the foundation for the permanent road, also stabilised by the same geogrids.

CASE STUDY 3 Flooding of River Derwent, Cumbria, England

TriAx™ geogrid helped build a new crossing over the River Derwent when floods destroyed existing bridges in Workington. Tensar International helped design the new bridge abutments and an assembly platform. It also delivered the required TriAx™ the next day so that work could start immediately.

Constructing abutment bank seat supports from aggregate, mechanically stabilised with multiple layers of TriAx™ reduced the need for piling or deep foundations. The use of TriAx™ also meant that the geogrid construction immediately became load bearing (with no concrete setting time required) allowing the bridge deck to be rapidly installed.

TriAx represents the future of geogrid technology, replacing conventional biaxial geogrids.

Photography courtesy of www.jackthehat.co.uk

Your local distributor is:

GreenScape Ltd.

For Landscape & Geosynthetic Engineering

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