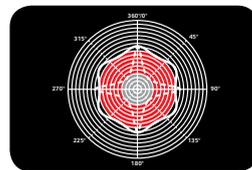


**TriAx™**

**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 the 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.

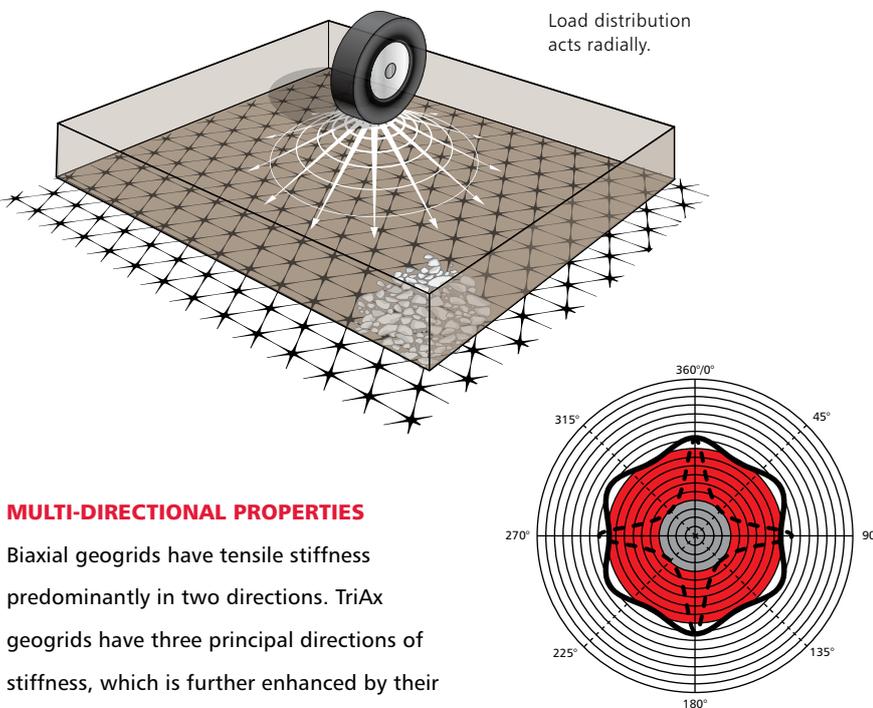
This was a revolution in geogrid technology with significant, new and improved benefits over the biaxial geogrid. A series of rigorous tests followed comparing the functional performance of TriAx with Tensar biaxial grids. These tests confirmed the research effort and demonstrated that TriAx out-performed the 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 conventional 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 high stiffness through 360 degrees. A truly multi-directional product with near isotropic properties.

The polar diagram compares the tensile stiffness of Tensor biaxial and TriAx geogrids through 360°, 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 Tensor 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 junction strength was found to be essentially equal to the rib strength - giving a junction efficiency of 100%.



Node structure providing junction efficiency of 100%.

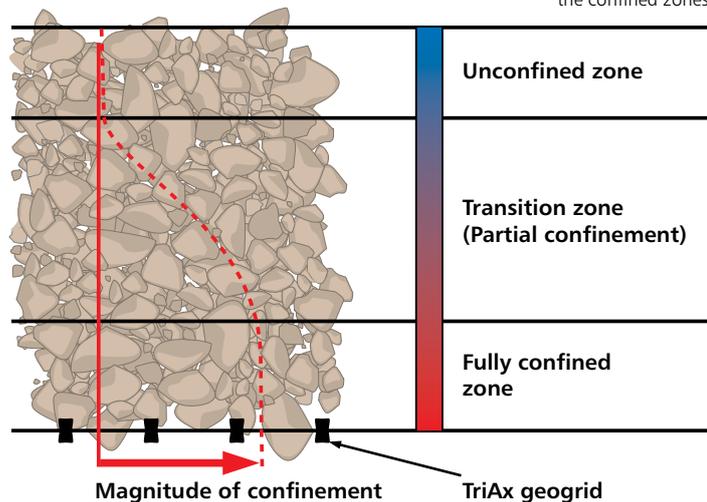
# GEOGRIDS

## 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. TriAx increases the magnitude of confinement and increases the depth of the confined zones.



## PROVING THE IMPORTANCE OF RIB PROFILE

TriAx geogrids have greater rib depth compared with conventional biaxial geogrids. Trafficking tests and analytical modelling were undertaken to compare performance advantages between the two forms of geogrid with various rib depths in a mechanically stabilised layer. The results were conclusive in confirming that an improved structural performance was achieved with the TriAx geogrid and its deeper rib depth and unique profile. Numerical modelling techniques confirm the importance of geogrid rib thickness on aggregate confinement and load dissipation.



TriAx

Tensor biaxial

Compared with a conventional biaxial geogrid, TriAx geogrid has a much greater rib depth contributing to improved confinement.

## 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.



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



A number of tests and trials have been conducted to prove the performance benefits of the TriAx geogrid compared with conventional 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**

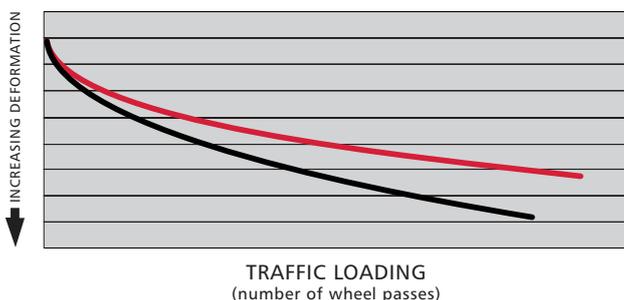
Facilities at the Nottingham Transportation Engineering Centre (NTEC) at the University of Nottingham were used to identify the design features required for improved performance and to help shape and define the TriAx

geogrid. The trafficking test facility at NTEC was used to produce a large quantity of trafficking data across both TriAx and biaxial geogrids, confirming the much improved performance benefits of the TriAx geogrids compared with biaxial geogrids.



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

**TRL TRAFFICKING TRIALS**



Trafficking trials at TRL prove the performance advantage of TriAx compared to Tensar biaxial geogrids.

Trafficking trials were conducted on a much larger scale at the Transport Research Laboratory. Both TriAx and biaxial geogrids were tested across varying aggregate depths - each up to 10,000 wheel 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 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 conventional 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.



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, is robust and tough enough to be installed over weak sub-grades.



TriAx geogrid can be handled by machine or carried by two men.



TriAx geogrid unrolled on site.



Aggregate placed over TriAx geogrid prior to full compaction.

## 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.

Tensor TriAx geogrids are supplied with the support of Tensor Technology - high performance products backed up by the knowledge and know-how to get optimum results. The Technical team at Tensor 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.



Tensor TriAx geogrids are supplied with the support of Tensor Technology.

### TENSARPAVE DESIGN SOFTWARE

TensorPave is a software package developed by Tensor 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, TensorPave software is available free of charge with specific user training from Tensor 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

Installation support 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.



TriAx geogrid represents the future of geogrid technology.



TriAx geogrid is easy to handle.



Tensar are world-renowned for unrivalled knowledge and expertise.



Delivering the best performance in trafficked applications.



TriAx geogrids are available from stock.



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.



TriAx represents the future of geogrid technology, replacing 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 also reduces 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 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 to conventional solutions.

## SPANNING VOIDS

TriAx geogrids can be used to help protect against sinkholes and subsidence, such as those encountered in areas of abandoned mine workings and can help to provide indications of voids developing below the surface.

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



**TriAx**  
meets the challenge  
of marshy ground and  
provides a platform for  
this lorry park in Scotland.



**Geogrids**  
rolled out in this  
Highways Agency scheme  
in the North of England.



**Stabilisation**  
of industrial pavements  
for this client in North  
West England.



**TriAx**  
used with aggregate to  
cap waste material and manage  
differential settlement on the  
A66 Scotch Corner.



**TriAx**  
stacks up for this  
contractor in Derbyshire.

Your local distributor is:



**Q 05288**

BS EN ISO 9001:2000



**EMS 86463**

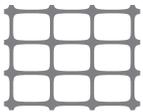
BS EN ISO 14001:2004

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January 2008 - issue 3



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