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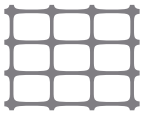
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Tensar
INTERNATIONAL

Tensar International Limited

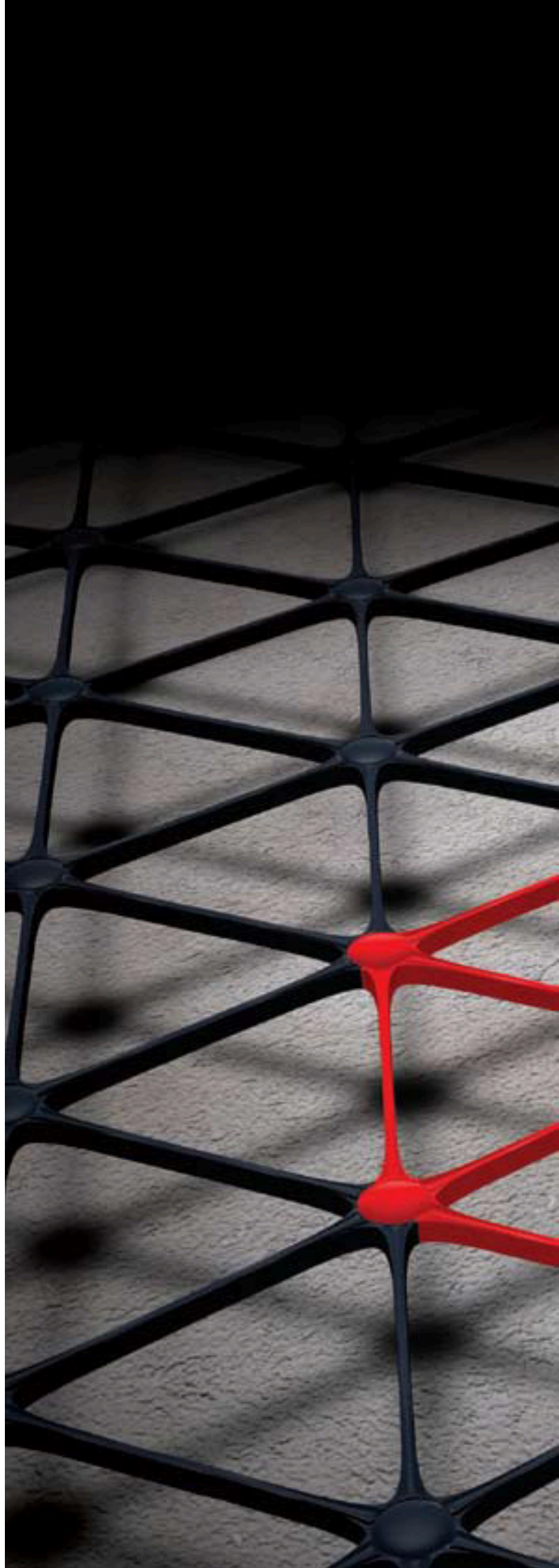
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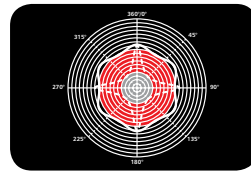
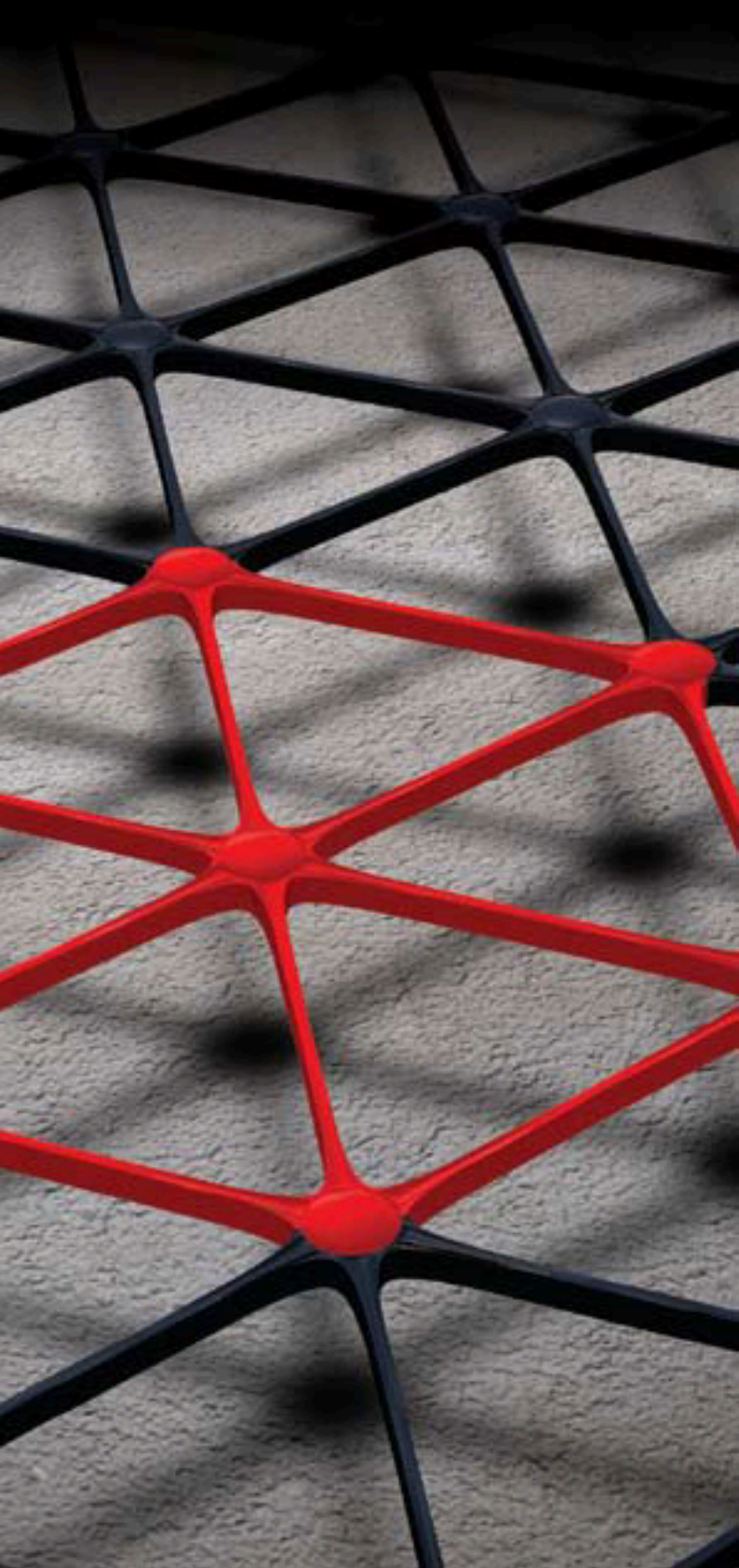
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TriAx™

A REVOLUTION
IN GEOGRID TECHNOLOGY



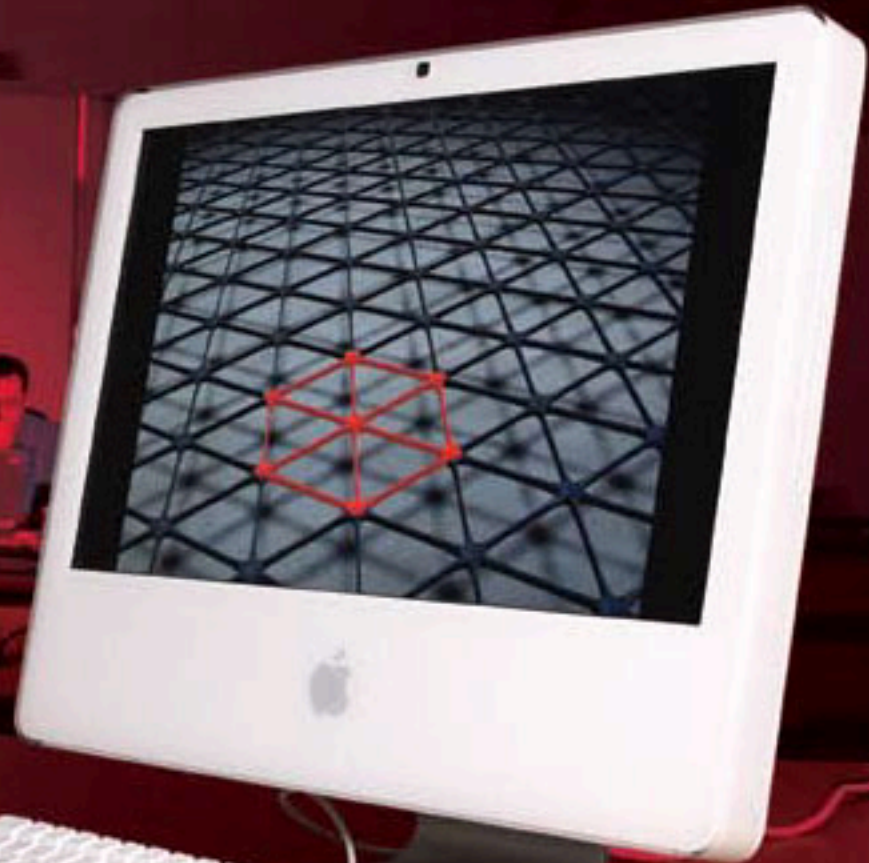
The properties and performance advantages of Tensar **TriAx™** geogrids



Tensar
INTERNATIONAL

TriAx™

A REVOLUTION IN GEOGRID TECHNOLOGY



Tensor International has almost 30 years of experience in analysing and optimising the performance of geogrids. Drawing on this technical knowledge and expertise, Tensor 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



The development team identified and optimised geogrid characteristics that influence performance.

Tensar invented and pioneered the original biaxial form of geogrid - until now the best performing geogrid.

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.

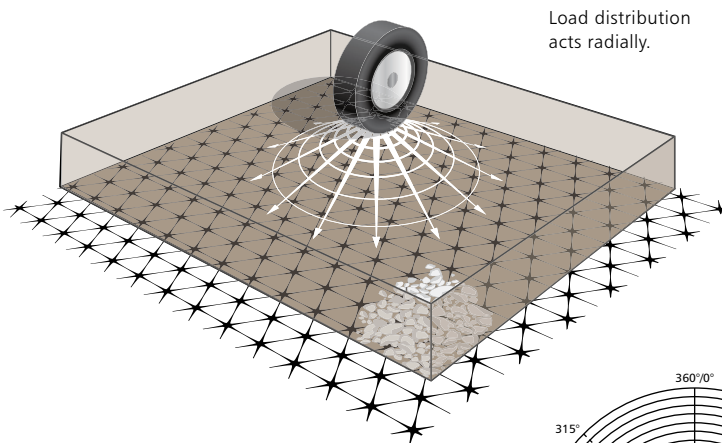
This was a revolution in geogrid technology with significant, new and improved benefits over the biaxial geogrid. A series of rigorous tests followed, comparing the performance characteristics of a biaxial geogrid with a TriAx geogrid. The tests confirmed the research effort and demonstrated conclusively that TriAx is the best performing geogrid in the industry.

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. When combined with a suitable aggregate TriAx produces a mechanically stabilised layer with unrivalled performance.

LOAD DISTRIBUTION

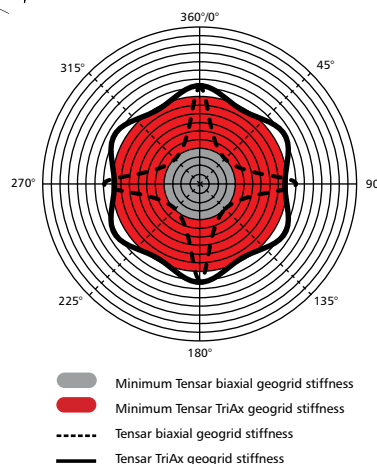
Load distribution is 3-dimensional in nature and acts radially at all levels in the aggregate. For a stabilised layer to be effective it must have the ability to distribute load through 360 degrees. To ensure optimum performance, the geogrid reinforcement in a mechanically stabilised layer should have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

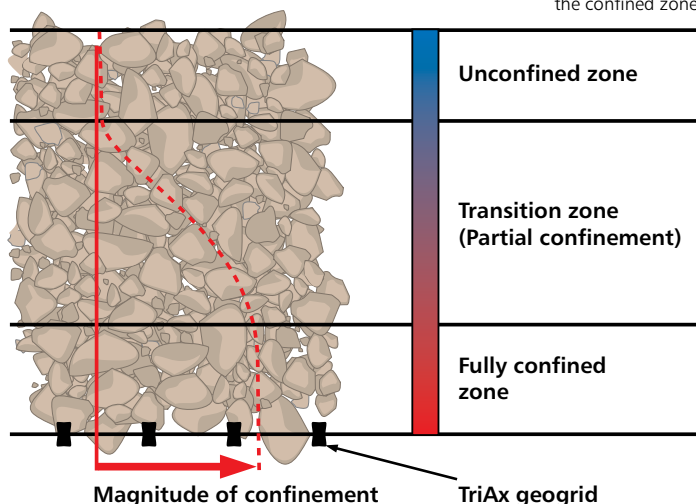
GEOGRIDS

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.

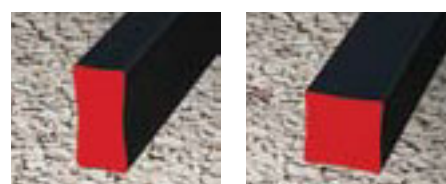


PROVING THE IMPORTANCE OF RIB PROFILE

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



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



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 and removed. These additional savings will help engineers to meet their sustainability objectives.



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 testing, bearing capacity and field tests were also conducted as part of the comprehensive and rigorous testing programme.

**THE UNIVERSITY OF NOTTINGHAM
SLAB TEST**

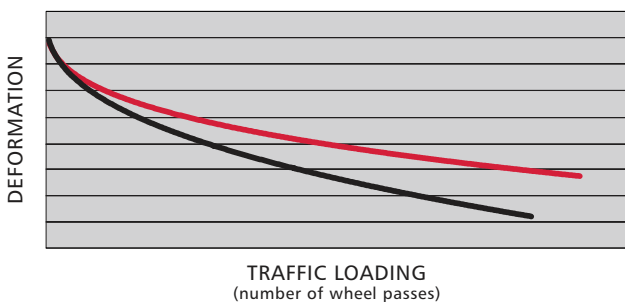
The Nottingham Transportation Engineering Centre (NTEC) at the University of Nottingham was used to identify the design features required for improved performance and to help shape and define the TriAx geogrid. The trafficking

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.



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 Tensor 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 were extensively researched at the University of Nottingham.



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

INSTALLATION DAMAGE TESTS

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 any loss of integrity to the overall structure or tensile properties.

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.

Deformation measurements showed that TriAx geogrid performed equally well in all 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 tests.

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 FIELD TRIALS

The final aspect of performance is handling on-site. Field trials have confirmed that TriAx is easy to handle and install. It 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 on top of 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.

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.



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

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 project concepts 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 be through project concepts 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.



Tensar are world-renowned for unrivalled knowledge and expertise.



TriAx geogrids are available from stock.

APPLICATIONS

TriAx geogrids from Tensar International offer unrivalled 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.

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 over 75% compared to conventional solutions, such as piled platforms.

SPANNING VOIDS

TriAx geogrids can be used to help protect against sinkholes and subsidence, such as those encountered in areas of abandoned mineworkings 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.

The TriAx geogrid, designed and developed by Tensar Technology is testimony to Tensar's commitment to innovation, their high calibre of technical expertise and their breadth of capabilities.

The TriAx geogrid represents a substantial leap forward in geogrid structures with outstanding performance and installation benefits.

TriAx[™]

A REVOLUTION IN GEOGRID TECHNOLOGY