TENAX LBO BI-AXIAL SUBGRADE GEOGRID

NEW ZEALAND'S LEADING PAVEMENT SUB-GRADE IMPROVEMENT REINFORCEMENT
PROVEN 16 YEAR NEW ZEALAND HISTORY
FULLY TESTED, DOCUMENTED AND CERTIFIED TO RECOGNISED INTERNATIONAL TEST STANDARDS

TENAX **LBO SAMP**

Type: **220 - 330 - 440**

Bi-oriented geogrids

TENAX **LBO SAMP** are polypropylene geogrids especially designed for soil stabilization and reinforcement applications.
The **LBO SAMP** geogrids are manufactured from a unique process of extrusion and biaxial orientation to enhance their tensile properties. TENAX **LBO SAMP** features consistently high tensile strength and modulus, excellent resistance to construction damages and environmental exposure. Furthermore, the geometry of the TENAX **LBO SAMP** allows strong mechanical interlock with the soil being reinforced.

Typical applications

Base reinforcement; reduction of required structural fill; load distribution; reduction of mud pumping; subgrade stabilization; embankment stabilization; slope reinforcement; erosion control mattresses.

PHYSICAL CHARACTERISTICS	TEST METHOD	UNIT	DATA	NOTES
STRUCTURE			BI-ORIENTED GEOGRIDS	
MESH TYPE			RECTANGULAR APERTURES	
STANDARD COLOR			BLACK	
POLYMER TYPE			POLYPROPYLENE	
CARBON BLACK CONTENT	ASTM D4218		2.0%	
PACKAGING	ISO 10320		ROLLS IN POLYETHYLENE BAGS WITH I.D. LABEL	

DIMENSIONAL CHARACTERISTICS	TEST METHOD	UNIT	LBO 220 SAMP	LBO 330 SAMP	LBO 440 SAMP	NOTES
APERTURE SIZE MD		mm	41	40	34	b,d
APERTURE SIZE TD		mm	31	27	27	b,d
MASS PER UNIT AREA	ISO 9864	g/m²	250	370	640	b
ROLL WIDTH		m	4.0	4.0	4.0	b
ROLL LENGTH		m	100	75	50	b
ROLL DIAMETER		m	0.41	0.45	0.52	b
ROLL VOLUME		m³	0.69	0.81	1.10	b
GROSS ROLL WEIGHT		kg	107.0	118.0	135.0	b

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	LBO 220 SAMP		LBO 330 SAMP		LBO 440 SAMP		NOTES
			MD	TD	MD	TD	MD	TD	
STRENGTH AT 2% STRAIN	ISO 10319	kN/m	7.0	7.0	10.5	10.5	14.0	15.0	b,c,d
STRENGTH AT 5% STRAIN	ISO 10319	kN/m	14.0	14.0	21.0	21.0	28.0	30.0	b,c,d
PEAK TENSILE STRENGTH	ISO 10319	kN/m	20.0	20.0	30.0	30.0	40.0	40.0	a,c,d
YIELD POINT ELONGATION	ISO 10319	%	11.0	10.0	11.0	10.0	11.0	11.0	b,c,d

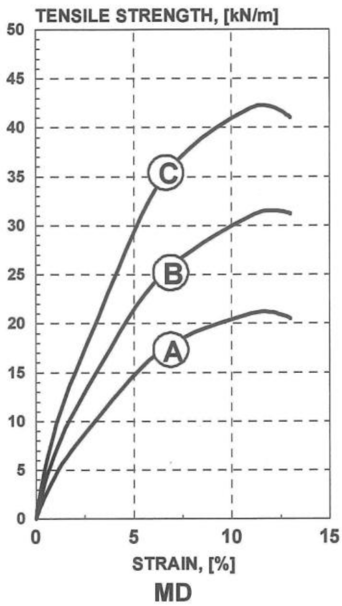
NOTES:
a) 95% lower confidence limit values, ISO 2602
b) Typical values
c) Tests performed using extensometers
d) MD: machine direction (longitudinal to the roll)
TD: transverse direction (across roll width)

Man, Technology, Environment.

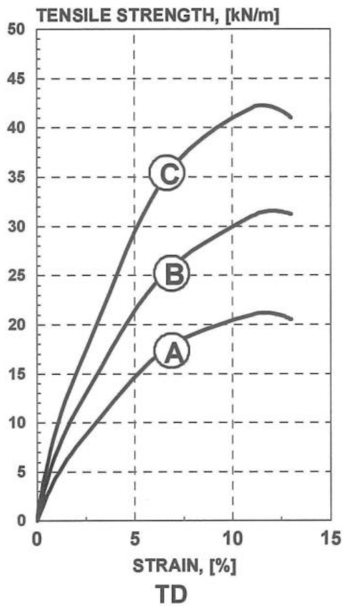
GE0 78.8 - E – 02/06

Typical Tensile Characteristics

TENAX LBO SAMP

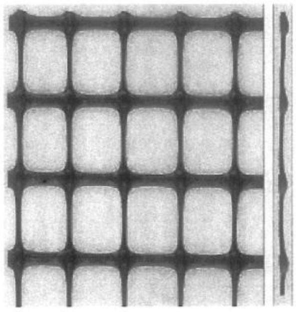


TENAX LBO SAMP



GEOGRID TYPE:

A = TENAX **LBO 220 SAMP**
B = TENAX **LBO 330 SAMP**
C = TENAX **LBO 440 SAMP**



0799-CPD-25

TESTING LABORATORY TENAX

The TENAX Laboratory has been created in 1980 and has been continuously improved with the purpose of assuring unequalled technical development of the products and accurate Quality Control,

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TENAX®
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Road : Low Bearing Capacity SubGrade Reinf.

Railtrack : Ballast Reinf.
See also LBO 370 Railgrid

TENAX LBO ‘HM’ SERIES BIAXIAL GEOGRID

FULLY TESTED, DOCUMENTED AND CERTIFIED TO RECOGNISED INTERNATIONAL TEST STANDARDS

TENAX LBO HM geogrids are HIGH MODULUS (HM) bi-oriented geogrids especially designed for soil stabilisation and reinforcement applications.
TENAX LBO HM geogrids are manufactured using a unique process of extrusion and biaxial orientation to enhance their tensile properties and overall performance when operating at low strains of 0.5% and 2%.
They are manufactured from polypropylene (PP) and tested to maintain a high tensile modulus, high strength junction, as well as an increased durability against installation damage.

Typical applications for a reduction of required structural fill in applications such as:

- Ground stabilisation / reinforcement.
- Road pavements
- Haul roads
- Drilling and crane platforms
- Foundation and piling platforms
- Airport foundation layers,
- Railway construction layers.
- Georaft structures for reinforced soil mattress and other solutions involving control of differential settlements.

PHYSICAL CHARACTERISTICS	TEST METHOD	UNIT	DATA	NOTES
STRUCTURE	--	--	Bi-oriented geogrids	--
MESH TYPE	--	--	Rectangular apertures	--
STANDARD COLOR	--	--	Black	--
POLYMER TYPE	--	--	Polypropylene	--
CARBON BLACK CONTENT	ASTM D4218	--	2.0%	--
PACKAGING	ISO 10320	--	Rolls in polyethylene bags with identity. label	--

DIMENSIONAL CHARACTERISTICS	TEST METHOD	UNIT	LBO HM 3	LBO HM 4	NOTES
APERTURE SIZE MD	--	mm	40	40	b,d,e
APERTURE SIZE TD	--	mm	27	27	b,d,e
ROLL WIDTH	--	m	4.0	4.0	b
ROLL LENGTH	--	m	75	50	b
ROLL DIAMETER	--	m	0.45	0.45	b

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	LBO HM 3		LBO HM 4		NOTES
			MD	TD	MD	TD	
STRENGTH AT 0.5% STRAIN	ISO 10319	kN/m	5.0	5.0	6.5	7.5	a,b,c,d
STRENGTH AT 2% STRAIN	ISO 10319	kN/m	12.0	12.0	16.0	17.5	a,b,c,d
RESISTANCE TO CHEMICAL DEGRADATION	EN 14030	%	100		100		b
RESISTANCE TO WEATHERING	EN 12224	%	100		100		b

NOTES:
a) Tensile Tolerance: ± 1 kN/m
b) Typical values
c) Tests performed using extensometers
d) MD: machine direction (longitudinal to the roll)
TD: transverse direction (across roll width)
e) Aperture Tolerance: ± 3mm

TENAX GEOSYNTHETICS

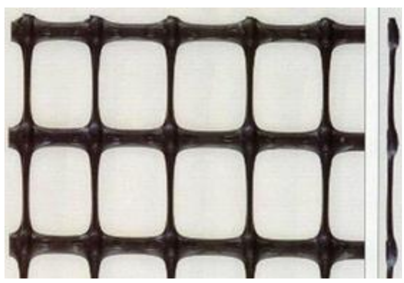
IMAGE OF TENAX LBO ‘HM’ GEOGRID

TECHNICAL NOTE : THE IMPORTANCE OF GEOGRID MODULUS

Of the various biaxial geogrid characteristics that can be measured through index tests it is important to evaluate and identify the characteristics that are crucial when designing a biaxial geogrid structure.
Generally said characteristics can be summarized as follows;

- Geogrid modulus
- Geogrid junction strength
- Direction of the geogrid strength
- Resistance to compaction/construction damage
- Interaction with the soil/aggregate.

Peak tensile strength has no relevance in design but is a value that is commonly measured to identify and compare products, this misconception is due principally to two reasons:

1. At the peak tensile value a geogrid usually develops strain values that are not compatible with the stability of a structure.
Let's assume a geogrid is laid at the base of a railway embankment 30m wide. If we decide to carry out a design using the peak tensile strength of a geogrid, this means we are accepting a strain equal to at least 10%. This would be equivalent to a geogrid deformation of 3m. Therefore, the new railway base extends from 30 to 33m which means that in the middle we are accepting a settlement equal to $[(33/2)^2-15^2]1/2 = 6.87$m...! This value is clearly not a realistic in practice.

2. At the peak tensile value the creep behaviour of the geogrid will result in unsafe structures.
When employing plastic materials, the creep behaviour corresponding to peak tensile strength values are very high, therefore, structures cannot be designed safely.
It is common practice in ground stabilisation the parameter used to define the effectiveness of a product is the **modulus** at **low strains**, typically a figure of **2% strain is used**.
At these lower value strains, viscous type phenomena ('creep') does not occur, even if the strain is applied for a relatively long period of time.

BS 8006-1995 states;

"...the stability of an embankment on soft soil is most critical during construction. This is because the relatively low permeability of the soft foundation does not permit full consolidation in the normal time scale of construction.
At the end of construction the embankment loading has been applied, but the gain in shear resistance of the foundation due to consolidation may be insufficient for stability. Once consolidation has occurred, the resulting improvement in shear resistance in the foundation will usually remove the need for the reinforcement to improve stability.
Thus, during the period between the end of construction and consolidation of the foundation, the fundamental strength requirement of the reinforcement is that at any instant in time the factored reinforcement design strength equals or exceeds the design load…"

Following this approach, designing with an allowable state of stress corresponding to a 2% strain is a safe and correct design value to use.

Hence a 'design tensile strength at 2% strain' is the correct value to use when comparing products and when executing the design.

Peak tensile strength is not relevant for design purposes, and it should not be included in tender specification documents as this could lead to the selection of an inappropriate product resulting in failure of the structure.

Having the option to choose, a geogrid with a higher resistance at low strain but with a lower resistance at peak is far better than a geogrid with a higher peak value but a lower strength at low strains.

Reference:
BS 8006: 1995: "Code of practice for Strengthened/reinforced soils and other fills"

0799-CPD-25

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TENAX LBO 370 SERIES 'RAILGRID'

LARGE AGGREGATE / BALLAST SUBGRADE IMPROVEMENT GEOGRID

FULLY TESTED, DOCUMENTED AND CERTIFIED TO RECOGNISED INTERNATIONAL TEST STANDARDS

TENAX **LBO SAMP**

Type: **370**

Bi-oriented geogrids

TENAX **LBO 370 SAMP** are polypropylene integral geogrids manufactured from a unique process of extrusion and biaxial orientation to enhance the tensile stiffness. They have been shown to increase the design life of projects by improving performance of the reinforced granular bases and reducing differential settlement. A larger than average aperture size and rib thickness combined with the high junction strength creates optimal interlock and confinement with coarse aggregate. The 65x65mm apertures allow for a wider range of granular material to be selected especially those materials having large granular stones thereby offering the potential for significant cost savings.

TENAX **LBO 370 SAMP** geogrids feature consistently high tensile strength and modulus, excellent resistance to construction damage and environmental exposure. Furthermore, the geometry of these geogrids allow for strong mechanical interlock to take place in applications such as ballast stiffening of railway construction layers.

Typical applications

Ballast reinforcement, load transfer platforms (LTPs), crane / piling platforms and access routes, HGV areas, airport runways, port loading areas and temporary or permanent access roads e.g. wind farm access roads.

PHYSICAL CHARACTERISTICS	TEST METHOD	DATA
STRUCTURE		BI-ORIENTED GEOGRIDS
MESH TYPE		SQUARE APERTURES
STANDARD COLOR		BLACK
POLYMER TYPE		POLYPROPYLENE
CARBON BLACK CONTENT	ASTM D4218	2.0%
PACKAGING	ISO 10320	ROLLS IN POLYETHYLENE BAGS WITH I.D. LABEL

DIMENSIONAL CHARACTERISTICS	TEST METHOD	UNIT	LBO 370 SAMP	Notes
MESH SIZE MD		mm	65	b,d,e
MESH SIZE CMD		mm	65	b,d,e
MASS PER UNIT AREA	ISO 9864	g/m²	370	b
ROLL WIDTH		m	4.3	b
ROLL LENGTH		m	70.0	b
ROLL DIAMETER		m	0.41	b
ROLL VOLUME		m³	0.74	b
GROSS ROLL WEIGHT		kg	118.6	b

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	LBO 370 SAMP		Notes
			MD	CMD	
TENSILE STRENGTH AT 2% STRAIN	ISO 10319	kN/m	11.0	12.0	b,c,d
PEAK TENSILE STRENGTH	ISO 10319	kN/m	30.0	30.0	a,c,d
YIELD POINT ELONGATION	ISO 10319	%	12.0	12.0	b,c,d
JUNCTION STRENGTH	GRI GG2	kN/m	29.0	29.0	b,d
RESISTANCE TO ABRASION	ISO 13427	%	>94		b,d,f

NOTES:
a) 95% lower confidence limit values, ISO 2602
b) Typical values
c) Tests performed using extensometers
d) MD: machine direction (longitudinal to the roll)
CMD: transversal direction (across roll width)
e) Mesh Size Tolerance: ±3 mm
f) independent Testing by BTTG (U.K.)

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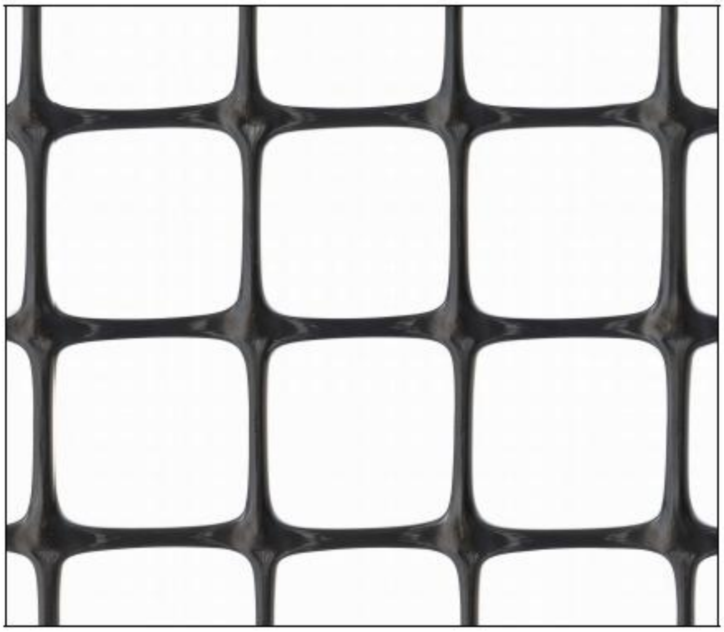
TENAX
LBO 370 SAMP



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TENAX 3D XL BIAXIAL GEOGRID

PAVEMENT SUB-GRADE IMPROVEMENT REINFORCEMENT

FULLY TESTED, DOCUMENTED AND CERTIFIED TO RECOGNISED INTERNATIONAL TEST STANDARDS

TENAX **3D Grid**

Type: **XL**

Bi-oriented geogrids

TENAX **3DGrid XL** is manufactured from a unique extrusion technique resulting in a perforated polypropylene sheet that is specifically shaped in three directions (3D). This unique extrusion technique produces a particularly large concaved shaped rib thereby trapping stone particles within the large apertures and enhancing the interaction mechanism between geogrids and granular soils by restricting the horizontal movement of stone particles and preventing further displacements. This increase in interaction from the **3D Grids** enables consistent reductions in aggregate layer thickness.

Typical applications

Ground stabilisation and sub-base reinforcement for permanent roads, unpaved and temporary access roads, safe working platforms as well as piled platforms.

PHYSICAL CHARACTERISTICS	TEST METHOD	UNIT	DATA	NOTES
STRUCTURE			BI-ORIENTED GEOGRIDS	
MESH TYPE			QUADRANGULAR APERTURES	
STANDARD COLOR			BLACK	
POLYMER TYPE			POLYPROPYLENE	
CARBON BLACK CONTENT	ASTM D4218		2.0%	
PACKAGING	ISO 10320		ROLLS IN POLYETHYLENE BAGS WITH I.D. LABEL	

DIMENSIONAL CHARACTERISTICS	TEST METHOD	UNIT	3D Grid XL		NOTES
			MD	TD	
APERTURE SIZE		mm	55	55	a,c,d
RIB THICKNESS		mm	3.50	2.00	a,c,e
JUNCTION THICKNESS		mm	7.00		a
ROLL WIDTH		m	4.0		a
ROLL LENGTH		m	50		

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	3D Grid XL		NOTES
			MD	TD	
STIFFNESS at 0.5 % STRAIN	ISO 10319	kN/m	900	600	a,b,c
JUNCTION EFFICIENCY	GRI-GG2	%	90	100	a,c
RESISTANCE TO INSTALLATION DAMAGE	ISO 10722-1	%	100	95	a
RESISTANCE TO CHEMICAL DEGRADATION	EN 14030	%	100		a
RESISTANCE TO WEATHERING	EN 12224	%	100		a
APPARENT COEFFICIENT OF FRICTION SOIL/GEOSYNTHETICS (μs/gsy)	EN 13738		1.20		a,f

NOTES:
a) Typical values
b) Tests performed using extensometers
c) MD: machine direction (longitudinal to the roll) - TD: transverse direction (across roll width)
d) Aperture Tolerance: ± 5 mm
e) Thickness Tolerance: - 5%
f) Pullout testing in accordance to EN 13738 using special apparatus that measures the force required to pull-out a geogrids that is fully embedded in soil. Vertical stress 10 kPa

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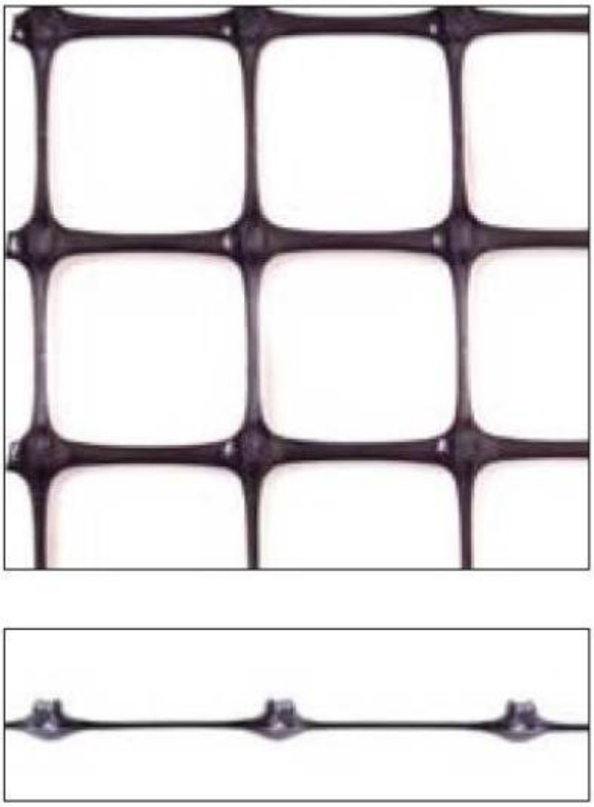
Typical Characteristics

TENAX 3D Grid XL



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TENAX 3D MS BIAXIAL GEOGRID

PAVEMENT SUB-GRADE IMPROVEMENT REINFORCEMENT

FULLY TESTED, DOCUMENTED AND CERTIFIED TO RECOGNISED INTERNATIONAL TEST STANDARDS

TENAX **3D Grid**

Type: **MS**

Bi-oriented geogrids

TENAX **3D Grid MS** are polypropylene geogrids especially designed for soil stabilization and reinforcement applications.
The **3D Grid MS** geogrids are manufactured from a unique process of extrusion and biaxial orientation to enhance their tensile properties. TENAX **3D Grid MS** features consistently high tensile strength and modulus, excellent resistance to construction damages and environmental exposure. Furthermore, the geometry of the TENAX **3D Grid MS** allows strong mechanical interlock with the soil being reinforced.

Typical applications

Base reinforcement; reduction of required structural fill; load distribution; reduction of mud pumping; subgrade stabilization; embankment stabilization; slope reinforcement; erosion control mattresses.

PHYSICAL CHARACTERISTICS	TEST METHOD	UNIT	DATA	NOTES
STRUCTURE			LAYERS of BI-ORIENTED GEOGRIDS EXTRUDED TOGETHER	
MESH TYPE			RECTANGULAR APERTURES	
STANDARD COLOR			BLACK	
POLYMER TYPE			POLYPROPYLENE	
CARBON BLACK CONTENT	ASTM D4218		2.0%	
PACKAGING	ISO 10320		ROLLS IN POLYETHYLENE BAGS WITH I.D. LABEL	

DIMENSIONAL CHARACTERISTICS	TEST METHOD	UNIT	3D Grid MS	NOTES
APERTURE SIZE MD		mm	53	a,c,d
APERTURE SIZE TD		mm	38	a,c,d
THICKNESS at 2kPa	ISO 9893	mm	5.20	a,e
ROLL WIDTH		m	4.0	
ROLL LENGTH		m	50.0	

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	3D Grid MS		NOTES
			MD	TD	
STIFFNESS at 0.5 % STRAIN	ISO 10319	kN/m	250	450	a,b,c
RESISTANCE TO INSTALLATION DAMAGE	ISO 10722-1	%	100	95	a
RESISTANCE TO CHEMICAL DEGRADATION	EN 14030	%	100	100	a
RESISTANCE TO WEATHERING	EN 12224	%	100		a

NOTES:
a) Typical values
b) Tests performed using extensometers
c) MD: machine direction (longitudinal to the roll)
TD: transverse direction (across roll width)
d) Aperture tolerance: ± 3 mm
e) Thickness tolerance: ± 0.50 mm

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