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SPECIFICATION, DESIGN & INSTALLATION GUIDE

STANDARD GEOTEXTILE

SDI/GT Iss Apr 2024

CONTENTS

INSTALLATION

1. Excavate ground to the required formation level, clearing the area of any large angular objects such as stones and tree stumps, while ruts and sharp undulations in excess of 100mm should be levelled. Underground service pipes and cables should be installed beforehand to avoid excavation and damage to the Terram Geotextile layers.

2. Terram Geotextile is supplied rolled onto cardboard tubes and wrapped in polyethylene sheeting to protect against excessive UV (ultra violet) radiation exposure from sunlight. The rolls can be stacked up to 4 rows high on a dry, clean, stable and level surface. Mechanical lifting equipment such as a spreader bar can be used to deploy rolls of Terram Geotextiles. Terram Geotextiles should be installed and covered with fill as soon as possible but less than 30 days once the outer packaging has been removed.

3. Unroll Terram Geotextile onto the prepared subgrade removing any wrinkles or folds. Terram Geotextile can be held in place with a small pile of fill material every 3m with a minimum of 300mm overlap at any joints. Greater overlaps are needed for softer soils (CBR < 5%) and mechanical joints such as stitching may be more economical in very soft ground. See design section & Terram Geotextile jointing guide for more details.

*

* Images courtesy of Freudenberg Performance Materials

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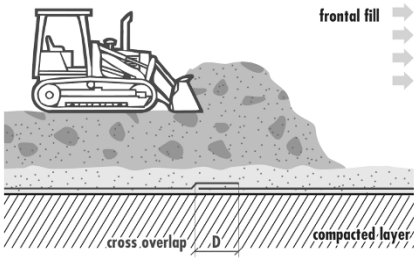
INSTALLATION continued

4. Terram Geotextile can be cut using sharp shears or a rotary disc cutter/angle grinder. Rolls can be trimmed before installation with a cut-off saw but suitable safety precautions should be taken including wearing personal protective equipment.

*

5. Prior to placement of the fill material, Terram Geotextile should be inspected for any damage and can be repaired with a patch extending a minimum of 500 mm beyond the edge of the damaged area and the outside edge of the patch.

6. Vehicles must not be allowed to run directly on exposed Terram Geotextile. Construction vehicles should be restricted to areas which have already been covered with aggregate compacted to a minimum depth of 200mm.



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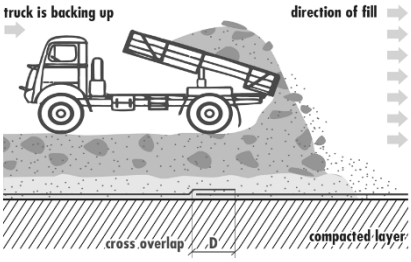
7. The fill material should generally be a well-graded granular aggregate such as DoT type 1 or 3 matched to the geogrid aperture size to achieve optimum granular interlock. #

8. The granular fill material should be installed and compacted in a front spreading method; bladed forward onto the Terram Geotextile layer and graded down to the required uncompacted depth. It is typical practise to install fill material in layers which are compacted to 150mm using a vibratory roller. On soft subgrades it is prudent to place at least 300mm of lightly compacted material in one lift (500mm on exceptionally soft soils) before overlaying with a thinner layer of well compacted material.



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For further guidance regarding subbase materials see design notes and material specification sections.

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Jointing

Jointing TERRAM Geotextiles can be achieved by overlapping, sewing, stapling or bonding. Overlapping adjacent or subsequent rolls is the most-frequently-used method. However, there are situations when a more-substantial seam is required on the grounds of economy (reducing overlap waste), providing a degree of tensile strength continuity, or where the textile could move if a simple overlap was used. Sewing is generally the most satisfactory method in these cases.

Overlapping

For sub-base/subgrade separation, the overlap width can vary between 300mm and 1000mm depending upon subgrade strength, profile, and the stress anticipated at the overlap. 300mm is generally adequate for a firm, level subgrade but 1000mm may be necessary on a soft, uneven subgrade (see Fig 1).

Fig 1

Overlaps should be formed so that sub-base is spread over, not against, the leading edge of the top textile. Care must be taken to avoid undue stress of the overlap if displacement is to be avoided.

If high-strength grades are to be placed as filters beneath large rock e.g. coastal and river defences, then the overlap should have a minimum width equal to the diameter of the rock.

Sewn joints

Sewn joints can be formed with edges face to face -prayer seam (Fig 2) or with a lapped J seam (Fig 3),each with either a single or double stitch line depending upon the strength required. Polyester oraramid sewing thread can be used.

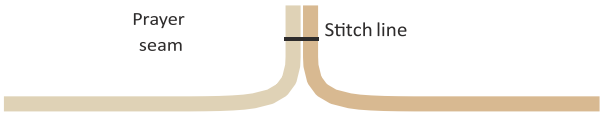

Fig 2

The single-seam prayer joint is satisfactory for most Terram Geotextile grades since it produces a strength equivalent to about 75% of the textile's strength.

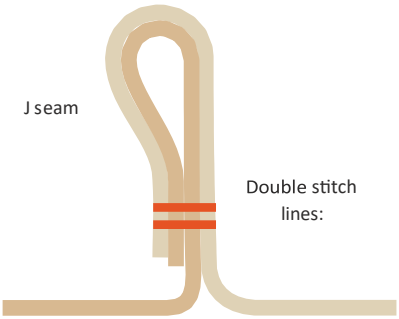

Fig 3

Stitch lines should be parallel to the edge, with the outer line at the selvedge inside edge and the stitch frequency per inch of the outer line maximised for optimum results.

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It is advisable to use the sewn joints where sand is the trafficked surface above the textile otherwise it is possible for the sand to migrate through a simple overlap. Ensure that the seam stand up faces down.

Portable hand-operated battery-powered stitching machines are generally used with Metric 9 polyesterthread, providing a double-thread-feed chain, singlestitch generally set to provide 16 stitches per 100mm. Metric 25 polyester thread can be used with lightweight Geotextiles e.g. Terram T1500 and below.

Aramid thread (around 420 tex) is used to form high-strength sewn joints. These should ideally be sample and tested for performance. It is also worth noting that factory-produced seams, using more robust sewing equipment and under more ideal processing conditions, are likely to produce more superior results than on-site sewing.

Portable, electrically-powered, sewing machines(mains/ battery) are obtainable from:

J & B Sewing Machine Co Ltd. Curlew Close,Queensway Meadows, Newport NP19 4SY

Tel:- +44 (0)1633 281555 Fax:- +44 (0)1633 281666

www.jbsewing.com

The sewing operation requires a short training period (2 hours) to master the technique and familiarise with the machine and a period of practice (1 day) to perfect the method. One operator plus two labourers are normally required.

Once set up the sewing machine operation can provide acceptable installation rates. However, construction site conditions can cause problems: a broken thread can lead to unthreading problems, dampness can cause the thread or needle to break,bobbins need to be covered to keep the yarn clean and dry (a plastic bag will suffice).

It is essential to keep machines in good order andclose liaison with the sewing machine manufacturer's representative is recommended.

Stapled joints

Terram Geotextiles can be joined by stapling, preferably using a lapped seam and an industrialstapling device. Seam strengths are likely to bemuch lower than those achievable by sewing.

A suitable stapler is obtainable from Rosenheim,Lancaster Fields Gateway, Crewe CW1 6FF

Tel: 01270 585959

Bonded joints

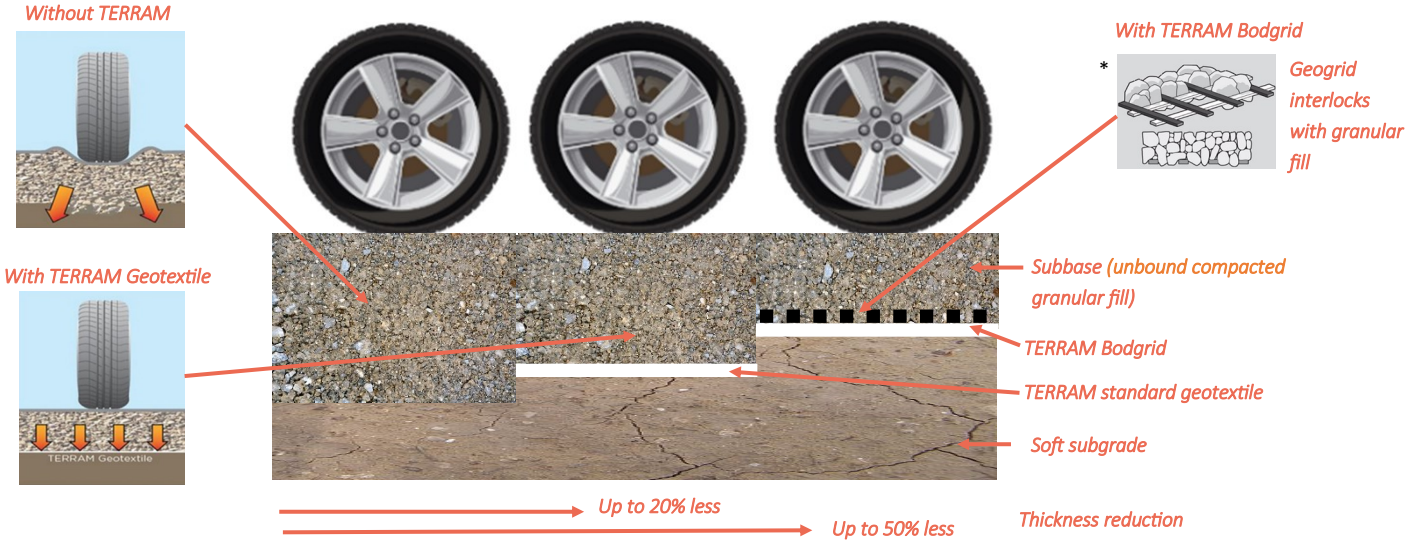
Joints can be bonded using adhesives, but this is not generally recommended for site-formed joints as the textile needs to be clean and dry, and joints formed on a firm base. However, a good seam strength can be achieved using a hot-melt adhesiveto form a simple 100mm wide overlap under controlled conditions.

The hot-melt adhesive should be applied in accordance with the manufacturer's instructions.Pressure must be applied to the joint in order to force the glue into the textile. Pressure may be applied by standing on the joint.

Hot-melt adhesives and applicator guns are obtainable from The Adhesive Company (AHS),Unit 2a, Hargreaves Road, Groundwell IndustrialEstate, Swindon, SN25 5AZ Tel: 01793 721112

Fiberweb Geosynthetics Ltd offers a wide range of geosynthetic products. For further information please call our Customer Services 01621 874200 or visit www.terram.com to download case studies, design guidance, installation procedures and product data sheets.

DESIGN—INTRODUCTION



Terram geotextiles have been extensively utilised in civil engineering projects worldwide for over 50 years. Their primary purpose is to provide effective separation between subgrade and subbase layers, significantly enhancing the lifespan of pavements. By preserving the integrity of the unbound granular fill layer, Terram geotextiles play a crucial role in preventing the intermixing and contamination of materials, thereby promoting long-term stability and performance. The inclusion of the Terram Bodgrid geocomposite within this range further reinforces the capabilities of Terram products in delivering reliable separation and reinforcement solutions for various civil engineering applications.

In occasions where a reinforcement solution is required, the inclusion of Terram Bodgrid geocomposite, which combines a biaxial geogrid and a Terram geotextile bonded together, can provide simultaneous functions of separation, filtration, and reinforcement. This inclusion can effectively reduce subbase thickness and extend the design life of the pavement foundation. The stiff biaxial geogrid within the geocomposite interlocks with the compacted granular fill, resulting in increased bearing capacity and shear resistance.

. The thickness and type of granular material used to form the subbase will depend on a number of factors including the following:

1. Strength of the underlying ground (subgrade) generally measured in CBR* %
2. Type of underlying ground (subgrade) E.g. clay/silt/sand/gravel/rock
3. Frequency and intensity of the construction traffic converted to ESA (Equivalent Standard Axles)
4. Water permeability of the underlying ground (subgrade) k measured in m/s
5. Presence of ground water and depth of water table below formation level
6. Finished surface; paved/unpaved and/or permeable/impermeable

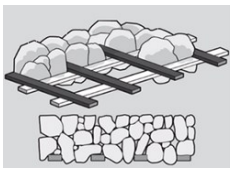
*California Bearing Ratio test

A comprehensive ground investigation survey with suitable testing is highly recommended to ensure the subbase is suitably strong and sufficiently durable for the anticipated use. **This design guide can be used for estimating ground conditions and assist with producing preliminary pavement foundation designs but it is not a substitute for site specific ground investigation works and a detailed pavement design by a suitably qualified civil engineer.**

* Images courtesy of Freudenberg Performance Materials

DESIGN continued

TABLE 1 MINIMUM SUBBASE THICKNESS (Tx) WITH GEOTEXTILE <60kN (6Tn) axle



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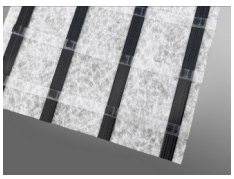


TERRAM Bodgrid Geocomposite

SUBGRADE CBR* %	Thickness (mm) #	Terram Bodgrid	Overlap (mm)
1	300	GC30	600
2	175	GC30	500
3	150	GC30	450
4	150	GC30	400
5+	150	GC30	300

TABLE 2 MINIMUM SUBBASE THICKNESS (Tx) WITHOUT GEOTEXTILE <60kN (6Tn)

TERRAM standard Geotextile

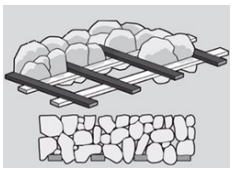
SUBGRADE CBR* %	Thickness (mm) #	Terram geotextile	Overlap (mm)
1	400	T2000	1000
2	200	T1500	800
3	175	T1000	600
4	175	T1000	450
5+	150	T1000	300

* California Bearing Ratio test

If construction traffic axle load exceeds 60kN (6 Tonnes) and/or the pavement is used as a site access haul road the minimum subbase thickness over TERRAM should be 200mm.

DESIGN continued

TABLE 3 MINIMUM SUBBASE THICKNESS (Tx) WITH GEOTEXTILE <100kN axle (10Tn)



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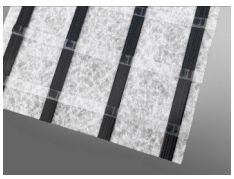

TERRAM Bodgrid Geocomposite

SUBGRADE CBR* %	Thickness (mm)	Terram Bodgrid	Overlap (mm)
1	400	GC30	600
2	250	GC30	500
3	250	GC30	450
4	200	GC30	400
5+	200	GC30	300

TABLE 4 MINIMUM SUBBASE THICKNESS (Tx) WITHOUT GEOTEXTILE <100kN axle (10Tn)

TERRAM standard Geotextile

SUBGRADE CBR* %	Thickness (mm) #	Terram Geotextile	Overlap (mm)
1	600	T2000	1000
2	350	T1500	800
3	300	T1000	600
4	200	T1000	450
5+	200	T1000	300

* California Bearing Ratio test

DESIGN continued

TABLE 5 FIELD GUIDANCE FOR ESTIMATING SUBGRADE STRENGTH

Consistency	Indicator		Strength		
	Tactile (feel)	Visual (observation)	Mechanical (test) SPT	CBR %	Cu Kn/SQM
Very Soft	Hand sample squeezes through fingers	Person standing will sink >75mm	<2	<1	<25
Soft	Easily moulded by finger pressure	Person walking sinks 50-70mm	2-4	~1	~25
Medium	Moulded by moderate finger pressure	Person walking sinks 25mm	4-8	1-2	25-40
Firm	Moulded by strong finger pressure	Utility truck ruts 10-25mm	8-15	2-4	40-75
Stiff	Cannot be moulded but can be indented by thumb	Loaded construction vehicle ruts by 25mm	15-30	4-6	75-150

TABLE 6 TYPICAL SOIL TYPES AND PROPERTIES

Soil Type	Plasticity Index %	CBR% Depth of water table below formation level		Typical range for coefficient of permeability	Infiltration
		>600mm	<600mm	K (m/s)	
Heavy clay	70 60 50 40	2 2 2.5 3	1 1.5 2 2	10^{-10} to 10^{-8}	No
Silty clay	30	5	3	10^{-9} to 10^{-8}	No
Sandy clay	20 10	6 7	4 5	10^{-9} to 10^{-6}	Partial
Silt	Non-plastic	2	1	10^{-8} to 10^{-6}	Partial
Poorly graded sand	Non-plastic	20	10	10^{-7} to 10^{-6}	Partial
Well graded sand	Non-plastic	40	15	10^{-6} to 10^{-4}	Total
Well graded sandy gravel	Non-plastic	60	20	10^{-5} to 10^{-3}	Total

CLAY

SILT

SANDY GRAVEL

This field guide is provided as an aid to assessing the mechanical stabilisation requirements in commonly encountered site conditions. TERRAM accepts no responsibility for any loss or damage resulting from the use of this guide.

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DESIGN NOTES

1. Minimum subbase thickness (Tx) can be selected from tables 1-4 with ground strength and permeability estimated from tables 5 and 6 in the absence of any site specific ground investigation report.

2. Minimum subbase thickness (Tx) are shown for preliminary pavement foundation designs and estimating purposes only, a detailed site specific design should be undertaken for construction.

3. Minimum subbase thickness (Tx) are based upon a maximum rut depth at the surface of 100mm, aggregate delivered by trucks with rubber road tyres with an overall weight of 20Tn, a maximum axle load of 10Tn and up to 1,000 ESA's of construction traffic required to build the subbase/pavement foundation only.

4. Minimum subbase thickness (Tx) is based upon a well graded compactable angular granular aggregate such as DoT type 1 SHW (Specification for Highways Works) clause 803. To ensure efficient granular interlock with the apertures of Terram Geotextile, the aggregate fill should have 50% less than 40mm maximum stone size and no more than 15% greater than 80mm. Other granular fill materials may be used (see table 8) but subbase thickness must be increased to allow for a reduction in shear strength.

5. If construction traffic axle load exceeds 100kN (10 Tonnes) an additional static bearing capacity check will be required to confirm if the subbase thickness is sufficient. The nomogram shown below can be used to check initial layer thickness of the subbase (unbound layer) for both unsurfaced and paved roads for axle loads up to 30 tonnes when using a Terram standard geotextile separation layer. For CBR values less than 3% this thickness can be reduced by up to 40% by specifying a layer of Terram Geotextile. Contact Terram for further advice on subbase layer thickness if construction traffic exceeds 1,000 ESA and axle loads over 100kN (10 Tonnes).

6. **The total subbase layer thickness (Tx) must be increased if the Terram Geotextile or standard geotextile layer is omitted.**

7. A Terram standard geotextile separation layer should be specified in accordance with BS8661:2019 with lower subgrade strength (CBR value) requiring a more robust grade.

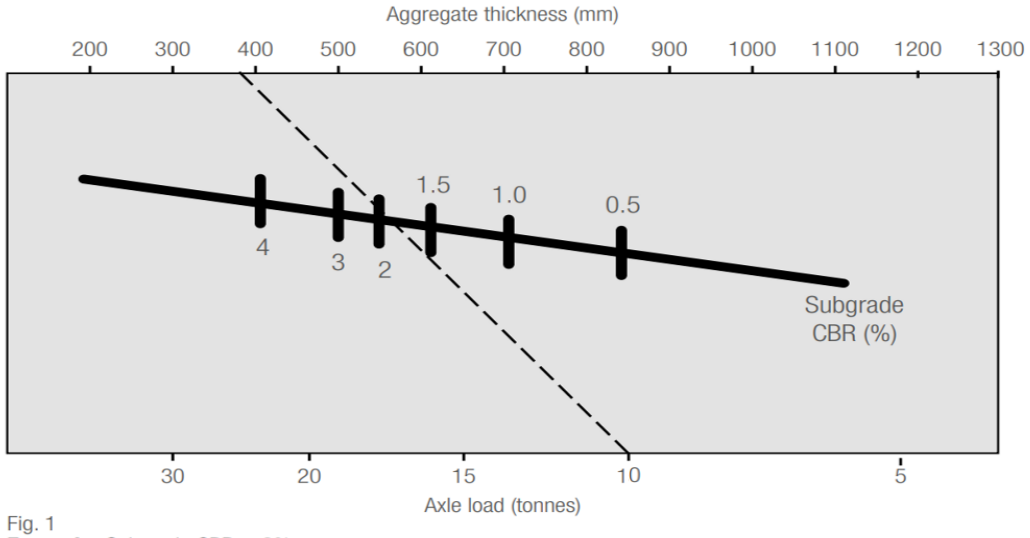


Fig. 1
Example: Subgrade CBR = 2%,
Axle load = 10 tonnes,
Stone thickness required = 350mm

BS 8661:2019

Geotextiles. Guidance for specification for basic separation and filtration functions

When it comes to the geotextile selection, **BS 8661 :2019** provides guidance on three specification profiles: 1, 2, and 3. While T1000 geotextiles are commonly preferred, higher strength geotextiles may be necessary for certain ground conditions and fill materials. In accordance with BS 8661, the three specification profiles (1, 2, and 3) correspond to T1000, T1500, and T2000 geotextiles, respectively. These higher strength geotextiles provide increased performance and suitability for specific ground conditions and fill materials.

It is crucial to consider the recommendations of **BS 8661:2019** when choosing the appropriate geotextile specification. This ensures that the selected geotextile aligns with the specific project requirements, enhancing stability and longevity. By following the guidance of BS 8661 and considering the specific ground conditions, fill materials, and construction requirements, suitable product grade and type could be selected and utilised.

Terram offer range of nonwoven needle-punched geotextiles that comply with **BS 8661 : 2019** guidelines and requirements. Figure 3 illustrates how Terram non-woven Geotextile aligns with the BS 8661 subbase profiles and requirements depending on the CBR and the maximum stone size.

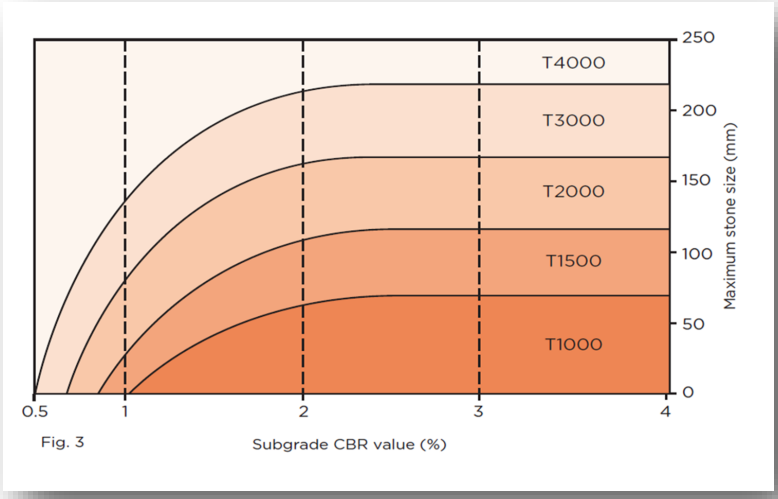


Fig. 3

BS 8661: 2019 SUMMARY

In summary, **BS 8661 : 2019** has got three specification profiles available. While TERRAM appreciates the preference for specifying T1000, it may not always be suitable for all ground conditions. In certain situations or when specific ground conditions and fill materials are present, a higher strength geotextile would be more appropriate.

These three specification profiles, namely 1, 2, and 3, can be roughly equated to T1000, T1500, and T2000. However, their selection is based on factors such as ground strength, fill size, and construction conditions. It is important to consider these variables in order to choose the most suitable geotextile for the project.

Hydraulic recommendations for separation with filtration

If the geotextile is required mainly for separation with filtration then the properties in BS 8661 Table 7 should be satisfied. Woven slit-film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) are not considered suitable for separation with filtration.

*

* **According to the BS 8661, Woven Geotextiles may not be suitable when (significant) filtration is required.**

MATERIAL SPECIFICATIONS

TABLE 7 Terram Geotextile & Bodgrid Geocomposite

TERRAM Bodgrid			
Grades	GC30	GC40	
Tensile strength kN BS EN ISO 10319	30	40	
Tensile elongation % BS EN ISO 10319	7	7	
Min. radial stiffness kN/m at 0.5% strain	725	975	
Min. radial stiffness kN/m at 2.0% strain	500	645	
Geogrid nominal aperture size mm	40 x 40		
Geogrid	Stiff polypropylene strips		
Geogrid joints	Laser welded		
Standard roll dimensions	4.8 m x 50 m long		
Geogrid and geotextile lamination method	Thermally bonded		
Material	Polypropylene		
Geotextile	Nonwoven, mechanically and thermally bonded		
TERRAM nonwoven standard Geotextile			
Grades	T1000	T2000	T3000
BS8661 Classification	1	2	3
Tensile strength kN/m	8.0	12.5	14.5
Elongation %	50	50	50
CBR puncture resistance kN	1.5	2.25	2.75
Standard roll dimensions	4.5m wide x 100m long		
Material	Polyolefin		

Bodgrid Geocomposite

Standard Geotextile

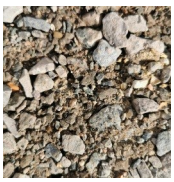
MATERIAL SPECIFICATIONS

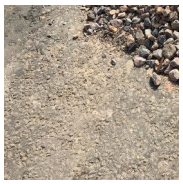
TABLE 8 typical granular fills (for subbase construction)

Description	Well graded granular DoT **Type 1**
Aggregate size range	0 to 63mm (<9% fines)
Grading to BS EN 13242	Gc 75/32 1/31.5 (**SHW Clause 803**)
Typical aggregate sources	Crushed quarried rock E.g. Limestone, Granite and Sandstone. Crushed concrete, slag, recycled aggregates.
Description	Well graded granular DoT **Type 2**
Aggregate size range	0 to 63mm (<9% fines)
Grading to BS EN 13242	Gc 75/35 1/31.5 (**SHW Clause 804**)
Typical aggregate sources	Crushed rock, concrete, slag, recycled aggregates, natural sand and crushed gravel
Description	**Permeable** open graded granular DoT **Type 3** (Type 1x)
Aggregate size range	0 to 80mm (<5% fines)
Grading to BS EN 13242	Gc 80/26 1/40 (**SHW Clause 805**)
Typical aggregate sources	Crushed rock, blast furnace slag and concrete
Description	Asphalt Arisings DoT **Type 4**
Aggregate size range	0 to 63mm (<9% fines)
Grading to BS EN 13242	Gc 75/32 1/31.5 (**SHW Clause 807**)
Typical aggregate sources	Recycled aggregates; asphalt arisings (road planings), crushed rock, crushed slag, crushed concrete
Description	**Clean drainage stone**, course graded aggregate type 4/20
Aggregate size range	0 to 40 mm (<5% fines)
Grading to BS EN 13242	Gc 90/15 4/20
Typical aggregate sources	Hard crushed rock

UNCOMPACTED *COMPACTED*

Type 1





Type 2

Type 3 (1x) - permeable

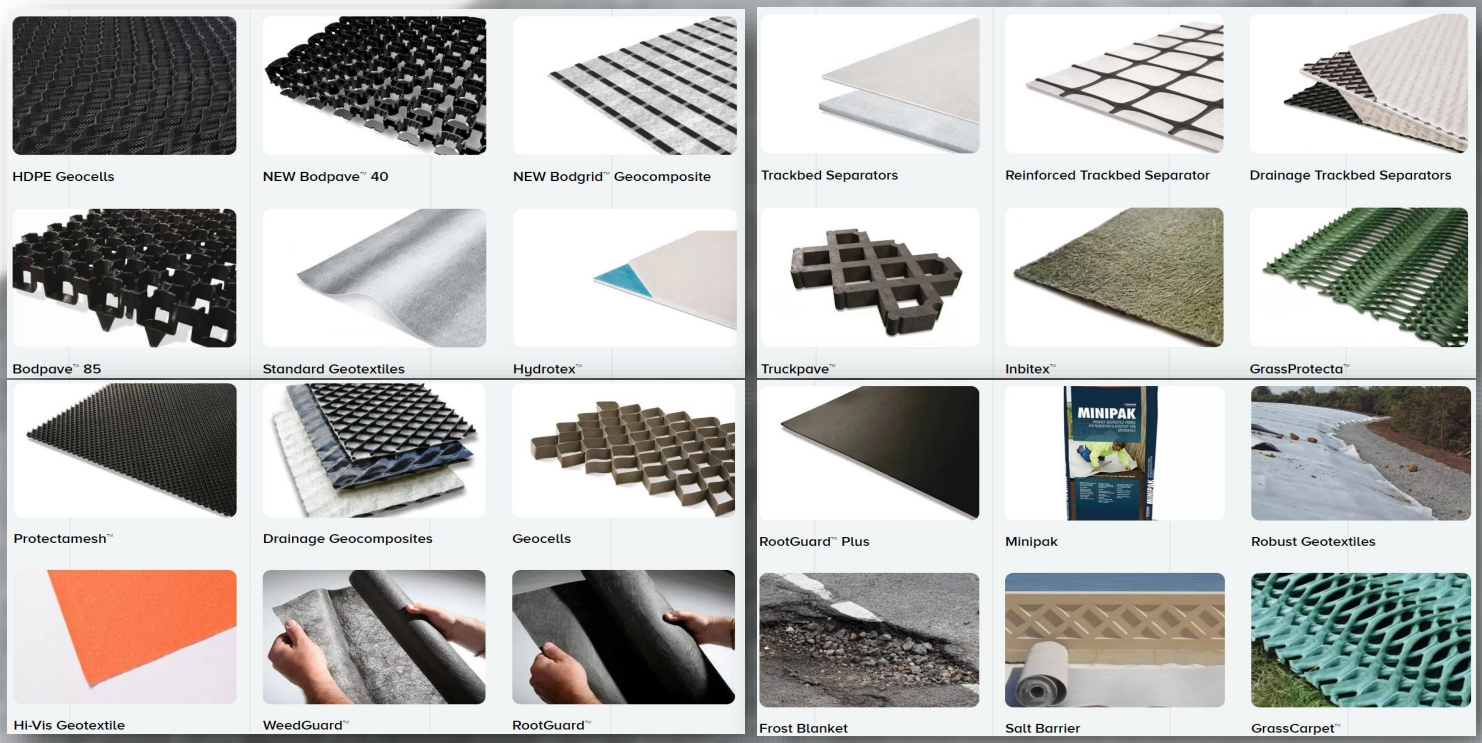
Type 4 - Asphalt arisings

CGA type 4/20 (Clean stone) - permeable

UNCOMPACTED *COMPACTED*

Other granular fill materials such as 50mm crusher run and 40mm scalpings may be suitable for subbase construction but an increase in thickness will be required due to their poorer grading distribution and reduced load-bearing capacity compared to a well graded material like DoT Type 1.

TERRAM Product Range



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