*

CONTENTS

* Images courtesy of Freudenberg Performance Materials

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 layers.

2. Terram 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. The edges of Terram Bodgrid can be sharp; protective safety gloves should be worn during any manual handling to prevent injury. Terram 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 Bodgrid geocomposite (white geotextile below, black geogrid above) onto the prepared subgrade removing any wrinkles or folds. Terram 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 jointing guide for more details.


*


*

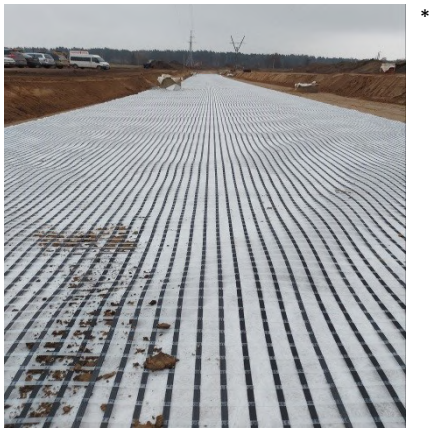
* Images courtesy of Freudenberg Performance Materials

INSTALLATION continued

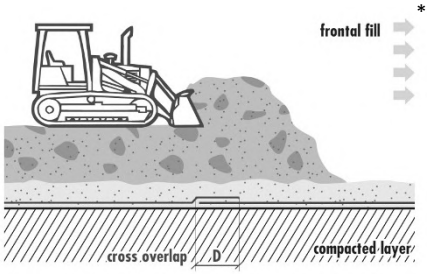
4. Terram Bodgrid can be cut using sharp shears or a rotary disc cutter/ angle grinder. Rolls can be trimmed before installation with a cut-off saw but suitable safety precautions should be taken including wearing personal protective equipment.

5. Prior to placement of the fill material, Terram 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.

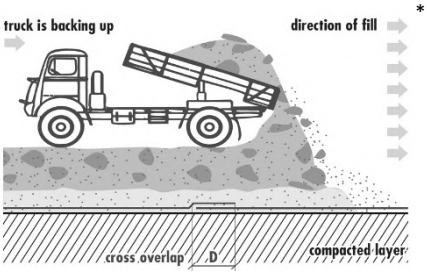
6. Vehicles must not be allowed to run directly on exposed Terram. Construction vehicles should be restricted to areas which have already been covered with aggregate compacted to a minimum depth of 200mm.

 *

7. The fill material should generally be a well-graded granular aggregate such as DoT type 1 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 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.


*

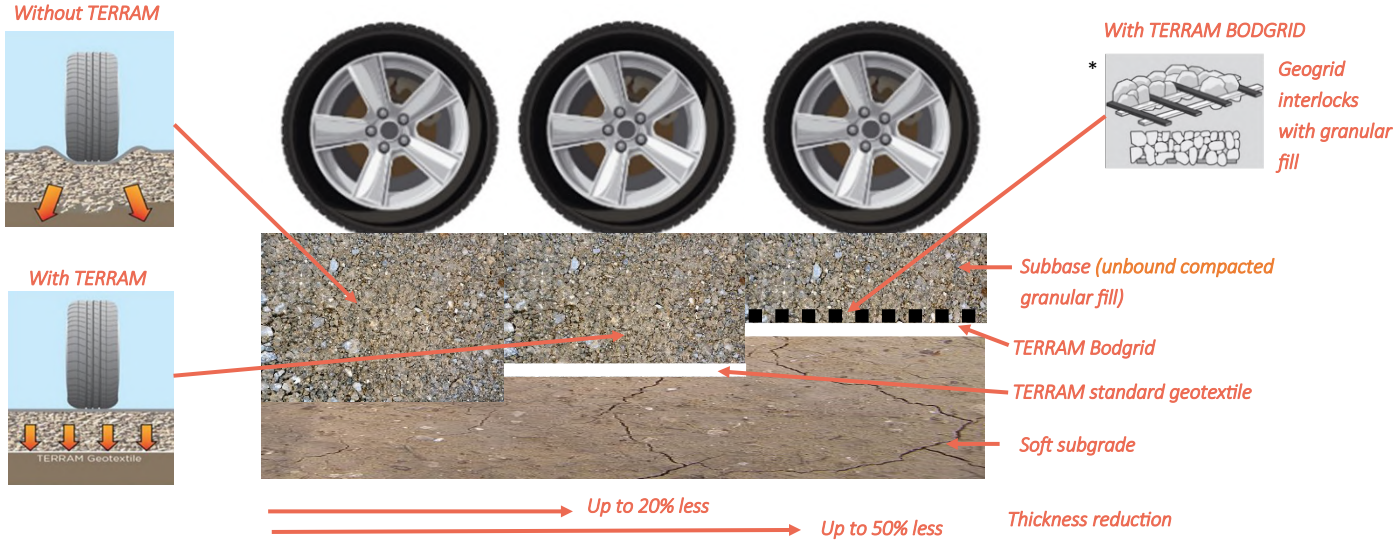
For further guidance regarding subbase materials see design notes and material specification sections.

 *

 *

* Images courtesy of Freudenberg Performance Materials

DESIGN—INTRODUCTION



Terram geotextiles have been used within worldwide civil engineering projects for over 50 years to separate sub-grade and subbase layers substantially increasing the life time of the pavement by maintaining the integrity of the unbound granular fill layer. Terram Bodgrid is a 3 in 1 stiff biaxial geogrid and nonwoven geotextile geocomposite providing separation, filtration **and reinforcement** functions **reducing subbase thickness** and **extending** the design **life** of the pavement foundation. The stiff biaxial geogrid effectively interlocks with the compacted granular fill increasing bearing capacity and shear resistance. The thickness and type of granular material used to form the sub-base 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

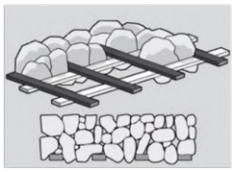
*California Bearing Ratio test

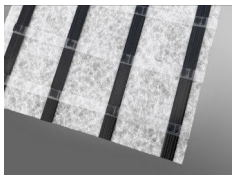
A comprehensive ground investigation survey with suitable testing is highly recommended to ensure the subbase is suitably strong and sufficiently durable for the anticipated use. **This design guide can be used for estimating ground conditions and assist with producing preliminary pavement foundation 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 BODGRID <60kN (6Tn) axle





TERRAM Bodgrid

SUBGRADE CBR* %	Thickness (mm) #	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 BODGRID <60kN (6Tn) axle

TERRAM standard geotextile

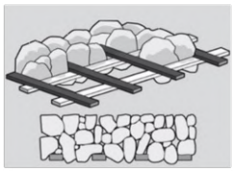
SUBGRADE CBR* %	Thickness (mm) #	Standard geotextile	Overlap (mm)
1	400	T2000	1000
2	200	T1500	800
3	175	T1000	600
4	175	T1000	450
5+	150	T1000	300

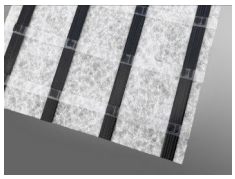
* California Bearing Ratio test

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 BODGRID <100kN (10Tn)





TERRAM Bodgrid

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

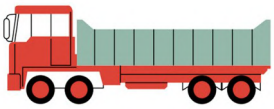
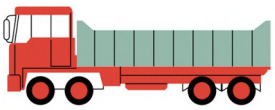


TABLE 4 MINIMUM SUBBASE THICKNESS (Tx) WITHOUT BODGRID <100kN axle (10Tn)

TERRAM standard geotextile

SUBGRADE CBR* %	Thickness (mm) #	Standard 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.

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 Bodgrid, 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 Bodgrid. 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 Bodgrid 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.

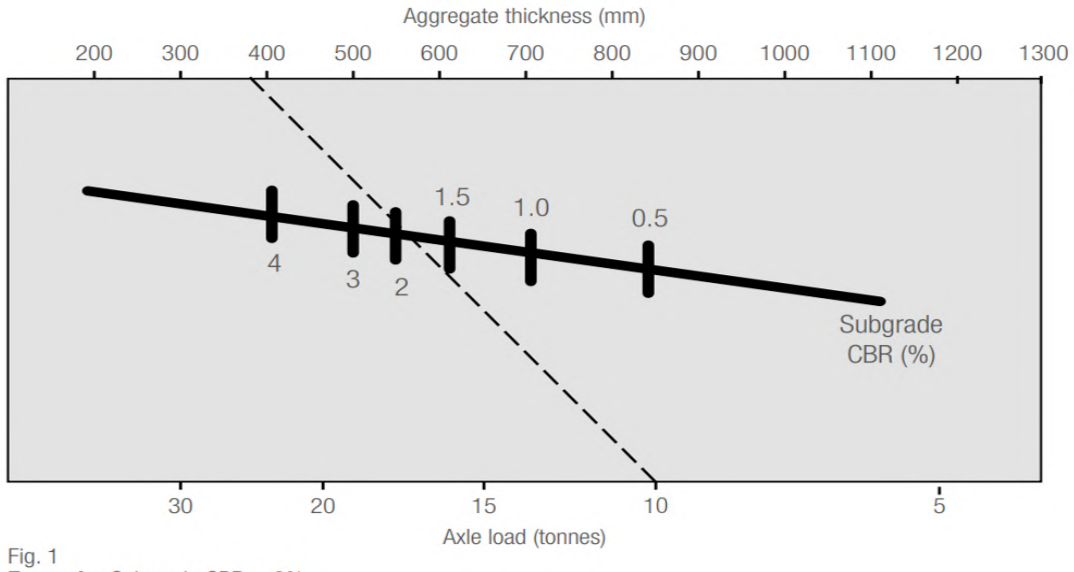
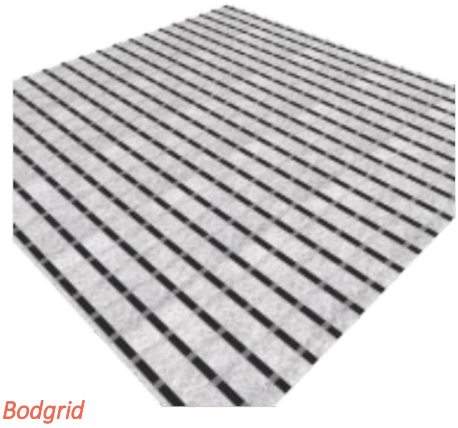


Fig. 1
Example: Subgrade CBR = 2%,
Axle load = 10 tonnes,
Stone thickness required = 350mm

MATERIAL SPECIFICATIONS

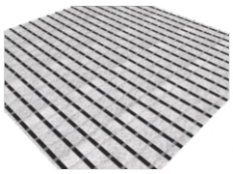
TABLE 7 Terram Bodgrid and standard geotextiles

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

Standard geotextile



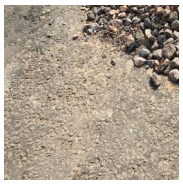
MATERIAL SPECIFICATIONS

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.