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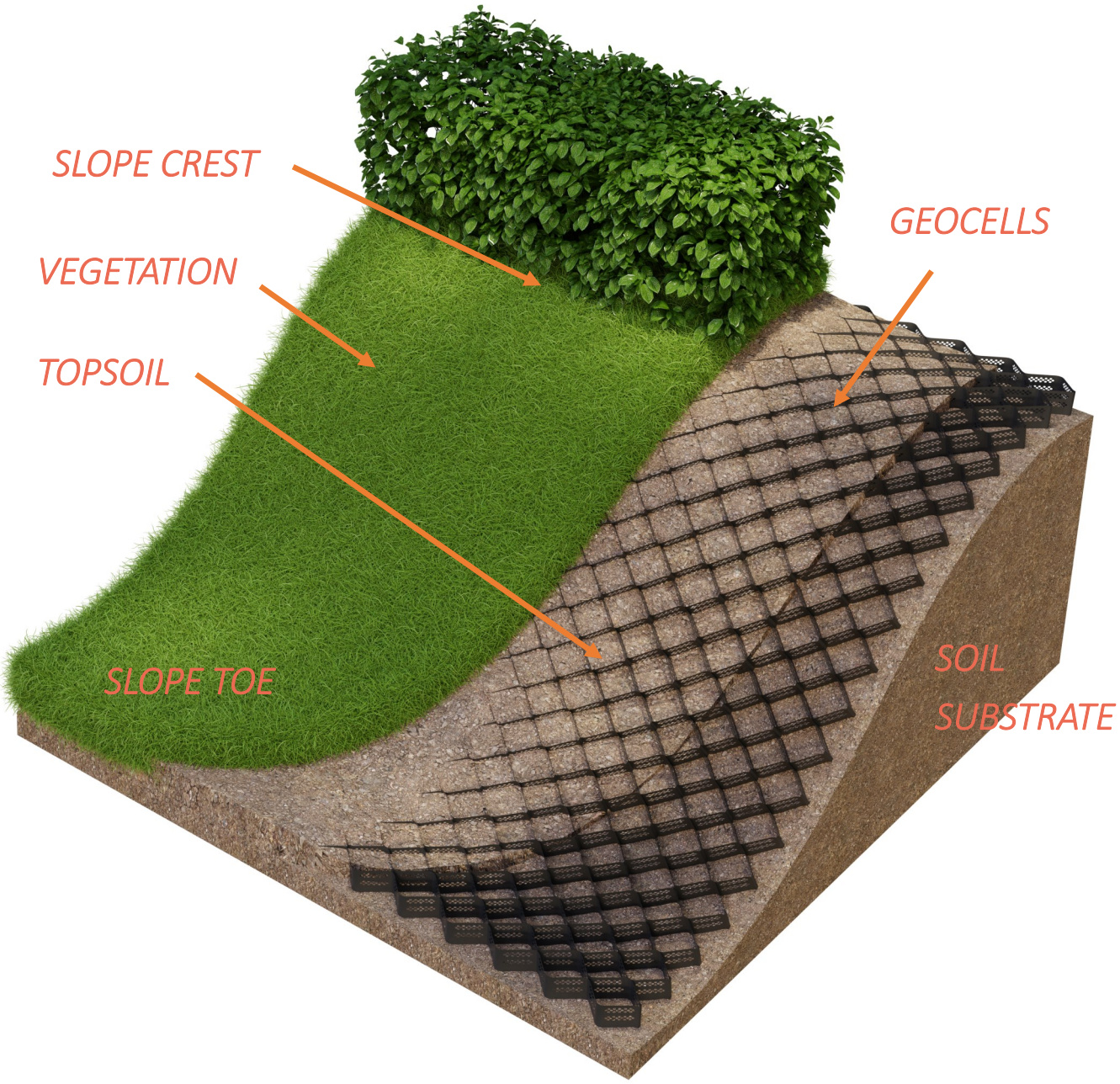
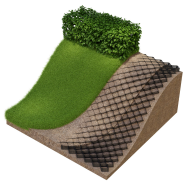

SLOPE CREST
VEGETATION
TOPSOIL
GEOCELLS
SLOPE TOE
SOIL
SUBSTRATE



INSTALLATION

1. Ensure that the slope is free from buried services, surface vegetation and shaped to achieve a generally even gradient. If required excavate anchor trenches a minimum 300mm (1') wide x 300mm (1') deep and set back a minimum of 600mm (2') from the edge of the slope crest. See design section for guidance on anchor trench size and TERRAM geocell support system.

2. For a non-vegetated finish or above an impermeable membrane, install a nonwoven TERRAM geotextile down the slope securing within anchor trenches, overlapping adjacent rolls by a minimum of 150mm (6"). Hold the Terram geotextile temporarily in place using pins or sandbags until the overlying TERRAM Geocell layer is installed and the anchor trenches backfilled.

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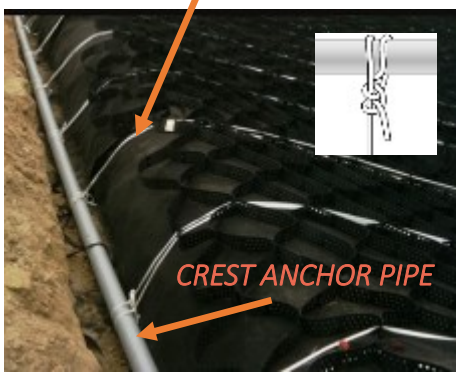
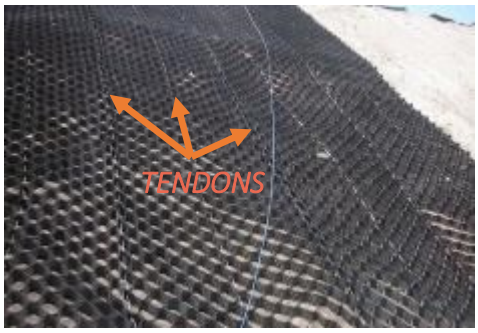
INSTALLATION CONTINUED

3. Cut &/or join TERRAM Geocell panels together to suit the length of the slope in advance. Prepare extended or trimmed panels at the top of the slope where possible. If required feed tendons through the central holes in the collapsed geocell panel at the required spacing and attach one end securely to a crest anchor system with a round turn and two half hitches knot. E.g. pipe or concrete blocks placed at the base of the anchor trench or earth anchors. Connect load transfer washers to the tendon every 3-6 cells(#) and at the end of the lowest panel. Pull the tendons down the slope to the toe, a single tendon should run the entire length of the slope.

4. Partially open the TERRAM Geocell panel(s) and fix every cell along the slope crest using steel U, J or helical pins with a full cell inside any anchor trench. Fully expand the TERRAM Geocell panel down the slope manually pulling into tension so that the cells are fully open. Fix or infill several cells around the perimeter to hold the panels in an open and fully expanded position. Backfill and compact soil within crest anchor trench.

Varies depending on slope gradient, substrate soil, infill material type, depth and grade of geocell. See design section for further guidance on suitable fixings, spacings and selection of correct TERRAM Geocell grade.





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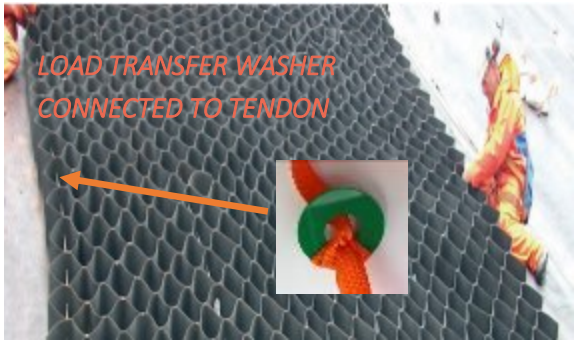
INSTALLATION CONTINUED

5. Fix J, U or helical steel pins within every other cell around the perimeter of the geocell panels and generally on an orthogonal grid between 0.6m and 1.5m(#) centres down and across the slope face. Alternatively if using tendons, connect load transfer washers every 3-6 cells (on the downward side of the cell wall) and at the base of the lowest panel if not previously attached.(#)

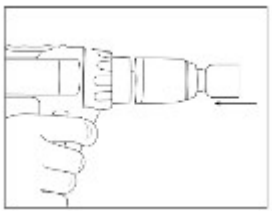


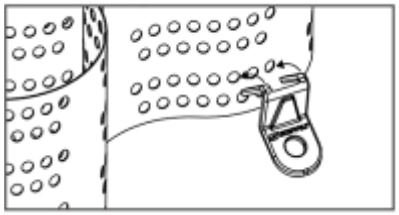
Varies depending on slope gradient, substrate soil, infill material type, depth and grade of geocell. See design section for further guidance on suitable fixings, spacings and selection of correct TERRAM Geocell grade.

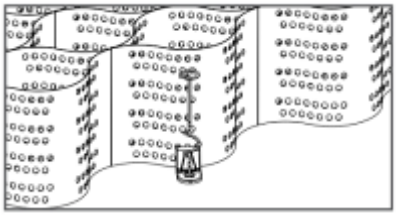
STEEL J PINS

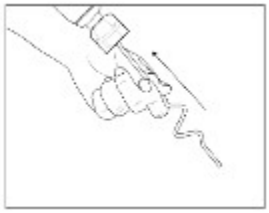
STEEL U PINS

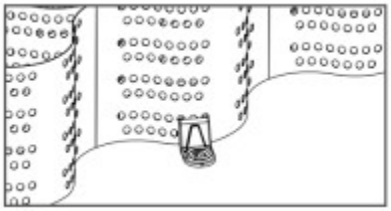
STEEL HELICAL PINS











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INSTALLATION CONTINUED

6. TERRAM Geocell panels are very flexible and can easily be installed around obstacles such as trees or structures. TERRAM HDPE Geocell panels can easily be cut by hand using safety cutting tools with a downward action close to the welded joints. Geocell panels can be joined together at every cell with galvanised staples installed with a pneumatic heavy duty stapling plier or UV stabilised nylon cable ties. Changes in gradient and curves can easily be accommodated by either allowing some variations in cell shapes and sizes (over or under expanding the cells) or cutting an entire panel at an angle and then joining to form a taper or L-shape. (See figures 1-4).

INSTALLATION CONTINUED

Installation of Geocell on Curved or irregular sufaces

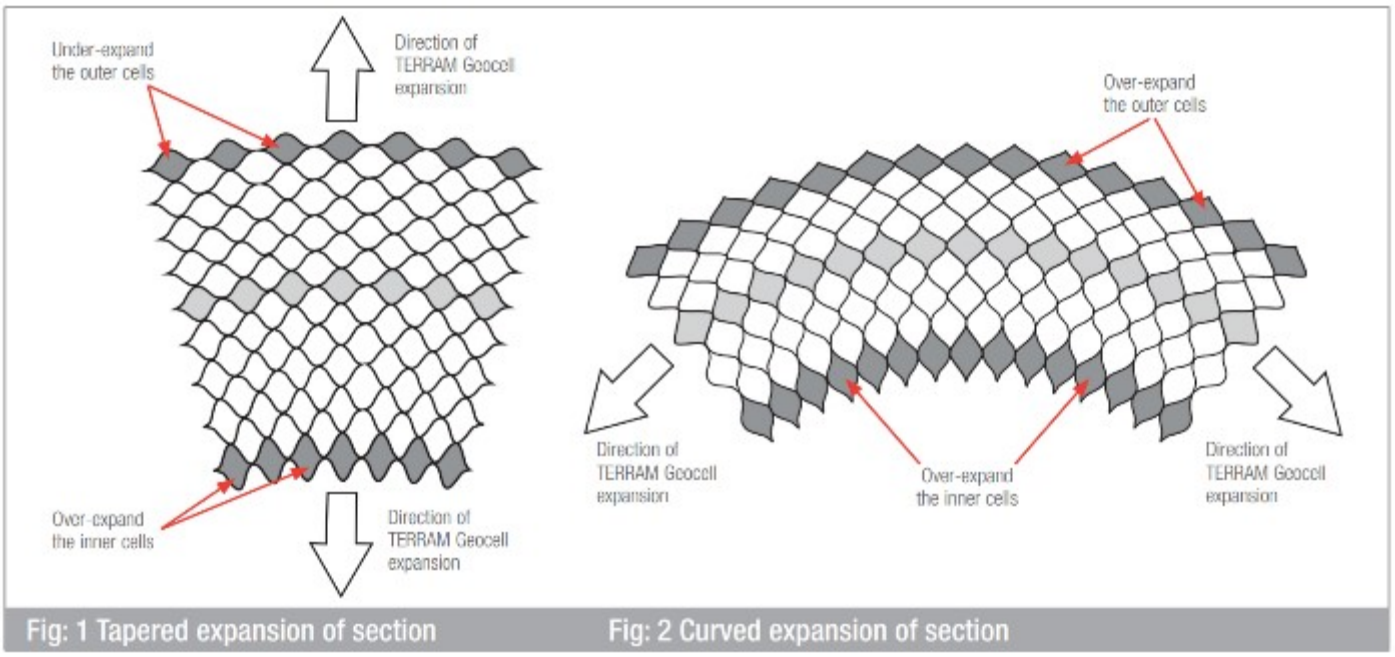


Fig: 1 Tapered expansion of section

Fig: 2 Curved expansion of section

Field cutting of TERRAM Geocell to form tapers and "L"-shapes

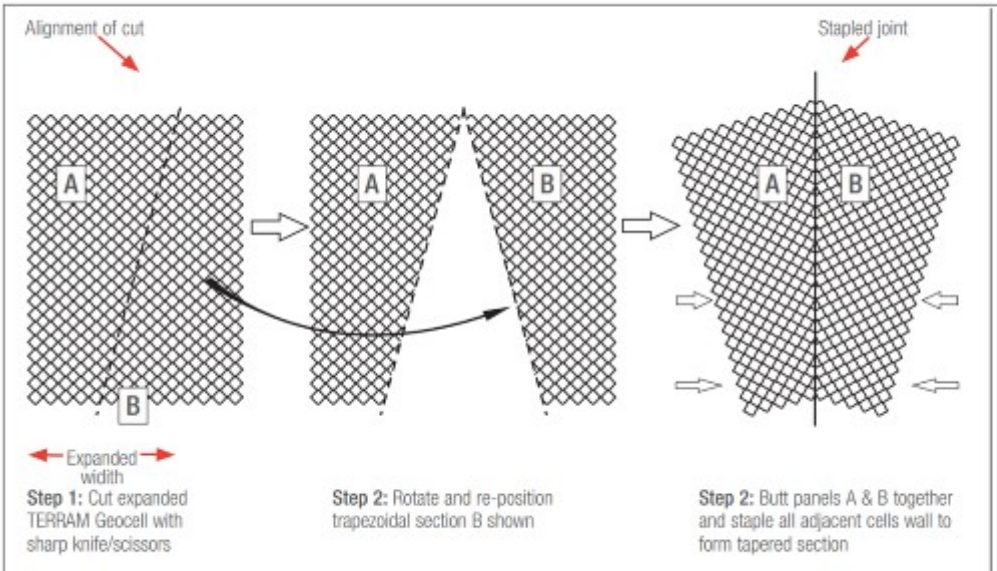


Fig: 3 Longitudinal cuts

Fig: 4 Transverse cuts

INSTALLATION CONTINUED

7. Once the TERRAM Geocell panels have been fixed and anchored in place, in-filling of the cells may be carried out. The infill material should be well graded and a good quality friable sandy topsoil where a vegetated finish is required. The infill material should be carefully placed within the cells in a uniform manner ensuring there are no localised areas which are overloaded. Placement may be by mechanical or manual means preferably commencing at the crest (top) of the slope and progressing downwards. The final depth and compaction of the fill material should be controlled manually, using hand tools to ensure the TERRAM Geocells are fully filled and covered by a uniform layer of overburden typically 25mm to 50mm to allow for settlement and compaction. Do not drop infill material from a height greater than 1m (3').

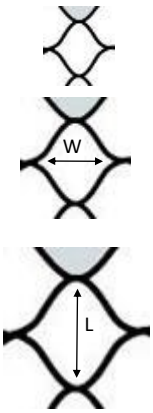
DESIGN—INTRODUCTION

TERRAM Geocell is a three dimensional geocellular confinement system designed for steep slopes, river banks, ditches, spillways, and other exposed areas that are often prone to damage caused by erosion due to wind or water.

A Terram Geocell system can help to prevent erosion by confining soils and aggregates within the cell structure. Seeded topsoil provides protection for less exposed areas which can be increased by introducing vegetation such as small shrubs. For greater protection granular and concrete infill materials can be used instead of a vegetated topsoil. The standard TERRAM Geocell system for erosion protection is normally suitable for use on slopes with an incline of up to 45 degrees (1:1 Slopes). If the slope angle is greater than 45 degrees additional considerations need to be given to the design of the cellular system, specification of the infill material and the anchorage support system. In these instances please contact TERRAM for further assessment. Terram Geocells are supplied flat packed and open to form a strong three dimensional geocellular structure.

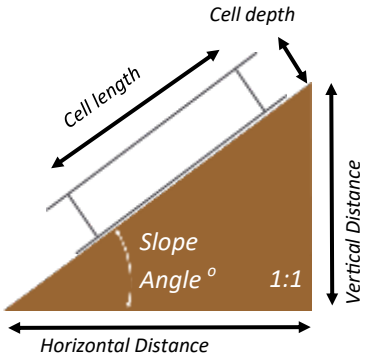
DESIGN CONTINUED

Table 1 is a conservative guide for the selection of a suitable grade and depth of TERRAM Geocell based on a typical well draining sandy friable top soil with a vegetated finish. As the slope gradient increases smaller size apertures yet deeper cells are required to maintain a minimum soil cover at the top of each cell. Steeper gradients may be achieved with infill materials with a higher natural angle of repose. Please note that the maximum slope gradient is ultimately determined by the natural angle of repose of the substrate soil and not the geocell grade or infill material. When forming a new or steeper slope a stability assessment should be carried out by a suitably qualified geotechnical engineer to determine the maximum slope gradient.



Cell aperture sizes (+/- 10%) mm		
Grade	Width W	Length L
TG356	259	224
TG445	320	287
TG712	508	475

TABLE 1 GEOCELL GRADE AND CELL DEPTH SELECTION vs MAXIMUM SLOPE GRADIENT



Maximum Slope Gradient (#)					Geocell grade and Cell depth (mm)			
Horizontal Distance	Vertical Distance	Ratio	Angle (°)	%	75 (3")	100 (4")	150 (6")	200 (8")
1	1	1:1	45	100	TG356	TG356	TG356	TG356
1	1	1:1	45	100		TG445	TG445	TG445
1.5	1	1.5:1	33	67	TG356	TG356	TG356	TG356
1.5	1	1.5:1	33	67		TG445	TG445	TG445
2	1	2:1	26	50	TG356	TG356	TG356	TG356
2	1	2:1	26	50		TG445	TG445	TG445
2.5	1	2.5:1	22	40	TG445	TG445	TG445	TG445
2.5	1	2.5:1	22	40		TG445	TG445	TG712
3	1	3:1	18	33.5	TG445	TG445	TG445	TG445
3	1	3:1	18	33.5		TG712	TG712	TG712
4+	1	4:1	<14	<25	TG445	TG445	TG445	TG445
4+	1	4:1	<14	<25	TG712	TG712	TG712	TG712

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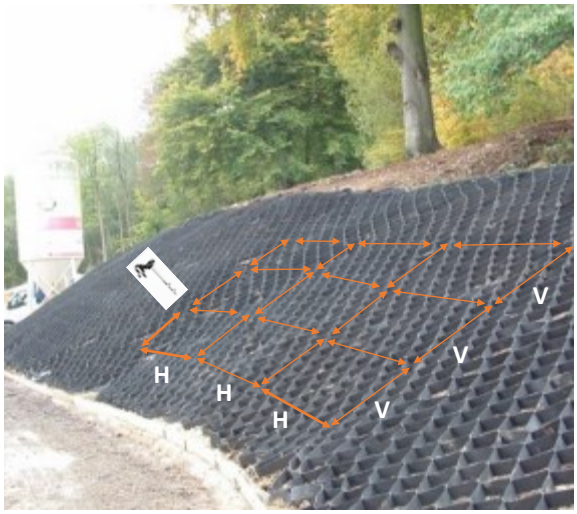
DESIGN CONTINUED

TABLE 2 FIXING PIN LAYOUT vs SLOPE GRADIENT AND CELL DEPTH

Maximum Slope Gradient (#)					Slope crest pins per m	Slope face pin layout (orthogonal grid)			
Horizontal Distance	Vertical Distance	Ratio	Angle (°)	%		Geocell depth mm	Pins per SQM	Vertical spacing m V	Horizontal spacing m H
1	1	1:1	45	100	4	75	1.2	0.9	0.9
1.5	1	1.5:1	33	67	4	100	1.5	0.8	0.8
						150	2.0	0.7	0.7
						200	2.8	0.6	0.6
2	1	2:1	26	50	4	75	1.0	1.0	1.0
						100	1.2	0.9	0.9
						150	1.5	0.8	0.8
						200	2.0	0.7	0.7
2.5	1	2.5:1	22	40	3	75	0.5	1.4	1.4
						100	0.7	1.2	1.2
						150	1.0	1.0	1.0
						200	1.0	1.0	1.0
3	1	3:1	18	33.5	3	All	0.4	1.5	1.5
4+	1	4:1	<14	<25	2				

Suitable fixings are required at regular intervals on the slope face and around all perimeters to hold the geocell panels open prior to infilling with soil, to avoid overstressing and prevent the filled geocell panels sliding down the slope. The slope gradient, substrate soil, slope length, loadings (snow), type of infill material, presence of an impermeable liner beneath, and cell depth will determine the most suitable anchorage method and spacings of fixings. Table 2 is a conservative guide for typical spacing of fixings pins for vegetated slopes up to 1:1 gradient using a well draining sandy friable top soil infill and the use of Gripple Cellgrip™ helical steel pins. Steeper gradients may be achieved with infill materials with a higher natural angle of repose but often require a crest anchorage system and the use of load transfer tendons (see table 3). Installing fixing pins in very hard ground can be problematic, initial site trials are recommended to confirm if the pins are suitable. Conventional steel J or U pins should be installed 2x depth of the geocell into the substrate (underlying ground).

FIXING PIN LAYOUT



DESIGN CONTINUED

TABLE 3 CREST ANCHORAGE & TENDON SPACING vs MAXIMUM SLOPE GRADIENT

Maximum Slope Gradient (#)					Crest Anchor trench size		Minimum distance slope crest to anchor trench m	Geocell depth mm	Maximum spacings mm		Minimum tendon break strength kg
Horizontal Distance	Vertical Distance	Ratio	Angle (°)	%	Width mm	Depth mm *			Vertical spacings washers W	Horizontal spacings tendons T	
1	1	1:1	45	100	500	1000	1.2	75	1000	800	2000
					500	1100	1.5	100	1000	600	2000
					500	1300	2.0	150	1000	500	2000
					500	1500	2.0	200	1000	400	2000
1.5	1	1.5:1	33	67	400	700	0.7	75	1000	700	1000
					400	800	0.8	100	1000	600	1000
					400	1000	1.0	150	1000	800	2000
					400	1200	1.0	200	1000	600	2000
2	1	2:1	26	50	400	650	0.6	75	1200	1700	1000
								100	1000	1300	1000
								150	1000	1000	1000
								200	1000	800	1000
2.5	1	2.5:1	22	40	300	300	0.6	All	1500	3000	1000
3+	1	3:1	18	33.5	N/A	N/A	N/A	All	N/A	N/A	N/A

If the geocells are to be installed on an impermeable liner, very hard ground or for practical safety reasons it may not be possible to install conventional fixings into the slope face. Table 3 is a conservative guide for the typical spacing of vertical load transfer tendons and washers for vegetated geocell protected slopes up to 1:1 gradient, up to 10m slope length using a well draining sandy friable top soil infill over an impermeable membrane with a crest anchorage system. Every tendon should be connected to "deadman" pipe (or concrete block) buried in an anchor trench at the slope crest (top). Anchor trenches can be omitted if suitable earth anchors such as Gripple Terra-Lock™ Anchors are installed and connected to the tendons at the slope crest. Longer slopes and steeper gradients with different infill materials may require load transfer tendons and washers at shorter spacings and/or higher strength tendons. Please contact Terram for site specific project advice on suitable anchorage system, anchor trench sizing, spacings of load transfer washers/tendons and earth anchors for different infill materials, longer and steeper slopes.

*Anchor trench depth can be reduced by 60% up to a minimum of 300mm with concrete backfill.

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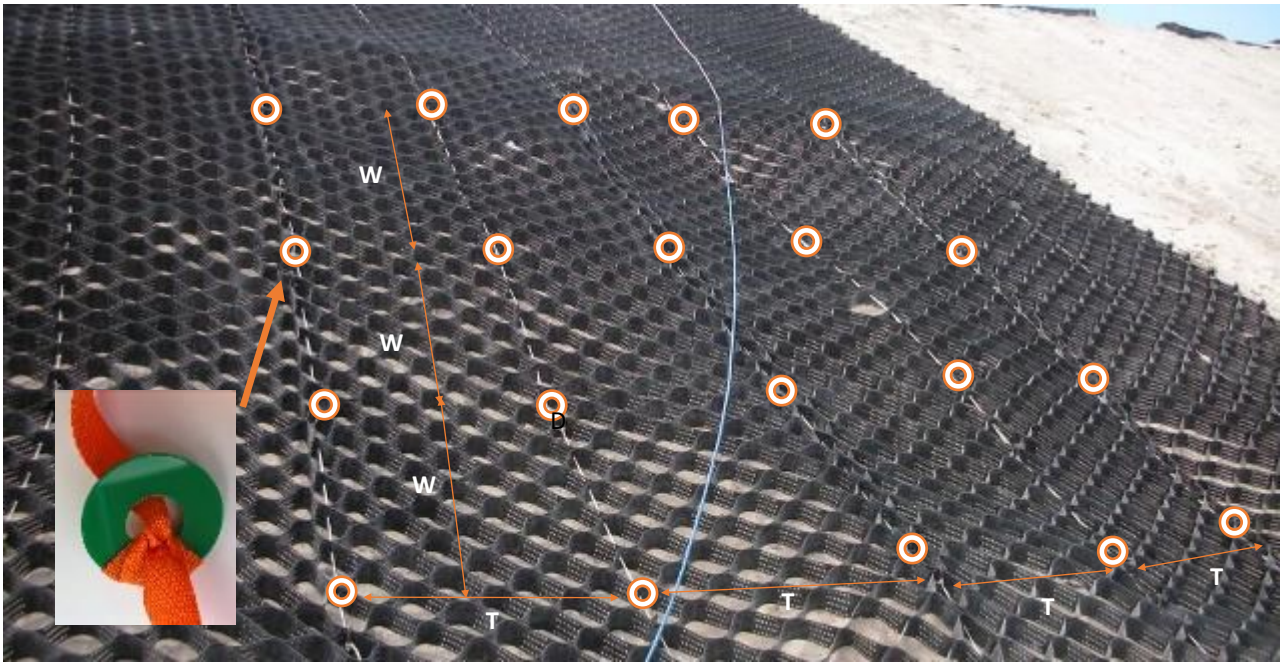
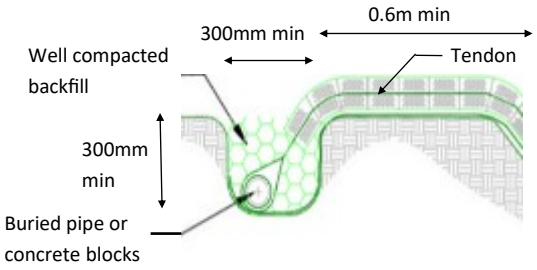
LOAD TRANSFER TENDONS AND WASHER SPACINGS



CREST ANCHOR TRENCH DETAIL



EXAMPLE CREST EARTH ANCHOR

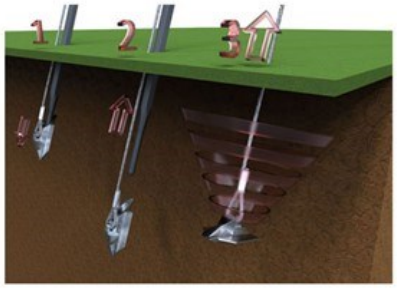


TABLE 4 FIELD GUIDANCE FOR ESTIMATING SUBGRADE SOIL STRENGTH

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 5 TYPICAL SOIL TYPES AND PROPERTIES

Soil Type	Plasticity Index %	CBR% Depth of water table below formation level		Typical soil shear friction angle (°)	Typical undrained shear strength (Cu Kn/SQM)
		>600mm	<600mm		
Heavy clay	70	2	1		25-65
	60	2	1.5		
	50	2.5	2		
	40	3	2		
Silty clay	30	5	3		75-125
Sandy clay	20	6	4		75-200
	10	7	5		
Silt	Non-plastic	2	1		25-40
Poorly graded sand	Non-plastic	20	10	30	
Well graded sand	Non-plastic	40	15	35	
Well graded sandy gravel	Non-plastic	60	20	38	

CLAY

SILT

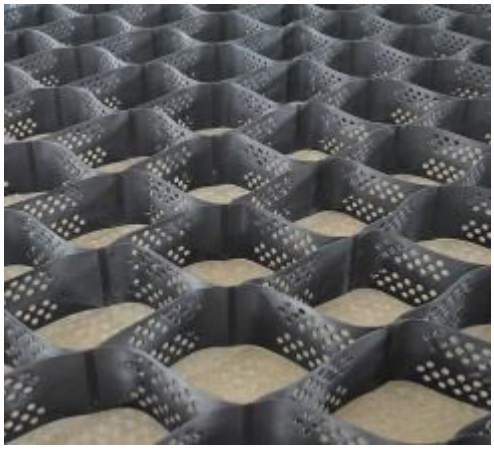
SANDY GRAVEL

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.

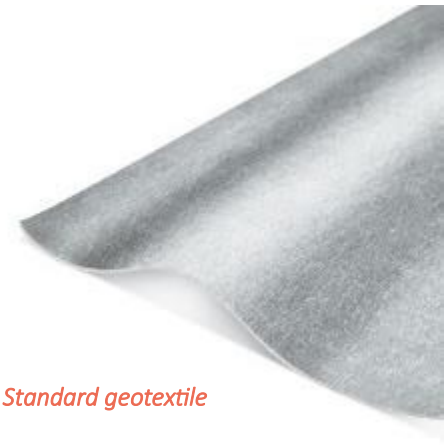
MATERIAL SPECIFICATIONS

TABLE 6 Terram products

TERRAM HDPE GEOCELLS					
Grades	TG330	TG356	TG445	TG660	TG712
Depths (mm)	75, 100, 125, 150, 200				
Cell width (mm)	244	259	320	488	508
Cell length (mm)	210	224	287	436	475
Panel width (m)	2.4	2.5	2.5	2.4	2.5
Panel length (m)	6.1	6.5	8.3	12.6	13.7
TERRAM nonwoven standard geotextile					
Grades	T1000	T1500	T2000	T3000	T4000
Tensile strength kN/m	8.5	12.5	14.5	18	22
CBR Puncture resistance kN	1.5	2.2	2.7	3.2	4.3
Standard roll dimensions (m)	4.5 x 100	4.5 x 100	4.5 x 100	4.5 x 100	4.5 x 50
TERRAM steel U-pins					
Type of steel	Mild				
Diameter mm	8				
Length mm	550				
Width mm	100				
Shape	U				



HDPE Geocell



Standard geotextile

Steel U-pins

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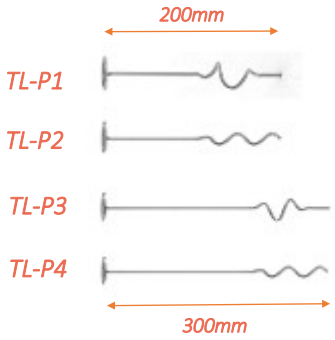
MATERIAL SPECIFICATIONS

TABLE 7 Accessories

Fixing pins				
Description	**Conventional mild steel J-pins**			
Geocell panel depth mm	Up to 100		Up to 200	
Diameter mm	8mm		10mm	
Long leg mm	300		500	
Short leg mm	100		100	
Width mm	50		50	
Description	**Gripple Cellgrip™ helical pins**			
Geocell panel depth mm	Up to 100mm		Up to 200mm	
Soft ground	TL-P1		TL-P3	
Hard ground	TL-P2		TL-P4	
Panel jointing				
Description	**Heavy duty galvanized steel metal staples**			
Size	25mm wide x 25mm long, 1.40mm x 1.60mm wire diameter			
Geocell panel depth mm	75	100	150	200
Number staples at each joint	2	3	4	5
Description	**UV resistant nylon cable ties**			
Dimension	500mm long x 4.8mm wide			
Minimum breaking load kg	22			
Load transfer tendon, washers and earth anchors				
Description	**High strength low extension woven polyester (nylon) tendons**			
Typical width mm	25mm tape or 10mm diameter rope			
Minimum breaking strength	1,000 kg		2,000 kg	
Description	**Load transfer washer (nylon or galvanized steel)**			
Dimensions	External diameter	Internal diameter	thickness	
	60mm	25mm	3mm	
Description	earth anchor and wire			
Minimum working load	1,250kg		1,250kg	
Gripple Terra-Lock Anchor	TL-A3		TL-A4	

Steel J-bar

Gripple Cellgrip™



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