GEOKRATA

SOIL STABILIZATION SYSTEMS

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ANTIEROSION PROTECTION OF SCARPS, DITCHES AND RESERVOIRS

TABOSS GEOKRATA

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ON-SCARP SYSTEM OPERATION MECHANISM

Implementation of TABOSSYSTEM® provides solutions for many problems related to soil maintenance and stability at steep scarps and slopes. Enclosing soil or aggregates inside cells increases their erosion resistance and protects against downward movement of particles. Soil with vegetation, soil from site excavations, aggregates, stones and concrete may be used to fill up the system. Well stabilized vegetation is considered as an effective and attractive form of protection of scarps and slopes that are exposed to moderate surface erosion. However, in case of continuous or concentrated land runoffs vegetable protection is often ineffective, as such runoffs result in leaching of progressive soil particles from the root-zone. Formation of flows and erosion drains leads to solifluction and ultimate destruction of protective layer.

In case of TABOSSYSTEM® implementation soil-filled cell walls form a series of micro-barriers spread across the protected scarp or slope. Normal formation of flow drains caused by concentrated land runoffs that cuts into the soil is therefore stopped by redirecting it towards the surface. Such mechanism decreases flow speed and in consequence lowers the land runoff erosive force. Using of TABOSS II GEONET (Factory Quality Control Certificate: CE 1488-CPD-0095; Technical Approval AT/2002-04-1216 — 6.02.2012r.) is strongly recommended for surface protection of scarps. This geonet is a version of the product made of notched or perforated tapes that enables uniform distribution of land runoffs. The soil with rooting vegetation is maintained and protected up to specific depths inside individual cells. The roots penetrate geotextiles to the natural ground base, forming integral reinforcement of the whole layer protecting the scarp surface. Using of the cell geonets to protect scarps in dry areas boosts the vegetation thanks to increased soil humidity at the near-surface zone.The natural tendency to slip the protective layer down is opposed by friction between the system contact layer and the soil base. Resistance to slide of the whole system, that also includes the geomembrane, can be limited significantly by a relatively low friction coefficient, typical for such geosynthetic materials.

FOR ANTIEROSION PROTECTION OF SCARPS AND MOUNDS TABOSS COMPANY RECOMMENDS:

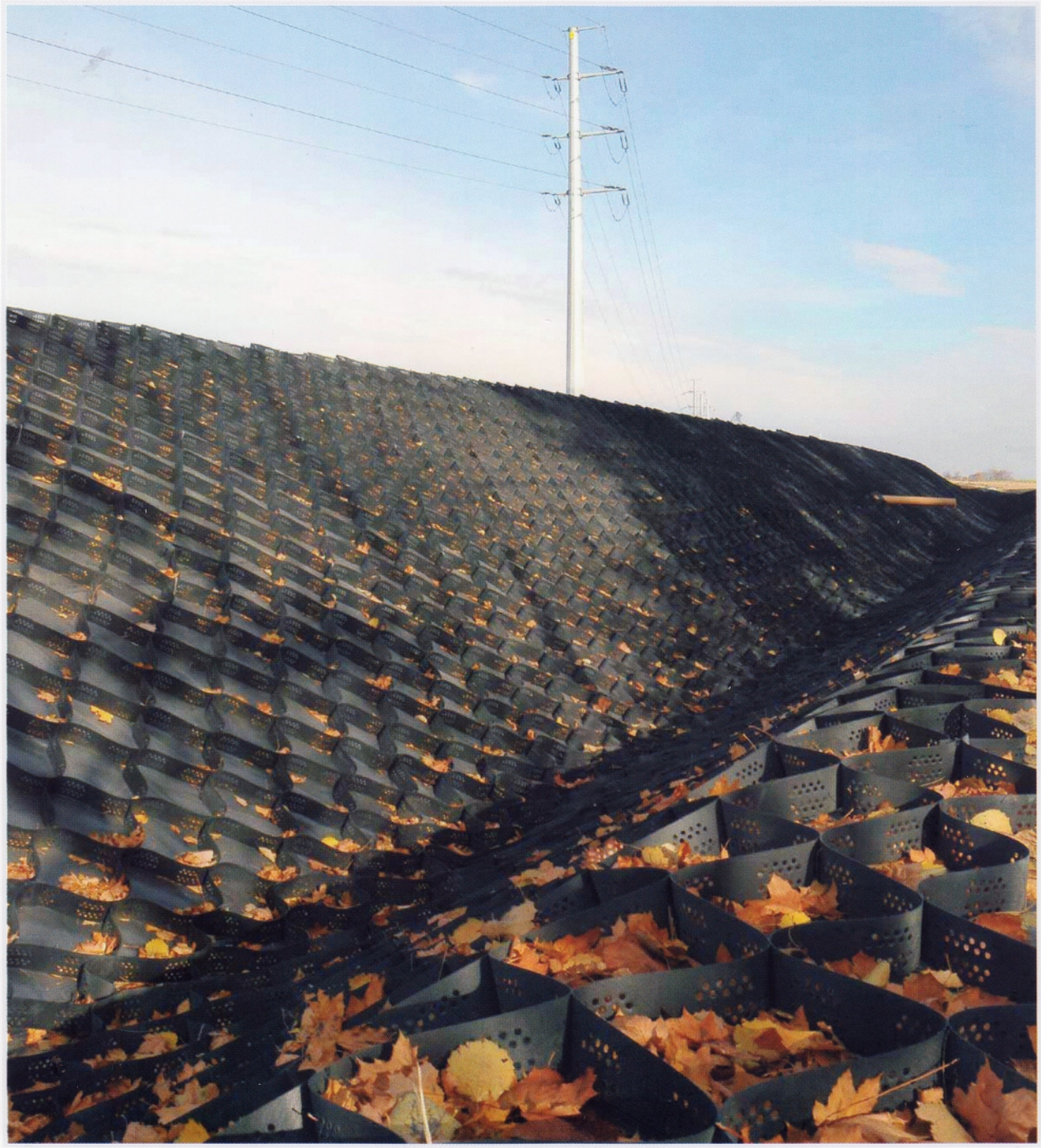
Standard solutions with use of geosynthetics for scarp and mound protection. However, the project success requires meeting two basic requirements: it is necessary to calculate the scarp stability (and ensure that no further reinforcement will be provided) and carefully select the geosynthetics parameters. With consideration to the soil types in Poland, the table below includes suggestions for most commonly used TABOSSYSTEM® solutions, depending on the scarp inclination, length and filling material:

TYPE OF GEONET	HUMUS COVERING							STONE COVERING		
	1:3 18*	1:2 27*	1:1,5 33*	1:1 45*	1:0,65 56*	1:0,5 64*	1:0,33 72*	1:2 27*	1:1,5 33*	1:1 45*
GT MK 36MM	X							Not recommended due to aggregate bulk density		
GT DK 50MM	X	X	X							
GT DK 75MM		X	X	X*						
GT DK 100MM			X	X						
GT MK 100mm				X	X	X	X*	X	X	X
GT MK 150MM				X	X	X	X			

* means exemplary solutions for antierosion protection

The scarp should be levelled off and condensed as much as possible before the geonet application. So prepared ground base can be then covered with cell geonet TABOSS-DK-150, beginning from the top of the scarp. The overall geonet placement area should be anchored using J-type pins, maintaining following distances: every 150cm horizontally (3 x Bk) and every 150cm vertically (3 x Hk).

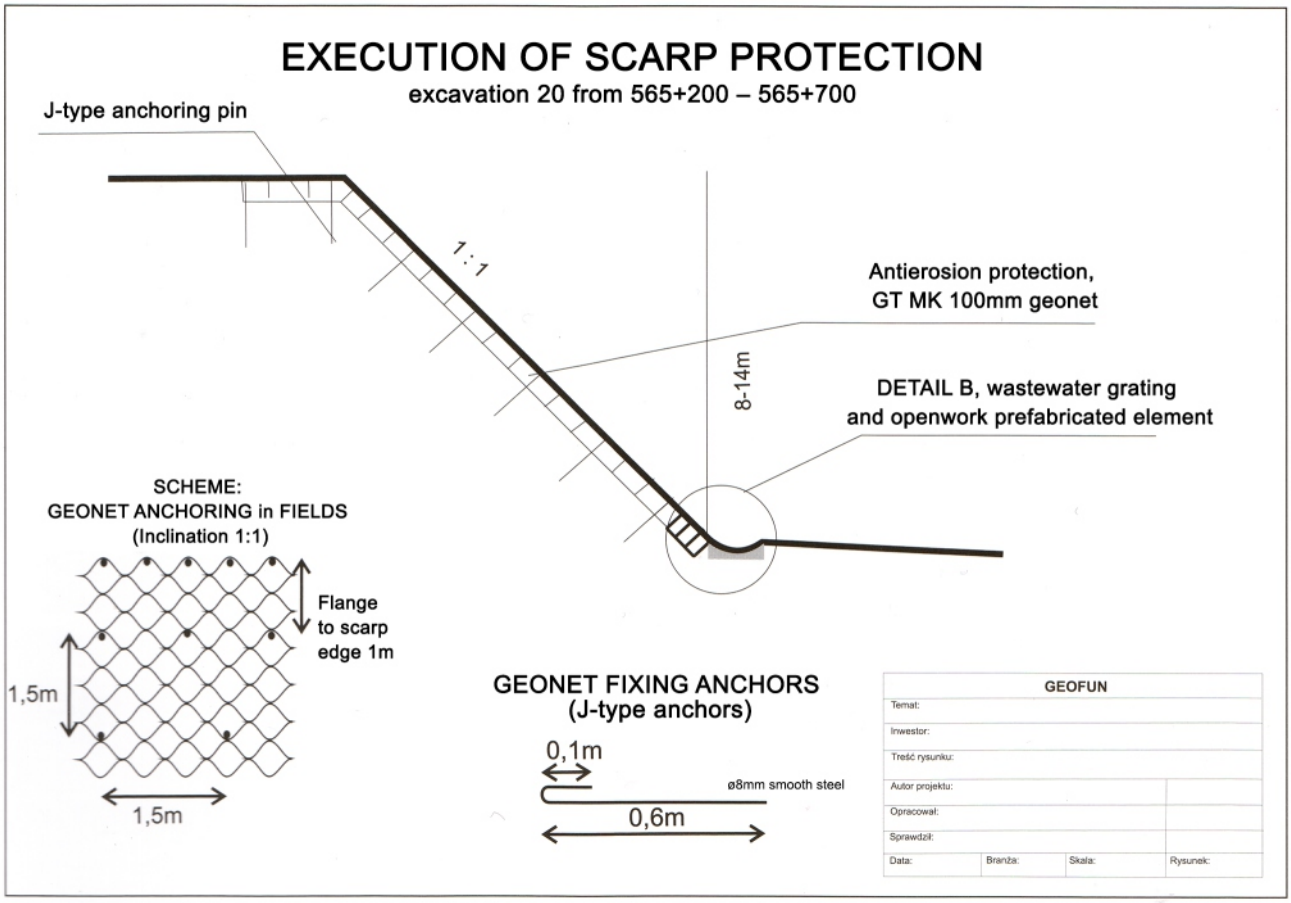
To minimize stress concentration in the geonet pins should maintain the staggered arrangement in following horizontal rows (shifted by Bk=50cm in relation to pins at adjoining horizontal rows.) The geonet should be flanged along the top of the scarp by a distance of 1m. Two outermost geonet rows running along the top scarp edge should be anchored in the ground base with J-type pins in every cell. All geonet sections should be then covered (starting from the top of the scarp) with vegetal soil with thickness of 3cm above the geonet section. After preliminary compacting the filling material of geonet cells additional 1-2cm layer of vegetal soil should be added. After sowing grass the overall soil should be compacted again to achieve the Proctor compaction index Is ≥ 0.95. Vibratory soil compactors can be used to compact the filling material. After geonet soil compaction and grass sowing the scarp should be systematically bedewed for 2-3 weeks. Please note, that it is forbidden to pour a strong jet of water onto the scarp.



1. TABOSSYSTEM ANTIEROSION PROTECTION 1:1

In case of antierosion protection of 12-16m long scarp at the A1 motorway construction site the GT MK 100mm geonet was used:

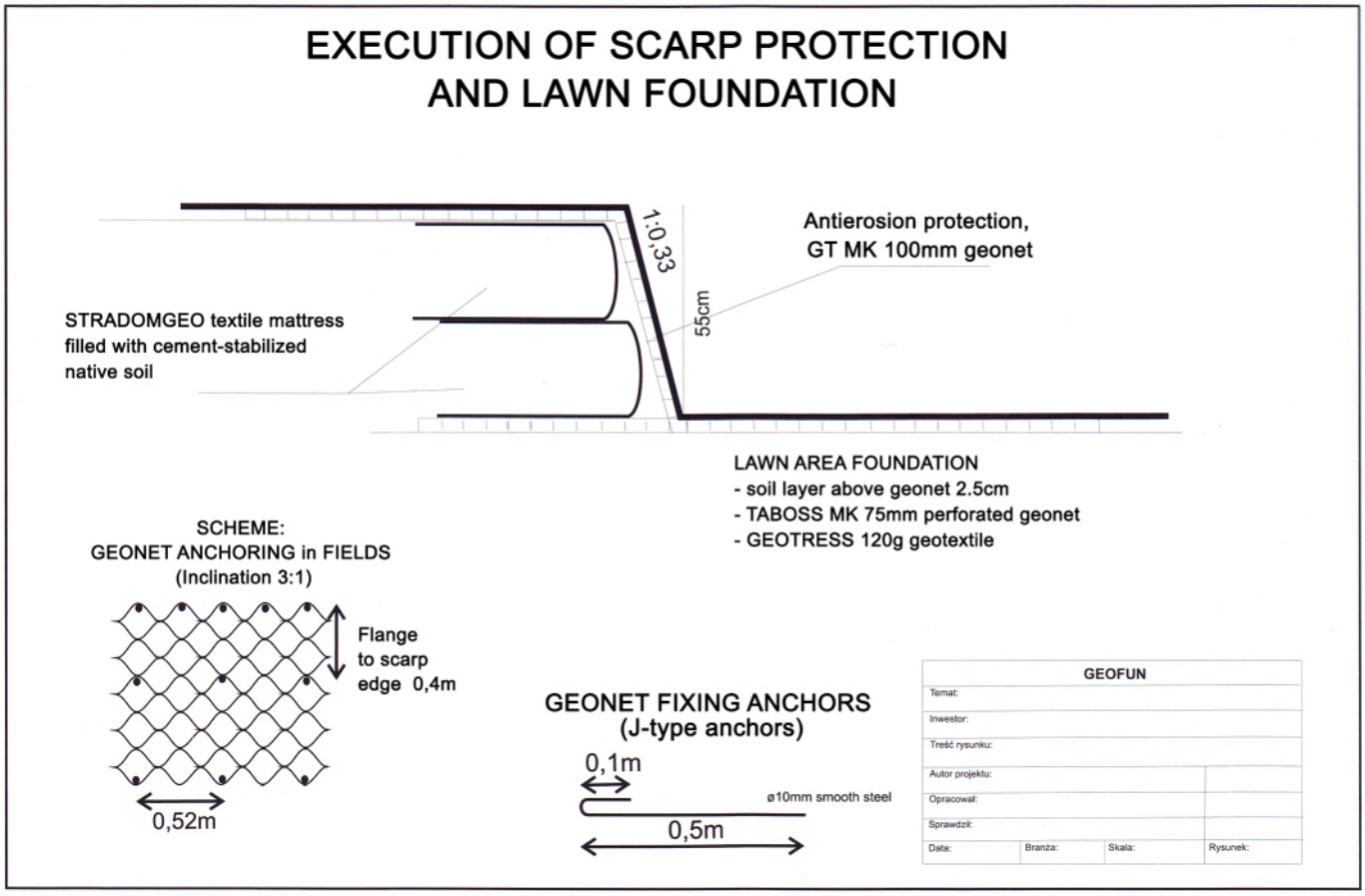
- The number of J-type anchoring pins for 100 running meters, top (192pcs+96pcs) + scarp 400pcs – 0.52 piece/sq.m.
- To avoid section stretching, each cell should be bound using the tie-wraps. For every 100 running meters 1155 tie-wraps should be used (1.2 piece/sq.m.)
- Minimal overlap length should be 1m (1.5m recommended)



2. TABOSSYSTEM ANTIEROSION PROTECTION 1:0.33

In case of antierosion protection of scarp with very steep slope, but relatively low, running along Siekierkowska route in Warsaw the GT MK 10mm geonet was used:

- The number of J-type anchoring pins for 100 running meters, top (385pcs+192pcs) + scarp 277pcs – 7 pieces/sq. m.
- To avoid section stretching, each cell should be bound using the tie-wraps. For every 100 running meters 230 tie-wraps should be used (0.5 piece/sq. m.)
- Minimal overlap length should be 1m (1.5m recommended)



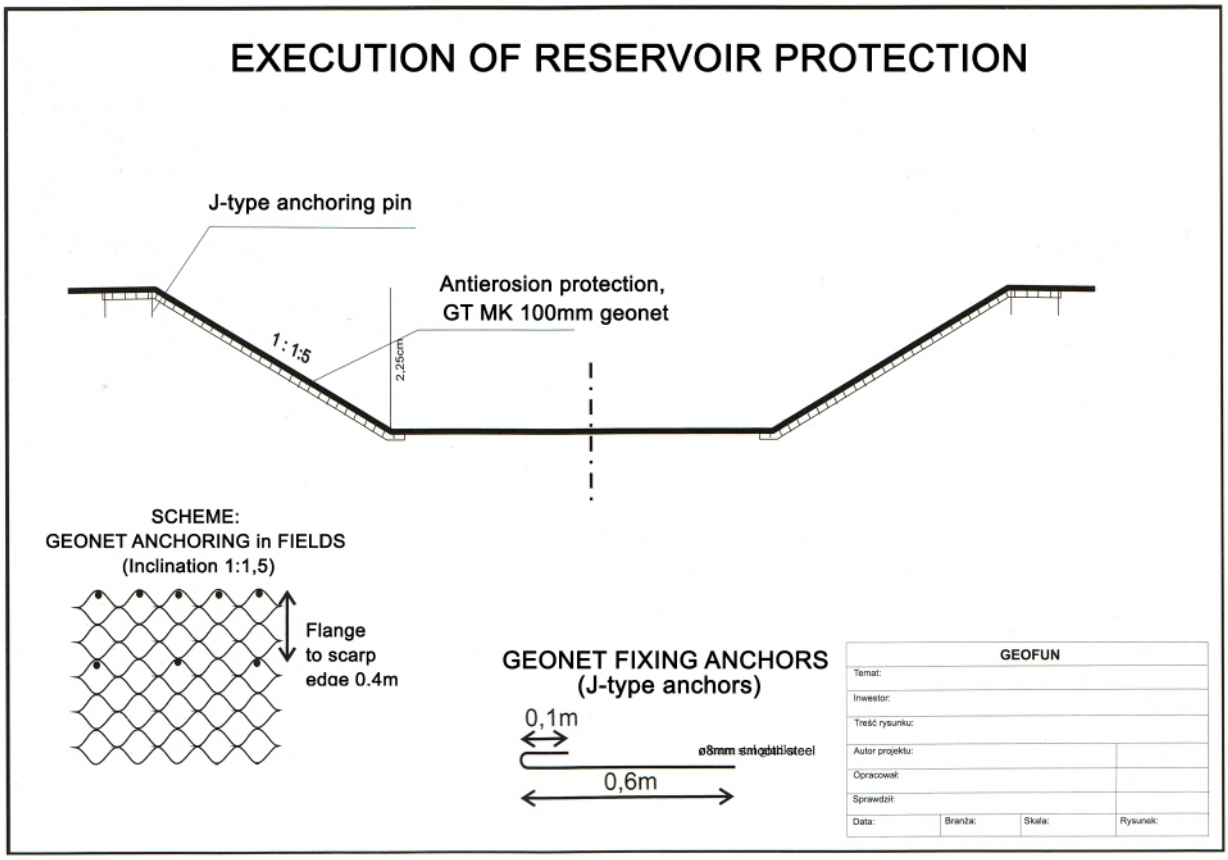
FIELD TRIAL RESULTS

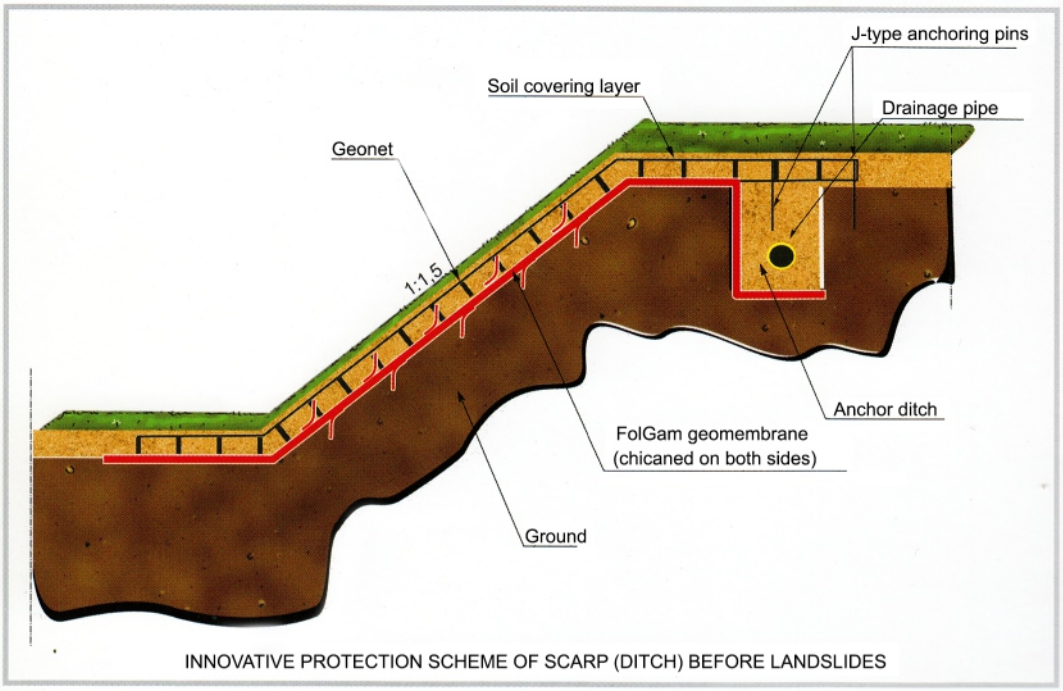
Field trial results that are closest to actual conditions with most suggestive and convincing effects of TABOSSYSTEM® are often deemed impossible in theory. During the on-site verification executed by Opole Technical University scientific workers the followings trial conclusions were found: mound construction with the use of geotextile layer on geonet mattress and scarp surface protection with the use of geonet provides high durability and achievement of the assumed effect. Geosynthetics enable achieving the desired effect in minimal space.

3. TABOSSYSTEM ANTIEROSION PROTECTION 1:1.5

In case of antierosion protection of water reservoir walls with 5m-long scarp running along A1 motorway and of reservoirs in Szczecin the GT MK 10mm geonet was used:

- The number of J-type anchoring pins for 100 running meters, top (385pcs+192pcs) – 2 pieces/sq. m.
- To avoid section stretching, each cell should be bound using the tie-wraps. For every 100 running meters 230 tie-wraps should be used (0.5 piece/sq. m.)
- Minimal overlap length should be 1m (1.5m recommended)





INNOVATIVE PROTECTION SCHEME OF SCARP (DITCH) BEFORE LANDSLIDES

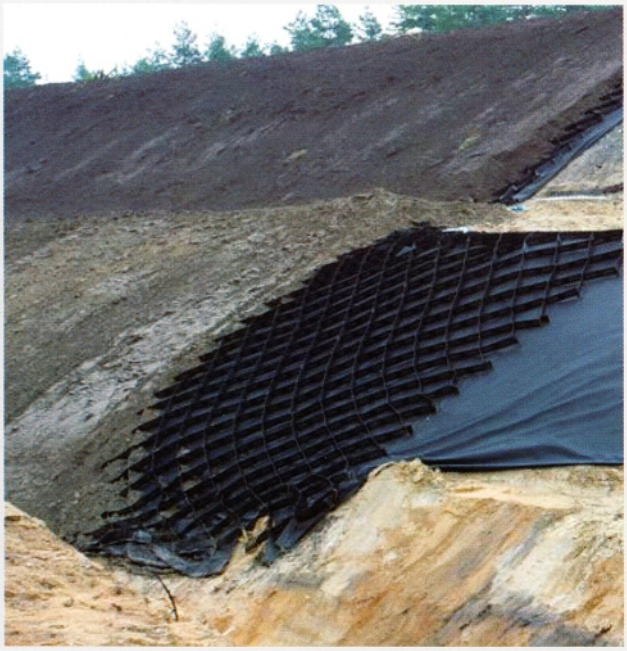
4. INNOVATIVE SCARP (DITCH) PROTECTION

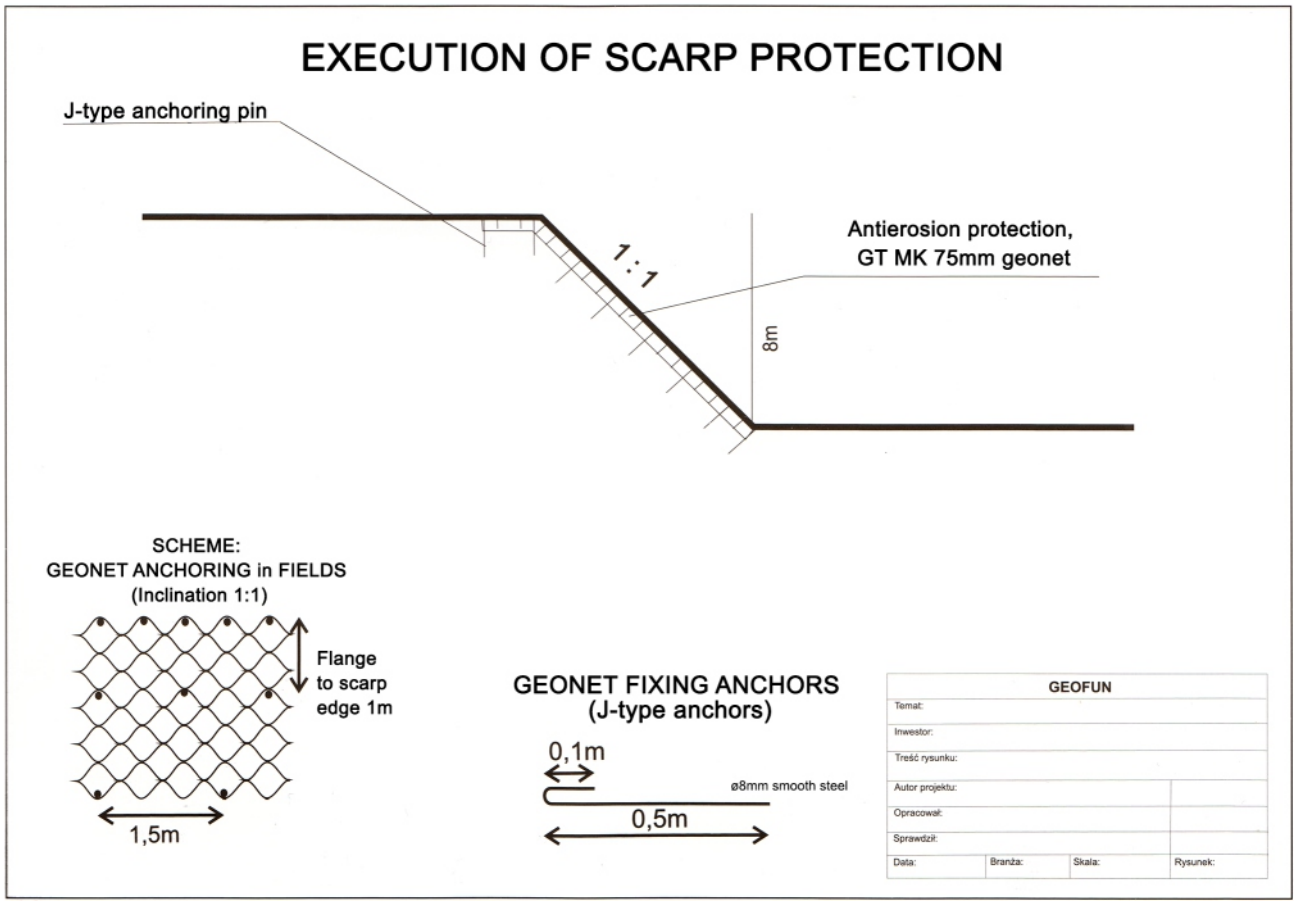
Developed with environmental protection in mind. Its innovative character is a result of combining the sealing element (FolGam H hydroinsulation foil) with an effective element that provides antierosion protection of TABOSS geonet. Application of the FolGam H foil chicaned on both sides enables TABOSS geonet installation without need to use traditional methods (anchoring pins). So far such geosynthetic consolidation was impossible due to lack of possibility of geonet installation without damaging the foil. It should also be mentioned that bottom FolGam geomembrane chicanes guarantee maintaining the overall construction on the formed slope, which is crucial in case of big inclinations.

TABOSSYSTEM – SCARP PROTECTION WITH A1 MOTORWAY AS AN EXAMPLE

TABOSSYSTEM FOR ANTIEROSION PROTECTION 1:1

- In case of antierosion protection of a 6m-high scarp running along A1 motorway the GT MK 75mm was used:
- The number of J-type anchoring pins for 100 running meters, top (50pcs+25pcs) – scarp 420 pieces – 0.8 piece/sq.m.
- To avoid section stretching, each cell should be bound using the tie-wraps. For every 100 running meters 545 tie-wraps should be used (0.9 piece/sq.m.)





GENERAL GEONET OVERVIEW

The geonet is made of high density polyethylene (HDPE) tapes, double-side textured, connected by series of deep, ultrasonic point welds located in stripes and perpendicularly to longitudinal tape axles. The geonet height is 75 mm and equals to tape height. In case of a standard geonet the weld stripes are separated by 680mm. The geonet is produced in sections of sixty tapes each. In closed position (for storage and transportation) the section is a series of close-fitting tapes. In open (extended) position the section is a form of wavily bent tapes with linked tops that designate tridimensional cell structures. The geonet is made of flammable material that is plasticized in 130ºC and burns in approximately 360ºC. Table 1 below specifies parameters required for perforated TABOSS 75mm system.

No.	PROPERTIES	UNIT	HEIGHT	TEST METHODOLOGY
1	Tape width	mm	75mm	Gauge
2	Tape tensile strength	kN/m	15.00	PN-EN 10319
3	Joint shear resistance	kN/m	22.00	PN-EN 10321
4	Joint tear resistance	kN/m	21.00	PN-EN 10321

Tabela 1.

GENERAL GEOTEXTILE OVERVIEW

BS13 nonwoven geotextiles made of short cut fibers have the same shear resistance properties in longitudinal and transverse directions. High boundary expansion, flexibility and puncture resistance, and consequently, adoption of ground shape causes that this geotextile is particularly usable as a separating layer. Moreover it is water-permeable under load in both horizontal and vertical plane, between the scarp ground base and the soil that fills the system.

Geotextiles have compact, rough and furry texture that offers perfect adhesion and cooperation with soil and other aggregates, adapts to substantial local soil deformations and extends without risk of material breakage.

No.	PROPERTIES	UNIT	HEIGHT	TEST METHODOLOGY
1	Surface mass	g/sq.m	170	PN-EN 9864
2	Tensile strength MD; CMD	kN	13,00 13,00	PN-EN 10319
3	CBR puncture force	kN	2,2	PN-EN 12236
4	Water flow speed, perpendicular to geotexture	m/s	10×10^{-3}	PN-EN 11058

Tabela 2.

The TABOSS system is an innovative and patented solution (patent no 63459) with possibility of linking sections with certified tie-wraps. This provides the effect of uniform semi-rigid plate. Section durability, that is comparable to tape strength, enables elimination of the weakest link. To achieve proper durability and the semi-rigid plate effect the geonet sections should be linked with durability that is not lower than the one mentioned in table 3.

1	Semi-rigid plate durability	N	655:700	PN-EN 50146
2	Durability: • cover one month after installation • estimated durability at least 25 years in neutral soils with 4 < pH < 9 and in soil with temperature < 250C, based on durability assessment related to anti-microbial resistance test (EN 12225)			

Tabela 3.

CONTROL STATISTICAL CALCULATIONS

Authoritative scarp geotechnical parameter calculations of "Fine sands and compacted silted sands" were adopted for control statistical calculations on the basis of general information and data from the literature.

Gamma-04/ZS Calculation date: July 23, 2010
SCARP SURFACE PROTECTION WITH CELL GEONET
A1 STRABAG

DATA

Soil in scarp body - fine sands and compacted silted sands	
Module of scarp soil susceptibility	
at depth of 2m	C(-2) = 40000 kN/sq.m.
Angle of internal friction in scarp soil	fik = 19.0°
Scarp inclination up to level	alfask = 45.0°
Overload coefficient	gammap = 1.400
Cell geonet height	hg = 0.075 m
Geonet cell size	
- Transverse to section	Bk = 0.500 m
- Longitudinal to section	Hk = 0.420 m
Pin diameter	Fis = 10.0 mm
Pin length	ls = 0.650 mm

RESULTS

Reference capsizing moment of the pin (per 1 sq.m. of the scarp)		Mw = 0.399 kNm
Required number of pins per 1 sq.m. of the scarp		ns0 = 0.7 pcs/sq.m.
		adopted nss = 0.8 pcs/sq.m.
Pin spacing	- Transverse to section	rp = 1.00 m (every 2 cells)
	- Longitudinal to section	rw = 1.26 m (every 3 cells)

TECHNICAL WORKING GUIDELINES

The scarp should be levelled off and condensed as much as possible before the geonet application. So prepared ground base can be then covered with geotexture Terealis BS13 and fixed with anchoring pins. Next, the cell geonet TABOSS-DK-150 should be placed, beginning from the top of the scarpThe overall geonet placement area should be anchored using J-type pins, maintaining following distances: every 100cm horizontally (2 x Bk) and every 126cm vertically (3 x Hk).

To minimize stress concentration in the geonet pins should maintain the staggered arrangement in following horizontal rows (shifted by Bk=50cm in relation to pins at adjoining horizontal rows.) The geonet should be flanged along the top of the scarp by a distance of 0.6m (recommended 1m, if possible). The outermost geonet row running along the top scarp edge should be anchored in the ground base with J-type pins in every cell. All geonet sections should be then covered (starting from the top of the scarp) with vegetal soil with thickness of 3cm above the geonet section. After preliminary compacting the filling material of geonet cells additional 1-2cm layer of vegetal soil should be added. After sowing grass the overall soil should be compacted again to achieve the Proctor compaction index Is ≥ 0.95. Vibratory soil compactors can be used to compact the filling material. After geonet soil compaction and grass sowing the scarp should be systematically bedewed for 2-3 weeks. Please note, that it is forbidden to pour a strong jet of water onto the scarp.