Institut für textile Bau- und Umwelttechnik GmbH

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Date: 05. November 2002
Ref.: br/bt

Test Report No. 1.1/13525/470.1-2002e

General:

Order by:	**Dörken GmbH & Co. KG Wetterstraße 58 58313 Herdecke**
Order date:	27. May 2002
Samples delivered:	04. April 2002 and 11. July 2002
Material:	Thermical bonded PP-nonwoven **Delta-TERRAXX** (declaration by Dörken)

Tests

	standard	part	issue
1. Mass per unit area	DIN EN 965		05.95
2. Thickness	DIN EN 964	1	05.95
3. Tensile strength / strain at max. load	DIN EN ISO 10319		06.96
4. Water permeability without normal load	DIN EN ISO 11058		06.99
5. Characteristic opening size O_{90}	DIN EN ISO 12956		06.99
6. Cone drop	DIN EN 918		02.96
7. Determination of the resistance to weathering	ENV 12224		10.96

The date of testing is reported on the enclosed machine reports.
The results apply exclusively to the specimens submitted.

Results are reported to the accuracy given in the standards. In statistical evaluation, the measured accuracy is taken.

This test report contains 6 pages and 7 enclosures (enclosures A1 - A7).
It may not be published in parts. Only the summary of results may be published as „Extract of Test Report No.1.1/13525/470-2002e".

Gesellschaft mit beschränkter Haftung
Sitz Greven, AG Steinfurt HRB 2375

Geschäftsführer:
Prof. Dr.-Ing. J. Müller-Rochholz

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Sparkasse Greven (BLZ 403 510 60)
Konto-Nr. 630 131 89

1. Mass per unit area in accordance with DIN EN 965 (05.95)

Test principle
The mass of 10 circular specimens were measured with an accuracy of 0.001 g. The calculated mass was rounded to 1 g/m².

Specimen
The diameter of each specimen was 200 mm.

Results

The **results** are quoted on page 6 (mean) and in enclosure A1.

2. Thickness in accordance with DIN EN 964 T1 (05.95)

Test principle
The thickness was measured at 10 round specimens, taken at random from the sample, using a flat loading area of 25 cm² at a load of 2 kPa at an accuracy of 0.001 mm and recorded to the next 0.01 mm.

Specimen
The specimen for the weight was taken; this was round specimen of a diameter of 200 mm.

The **results** are quoted on page 6 (mean) and in enclosure A1.

3. Tensile strength / strain at maximum load in accordance with DIN EN ISO 10319 (06.96)

Test principle
The specimens were tested at constant crossheadspeed in an electromechanical PC-controlled testing machine Instron 5567 (30 kN). The force/deformation curve is recorded. The strain was measured with a video-extensometer between two reflective points. The accuracy is better than 1 %. The test parameters are printed on the record. 2 typical records are given in enclosure A2 – A3.
The strain rate in machine direction (MD) and cross machine direction (CMD) was 20 ± 5 %/min.

Specimen

From the material 5 specimens of 200 mm x 300 mm were taken in machine direction and 5 in cross machine direction.

Results

For geogrids or composites with linear loadbearing elements the number of strands per m is counted. The values in kN/m are related to the number counted.

The **results** are quoted on page 6 (mean) and in enclosures A2 - A3.

4. Water permeability (normal to the plane) without normal load in accordance with DIN EN ISO 11058 (06.99)

Falling head

Test principle
A single-layer, unloaded specimen is passed by water in a direction normal for its plane with falling head.

When this is done, the dependency of the specimens' permeability on the difference in hydraulic height H is determined in a measuring procedure. The tests are carried out with a semi-automatic testing device made by the company Ecomess. The processing and evaluation of the readings are done with GE-TE-FLOW K, a data-acquisition program.

Before mounting in the test device, the specimen is stored in de-aired water for 12 h.

Test parameters

Specimen	∅ 75 mm
Diameter of specimen supplied with water	∅ 67.8 mm
Number of specimens	5
Difference in hydraulic height	0<H<540 mm
Water	de-aired
Testing device	Ecomess Type GE-TE-FLOW-K

Results

The **results** are quoted on page 6 (mean) and in enclosure A1.

5. Characteristic opening size O_{90} in accordance with DIN EN ISO 12956 (06.99)

Test principle
A specimen of a diameter of 200 mm (sieving diameter 160 mm) is fixed in a plastic cylinder on a sieving machine. 140 g of the standard soil (grading in enclosure A4 – A6) are sieved passing vertically through the specimen at a vertical oscillation during 10 minutes with continuous irrigation (sieving machine: Retsch VE 1000, frequency 50 cps, double amplitude 1,5 mm).
The initial amount of granular material, the material passed and retained are typed in a spreadsheet (table 1 as in enclosure A5 – A7).
The granular material passed through the individual specimen (3 or 5 specimens) is combined and the particle size distribution is determined.

The cumulative percentage of the passed granular material against the corresponding sieve size is plotted on a semi logarithmic scale (enclosure A5 – A7).
The characteristic opening size O_{90} of the geotextile is equal to the d_{90} of the particle size distribution curve of the material passing the geotextile, i.e. $O_{90} = d_{90}$.

Results

The **results** are quoted on page 6 (mean) and in enclosure A1.

6. Cone drop test in accordance with DIN EN 918 (02.96)

Test procedure
A stainless steel cone was dropped from a distance of 500 mm onto the center of the specimen.
The degree of penetration was measured by insertion of a narrow-angle graduated cone into the hole.

Specimen
From the material 10 specimens ∅ 200 mm were taken.

Results

The **results** are quoted on page 6 (mean) and in enclosure A1.

7. Determination of the resistance to weathering in accordance with ENV 12224 (10.96)

Test principle

Specimens of the material were exposed to periods of water spray during a continuos UV exposure.
The change in tensile properties of exposed specimens to unexposed reference specimens was determined.
The used exposure apparatus was an Global UV Tester, Fa. Weiß (Licence BAM). The used light source were fluorescent UV-Lamps in accordance with ISO 4892-3. The fluorescent tubes are used for 2000h and the time dependent loss of radiation is controlled by increasing voltage.
A cycle involved:
- 5h dry UV exposure with a temperature of 50 ±3°C and a relative air humidity of 10 ±5%
- followed by 1h spray with conditioned water at 20 ±3°C. The radiation is continued while spraying.

54 cycles (323h) were carried out to get 50 MJ/m² total irradiance, corresponding to 6 months of typical weather conditions in middle Europe (according to German regulation).
The properties of the exposed- and reference specimens were determined in accordance with **DIN EN 29073 T3**.

Specimen
From the material 20 specimen of 50 mm x 300 mm (10 for exposition and 10 reference specimen) were taken.

Results

Specimen	Tensile strength in N		Strain at maximum force in %	
	Reference specimen	Exposed specimen	Reference specimen	Exposed specimen
1	211	264	17.3	23.8
2	222	224	22.6	18.7
3	220	217	19.9	21.3
4	277	271	19.1	24.4
5	283	241	34.6	24.1
6	253	243	23.3	29.4
7	228	239	24.0	15.7
8	225	268	17.3	23.5
9	251	177	26.8	18.1
10	210	176	14.0	16.9
Mean	**238**	**232**	**21.9**	**21.6**
Standard deviation	**26.5**	**34.2**	**5.86**	**4.23**
Coefficient of Variation	**11.1%**	**14.7%**	**26.8%**	**19.6%**

Change in properties

Material	Tensile strength	Strain at maximum force
Delta-TERRAXX	**- 2.5 %**	**- 1.4 %**

Date: 05. November 2002
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Summary of results Test Report No. 1.1/13525/470.1-2002e

Order by: Dörken GmbH & Co. KG, Wetterstraße 58, 58313 Herdecke

Material: Thermical bonded PP-nonwoven
Delta-TERRAXX
(declaration by Dörken)

Test	Standard	Unit	Results		
			mean $\bar{x}$	standard-deviation s	coefficient of variation v in %
Mass per unit area	DIN EN 965 (05.95)	g/m²	101	4.6	4.5
Thickness	DIN EN 964 T1 (05.95)	mm	0.43	0.02	5.1
Tensile strength MD CMD	DIN EN ISO 10319 (06.96)	 kN/m kN/m	 6.0 6.5	 0.81 0.45	 13.6 6.9
strain at maximum load MD CMD	DIN EN ISO 10319 (06.96)	 % %	 41.6 47.2	 9.14 3.35	 22.0 7.1
Water permeability VI_{H50}-Index (falling head)	DIN EN ISO 11058 (06.99)	m/s	8.5E-02	---	---
1. sample **Characteristic opening size O_{90}**	DIN EN ISO 12956 (06.99)	mm	0.17	---	---
2. sample **Characteristic opening size O_{90}**	DIN EN ISO 12956 (06.99)	mm	0.17	---	---
Cone drop	DIN EN 918 (02.96)	mm	30	6.0	19.9
Determination of the resistance to weathering **changing tensile strength / strain at maximum load**	ENV 12224 (10.96)	 % %	 - 2,5 - 1,4	 --- ---	 --- ---

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Dipl.-Ing. (FH) Staubermann

Institut für textile Bau- und Umwelttechnik, Gutenbergstr. 29 48268 Greven

Test-Report No: **1.1/13525/470.1-2002e**
Company: **Dörken**
Material: **DELTA-TERRAXX**
Date: **30.08.2002**

Sample No.	Mass g	m.p.a. DIN EN 965 g/m²	Thickness DIN EN 964 mm	O_{90} DIN EN ISO 12956 mm	Cone drop DIN EN 918 mm
1	3,096	99	0,41	0,17	28
2	3,132	100	0,44	0,17	33
3	3,154	100	0,46		36
4	3,036	97	0,39		28
5	3,175	101	0,43		24
6	3,301	105	0,43		22
7	2,883	92	0,41		34
8	3,242	103	0,43		39
9	3,305	105	0,45		23
10	3,363	107	0,45		35
$\bar{x}$	3,169	101	0,43	0,17	30
s	0,14	4,6	0,02		6,0
V%	4,5	4,5	5,1		19,9
x - s					

In-plane water flow capacity DIN EN ISO 12958 (06.99)						
Hydraulic Gradient i	Test direction	Normal compressive stress in kPa / Thickness in mm				
		20/--	50/--	200/--		
		$q_{stress/gradient}$ in m²/s / x10^3 l/(mxs)* bei 20°C				
0,1	MD					
0,3	MD					
1,0	MD					
0,1	CMD					
0,3	CMD					
1,0	CMD					
Contact surfaces:						

* Mean of 3 specimen

Water permeability DIN EN ISO 11058 (06.99) Specimen No.	$VI_{H50\ at}$ H = 50 mm m/s
1	8,6E-02
2	8,6E-02
3	7,4E-02
4	8,5E-02
5	9,2E-02
Mean	8,5E-02
Max	9,2E-02
Min	7,4E-02

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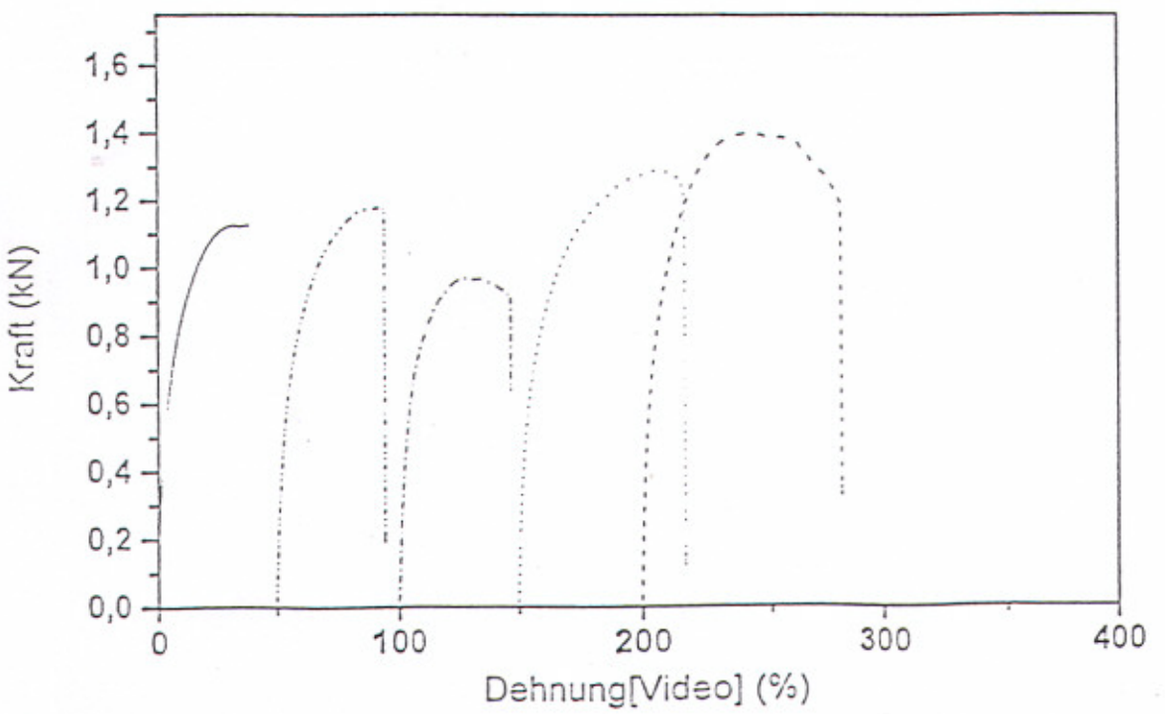
Parametertabelle:

Prüfnorm:	DIN EN ISO 10319	Strg./m:	
Kunde:	Dörken	Probenbreite:	200.00 mm
Auftragsnummer:	1.1/13525/470.1-2002e	Einspannlänge:	100.00 mm
Material:	Delta-TERRAX - MD	Wegaufnehmer:	Video
Datum:	29.08.2002	Vorkraft	10.00 N
Prüfer:	cs	Prüfgeschwindigkeit:	25.00 mm/min
Kraftaufnehmer:	30 kN	Probenhalter:	hydraulische Spannzeuge
Klima:	24°C / 72%	Bemerkung:	

Ergebnisse:

	Fm (kN)	Fm (kN/m)	Am (%)
1	1.400	7.00	41.96
2	1.288	6.44	55.45
3	0.973	4.86	29.95
4	1.180	5.90	41.76
5	1.129	5.64	38.93

Seriengrafik



Statistik:

	Fm (kN)	Fm (kN/m)	Am (%)
Mittelwert	1.194	5.97	41.62
Std. Abw.	0.162	0.81	9.14
Var. Koeffiz	13.569	13.57	21.97

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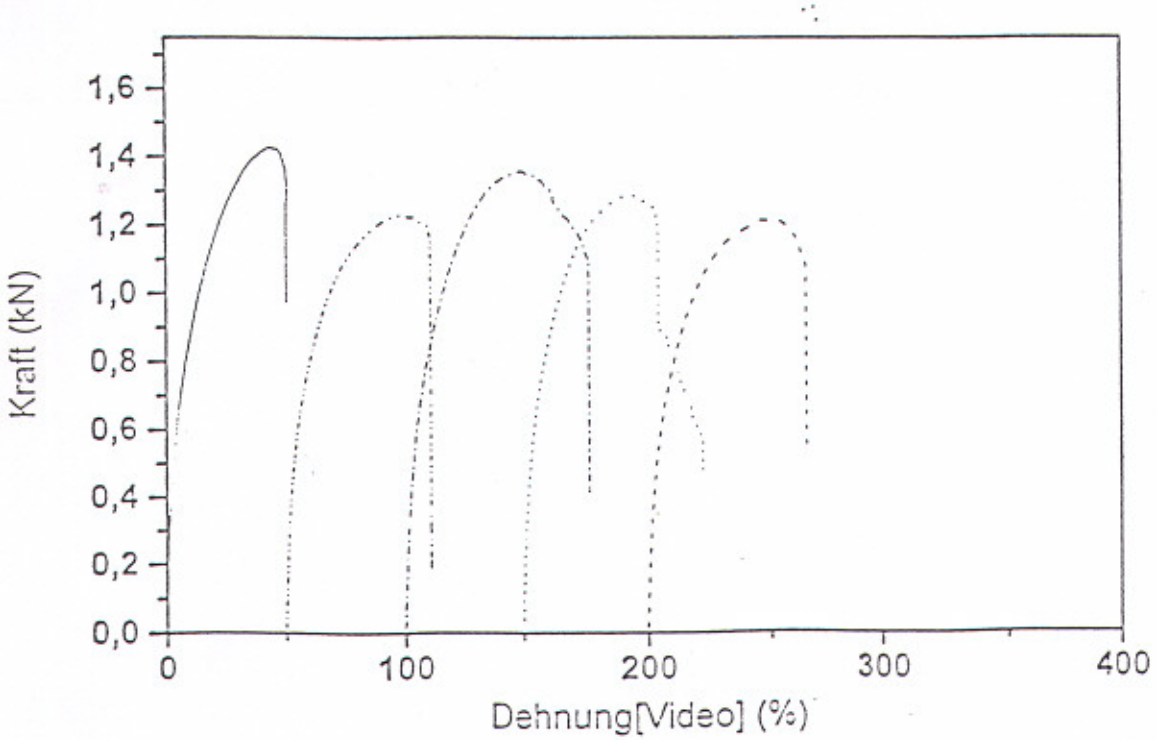
Parametertabelle:

Prüfnorm:	DIN EN ISO 10319	Strg./m:	
Kunde:	Dörken	Probenbreite:	200.00 mm
Auftragsnummer:	1.1/13525/470.1-2002e	Einspannlänge:	100.00 mm
Material:	Delta-TERRAX - CMD	Wegaufnehmer:	Video
Datum:	29.08.2002	Vorkraft	15.00 N
Prüfer:	cs	Prüfgeschwindigkeit:	25.00 mm/min
Kraftaufnehmer:	30 kN	Probenhalter:	hydraulische Spannzeuge
Klima:	24°C / 72%	Bemerkung:	

Ergebnisse:

	Fm (kN)	Fm (kN/m)	Am (%)
1	1.213	6.06	51.42
2	1.286	6.43	44.06
3	1.357	6.78	49.21
4	1.228	6.14	47.67
5	1.428	7.14	43.61

Seriengrafik



Statistik:

	Fm (kN)	Fm (kN/m)	Am (%)
Mittelwert	1.302	6.51	47.19
Std. Abw.	0.090	0.45	3.35
Var. Koeffiz	6.934	6.93	7.10

Determination of the characteristic opening size DIN EN ISO 12956

Test Report No: 1.1/13525/470.1-2002e Date: 30.08.2002
Material: DELTA-TERRAXX

wet sieving

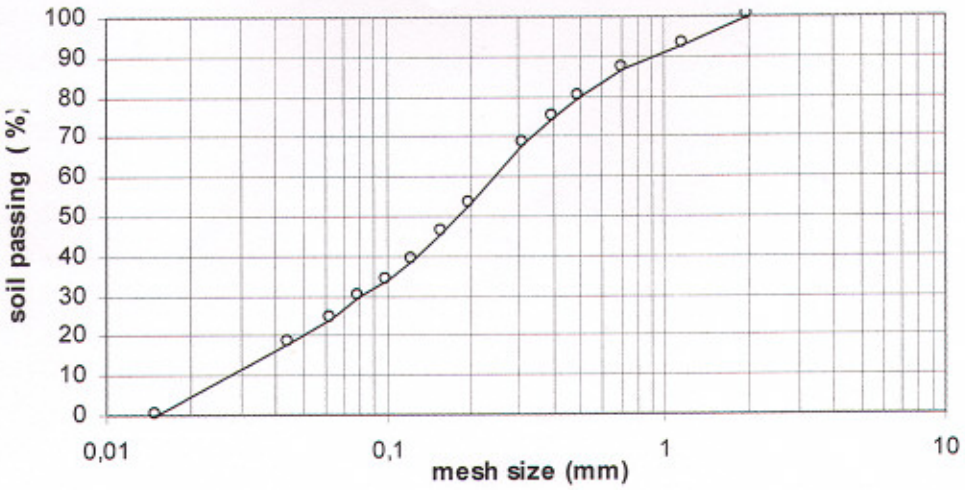
specimen:	soil mass: [g]	soil passing: [g]	soil retained: [g]	soil loss: [%]	soil passing: [%]	variation from average [%]
1	140	74,23	65,14	0,45	53,02	-1,21
2	140	79,73	59,84	0,31	56,95	6,11
3	140	71,46	67,75	0,56	51,04	-4,90
4						
5						
total =	420	225,42	192,73	mean =	53,67	

dry sieving of soil passing start mass: 225,42

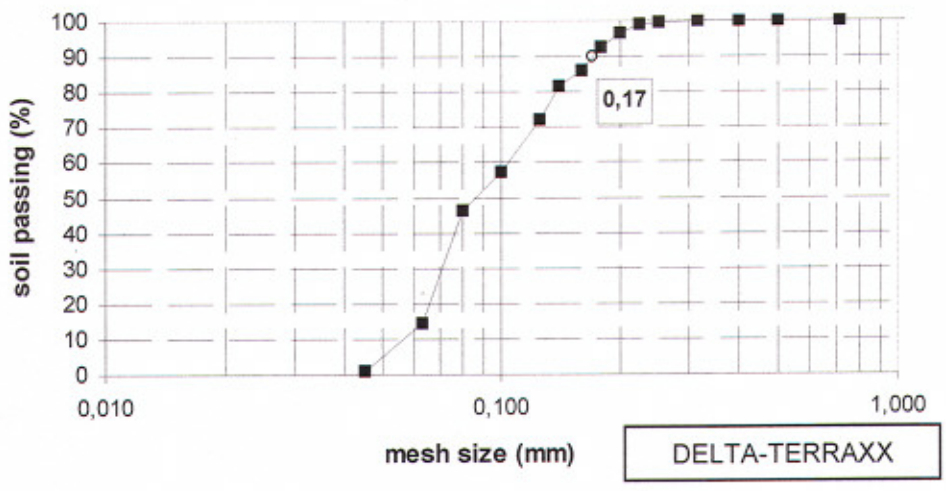
mesh size mm	mass of empty sieve g	mass of sieve and soil g	soil retained g	cumulative mass of soil passing g	cumulative percent of soil passing %	mesh size mm
<0,045	241,54	243,28	1,74			<0,045
0,045	330,22	361,45	31,23	1,74	**0,77**	**0,045**
0,063	324,06	395,17	71,11	32,97	**14,63**	**0,063**
0,080	324,86	349,76	24,90	104,08	**46,18**	**0,080**
0,100	328,26	361,72	33,46	128,98	**57,23**	**0,100**
0,125	336,84	358,06	21,22	162,44	**72,07**	**0,125**
0,140	399,91	410,76	10,85	183,66	**81,49**	**0,140**
0,160	342,04	356,28	14,24	194,51	**86,30**	**0,160**
0,180	407,18	415,62	8,44	208,75	**92,62**	**0,180**
0,200	342,84	348,69	5,85	217,19	**96,36**	**0,200**
0,224	414,82	416,47	1,65	223,04	**98,96**	**0,224**
0,250	412,39	413,00	0,61	224,69	**99,69**	**0,250**
0,315	353,25	353,32	0,07	225,30	**99,96**	**0,315**
0,400	360,86	360,88	0,02	225,37	**99,99**	**0,400**
0,500	370,83	370,83	0,00	225,39	**100,00**	**0,500**
0,710	395,84	395,84	0,00	225,39	**100,00**	**0,710**
1,180	375,90	375,90	0,00	225,39	**100,00**	**1,180**
		total =	225,39			
		loss =	0,01%			

Test report No. 1.1/13525/470.1-2002e enclosure A4

particle size distribution curve of the test soil



cumulative particle size distribution curve of the soil passing and determination of O_{90}



Institut für textile Bau- und Umwelttechnik	determination of the characteristic opening size DIN EN ISO 12956 (06.1999)	

Determination of the characteristic opening size DIN EN ISO 12956

Test Report No: 1.1/13525/470.1-2002e Date: 30.08.2002
Material: DELTA-TERRAXX

wet sieving

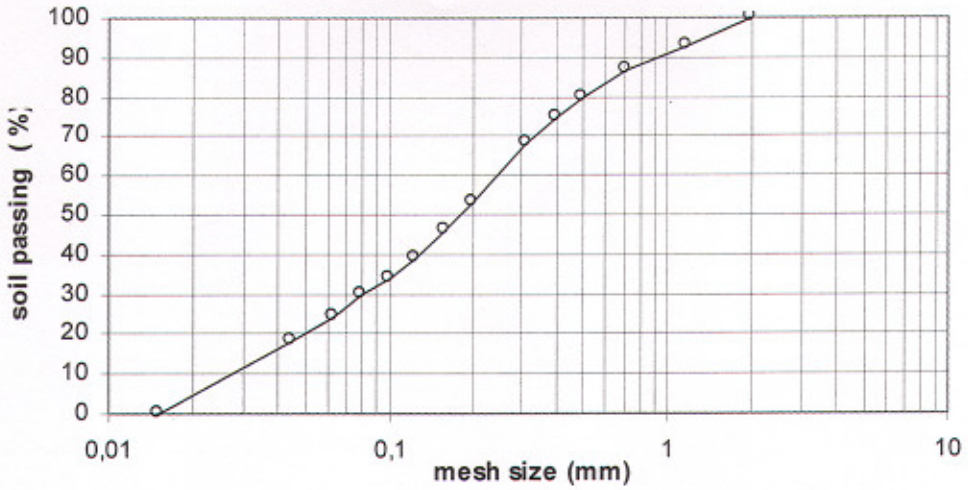
specimen:	soil mass: [g]	soil passing: [g]	soil retained: [g]	soil loss: [%]	soil passing: [%]	variation from average [%]
1	140	76,22	63,06	0,51	54,44	0,58
2	140	74,9	64,55	0,39	53,50	-1,17
3	140	76,23	62,92	0,61	54,45	0,59
4						
5						
total =	420	227,35	190,53	mean =	54,13	

dry sieving of soil passing start mass: 227,35

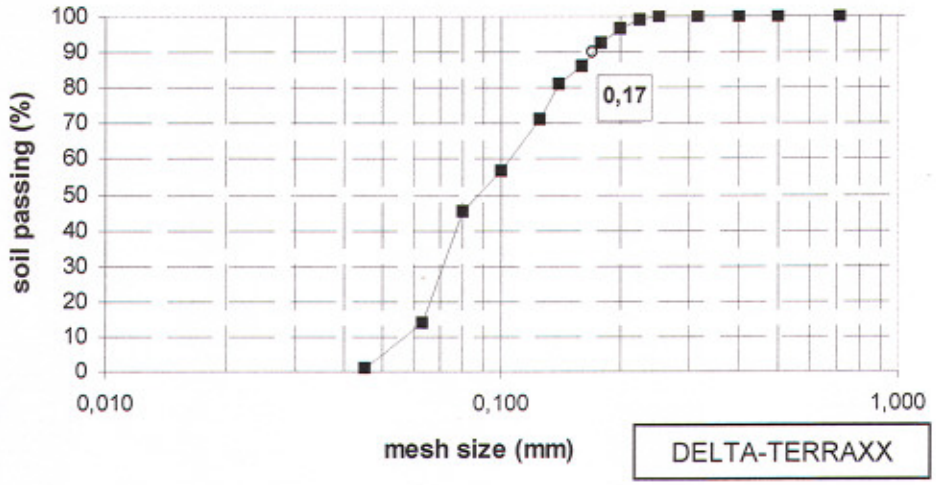
mesh size mm	mass of empty sieve g	mass of sieve and soil g	soil retained g	cumulative mass of soil passing g	cumulative percent of soil passing %	mesh size mm
<0,045	241,56	243,29	1,73			<0,045
0,045	330,23	359,92	29,69	1,73	**0,76**	**0,045**
0,063	324,01	395,77	71,76	31,42	**13,82**	**0,063**
0,080	324,88	350,37	25,49	103,18	**45,38**	**0,080**
0,100	328,23	361,83	33,60	128,67	**56,59**	**0,100**
0,125	336,82	358,93	22,11	162,27	**71,37**	**0,125**
0,140	399,89	411,30	11,41	184,38	**81,10**	**0,140**
0,160	342,00	356,84	14,84	195,79	**86,11**	**0,160**
0,180	407,19	416,23	9,04	210,63	**92,64**	**0,180**
0,200	342,79	348,51	5,72	219,67	**96,62**	**0,200**
0,224	414,76	416,21	1,45	225,39	**99,13**	**0,224**
0,250	412,34	412,73	0,39	226,84	**99,77**	**0,250**
0,315	353,21	353,31	0,10	227,23	**99,94**	**0,315**
0,400	360,82	360,85	0,03	227,33	**99,99**	**0,400**
0,500	370,83	370,83	0,00	227,36	**100,00**	**0,500**
0,710	395,82	395,82	0,00	227,36	**100,00**	**0,710**
1,180	375,90	375,90	0,00	227,36	**100,00**	**1,180**
		total =	227,36			
		loss =	0,00%			

Test report No. 1.1/13525/470.1-2002e enclosure A6

particle size distribution curve of the test soil



cumulative particle size distribution curve of the soil passing and determination of O_{90}



tbu Institut für textile Bau- und Umwelttechnik	determination of the characteristic opening size DIN EN ISO 12956 (06.1999)	