Woudenberg

TEST REPORT
32/01
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PHYSICAL, MECHANICAL and HYDRAULIC PROPERTIES of

MEBRADRAIN MD7007 and MD88-75

for:

GEOTECHNICS HOLLAND bv
P.O.Box 94900
1090GX Amsterdam

by:

Nico van Rijn
Q.C. Geosynthetics Laboratory
Amsterdam, The Netherlands

Content

1. Introduction

This report gives a summary of physical and mechanical tests that are executed according ASTM standards. The chosen tests are based on the tender documents for Penny's Bay Reclamation, Hong Kong, where the following properties are determined:

Core:
- ◊ Appearance
- ◊ Raw material
- ◊ Dimensions
- ◊ Weight

Filter:
- ◊ Appearance
- ◊ Raw material
- ◊ Weight
- ◊ Thickness
- ◊ Grab strength
- ◊ Permittivity
- ◊ Pore Size

Total drain:
- ◊ Size of the drain
- ◊ Weight and dimensions of the drain
- ◊ Visual inspection of the samples
- ◊ Configuration of the drain
- ◊ Tensile strength
- ◊ Elongation
- ◊ Discharge capacity
- ◊ Discharge capacity buckled

2. Drain Samples

The samples delivered by Geotechnics Holland were marked as follows:

Mebradrain MD7007
Mebradrain MD88

According information provided by Geotechnics Holland the drains were manufactured at the following location:

Geotechnics Holland bv
Zuider IJdijk 58
Amsterdam
The Netherlands

All samples had a length of 10 meter. The filter material used was Typar 5417. The seams were made by ultrasonic equipment. From each sample 18 pieces with a length of 500mm were cut to perform the following tests:

Discharge tests straight	3 tests
Discharge tests folded	3 tests
Tensile strength drain	5 tests
Apparent Opening Size	3 tests
Grab strength	5 tests
Permittivity	3 tests
Tear Strength	5 tests

The Grab Strength, Permittivity. Tear strength and Pore Size test were executed only in one serie for the 5417 filter fabric because all filter material was coming from one production batch Typar. Five samples drain were taken from different types of drain (MD88 and MD7007). Tensile strength tests were executed on 5 samples and discharge tests were executed on 3 samples of both drain types. In total 38 tests were executed on above mentioned properties.

3. Drain Configuration

Mebradrain MD7007 (100 x 3 mm) 2 x 19 grooves

Mebradrain MD88 (100 x 4 mm) 2 X 28 grooves

4. Description of tests:

The ASTM standards D 638 and ASTM D 4632-91 as specified in the tender documents are not suitable to test the tensile strength and elongation of a drain. D 638 is developed to test homogeneous plastics, not to test geosynthetics. D 4632-91 is a grab test suitable for geotextiles, but not suitable to test composites. Instead ASTM standard D 4595-86 was used to determine the tensile strength and elongation properties of the drains.

The testing procedures can be summarised as follows:

Weight drain	ASTM D3774
Thickness drain	ASTM D5199-91
Mass filter	ASTM D5261-92
Thickness filter	ASTM D5199-91
Grab strength filter	ASTM D4632-91
Permittivity	ASTM D4491-92
Pore Size	ASTM D4751-95
Tensile strength	ASTM D4595-86
Discharge capacity	ASTM D4716-87
Trapezoid Tearing strength	ASTM D4533-91

4. 1 Discharge test

The discharge tests were executed under following conditions:

1. Closed-sell foam rubber was used on both sides of the specimen to model the soil
2. Sample size was 300 mm long and 100 mm width.
3. A hydraulic gradient of i = 0.5 to model gravity flow conditions.
4. Test were executed at a temperature of 20°C
5. Instead of the minimum seating time of 15 minutes, a testing time of 5 days was used in order to determine the long term hydraulic conductivity.
   At this test procedure the measured values are much lower than at the standard test procedure.
6. A load was applied in 5 steps to a maximum of 450 kPa.

4.2 Permittivity, Grab, Tear and Pore Size tests on the filter fabric

Since all the fabric of a certain style was produced during the same production run, there were only three pore size tests and permittivity tests executed per fabric style from different drains. The average results of three tests were used to determine the values for all drains with the same type of fabric. Therefor the values found in the table are equal.

4.2.1. Permittivity

Permittivity tests were executed according the constant head method by applying head at intervals of 5 mm and using deaired water with a temperature of 20°C. The permittivity was determined by using the formula:

$$\Psi = \frac{Q}{\Delta h.A}$$

4.2.2 Pore size

The pore size was determined using U.S. Sieve # and Glass Beads according following table:

U.S. sieve #	Bead Size
140	0.106
170	0.090
200	0.075

4.2.3 Grab Strength Test

Samples are immersed in water for one hour and tested with a constant rate of 300 mm/min. Tests were executed in machine direction.

4.2.4 Tear Strength test

All test were done in machine direction. Testing speed was 300 mm/min.

4.3 Tensile Test on the total drain

In deviation from par. 11.1 from ASTM D4595 the tensile strength is given as an absolute value and not strength per width, because of the limited width of the material. The samples were tested at a speed of 300 mm/min.

5. Summary of the test results

Drain	Unit	MD7007-5417	MD88-5417
CORE			
Visual Inspection		No anomalies	no anomalies
Configuration		extrusion profile PP 2 x 19 grooves	extrusion profile PP 2 x 28 grooves
Weight	g/m	40	68
Thickness	mm	2.4	3.4
Width	mm	96	98
FILTER			
Configuration		PP nonwoven	PP nonwoven
Weight	g/m²	141	141
Thickness	mm	0.43	0.43
Grab strength	N	697	697
Tear Strength	N	128	128
Permeability	10^{-4} m/s	1.16	1.16
Permittivity (at 50 mm head)	s^{-1}	0.27	0.27
Pore Size O_{95}	µm	73	73
DRAIN			
Thickness	mm	3.1	4.2
Width	mm	100	101
Weight	g	72	99
Tensile Strength	kN	2.51	3.35
Elongation at break	%	42	41
Elongation at 1 kN	%	2.7	2.5
Discharge capacity straight (250kPa)	10^{-3} l/s	120	135
Discharge capacity 50% buckled (250kPa)	10^{-3} l/s	71	52

APPENDIX I

Proposal Kiwa Certification Requirements:

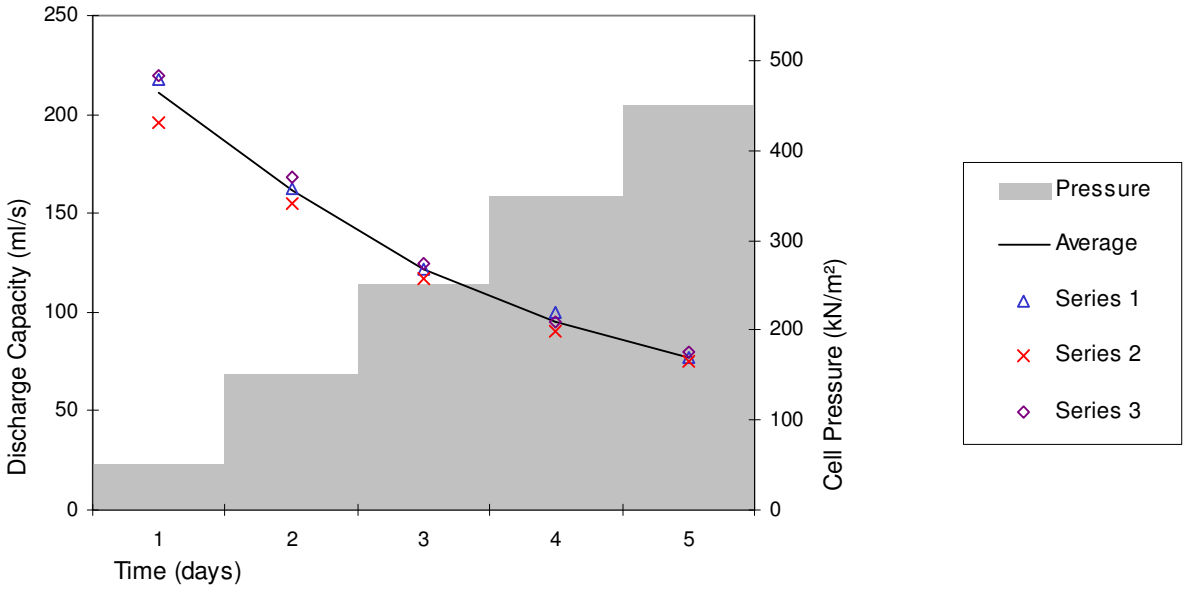
Property	Requirement	Unit	Standard
Core			
Appearance	without tears, holes Damages		
Raw Material	PE, PP, PET or PVC		
Shape	Profile or Mat		
Mass	weight per length unit according specifications supplier	g/m'	ISO 9864
Width	width according specifications supplier	mm	D3774
Thickness	thickness according specifications supplier	mm	D5199
Filter			
Raw Material	PP, PE or PET		
Mass	weight per area according specifications supplier	g/m²	D5261 ISO 9073/1
Thickness	no requirement for calculation permittivity	mm	D5199 ISO 9073/2
Tear Strength	> 150	N	D4533 ISO 9073
Permittivity	> 0.005	s^{-1}	D4491 ISO 811
Pore Size at Peat or Silt Soils	< 150	µm	D4751
Pore Size at Clay Soil	< 75	µm	D4751
Tensile Strength	no break during discharge tests		
Drain			
Appearance	without tears, holes, folds or damages		
Seam	no holes, frost resistant, 25% tensile strength filter		
Mass	weight per unit according specifications supplier	g/m'	D5261 ISO 9864
Width	according specifications supplier	mm	D3774
Thickness	according specifications supplier	mm	D5199 ISO 9863
Tensile Strength	> 1	kN	D4595 ISO 527-1/2
Elongation	> 2	%	D4595 ISO 527-1/2
Elongation at 0.5 kN	< 10	%	D4595 ISO 527-1/2
Discharge capacity at I = 0,1 and 350 kPa after 4 days	> 50	ml/s	proposal discharge standard
Discharge capacity buckled at I = 0,1 and 350 kPa after 3 days	> 30	ml/s	proposal discharge standard

APPENDIX II

DISCHARGE TESTS (Straight)

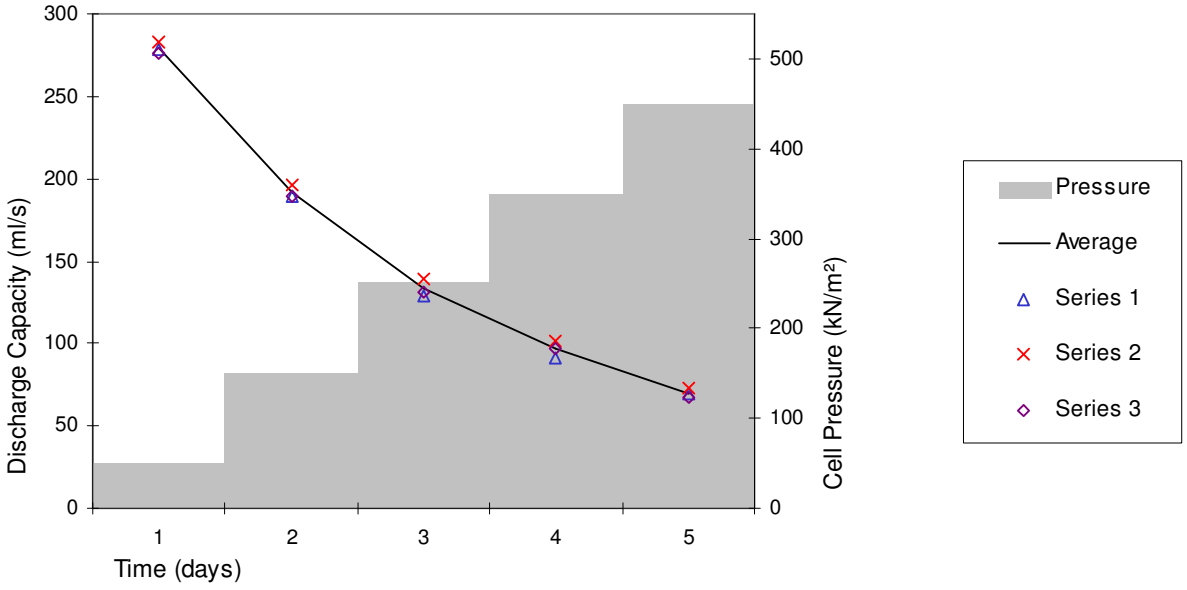
MEBRADRAIN MD7007-5417

(At i = 0.5)



MEBRADRAIN MD88-5417

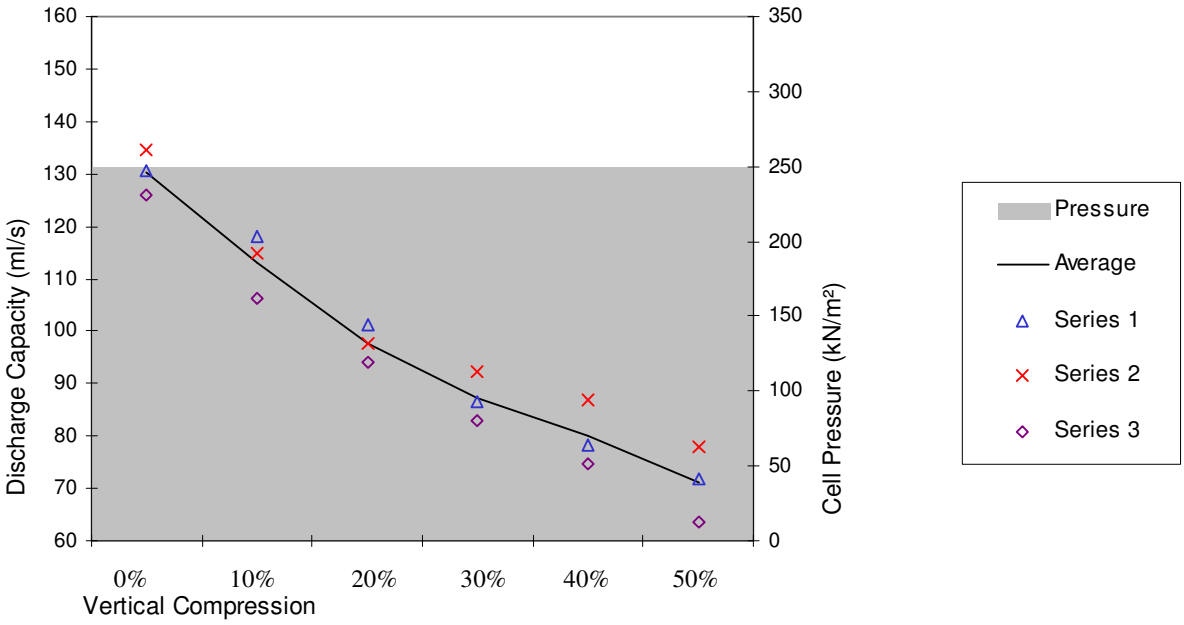
(At i = 0.5)



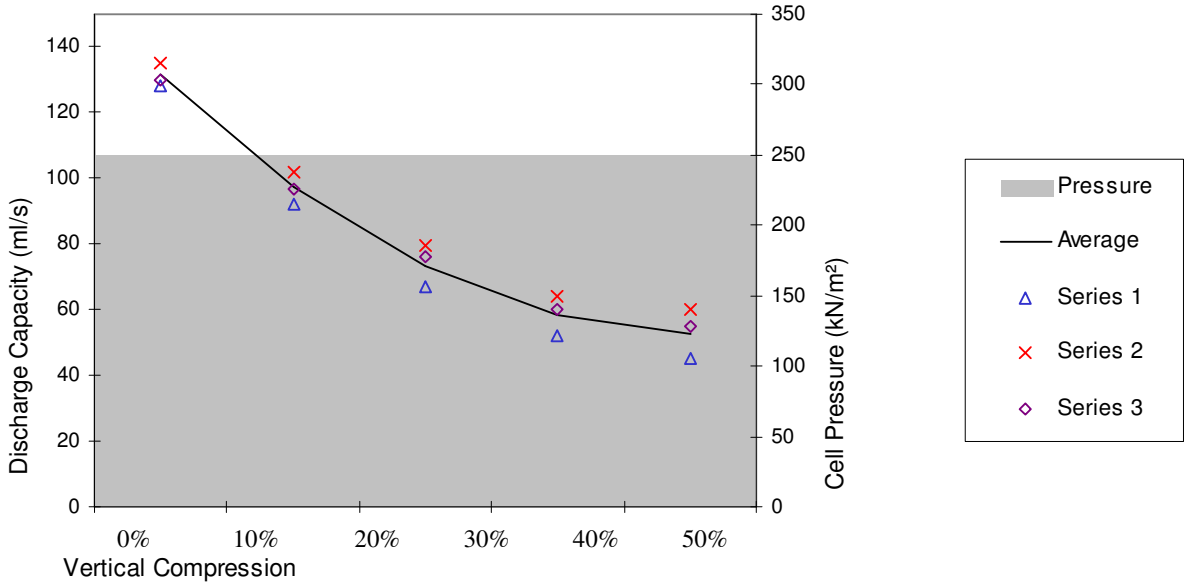
APPENDIX III

DISCHARGE TEST RESULTS (Buckled)

MEBRADRAIN MD7007-5417
(Buckled at i = 0.5)

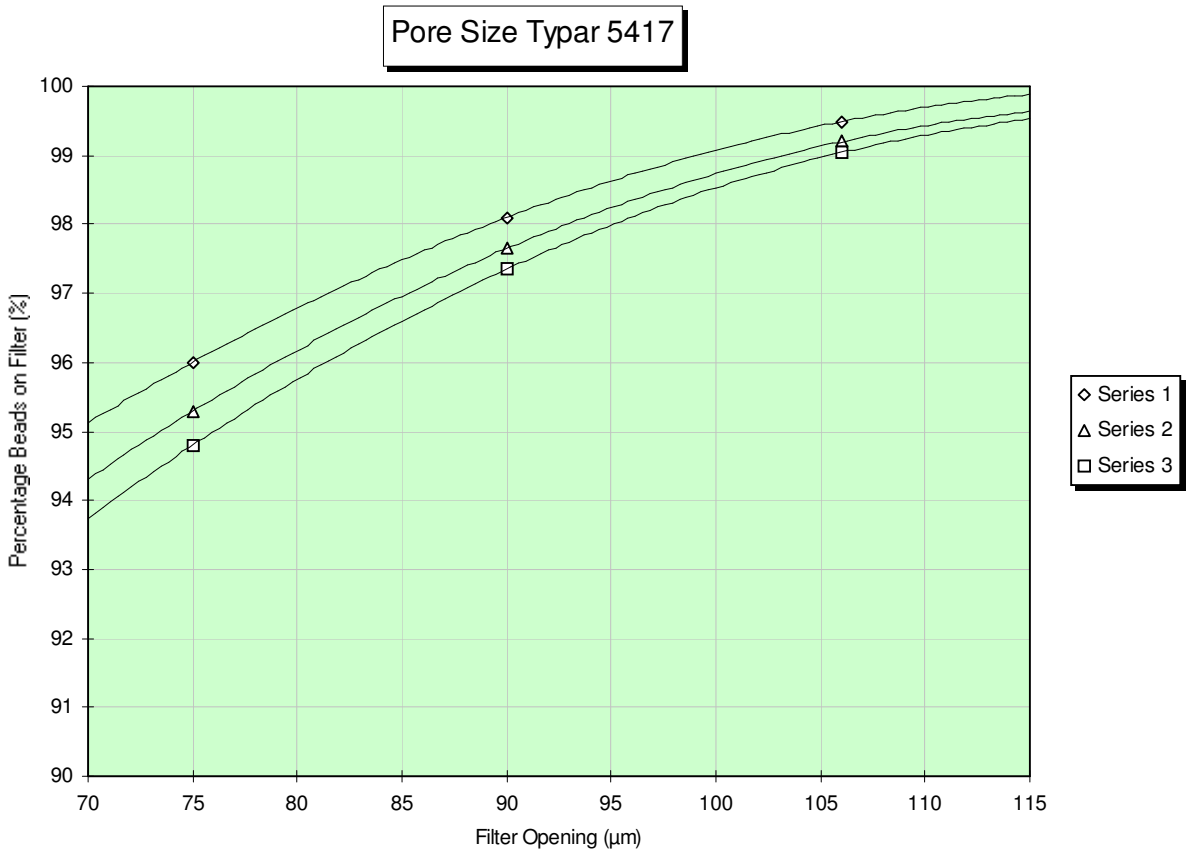


MEBRADRAIN MD88-5417
(Buckled at i = 0.5)



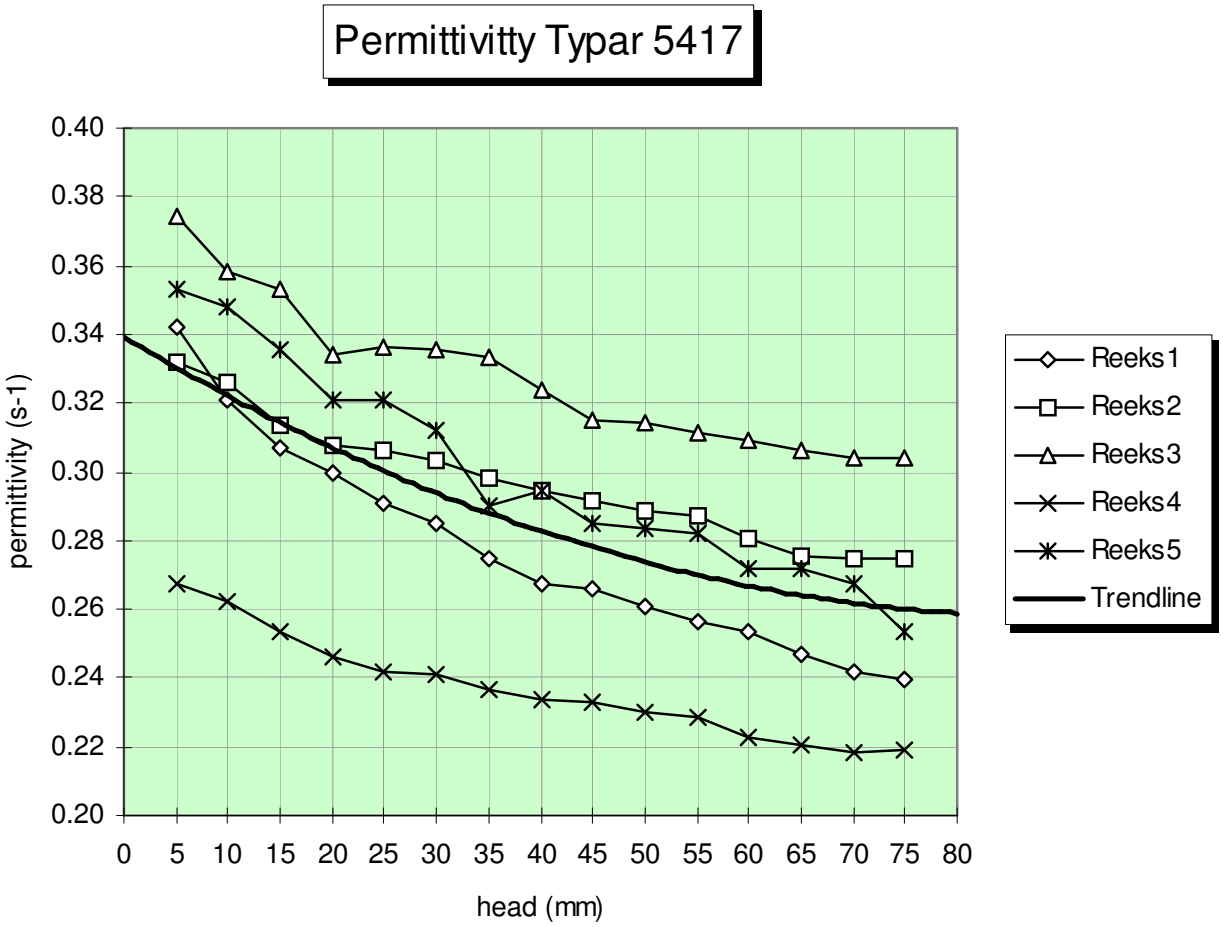
APPENDIX IV

PORE SIZE TEST RESULTS



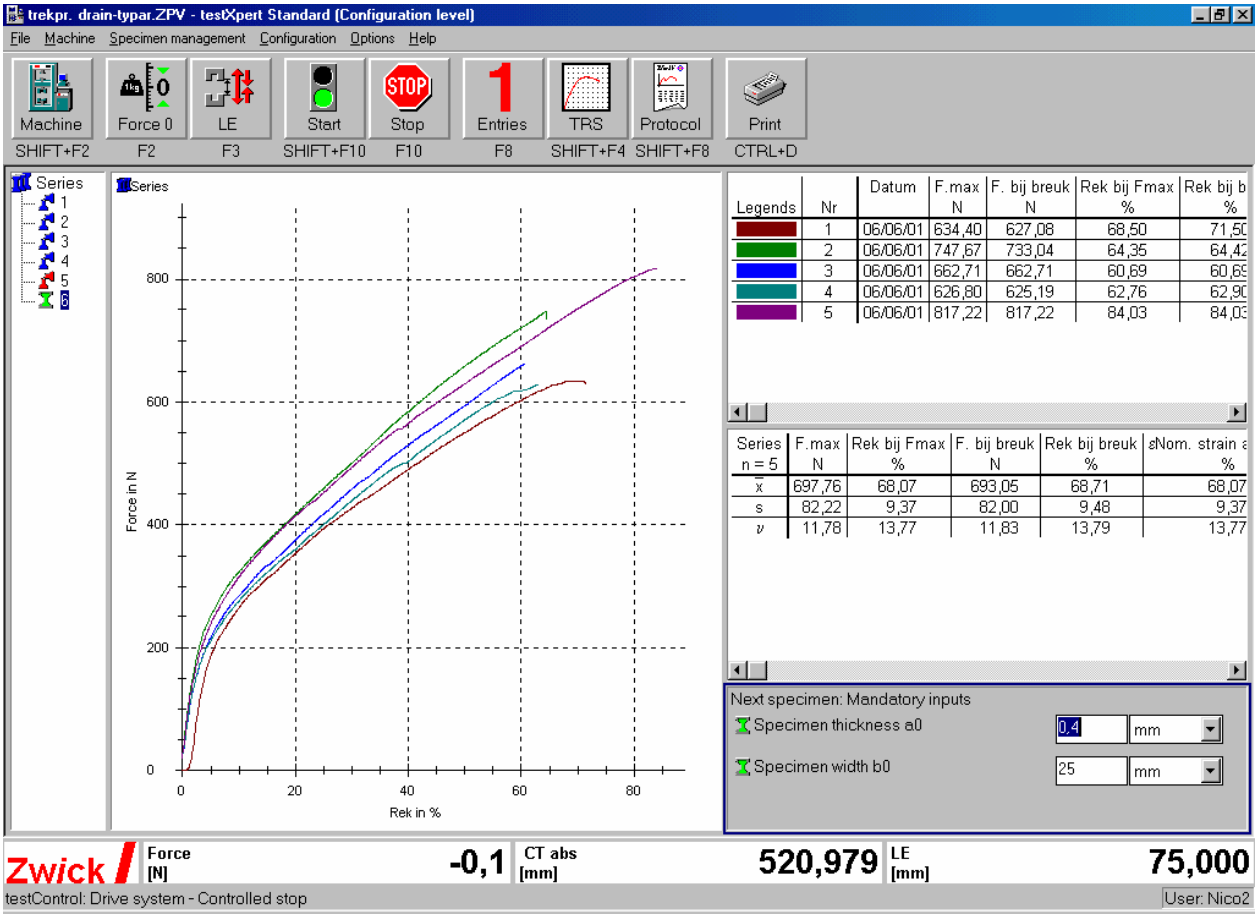
APPENDIX V

PERMITTIVITY TEST RESULTS



APPENDIX VI

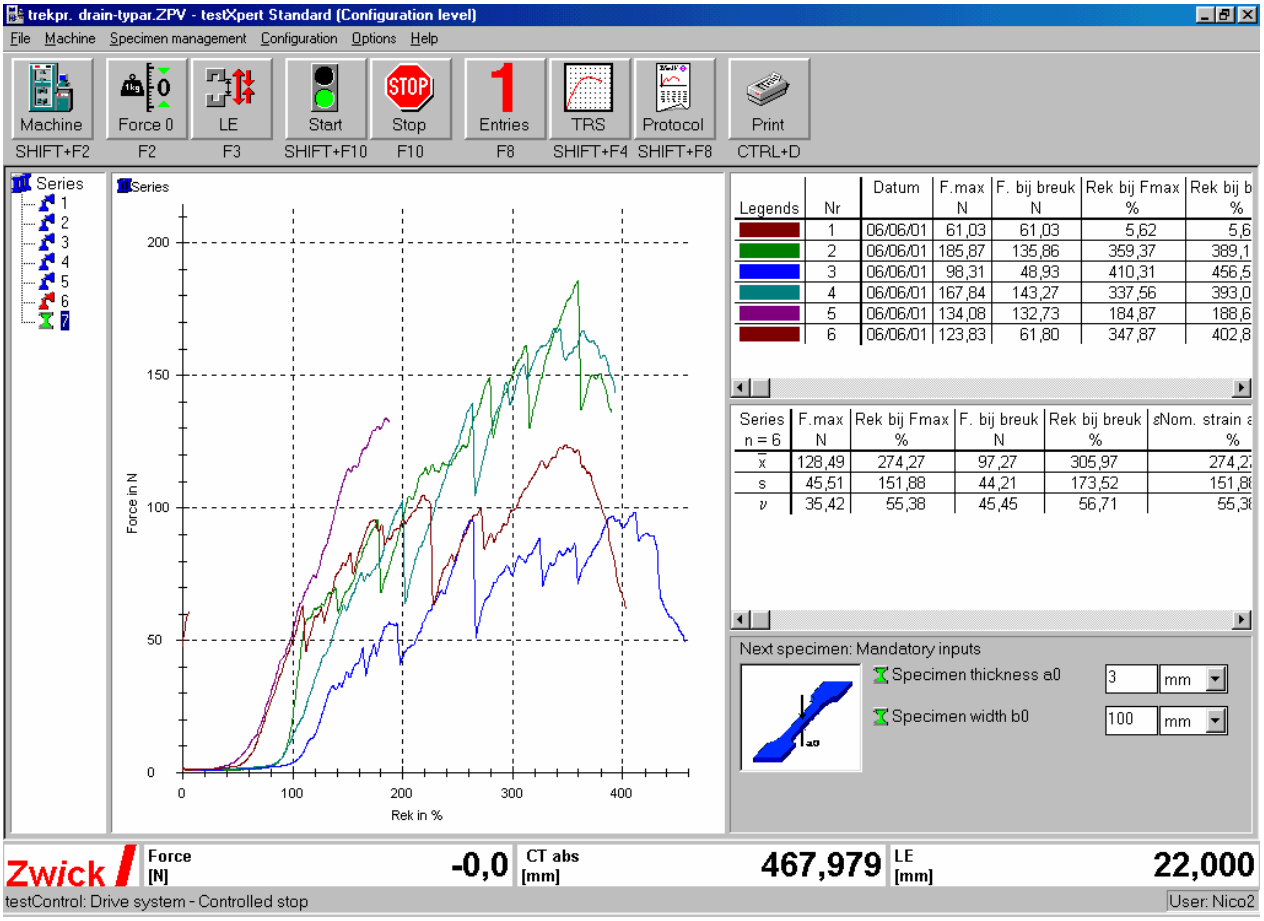
GRAB TEST RESULTS



Test	: Grab Strength according ASTM D 4632-91
Material	: Typar 5417
Test Speed	: 300 mm/min
Test Machine	: Zwick Z010 (10kN)
Clamps	: Pneumatic
Date	: 060601

APPENDIX VI

TRAPEZOID TEAR STRENGTH

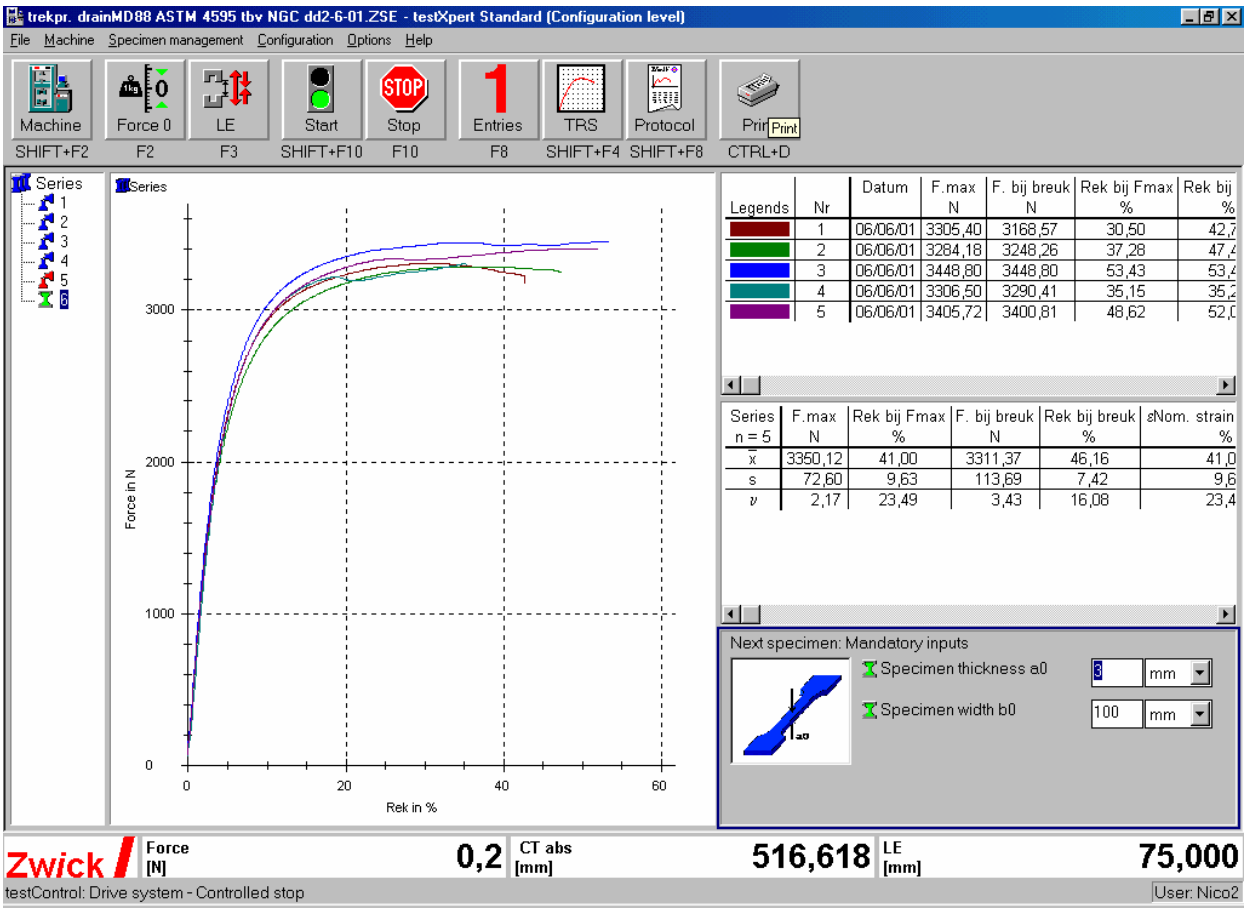


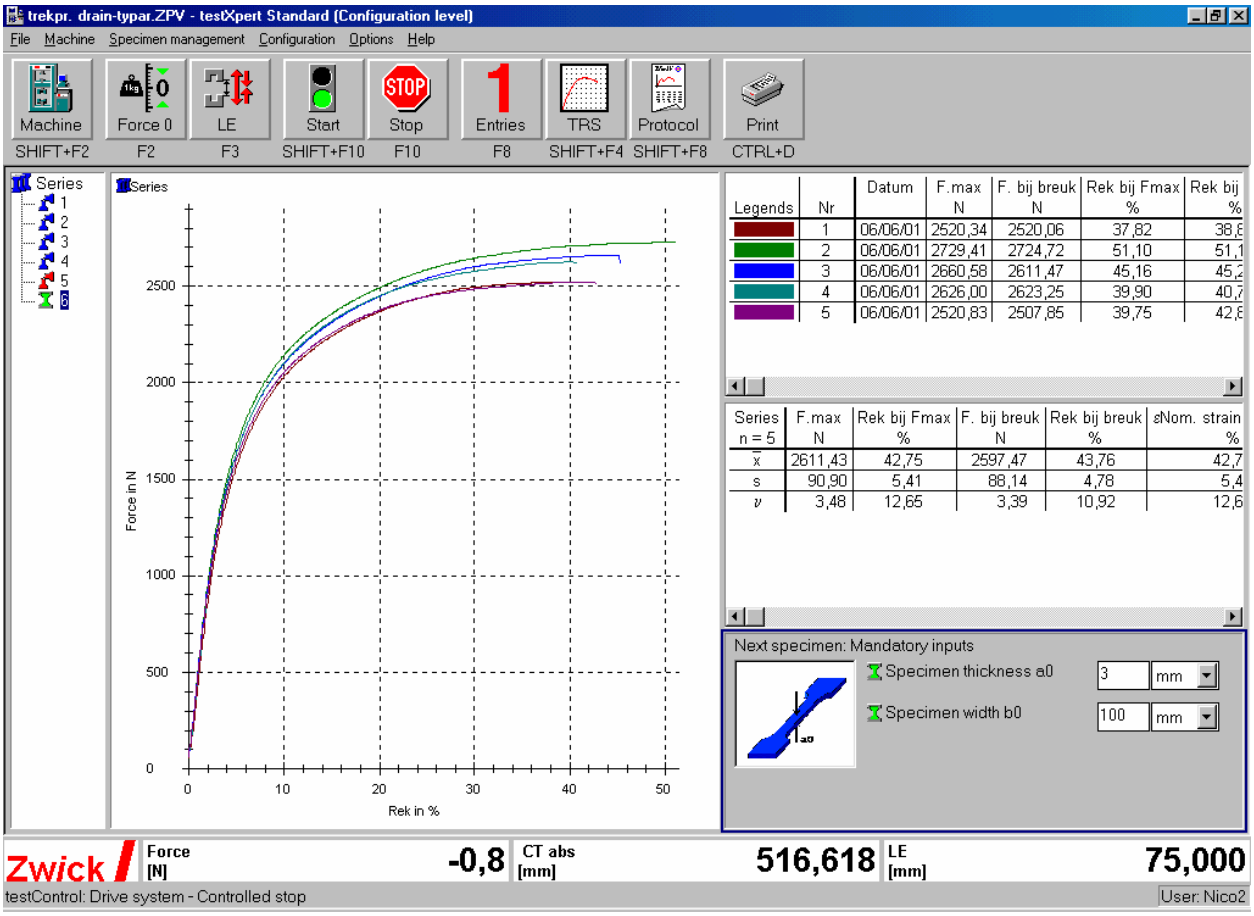
Test	:Trap Tear Strength according ASTM D 4533-91
Material	:Typar 5417
Test Speed	: 300 mm/min
Test Machine	: Zwick Z010 (10kN)
Clamps	: Pneumatic
Date	: 060601

APPENDIX VIII

TENSILE TEST RESULTS

Test	: Strip Tensile Strength Test ASTM D 4595-86
Material	: Mebradrain MD88
Test Speed	: 300 mm/min
Test Machine	: Zwick Z010 (10kN)
Clamps	: Pneumatic





Test	: Strip Tensile Strength Test ASTM D 4595-86
Material	: Mebradrain MD7007
Test Speed	: 300 mm/min
Test Machine	: Zwick Z010 (10kN)
Clamps	: Pneumatic

APPENDIX IX

SPECIFICATIONS SUPPLIER

Physical properties			**unit**	**MD7007**	**MD7007**	**MD88-75**	**MD88-75**
Drain body	configuration						
material				PP	PP	PP	PP
	colour			white	white	white	white
Filter	Typar			**5417**	**5357**	**5417**	**5357**
	material			PP	PP	PP	PP
	colour			grey	grey	grey	grey
Weight			g/m	70	67	88	85
Width			mm	100	100	100	100
Thickness			mm	3	3	4	4
Mechanical properties	**symbol**	**test**	**unit**				
Tensile strength drain	F		kN	2.4	2.1	2.9	2.7
Elongation	ε		%	40	40	40	40
Elongation at 0,5 kN	$\varepsilon_{0,5\kappa N}$		%	6	6	5	5
Discharge capacity at 350 kPa	q_w	Delft (i = 0.1)	m^3/s	$80*10^{-6}$	$80*10^{-6}$	$85*10^{-6}$	$85*10^{-6}$
Disch.cap. buckled at 250 kPa	q_w	Delft (i = 0.1)	m^3/s	$65*10^{-6}$	$65*10^{-6}$	$70*10^{-6}$	$70*10^{-6}$
Permittivity filter	ψ	ASTM D4491	s^{-1}	0.25	0.5	0.25	0.5
Permeability	k	ASTM D4491	mm/s	0.1	0.2	0.1	0.2
Pore Size	O_{95}	ASTM D4751	µm	75	75	75	75
Puncture resistance filter		ASTM D4833	kN	150	115	150	115
Grab strength filter		ASTM D4632	N	400	350	400	350
Bursting strength		ASTM D3785	kPa	900	800	900	800
Tear strength filter		ASTM D4533	N	200	150	200	150
Transport details			**unit**				
Roll length			m	300	300	250	250
Outside diameter roll			m	1.10	1.10	1.10	1.10
Inside diameter roll			m	0.15	0.15	0.15	0.15
Weight roll			kg	21	20	22	21
40ft container			m	160,000	160,000	130,000	130,000