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Permeability tests on Silkeborg Sand No 0000

W.P. Lund, K.P. Jakobsen

1998

Laboratory Testing Paper No 21



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Permeability Tests on Silkeborg Sand No. 0000

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1 INTRODUCTION

The flow through porous media plays an important role in various engineering disciplines, as for example in ground water hydrology and soil mechanics. In the present study the permeability is determined for a fine, saturated sand. As the flow through a porous media strongly depends on the characteristics of the soil matrix, the permeability is determined for different void ratios. All tests are performed on reconstituted specimens of Silkeborg Sand No. 0000. The permeability is determined by use of a falling head apparatus. The apparatus, test procedures and the analysis method are described in the succeeding sections. Finally the test results are briefly summarised and a relationship between void ratio and permeability is established.

2 SILKEBORG SAND NO. 0000

The sand, denoted Silkeborg Sand No. 0000, is an artificial sand from a gravel pit near Horsens in Denmark.

The grain size distribution is given in Figure 1. The material contains approximately 1.4% of fines and has a maximum grain size of approximately 0.425 mm. The classification properties are summarised in Table 1.

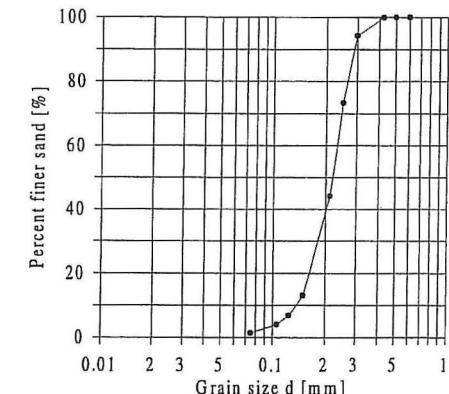


Figure 1. Grain size distribution for Silkeborg Sand No. 0000.

Table 1. Classification properties for Silkeborg Sand No. 0000.

Property	Value
Specific gravity, G_s	2.653
Maximum void ratio, e_{max}	0.932
Minimum void ratio, e_{min}	0.578
Mean grain size, d_{50}	0.220 mm
Uniformity coefficient, $C_U = \frac{d_{60}}{d_{10}}$	1.69
Curvature coefficient, $C = \frac{d_{30}^2}{d_{10}d_{60}}$	1.06

3 FALLING HEAD PERMEAMETER

The test set-up consists of a permeameter containing the fully saturated soil specimen, a standpipe and an overflow basin, see Figure 2.

When the valve in the overflow basin is opened, the water level in the standpipe falls and the water flows through the specimen.

An initial and a final hydraulic head are chosen prior to testing. These hydraulic heads are in the following denoted h_0 and h_2 and the flow times measured during the test are correspondingly denoted t_0 and t_2 . The test is repeated until a reproducible value of flow time, t_2 , is obtained.

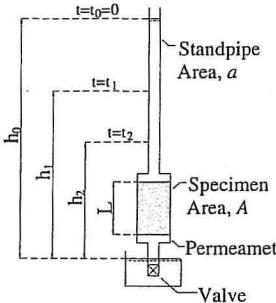


Figure 2. Principle of the falling head permeameter test.

Based on corresponding values of passed time, temperature and loss of head (at a given discharge) the hydraulic conductivity and the permeability may be determined by the simple analytical relationship given in Equation (3).

Besides the measurement of total head loss (h_0-h_2) and total time t_2 , measurement of flow time, t_1 , at an intermediate head, h_1 , are performed to control whether quasi-steady flow conditions exist (see Section 5).

4 SPECIMEN PREPARATION

All specimens are prepared by air pluviation in a cylindrical Plexiglas permeameter with a diameter of 70 mm and a length of approximately 200 mm. The specimens are saturated

by the water percolation method, where de-ionised and de-aired water is introduced through the bottom filter. As the water slowly seeps up through the specimen under a small gradient, entrapped air gets flushed out through the upper filter. As complete saturation of the specimen is necessary to avoid clogging of the pores and to obtain reliable flow parameters the saturation process is furthermore performed under vacuum, causing the volume of air to enlarge and, in part, be sucked out of the specimen.

5 ANALYSIS OF TEST RESULTS

On the assumption that the flow can be considered to be laminar and quasi-steady, the discharge from the standpipe equals the amount of water passing through the specimen per unit time, and the forces of inertia due to velocity changes become negligible. Thus, the hydraulic conductivity can with reasonable accuracy be described by use of the continuity equation and Darcy's law:

$$\frac{dh}{dt}a = Av \quad (1)$$

$$v = ki \quad (2)$$

Solving the differential equation, using the boundary condition, $h=h_0$ and $t=t_0=0$, yields the relationship between loss of head, flow time and hydraulic conductivity:

$$\ln(h) = -\frac{Ak}{aL}t + \ln(h_0) \quad \text{or} \quad k = \ln\left(\frac{h_0}{h}\right)\frac{aL}{At} \quad (3)$$

The hydraulic conductivity depends on the flow properties of the soil matrix and the fluid. This mixture is disadvantageous and it is preferable to introduce the fluid properties and the permeability, K , which solely refers to the properties of the soil matrix:

$$K = k \frac{\nu_{Tc}}{g} \quad (4)$$

where ν_{Tc} is the kinematic viscosity at T °C.

As stipulated in Section 3 an intermediate head and the corresponding flow time can be used as an indication of whether the assumption of quasi-steady flow is applicable or not.

Assuming that the intermediate flow time, t_1 , corresponds to half the total flow time, t_2 , an intermediate hydraulic head, h_1 , can be determined from Equation (3). Rearrangement of (3) and use of the boundary condition $h=h_2$ for $t=t_2$, yields:

$$t_2 = \frac{aL}{Ak} \ln\left(\frac{h_0}{h_2}\right) \quad (5)$$

Insertion of $t_1=\frac{1}{2}t_2$ in Equation (3) yields the intermediate head, h_1 :

$$h_1 = \sqrt{h_0 h_2} \quad (6)$$

Thus, the intermediate hydraulic head of $h_1 = \sqrt{h_0 h_2}$, corresponds to half the total flow time for quasi-steady flow conditions.

A more thorough evaluation of the quasi-steady flow assumption is found in Jakobsen (1998).

6 PRESENTATION OF TEST RESULTS

The performed permeability tests are presented in Enclosures 1-27, with test conditions, measured values and results. Each enclosure consists of three tables. The first table contains information about test material, void ratio, length and diameter of the specimen and degree of saturation.

The second table contains the scheduled test program and factors correcting for the disparity between nominal and actual volumes of the permeameter and the standpipe.

In the third table the measured quantities, i.e. water temperature at top and bottom of the permeameter and flow times corresponding to intermediate and total loss of head, are tabulated together with the calculated hydraulic conductivity and permeability.

The calculated permeabilities are not corrected for incomplete saturation, as the degree of saturation in all the tests is close to unity

and the deviations merely indicate the uncertainty on the measuring method. The test results are summarised in Table 2.

Table 2. Results from performed permeability tests on Silkeborg Sand No. 0000.

Test No	Void ratio $e [-]$	Permeability $K [10^{-12} m^3]$
9810.P1	0.638	16.52
9810.P2	0.680	20.23
9810.P3	0.622	14.21
9810.P4	0.627	14.66
9810.P5	0.622	13.90
9810.P6	0.615	13.13
9810.P7	0.613	12.54
9810.P8	0.615	13.85
9810.P9	0.658	16.81
9810.P10	0.645	16.97
9810.P11	0.641	15.69
9810.P12	0.637	15.32
9810.P13	0.607	12.74
9810.P14	0.601	14.23
9810.P15	0.667	16.51
9810.P16	0.791	29.86
9810.P17	0.658	18.18
9810.P18	0.810	32.78
9810.P19	0.629	15.62
9810.P20	0.675	20.28
9810.P21	0.667	20.22
9810.P22	0.718	23.22
9810.P23	0.755	25.30
9810.P24	0.747	25.77
9810.P25	0.706	20.46
9810.P26	0.720	24.64

6.1 Void ratio dependency

The results in Table 2 show that the permeability of the soil skeleton is strongly dependent on the void ratio. This dependency has been described by Taylor (1948) and Lund and Møldrup (1996), both fulfilling physical prerequisite of zero permeability for zero

porosity or void ratio. The proposed relationships are given in Equation (13) and (14), respectively:

$$K = C_1(1+e)e^2 = 2.500 \cdot 10^{-11}(1+e)e^2 \quad (13)$$

$$K = C_2 \frac{e^3}{(1+e)} = 1.037 \cdot 10^{-10} \frac{e^3}{(1+e)} \quad (14)$$

The suggested relationships and the measured permeabilities are shown in Figure 3. Both relationships lead to an overestimation of the permeability at low void ratios and vice versa.

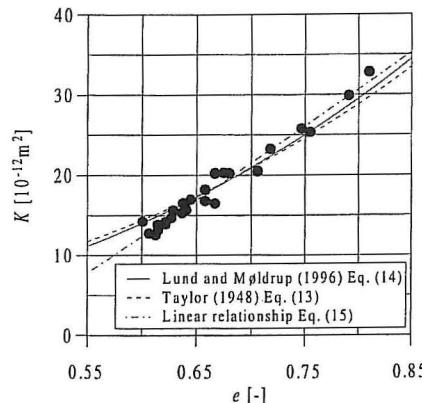


Figure 3. Relation between void ratio and permeability.

However, a simple linear relationship between void ratio and permeability yields a more satisfactory result within the range of e_{min} and e_{max} , whereby it becomes applicable for all practical purpose. The linear relationship is given by:

$$K = 91.567 \cdot 10^{-12}e - 42.602 \cdot 10^{-11} \quad (15)$$

7 ACKNOWLEDGEMENT

The authors are grateful to Jens Chr. Ildal for his careful execution of several of the permeability tests used in the present study.

9 NOTATION

a [mm ²]	: cross sectional area of standpipe
A [mm ²]	: cross sectional area of permeameter
C [-]	: curvature coefficient
C_u [-]	: uniformity coefficient
d [mm]	: particle diameter
d [mm]	: standpipe diameter
e [-]	: void ratio
F_s [-]	: volume correction factor for standpipe
F_p [-]	: volume correction factor for permeameter
h [mm]	: hydraulic head
h_0 [mm]	: initial hydraulic head
h_i [mm]	: intermediate hydraulic head
h_2 [mm]	: final hydraulic head
k [m/s]	: hydraulic conductivity
k_{T^c} [m/s]	: hydraulic conductivity at temperature T °C
K [m ²]	: permeability
L [mm]	: specimen length
t [s]	: flow time
t_1 [s]	: flow time for intermediate head
t_2 [s]	: total flow time
T [°C]	: temperature
T_1 [°C]	: temperature at the top of the specimen
T_2 [°C]	: temperature at the bottom of the specimen
v [m/s]	: velocity
v [m ² /s]	: kinematic viscosity
v_{T^c} [m ² /s]	: kinematic viscosity at given temperature T °C

Enclosures

Enclosure 1	Permeability Test 9810.P1	1 page
Enclosure 2	Permeability Test 9810.P2	1 page
Enclosure 3	Permeability Test 9810.P3	1 page
Enclosure 4	Permeability Test 9810.P4	1 page
Enclosure 5	Permeability Test 9810.P5	1 page
Enclosure 6	Permeability Test 9810.P6	1 page
Enclosure 7	Permeability Test 9810.P7	1 page
Enclosure 8	Permeability Test 9810.P8	1 page
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Enclosure 24	Permeability Test 9810.P24	1 page
Enclosure 25	Permeability Test 9810.P25	1 page
Enclosure 26	Permeability Test 9810.P26	1 page

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation	Specimen dimensions	
		Length [mm]	201	
Date	Falling head apparatus	Diameter [mm]	70	
1998-04-23	Permeameter A	Void ratio [-]	0.638	
		Saturation [-]		

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[-]	1.0936
	Volume correction factor for permeameter (F_p)	[-]	1.0129

Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.9	24.4	24.9	
Temperature (T_2)	[°C]	23.8	24.1	24.6	
Elapsed time for flow (t_1)	[s]	46	45	45	
Elapsed time for flow (t_2)	[s]	92	90	90	
Hydraulic conductivity ($k_{Tc} \cdot 10^4$)	[m/s]	1.764	1.804	1.804	
Mean temperature (T)	[°C]	23.9	24.3	24.75	
Kinematic viscosity ($\nu_{Tc} \cdot 10^6$)	[m ² /s]	0.9178	0.9095	0.8994	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.649	1.670	1.652	

Remarks: Incorrect measurement of water content after test. Degree of saturation not accessible.

Job: 9810	Aalborg University
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Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	200	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[\cdot]	0.680	
1998-04-21	Permeameter B	Saturation	[\cdot]	1.02	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9921

Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.8	24.4	24.6	
Temperature (T_2)	[°C]	24.0	24.3	24.5	
Elapsed time for flow (t_1)	[s]	38	38	37	
Elapsed time for flow (t_2)	[s]	76	76	75	
Hydraulic conductivity ($k_{Tc} \cdot 10^{-4}$)	[m/s]	2.170	2.170	2.199	
Mean temperature (T)	[°C]	23.9	24.4	24.6	
Kinematic viscosity ($\nu_{Tc} \cdot 10^6$)	[m ² /s]	0.9158	0.9075	0.9034	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.413	1.424	1.421	

Remarks:

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	201	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[\cdot]	0.622	
1998-04-23	Permeameter B	Saturation	[\cdot]	1.00	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9935

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.6	25.2	25.5	
Temperature (T_2)	[°C]	24.2	24.6	25.3	
Elapsed time for flow (t_1)	[s]	54	53	52	
Elapsed time for flow (t_2)	[s]	108	106	106	
Hydraulic conductivity ($k_{Tc} \cdot 10^{-4}$)	[m/s]	1.532	1.561	1.576	
Mean temperature (T)	[°C]	24.4	24.9	25.4	
Kinematic viscosity ($\nu_{Tc} \cdot 10^6$)	[m ² /s]	0.9054	0.8954	0.8853	
Permeability ($K \cdot 10^{11}$)	[m ²]	2.024	2.005	2.023	

Remarks:

Job: 9810	Aalborg University
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Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 3
Evaluated: KPJ	Approved: WL

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
		Length	[mm]	201	
		Diameter	[mm]	70	
Date		Void ratio	[\cdot]	0.627	
1998-04-23		Saturation	[\cdot]	1.03	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9935

Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.0	23.4	23.7	
Temperature (T_2)	[°C]	23.0	23.1	23.6	
Elapsed time for flow (t_1)	[s]	53	53	53	
Elapsed time for flow (t_2)	[s]	107	106	106	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.547	1.561	1.561	
Mean temperature (T)	[°C]	23.0	23.3	23.7	
Kinematic viscosity ($v_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9352	0.9309	0.9222	
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.473	1.480	1.466	

Remarks:

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
		Length	[mm]	202	
		Diameter	[mm]	70	
Date		Void ratio	[\cdot]	0.622	
1998-04-21		Saturation	[\cdot]	1.01	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0130

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.7	25.2	25.5	
Temperature (T_2)	[°C]	24.4	24.7	25.2	
Elapsed time for flow (t_1)	[s]	54	54	53	
Elapsed time for flow (t_2)	[s]	109	108	106	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.496	1.510	1.539	
Mean temperature (T)	[°C]	24.6	25.0	25.4	
Kinematic viscosity ($v_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9034	0.8954	0.8873	
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.377	1.377	1.390	

Remarks:

Job: 9810	Aalborg University
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Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 5
Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	201	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[\cdot]	0.615	
1998-04-16	Permeameter B	Saturation	[\cdot]	1.01	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9935

Test	1	2	3	4	5
Temperature (T_1)	[°C]	22.1	22.2	22.4	
Temperature (T_2)	[°C]	21.9	22.1	22.3	
Elapsed time for flow (t_1)	[s]	61	61	61	
Elapsed time for flow (t_2)	[s]	122	122	122	
Hydraulic conductivity ($k_{rc} \cdot 10^4$)	[m/s]	1.357	1.357	1.357	
Mean temperature (T)	[°C]	22.0	22.2	22.4	
Kinematic viscosity ($\nu_{rc} \cdot 10^6$)	[m ² /s]	0.9569	0.9547	0.9504	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.322	1.319	1.313	

Remarks:

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	201	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[\cdot]	0.613	
1998-04-16	Permeameter B	Saturation	[\cdot]	1.01	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9935

Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.9	24.2	24.4	
Temperature (T_2)	[°C]	23.5	23.8	24.3	
Elapsed time for flow (t_1)	[s]	62	61	61	
Elapsed time for flow (t_2)	[s]	124	122	122	
Hydraulic conductivity ($k_{rc} \cdot 10^4$)	[m/s]	1.335	1.357	1.357	
Mean temperature (T)	[°C]	23.7	24.0	24.4	
Kinematic viscosity ($\nu_{rc} \cdot 10^6$)	[m ² /s]	0.9200	0.9135	0.9075	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.250	1.262	1.254	

Remarks:

Job: 9810	Aalborg University
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Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 7
Evaluated: KPJ	Approved: WL

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
		Length	[mm]	200	
		Diameter	[mm]	70	
Date 1998-04-16		Void ratio	[\cdot]	0.615	
		Saturation	[\cdot]	1.03	

Test program	Standpipe diameter (d)	[mm]	20	
	Initial hydraulic head (h_0)	[mm]	2000	
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265	
	Final hydraulic head (h_2)	[mm]	800	
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936	
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0129	

Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.0	23.3	23.5	
Temperature (T_2)	[°C]	22.7	23.0	23.3	
Elapsed time for flow (t_1)	[s]	56	55	55	
Elapsed time for flow (t_2)	[s]	112	110	110	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.442	1.468	1.468	
Mean temperature (T)	[°C]	22.9	23.2	23.4	
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9395	0.9330	0.9265	
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.380	1.395	1.385	

Remarks:

Description of soil Silkeborg No. 0000	Sample preparation method Air pluviation	Specimen dimensions
		Length [mm] 200
		Diameter [mm] 70

Date 1998-04-16	Falling head apparatus Permeameter A	Void ratio [-] 0.658	Saturation [-] 1.02
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Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.9	24.5	24.8	25.1
Temperature (T_2)	[°C]	23.7	24.1	24.6	25.1
Elapsed time for flow (t_1)	[s]	45	44	44	44
Elapsed time for flow (t_2)	[s]	90	88	88	88
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.795	1.835	1.835	1.835
Mean temperature (T)	[°C]	23.8	24.3	24.7	25.1
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9178	0.9075	0.8994	0.8913
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.677	1.696	1.681	1.666

Remarks:

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 8
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 9
Evaluated: KPJ	Approved: WL

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
Length	[mm]	201			
Diameter	[mm]	70			
Date	Falling head apparatus	Void ratio	[\cdot]	0.645	
1998-04-21	Permeameter A	Saturation	[\cdot]	1.01	

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
Length	[mm]	202			
Diameter	[mm]	70			
Date	Falling head apparatus	Void ratio	[\cdot]	0.641	
1998-04-21	Permeameter B	Saturation	[\cdot]	1.01	

Test program	Standpipe diameter (d)	[mm]	20	
	Initial hydraulic head (h_0)	[mm]	2000	
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265	
	Final hydraulic head (h_2)	[mm]	800	
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936	
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0129	

Test program	Standpipe diameter (d)	[mm]	20	
	Initial hydraulic head (h_0)	[mm]	2000	
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265	
	Final hydraulic head (h_2)	[mm]	800	
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936	
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9935	

Test	1	2	3	4	5
Temperature (T_1)	[°C]	23.2	23.6	24.0	
Temperature (T_2)	[°C]	23.5	23.6	24.0	
Elapsed time for flow (t_1)	[s]	45	45	44	
Elapsed time for flow (t_2)	[s]	90	90	89	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.804	1.804	1.824	
Mean temperature (T)	[°C]	23.4	23.6	24.0	
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9287	0.9222	0.9135	
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.706	1.694	1.697	

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.7	25.0	25.3	
Temperature (T_2)	[°C]	24.6	24.8	25.2	
Elapsed time for flow (t_1)	[s]	49	48	48	
Elapsed time for flow (t_2)	[s]	98	96	96	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.697	1.732	1.732	
Mean temperature (T)	[°C]	24.7	24.9	25.3	
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9014	0.8954	0.8893	
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.558	1.580	1.569	

Remarks:

Remarks:

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 10
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 11
Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	202	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[-]	0.637	
	1998-04-23	Permeameter A	Saturation	[-]	0.99

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0130

Test		1	2	3	4	5
Temperature (T_1)	[°C]	24.8	25.2	25.4		
Temperature (T_2)	[°C]	25.6	25.2	25.4		
Elapsed time for flow (t_1)	[s]	48	48	48		
Elapsed time for flow (t_2)	[s]	97	96	96		
Hydraulic conductivity ($k_{TC} \cdot 10^{-4}$)	[m/s]	1.682	1.699	1.699		
Mean temperature (T)	[°C]	25.2	25.2	25.4		
Kinematic viscosity ($\nu_{TC} \cdot 10^{-6}$)	[m ² /s]	0.8893	0.8893	0.8853		
Permeability ($K \cdot 10^{-11}$)	[m ²]	1.523	1.539	1.532		

Remarks:

Description of soil		Sample preparation method Air pluviation	Specimen dimensions		
Silkeborg No. 0000	Date 1998-04-21		Length [mm]	201	
		Diameter [mm]	70		
		Void ratio [-]	0.601		
		Saturation [-]			

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[-]	1.0936
	Volume correction factor for permeameter (F_p)	[-]	0.9935

Test		1	2	3	4	5
Temperature (T_1)	[°C]	22.5	22.8	23.0		
Temperature (T_2)	[°C]	22.4	22.6	22.9		
Elapsed time for flow (t_1)	[s]	62	62	62		
Elapsed time for flow (t_2)	[s]	125	124	124		
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.324	1.335	1.335		
Mean temperature (T)	[°C]	22.5	22.7	23.0		
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.9482	0.9417	0.9374		
Permeability ($K \cdot 10^{11}$)	[m ²]	1.278	1.280	1.274		

Remarks: Incorrect measurement of water content after test. Degree of saturation not accessible.

Job: 9810 Aalborg University
Executed: JCI, KPJ Enclosure No. 12
Evaluated: KPJ Approved: WL

Job: 9810	Aalborg University
Executed: JCI, KPJ	Enclosure No. 13
Evaluated: KPJ	Approved: WL

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
Length	[mm]	201			
Diameter	[mm]	70			
Void ratio	[‐]	0.601			
Saturation	[‐]	1.02			

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation		Specimen dimensions	
Length	[mm]	199			
Diameter	[mm]	70			
Void ratio	[‐]	0.667			
Saturation	[‐]	1.00			

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	1.0129

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	0.9945

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.9	24.8	24.8	
Temperature (T_2)	[°C]	25.1	25.0	25.0	
Elapsed time for flow (t_1)	[s]	52	52	52	
Elapsed time for flow (t_2)	[s]	103	104	104	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.576	1.561	1.561	
Mean temperature (T)	[°C]	25.0	24.9	24.9	
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.8934	0.8954	0.8954	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.434	1.423	1.423	

Test	1	2	3	4	5
Temperature (T_1)	[°C]	25.0	25.0	25.1	25.1
Temperature (T_2)	[°C]	25.0	25.0	25.1	25.1
Elapsed time for flow (t_1)	[s]	46	45	45	45
Elapsed time for flow (t_2)	[s]	92	91	90	90
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	1.779	1.799	1.819	1.819
Mean temperature (T)	[°C]	25.0	25.0	25.1	25.2
Kinematic viscosity ($\nu_{rc} \cdot 10^{-6}$)	[m ² /s]	0.8934	0.8934	0.8913	0.8913
Permeability ($K \cdot 10^{11}$)	[m ²]	1.619	1.636	1.651	1.651

Remarks:

Remarks: Leaky neck ring

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 14
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 15
Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	191	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[‐]	0.791	
1998-06-19	Permeameter A	Saturation	[‐]	1.03	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	1.0118

Test		1	2	3	4	5
Temperature (T_1)	[°C]	23.6	23.8	23.9		
Temperature (T_2)	[°C]	23.5	24.1	24.4		
Elapsed time for flow (t_1)	[s]	24	24	24		
Elapsed time for flow (t_2)	[s]	48	48	48		
Hydraulic conductivity ($k_{Tc} \cdot 10^4$)	[m/s]	3.217	3.217	3.217		
Mean temperature (T)	[°C]	23.6	24.0	24.2		
Kinematic viscosity ($\nu_{Tc} \cdot 10^6$)	[m ² /s]	0.9244	0.9158	0.9115		
Permeability ($K \cdot 10^{11}$)	[m ²]	3.028	3.000	2.986		

Remarks:

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	202	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[‐]	0.658	
1998-06-19	Permeameter B	Saturation	[‐]	1.00	

Test program	Standpipe diameter (d)	[mm]	20.0
	Initial hydraulic head (h_0)	[mm]	2000.0
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265.0
	Final hydraulic head (h_2)	[mm]	800.0
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	0.9935

Test		1	2	3	4	5
Temperature (T_1)	[°C]	23.8	24.1	24.3	24.5	
Temperature (T_2)	[°C]	24.2	24.2	24.6	24.8	
Elapsed time for flow (t_1)	[s]	43	43	42	42	
Elapsed time for flow (t_2)	[s]	86	85	84	84	
Hydraulic conductivity ($k_{Tc} \cdot 10^4$)	[m/s]	1.934	1.957	1.980	1.980	
Mean temperature (T)	[°C]	24.0	24.2	24.5	24.7	
Kinematic viscosity ($\nu_{Tc} \cdot 10^6$)	[m ² /s]	0.9135	0.9115	0.9054	0.9014	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.799	1.816	1.826	1.817	

Remarks:

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 16
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 17
Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	198	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[‐]	0.810	
1998-06-19	Permeameter A	Saturation	[‐]	0.98	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	1.0124

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.1	24.3	24.8	24.9
Temperature (T_2)	[°C]	25.1	25.1	25.3	25.6
Elapsed time for flow (t_1)	[s]	22	22	22	22
Elapsed time for flow (t_2)	[s]	44	44	44	44
Hydraulic conductivity ($k_{T,C} \cdot 10^4$)	[m/s]	3.636	3.636	3.636	3.636
Mean temperature (T)	[°C]	24.6	24.7	25.1	25.3
Kinematic viscosity ($\nu_{T,C} \cdot 10^6$)	[m ² /s]	0.9014	0.8994	0.8934	0.8893
Permeability ($K \cdot 10^{11}$)	[m ²]	3.338	3.330	3.308	3.293
					3.278

Remarks:

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	202	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[‐]	0.629	
1998-06-19	Permeameter B	Saturation	[‐]	1.01	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	0.9935

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.6	25.1	25.4	
Temperature (T_2)	[°C]	25.3	25.1	25.4	
Elapsed time for flow (t_1)	[s]	48	48	48	
Elapsed time for flow (t_2)	[s]	97	96	96	
Hydraulic conductivity ($k_{T,C} \cdot 10^4$)	[m/s]	1.715	1.732	1.732	
Mean temperature (T)	[°C]	25.0	25.1	25.4	
Kinematic viscosity ($\nu_{T,C} \cdot 10^6$)	[m ² /s]	0.8954	0.8913	0.8853	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.563	1.572	1.562	

Remarks:

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 18
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 19
Evaluated: KPJ	Approved: WL

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation	Specimen dimensions	
Length	[mm]	201		
Diameter	[mm]	70		
Date			Void ratio	[\cdot] 0.675
1998-06-19			Saturation	[\cdot] 1.01

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0129

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.8	25.1	25.4	
Temperature (T_2)	[°C]	25.4	25.3	25.6	
Elapsed time for flow (t_1)	[s]	36	36	36	
Elapsed time for flow (t_2)	[s]	72	72	72	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	2.255	2.255	2.255	
Mean temperature (T)	[°C]	25.1	25.2	25.5	
Kinematic viscosity ($v_{rc} \cdot 10^6$)	[m ² /s]	0.8913	0.8893	0.8833	
Permeability ($K \cdot 10^{11}$)	[m ²]	2.046	2.042	2.028	

Remarks:

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 20
Evaluated: KPJ	Approved: WL

Description of soil Silkeborg No. 0000		Sample preparation method Air pluviation	Specimen dimensions	
Length	[mm]	202		
Diameter	[mm]	70		
Date		Falling head apparatus	Void ratio	[\cdot] 0.667
1998-06-19		Permeameter B	Saturation	[\cdot] 0.99

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	0.9935

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.9	25.2	25.3	
Temperature (T_2)	[°C]	25.9	25.6	25.7	
Elapsed time for flow (t_1)	[s]	37	37	37	
Elapsed time for flow (t_2)	[s]	75	74	74	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	2.218	2.248	2.248	
Mean temperature (T)	[°C]	25.4	25.4	25.5	
Kinematic viscosity ($v_{rc} \cdot 10^6$)	[m ² /s]	0.8853	0.8853	0.8833	
Permeability ($K \cdot 10^{11}$)	[m ²]	1.999	2.026	2.022	

Remarks:

Job: 9810	Aalborg University
Executed: KPI	Enclosure No. 21
Evaluated: KPI	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	199	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[‐]	0.718	
1998-07-13	Permeameter A	Saturation	[‐]	1.02	

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	198	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[‐]	0.755	
1998-07-13	Permeameter B	Saturation	[‐]	1.00	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	1.0125

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[‐]	1.0936
	Volume correction factor for permeameter (F_p)	[‐]	0.9943

Test	1	2	3	4	5
Temperature (T_1)	[°C]	25.6	25.6	25.6	25.5
Temperature (T_2)	[°C]	26.7	26.3	26.1	25.9
Elapsed time for flow (t_1)	[s]	30	31	31	31
Elapsed time for flow (t_2)	[s]	60	62	62	62
Hydraulic conductivity ($k_{T\cdot C} \cdot 10^{-4}$)	[m/s]	2.680	2.593	2.593	2.593
Mean temperature (T)	[°C]	26.2	26.0	25.9	25.7
Kinematic viscosity ($\nu_{T\cdot C} \cdot 10^{-6}$)	[m ² /s]	0.8713	0.8752	0.8772	0.8792
Permeability ($K \cdot 10^{-11}$)	[m ²]	2.377	2.311	2.316	2.322

Test	1	2	3	4	5
Temperature (T_1)	[°C]	25.6	26.0	26.2	
Temperature (T_2)	[°C]	26.2	26.0	26.2	
Elapsed time for flow (t_1)	[s]	28	29	28	
Elapsed time for flow (t_2)	[s]	57	58	57	
Hydraulic conductivity ($k_{T\cdot C} \cdot 10^{-4}$)	[m/s]	2.858	2.809	2.858	
Mean temperature (T)	[°C]	25.9	26.0	26.2	
Kinematic viscosity ($\nu_{T\cdot C} \cdot 10^{-6}$)	[m ² /s]	0.8752	0.8732	0.8695	
Permeability ($K \cdot 10^{-11}$)	[m ²]	2.547	2.497	2.530	

Remarks:

Remarks:

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 22
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 23
Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	199	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[\cdot]	0.747	
1998-07-13	Permeameter A	Saturation	[\cdot]	1.00	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0125

Test	1	2	3	4	5
Temperature (T_1)	[°C]	25.0	25.2	25.5	
Temperature (T_2)	[°C]	25.8	25.6	25.7	
Elapsed time for flow (t_1)	[s]	28	28	28	
Elapsed time for flow (t_2)	[s]	56	56	56	
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	2.871	2.871	2.871	
Mean temperature (T)	[°C]	25.4	25.4	25.6	
Kinematic viscosity ($\nu_{rc} \cdot 10^6$)	[m ² /s]	0.8853	0.8853	0.8813	
Permeability ($K \cdot 10^{11}$)	[m ²]	2.588	2.588	2.577	

Remarks:

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000	Air pluviation	Length	[mm]	201	
		Diameter	[mm]	70	
Date	Falling head apparatus	Void ratio	[\cdot]	0.706	
1998-07-13	Permeameter A	Saturation	[\cdot]	1.00	

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[\cdot]	1.0936
	Volume correction factor for permeameter (F_p)	[\cdot]	1.0129

Test	1	2	3	4	5
Temperature (T_1)	[°C]	24.7	24.6	24.8	24.9
Temperature (T_2)	[°C]	25.4	25.1	25.2	25.3
Elapsed time for flow (t_1)	[s]	36	36	36	36
Elapsed time for flow (t_2)	[s]	72	72	72	72
Hydraulic conductivity ($k_{rc} \cdot 10^{-4}$)	[m/s]	2.255	2.255	2.255	2.255
Mean temperature (T)	[°C]	25.1	24.9	25.0	25.1
Kinematic viscosity ($\nu_{rc} \cdot 10^6$)	[m ² /s]	0.8934	0.8974	0.8934	0.8913
Permeability ($K \cdot 10^{11}$)	[m ²]	2.051	2.060	2.051	2.046

Remarks:

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 24
Evaluated: KPJ	Approved: WL

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 25
Evaluated: KPJ	Approved: WL

Description of soil		Sample preparation method		Specimen dimensions	
Silkeborg No. 0000		Air pluviation		Length [mm]	201
Date	1998-07-13	Falling head apparatus		Diameter [mm]	70
		Permeameter B		Void ratio [-]	0.723
				Saturation [-]	1.01

Test program	Standpipe diameter (d)	[mm]	20
	Initial hydraulic head (h_0)	[mm]	2000
	Intermediate hydraulic head ($h_1 = \sqrt{h_0 h_2}$)	[mm]	1265
	Final hydraulic head (h_2)	[mm]	800
	Volume correction factor for standpipe (F_s)	[-]	1.0936
	Volume correction factor for permeameter (F_p)	[-]	0.9935

Test		1	2	3	4	5
Temperature (T_1)	[°C]	25.3	25.4	25.5	25.6	
Temperature (T_2)	[°C]	26.7	26.4	26.2	26.1	
Elapsed time for flow (t_1)	[s]	29	30	30	30	
Elapsed time for flow (t_2)	[s]	60	61	61	60	
Hydraulic conductivity ($k_{T\cdot C} \cdot 10^{-4}$)	[m/s]	2.758	2.713	2.713	2.758	
Mean temperature (T)	[°C]	26.0	25.9	25.9	25.9	
Kinematic viscosity ($\nu_{T\cdot C} \cdot 10^{-6}$)	[m ² /s]	0.8732	0.8752	0.8772	0.8772	
Permeability ($K \cdot 10^{11}$)	[m ²]	2.453	2.418	2.423	2.464	

Remarks:

Job: 9810	Aalborg University
Executed: KPJ	Enclosure No. 26
Evaluated: KPJ	Approved: WL

AGEP: Laboratory testing papers

- 1 Ibsen, L.B., Borup, M., Hedegaard, J. (1995). Triaxial tests on Baskarp Sand No 15. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9501
- 2 Ibsen, L.B., Lund, W., Jacobsen, F.R. (1995). Triaksialforsøg på yoldia ler (Triaxial tests on Yoldia Clay; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9502
- 3 Ibsen, L.B., Bødker, L. (1995). Triaxial tests on Blokhus Sand. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9510.
- 4 Ibsen, L.B., Jacobsen, F.R. (1995). Triaxial tests on Lund Sand No 0. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9511.
- 5 Ibsen, L.B., Jacobsen, F.R. (1995). Triaxial tests on Portland Gravel. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9512.
- 6 Ibsen, L.B., Lund, W., Bødker, L. (1995). Bender element and triaxial tests on coral sand. Fort George Power Station, Mauritius. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9513.
- 7 Rasmussen, M.S., Sørensen, C.S. (1995). New Large Test Setup for Dynamic Testing of Soils. Proc. 1st Int. Conf. on Earthquake Geotechnical Engineering. Tokyo, Vol 2, pp 749-754. Also in *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9516.
- 8 Ibsen, L.B., Steenfelt, J.S. (1995). Triaxial and True Triaxial tests on Pleistocene clay. The Mississippi Canyon Area, the Gulf of Mexico. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9519.
- 9 Steenfelt, J.S., Ibsen, L.B., Jacobsen, F.R. (1995). Triax- og konsolideringsforsøg på Branden ler. Hovedlandevej 472, Vium-Sundsøre (Triaxial and oedometer tests on Branden Clay; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9520.
- 10 Bødker, L., Steenfelt, J.S., Lund, W. (1995). Triaxforsøg på stærkt siltet sand. Gl. Løkkensvej, Hjørring (Triaxial tests on very silty sand; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9521.
- 11 Bødker, L. (1996). G_{max} for sand by bender elements at anisotropic stress states. *Proc. Nordic Geotechnical Meeting, NGM-96, Reykjavík*, Vol 1, pp 93-122. Also in *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9602.
- 12 Ibsen, L.B., Lund, W., Steenfelt, J.S. (1996). Konsolideringsforsøg på tørv. Skjern Å - Naturprojekt (Oedometer tests on peat). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9610.
- 13 Steenfelt, J.S., Lund, W. (1997). Ødometerforsøg, Fibo letklinker (10-20) (Oedometer tests on Fibo light weight aggregates; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9703.
- 14 Steenfelt, J.S. (1997). Ødometerforsøg, Fibo letklinker (specialsortering) (Oedometer tests on Fibo light weight aggregates (special grade); in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9704.

AGEP: Laboratory testing papers

- 15 Steenfelt, J.S., Ibsen, L.B. (1997). Konsolideringsforsøg på moræneler. DORAS - Fredericia Terminal (Oedometer tests on clay till; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9705.
- 16 Steenfelt, J.S., Thøgersen, L.(1997). Konsoliderings- og triaxforsøg på fyld/gytje med skaller. Forlægning ved Kolind (Oedometer and triaxial tests on fill/gyttja with shell fragments; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9711.
- 17 Steenfelt, J.S. (1998). Konsolideringsforsøg på senglacialt ler. Ostemejeri i Taulov (Oedometer tests on late glacial clay; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9801.
- 18 Steenfelt, J.S. (1998). Konsolideringsforsøg på silt og ler. Ostemejeri i Taulov (Oedometer tests on silt and clay; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9806.
- 19 Steenfelt, J.S. (1998). Konsolideringsforsøg på gytje. Renovering af Skive Stadion (Oedometer tests on gyttja; in Danish). *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9807.
- 20 Steenfelt, J.S., Jakobsen, K.P. (1998). Triaxial tests on heavy sand. Namibia. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9808.
- 21 Lund, W.P., Jakobsen, K.P. (1998). Permeability tests on Silkeborg Sand No 0000. *AAU Geotechnical Engineering Papers*, ISSN 1398-6465 R9811.