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Deltares
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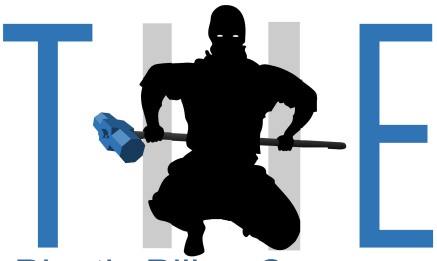
Factual Report:

Monitoring of leakage through the connection lock of MultiLock® Delta PVC Sheet Piling



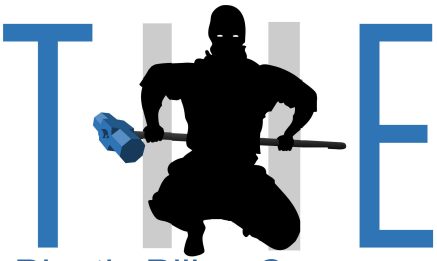
Deltares

Factual Report:

Monitoring of leakage through the connection lock of PVC sheet piles

R.A. Zwaan

11201482-000



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Title
Factual Report:

Monitoring of leakage through the connection lock of PVC sheet piles

Client	Project	Reference	Pages
Profextru Productie B.V. de heer A. van Noordenne Bruchterweg 88 7772 BJ HARDENBERG	11201482-000	11201482-000-GEO-0001-jvm	7

Keywords
Prolock, PVC, Sheet pile, Profextru

Summary
The water tightness of a connection lock of PVC sheet piles was investigated. The test set-up consisted of two halves of sheet pile sections in a steel test box. These were positioned in such a way that the connection lock was placed vertically in the middle of one of the sides of the box. The inside of the box was filled with permeable and fully saturated sand. The top of the box was closed-off with a water proof lid, which was connected to a water reservoir that could be lifted up to 10 metres height relative to the top of the box. In this way the water pressure in the box could be increased to perform a six-step-pressure monitoring procedure. Each step was maintained for thirty minutes, during which the connection lock was closely monitored for any signs of possible leakage.

The result of this monitoring was that there was no visible leakage through the connection lock of the PVC sheet piles during all six pressure steps.

Version	Date	Author	Initials	Review	Initials	Approval	Initials
1.0	Aug. 2017	R.A. Zwaan		J. Terwindt		ing. A.T. Aantjes	

State
final

Contents

1 Motivation for the test

Profextru Productie B.V. has manufactured PVC sheet piles that are fitted with connection locks. To get more insight in the water tightness of these locks it is necessary to perform leak tests. In order to obtain an independent factual report of this test, Deltares was asked to perform the monitoring of this test.

2 Division of labour

The work on the different steps in the project is divided between Profextru Productie B.V. and Deltares, as follows:

- The test box is designed and manufactured by Profextru Productie B.V..
- The sheet pile sections that were tested were provided and mounted in the test box by Profextru Productie B.V..
- Deltares has inspected this test set-up and filled the box with permeable and fully saturated sand.
- Profextru Productie B.V. sealed the test box and connected the water reservoir needed to apply different pressures to the test box.
- Deltares has inspected the complete test set-up.
- The test was performed by Profextru Productie B.V. while Deltares monitored the test and possible leakage through the connection lock during the test.

3 Test set-up

For the test Profextru Productie B.V. has designed and manufactured a steel test box of which one of the sides consisted of 2 PVC sheet pile sections with the connection lock vertically in the middle (Photo 3.1 and 3.2).

Photo 3.1 Front side of the sheet pile sections

Photo 3.2 Back-side of the sheet pile sections

The test box is manufactured of steel plates and reinforced with steel profiles to withstand the pressure during the test in the box without excessive deformation. To prevent deformation of the PVC sheet pile sections that side of the box is also fitted with (detachable) steel profiles for support. Refer to Appendix A for details.

The edges of the sheet pile sections are bonded to the steel side walls with waterproof kit to ensure a water tight connection between the PVC and the steel plates. The top of the box has a detachable lid in order to access the test box to mount the sheet pile sections and fill the box with water and sand.

When the sheet pile sections are mounted and the box is filled with the saturated sand the top lid closes the box. Rubber strips and waterproof kit ensure a watertight connection (Photo 3.3). The lid is fitted with a hose connection and valve to connect the water reservoir with the test box (Photo 3.4).

Photo 3.3 Top view of the flattened sand

Photo 3.4 Test box closed with detachable lid

The top lid is connected with a bucket by means of a hose. The water bucket serves as the water reservoir. The height of the bucket can then be varied in order to create the desired water pressure in the test box (i.e. the water pressure inside the box corresponds to the hydraulic head, assuming the situation is static).

The first two steps (two and four metres water height) are created by using a fork lift to vary the height of the bucket (Photo 3.5). For the higher steps the set-up was moved to a silo with a height of more than ten metres (Photo 3.6). The ladder besides the silo was used to fix the

bucket at the desired heights of six, eight and ten metres. Using the hydraulic head to apply pressure to the set-up ensures a controllable and reproducible test.

Photo 3.5 Height variation with forklift

Photo 3.6 Height variation with ladder next to silo

The tests were performed with regards to the safety regulations that are applicable on the Profextru Productie B.V. location and Deltares' health and safety standards.

4 Preparations before test

The mounting of the PVC sheet pile sections in the test box was done by Profextru Productie B.V. The used sheet piles were type “PROLOCK *DELTA* 0040GR/VM P-07-14-07” (Photo 4.1). Appendix B provides details on the used sheet pile sections. The sheet piles were bonded to the test box using “Innotec” sealant kit which ensured a watertight and firm connection (Photo 4.2)

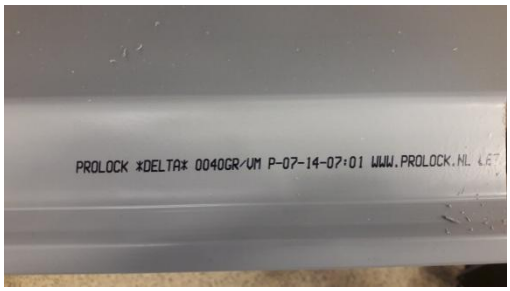

Photo 4.1 Sheet pile type

Photo 4.2 Sealant on edges sheet pile sections

The box is completely filled with water. The sand is poured into the water in layers of approximately two centimetres each after which every layer is densified by tamping the sand by hand with a tamper with a diameter of five centimetres. In this way a densified and fully saturated sand bed is created in the test box (Photo 4.3). Appendix A provides details on the applied sand.

The surface of the sand bed is levelled with a steel ruler in order to create a flat surface on which the top lid can be placed. Rubber seals, bolts and kit ensure a watertight and firm connection of the top lid to the test box (Photo 4.4).

Photo 4.3 Test box filled with sand

Photo 4.4 Top view of filled test box

After placement of the top lid the test box is connected to the bucket (water reservoir) and the remaining air was removed from the test box and connecting hose to ensure a completely saturated test set-up. An air-free set-up is required to ensure a proper distribution of pressure from the reservoir to the test box. The water reservoir was attached to the fork lift and adjusted to a height of two metre relative from the top of the test box.

After positioning the water reservoir the PVC sheet pile side of the box was made completely dry on the outside in order to avoid any misinterpretation about possible leakage. A final check was performed to ensure that the set-up was still completely free of air. After this final check the test was started.

5 Monitoring results

The test was continuously monitored by Deltares. Assistance for applying the pressure steps was delivered by the staff of Profextru Productie B.V.

The test is performed by increasing the water pressure from two to ten metres water column in steps of two metres water column. Each step was maintained for thirty minutes.

From the six metre level and up the test box started to leak slightly on the back- and topside which made it essential to constantly monitor and adjust the water level in the water reservoir. Since this leakage was not severe, did not introduce air into the test set-up and did not wet the test side of the box containing the sheet pile sections, this leakage was found to have no further influence on the test results, and is therefore neglected. Any loss in water pressure due to the leakage was mitigated by maintaining a constant (plus or minus five centimetres) water level in the water reservoir (bucket).

The applied pressure in metres water column is measured relative from the top of the test box to the water level in the water reservoir. The test results are summarized in Table 5.1.

Time	Action/result
11:01	Pressure of 2 metres water column applied to test box
11:31	No visible leakage through connection lock
11:35	Pressure of 4 metres water column applied to test box
12:06	No visible leakage through connection lock
12:10	Test set-up move to silo location
12:28	Pressure of 6 metres water column applied to test box
12:59	No visible leakage through connection lock
13:07	Pressure of 8 metres water column applied to test box
13:37	No visible leakage through connection lock
13:38	Pressure of 10 metres water column applied to test box
14:08	No visible leakage through connection lock

Table 5.1 Test results

After the end of the complete test run the side of the test box containing the sections of the sheet piles was inspected thoroughly again. No signs of leakage through the connection lock could be found.

6 Results

For this specific test situation and procedure the results are that the connection lock between the two sheet pile sections did not show any signs of leakage, when applying an hydraulic head up to 10 m (corresponding to approximately 100 kPa) for thirty minutes.

A The test box

For the tests a test box is designed and manufactured by Profextru Productie B.V. The test box should be able to hold two sections of the PVC sheet piles in place, withstand the pressure during test, connect the box with the water reservoir and must be watertight (Figure A.1 to Figure A.3)

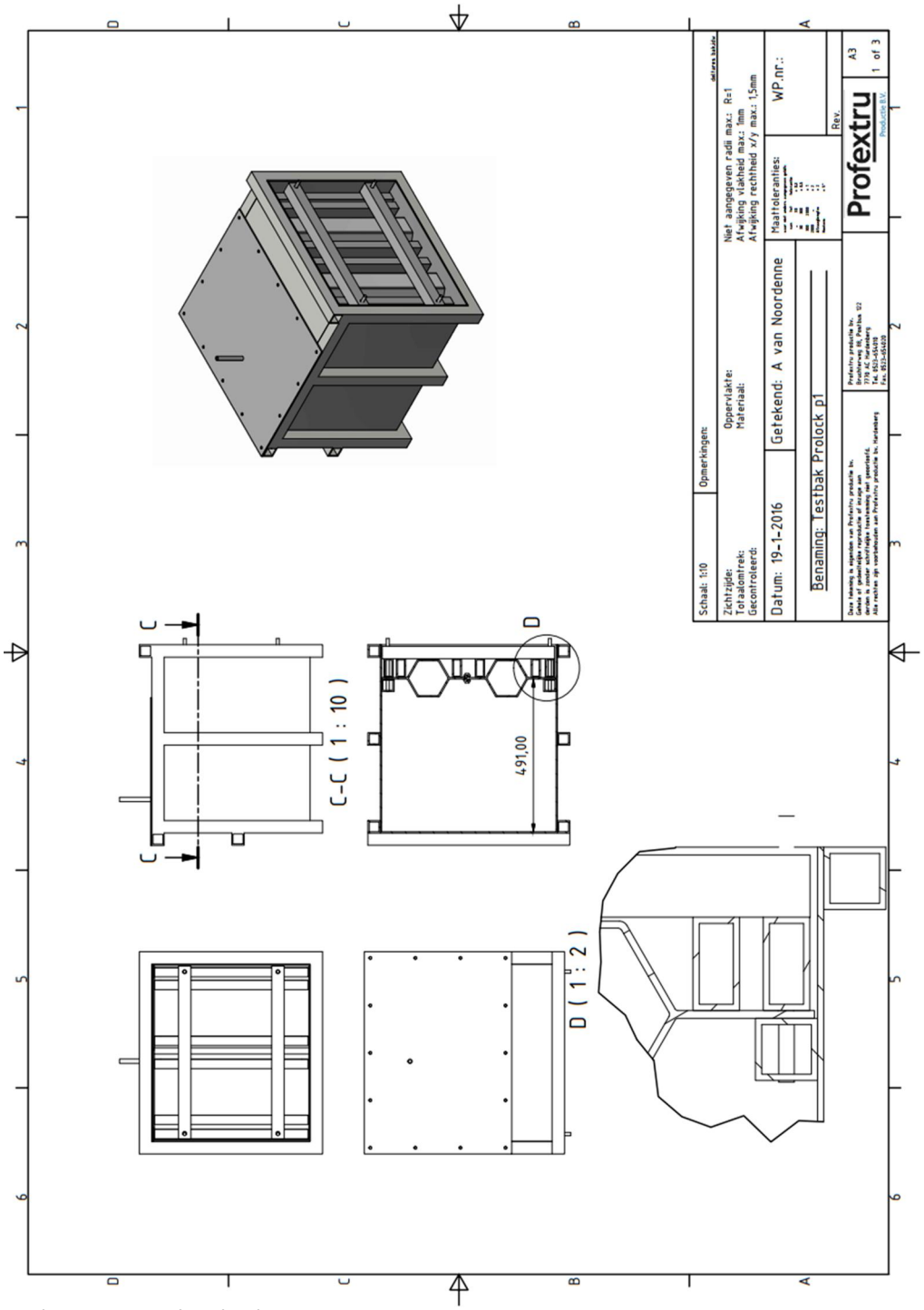

Figure A.1 Test box drawing 1

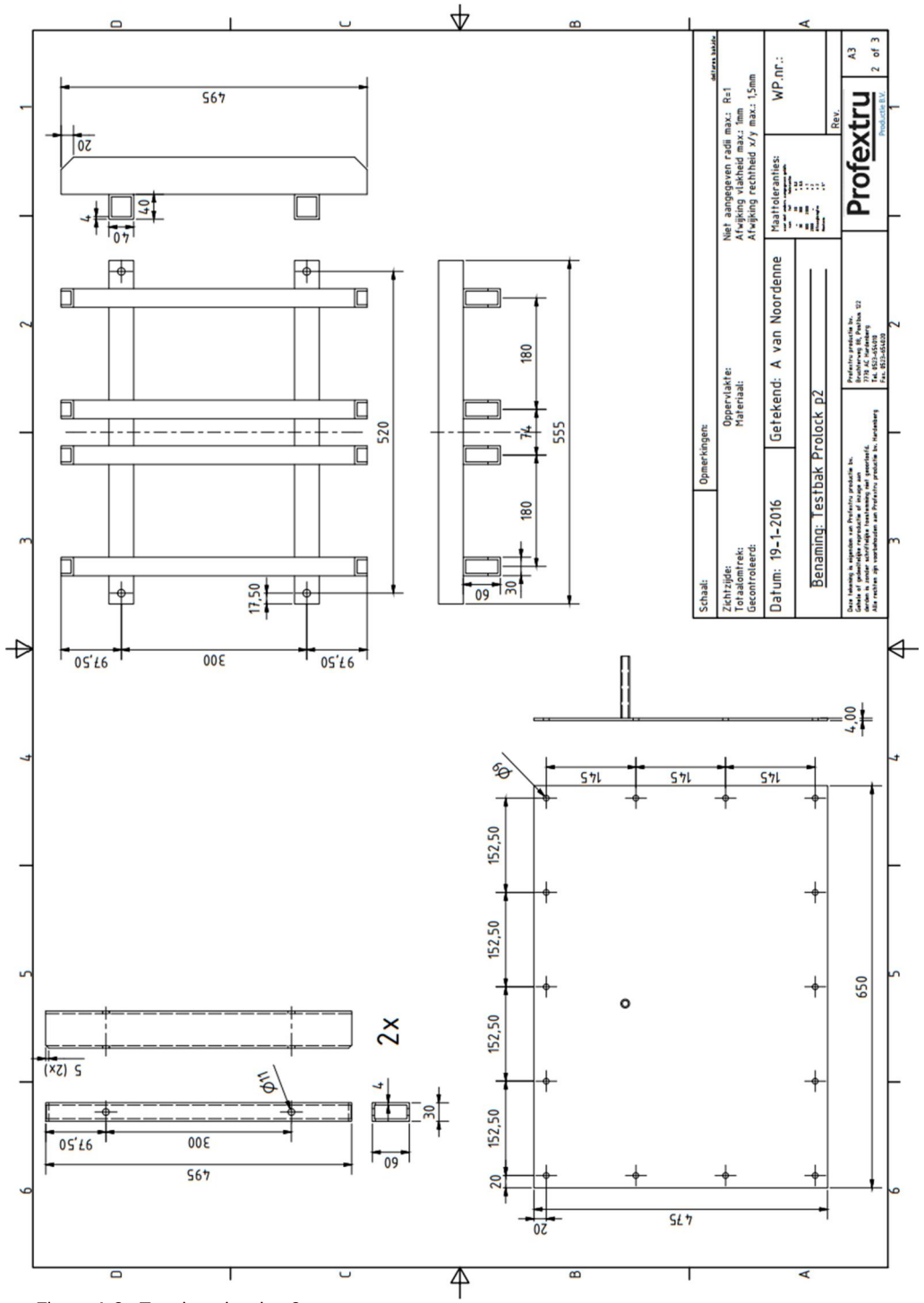

Figure A.2 Test box drawing 2

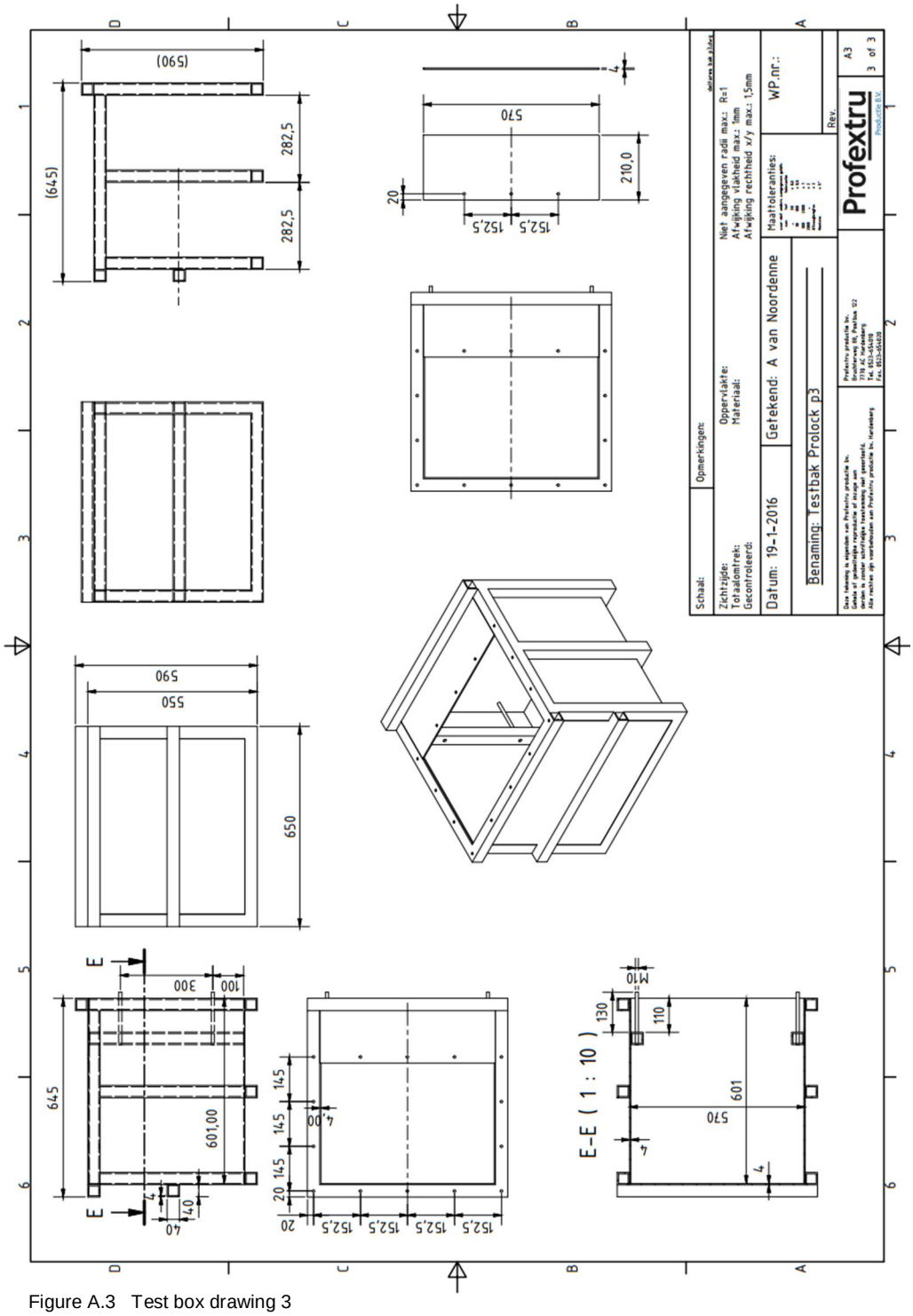

Figure A.3 Test box drawing 3

B The used sheet piles

The PVC sheet pile sections were of the “PROLOCK *DELTA* 0040GR/VM P-07-14-07” type (Photo B.1).
MultiLock Self Seal - UK

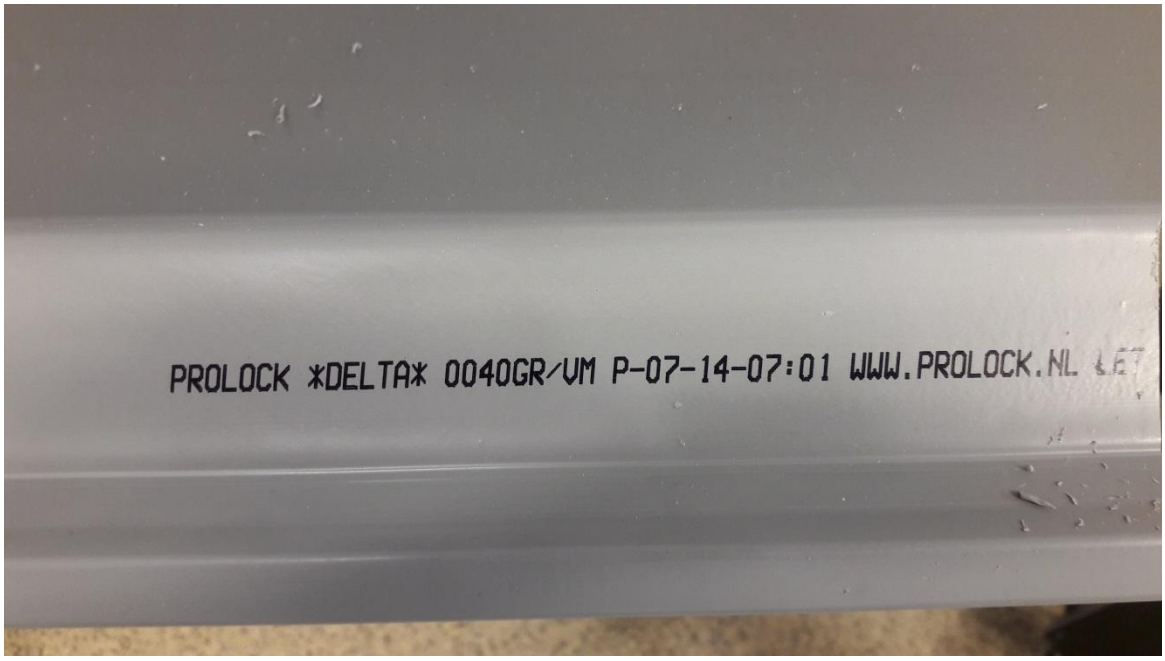

Photo B.1 Sheet pile type

The sections were not scaled but used “as is”. The connection lock was not modified or altered for the test (Photo B.2).

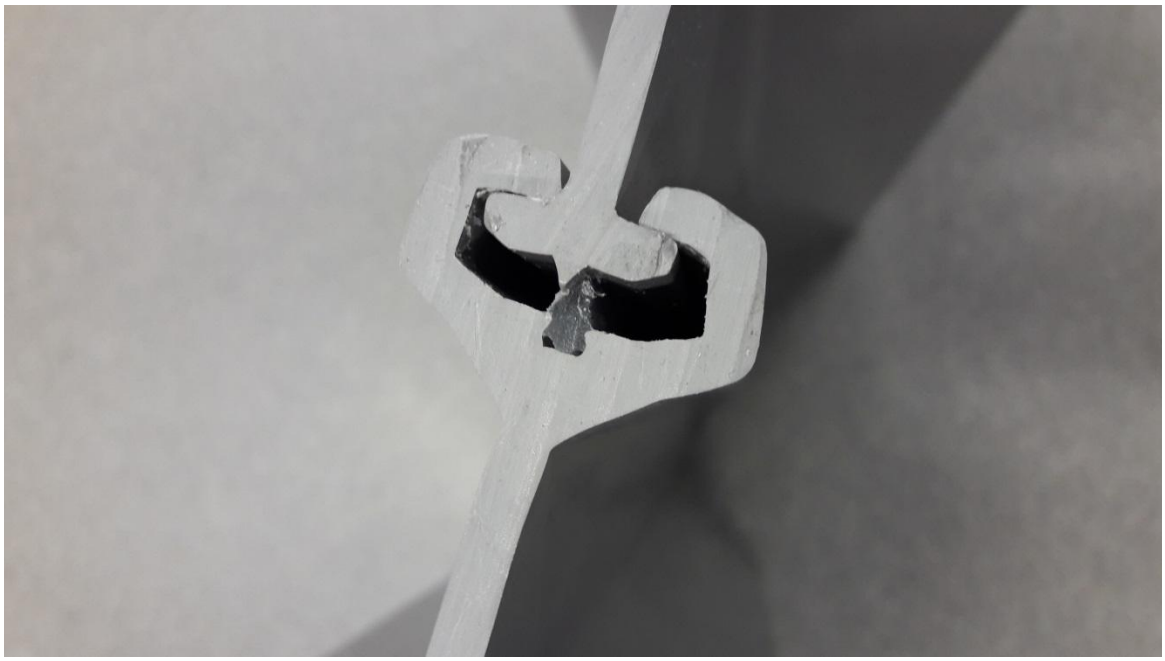

Photo B.2 Close-up connection lock

C The used sand

The sand chosen for this test was masonry sand with a relatively high permeability. A high permeability is required in order to be able to detect any possible leakage through the connection lock. The sand was supplied by BMN Bouwmaterialen BV. (Photo C.1 and C.2).

Photo C.1 The masonry sand

Photo C.2 Type indication on big-bag

To have an indication of the porosity of the sand in the test box, two samples were taken with the “Deltares density sampler” after completion of the test (Photo C.3). With this sampler a certain accurately known volume of the sand bed can be taken. This known volume together with the dry weight of the sample and the particle density is used to determine the porosity.

Before the samples were taken the water was drained partially from the test box with a small hose to create cohesion between the sand grains in order to improve the quality of the samples. The samples were taken on two different locations on the surface of the sand bed (Photo C.4).

Photo C.3 Deltares density sampler

Photo C.4 Locations of taken samples

Sample nr.	Diameter (cm)	Height (cm)	Dry weight sand (g)	Porosity (%)
1	6.67	5.2	308.0	36.0
2	6.67	5.2	307.3	36.2

Table C.1 Results of the samples taken

In order to provide a (rough) estimate of the permeability of the sand, grain size analysis of the sand was performed. This gives an overview of the different particle sizes in the sand (Figure C.5 and C.6). The used sand can be called “coarse sand” with a median diameter (D50) of 600 µm.

The permeability of the sand must be significantly higher than the possible leakage through the connection lock of the sheet pile sections. Based on the grain size distribution, the

estimated permeability (K-factor) of the sand bed in the test box is approximately 50 to 75 metre/day. This is more than sufficient to perform the test.

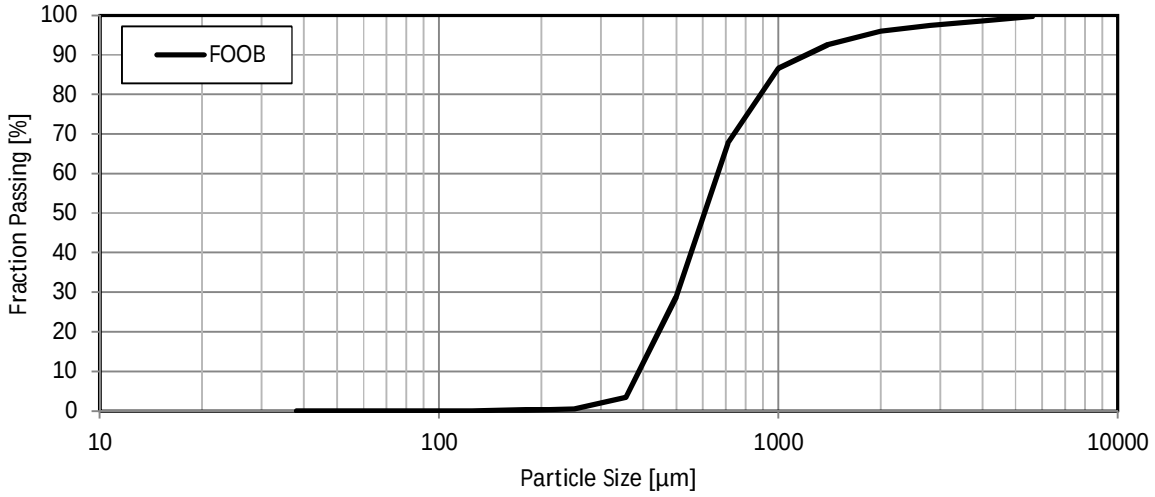

Figure C.5 Fraction passing/particle size

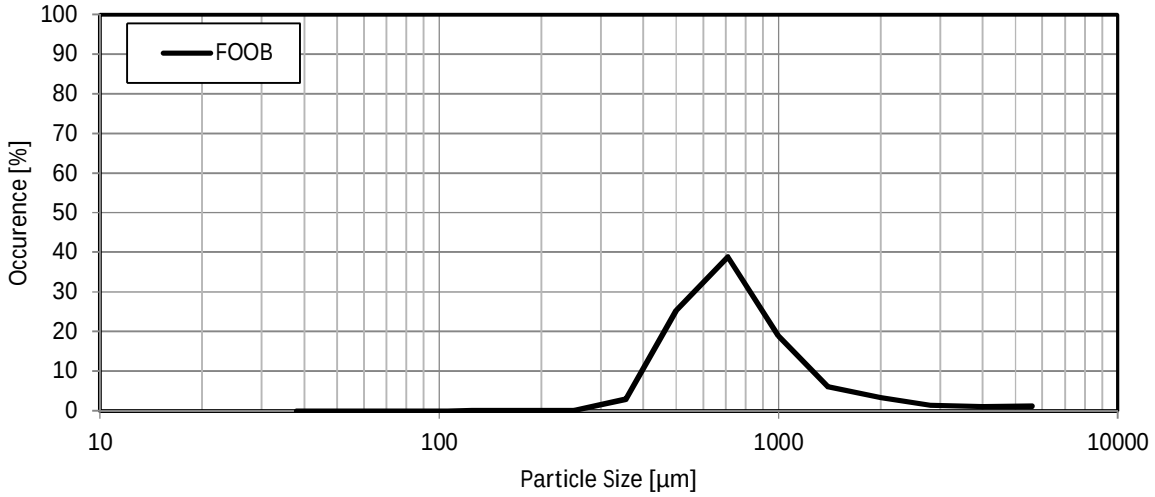

Figure C.6 Occurrence/particle size