BRL 1120
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Assessment Directives

Approved by the Harmonisation Committee Building of the Foundation Building Quality

for the KOMO-product certificate for
Geo-synthetics: prefabricated vertical drains

Binding statement
The director of Certification and Inspection for Kiwa has declared this assessment directive binding per 15november 1997

Acknowledgement

Acknowledged by the Counsel for Accreditation
RvC

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PREFACE

This Assessment directive has been drawn up by the "College of Experts in Geo-synthetics for Civil Engineering" for Kiwa, interested parties in the field of vertical drainage materials are represented in this college.

This assessment directive will be applied by Kiwa in connection with the Kiwa-Rules for Product Certification. In these rules the working method for the implementation of the investigation to obtain the certificate and the external inspection being used by Kiwa has been laid down. The above mentioned College of Experts advises on the frequency of the inspections.

CONTENTS

1 INTRODUCTION 5
1.1 Topic 5
1.2 Application area 5
1.3 General 6

2 REQUIREMENTS FOR RAW MATERIALS 6
2.1 Core 6
2.2 Jacket 6

3 REQUIREMENTS FOR THE CORE 7
3.1 General 7
3.2 Shape 7
3.3 Visual 7
3.4 Measurements 7
3.5 Linear mass 8
3.6 Durability 8
4 REQUIREMENTS FOR THE JACKET 8
4.1 General 8
4.2 Filter Fabric 8
4.3 Visual 8
4.4 Mass 9
4.5 Tensile Strength 9
4.6 Permittivity 9
4.7 Pore Size 9
4.8 Deformation resistance 10
4.9 Durability 10

5 REQUIREMENTS FOR THE VERTICAL DRAINAGE MATERIALS 10
5.1 General 10
5.2 Visual 10
5.3 Assembly 10
5.4 Resistance of glued or welded seams against frost 11
5.5 Tear Strength and Elongation 11
5.6 Discharge Capacity 11
5.7 Discharge capacity of a buckled drain 11

6 TEST METHODS 12
6.1 Determination of the resistance of the glued or welded seams against frost 12
6.2 Determination of the discharge capacity of a drain 12
6.3 Determination of the discharge capacity of a buckled drain 15

7 MARKINGS 16

8 REQUIREMENTS FOR THE QUALITY CONTROL 17
8.1 General 17
8.2 Internal Quality Control 17
8.3 Working Procedures and Instructions 17
8.4 External Assessments 17

9 LIST OF DOCUMENTS 18

10 TERMS AND DEFINITIONS 19

Appendix I. Suggestion form for improvements for the next edition
20

1 INTRODUCTION

1.1 Topic

The requirements mentioned in the assessment directive will by applied by certification institutes, Acknowledged by the Counsel for Accreditation, during procedures for the application or preservation of a certificate for "Vertical Drains".
The quality certificates that are issued are referred to as Kiwa-product certificates.

Besides the requirements that are laid down in the assessment directiv, the certification institutes can propose additional requirements, such as the general procedure requirements of certification which are laid down in the certification rules of the institute.

The vertical drain mentioned in the assessment directive is a so-called "composite drain" and consists of a profile shaped core for the water transport (see section 3.2) and a fabric that wraps round the core, such as a filter jacket. The core and filter fabric are industrialy assembled.

1.2 Application areas

Vertical drains have been developed to enable increased discharge of high pore water pressure in soil structures. As a result the following effects have been achieved:
- acceleration of the settlement period,
- acceleration of the consolidation period, which means accelerated stabilisation.

Examples of areas where this civil engineering technique has been applied are:
- embankments for roads and railroads,
- construction and reinforcement of dikes,
- embankments for construction sites of housing estates, industrial estates, terminals etc.
- reclamation
- preloading for landfills

The required life span of vertical drains is limited. In the assessment directive a maximum life span has been assumed of three years.

Guidelines for the storage of the jacket for the vertical drains.
If the jackets of the vertical drains have not been processed within three months they should be protected against direct influence of sunlight. Long exposure to direct sunlight will deteriorate the jackets.

1.3 General

The procedures for the application of a Kiwa-certificate will be based on the Kiwa-assessment directives that are in force at the date of application.

2 REQUIREMENTS FOR RAW MATERIALS

2.1 Core

The core should be manufactured using one of the following raw materials, or a mixture of these:

- polypropylene (PP),
- polyethylene (PE),
- polyester (PET),
- polyvinylchloride (PVC),
- polyamide (PA).

The use of recycled material is not permitted.
The use of internal regenerate for the production of the core is permitted. Internal regenerate is understood to consist of raw materials made out of unused core and test products. The composition should be known and the material should be processed in the same facility as the original product.

2.2 Filter Jacket

The jacket core should be manufactured using one of the following raw materials, or a mixture of these:

- polypropylene (PP),
- polyethylene (PE),
- polyester (PET),
- polyamide (PA).

The use of recycled material is not permitted.
The use of internal regenerate for the production of the jacket is permitted. The composition should be known and the material should be processed in the same facility as the original product.

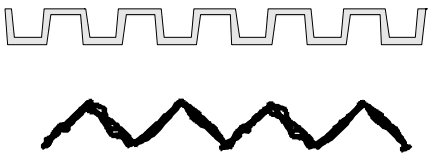
3 REQUIREMENTS FOR THE CORE

3.1 General

This chapter discusses the requirements for the core for the vertical drains. These requirements will be part of the technical specification for the vertical drains which will be used in the certificate.

3.2 Shape

The core should consist of one of the following shapes (see figure 1):
- a profiled strip, with or without perforation
- a profiled mat with an open or closed structure.



Profiled strip without perforations

Profiled mat with open structure

Figure 1. Example of a profiled strip and a profiled mat.

3.3 Visual

The core should have a regular structure, tears and/or other deflections must not be allowed to occur. Visual inspections for damage should be made regularly.

3.4 Measurements

No negative deviations on the roll length given by the manufacturer will be permissible. The width and thickness of the core should, at any given place, comply with the measurements (within allowable deviation parameters, as given by the manufacturer). The manufacturer should be able to produce a section drawing of the core, including measurements and permitted deviations.
The width and thickness should be determined with a calibrated measuring instrument. The results for thickness should be rounded to the nearest 0.1 mm and for the width to 1.0 mm. The measuring instrument should therefore preferably be set to 0.05 mm respectively to 0.1 mm.

3.5 Linear Mass

The manufacturer should provide Kiwa with the nominal value of the mass per unit length (linear mass).

After weighing five samples with a length of 1000 ± 1 mm, the average of the individually measured values must not be more that 5% lower than the nominal value of the linear mass as given by the manufacturer.

3.6 Durability

Durability aspects are thermo-oxidative, chemical and U.V.- resistance. In connection with the limited period of the application of vertical drains (maximum three years), there are no requirements for the durability of the core.

In connection with the U.V.- resistance it should be mentioned that, in a situation where the vertical drains have been exposed to sunlight during storage (which should be avoided, see 4.10), the jacket protects the core against the influence of direct sunlight.

4 REQUIREMENTS FOR THE JACKET

4.1 General

This chapter discusses the requirements for the vertical drain jackets. They will be part of the technical specification for the vertical drain which will be inserted in the certificate

4.2 Jacket

The jacket should be a filter fabric.

The filter fabric should be composed of a packet of fabrics that are mechanically, chemically or thermally bonded.

4.3 Visual

The jacket should have a regular structure, creases, tears, holes and/or other deflections must not be allowed to occur.

Visual inspections for damage should be made regularly.

4.4 Mass

The manufacturer should provide Kiwa with the nominal value of the mass per square-unit. After weighing five samples according to NEN-EN 965 / D5261-92 the average of the individually measured values must not be more that 10% lower than the nominal value of the mass as given by the manufacturer.

4.5 Tensile Strength

When testing five samples in line with the production direction and five samples perpendicular to the production direction in accordance with ASTM D4595-86, the average of the individually measured values for the tensile strength in the production direction and perpendicular to the production direction must not be more that 10% lower than 6 kN/m.

Testing should be executed under following conditions:

- the length of the sample should be 200 ± 1 mm.
- the tensile speed should be 200 ± 5 mm/min.
- the width of the samples should be 50 ± 1 mm.

4.6 Permittivity

When testing four samples in accordance with NEN 5167 / D4491-92, none of the individual measured values of the permittivity may be lower than 0.005 s^{-1}.

4.7 Pore Size

The manufacturer should provide Kiwa with the Class-indication of the pore size O_{90} (NEN 5168) in accordance with Table 1 or O_{95} (for ASTM D4751).
When testing four samples in accordance with NEN 5168 / ASTM D4751-87, the average of the individually measured values should comply with the requirements and be valid for the relevant class as given in Table 1.

Table 1 Class indication and required pore size (0_{90} in μm)

Class	A*	B**
Pore Size	≤ 80	≤ 160

* Recommended application of vertical drains in severely erosion sensitive soils

** Recommended application of vertical drains in non-erosion sensitive soils

4.8 Deformation resistance

When testing in accordance with 6.1 and 6.2 the jacket must not show any cracks.

4.9 Durability

In connection with the limited period of the application of vertical drains, there are no requirements for the durability of the jacket

5 REQUIREMENTS FOR VERTICAL DRAINAGE MATERIALS

5.1 General

This chapter discusses the requirements for composite vertical drains (core and jacket), they will be part of the technical specification of the vertical drain which will be inserted in the certificate.

5.2 Visual Appearance

The jacket should have a regular structure, creases, tears, holes and/or other deflections must not be allowed to occur.
Visual inspections for damage should be made regularly.

5.3 Assembly

There are three different systems to assemble the jacket around the core:

- the jacket is folded around the core and, on the overlap, glued or welded length wise;
- the jacket is glued to the profile of the core;
- the jacket is welded to the borders of the core using a high frequency sonar method.

The following points are especially important:

- the jacket should be wrapped tightly around the core,
- the glue and welding seams should be regular and holes should not be allowed to occur.

5.4 Resistance of glued or welded seams against frost

When testing in accordance with 6.1 the glued or welded seams must not rip.

5.5 Tensile Strength and Elongation

Testing for tensile strength and elongation will be in accordance with NEN-EN 29073 part 3 / ISO 5081 / ASTM D4595-86, taking into consideration the following conditions:

- five samples will be tested, each sample consisting of a complete drain section with a length of 400 ± 4 mm,
- the distance between the clamps should be 200 ± 1 mm,
- testing speed will be 200 mm/min ± 5 mm/min

For the tests of each sample the following is relevant:

- Elongation at break of the weakest element: $\geq$ 2%,
- Elongation at a pulling force of 0.5 kN: $\leq$ 10%,
- Minimum tensile strength at break of the weakest element or ripping of the glue or welding

  beam: 1.0 kN.

5.6 Discharge capacity

Determination of the discharge capacity is in accordance with 6.2.

When testing three samples at a pressure of 300 kPa the following criteria should be accomplished:

- the discharge capacity has to be at least $50 * 10^{-6}$ m³/s,
- the jacket must not break or tear (see also 4.9),
- the glue and welding seam must not rip.

5.7 Discharge capacity of a buckled drain

Determination of the discharge capacity of a buckled drain will be in accordance with 6.3.

When testing three samples at a pressure of 200 kPa and a vertical compression of 25 % the following criteria should be achieved:

- the discharge capacity should be at least $37.5 * 10^{-6}$ m³/s,
- the jacket must not break or tear (see also 4.9),
- the glue and welding seam must not rip.

6 TESTING METHODS

6.1 Testing the resistance of the glued or welded seams against frost

Expose a sample with a length of 0.5 m to a temperature of -20°C for a period of 24 hours. Inspect the glued or welded seams visually..

6.2 Testing the discharge capacity of a drain

General

This testing method describes the procedure to determine the discharge capacity of a vertical drain in stretched position with a lateral pressure as this occurs in practice. The discharge capacity is determined by measuring the amount of water that flows through a sample during a given time unit at a given pressure and head.
In reference with this assessment directive the testing methods should be regarded as a typical test, by which the standard width of 100 mm is being tested..

Terminology

- **Discharge capacity -** is the volumetric flow rate of water per hydraulic gradient through the drain.
- **Head -** pressure at a point in a liquid, expressed in terms of the vertical distance of a point below the surface of the liquid..
- **Flow -** is the volumetric flow through the drain.
- **Hydraulic gradient -** is the loss of hydraulic head per unit distance of flow($\Delta h/L$; see calculation below).

Testing instrument

A schematic drawing of a drain tester is shown in figure 2. The individual components and accessories are as follows:

– A steel or perspex tube or box with a diameter of 300 mm and with strength enough to withstand an internal pressure of 150 % of the working pressure acts as testing cell.
– The bottom of the cell is provided with a slot (modified to the size of the drainage material) which leads into the inflow chamber.
– The top of the cell is provided with a slot (modified to the size of the drainage material) which leads into the outflow chamber.
– In between the two sleeves a drain sample can be placed, the sample will be covered with a latex membrane over the full length.

– The cell will be filled with water or air which is pressurised to the desired value, a manometer monitors the pressure while a flow meter regulates and monitors the amount of water that flows through the sample. Transparent tubes connected to the in- and outflow chamber detect the head over the sample.

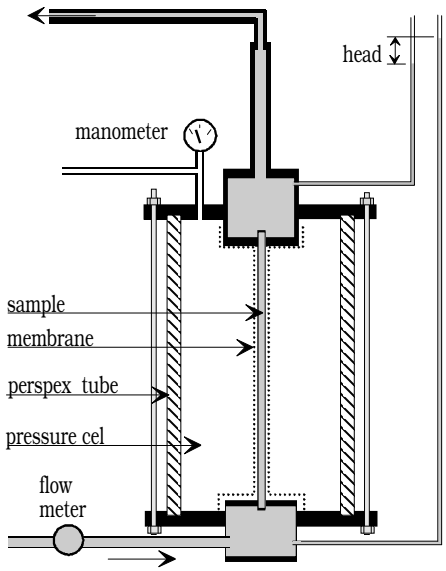


Figure 2. Testing instrumentation for the determination of the discharge capacity

Samples

Three samples of the vertical drain (core plus jacket) will be tested separately. The length of the sample (see procedure) should be 300 mm, minimum. The samples must not be more than 50 mm longer than the length of the sample.

Procedure

- Cut the sample to the required length and wrap it in a single layer of latex membrane with a maximum thickness of 0.35 mm. See that the membrane attached to the inflow and outflow chamber is water/air tight.
- Place the sample vertically in the test cell and fix it into the slots. The distance between the top of the inflow chamber and the bottom of the outflow chamber should be 300 mm, minimum.
- Put a pressure on the cell of 50 kPa and check if the cell, the membrane and the sample are watertight. The temperature of the water should be equal to the temperature in the testing area.
- Select a flow (Q) that creates a gradient of 0.1 and calculate the discharge capacity (see "Calculation"). Increase the pressure to 300 kPa and maintain this pressure for seven days.
- In the calculation below the resistance of the vertical drains is to be considered zero. This resistance is, in practice, only minimal when the hydraulic gradient (i) is lower or equal to 0.1 (see ASTM D4716, par. 8.3.2). In this AD it is assumed that i = 0.1.
- An alternative way to determine the discharge capacity is to adjust a flow of $5*10^{-6}$ m³/s. After the above mentioned seven days with a pressure of 300 kPa, the difference in head should be measured. After this the discharge capacity has to be calculated.
- After seven days of constant flow at a pressure of 300 kPa compare the calculated value for the discharge capacity, with the requirements in accordance with 5.6.

Calculation

The calculation of the discharge capacity will be as follows:

$q_w = Q / i$
$i = \Delta h / L$

by which:

q_w = discharge capacity (m³/s)
Q = flow (m³/s)
Δh = head
L = length sample
i = hydraulic gradient

Correct the hydraulic flow to that of 20°C by multiplying the hydraulic flow by the ratio of the viscosity of water at test temperature to the viscosity of water at 20°C.

Test report

The test report shall include the following information:

- type, size and description of the drain,
- raw materials used for core and jacket,
- scheme of sampling and sample size,
- weight per meter of the core and jacket,
- testing conditions and measurement schedule,
- plots with pressure/q_W/time relation,
- table with deviations of standard.

6.3 Determination of the discharge capacity of a buckled drain

Determination of the discharge capacity of a buckled drain take place in accordance with 6.1 considering the following deviations.

– The samples must be 50 mm longer than the distance between the inflow chamber and the outflow chamber, inclusive of the buckle.
– Place the sample (inclusive of the latex membrane) in the apparatus that buckles the drain and buckle the test sample slowly according to figure 3. The sample will be placed into the cell along with the buckle apparatus.
– Follow the procedures of 6.1 up to a pressure of 200 kPa.
– After seven days of constant flow at a pressure of 200 kPa compare the calculated value for the discharge capacity with the requirements in accordance with 5.7.

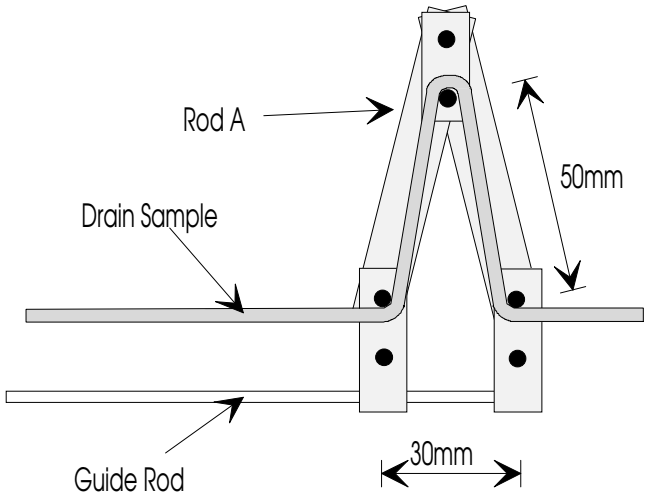


Figure 3. Apparatus to test vertical drain for discharge capacity.

7 Marking

At least once every five meters on the outside of the jacket the following indelible markings should be made:

- trade name or registered trade mark,
- KOMO-mark: "KOMO",
- year of production,
- type-indication (manufacturer's type code or name).

On every roll the following markings should be placed, clearly legible on weather resistant labels:

- trade name or registered trade mark,
- KOMO-mark: "KOMO",
- type-indication (manufacturer's type code or name).
- Geosynthetic: prefab vertical drain,
- production date (day/month/year) or code from which this can be deduced,
- raw material of the core (PP, PE, PET, PVC, PA), incl. the batch number,
- raw material of the jacket (PP, PE, PET, PA), incl. the batch number,
- Kiwa-assessment directive number: "BRL 1120",
- Class-indication pore size (A or B)
- Total mass of the roll.

8 REQUIREMENTS FOR QUALITY CONTROL

8.1 General

This chapter discusses the requirements for the quality control system of the manufacturer and the manner in which this system will be inspected by Kiwa.

8.2 Internal Quality Control

The manufacturer has to have a scheme for internal quality control (IKB-scheme).
This IKB-scheme should clearly show the following:

- which aspects are subject to quality control;
- which methods are being used for the different aspects;
- frequency of the controls;
- Registration and storage of the results of the Quality Control.

The IKB-scheme has to be drafted according to the blank IKB-form shown in Appendix I.

8.3 Working procedures and instructions

The manufacturer should be able to produce:

- procedures for:
  a. handling of rejected and/or reparable products and regenerates;
  b. handling of complaints about delivered products and or services;
- procedures, instructions and control forms.

8.4 External assessment

The quality control system of the manufacturer will be inspected by the certification institute.
This inspection should comply with par. 3.2 and 3.3 and include the aspects mentioned in the Rules of the certification institute.
The above mentioned College of Experts will advise on the frequency of the controls. The minimum amount of controls is set at 4 times per year.

9 LIST OF DOCUMENTS

- NEN 5167 (1990):
  Geotextile: Determination of the Permittivity.

- NEN 5168 (1990):
  Geotextile: Determination of the characteristic Pore Size (dry).

- NEN-ISO 5081 (1978):
  Textiles - Woven fabrics - Determination of breaking strength and elongation (Strip method).

- ISO 9073-1 (1989):
  Textiles: Test methods for non-wovens. Part 1: Determination of mass per unit area.

- ISO 9073-2 (1995):
  Textiles: Test methods for non-wovens. Part 2: Determination of thickness.

- ISO 9074-4 (1989):
  Textiles: Test methods for non-wovens. Part 4: Determination of tear resistance.

10 TERMS AND DEFINITIONS

Fibre:
a flexible element for the manufacturing of (geo)-textiles, with a large length to thickness ratio.

Nominal value:
a numeric indication of the properties, based on the testing methods mentioned in the assessment directive.

Permittivity:
a measurement of the capacity to let water through, perpendicular to the filter surface.

O95 number:
a measurement for the pore size, by which the filter fabric filters 95% of a sand fraction with an average grain diameter equal to the O95 value.

Appendix I

SUGGESTION FORM FOR IMPROVEMENTS FOR THE NEXT EDITION

Purpose: This form is meant to optimise the present assessment directive. For this purpose you can submit your comments to the secretary of the College of Experts "Synthetics for Civil Engineering ". The secretary will gather the proposals and will, depending on the comments, propose to the college ways of improving this assessment directive.

Presenter

Name : .....

Company :

. . . . . .

. . . . . .

. . . . . .

Address : .....

Postcode : .....

City :.....

Telephone : .....

Fax : .....

Re: BRL : 1120	Date: ... - ... - 199...	Proposal no.: ..... Att. Secr. CoE
Current Text:		
Comments:		
Text proposal:		

The form can be send to:

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Att. of the secretary of CoE ing. J.P. den Boer

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