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European Assessment Document for

Pre-assembled drainage panels made of gabions and geotextile

This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD applies to pre-assembled drainage panels made of gabions and geotextile (hereinafter referred to as pre-assembled drainage panels).

The pre-assembled drainage panels (Figure 1.1.1) consist of:

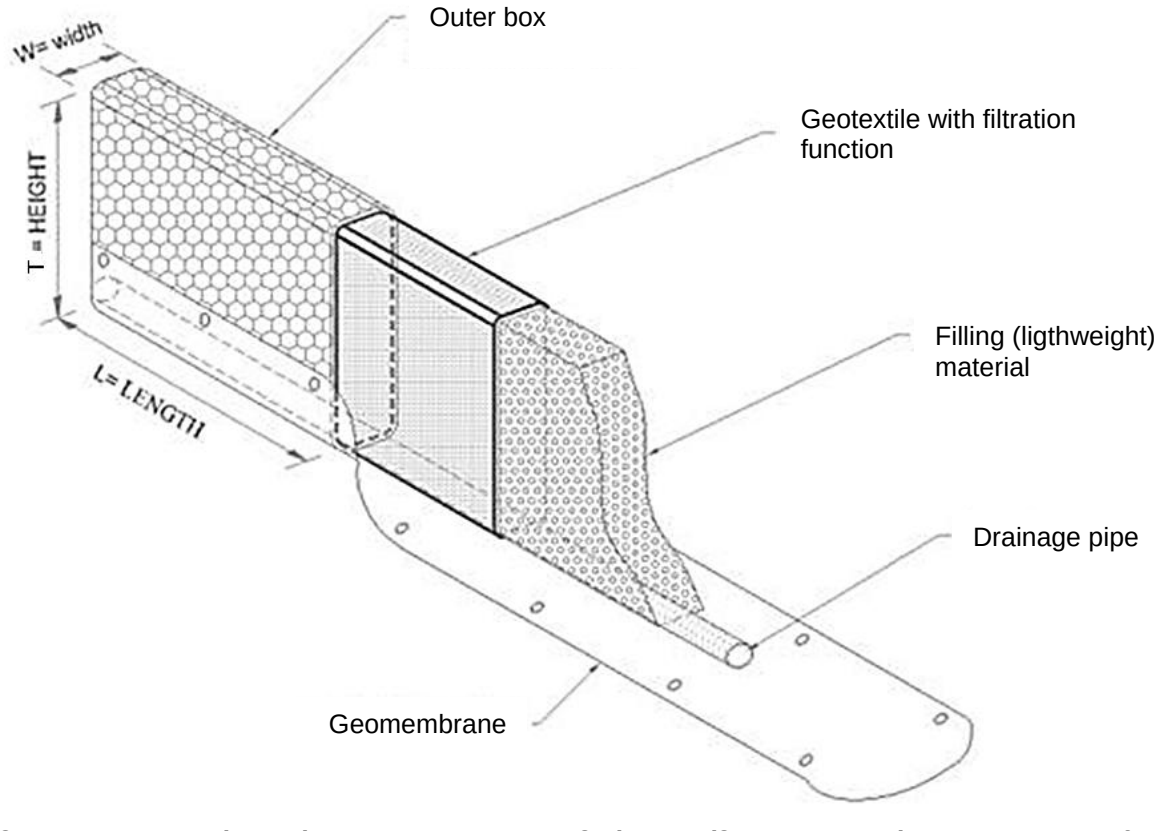
- Outer box made of metallic double twist polymeric coated wire mesh (or stainless-steel wire mesh) in accordance with EAD 200019-01-0102;
- geotextile with filtration function in accordance with EN 13252[1]
- and filling material (lightweight porous mass) made of synthetic material or polymer foam.

Dimensions of the pre-assembled drainage panels are shown in Figure 1.1.1.

An additional drainage pipe can be inserted inside the panel. Under the panel a geomembrane can be placed during installation in order to facilitate the flowing of drained water and avoiding dispersions. The additional pipe and the geomembrane are not part of this EAD.

The product is assessed as a kit and placed on the market with defined outer box, geotextile, filling material and fasteners and no other components are possible.

The components of pre-assembled drainage panels cannot be placed separately on the market. The geotextile and filling material used by the manufacturer for the pre-assembled drainage panels can be purchased on the market under responsibility of the product manufacturer.



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a) **The outer box** is produced from double-twisted steel wire mesh for use in direct contact with soil. Wire is Zinc/Aluminium (Zn/Al) alloy (including advanced coating as defined clause 1.3.10 in EAD 200019-

[1] All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

01-0102) coated and additionally polymeric coated. The outer box is completely covered by EAD 200019-01-0102.

b) **The geotextile filtration layer** is in accordance with EN 13252 as drainage system with function of filtration.

c) **The filling lightweight material**, in the form of irregular parallelepipeds, is made up of expanded polymers such as expanded polystyrene (EPS), expanded polyethylene or foamed PVC or other. Recycled materials of the same materials can be used. Similarly, material with low apparent density, made up of: hollow articles (i.e. pieces of plastic tubes), foamed glass and lightweight aggregates may be used.

The product is not fully covered by the following harmonised technical specification:

- EAD 200019-01-0102 because of the different intended use and consequently new essential characteristic “Water flow capacity in operating simulated conditions”. Only the essential characteristics of the outer box are covered by technical specification: EAD 200019-01-0102;
- EN 13252 because the products subject to this standard refer to geotextile or geotextile-related products. Only the essential characteristics of the geotextile filtration layer are covered by the technical specification: EN 13252.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer’s instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer’s stipulations, e.g., with regard to the intended end use conditions, having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA as long as the details of the assessment methods as laid down in this EAD are respected.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The pre-assembled drainage panels are used as drainage system to collect and remove water from soil in landslide remedial works, agricultural soil improvement, construction of roads and other traffic areas, railways, reservoirs and dams, canals, solid and liquid waste disposals, tunnels and underground structures, earthworks foundations and retaining structures.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer’s request to take into account the following working lives of the pre-assembled drainage panels when installed in the works, provided that the kit is subject to appropriate installation:

A) For outer box made of metallic double twisted polymeric coated wire mesh 120 years in accordance with EAD 200019-01-0102 (clause 1.2.2 points b) and d)). It is foreseen that the wet conditions C4 and C5 are always more adverse than any condition in soil.

B) For geotextile, the durability is based on Annex B.4 of EN 13252.

The durability of pre-assembled drainage panel is the minimum from A) and B).

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific terms used in this EAD

For specific terms see clauses 1.3.1 to 1.3.11 in EAD 200019-01-0102.

1.3.1 Symbols

δ_m	(mm)	mesh punching deflection
ΔH	(m)	head loss
σ	(kPa)	normal compressive stress
ρ_a	(g/m^3)	apparent density of pre-assembled drainage panel
ρ_b	(kg/m^3)	bulk density of filling material
η_{20}	(mPa*s)	dynamic viscosity of water at 20°C
η_T	(mPa*s)	dynamic viscosity of water at the testing temperature
D	(m)	actual width of the specimen according to configuration
D_c	(mm)	wire diameter with organic coating
d_{90}	(µm)	particle size for which *90* % mass fraction is smaller than the mass of measured particles
ε_{max}	(%)	tensile strain exhibited by the specimen under maximum tensile force
F_k	(kN)	C-ring (or similar fastener) resistance to opening
F_m	(kN)	mesh punching load
h	(m)	water head
h_d	(m)	downstream water head
h_u	(m)	upstream water head
H_d	(mm)	diameter of the hole made by the cone in penetrating the specimen
i		hydraulic gradient
ℓ	(m)	effective flow length
L	(m)	length of box
l	(mm)	cut off length of organic coated wire
W	(m)	width of block
T	(m)	height of block
O_{90}	(µm)	size of opening which is equal to the particle of size d_{90} of the granular material which passes through the geotextile or geotextile-related product
p_m	(kN/m)	tensile resistance of mesh
p_x	(g)	measured mass of filling material
P	(kg)	measured mass of pre-assembled drainage panel
$q_{m(\sigma, i, t)}$	(l/(m*s))	average water flow capacity in operating simulated conditions

2 The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

$q_{s(\sigma, i, t)}$	(l/(m*s))	measured water flow capacity in operating simulated conditions
Q_s	(l/s)	water flow rate (measured)
R_T		correction factor for converting to a water temperature of 20 °C
t	(s)	recording time
T_{max}	(kN/m)	maximum force per unit width observed during a tensile test
T_w	(°C)	testing temperature of water
v_x	(m^3)	measured volume of filling material
V	(m^3)	measured volume of pre-assembled drainage panel
V_{iH50}	(l/m^2 s)	the velocity corresponding to a head loss of 50 mm across a specimen
V_w	(l)	average water volume measured (measured in litres)

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of pre-assembled drainage panels is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Tensile resistance of mesh	EAD 200019-01-0102, clause 2.2.2	Level: p_m (kN/m)
2	C-ring (or similar fastener) characteristic resistance to opening	EAD 200019-01-0102, clause 2.2.3	Level: F_k (kN)
3	Mesh punching load and deflection	EAD 200019-01-0102, clause 2.2.5	Level: F_m (kN), δ_m (mm)
4	Water flow capacity in operating simulated conditions	2.2.1	Level: $q_{m(\sigma, i, t)}$ (l/(m*s)) and description
5	Tensile strength of the geotextile	EN 13252 clause 4.1, Table 1 (1) and clause 5.1	Level: T_{max} (kN/m)
6	Elongation at maximum load of the geotextile	EN 13252 clause 4.1, Table 1 (2) and clause 5.1	Level: ε_{max}(%)
7	Dynamic perforation resistance of the geotextile	EN 13252 clause 4.1, Table 1 (7) and clause 5.1	Level: H_d (mm)
8	Characteristic opening size of the geotextile	EN 13252 clause 4.1, Table 1 (11) and clause 5.1	Level: O_{90} (µm)
9	Water permeability normal to the plane of the geotextile	EN 13252 clause 4.1, Table 1 (12) and clause 5.1	Level: V_{iH50} (l/m^2 s)
Basic Works Requirement 3: Hygiene, health and the environment			
10	Content, emission and/or release of dangerous substances (leachable substances)	2.2.2	Level and description
Aspects of durability			
11	Durability Non-ferrous metallic coating: type coating mass/thickness	EAD 200019-01-0102, clause 2.2.9	Description
12	Additional corrosion protection: - Organic coating on wire: type organic coated wire diameter concentricity - Organic coating on wire: resistance to abrasion - Organic coating in double twist region of mesh: coating integrity	 EAD 200019-01-0102, clause 2.2.10.1 EAD 200019-01-0102, clause 2.2.10.1 EAD 200019-01-0102, clause 2.2.10.1 EAD 200019-01-0102, clause 2.2.10.2 EAD 200019-01-0102, clause 2.2.10.3	 Description Level: (mm) Level: (%) Level Description

No	Essential characteristic	Assessment method	Type of expression of product performance
13	Durability in artificial atmospheres: - sulphur dioxide - neutral salt spray - UV resistance of organic coating Durability of stainless-steel components	EAD 20019-01-0102, clause 2.2.11.1 EAD 200019-01-0102, clause 2.2.11.2 EAD 200019-01-0102, clause 2.2.11.3 EAD 200019-01-0102, clause 2.2.11.4	Description
14	Durability of geotextile	EN 13252 Annex B, Table 1 (15)	Level and description (to be declared in accordance with the relevant clause of EN 13252 Annex B)

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer, and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant essential characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

The pre-assembled drainage panels shall be described in the ETA in accordance with the minimum data for each component as indicated in Table 2.2.1.

Table 2.2.1 – Minimum data for each component to be given in the ETA

Outer box	
Outer box dimensions	EAD 080007-00-0101, Figure 1.1.1
Mesh designation	EAD 200019-01-0102 clause1.3.3
Mesh wire diameter	EAD 200019-01-0102 clause1.3.11
Selvedge wire diameter	EAD 200019-01-0102 clause1.3.11
Non-ferrous metallic coating type and class	EAD 200019-01-0102 clause 2.2.9
Organic coating type and thickness	EAD 200019-01-0102 clause 2.2.10.1
Connection type of outer boxes (C-ring or similar fasteners or lacing wire)	EAD 200019-01-0102 clauses 1.3.4 and 1.3.5
Filter geotextile	
Tensile strength and its tolerance	EN ISO 10319, Clause 8 EAD 080007-00-0101, clause A.5
Elongation at maximum load and its tolerance	EN ISO 10319, Clause 8 EAD 080007-00-0101, clause A.5
Dynamic perforation resistance (cone drop test) and its tolerance	EN ISO 13433, Clause 8 EAD 080007-00-0101, clause A.5
Characteristic opening size (O_{90}) and its tolerance	EN ISO 12956, Clause 7 EAD 080007-00-0101, clause A.5
Water permeability normal to the plane and its tolerance	EN ISO 11058, Clauses 5 and 6 EAD 080007-00-0101, clause A.5
Filling material	
Bulk density ρ_b	EAD 080007-00-0101, clause A.5
Apparent density of pre-assembled drainage panels	
Apparent density ρ_a of drainage panel and its tolerance	EAD 080007-00-0101, clause A.5

2.2.1 Water flow capacity in operating simulated conditions

Assessment method

The water flow capacity $q_{m(\sigma, i, t)}$ (l/(m*s)) in function of normal compressive stress (σ) and hydraulic gradient (i) – is defined as the average value of the measured water flow capacity $q_{s(\sigma, i, t)}$ (l/(m*s)) and its tolerances corresponding to 95% level of confidence obtained from at least three tests performed in accordance with

Annex A on three specimens with the same mesh designation/mesh wire diameter and test layout, filling material and for both horizontal and vertical test configuration layout.

The water flow capacity $q_{m(\sigma, i, t)}$ (l/(m*s)) shall be tested and assessed in accordance with Annex A.

Expression of results

The average water flow capacity $q_{m(\sigma, i, t)}$ (l/(m*s)) in operating simulated conditions expressed by diagrams according to Annex A, Figure A.7.1, shall be given in ETA.

Description of tested product, in accordance with Annex A, Clause A.5, shall be given in the ETA.

2.2.2 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer[3] after identifying the release scenarios taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The identified intended release scenarios for this product and intended use with respect to dangerous substances are:

S/W1: Product with direct contact to soil, ground- and surface water

The leaching of dangerous substances therefore shall be assessed.

2.2.2.1 Leachable substances

Assessment method

For the intended use covered by the release scenario S/W1 the performance of the **geotextile filtration layer** concerning leachable substances shall be assessed. A leaching test with subsequent eluate analysis shall take place, each in duplicate. Leaching tests of the **geotextile filtration layer** shall be conducted in accordance with EN 16637-2.

For the intended use covered by the release scenario S/W1 the performance of the **filling lightweight material** concerning leachable substances shall be assessed. A leaching test with subsequent eluate analysis shall take place, each in duplicate. Leaching tests of the **filling lightweight material** shall be conducted in accordance with EN 16637-2.

For the intended use covered by the release scenario S/W1 the performance of the organic coating of wire, concerning leachable substances shall be assessed. A leaching test with subsequent eluate analysis shall take place, each in duplicate. Leaching tests of the organic coating of wire shall be conducted in accordance with EN 16637-2 . The leachant shall be pH-neutral demineralised water and the ratio of liquid volume to surface area shall be (80 ± 10) (l/m²). Each test specimen shall be prepared by cutting off the piece of finally organic coated wire of length *l* (mm) calculated according to equation:

$$l = \frac{40000}{\pi \times {D_c}^2}$$

[3] The manufacturer may be asked to provide to the TAB the REACH related information which shall accompany the DoP (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **not** obliged to:
- provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS, taking into account the installation conditions of the construction product and the release scenarios resulting from there.

Any information provided by the manufacturer regarding the chemical composition of the products is not to be distributed to EOTA to other TABs or beyond.

where l cut off length of organic coated wire in mm

D_c wire diameter in mm with organic coating in accordance with clause 2.2.12 of EAD 200019-01-0102.

After that, cut off pieces of organic coated wire shall be wound into a coil of diameter suitable for following preparation of eluates.

In eluates of "6 hours" and "64 days", the following biological tests shall be conducted:

- Acute toxicity test with Daphnia magna Straus in accordance with EN ISO 6341
- Toxicity test with algae in accordance with EN ISO 15799
- Luminescent bacteria test in accordance with EN ISO 11348-1, EN ISO 11348-2 or EN ISO 11348-3

For each biological test, EC20-values shall be determined for dilution ratios 1:2, 1:4, 1:6, 1:8 and 1:16.

If the parameter TOC (total organic carbon) is higher than 10 mg/l, the following biological tests shall be conducted with the eluates of "6 hours" and "64 days" eluates:

- Biological degradation in accordance with OECD Test Guideline 301 part A, B or E.

Expression of results

Determined toxicity in biological tests shall be expressed as EC20-values for each dilution ratio. Maximum determined biological degradability shall be expressed as "…% within …hours/days". The respective test methods for analysis shall be specified.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Delegated Decision (EU) 2015/1958.

The system is 2+.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

The manufacturer (regarding the components he buys from the market with DoP) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Steel wire mesh: Mesh tensile strength	EAD 200019-01-0102, clause 2.2.2	According to control plan	3 samples/type (of different mesh designation wire combination)	Twice every year
2	C-ring (or similar fastener) characteristic resistance to opening	EAD 200019-01-0102, clause 2.2.3	According to control plan	5 samples/type	Once every year
3	Durability: Non-ferrous metallic coating: type coating mass	EAD 200019-01-0102, clause 2.2.9	According to control plan	Checking the inspection certificate of supplier, type 3.1 EN 10204 In addition, test 1 / each diameter	Every shipment Once every day
4	Durability: Additional corrosion protection: - Organic coating on wire: type organic coated wire diameter concentricity	EAD 200019-01-0102, clause 2.2.10.1	a) According to control plan	a) Checking the inspection certificate of supplier, type 3.1, EN 10204, in addition, test 1 / each diameter	Every shipment
			b) Tested and measured when produced by the manufacturer	b) 1 sample / type / thickness	Once every day
5	Durability: - Organic coating on wire: resistance to abrasion	EAD 200019-01-0102, clause 2.2.10.2	According to control plan	3 sample / organic coating type and thickness	Once every year

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
6	Durability: - Organic coating in double twist region of mesh: coating integrity	EAD 200019-01-0102, clause 2.2.10.3	According to control plan	1 sample / type	Once every year
7	Durability Sulphur dioxide test	EAD 200019-01-0102, clause 2.2.11.1	According to control plan	1 sample / mesh designation/wire diameter	Once every 2 years
8	Durability Neutral salt spray test	EAD 200019-01-0102, clause 2.2.11.2	According to control plan	1 sample / mesh designation/wire diameter	Once every 2 years
9	Durability UV resistance	EAD 200019-01-0102, clause 2.2.11.3	According to control plan	1 sample / mesh designation/wire diameter	Once every 2 years
10	Coating filter geotextile: Tensile strength	EN ISO 10319	According to control plan	Supplier accompanying document (DOP) and 5 specimens/type	Each shipment Once every week
11	Coating filter geotextile: Elongation at maximum load	EN ISO 10319	According to control plan	Supplier accompanying document (DOP) and 5 specimens/type	Each shipment Once every week
12	Coating filter geotextile: Dynamic perforation resistance (cone drop test)	EN ISO 13433	According to control plan	Supplier accompanying document (DOP) and 5 specimens/type	Each shipment Once every 6 months
13	Coating filter geotextile: Characteristic opening size	EN ISO 12956	According to control plan	Supplier accompanying document (DOP) and 5 specimens/type	Each shipment Once every year
14	Coating filter geotextile: Water permeability normal to the plane	EN ISO 11058	According to control plan	Supplier accompanying document (DOP) and 5 specimens/type	Each shipment Once every year
15	Coating filter geotextile: Durability	Annex B of EN 13252	According to control plan	Supplier accompanying document (DoP)	Each shipment
16	Apparent density of pre-assembled drainage panel	3.4.1	According to control plan	1 assembled panel / type	Each production batch

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for pre-assembled drainage panels are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control *(for systems 1+, 1 and 2+ only)*					
1	Notified Body will ascertain that the factory production control and accurate description of assembly of the product with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the "***pre-assembled drainage panels***".	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to Control plan	According to Control plan	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control *(for systems 1+, 1 and 2+ only)*					
3	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	According to Control plan	According to Control plan	n[number]/year

3.4 Special methods of control and testing used for the assessment and verification of constancy of performance

As the water flow capacity $q_{s(\sigma, i, t)}$ is influenced by the filling procedure, the following method of control and testing shall be used to assess and verify the assembly of the product.

3.4.1 Apparent density of the pre-assembled drainage panel

The procedure used to evaluate the apparent density ρ_a of pre-assembled drainage panels shall be in accordance with the following steps:

- Determination of the pre-assembled drainage panel nominal volume (V) = W * T * L see Figure 1.1.1 (m^3);
- Determination of the pre-assembled drainage panel mass (gross mass (P); The mass of the panel shall be measured using the weighting equipment (for example platform scale) with precision of 0,5 kg.
- Calculation of apparent density: $\rho_a = P / V$ (kg/m^3).

4 REFERENCE DOCUMENTS

[1]	EAD 200019-01-0102	Hexagonal Woven Mesh Gabion Boxes and Mattresses
[2]	EN 10223-3:2013	Steel wire and wire products for fencing and netting. Part 3: Hexagonal steel wire mesh products for civil engineering purposes
[3]	EN 13252:2016	Geotextiles and geotextile-related products. Characteristics required for use in drainage systems
[4]	EN 16637-2:2023	Construction products: Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test
[5]	EN ISO 10319:2015	Geosynthetics - Wide-width tensile test
[6]	EN ISO 11058:2019	Geotextiles and geotextile-related products. Determination of water permeability characteristics normal to the plane, without load
[7]	EN ISO 11348-1:2008/A1:2018	Water quality. Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test). Part 1: Method using freshly prepared bacteria
[8]	EN ISO 11348-2:2008/A1:2018	Water quality. Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test). Part 2: Method using liquid-dried bacteria
[9]	EN ISO 11348-3:2008/A1:2018	Water quality. Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test). Part 3: Method using freeze-dried bacteria
[10]	EN ISO 12956:2020	Geotextiles and geotextile-related products. Determination of the characteristic opening size
[11]	EN ISO 12958-2:2020	Geotextiles and geotextile-related products. Determination of water flow capacity in their plane. Part 2: Performance test
[12]	EN ISO 13433:2006	Geosynthetics. Dynamic perforation test (cone drop test)
[13]	EN ISO 15799:2022	Soil quality. Guidance on the ecotoxicological characterization of soils and soil materials
[14]	EN ISO 6341:2012	Water quality. Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea). Acute toxicity test
[15]	EN ISO 9223:2012	Corrosion of metals and alloys. Corrosivity of atmospheres. Classification, determination and estimation
[16]	OECD GUIDELINE 301 FOR TESTING OF CHEMICALS Adopted by the Council on 17th July 1992	Ready Biodegradability

ANNEX A: TEST METHOD FOR WATER FLOW CAPACITY

A.1 Scope

This Annex specifies a method for determining the water flow capacity in operating simulated conditions of pre-assembled drainage panel specimen.

The purpose of the test is to evaluate the water flow capacity under loading of the built-in product, where the loads result from earth pressure or other site conditions.

This test procedure is applicable only to factory assembled specimens. This test procedure is in line with EN ISO 12958-2, with adaptations of the testing apparatus to cope with the dimensions of the pre-assembled drainage panel.

The water flow capacity $q_{m(\sigma,\ i,\ t)}$ (l/(m*s)) – measured in function of normal compressive stress (σ) and hydraulic gradient (i) – is defined as the average value of the measured water flow capacity $q_{s(\sigma,\ i,\ t)}$ (l/(m*s)) obtained from at least three tests performed in accordance with clause A.6 on three specimens with the same mesh designation/mesh wire diameter, filling material and for both horizontal and vertical test configuration layout. The water flow capacity $q_{m(\sigma,\ i,\ t)}$ (l/(m*s)) is expressed as water flow capacity plots shown in Figure A.7.1.

The basic normal compressive stresses (σ) to be plotted, for vertical configuration layout shall be:
2 kPa; 20 kPa and 50 kPa.

The basic normal compressive stresses (σ) to be plotted, for horizontal configuration layout shall be:
2 kPa; 20 kPa and 100 kPa.

The basic hydraulic gradients (i) to be plotted, for both vertical and horizontal configuration layouts shall be:
0,10; 0,20 and 0,40.

A.2 Definitions

For the purposes of this test method, the following terms and definitions apply:

Normal compressive stress σ
Compressive stress component normal to the top horizontal plane of the pre-assembled drainage panel, expressed in (kPa).

Water flow rate Q_s
Fluid flow per unit of time within the pre-assembled drainage panel and parallel to its long side.

NOTE – Water flow rate is expressed in (l/s).

Water flow capacity $q_{s(\sigma,\ i,\ t)}$
Measured volumetric flow rate of water per unit width of specimen at a defined gradient (i) and normal compressive stress (σ).

NOTE 1 – Water flow capacity is expressed in (l/(m*s)).

NOTE 2 – The term transmissivity is related to laminar flow conditions only and equals the water flow capacity at a hydraulic gradient equal to unity. As non-laminar flow may occur, the term water flow capacity is preferred.

Head loss ΔH
Difference between the water head (h) in the pre-assembled drainage panel specimen measured upstream (h_u) and downstream (h_d).

NOTE – Head loss is expressed in (m)

Hydraulic gradient i
Ratio of the head loss in the pre-assembled drainage panel specimen between two measuring points to the distance between the measuring points (nominal flow length ℓ).

$$i = \Delta H / \ell \qquad \text{(A.2.1)}$$

A.3 Principle of test

The flow of water within the pre-assembled drainage panel and parallel to its long side shall be measured under varying normal compressive stresses (σ) (simulating the built-in product conditions, where the loads result from earth pressure), with typical hydraulic gradients (i).

A.4 Test equipment

A.4.1 General description of constant-head water flow apparatus

The constant-head water flow apparatus shall at least satisfy the following requirements:

a) The test equipment shall be capable of maintaining a constant head loss (ΔH) at different water levels, at least that corresponding to hydraulic gradients (i) in range 0,10 to 0,60; while maintaining a water head (h_d) at the point of discharge of not greater than 1000 mm.

b) The equipment shall include a loading mechanism capable of providing a constant normal compressive stress on the pre-assembled drainage panel specimen.

c) The specimen shall be contained by rigid surfaces and all the sides, excluding the inlet and outlet sides shall be waterproofed by wrapping the specimen in a smooth PVC or bituminous liner or by any other suitable method. The rigid surfaces (e.g. steel plates) shall surround the sample tightly to avoid any water penetrating around its corners. The tightness on the upper surface is ensured by self-weight of the rigid surface and by compression. The tightness on the sides can be ensured e.g. by fixing them to the rigid channel (see clause A.4.2) by rods. The top plate on the upper surface shall be coated by rubber gaskets to avoid lateral leakage of water.

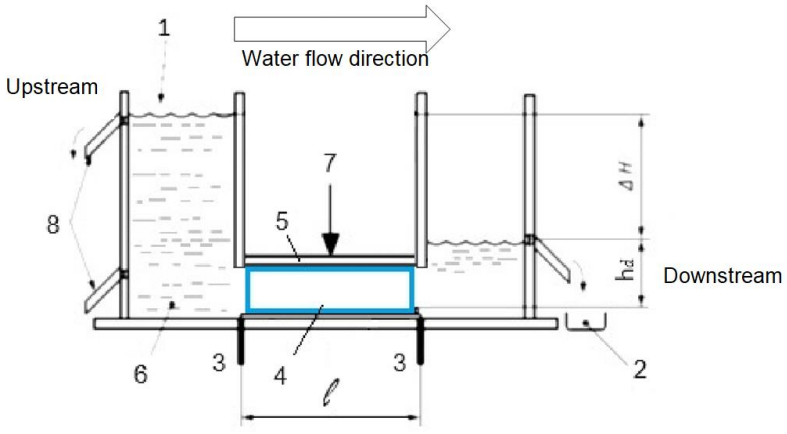
d) The apparatus shall have a minimum width of 0,5 m and a minimum nominal flow length (ℓ) of 1,0 m. It shall be capable of testing specimens up to 0,5 m height (Figure A.4.1.1). The apparatus shall have changeable cross section to be adapted to specimen.

e) The apparatus shall be essentially leak tight when the specimen is inside.

f) For determination of the hydraulic head loss (ΔH), the apparatus shall be provided with two manometers or piezometers.

g) The water flow rate (Q_s) shall be determined by measurements of volume and time, or measured directly by an electromagnetic flowmeter. The volume shall be determined by weighting, and then dividing the measured weight by the unit weight of water.

h) The water head (h_d) at the point of discharge shall not be less than 0,5 m for the vertical layout configuration and shall not be less than 0,3 m for the horizontal layout configuration.



Key

1	water supply	6	water reservoir
2	water collection	7	normal compressive load
3	upstream water head manometers/piezometers	8	overflow weirs
4	specimen	ℓ	nominal flow length (≥1,0 m)
5	loading platen	ΔH	head loss
		h_d	downstream water head

Figure A.4.1.1 – Example of typical test equipment

NOTE – Figure A.4.1.1 represents a typical cross section of a testing apparatus in equilibrium conditions aimed only to introduce the parameters. The testing procedure is characterized by steps where the conditions are mostly transitional. The detailed step by step procedure is described in clause A.6.

A.4.2 Additional construction details of constant-head water flow apparatus

The tests equipment shall be put in a channel made of rigid material, as concrete, able to accommodate the specimen (typical dimensions of the channel are height of 1 m, width of 1 m and length of 20 m).
The channel used for the tests shall be connected to the water feeding system and the discharge shall be controlled by electrical valves.

The test equipment consists of an upstream gate, a downstream gate (optional), a downstream rectangular weir and a triangular weir.

The upstream gate creates an upstream reservoir with a fixed water level kept steady during the measurements and then increased by varying the water in-flow with the valve in order to obtain different hydraulic gradients.

The specimen shall be either placed vertically or horizontally inside the equipment, by changing the upstream / downstream gates, the plates for the specimen lateral confinement and the loading platen.

The downstream condition for the water level (h_d) is imposed by the weir height.

Opening of the gates is adjusted to follow the sample vertical deformation with the increasing normal load according to the test procedure.

Rubber gaskets are attached along all the gates sides to avoid water leakages.

The specimen is laterally confined using 4 rigid plates coated by rubber gaskets to avoid water leakage.

The upstream and downstream sections of the specimen are not confined to allow the water flow. The downstream triangular weir allows monitoring the discharges, in case of small values.

A.4.3 Water

The water used shall be fed from a stilling tank. The water shall be at temperature between 18 °C and 24 °C and be at or above the ambient temperature of the test laboratory.

The water may be recirculated but changes of temperature during the test shall be avoided. The water from the mains supply shall be used only if its normal temperature is between 18 and 24 °C. Mixing hot and cold water to achieve the requested temperature is not acceptable.

NOTE – As the temperature correction relates only to laminar flow, it is advisable to work at temperatures as close as possible to 20 °C to minimize inaccuracies associated with inappropriate correction factors.

A.4.4 Accuracies of measuring devices

During the tests the following measuring devices with the given accuracies shall be used:

a) Stopwatch with a maximum permissible measurement error of 0,5 s.

b) Thermometer with a maximum permissible measurement error of ± 0,5 °C.

c) The water flow rate Q_s shall be determined by measurements of volume and time, or measured directly by an electromagnetic flowmeter. The volume shall be determined by weighting, and then dividing the measured weight by the unit weight of water. The water flow rate Q_s shall be measurable to a maximum permissible measurement error of ± 2 %.

d) Measuring device for determining the applied water head (h) to a maximum permissible measurement error of ± 1 mm of water head. For hydraulic gradients (i) manometer with maximum permissible error of 5 % shall be used.

e) Measuring device for determining the applied normal stress σ to a maximum permissible measurement error of 1 % or 1 kPa, whichever is greater.

A.5 Test specimen

In order to prevent damage to its structure, the specimen shall not be folded and kept in a flat position without any load. The specimens shall be clean, free from surface deposits and without visible damage or fold marks.

The description of the pre-assembled drainage panel shall contain the following information:

a) Outer box mesh designation, steel wire diameter, organic coating type and thickness and its dimension (width "*W*", height "*T*" and length "*L*" in line with Figure 1.1.1 shall be described).

b) As the water flow capacity $q_{s(\sigma,\ i,\ t)}$ is influenced by the filter geotextile, which performs the function of filtration in a drainage system in accordance with EN 13252, the filter geotextile shall be described by the following properties:

- Tensile strength (T_{max}) and elongation at maximum load (ε_{max}), tested in accordance with EN ISO 10319, Clause 8;
- Dynamic perforation resistance (cone drop test) (H_d), tested in accordance with EN ISO 13433, Clause 8;
- Characteristic opening size (O_{90}), tested in accordance with EN ISO 12956, Clause 7;
- Water permeability normal to the plane (velocity index) V_{iH50}, tested in accordance with EN ISO 11058, Clauses 5 and 6.

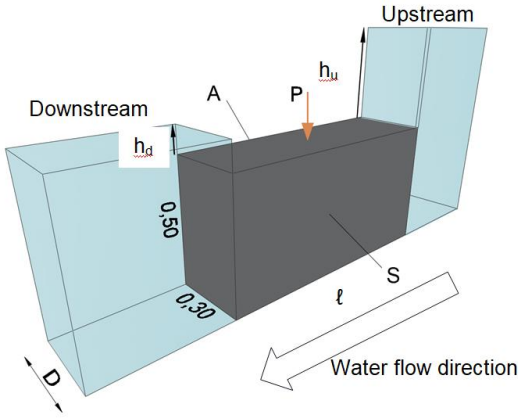
c) As the water flow capacity $q_{s(\sigma,\ i,\ t)}$ is influenced by the filling material and filling procedure, the following information shall be provided:

- To determine the bulk density ρ_b of filling material seven specimens of random geometric shape shall be selected and the volume (v_x) and mass (p_x) of each specimen shall be measured. The sum of volumes (v) and sum of masses (p) shall then be calculated. The bulk density shall be calculated as: $\rho_b = p / v$ (g/m^3);
- Apparent density ρ_a of pre-assembled drainage panel. The specific mass of a set of filling elements that occupy a given volume is understood as the ratio of the mass of the set of filling elements to the volume that these elements occupy together. The procedure used to evaluate the apparent density ρ_a of pre-assembled drainage shall be in accordance with the following steps:
  - Selection of a pre-assembled drainage panel of specified volume (V);
  - Determination of the full container mass (gross mass (P));
  - Calculation of apparent density: $\rho_a = P / V$ (kg/l or kg/m^3).

The pre-assembled drainage panel specimen dimensions shall be given in test report: W= 0,3 m, L= 1,0 m and T =0,5 m (tolerance on dimensions of the specimens + 10 %).

The pre-assembled drainage panel specimen shall be tested in two layout configurations:

- "Vertical" configuration layout (Figure A.5.1): with nominal flow length (ℓ) parallel and equal to the long side of the panel L, with the shortest side W (0,30 m) of the cross-section, placed horizontally.

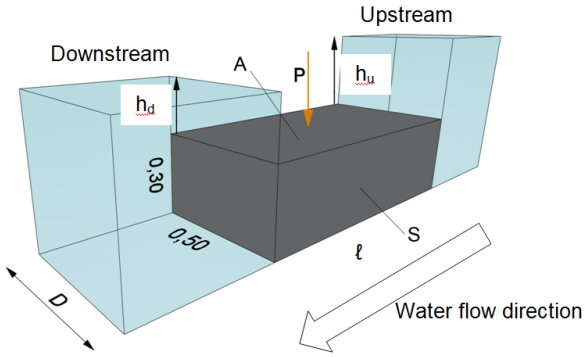


Key

h_u	upstream water head	ℓ	nominal flow length (≥1,0 m)
h_d	downstream water head	P	normal compressive load
S	specimen	A	loading platen
		D	actual width of the specimen according to configuration

Figure A.5.1—Example of "vertical" layout configuration

- "Horizontal" configuration layout (Figure A.5.2): with nominal flow length (ℓ) parallel and equal to the long side of the panel *L*, with the longest side *T* (0,50 m) of the cross-section, placed horizontally.



Key

h_u	upstream water head	ℓ	nominal flow length (≥1,0 m)
h_d	downstream water head	P	normal compressive load
S	specimen	A	loading platen
		D	actual width of the specimen according to configuration

Figure A.5.2 — Example of "horizontal" layout configuration

The dimensions of the loading platen shall be equal to the specimen nominal dimensions according to test layout:

- In horizontal layout: 500 × 1 000 × min. 20 mm with tolerance on each dimension +10 %
- In vertical layout: 300 × 1 000 × min. 20 mm with tolerance on each dimension +10 %

The calculation of the water flow capacity $q_{s(\sigma, i, t)}$ shall be made using the actual width of the specimen according to configuration (D).

A.6 Test procedure

The test procedure shall follow the following steps:

a) Measure the dimensions length (*L*), width (*W*) and height (*T*) along the edges of the test specimens before the test with the maximum permissible measurement error of ± 1 mm.

b) Place the specimens under water and gently stir to remove air bubbles and leave to saturate for at least 12 h.

c) Place the test specimen in the apparatus and proceed to waterproofing the sides of the specimen using the PVC or bituminous membrane or the selected method, and ensure that no water is passing through the sides. Lower the loading platen on to the test specimen.

d) Fill the inlet reservoir with water to allow the water to flow through the test specimen in order to remove air. All necessary precautions shall be taken to avoid preferential flow paths along the boundaries of the specimen. If such flows are observed, seal the boundaries or re-seat the specimen or discard the specimen when necessary.

e) Adjust the load to achieve the first normal stress (σ) and hold this pressure while changing the hydraulic gradient (*i*).

f) Fill the inlet reservoir to the level corresponding to the lowest hydraulic gradient (*i*). Hydraulic gradient (i) is dimensionless, for this reason the corresponding level depends on the laboratory test conditions.
Note: During the test, after each increment of the normal load on the specimen, the water discharge shall be varied in order to achieve the steady water level in the upstream reservoir.

g) Allow the water to flow through the specimen under the above steady conditions for at least 120 s ± 5 s.

For pre-assembled drainage panel the stress may tend to decay during the test if e.g. a hydraulic jack is employed to apply the load. In this case, continual readjustment of the stress shall be necessary to maintain a constant value during the test period.

h) Collect the water passing through the system over a fixed period of time in the measuring vessel or directly measure the water flow rate Q_s with a flowmeter. The volume of water collected shall be at least 1 litre and the collection time shall be at least 5 s. Record the volume of water collected and the related collecting time, or directly the water flow rate Q_s (l/s). If an electromagnetic flowmeter gauge is used then the flow rate Q_s shall be the average of three consecutive readings with a minimum time interval between readings of 15 s.

i) Increase the hydraulic gradient (*i*) to the second selected value while maintaining the stress value (σ). Repeat the procedure given in g) and h).

j) Continue the procedure given in g) and h) for all selected hydraulic gradients (*i*) while maintaining the stress value (σ).

k) Decrease the hydraulic gradient (*i*) to the lowest selected value (or to hydraulic gradient (*i*) = 0) and increase the normal compressive stress (σ) to the next selected value. Repeat the procedure given in g) to j).

l) Continue in this way until the specimen has been tested at each hydraulic gradient (*i*) and at each selected stress (σ) given in clause A.1.

m) Different hydraulic gradients (*i*) and normal compressive stresses (σ) may be also added (e.g. 200 kPa) providing the possibility to perform additional combinations of hydraulic gradients (*i*) and normal compressive stresses (σ) on top of the minimum requested combinations listed in clause A.1.

A.7 Calculations and expression of results

The water flow capacity $q_{s(\sigma, i, t)}$ at 20 °C, for each given hydraulic gradient (*i*) and normal stress (σ) given in clause A.1 and shall be calculated using the following formula:

$$q_{s(\sigma, i, t)} = (V_w . R_T) / (D . t) \quad \text{(A.7.1)}$$

where

$q_{s(\sigma, i, t)}$ water flow capacity at a defined stress and gradient (l/(m*s))

V_w average water volume measured (measured in litres)

R_T correction factor for converting to a water temperature of 20 °C (formula A.7.3)

D actual width of the specimen according to configuration (m), see Figure A.5.1 and Figure A.5.2

t recording time (s)

Where the water flow rate Q_s has been measured directly, a temperature correction is still necessary and the in-plane water flow capacity $q_{s(\sigma, i, t)}$ is then given by formula:

$$q_{s(\sigma,i, t)} = Q_s . R_T / D \quad \text{(A.7.2)}$$

where

Q_s measured flow rate (l/s)

The correction factor is calculated according to the formula (A.7.3)

$$R_T = \frac{\eta_T}{\eta_{20}} = \frac{1{,}762}{1+0{,}0337.T_w+0{,}00022.T_w^2} \quad \text{(A.7.3)}$$

where

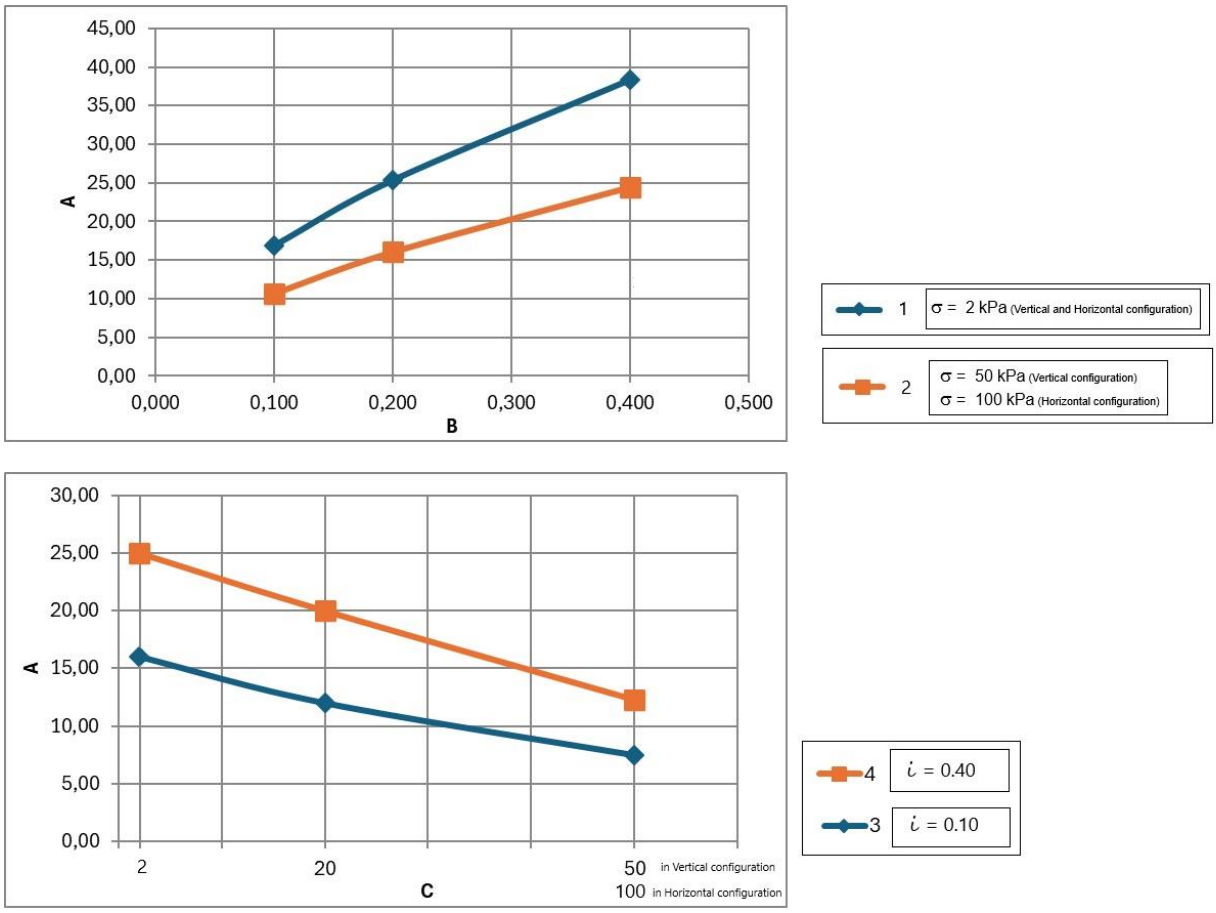
T_w testing temperature of water (°C)

η_{20} dynamic viscosity of water at 20°C (mPa*s)

η_T dynamic viscosity of water at the testing temperature (mPa*s)
R_T correction factor for converting to water temperature of 20°C

Average water flow capacity $q_{m(\sigma, i, t)}$ shall be calculated as given in clause 2.2.1

Express the diagrams of hydraulic gradient (*i*) - water flow capacity $q_{m(\sigma, i, t)}$ and the diagram of normal compressive stress (σ) – water flow capacity $q_{m(\sigma, i, t)}$ according to Figure A.7.1.



Key

A	$q_{m(\sigma, i, t)}$ water flow capacity (l/(m*s))
B	*i* hydraulic gradient
C	σ normal compressive stress (kPa)
1	lower normal compressive stress (kPa)
2	higher normal compressive stress (kPa)
3	lower hydraulic gradient
4	higher hydraulic gradient

Figure A.7.1 – Typical examples of plots of water flow capacity $q_{m(\sigma, i, t)}$

A.8 Test report

The test report shall include at least the following information:

a) Reference to this document, i.e. EAD 080007-00-0101 - Annex A.
b) Testing laboratory.
c) Description of the pre-assembled drainage panel product according to clause A.5.

d) Details of test equipment according to Annex A (i.e. details of apparatus used, detail of the loading system and flow measuring technique).

e) Dimensions of test specimen before the test according to clause A.6a (i.e. width “W”, height “T” and length “L” in line with Figure 1.1.1) and layout configuration (i.e. “horizontal” layout configuration).

f) Description of the boundary conditions (e.g. any systems applied to seal or waterproof the specimen, place, time).

g) Test conditions: normal load (σ), hydraulic gradient (i), seating time (t).

h) Table giving the experimental data and the calculations for each specimen.

i) Average water flow capacity $q_{m(\sigma, i, t)}$ at the defined hydraulic gradients (i) and normal stresses (σ) and the individual values $q_{s(\sigma, i, t)}$.

j) Plot of hydraulic gradient (i) - average water flow capacity $q_{m(\sigma, i, t)}$ and plot of normal compressive stress (σ) – average water flow capacity $q_{m(\sigma, i, t)}$ according to Figure A.7.1 for both “vertical” and “horizontal” configuration layout.

k) Water temperature range.

l) Water type (stilled or mains supply).

m) Any deviation from the procedure described in this Annex.

n) Any anomaly in the hydraulic behaviour of the pre-assembled drainage panel product under test.

o) Place and date of the test.