Deutsches Institut für Bautechnik

DIBt

Zulassungsstelle für Bauprodukte und Bauarten

Bautechnisches Prüfamt

Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

Mitglied der EOTA, der UEAtc und der WFTAO

National technical approval / General construction technique permit

Date: 21 Apr 2020

Reference: III 55-1.42.1-20/20

Number:

Z-42.1-494

Validity

from: **21 April 2020**

to: **26 March 2025**

Applicant:

INTEWA Ingenieur-Gesellschaft für Energie- und Wassertechnik mbH
Auf der Hüls 182
52068 Aachen
GERMANY

Subject of decision:

Tunnel stormwater infiltration system with the designation "DRAIN MAX" made of HD-PE

The subject named above is herewith granted a national technical approval (*allgemeine bauaufsichtliche Zulassung*) / general construction technique permit (*allgemeine Bauartgenehmigung*).

This decision contains twelve pages and three annexes.

This national technical approval / general construction technique permit replaces national technical approval / general construction technique permit no. Z-42.1-494 of 26 March 2020. The subject concerned was granted the first national technical approval on 10 October 2012.

I GENERAL PROVISIONS

1 This decision confirms the fitness for use and application of the subject concerned within the meaning of the Building Codes of the federal states (*Landesbauordnungen*).

2 This decision does not replace the permits, approvals and certificates required by law for carrying out construction projects.

3 This decision is granted without prejudice to the rights of third parties, in particular private property rights.

4 Notwithstanding further provisions in the 'Special Provisions', copies of this decision shall be made available to the user and installer of the subject concerned. The user and installer of the subject concerned shall also be made aware that this decision must be made available at the place of use or place of application. Upon request, copies of the decision shall be provided to the authorities involved.

5 This decision shall be reproduced in full only. Partial publication requires the consent of DIBt. Texts and drawings in promotional material shall not contradict this decision. In the event of a discrepancy between the German original and this authorised translation, the German version shall prevail.

6 This decision may be revoked. The provisions contained herein may subsequently be supplemented and amended, in particular if this is required by new technical findings.

7 This decision is based on the information and documents provided by the applicant. Alterations to this basis are not covered by this decision and shall be notified to DIBt without delay.

8 The general construction technique permit included in this decision also serves as a national technical approval for the construction technique.

II SPECIAL PROVISIONS

1 Subject concerned and field of use and application

The subject of this national technical approval is a tunnel system made of polyethylene (HD-PE) with the designation "DRAIN MAX" for stormwater infiltration as part of underground infiltration and retention systems.

The national technical approval applies to the "DRAIN MAX" tunnel system, consisting of

- start section with the designation "DM-T100S",
- middle tunnel with the designation "DM-T1600M" and
- end section with the designation "DM-T100E".

The stormwater infiltration systems assembled from the above-named tunnel system, hereafter referred to as infiltration systems, shall only be used for stormwater infiltration into the substrate, in accordance with the scope of DWA-A 138[1]. Other applications such as infiltration of untreated runoff from suspected or known contaminated sites as well as from sites where substances hazardous to water are handled (such as petrol stations) are not covered by this decision.

The tunnel system shall be installed with a soil cover of at least 1.00 m.

The surfaces above the infiltration system may not be built over for any purposes except for traffic areas. The traffic loads on the surfaces above infiltration systems shall not exceed load class Bk0.3 in accordance with RStO 12[2].

This decision applies only to use of the tunnel system in non-earthquake-prone areas.

The infiltration systems shall consist of no more than one tunnel layer with an overall height of 805 mm. The tunnels may be installed parallel to each other with a minimum distance of 430 mm at base level, but never in multiple layers.

The tunnel systems are classified as non-accessible within the meaning of the applicable accident prevention regulations.

2 Provisions for the tunnel system components

2.1 Properties and composition

2.1.1 General

An infiltration system consists of one or several middle tunnels, whose end faces are closed off by start or end sections. In the system, the middle tunnels and start or end sections are joined with interlocking connecting ribs that overlap at the ends.

All tunnels in an infiltration system are completely wrapped in a geotextile. Tunnels in which high-pressure flushing is scheduled to take place shall be equipped with a complete underlay of a geocomposite.

1	DWA-A 138	German Association for Water, Wastewater and Waste (DWA) – Worksheet 138: Planning, construction and operation of facilities for the percolation of precipitation water, issue: 2005-04
2	RStO 12	Road and Transportation Research Association (FGSV): Guidelines for the standardisation of pavement structures of traffic areas; FGSV Verlag; 2012

2.1.2 Material and material characteristics

The tunnel system components, made of high-density polypropylene in accordance with the formula specifications deposited with DIBt, shall at least have the following properties after processing:

- Density in accordance with DIN EN ISO 1183-1[3] 1.08 g/cm³ ± 0.1 g/cm³
- Melt mass-flow rate (MFR 190 °C / 5.0 kg)
  in accordance with DIN EN ISO 1133[4] 0.50 g/10 min – 1.00 g/10 min
- Thermal stability in accordance with DIN EN 728[5] >2.8 min
- Charpy impact strength (test method 'eA')
  in accordance with DIN EN ISO 179-1[6] at 23 °C ≥ 4.0 kJ/m²
- Longitudinal reversion in accordance with DIN EN ISO 2505[7] ≤ 1.1
- Filler content in accordance with DIN EN ISO 1172[8] ≤ 22.0%
- Tensile properties in accordance with DIN EN ISO 527-2[9]
  Modulus of elasticity under tension E_T ≥ 850 MPa
  Tensile strength σ_M ≥ 18.0 MPa
- Flexural strength σ_{fM} in accordance with DIN EN ISO 178[10] ≥ 25.0 MPa

2.1.3 Dimensions and weight

The shapes, dimensions and tolerances of the tunnel system shall meet the specifications given in Annexes 1 to 3.

The weight of the middle tunnel shall be at least 36.2 kg, the start section at least 5.2 kg and the end section at least 5.3 kg.

2.1.4 Condition of the tunnel system

In a visual inspection without optical aids the tunnel system components shall have a smooth surface free of scratches, bubbles, impurities, sunken areas and other irregularities (defects) as can be expected for the manufacturing process. All surfaces shall be free from burrs.

2.1.5 Colour

The tunnel system components shall be uniformly black throughout.

3	DIN EN ISO 1183-1	Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pyknometer method and titration method (ISO 1183-1:2004); German version EN ISO 1183-1:2004; issue: 2004-05
4	DIN EN ISO 1133	Plastics – Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics (ISO 1133:2005); German version EN ISO 1133:2005; issue: 2005-09
5	DIN EN 728	Plastics piping and ducting systems - Polyolefin pipes and fittings - Determination of oxidation induction time; German version EN 728:1997; issue: 1997-03
6	DIN EN ISO 179-1	Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test (ISO 179-1:2010); German version EN ISO 179-1:2010; issue: 2010-11
7	DIN EN ISO 2505	Thermoplastics pipes – Longitudinal reversion – Test method and characteristic values (ISO 2505:2005); German version EN ISO 2505:2005; issue: 2005-08
8	DIN EN ISO 1172	Textile-glass-reinforced plastics – Prepregs, moulding compounds and laminates – Determination of the textile-glass and mineral-filler content; calcination methods (ISO 1172:1996); German version EN ISO 1172:1998; issue: 1998-12
9	DIN EN ISO 527-2	Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Cor.1:1994); German version EN ISO 527-2:1996; issue: 1996-07
10	DIN EN ISO 178	Plastics – Determination of flexural properties (ISO 178:2010); German version EN ISO 178:2010; 2011-04

2.1.6 Strength properties

When a vertical crown compressive force of at least 11.7 kN/m is applied distributed across the crown in accordance with the specifications set out in Section 2.3.2 point 10, the infiltration tunnels shall have a maximum deformation of 95 mm at the crown.

2.1.7 Geotextile

The entire base area for the tunnels in which high-pressure flushing is scheduled to take place shall be lined with a geocomposite that is resistant to high pressure flushing before the tunnel is installed.

All tunnels shall be completely wrapped in a geotextile.

Only the geotextiles with the designations

- "INTEWA GT300" and
- "INTEWA GTB190"

complying with the declared performances deposited with DIBt shall be used.

2.2 Manufacture, packaging, transport, storage and marking

2.2.1 Manufacture

The tunnel system components shall be manufactured using the vacuum forming process in consideration of the specifications set out in Section 2.3.2 and Annexes 1 to 3 and shall have the properties described in Section 2.1.

During manufacture, at least the following production parameters shall be calibrated and continuously recorded each time the machine is started:

- vacuum forming temperature,
- vacuum,
- sheet weight.

Only the material in accordance with Section 2.1.2 for which the specifications have been deposited with DIBt and designated with the trade names, manufacturers and characteristic values shall be used in the manufacturing process.

Use of process scrap of the same formulation from the applicant's manufacturing plants is permitted.

2.2.2 Packaging, transport and storage

The tunnel system components shall be secured for storage and transport such that no impermissible deformation and no damage occurs. The corresponding storage and transport instructions of the applicant and the relevant accident prevention regulations shall be observed.

2.2.3 Marking

The tunnel system components shall be marked by the applicant with the national conformity mark (Ü-Zeichen) in accordance with the Conformity Marking Ordinances (*Übereinstimmungszeichen-Verordnungen*) of the federal states, including approval no. Z-42.1-494. The mark shall only be applied if the requirements given in Section 2.3 are met.

The tunnel system components shall also each be marked at least once in a clearly visible and durable manner with the following information:

- Type designation
- Material: HD-PE
- Manufacturing plant
- Manufacturing date

2.3 Confirmation of conformity

2.3.1 General

The confirmation of conformity of the components of the tunnel system with the provisions of this national technical approval shall be issued for every manufacturing plant in the form of a certificate of conformity based on factory production control and regular external surveillance, including initial type-testing of the components of the tunnel system in accordance with the following provisions.

To issue the certificate of conformity and for external surveillance, including the associated product testing, the applicant shall use a certification body and an inspection body recognised for these purposes.

The declaration that a certificate of conformity has been granted shall be submitted by the applicant through marking of the construction products with the national conformity mark (*Ü-Zeichen*), stating the intended use.

The certification body shall send a copy of the certificate of conformity issued by it to DIBt.

A copy of the initial type-testing evaluation report shall also be sent to DIBt.

2.3.2 Factory production control

A factory production control system shall be set up and implemented in each manufacturing plant. Factory production control is understood to be continuous surveillance of production by the applicant to ensure that the construction products manufactured satisfy the provisions of this decision.

The factory production control shall at least include the measures listed below:

- Description and verification of the starting material and the components:

  The properties of the material used and its verification shall comply with the specifications given in Section 2.1.2. For each delivery, the manufacturer of the tunnel system components shall obtain confirmation of conformity of the material used with the specifications given in Section 2.1.2 in the form of a test report 'type 2.2' based on DIN EN 10204[11] from the raw material supplier.

  Within the scope of the factory production control, a spot check shall be carried out on each delivery to determine whether the supplied material complies with the requirements for density and the melt mass-flow rate.

- Checks and tests to be carried out during manufacture:

  The specifications given in Section 2.2.1 shall be complied with.

- Verifications and tests to be carried out on the finished construction product:

  At least the requirements listed below shall be verified:

  1. Compliance with the density specifications for the processed material as given in Section 2.1.2 shall be verified in accordance with DIN EN ISO 1183-1[3] at least once a week and each time the raw material is changed.
  2. Compliance with the melt mass-flow rate specifications for the processed polypropylene given in Section 2.1.2 shall be verified in accordance with DIN EN ISO 1133[4] to ensure compliance with the limit values at least once every production week and each time the raw material is changed.
  3. Compliance with the specifications for dimensional stability after warm storage as given in Section 2.1.2 shall be verified in accordance with DIN EN ISO 2505[7] at least every six months and each time the raw material is changed.

[11] DIN EN 10204 Metallic products – Types of inspection documents; German version EN 10204:2004; issue: 2005-01

4. Compliance with the specifications for tensile strength σM and the modulus of elasticity under tension E_T given in Section 2.1.2 shall be verified in accordance with DIN EN ISO 527-2[9] at least once every production month and each time the raw material is changed.
5. Compliance with the specifications for short-term bending strength σ_M given in Section 2.1.2 shall be verified in accordance with DIN EN ISO 178[10] at least once every production month and each time the raw material is changed.
6. Compliance with the specifications for the Charpy impact strength given in Section 2.1.2 shall be verified in accordance with DIN EN ISO 179-1/1eA[5] at least once every production month and each time the raw material is changed.
7. Compliance with the dimensional specifications for the tunnel system components given in Section 2.1.3 shall be verified upon start of production and thereafter once every production week, each time the raw material is changed and whenever changes are made to the system parameters.

   All dimensions affecting the functionality shall be checked. These include:

   - length, width and height dimensions,
   - rib geometry,
   - wall thicknesses and
   - weight.
8. Compliance with the specifications regarding the condition of the tunnel system components as given in Section 2.1.4 shall always be verified upon start of production and thereafter continuously once every shift.
9. Compliance with the specifications regarding the colouring of the tunnel system components as given in Section 2.1.5 shall always be verified upon start of production and thereafter continuously once every shift.
10. For the verification of the strength properties given in Section 2.1.6, the infiltration tunnels shall be loaded with an increasing force that is distributed longitudinally along the crown, after a conditioning time of at least 24 h at 22 °C to 23 °C room temperature and with lateral restraint by the supports. The applied force and the vertical deformation at the crown shall be recorded continuously over the entire course of the test.

    The force shall be applied with a test speed of 0.5 kN/(ms) and shall be continuously increased until the maximum test load of 11.7 kN/m is reached. The infiltration tunnel being tested is deemed to have failed if there is

    - a drop in force before the maximum test load has been reached,
    - a loss of stability before the maximum test load has been reached or
    - a vertical deformation in the crown area > 95 mm before the maximum test load has been reached.

    The strength properties of the infiltration tunnels shall be checked at least once per batch and each time the raw material is changed.
11. Compliance with the manufacturing and marking specifications given in Sections 2.2.1 and 2.2.3 shall be verified continuously during production.

The results of factory production control shall be recorded and evaluated. The records shall include at least the following information:

- designation of the construction product or the starting products and the components,
- type of check or test,
- date of manufacture and testing of the construction product or the starting material,
- results of the checks and tests as well as, if applicable, comparison with requirements,
- signature of the person responsible for factory production control.

The records shall be kept for at least five years and submitted to the inspection body used for external surveillance. They shall be presented to DIBt and the competent supreme building authority upon request.

If the test result is unsatisfactory, the applicant shall immediately take the necessary measures to resolve the defect. Construction products which do not meet the requirements shall be handled in such a way that they cannot be mixed up with compliant products. After the defect has been remedied, the relevant test shall be repeated immediately – where technically feasible and necessary to show that the defect has been eliminated.

2.3.3 External surveillance

The factory production control system at each manufacturing plant shall be inspected regularly, i.e. at least twice a year, by means of external surveillance.

Initial type-testing of the tunnel system components shall also be carried out within the scope of external surveillance. Spot checks shall be carried out to verify compliance with the requirements given in Section 2.3.2, in particular the requirements for the strength properties of the tunnel system components in accordance with the specifications given in Section 2.1.6.

Sampling and testing shall be the responsibility of the recognised inspection body.

The results of certification and external surveillance shall be kept for at least five years. They shall be submitted by the certification or inspection body to DIBt and the competent supreme building authority upon request.

3 Provisions for planning, design and execution

3.1 Provisions for design

3.1.1 Infiltration performance

Unless otherwise specified below, the design principles and conditions set out in worksheet DWA-A 138[1] and advisory leaflet ATV-DVWK-M 153[12] issued by the German Association for Water, Wastewater and Waste (DWA) shall apply to the design of the infiltration systems assembled from the construction products given in Sections 1 to 2.3.3 of this decision.
For the purposes of ensuring the performance of the infiltration system, the corresponding hydraulic verifications of the infiltration capacity of the ground as well as the local groundwater conditions shall be obtained, for instance in conjunction with a geotechnical report, as a basis for system dimensioning.

[12] ATV-DVWK-M 153 German Association for Water, Wastewater and Waste (*DWA*) - Advisory leaflet 153: Recommended actions for dealing with stormwater; issue: 2000-02

3.1.2 Stability

The stability of the infiltration systems shall be verified in each individual case by means of a structural analysis or a design type approval for the ultimate limit state (ULS) and for the serviceability limit state (SLS) for a maximum allowable deflection of $\Delta h_{zul} \leq 6$ % where:

$$\sigma_{E,d} \leq \sigma_{R,d} \quad (1)$$

where $\sigma_{E,d}$ is the design value for the loads/forces acting on the component and
$\sigma_{R,d}$ is the design value of the resistance

The structural analysis carried out shall be reviewed by a structural design control authority or an accredited structural design review engineer. Verification shall be deemed provided when the resistance is verified in accordance with equation (1). Type designs may be drawn up for standard installations. These need to be reviewed by a structural design control authority.

The stresses (actions) $\sigma_{E,d}$ shall be determined based on a failure model with lateral bedding.

The forces acting on the system (actions) shall be determined for:

- constant loads $\sigma_{G,k}$ in accordance with DIN 1055-1[13], DIN 1055-2[14], DIN 1055-3[15] and if applicable DIN EN 1055-5[16]. The partial safety factor γ_G in accordance with DIN 1054[17] shall be applied, but shall at least correspond to the value given in Table 2.
- for variable loads $\sigma_{Q,k}$ in accordance with DIN technical report 101[18] with a partial safety factor γ_Q which, however, shall at least correspond to the value given in Table 2.

When determining the design resistance of the infiltration system components $\sigma_{R,d}$, the infiltration system shall be assumed to have a maximum characteristic short-term compressive strength $\sigma_{R,k}$ for the ULS and SLS as given in Table 1 in consideration of a partial safety factor γ_M for the design value of the resistance, which shall at least correspond to the value given in Table 2.

Table 1: Maximum characteristic short-term compressive strength $\sigma_{R,k}$ for ULS and SLS

	$\sigma_{R,k}$
SLS max. deformation 4.0% max. deformation 6.0%	 140 kN/m² 170 kN/m²
ULS	54.6 kN/m 220 kN/m²

13	DIN 1055-1	Actions on structures – Densities and weights of building materials, structural elements and stored materials; issue: 2002-06
14	DIN 1055-2	Actions on structures – Soil properties; issue: 2010-11
15	DIN 1055-3	Actions on structures – Self-weight and imposed loads in buildings; issue: 2006-03
16	DIN 1055-5	Actions on structures – Snow loads and ice loads; issue: 2005-07
17	DIN 1054	Subsoil – Verification of the safety of earthworks and foundations – Supplementary rules to DIN EN 1997-1; issue: 2010-12
18	DIN technical report 101	Actions on bridges; issue: 2009-03

Table 2: Applicable partial safety factors

Partial safety factor for		ULS	SLS
constant loads	γ_G	1.35	1.0
variable loads	γ_Q	1.5	1.0
Design value of the resistance	γ_M	1.3	1.0

For the reduction of the resistance of the components of the infiltration system at least the reduction factors given in Table 3 shall be applied.

Table 3: Reduction factors for the design value of the resistance

Creep	A_1	3.3[a)] / 2.3[b)]
Effect of media	A_2	1.0
Effect of temperature	A_3	1.0
Inhomogeneities (including effect of joints and connections)	A_4	1.1
Effect of dynamic loads	A_5	1.0

[a)] for SLS verification
[b)] for ULS verification

Verification for the limit states is then carried out using:

$$\sigma_{E,d} = \Sigma\, \sigma_{G,k} \times \gamma_G + \Sigma\, \sigma_{Q,k} \times \gamma_Q \leq \sigma_{R,k} / (\gamma_M \times A_1 \times A_2 \times A_3 \times A_4 \times A_5) = \sigma_{R,d} \qquad (2)$$

3.2 Provisions for execution

For assembly of the individual tunnel system components into an infiltration system, the design provisions given in Sections 3.1 and 3.2 shall apply. Unless otherwise specified, the following technical rules shall generally be observed:

- DWA-A 138[1]
- ATV-DVWK-M 153[12]
- DIN 1054[17]

The infiltration system may only be installed in connection with pipes, moulded components and access chambers which comply with the generally recognised technical rules and bear the national conformity mark.

The applicant shall supply an installation manual with each delivery. Installation shall be carried out in accordance with the installation instructions and in consideration of the following provisions:

The system shall only be installed by individuals possessing the necessary specialised knowledge.

For the excavation work, the principles of DIN 4124[19] shall apply.

[19] DIN 4124 Excavations and trenches – Slopes, planking and strutting breadths of working spaces, issue: 2002-10

A level, flat and strong subgrade made from non-cohesive, compactable ground material with a minimum load-bearing capacity of E_v^2 = 45 MN/m² shall be created to facilitate laying.

When the individual tunnel system components are being installed, it shall be ensured that they have the correct vertical and horizontal alignment. The minimum distance of the tunnels shall be at least 430 mm at base level. Damaged middle tunnels, start or end sections shall not be installed.

Every individual tunnel in an infiltration system shall be equipped with a separate ventilation device at crown height. The dimensioning of the ventilation device shall always be determined depending on the expected feed volume flow.

The infiltration system shall be completely wrapped in a geotextile (cover) or geocomposite (underlay) with each wrap having an overlap of at least 25 cm. The overlaps shall be designed such that no backfill material can penetrate into the infiltration system.

For ensuring the stability of the overall infiltration system, side backfilling shall always be carried out before the infiltration system is covered. Non-cohesive, compactable material shall be used for the side backfilling and final covering, which shall generally be installed in layers no thicker than 20 cm in height with a minimum compaction of $D_{pr} \geq 97\%$, with the required degree of compaction depending on the planned later surface use and to be determined for each individual case. The compaction shall be carried out with a suitable tool.

During installation of the infiltration system and the side backfilling and covering of the excavation, the infiltration system shall not be driven over. Installation shall always be carried out using an end tipping method, for example with wheel loaders or excavators.

The executing company shall provide a written declaration of compliance with the execution provisions set out in this decision for each infiltration system installed.

The relevant accident prevention provisions shall be observed during execution.

3.3 Marking of the infiltration system

The infiltration system shall be marked above ground by a sign which shall be labelled in a permanent and legible manner with the following information:

- size of infiltration system,
- depth of infiltration system,
- product designation,
- year of installation.

In addition, the tunnels in which high-pressure flushing is scheduled to take place shall be marked accordingly.

3.4 Declaration of conformity

The installer of the infiltration systems in accordance with Section 1 shall provide a written declaration of conformity of the installed system with the provisions set out in Sections 3.1, 3.2 and 3.3. of this general construction technique permit specifying the use of the subject concerned.

4 Provisions for use and maintenance

During use and maintenance of the infiltration systems assembled from the tunnel system components, the relevant accident prevention regulations shall be observed.

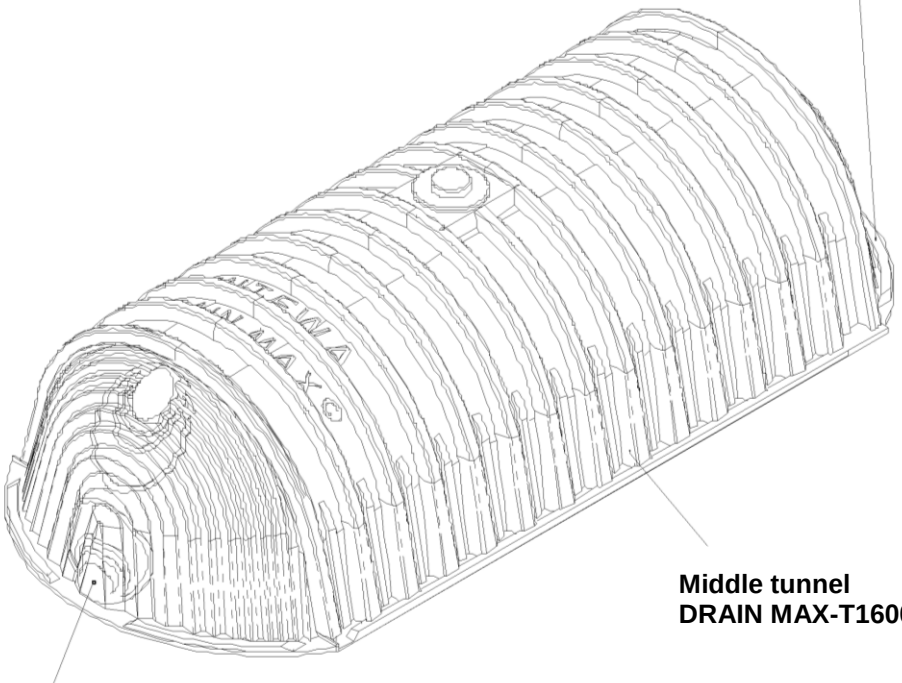
During the validity period of this decision, the applicant shall submit at least three reports on the inspections carried out on the infiltration systems to DIBt.

Rudolf Kersten
Head of Section

Drawn up by
Ronny Schmidt

Deutsches Institut für Bautechnik DIBt

Start section
DRAIN MAX-T100S



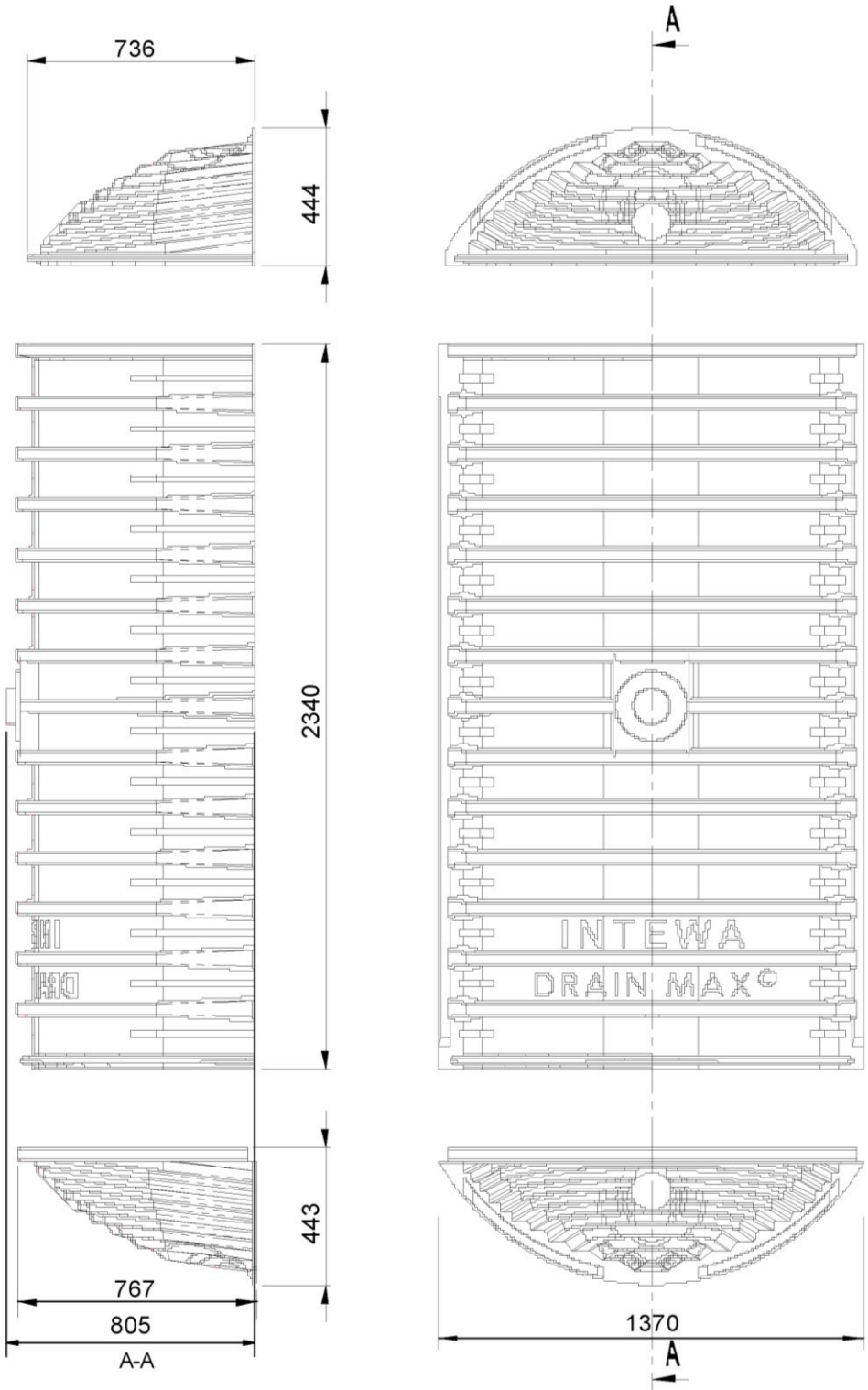
Middle tunnel
DRAIN MAX-T1600M

End section
DRAIN MAX T-100E

All dimensions in mm (tolerances +/- 4%)

DRAIN MAX tunnel system	**Annex 1**
Overview of the DRAIN MAX tunnel system	

Deutsches Institut für Bautechnik DIBt



All dimensions in mm (tolerances +/- 4%)

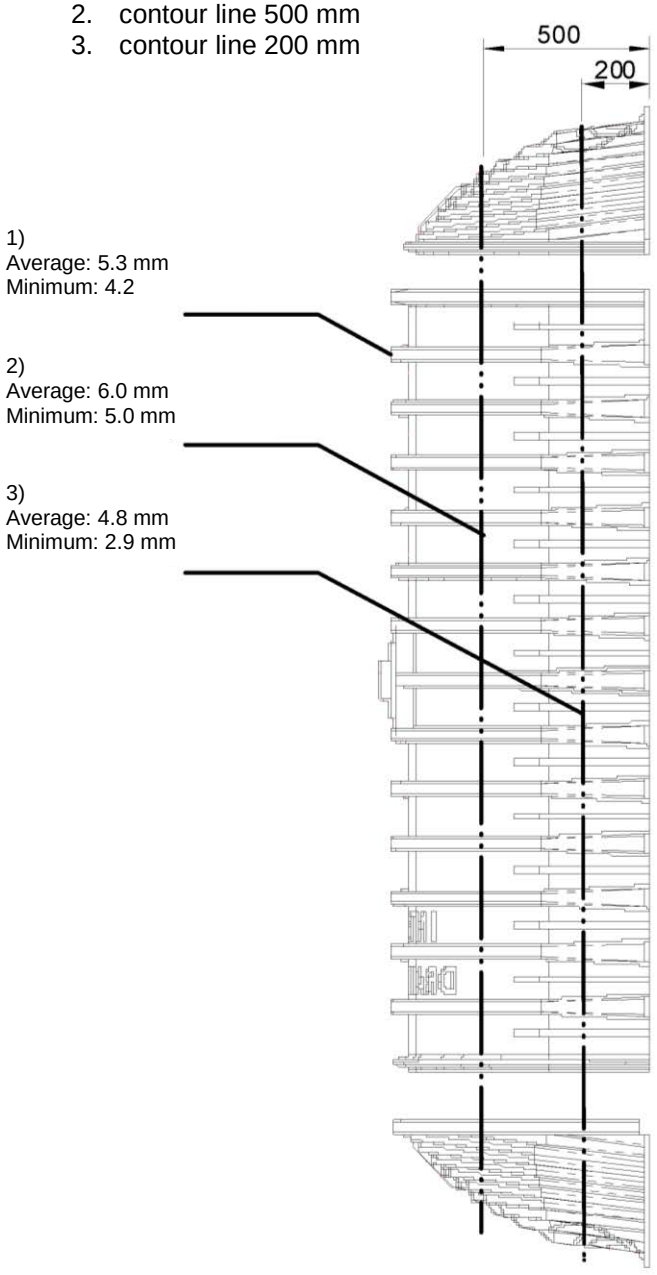
DRAIN MAX tunnel system

Dimensions for the DRAIN MAX middle tunnel and start and end sections

Annex 2

Material thicknesses over the entire contour of

1. tunnel shoulder
2. contour line 500 mm
3. contour line 200 mm



All dimensions given in mm (tolerances +/- 4 %)

DRAIN MAX tunnel system	**Annex 3**
Material thicknesses DRAIN MAX	