StormTech
A Division of ADS, Inc.
70 Inwood Road
Suite 3
Rocky Hill
Connecticut 06067
USA

Tel: 888 892 2694 Fax 866 328 8401
e-mail: info@stormtech.com
website: www.stormtech.com

Agrément Certificate
07/4480
Product Sheet 1

STORMTECH SUBSURFACE STORMWATER MANAGEMENT SYSTEM

STORMTECH SC-310 AND SC-740 CHAMBERS

This Agrément Certificate Product Sheet(1) relates to StormTech Sc-310 and Sc-740 Chambers, used for the control and management of stormwater run-off from impermeable and permeable surfaces.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Hydraulic design — data is provided in this Certificate to assist in the design of a sub-surface stormwater management system incorporating the chambers (see section 5).

Structural performance — when used in accordance with this Certificate, the chambers have adequate strength and stiffness to resist short- and long-term loading (see section 6).

Maintenance — information is provided to assist in planning the maintenance of a completed installation of the chambers (see section 10).

Durability — when installed in accordance with this Certificate, the chambers will have a service life in excess of 50 years (see section 11).

The BBA has awarded this Certificate to the company named above for the products described herein. These products have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of Second issue: 12 September 2017

Originally certificated on 12 October 2007

Brian Chamberlain
Head of Technical Excellence

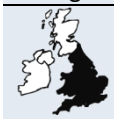
Claire Curtis-Thomas
Chief Executive

The BBA is a UKAS accredited certification body – Number 113.
The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk
Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA
tel: 01923 665300
fax: 01923 665301
clientservices@bbacerts.co.uk
www.bbacerts.co.uk

Regulations

In the opinion of the BBA, StormTech Sc-310 and Sc-740 Chambers, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):



The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	**H3(3)**	**Rainwater drainage**
Comment:		The products can be used in a construction to satisfy this Requirement. See section 5 of this Certificate.
Regulation:	**7**	**Materials and workmanship**
Comment:		The products are acceptable. See section 11 and the *Installation* part of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	**8(1)(2)**	**Durability, workmanship and fitness of materials**
Comment:		The products can contribute to satisfying this Regulation. See section 11 and the *Installation* part of this Certificate.
Regulation:	**9**	**Building standards applicable to construction**
Standard:	3.6(a)	Surface water drainage
Comment:		The products can contribute to a construction satisfying this Standard, with reference to clauses 3.6.1[(1)(2)] to 3.6.5[(1)(2)]. See section 5 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The system components can contribute to meeting the relevant requirements of Regulation 9, Standards 1 to 6 and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard.
Regulation:	**12**	**Building standards applicable to conversions**
Comment:		Comments in relation to the products under Regulation 9, Standards 1 to 6 also apply to this Regulation, with reference to clause 0.12.1[(1)(2)] and Schedule 6[(1)(2)].

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2012 (as amended)

Regulation:	**23(a)(i)**	**Fitness of materials and workmanship**
Comment:	**(iii)(b)(i)**	The products are acceptable. See section 11 and the *Installation* part of this Certificate.
Regulation:	**15**	**Rainwater drainage**
Comment:		The products can be used in a construction to satisfy this Regulation. See section 5 of this Certificate.

Construction (Design and Management) Regulations 2015
Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See sections: 3 *Delivery and site handling* (3.4) and 14 *Procedure* (14.1) of this Certificate.

Additional Information

This Certificate is a confirmation of Avis Technique 17/13-273*-V1 issued by CSTB, France to ADS Europe B.V. Marco Polostraat 2-14, 3165 AL Rotterdam, The Netherlands.

Technical Specification

1 Description

1.1 StormTech SC-310 and SC-740 Chambers consist of interlocking tunnels and end caps (see Figure 1) made from injection moulded yellow polypropylene. The chambers are assembled to form an underground structure. The characteristics and material properties of the products are given in Tables 1 and 2.

Figure 1 Components

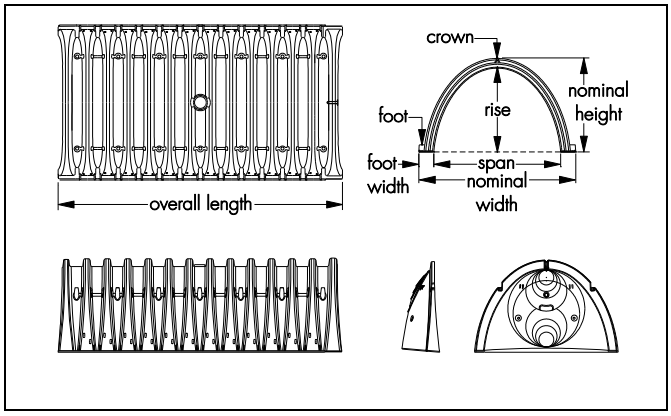


Table 1 Characteristics

Characteristic (unit)	**SC-310**	**SC-740**
Overall length (mm)	2300	2300
Installed length (mm)	2170	2170
Nominal width (mm)	864	1295
Nominal height (mm)	406	762
Span (mm)	617±10	1082±10
Rise (mm)	333±10	678±10
Foot width (mm)	100	100
Minimum wall thickness (mm)	3.18	4.45
Pitch of corrugations (mm)	165	165
Nominal mass (kg)	16	34
Maximum cut-out diameter for end cap (mm)	300	600
Nominal chamber storage volume (m^3)	0.4	1.3
Minimum installed storage volume (m^3)(1)	0.9	2.1

(1) Based on a minimum thickness of 150 mm of crushed stone above, below and between chambers assuming a porosity of 40% for the stone.

Table 2 Material properties

Property	Test method	Required specification
Tensile strength	ASTM D 638	Minimum 21 MPa (3100 psi)
Flexural modulus (1% secant)	ASTM D 790 procedure A	Minimum 931 MPa (135000 psi)
Melt flow rate	ASTM D 1238	16_5 g/10 min
Izod impact resistance	ASTM D 256 method A	Minimum 215 Jm^{-1} (4 ft-lb/in)
50-year creep modulus at 3.5 MPa (500 psi) and 23°C (73°F)	As ASTM D 2990 except test duration 10 000 hours or ASTM D 6992	Minimum 166 MPa (24000 psi)

1.2 The specification for the infill material is washed (clean), crushed stone to BS EN 13242 : 2013, sizes 20/40 or 20/32.

1.3 Spacers used to help maintain the correct spacing between adjacent rows are made from lengths of pipe to the dimensions given in Table 1.

1.4 The end caps are marked to allow holes to be cut to suit pipes up to 300 mm diameter for SC-310 or 600 mm for SC-740. Connection pipework for use with the products is outside the scope of this Certificate.

1.5 The chambers and the crushed stone edge are wrapped in a non-woven geotextile to prevent migration of fines from surrounding soils for infiltration and combined applications. A geomembrane is used to surround the crushed stone for attenuation applications where infiltration is not permitted or possible (see section 7 for additional information on geotextiles and geomembranes). Specifications of the geotextile and geomembrane are project specific and outside the scope of this Certificate. For more information, advice should be sought from the Certificate holder.

1.6 It is recommended that an isolator row (see section 5.8) is installed to prevent silting of the chambers and to allow for periodic maintenance cleaning. The isolator row traps silt, preventing it spreading to other rows, and allows access for periodic maintenance cleaning. A silt management plan should be put into effect on all sites.

1.7 Adequate venting must be provided where the chambers are wrapped with a geomembrane, see section 7.

1.8 Ancillary items used with the chambers to form a stormwater management system, but outside the scope of this Certificate, include:

- surface water connection pipework
- non-woven geotextiles and geomembranes
- air vent and ventilation systems
- silt trap and isolator row
- infiltration inlet modules
- flow control/chamber devices.

2 Manufacture

2.1 The products are manufactured by injection-moulding from polypropylene to a defined specification.

2.2 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

3 Delivery and site handling

3.1 The chambers are delivered banded onto wooden pallets with the end caps stored in the voids.

3.2 Chambers should be stored on level ground protected from accidental damage, eg by vehicular movements or other site activity.

3.3 The chambers should not be stored near fuel tanks, fuel bowsers or solvents to avoid potential chemical spillages. The units must be protected from direct sunlight if likely to be stored in excess of 12 months.

3.4 Individual chambers may be carried by two persons, normal manual handling precautions should be taken. The mass of the chambers is given in Table 1.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on StormTech Sc-310 and Sc-740 Chambers.

Design Considerations

4 Use

4.1 The StormTech Subsurface Stormwater Management System incorporating the chambers is satisfactory for the control of stormwater run-off from impermeable and permeable surfaces. It can be utilised in three main ways:

- infiltration (retention/recharge/soakaway) — stormwater is collected in the chambers during rainfall and allowed to drain away by soaking into the surrounding ground over a substantial period of time, during and following a storm event
- attenuation (detention) — water is collected in the chambers during rainfall and released at a reduced flow rate through a flow control device, into an appropriate outfall. This reduces peak flows in the watercourse and, therefore, minimises the risk of flooding
- combination system — excess flow attenuation with a controlled outlet and soakaway provisions for infiltration of a portion of the total flow.

4.2 The design of the stormwater management system incorporating the chambers must be in accordance with the Certificate holder's instructions. Guidance on the application of sustainable drainage systems (SUDS) for new developments, such as the StormTech Stormwater Management System, can also be found in the Planning Policy Statement PPS25 *Development and Flood Risk*.

4.3 Design of the appropriate system for a specific project must always be preceded by a detailed audit of the proposed site to establish:

- existing factors and considerations applicable to the site
- predicted factors relating to the site's use following the planned development, and the parameters within which the installation is required to function
- the type of function of application required by the audit.

4.4 Once the project criteria have been established from the site audit, there are two main parts to the design procedure:

- hydraulic design and
- structural design.

5 Hydraulic design

Infiltration

Calculation principles

5.1 There are two approaches, either of which may be adopted: the Construction Industry Research and Information Association (CIRIA) Report R156 or BRE Digest 365: 2016. Further information on the design of SUDS may be obtained from CIRIA C697.

5.2 A simplified approximate approach can be used on a very small site (ie a single-house development) where detailed site infiltration rate information may not be required nor available (see Table 3). Approved Document H of the England and Wales Building Regulations allows a storage volume equal to the area to be drained multiplied by 10 mm, for areas up to 25 m^2. Beyond this size, design should be carried out in accordance with BS EN 752 : 2008 or BRE Digest 365 : 2016. It is suggested in BS EN 752 : 2008 that a storage volume equal to 20 mm multiplied by the area to be drained may be used. In Scotland, guidance for the design of single-house soakaways is given in Mandatory Standard 3.6, clause 3.6.5(1).

(1) Technical Handbook (Domestic).

5.3 When the BRE or CIRIA approach is used, the design volumes for the chambers are given in Table 4.

Table 3 Simplified soakaway design for single-house development(1)

Number of units	Storage volume (m^3)		Max area to be drained (m^2)	
	SC-310	SC-740	SC-310	SC-740
1	0.42	2.12	25(2)	106(3)
2	0.84	4.24	42(3)	212(3)
3	1.26	6.36	63(3)	318(3)
4	1.68	8.48	84(3)	424(3)

(1) When doubt exists over suitability of ground for infiltration, permeability figures should be derived by test (see BRE Digest 365).
(2) In accordance with Approved Document H.
(3) In accordance with BS EN 752 : 2008, Clause NA 4.4.8.

Table 4 Volumetric data for infiltration applications

No of rows	SC-310				SC-740			
	Volume ($m^3 \cdot m^{-1}$)	Side area ($m^2 \cdot m^{-1}$)	Base area ($m^2 \cdot m^{-1}$)	End-of-chamber area ($m^2 \cdot m^{-1}$)	Volume ($m^3 \cdot m^{-1}$)	Side area ($m^2 \cdot m^{-1}$)	Base area ($m^2 \cdot m^{-1}$)	End-of-chamber area ($m^2 \cdot m^{-1}$)
1	0.19	0.81	1.17	0.94365	0.98	1.52	1.60	2.4244
2	0.39	0.81	2.18	1.76580	1.95	1.52	3.04	4.6208
2	0.58	0.81	3.20	2.58795	2.93	1.52	4.49	6.8172
4	0.78	0.81	4.21	3.41010	3.91	1.52	5.93	9.0136
5	0.97	0.81	5.23	4.23225	4.89	1.52	7.38	11.2100

Attenuation

Calculation principles

5.4 The anticipated run-off volume (A) from the site must be estimated. The most commonly used method for evaluating storm rainfall events in the UK is the Wallingford Procedure by which the total rainfall level of storms over defined time periods ranging from five minutes up to 48 hours are assessed. The depth of water (mm) found can be multiplied by the catchment area to assess the size of attenuation systems and is traditionally based upon a two-hour storm and of a return period appropriate for the catchment. The allowable discharge rate from the site to an appropriate outfall is established but will normally be set by the Environment Agency or Planning Authorities. The outflow volume (B) to be discharged at this rate over the two-hour period is calculated and subtracted from the run-off volume (A–B). This defines the excess volume (C) to be stored in the chambers constructed as an underground tank. The number of chambers needed to contain this excess is calculated on the basis that the storage volume of the chambers is in accordance with the values given in Table 4.

5.5 The outlet of detention systems should incorporate a flow control device. The flow control device and the connecting pipe work are outside the scope of this Certificate.

Connection

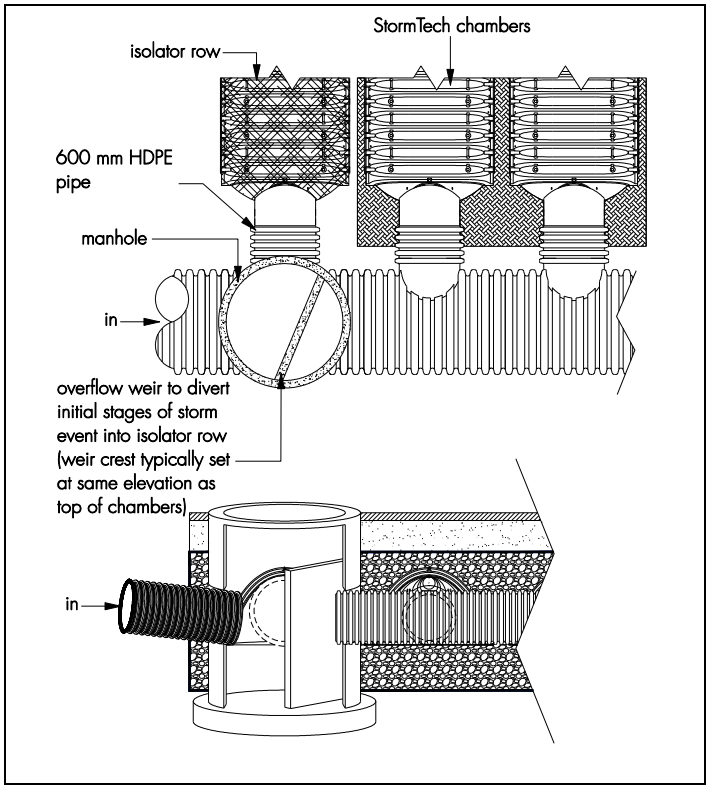
5.6 Connection is made from the chamber rows to inlet and outlet pipework through the end plates. The inlet pipework must be sized to ensure unimpeded flow for a design storm event. The inlet should be free of obstructions and, in some applications, it may be necessary to use multiple inlet pipes in a manifold configuration.

5.7 The inlet pipework should normally connect to an isolator row for capture of sediment and debris, see section 5.8. Oil separators may also need to be incorporated where there is a likelihood of contamination or the discharge site is particularly sensitive.

Isolator row

5.8 To control the build-up of sediment, chambers are normally configured with isolator rows. Chambers in the isolator row are completely enclosed with geotextile filter fabric. Sediment is captured in the isolator row and water passes through the fabric. Isolator rows are normally located at all inlet locations that receive sediments in stormwater and are configured with an upstream manhole and large diameter pipe access for inspection and removal of sediments. A high flow bypass (see Figure 2) is incorporated to enable flows that exceed the capacity of the isolator row to bypass the isolator row and feed the chamber bed directly. At the base of the chambers in the isolator row, a heavy duty woven geotextile, able to withstand jetting operations to remove sediment, must be used. The geotextile wrapped over the isolator row chambers is a non-woven geotextile generally to the same specification as that used around the crushed stone infill (see section 7).

Figure 2 Isolator row



Manifold design

5.9 The capacity of the inlet pipe must be sufficient for the anticipated flow load. The flow load may be split between a number of pipes from the adjacent manhole.

5.10 The maximum inlet pipe velocity into the chamber row is limited to prevent scouring of the stone foundation (see the *StormTech Design Manual* for maximum velocities for various inlet pipe diameters).

Flow control

5.11 The outflow from the tank must be controlled to comply with the discharge rate consent for the site. The main methods to achieve outflow control are by orifice plate, vortex control or small pipe. Comparative features and benefits of these various control flow devices should be considered before selection. However, these devices are outside the scope of this Certificate.

Outflow positioning and head calculations

5.12 There are generally two components to the outflow piping design:

- an outflow pipe or manifold of outflow pipes connecting the chambers directly to the outflow control structure
- a perforated underdrain pipe to drain the stone bedding under the chambers into the outlet control structure. These can be designed in combination or independent of each other based on the design objectives.

5.13 The invert level of the outflow pipe should be approximately flush with the bottom of the chambers to allow the chambers to drain. The outflow pipe is sized to convey the peak outflow to the outflow control structure. In some applications peak flows may be high enough to warrant multiple outflow pipes in a manifold configuration.

5.14 The underdrain is set to drain the volume of water in the stone voids below the outflow pipe. Since peak flows are conveyed through the outlet pipe, the underdrain is not sized for peak flow conveyance. Underdrains are located either along the perimeter of the bed or in trenches below the chamber array.

5.15 As the chambers fill, a depth of water develops on the upstream side of the outflow control. For design purposes, the head used in calculations is taken as that at the centre line of the outflow device.

6 Structural performance

6.1 The chambers may be placed under a wide variety of landscaped or trafficked areas and must be designed to carry all loads that will be applied, including dead and imposed loads. Design parameters and estimated loads in accordance with *AASHTO LRFD Bridge Design Manual*, Section 12.12, have been used to determine the maximum depth of installation and the maximum and minimum cover depths.

Table 5 Design values[1][2]

	Short-term (vehicle) loading[3]	**Long-term loading**
Minimum cover depth (mm)	460	460
Maximum cover depth (mm)	2440	2440
Expected service life (years)	Greater than 50	Greater than 50
Safety factor	1.75	1.95
Design load basis	Case 1: Design truck Single axle 142 kN Wheels at 1830 mm centres Case 2: Design tandem Two axles 111 kN each Axles at 1220 mm centres Wheels at 1830 mm centres In each case tyre contact area = 508 x 254 mm	18.9 $kN \cdot m^{-3}$
Dynamic impact load factor	1.27 for 460 mm depth N/A (varies linearly from 1.33 at 0 mm cover to 1.00 at 2440 mm cover)	N/A
Multiple presence multiplier	1.2	N/A
Lane load (kPa)	3.1	N/A
Strain limits[4]	3.3% for factored loads	3.3% for factored loads
Modulus for design condition	931 MPa	50 yr modulus = 166 MPa
Arch stiffness constant[5]	4.4 $kN \cdot m^{-1}\%^{-1}$	4.4 $kN \cdot m^{-1}\%^{-1}$

(1) Design vehicles, loads and load multipliers are based on *AASHTO LRFD Bridge Design Specifications*, Section 3. AASHTO is the American Association of State Highway Transportation Officials, who set design standards for all aspects of highway construction in the United States.
(2) Structural performance is dependent upon the properties of the materials and the section properties of the chamber wall. The moment of inertial (I) and cross sectional area of the chamber wall are controlled by ensuring minimum wall thicknesses of 3.18 mm for SC-310 and 4.45 mm for the SC-740 chambers.
(3) Parked and moving vehicles and construction equipment may impose load durations from instantaneous to several days. The live load design is based on the most severe combination of live load duration, load factors and modulus that is likely to occur.
(4) Design methods are based on *AASHTO LRFD Bridge Design Specifications*, Section 12.12. The product strain limit is based on compression testing of the product. Actual strains have been determined by finite element analysis and verified by test.
(5) Arch stiffness constant is defined as the load per unit length required to cause a 2% deflection in the chamber when the chamber feet are restrained laterally (see section 6.9).

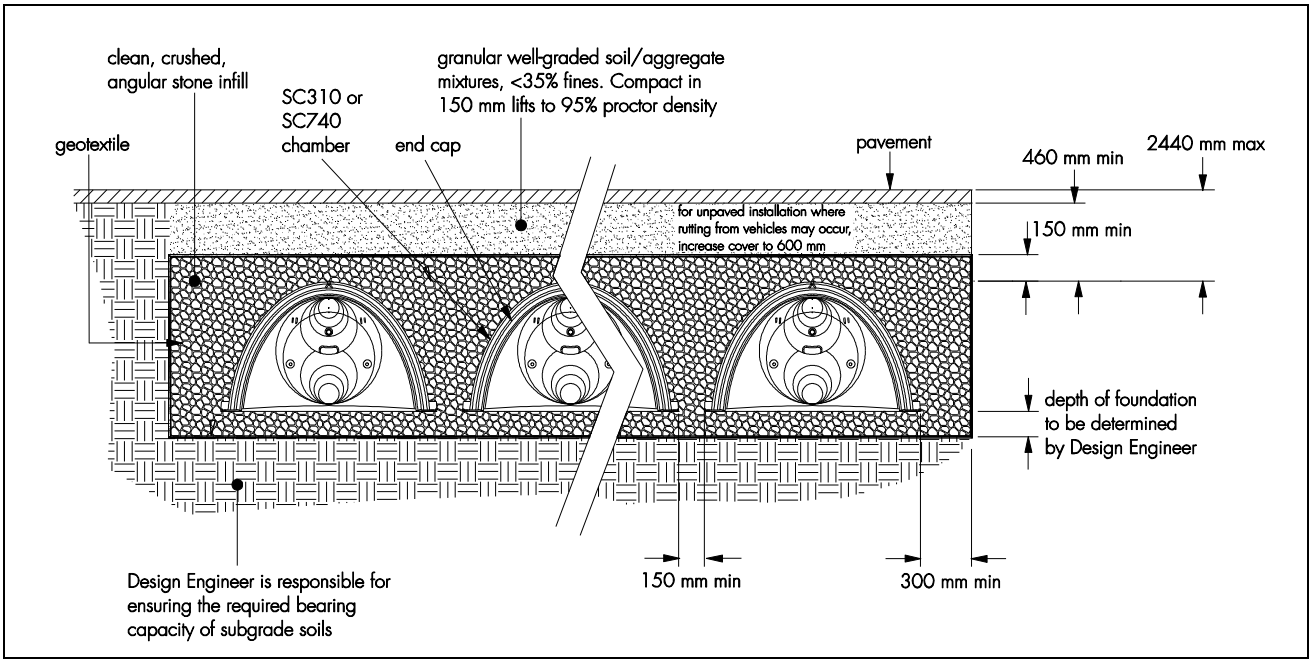
6.2 The Certificate holder does not vary the installation recommendations for lightly loaded scenarios, but instead recommends that all installations be designed to withstand vehicle traffic.

6.3 In accordance with AASHTO design methods, the maximum burial depth is limited by the long-term modulus of the polypropylene resin. Maximum burial depths given in this Certificate are based on the minimum 50-year creep modulus of 166 MPa.

6.4 One standard cross-section (see Figure 3) that details bedding and backfill requirements is specified to ensure that all installations provide the stated safety factors of 1.75 for live load design and 1.95 for long duration load design[1].

(1) These safety factors have been determined by evaluation of live loads and long-duration loads using the appropriate time-dependent (creep) material properties in accordance with *AASHTO LRFD Bridge Design Specifications*. This is a similar approach to that defined in BS 8006-1 : 2010 for polymeric soil reinforcement design.

Figure 3 Structural design cross-section



6.5 All foundation and infill stone to 150 mm above the crown of the chambers must be nominal 200 to 400 mm, clean, crushed stone in accordance with BS EN 13242 : 2013, sizes 20/40 or 20/32. Recycled crushed concrete may be an acceptable fill material but its use is outside the scope of this Certificate. Further details may be obtained from the Certificate holder.

6.6 The required minimum subgrade bearing capacity is dependent upon the cover height over the chambers and the depth of foundation stone under the chambers. Required bearing capacities range from 96 kPa for 460 mm of cover and a foundation depth of 460 mm, to 182 kPa for 2440 mm of cover and a foundation depth of 150 mm (see Table 6).

Table 6 Minimum required subgrade bearing capacity in (kPa)

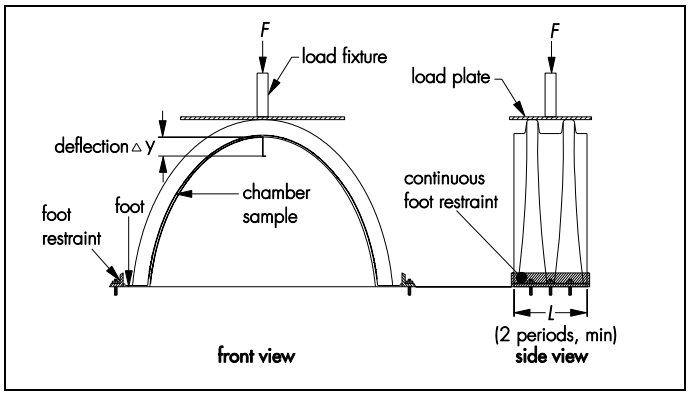
	Foundation depth (mm)		
Cover height (m)	**150**	**305**	**460**
2.44 (Max allowable)	182	134	110
2.29	172	129	105
2.13	168	124	101
1.98	158	120	96
1.83	153	115	96
1.68	148	110	96
1.50	144	110	96
1.37	144	105	96
1.22	139	105	96
1.07	139	105	96
0.91	134	101	96
0.76	129	96	96
0.61	124	96	96
0.46 (Min allowable)	120	96	96

6.7 For small-scale applications, such as soakaways for individual house roof drainage, the system is typically located at a minimum of 5 m away from the building beneath the garden.

6.8 For lightly-loaded applications, the bearing capacity of the underlying soils should typically not be exceeded by the stormwater management system. Therefore, settlement of the underlying soils should be negligible. On weak or compressible soils, the bearing capacity and settlement characteristics should be confirmed by a geotechnical engineer.

6.9 To determine the arch stiffness constant of the units, a section of chamber, at least two full periods of corrugation in length, is tested in the apparatus shown in Figure 4. The chamber foot is restrained laterally at the outer edge but is free to rotate and the load is applied at a constant crosshead speed of 2±0.2% of the rise of the chamber per minute. The arch stiffness constant is defined as the load required to cause 2% deflection divided by two times the length of the specimen. The sample is then taken to 6% deflection at the same crosshead speed to ensure its load carrying capacity is maintained and breakage does not occur.

Figure 4 Arch stiffness constant test apparatus



7 Geotextiles and geomembranes

7.1 A system incorporating the chambers requires a geotextile wrapping (see Table 7) in infiltration applications to:

- prevent clogging of the soil which surrounds the unit with silt present in run-off
- prevent soil entering the units and in storage applications to protect the geomembrane (when specified).

Table 7 Typical properties for a polypropylene geotextile

Property	Value	Test method
Mass per unit area (gm^{-2})	200	ASTM D 5261/ISO 9864
Thickness (mm)	1.5	ASTM D 5199
Grab tensile strength (N)	775	ASTM D 4632
Elongation at break (%)	60	—
Wide width tensile strength ($kN \cdot m^{-1}$)	15.0	ASTM D 4595
Elongation at break (%)	50	—
Trapezoidal tear (N)	350	ASTM D 4533
Mullen burst (kPa)	2340	ASTM D 3786
Puncture strength (N)	485	ASTM D 4833
CBR burst (N)	2670	BS EN ISO 12236
Cone drop (mm)	21	BS EN ISO 13433
Pore size (095) (mm)	0.150	ASTM D 4751 (Dry)
Permeability ($cm\ sec^{-1}$)	0.32	ASTM D 4491
Permittivity (sec^{-1})	1.8	ASTM D 4491
Water flow rate ($l \cdot min^{-1} \cdot m^{-2}$)	4885	ASTM D 4491
UV resistance (% retained at 500 hours)	70	ASTM D 4355

7.2 The selection of a suitable geotextile material for a specific StormTech infiltration system should be considered carefully, particularly with reference to the surrounding soil properties and required performance. The following points are to be considered in the selection:

- pore size — should be designed and specified to assist infiltration and prevent migration of fine soil particles
- permeability and breakthrough head — the geotextile should not limit flow of water in the system, and should have a similar or greater permeability than the surrounding materials
- puncture resistance — the geotextile must be able to resist the punching stresses caused by loading on sharp points of contact

- tensile strength — the geotextile should have sufficient strength to resist the imposed forces (eg from wheel loads)
- durability.

7.3 The Certificate holder advises that an AASHTO M288, Class 2, non-woven geotextile meets StormTech requirements. A specialist's advice should be sought if surrounding soil characteristics exhibit a high degree of fines/low infiltration capacity and/or there is risk of damage from ground contaminants.

7.4 A geomembrane is wrapped around the system in attenuation/storage applications where infiltration is not possible or permitted and acts to:

- prevent release of attenuated/stored water to surrounding ground
- prevent inflow of pollutants from contaminated subsoil into the storage reservoir.

7.5 The specification and selection of the impermeable geomembrane must be correct for the installation envisaged, to ensure it performs to the level required. It is essential that the specified material:

- withstands the rigours of installation
- resists puncture
- resists multi-axial elongation stress and strains associated with settlement
- resists environmental stress cracking
- resists damage from ground contaminants
- remains intact for the full design life.

7.6 Geomembranes less than 1 mm thick are unlikely to meet these criteria(1), and are not recommended for use with the chambers(2). A specification for a typical polypropylene geomembrane is shown in Table 8.

(1) Except in shallow, domestic installations.
(2) Further details can be supplied by the Certificate holder.

7.7 To ensure total impermeability, joints between adjacent sheets of impermeable geomembranes should be sealed correctly using proprietary welding techniques. The integrity of joints should be demonstrated by non-destructive testing(1).

(1) Advice on seam testing is given in CIRIA SP124 : 1996.

7.8 The upper surface of the isolator row is wrapped in a geotextile of the same specification as surrounding the excavation. The base of the isolator row is covered by an AASHTO M288, Class 1, woven geotextile, this must be sufficiently strong to resist damage from jetting when the isolator row is cleaned out. A typical specification for this is given in Table 9. Further information on suitable geotextiles can be supplied by the Certificate holder.

Table 8 Typical specification for a polypropylene geomembrane

Property	Value	Test Method
Thickness ±10% (mm)	1.0	ASTM D 751
Density (min) (g cm^{-3})	0.9	ASTM D 792
Tensile stress at break (min) (N·mm^{-2})	18	ASTM D 638
Elongation at break (%)	>700	ASTM D 638
Puncture resistance (min) (N)	150	FTMS 101C method 2065
Tear resistance (min) (N)	60	ASTM D 1004
Dimensional stability (max) (% change)	±2.0	ASTM D 1204 1 hour at 100°C
Stress crack resistance (%)	100	ASTM D 5397
Volatile loss 5% loss max	0.2	ASTM D 1203 method A
Ozone resistance	No cracks	ASTM D 1149
Carbon black content	2–3%	ASTM D 1603
Moisture vapour (gm^{-2}·day^{-1})	<0.1	ASTM E 96
Friction angle non-woven geotextile)	21°	Shear box
Methane permeability (gm^{-2}·day^{-1}·atm^{-1})	0.11	ASTM D 1434
Methane transmission rate (m^3·m^{-2}·s^{-1}·atm^{-1})	0.8 x 10^{-9}	BRE Digest 365
Permeability coefficient	1.8 x 10^{-12}	ASTM D 1434
Application temperature (°C)	>4	—

Table 9 Typical specification for a non-woven geotextile for isolator row

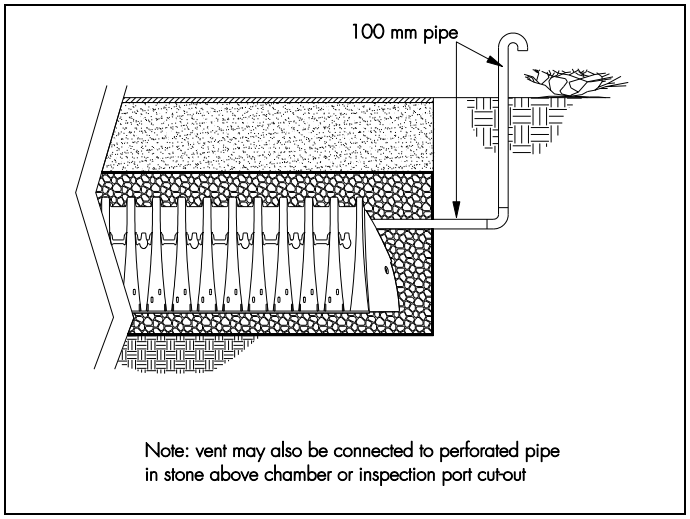
Property	Value	Test Method
Mass per unit area (g·m^{-2})	220	ASTM D 5261
Thickness (mm)	0.5	ASTM D 5199
Grab tensile strength (N)(1)	1400 x 1400	ASTM D 4632
Elongation at break (%)(1)	15 x 15	ASTM D 4632
Wide-width tensile strength (kN·m^{-1})(1)	30.6 x 35	ASTM D 4595
Elongation at break (%)(1)	10 x 8	ASTM D 4595
Trapezoidal tear (N)(1)	530 x 530	ASTM D 4533
Mullen burst (kPa)	4475	ASTM D 3786
CBR burst (N)	4780	BS EN ISO 12236
Apparent opening (mm)	0.212	ASTM D 4751
Permeability (cm sec^{-1})	0.03	ASTM D 4491
Permittivity (sec^{-1})	0.05	ASTM D 4491
Water flow rate (l min^{-1} m^{-2})	161	ASTM D 4491
Resistance (% retained at 500 hours)	90	ASTM D 4355

(1) Values for warp and fill respectively.

8 Venting

8.1 For most chamber applications, venting back through the inlet piping is sufficient. However, some applications, where inlet piping may be submerged, require additional vent capacity. A typical detail to achieve additional venting is shown in Figure 5. However, the consulting engineer may specify alternative details.

Figure 5 Typical air vent design



8.2 As a minimum, one 110 mm diameter air vent per 7500 m^2 of impermeable catchment area to be drained is generally sufficient. Venting should be positioned in a non-trafficked area, where possible.

9 Resistance to chemicals

9.1 An assessment of the polypropylene properties indicates that the products are suitable for use in contact with the chemicals likely to be found in rainwater.

9.2 An assessment of the suitability for use of the chambers on brownfield sites should be made only after a suitable site investigation (outside the scope of this Certificate) to determine the possibility for chemical attack. Particular care must be taken where acids and organic solvents are present at high concentrations. Further information can be supplied by the Certificate holder.

10 Maintenance

10.1 The owner of the structure is responsible for maintenance of the system incorporating the chambers.

10.2 The open design of the chambers allows inspection of the inside of the structure provided adequate access is available. Each chamber has a preformed socket that may be cut out to accept a 100 mm pipe to provide an inspection port. One inspection port for each isolator row is recommended.

10.3 For soakaways to individual houses, the only necessary maintenance of the system is to keep gullies clear of debris such as leaves and grass.

10.4 For large installations or where the receiving waters are environmentally sensitive, a programme of regular inspections should be established to prevent siltation of the system which, if allowed to develop, would reduce effectiveness. Chamber systems are normally inspected annually.

10.5 It is recommended that an isolator row (see section 5.8) or other silt trap is incorporated into the pipework at the inlet to the tank. There must be a maintenance plan that ensures regular cleaning of the trap to ensure correct performance. Other types of silt traps for use with the chambers are outside the scope of this Certificate.

10.6 For all flow control devices, it is sensible to incorporate access (via a manhole or similar) to the location of the pipe entry, orifice or vortex control. This will enable easy removal of any blockage. The orifice itself may be protected by a debris screen.

11 Durability

11.1 The polypropylene used to manufacture the chambers will not deteriorate significantly over the life of the structure. It will remain chemically stable under exposure to contaminants normally found in a stormwater environment and will not be susceptible to environmental stress cracking.

11.2 In common with all thermoplastic structures, the chambers will creep with time. This is taken into account in the long-term design by the use of a 50-year modulus for the material to allow for accumulated strain under a dead load. In the opinion of the BBA, the products, when used and installed in accordance with this Certificate will have a life in excess of 50 years.

12 Reuse and recyclability

StormTech Sc-310 and Sc-740 Chambers are manufactured from polypropylene materials, which are readily recyclable.

Installation

13 General

StormTech Sc-310 and Sc-740 Chambers must be installed in accordance with the Certificate holder's installation instructions and this Certificate. Special attention must be paid to temporary work requirements in excavations.

14 Procedure

14.1 The hole or trench is excavated to the required depth, dimensions and levels. It must be ensured that the plan area is sufficient to allow compaction plant access around sides to compact backfill material (300 mm minimum). The subgrade must be smooth and level without sharp drops or humps. Slopes must be cut to a safe angle or adequately supported and safe access must be provided to allow personnel to enter the excavation. Excavation should be carried out in accordance with BS 6031 : 2009, with particular attention paid to safety procedures.

14.2 The subgrade must be inspected for soft spots in the formation and if any are present, they must be excavated and replaced with compacted granular fill material to achieve the design loads in accordance with Table 5 of this Certificate or the structural engineer's requirements.

14.3 The geotextile and/or geomembrane should be placed over the prepared subgrade soils and up the side walls of the excavation. Where a membrane is used, the manufacturers' recommendations for making joints should be followed and care must be taken to prevent damage to the membrane during construction.

14.4 A layer of clean, crushed, angular, structural aggregate is placed over the entire base of the excavation and mechanically compacted to achieve a flat surface. The minimum thickness of this layer must be 150 mm (see Figure 6).

Figure 6 Installing foundation layer

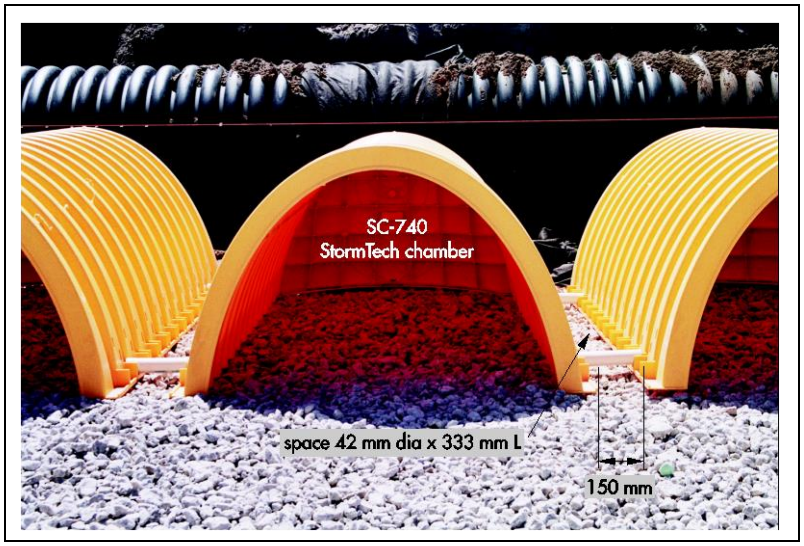
14.5 The correct position of the inlet pipe should be established and chambers laid from this point. The first chamber should be oriented with the end labelled 'Build rows in this direction' closest to the edge of the bed and the arrows pointing in the direction of build; the edge of the chambers should be a minimum of 300 mm from the perimeter of the excavation.

14.6 The row of chambers is laid with successive chambers overlapping its predecessor by the end corrugation.

14.7 End caps are placed into the end corrugation of the last chamber, which may have to be lifted to complete this operation.

14.8 Adjacent rows must be spaced at least 150 mm apart, measured at the toe of the chambers. Spacers as described in section 1.4 may be used between adjacent rows to maintain correct spacing (see Figure 7).

Figure 7 Spacing of chambers



14.9 When installing an isolator row, a woven geotextile is placed on the foundation layer immediately below the row of chambers and a non-woven geotextile is placed over the top of the isolator row (see Figure 8).

Figure 8 Isolator row

14.10 Where required, inlet and outlet connections are made by cutting holes in the end caps using a reciprocating saw. When installing a sealed system, particular care must be taken to ensure correct sealing of inlet and outlet pipes to the membrane.

14.11 Clean, crushed structural aggregate is placed between the adjacent rows and around the perimeter of the chambers. Care must be taken to ensure that the chambers are not displaced and the minimum 150 mm spacing is maintained. The aggregate must cover the crown of the chambers by at least 150 mm.

14.12 The geotextile and/or geomembrane is laid over the top of the aggregate.

14.13 The backfill above the geotextile should be Type 1 or Type 2 sub-base-selected granular material in accordance with *The Manual of Contract Documents for Highway Works*, Volumes 1 and 2. It should be compacted in 150 mm thick layers and carried out to a minimum 95% of the standard proctor density. Compaction plant should not exceed a maximum gross vehicle weight of 5 tonnes.

14.14 The overall thickness of the backfill above the crown of the chambers must be a minimum of 460 mm to the bottom of the pavement and a maximum of 2440 mm to the top of the pavement. Where it is unpaved, rutting from vehicles may occur, the minimum cover must be increased to 600 mm.

14.15 The pavement construction or landscaping is completed over the system.

Technical Investigations

15 Investigations

15.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details obtained on the quality and composition of the material used.

15.2 The technical data in the confirmation report of the CSTB's Commission Chargée de Formuler des Avis Techniques were evaluated in the context of UK practice.

15.3 A site visit was made to assess the practicability and ease of installation and connection.

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16 Conditions

16.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

16.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

16.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

16.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

16.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

16.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA

tel: 01923 665300
fax: 01923 665301
clientservices@bbacerts.co.uk
www.bbacerts.co.uk