ALL IN ONE SYSTEM NO GRAVEL IS NEEDED

drenotube®

Photo by Hatek Technical – Distributor – The Netherlands

PREASSEMBLED SUBSOIL DRAINAGE

GEOSYNTHETIC AGGREGATE AND GEOTEXTILE FILTER INCLUDED

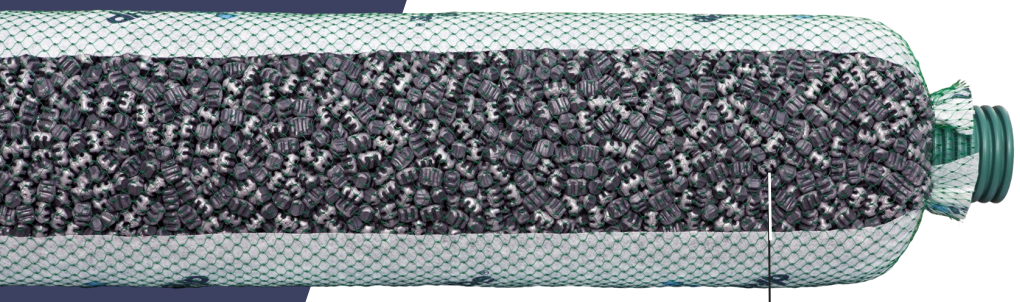
DIMENSIONS AND FLOW RATES ACCORDING TO SLOPE (i)

TOP VIEW

Ø 300 / 370 mm

L = 3 / 6 m

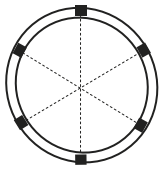
BOTTOM VIEW



Ø 110 / 160 mm

There is an opening along the bottom side to avoid clogging and to extend service life over 25 years.

FRONT VIEW



Corrugated pipe with 6 slits around the perimeter

Geosynthetic aggregate

Tube Ø mm	Bundle Ø mm	Length m	Flow rate i 0,5%	Flow rate i 1,5%	Flow rate i 2,5%
90/110	300mm	3 or 6	2,5 litres / sec	4,3 litres / sec	5,6 litres/sec
140/160	370mm	3 or 6	7,5 litres / sec	13 litres / sec	16,5 litres/sec

drenotube® is a factory-assembled unit that can be used for both underground drainage or infiltration applications.

drenotube® preassembled drainage segments consist of a double wall slotted corrugated pipe surrounded by a geo-synthetic aggregate enclosed in a high strength polyethylene netting that is clamped to both ends of the pipe.
There is a fabric geotextile filter in between the netting and aggregate. The fabric is used to prevent soil intrusion.

- No gravel is needed.
- 100 times lighter than gravel.
- Available in SN4 or SN8 ring stiffness
- Length 3 or 6 meters
- Placement rate 10 meters per minute.
- Joined with a fast click fit connector included.
- Superior water flow rate and higher storage capacity.
- Slotted (drainage) or drilled holes (infiltration) pipe

FIELD OF USE & CERTIFICATIONS

NF P 16-351 DRAINAGE NORM

drenotube® DR system (only available on request) is certified according TECHNICAL NOTICE (Avis Technique—France) Reference 17.2 / 19-346_V1
Intended uses:

Construction of subsurface drainage networks to protect infrastructures from interstitial overpressures.

- Road & Highways
- Public Works
- Infrastructures
- Other Civil Engineering Works

SUB-SURFACE DRAINAGE

Intended uses according to European Assessment Document EAD 280001-00-0704

ETA 15/0201

- Retaining Walls
- Foundations around Buildings and Houses
- Railway
- Landscaping & Gardening
- Sport Fields — football, golf
- Agriculture
- Roads & Highways

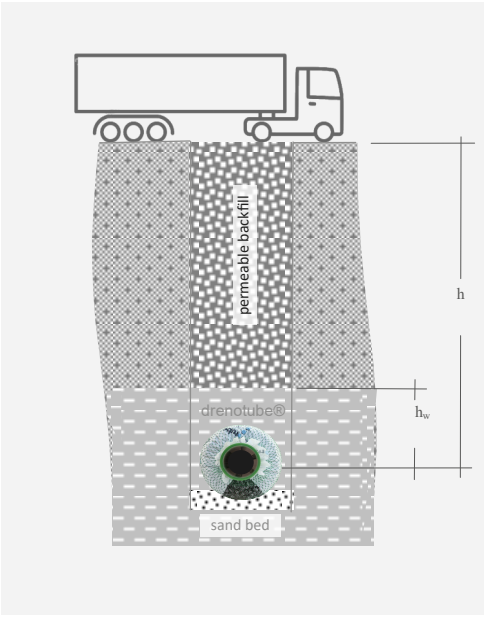
ENVIRONMENTAL AND HEALTH PERFORMANCE

In accordance with standard NF EN 15804 + A1 and its national supplement NF EN 15804 / CN

Verification No: 7-418: 2019

drenotube® FDES is a document that shows the results of a product's life cycle analysis (the extraction of raw materials, transport, implementation and performance to its end of life), as well as health information, used to calculate the environmental and health performance of the drainage networks.
It certifies that **drenotube®** makes a structure more sustainable, with limited impacts on the environment.

Depth and pressure figures applied on drenotube®

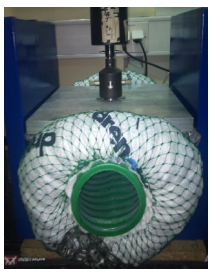


Depth (h) m	75 kN wheel force	h_w m	Total pressure acting on drenotube® kN/m^2
0,5	100	0	109
1	50	0 / 1	69 / 71
1,5	30	0 / 1	58 / 60
2	20	0 / 1	57 / 59
2,5	13	0 / 1	60 / 62
3	8	0 / 1	64 / 66
4	1	0 / 1	76 / 78

The above data is for orientative purposes only. It is considered a parallel trench with a backfill soil density of 1900 kg/m^3, and a live load wheel force of 75 kN - dynamic factor 1.75 The example show 2 figures. Groundwater level (h_w) = 0 (below drenotube®) h_w = 1 (above 1 m). Trench width is drenotube Ø + 20 / 40 mm. If there is no live load then subs-tract the "75 kN wheel force" column from the Total pressure.

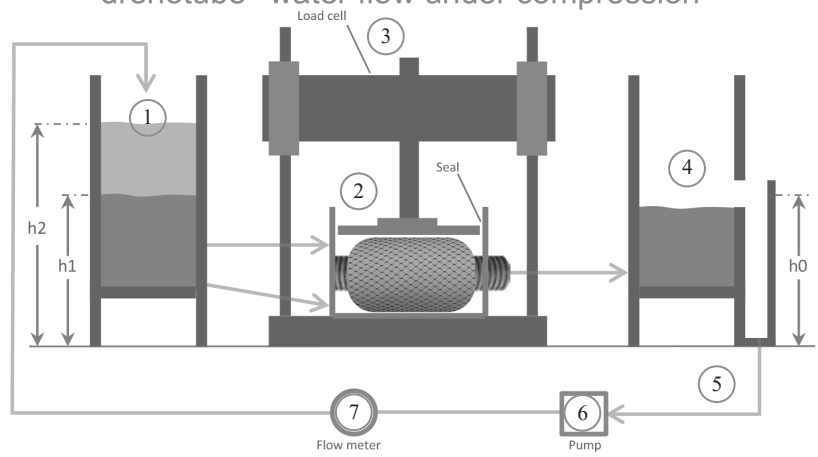
To find a more accurate results will depend on the soil density, porosity, water content, nature of different layers and cohesive forces amongst others.

drenotube® performance under pressure



- **drenotube®** performance under 6 tonnes of pressure / m2 (± 60 Kpa) and after compression and ageing tests carried out at Aitex Laboratory according to the Norm UNE-EN ISO 604: 2010
- The evaluation is based on a 50-year lifetime **drenotube®** installation and on the technical knowledge and experience currently available.
- Drainage tests under different loads were carried out at Cecam laboratory (Center for Studies in Construction and Materials Analysis).
- Draining capacity measured in the laboratory could differ from a real work site installation. Performance will depend on several factors: permeability of the soil, composition of the soil layers, porosity, density, height of the groundwater table, pressure head, slope, etc.

drenotube® water flow under compression



1 Water tank supply	3 Load cell	5 Return to pump	7 Flowmeter
2 Load surface	4 Constant pressure (h0)	6 Pump	

Tests evaluated by the European Organisation for Technical Assessment ITeC EOTAoffice ETA 15/0201 European Assessment Document 280001-00-0704

ADVANTAGES

PERFORMANCE

- Superior water flow rate and higher storage capacity compared with gravel.
- Test and certificates for the finished product and all components (Compressive strength, creep in compression, ageing, flow capacity, etc.)
- Product has been monitored and evaluated on-site and approved through most US States since 1991 with thousands of installations in use.
- **CE** approval ETA number 15/0201
- Avis technique (CSTB France) NF P 16-351 Drainage Norm Reference 17.2 / 19-346_V1
- FDES LCA (Life Cycle Assestment) NF EN 15804 + A1 and its national supplement NF EN 15804 / CN Verification No: 7-418: 2019

COST EFFECTIVE

- Saves time, money and avoids trouble-shooting
- Easier and cheaper transport
- Easily hand-carried into position reducing time and labor
- Reduces the volume of excavation
- No gravel is needed. Easier cleanup at job site

INSTALLATION

- Quick and easy installation without skilled labour
- No trucks or heavy equipment are needed to bring the product to the construction site
- Secure handling. Its lightness entails no labour risk
- It is clean and fines free.
- Ability to contour along sloped sites and around trees, corners or other obstacles
- Faster installation. Placement rate 10 meters per minute. Joined with a rapid click fit connection
- Pre-assembled modules provides entire on-site implementation. Central pipe is surrounded by uniform thickness of aggregate throughout the way. The geotextile filter is perfectly centered.
- Lightweight system is perfect for repairs in tight job sites. About 100 times lighter than gravel. It can be installed quickly with limited site disruption
- No need of shoring when working in deep trenches. Segments can be joined in the surface and pulled down without entering

SUSTAINABITILY

- Manufactured from post-industrial recycled environmentally friendly materials.
- All components are recyclable
- Avoids environmental impact of aggregate quarrying, preserving the landscape
- Durable. Expected life span of all components is over 50 years

PERFORMANCE STATEMENT DR -2404-EN

CE

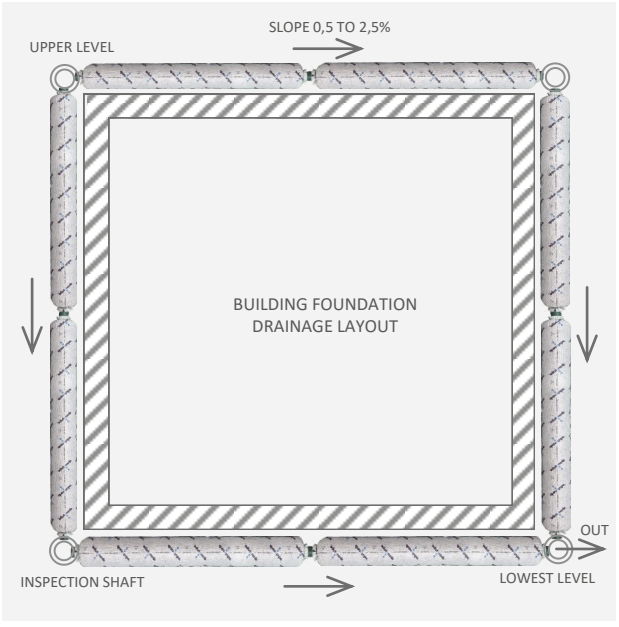
BASIC FEATURES	PERFORMANCE			TECHNICAL SPECIFICATIONS
Drainage capacity under pressure for SN4 version (4kN/m^2 ring stiffness) Above 60 KPa would be convenient to use a higher ring stiffness SN8 (8kN/m^2)		**DR300SN04ST6/3**	**DR370SN04ST6/3**	ETA 15/0201 22/04/2015
	kPa	dm^3/s/m		
	0	5,80	12,50	
	10	5,65	12,25	
	20	5,50	12,00	
	30	5,35	11,75	
	40	5,25	11,50	
	50	5,15	11,25	
	60	5,00	11,00	
	80	4,70	9,90	
	100	4,30	8,00	
	120	4,00	7,50	
b) Deformation under pressure (dry conditions)		**DR300SN04ST6/3**	**DR370SN04ST6/3**	ETA 15/0201 22/04/2015
	kPa	mm		
	10	40	40	
	20	50	65	
	40	72	90	
	60	100	110	
Deformation under pressure and ageing due to oxidation	Same values as b)			ETA 15/0201 22/04/2015
Deformation under pressure and ageing due to hydrolysis	Same values as b)			ETA 15/0201 22/04/2015
Deformation under pressure microbiologically aged	Same values as b)			ETA 15/0201 22/04/2015
Dangerous materials content	None, all components are inert			ETA 15/0201 22/04/2015

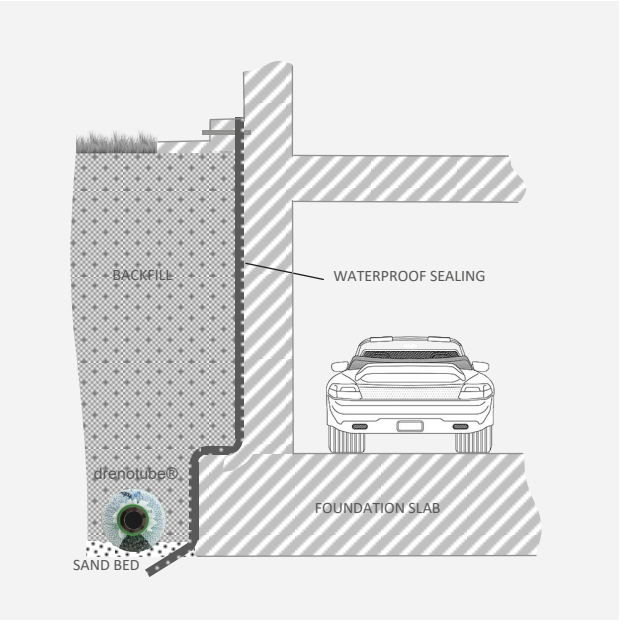
European Assessment Document EAD 280001-00-0704 ETA 15/0201

drenotube®

PREASSEMBLED DRAINAGE AND INFILTRATION

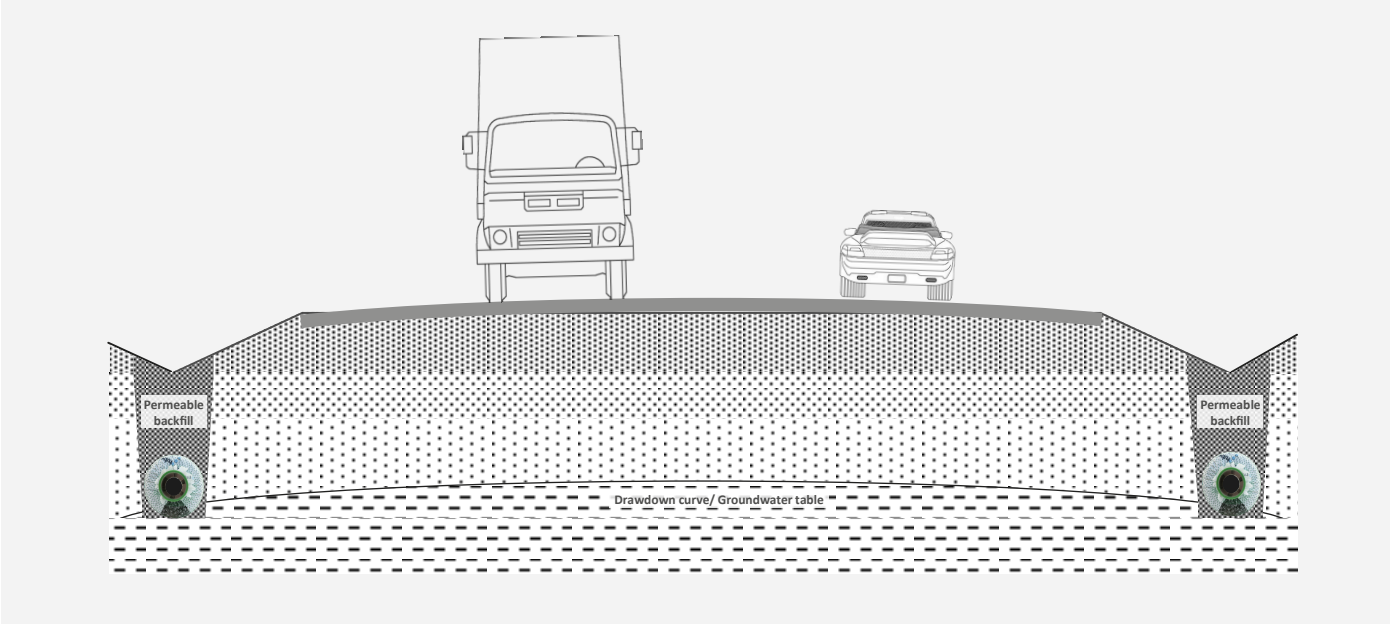
Foundation drainage around the building





drenotube® is a modular preassembled drainage / infiltration system. Replaces traditional gravel by using engineered geo-synthetic particles. **drenotube®** improves drainage performance eliminating fines and reducing compaction and embedding associated with crushed stone.

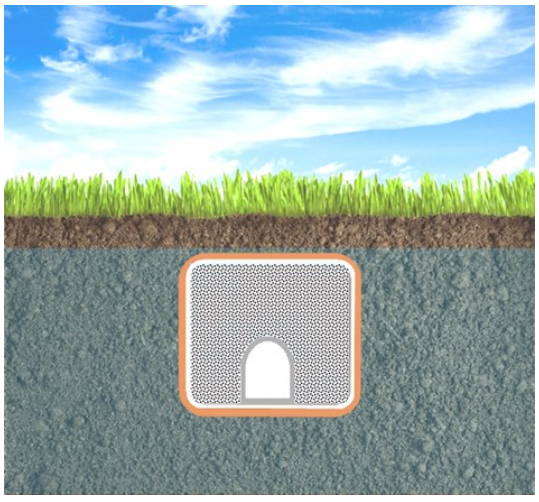
drenotube® subsoil drainage for road / highway pavements



Two parallel subsoil longitudinal drainage pipes. Minimum depth 1,2 metres. The drains lowers high water tables in permeable soils.

Durability and performance of a conventional system versus drenotube®

Gravel envelope

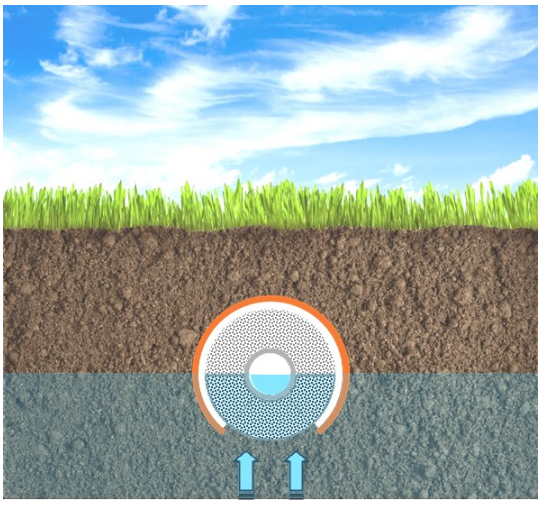


GEOTEXTILE IS WRAPPED ALL AROUND THE DRAIN

Over time a filter cake of fines will be develop and finally the geotextile will be clogged. Water will not flow.

Single wall drain with flat bottom slows water flow due to turbulence.

drenotube®



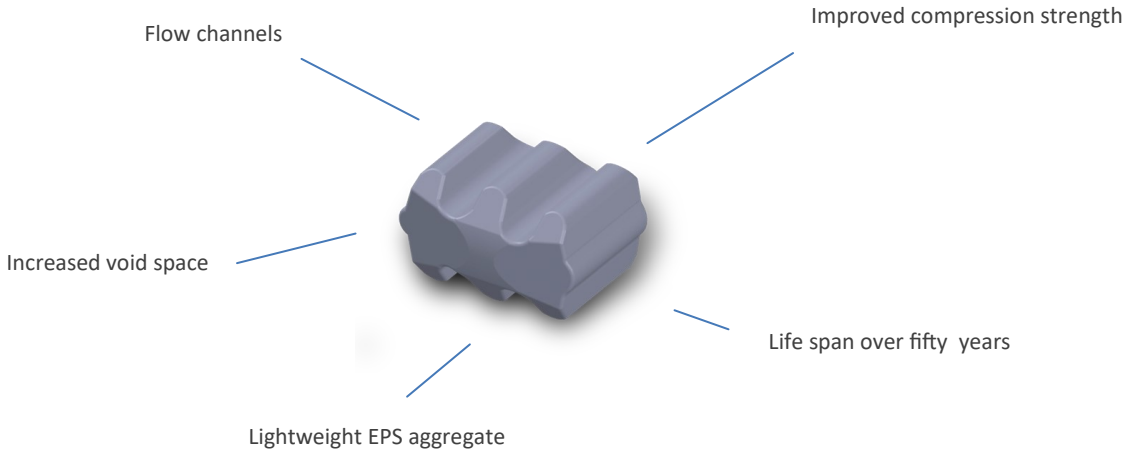
GEOTEXTILE COVERS THE UPPER 3/4

The bottom part of the **drenotube®** is open to increase durability ensuring the flow of water during many years.

Double wall 360^0 slotted corrugated HDPE pipe. Smooth inside avoids turbulence and speeds the water flow.

Geosynthetic EPS aggregate

The EPS aggregate can remain buried in a wet environment for decades without degradation.
It is a thermoplastic that can be heated, melted and recycled. Energy efficient both in their manufacture and processing.
Lightweight material. It is not attacked by fungi, mold and/or mildew.



EPS geosynthetic particles have a particular design to achieve high water flow and void space . Cell size structure suitable for a high compressive strength. It is not brittle at subzero temperatures.

drenotube® drain implementation at Mango Logistics Center in Barcelona

Preassembled

drenotube® is fully assembled at the factory and is subject to strict quality controls. Traditional drainages carried out on site possess major susceptibility of having constructive faults since they depend mostly on the workers' skill degree.

Modular segments

For drainage use, **drenotube®** comprises 3 series: DR 300, DR 370 and BD version (bundle without pipe). Depending on the soil nature BD is used to enhance water retention.

Applications

drenotube® can be installed in all kinds of longitudinal drains, either in agriculture, landscaping or public works: sport fields like pitch & golf courses, gardens, retaining walls, structures of cut-and-cover tunnels, bridge abutments or building foundations. It is also used for bio-treatment plants and septic drainfields.

drenotube® drainage at Tarragona road (Spain)

Water is the main contributor to the wear and damage of roads.
Ground and surface water can damage the road body by making it less resistant to traffic weakening the load bearing capacity.

Underground side drains are essential to allow water to flow away from the area. Also may be required to lower high water tables. The subgrade and base of a road needs to be protected from water

The surface water from the carriageway and shoulder should effectively be drained off without allowing it to percolate to sub grade

Seepage and other sources of under ground water should be drained off by the subsurface drainage system.

Isola Dana, Doha - Qatar

drenotube® Railway in Suria (Spain)

The profile along the track between two embankments of different levels caused by accumulation of clay soil on the rails after heavy rains.

Thanks to the installation of drenotube® in January 2015 the rails remain clean and dry . Also the water is controled within the track support system - beneath the track .

Installation done without traffic disruption.

drenotube® Coal mines in Germany

drenotube® 6 m lightweight sections were easily and fast installed in a difficult access place. It is not brittle at subzero temperatures.

RWE - coal mining and energy company - **drenotube®** came to good results regarding water quantity and quality.

Works at Arnhem - Netherlands

drenotube® drain at Aloha Golf Club Marbella - Spain

drenotube® drainage system eliminates problems caused by gravel which blocks pipes and damages mower blades.

Gravel contains fine particles that shorten the life of the drainage. Geosynthetic particles are fines free.

Another important benefit of the **drenotube®** is the removal or reduction of gravel. This system is ideal for walkways and bunkers, draining wet areas along the terrain. **drenotube®** can be used in new installations or in the maintenance of greens.

Technical Data DR300SN04 – SN08 ST6/3 Preassembled drainage system

Corrugated pipe	Standard	Unit	Value
Outer diameter	UNE EN 61386-1	mm	110
Inner diameter	UNE EN 61386-2-4	mm	SN04 : 93 SN08 : 91
Ring stiffness	UNE EN ISO 9969	kN/m^2	SN04 : 4 SN08 : 8
Perforation type		º	360
Slits surface		cm^2/m	50 (±10)
Polymer	UNE 53994 :2011		Polyethylene
Geosynthetic aggregate	**Standard**	**Unit**	**Value**
Bulk density	UNE 92120-2:1998	kg/m^3	10
Specific weight	UNE 83134	kg/m^3	20
Void space		%	50
Specific surface		m^2/m^3	230
Particle number		$units/m^3$	~115.000
Water absorbtion 7 days	UNE EN 12087:1997	%	2,0
Water absorbtion 21 days	UNE EN 12087:1997	%	2,2
Particle size distribution	UNE EN 933-1	% pass	<8 mm: 0 <20 mm: 73 <25 mm: 100
Working temperature	-	ºC	-20 a +65
Color	-	-	Graphite
Geotextile filter	**Standard**	**Unit**	**Value**
Polymer	-	-	Polypropylene
Bonding technique	-	-	Needle punched
Mass per unit area	UNE EN ISO 9864	g/m^2	100
Thickness 2 kPa	UNE EN ISO 9863-1	mm	0,7
Tensile strength MD/CMD	UNE EN ISO 10319	kN/m	8,0/8,0
Elongation at max. load MD/CMD	UNE EN ISO 10319	%	90/80
Static puncture resistance (CBR)	UNE EN ISO 12236	N	1300
Cone drop test	UNE EN ISO 13433	mm	28
Water permeability	UNE EN ISO 11058	$m^3/s/m^2$	0,120
In plane capacity @ 20 kPa	UNE EN ISO 12958	$m^3/s/m$	1x10-6
Opening size O90	UNE EN ISO 12956	µm	80
UV protection			Yes
Net	**Unit**	**Value**	
Polymer	-	Polyethylene	
Weight per unit	g/m	67	
Semiperimeter	cm	51	
Net type	-	Oriented tubular	
Drenotube ®	**Unit**	**Value**	
Length	m	3 or 6	
Weight	g/m	SN04 ~ 1300 SN08 ~ 1592	
Draining surface	cm^2/m	SN04 : 51 SN08 : 50	
Bundle diameter	mm	300	
Maximum installation depth	m	SN04 : 3 SN08 : 5	
Minimum installation depth	m	0,40	

Technical Data DR370SN04 – SN08 ST6/3 Preassembled drainage system

Corrugated pipe	Standard	Unit	Value
Outer diameter	UNE EN 61386-1	mm	160
Inner diameter	UNE EN 61386-2-4	mm	SN04 : 140 SN08 : 136
Ring stiffness	UNE EN ISO 9969	kN/m^2	SN04 : 4 SN08 : 8
Perforation type		º	360
Slits surface		cm^2/m	85 (±10)
Polymer	UNE 53994 :2011		Polyethylene
Geosynthetic aggregate	**Standard**	**Unit**	**Value**
Bulk density	UNE 92120-2:1998	kg/m^3	10
Specific weight	UNE 83134	kg/m^3	20
Void space		%	50
Specific surface		m^2/m^3	230
Particle number		$units/m^3$	~115.000
Water absorbtion 7 days	UNE EN 12087:1997	%	2,0
Water absorbtion 21 days	UNE EN 12087:1997	%	2,2
Particle size distribution	UNE EN 933-1	% pass	<8 mm: 0 <20 mm: 73 <25 mm: 100
Working temperature	-	ºC	-20 a +65
Color	-	-	Graphite
Geotextile filter	**Standard**	**Unit**	**Value**
Polymer	-	-	Polypropylene
Bonding technique	-	-	Needle punched
Mass per unit area	UNE EN ISO 9864	g/m^2	100
Thickness 2 kPa	UNE EN ISO 9863-1	mm	0,7
Tensile strength MD/CMD	UNE EN ISO 10319	kN/m	8,0/8,0
Elongation at max. load MD/CMD	UNE EN ISO 10319	%	90/80
Static puncture resistance (CBR)	UNE EN ISO 12236	N	1300
Cone drop test	UNE EN ISO 13433	mm	28
Water permeability	UNE EN ISO 11058	$m^3/s/m^2$	0,120
In plane capacity @ 20 kPa	UNE EN ISO 12958	$m^3/s/m$	1x10-6
Opening size O90	UNE EN ISO 12956	µm	80
UV protection			Yes
Net	**Unit**	**Value**	
Polymer	-	Polyethylene	
Weight per unit	g/m	76	
Semiperimeter	cm	63	
Net type	-	Tubulaire orientée	
Drenotube ®	**Unit**	**Value**	
Length	m	3 or 6	
Weight	g/m	SN04 ~ 2150 SN08 ~ 2482	
Draining surface	cm^2/m	SN04 : 51 SN08 : 50	
Bundle diameter	mm	370	
Maximum installation depth	m	SN04 : 3 SN08 : 5	
Minimum installation depth	m	0,40	

drenotube®

PREASSEMBLED DRAINAGE AND INFILTRATION

Trench | Connect | Place | Backfill

EASY TO INSTALL

EFFICIENCY

COST EFFECTIVE

ECO FRIENDLY

FUMOSO INDUSTRIAL S.A. LIMITED WARRANTY

drenotube® when installed and operated in a drainage system in accordance with Fumoso Industrial S.A. instructions, is warranted to the original purchaser "Holder" against defective materials and workmanship. Fumoso liability specifically excludes the cost of removal and/or installation of the drenotube® "Units"

The limited warranty is exclusive. There are no other warranties with respect to the Units.

This Limited Warranty shall be void if any part of the drenotube® system is manipulated by anyone other than Fumoso. The Limited Warranty does not extend to incidental, consequential, special or indirect damages. Fumoso shall not be liable for penalties or liquidated damages, including loss of production and profits, labor and materials, overhead costs, or other losses or expenses incurred by the Holder or any third party. Specifically excluded from Limited Warranty coverage are damage to the Units due to ordinary wear and tear, alteration, accident, misuse, abuse or neglect of the Units; the Units being subjected to vehicle traffic or other conditions which are not permitted by the installation instructions; failure to maintain the minimum ground covers set forth in the installation instructions; the placement of improper materials into the system containing the Units; failure of the Units due to improper siting or improper sizing or improper operation; or any other event not caused by Fumoso. This Limited Warranty shall be void if the Holder fails to comply with all of the terms set forth in this Limited Warranty. Further, in no event shall Fumoso be responsible for any loss or damage to the Holder, the Units, or any third party resulting from installation or shipment, or from any product liability claims of Holder or any third party. For this Limited Warranty to apply, the Units must be installed in accordance with all site conditions required by the local authorities and normatives and all other applicable laws and Fumoso Industrial S.A. installation instructions.

No representative of Fumoso Industrial S.A. has the authority to change or extend this Limited Warranty. No warranty applies to any party other than the original Holder.

CE ETA ITeC EOTAoffice

FDES VÉRIFIÉE inies

Edition August 2020 - FUMOSO INDUSTRIAL, SA - Barcelona - ESA084889371 - Documents and pictures are not contractually binding