drenotube®

ALL IN ONE SYSTEM NO GRAVEL IS NEEDED

SUBSURFACE TRACK DRAINAGE

GEOSYNTHETIC AGGREGATE AND GEOTEXTILE FILTER INCLUDED

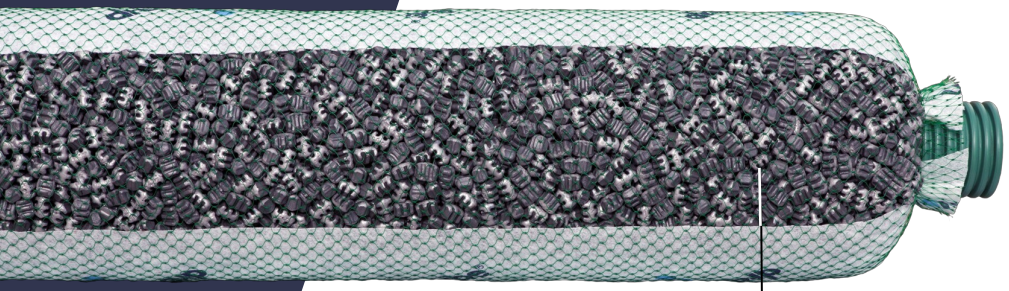
DIMENSIONS AND FLOW RATES ACCORDING TO SLOPE (i)

TOP VIEW

Ø 300 / 370 mm

L = 3 / 6 m

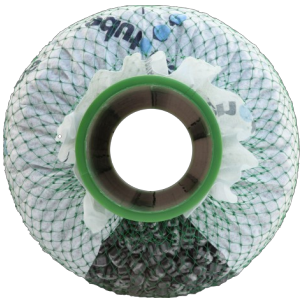
BOTTOM VIEW

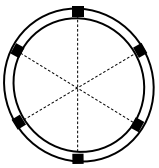


Ø 110 / 160 mm

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

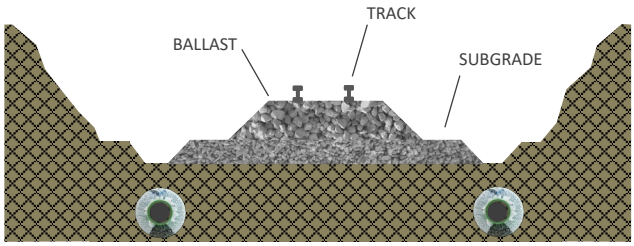
drenotube® FDES is a document that shows the results of a product's life cycle analysis (the extraction of raw materials, transport, implementation and performance to its end of life), as well as health information, used to calculate the environmental and health performance of the drainage networks.

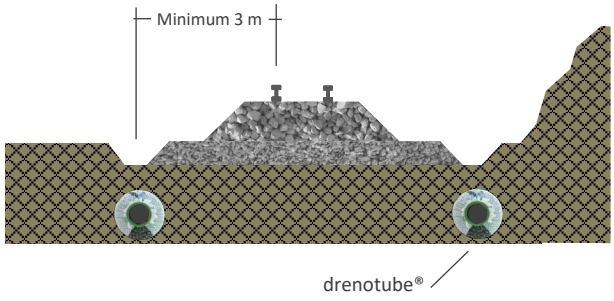
It certifies that the **drenotube®** makes a structure more sustainable, with limited impacts on the environment.

TRACK DRAINAGE

Track drainage can be defined as the interception, collection and disposal of water from, upon or under the track. It is accomplished by installing a proper surface and sub-surface drainage system.

In a cutting the surrounding ground is higher than the railway so water from the higher flows towards the track. The drain itself can be either an open ditch or piped. **drenotube®** protects the subgrade stability evacuating water to an outlet level.

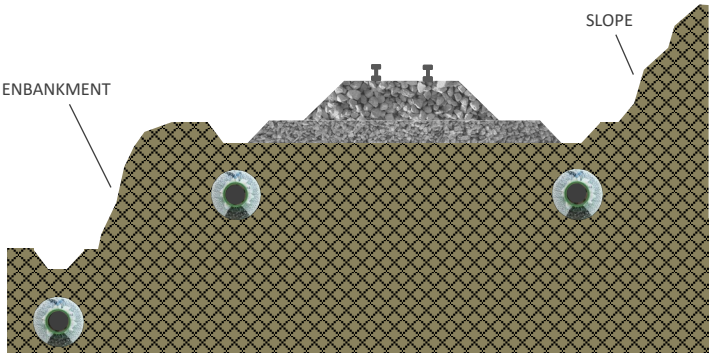




Track drainage controls the water within the track support system (that is the formation, ballast, capping layers, geosynthetics, etc, beneath the track itself).

Poor track drainage can lead to the failure of the track bed showing itself as the early failure of the ballast, resulting in additional maintenance and remedial costs together with an increased risk of broken rails.

When the railway is on an embakment the surrounding ground is lower than the track and water flows away from the track down the embankment slopes. Water is collected in a toe drain at the bottom of the embankment slope. The drainage is usually an open ditch but can also be piped. This prevents flooding which could cause embankment instability.



drenotube® drainage installation guide must be observed to guarantee a efficient performance.

Inspection boxes are generally located every 30 meters along the sidedrain. It can be connected to carrier pipes. Subsurface **drenotube®** drainage is usually located at a minimum of 3 meters from the track side.

Drainage running parallel to the track should be at minimum 900 mm below rail level. Elsewhere **drenotube®** should have a minimum cover of 400 mm.

RAILWAY DRAINAGE MAINTENANCE WORKS - SURIA SALT MINES TO BARCELONA PORT

Public Administration: FGC Ferrocarriles de la Generalitat de Cataluña

Works dates: Dec 2014 to Jan 2015 Product ref. DR370SN04ST6 Installation depth: 40 to 100 cm

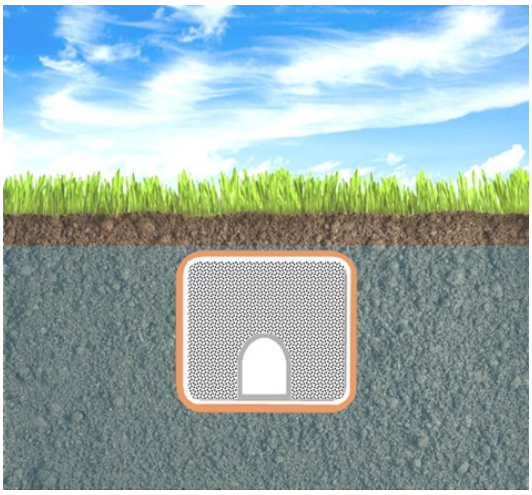
Water in the track structure tends to lead to deterioration in the track geometry through various mechanisms, which leads to lower speeds, increased derailment risk and more expensive track resurfacing.

Poor track drainage can lead to 'wet beds' That is the failure of the track bed showing itself as the early failure of the ballast, resulting in additional maintenance and remedial costs together with an increased risk of broken rails.

After trenching, **drenotube®** bundles are distributed along the sidetrack. Keep them in its original UV protected bags until placing into the trench. Connect the pipe with the external coupling being sure that they are fully inserted to insure proper coupling. **drenotube®** bundles are flexible and can fit in curved trenches.

Durability and performance of the conventional system versus drenotube®

Gravel envelope

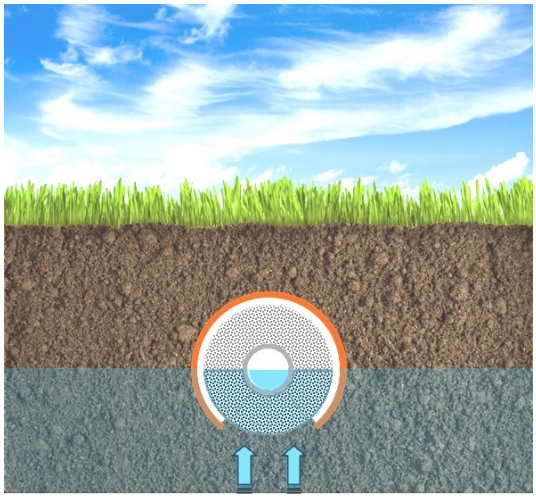


GEOTEXTILE IS WRAPPED ALL AROUND THE DRAIN

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

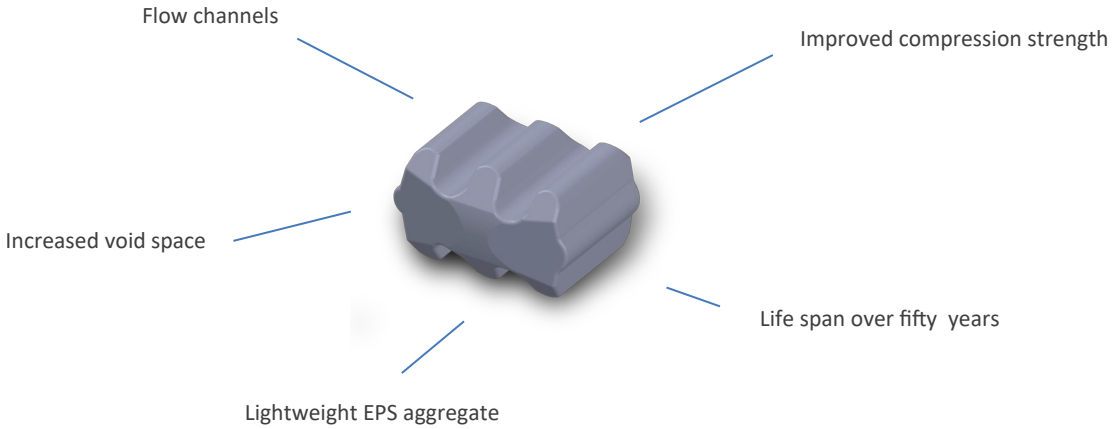
The bottom part of the **drenotube®** is open to increase durability ensuring the flow of water during many years.

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 & 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.

A good track drainage system should essentially ensure that no water percolates into the track at either the surface or sub-surface levels. Surface water due to rain, snow or from adjacent areas should be drained off properly by designing well-plannned and effective surface drains.

The sources of water:

1- Surface water due to rain, dew, snow.
2- Seepage water from adjacent area.
3- Hygroscopic water or held water
4- Rain water surface.
5- Moisture sucked up by capillary action resulting an increase of moisture in the subgrade or embankment.

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

The object of subsurface drainage is to keep these fluctuations of moisture as minimum as possible. The variations in moisture content of subgrade or embankment are mainly caused due to:

- Fluctuations in movement of capillary water
- Rising of ground water table
- Seepage water from adjacent area
- Percolation of rain water

The surface water is first collected in well designed side drains and cross- drains which is further disposed off at the nearest stream or natural water course.
Cross drainage structures like culverts and bridges may be necessary for disposing of the surface water.

drenotube® in a BARCELONA SUBWAY STATION Line 1 GLORIES

Installing **drenotube®** longitudinally between the railways to prevent water flooding. Drainage is connected to sump pumping stations. **drenotube®** was placed in between both railways covered by a railway ballast of 30 centimeters.

drenotube® Installation Guide must be carefully read before starting the works. Units are printed longitudinally with a line displaying the words "This side up". Segments must be installed positioning this line upwards. Cover the upper end of the pipe with the end cap to prevent soil or sand from getting into the pipe. The bottom of the trench needs to be leveled at a slope of 1 to 2,5 percent.

PERFORMANCE STATEMENT DR -2404-EN

CE

<table>
<tr><th>BASIC FEATURES</th><th colspan="3">PERFORMANCE</th><th>TECHNICAL SPECIFICATIONS</th></tr>
<tr><td rowspan="13">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)</td><td></td><td>DR300SN04ST6/3</td><td>DR370SN04ST6/3</td><td rowspan="13">ETA 15/0201
22/04/2015</td></tr>
<tr><td>kPa</td><td colspan="2">dm^3/s/m</td></tr>
<tr><td>0</td><td>5,80</td><td>12,50</td></tr>
<tr><td>10</td><td>5,65</td><td>12,25</td></tr>
<tr><td>20</td><td>5,50</td><td>12,00</td></tr>
<tr><td>30</td><td>5,35</td><td>11,75</td></tr>
<tr><td>40</td><td>5,25</td><td>11,50</td></tr>
<tr><td>50</td><td>5,15</td><td>11,25</td></tr>
<tr><td>60</td><td>5,00</td><td>11,00</td></tr>
<tr><td></td><td>DR300SN08ST6/3</td><td>DR370SN08ST6/3</td></tr>
<tr><td>80</td><td>4,70</td><td>9,90</td></tr>
<tr><td>100</td><td>4,30</td><td>8,00</td></tr>
<tr><td>120</td><td>4,00</td><td>7,50</td></tr>
<tr><td rowspan="6">b) Deformation under pressure (dry conditions)</td><td></td><td>DR300SN04ST6/3</td><td>DR370SN04ST6/3</td><td rowspan="6">ETA 15/0201
22/04/2015</td></tr>
<tr><td>kPa</td><td colspan="2">mm</td></tr>
<tr><td>10</td><td>40</td><td>40</td></tr>
<tr><td>20</td><td>50</td><td>65</td></tr>
<tr><td>40</td><td>72</td><td>90</td></tr>
<tr><td>60</td><td>100</td><td>110</td></tr>
<tr><td>Dedormation under pressure and ageing due to oxidation</td><td colspan="3">Same values as b)</td><td>ETA 15/0201
22/04/2015</td></tr>
<tr><td>Dedormation under pressure and ageing due to hydrolysis</td><td colspan="3">Same values as b)</td><td>ETA 15/0201
22/04/2015</td></tr>
<tr><td>Deformation under pressure microbiologically aged</td><td colspan="3">Same values as b)</td><td>ETA 15/0201
22/04/2015</td></tr>
<tr><td>Dangerous materials content</td><td colspan="3">None, all components are inert</td><td>ETA 15/0201
22/04/2015</td></tr>
</table>

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

drenotube®

PREASSEMBLED DRAINAGE AND INFILTRATION

Purpose of the works: Drainage renewal of 1400 meters between Marina and Glories stations.

Trains only stop 4 hours at night and works needs an efficient and fast execution.

In case water percolates into the formation due to bad soil or such other reasons, the formation gets adversely affected and this has a bearing on the safety and stability of the track. **drenotube®** system make installation quick and cost-effective, minimising track closures and general disruption.

Trench Connect Place Backfill

drenotube®

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.

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