

## Colbond

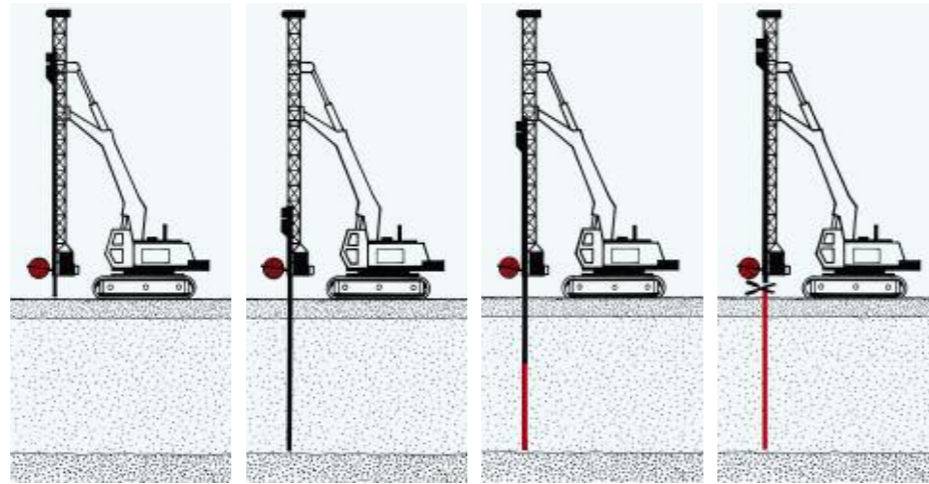
Colbond is a leading producer of high-quality synthetic nonwovens for flooring, automotive and construction applications and three-dimensional polymeric mats and composites for civil engineering, building and industrial applications. Colbond is based in Arnhem, the Netherlands, with production facilities in Emmen and Arnhem (NL), Obensburg (D) and Asheville (NC, USA). Regional sales offices are located all over the world. Colbond is a subsidiary to the Low & Bonar PLC Group.

### Proven Performance

Data from computer studies, laboratory tests and full scale field trials conducted by Delft Geotechnics, Geosyntec Consultants and Colbond Research Laboratories have been used in the design of Colbondrain PVD; to date more than 350 million linear meters of Colbondrain have been installed. Colbond is one of the leading suppliers of vertical drains in the world.

# Colbondrain

## Installation



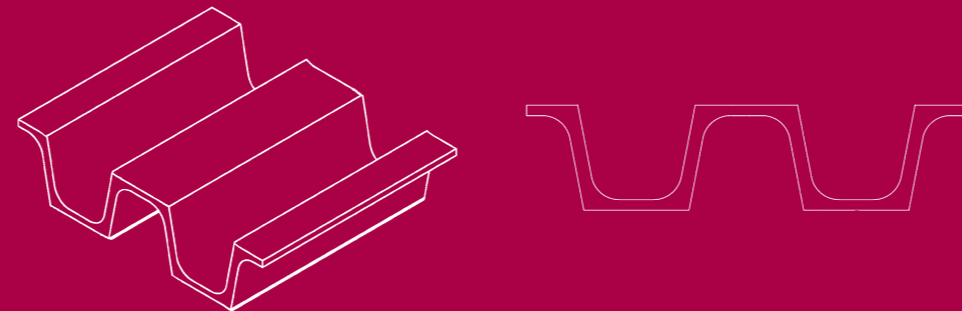
### Installation

A purpose-built installation rig mounted on a hydraulic excavator is usually used to install Colbondrain. The height of the rig is equal to the installation depth of the PVD.

*If the compressible clay is very deep and/or contains gravel bands, special techniques such as vibrators and heavy mandrels may be required.*

### Unique Core Design

Trapezoidal hydraulic core maximizes flow capacity



\* Patent number EP 1819880

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**A Low & Bonar Company**

Performance materials engineered to help build your business



**Quality**  
The Quality Management Systems of Colbond bv has been approved worldwide by Lloyd's Register Quality Assurance Limited to the ISO 9001:2008 quality management system standard (Certificate No. 935136).

**CE Certification**  
Colbondrain CX1000 is CE-certified by an independent notified body (Certificate No. 0799-CPD).

**Disclaimer**  
The information set forth in this brochure reflects our best knowledge at the time of publication. We have a policy of continuous

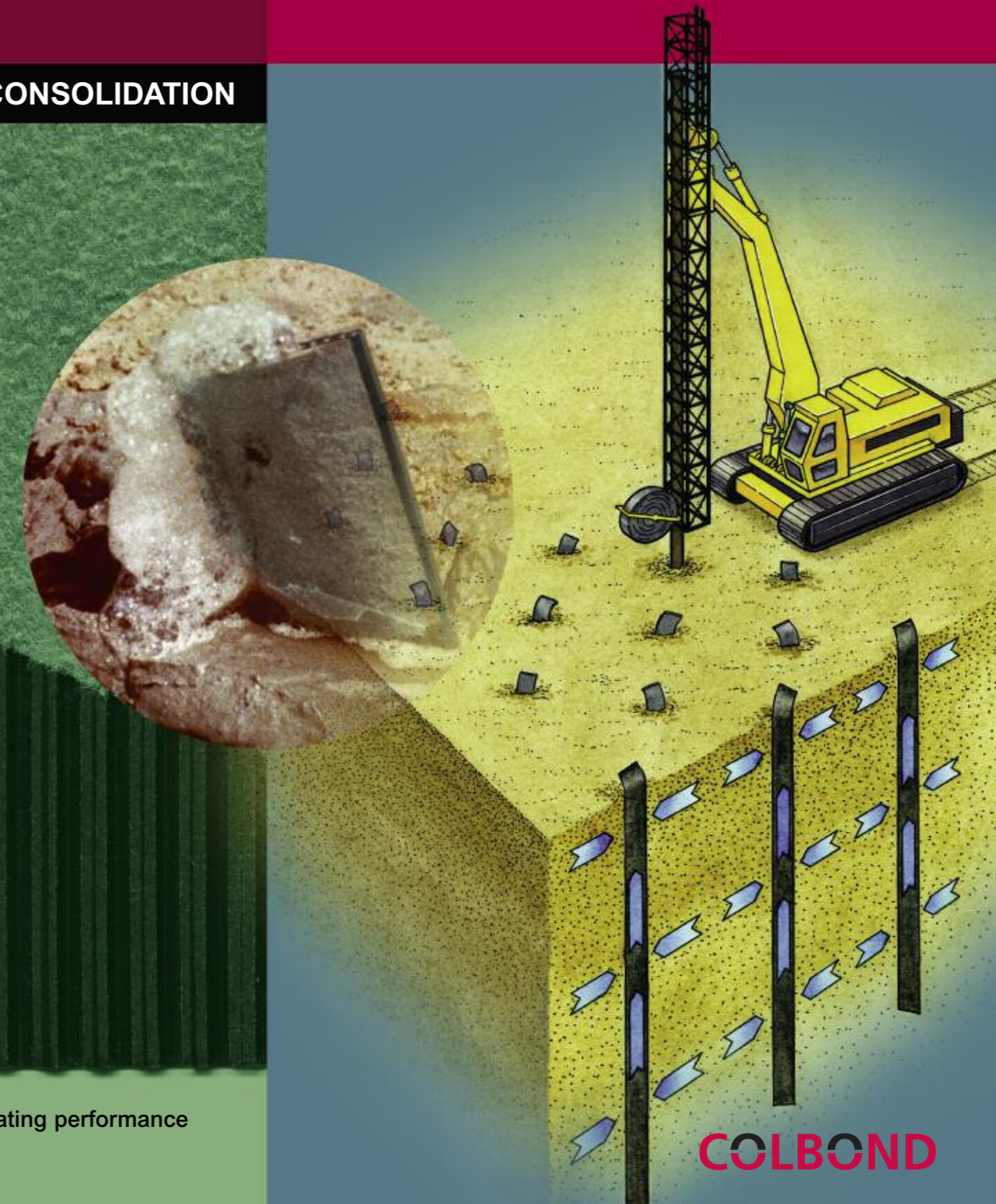
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## SOIL CONSOLIDATION



Consolidating performance on a roll

**COLBOND**

# Colbondrain

## Application

Over the past years Colbondrain CX1000 has continually evolved to remain a state-of-the-art vertical drain and retain its position as the product setting the benchmark in the world of soil consolidation solutions. The original Colbondrain vertical drain was launched in 1975. Since then, our research & development work has married laboratory tests with extensive practical experience gained from millions of meters of Colbondrain in service in the field. As a result, every new drain brings a significant improvement in product characteristics and performance, meeting and exceeding the demands made of it on construction sites worldwide.

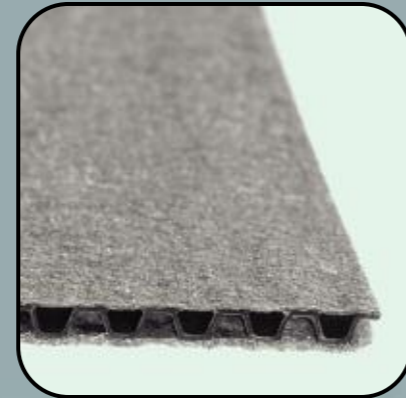
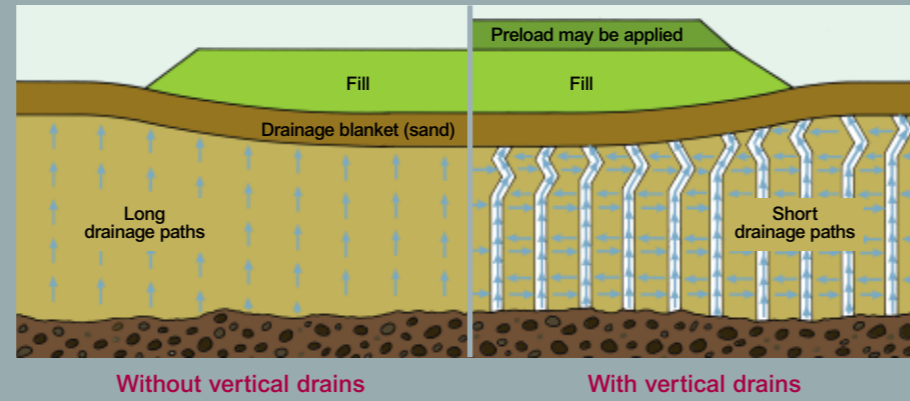
Our latest Colbondrain CX1000 is based on an **innovative extrusion and shaping technique**. It is a high-performance tough and durable vertical drain designed primarily to accelerate the consolidation of soft soils before construction.

The slow consolidation of soft clays (up to 25 years to achieve 90% consolidation) is an increasingly significant challenge. Examples are the many infrastructure projects which are being built in marshland areas. Our Colbondrain CX1000 prefabricated vertical drain (PVD) provides an economical solution, delivering consolidation in months instead of years.

This substantial reduction of the time taken to consolidate compressible clay leads to a higher factor of safety and reduces the time taken to finish construction, reducing project costs to the client.

## Product

- 10 cm wide product with a solid polymer core covered on both sides with a strong and permeable filter fabric
- Outer filter fabric bonded to the core structure over its entire surface to form a homogeneous geocomposite product
- **Unique patented core profile designed to hydraulic principles for maximum water flow capacity**



Thanks to its high performance Colbondrain is often the chosen PVD for major, technically demanding projects, such as the third runway at Changi Airport, Singapore. In this project Colbondrain has been installed to depths of up to 50 meters. The project required a total of 60 million linear meters of PVD and is one of the largest vertical drain reclamation projects in the world.

## Functions

- Forms a path for excess pore-water created by the overburden; water is drained off to the surface resulting in a stable subgrade on which construction can take place
- Reduces consolidation time of soft soils significantly, which results in substantial cost savings



## Product Benefits

### High performance

- Unique combination of patented core structure and nonwoven filter increases water flow capacity
- Core: Hydraulic channel profile (core) ensures laminar flow for maximum performance
- Innovative manufacturing technique maximizes performance
- Nonwoven filter layers deliver optimum filtration, permeability and strength. Thickness of core walls is increased in specific locations to offer high crushing strength to allow use of CX1000 to depths of up to 100 m
- High tensile strength of CX1000 allows usage on all installation rig types
- Suitable for use in all soil types

### Easy to handle

- Roll length of 280 linear meters reduces number of connections on site
- Efficient packaging allows high transport loads and fast unloading, with little storage space required on site

### Durable

- Thermal bonding of filter to the entire surface of the core structure ensures that the filter is kept taut across the flow channels
- Filter cannot tear or become separated from the core when passing over the pulleys at the rig top or during soil consolidation



## Vertical Drain Design

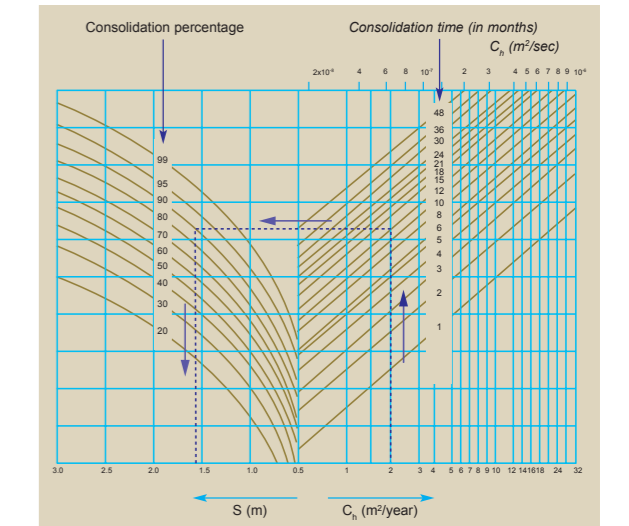
An assessment of the effect of vertical drains on the consolidation process can easily be made using a method first proposed by Kjellman and is shown in equation form below:

$$t = \frac{D^2}{8C_h} \left[ \ln \left( \frac{D}{d} \right) - \frac{3}{4} \right] \ln \frac{1}{1-U_h}$$

- t = consolidation period (year)
- D = diameter of drained soil cylinder (m)
- C<sub>h</sub> = horizontal coefficient of consolidation (m<sup>2</sup>/year)
- d = equivalent diameter of PVD (m)
- U<sub>h</sub> = average degree of consolidation

The equation has been developed into a design chart which relates the degree of consolidation, time available for consolidation, coefficient of consolidation (C<sub>h</sub>) and thus the required drain spacing (S) can be determined assuming the normal triangular grid of drain installation.

The use of a triangular grid for installation gives the most efficient relationship between the area of an equilateral triangle of side length S and the circle of influence of each drain.



### Design chart for Colbondrain CX1000

Reference: Eitzen, L.W.A. van den (1982), "Accelerated consolidation of compressible, low-permeable subsoil by means of Colbondrains"

