Enkadrain®

DRAINAGE

Drainage management on a roll

COLBOND
GEOSYNTHETICS

Introduction

Plaza deck

Basement walls

Underground parking

Managing soil-borne liquids and their effects on construction projects is a major challenge for engineers and builders around the world. Whether it is naturally occurring groundwater or liquid waste to be separated, monitored or controlled, each and every instance is uniquely demanding. Over the last twenty-five years, geocomposite drainage management systems have become increasingly widespread, replacing traditional methods.

The industry and market leader in geocomposite drainage systems is Enkadrain, an extensive range of off-the-shelf and tailor-made products developed to meet the specific needs of individual countries and national standards. To date, over fifty million square meters of Enkadrain have been installed around the world.

Enkadrain products are manufactured by Colbond. As originators of the geocomposite drainage concept and a corporate member of the International Geosynthetics Society, our company has a global track record of innovation, product performance, efficiency and customer support stretching over decades. Colbond is a globally active producer of high quality products for civil engineering applications including drainage, erosion control, landfill applications and soil improvement.

The company is also a leading producer of high performance polyester nonwovens for the flooring, automotive and construction industries.

Colbond is headquartered in Arnhem, the Netherlands and has production facilities in the Netherlands, Germany and the United States. Regional sales offices are located all over the world. Our name may be new — but our commitment to excellence, from the company that introduced the concept of geocomposite drainage over twenty-five years ago, is as strong as ever.

Applications

basement walls · road edge drains · findrain · lost shuttering · retaining walls · gas drainage landfills · plaza decks · water drainage landfills · roof garden · horizontal roofing · sports field

golf course · parking decks · external planters · internal planters · pressure relief mats underground parking · tunnel drainage · base drainage landfills · leachate detection · leachate drainage · behind r/e walls · drainage of embankments

Enkadrain — Drainage management on a roll

Enkadrain

What is Enkadrain?

Groundwater can cause significant problems for civil engineering and building projects, both during construction and in service; 70% of all damage to buildings is water-related, with half of this due to insufficient or incorrect sealant and lack of drainage.

A traditional drainage layer consists of granular material often more than 300mm thick. However, the performance of such a drain can be inconsistent and decrease with time, due to deterioration of the boundaries and clogging of the material itself. Enkadrain, a geocomposite material, offers significant advantages.

All Enkadrain products are lightweight, strong, flexible, easy to handle and fast to install in one operation. They deliver high flow transmissivity per unit volume with consistent, uniform and excellent long-term performance. Every variant is based on the same basic concept of a three-dimensional composite that consists of a drainage core either connected to one or sandwiched between two nonwoven synthetic geotextile fabrics. The drainage core is composed of tough, looped synthetic filaments that are fused together where they cross, forming an open structural material with a voids ratio of 95%. The resulting product is chemically inert and durable.

Application areas

Vertical
- basement walls
- retaining walls
- lost shuttering
- movement joints

Horizontal
- parking decks
- roof gardens
- green roofs
- underground pressure relief

Landfills
- water drainage
- gas drainage
- leachate detection
- leachate drainage

Roads & Rail
- edge drain
- findrain
- drainage of embankments
- tunnels

Enkadrain protects, filters & drains

- Protects waterproof coatings and membranes from damage during backfilling
- Prevents silting up of the collector drain
- High discharge capacity due to its open structure
- Forms an insulating air gap between wall and soil
- Lightweight and easy to handle
- Exceptional flexibility
- Simple to install
- Can be installed under all weather conditions, even at freezing temperatures
- Can easily be cut with a pocketknife or shears
- Negligible waste
- Rot-proof so no risk of pollution of the subsoil
- Unaffected by chemicals commonly occurring in the soil
- Fire resistant

Plaza deck, outlet

Plaza deck

Leachate detection

Enkadrain

The Family

Road edge drain

Lost shuttering

Basement wall

Enkadrain sparked off the geocomposite drainage revolution over twenty-five years ago. Today, the product range is extensive and continually expanding as new applications lead to tailor-made solutions.

Colbond engineers have a matrix of core and filter material types, structures and production techniques at their disposal, from which the Enkadrain family is grouped into five broad types:

Enkadrain Premium

- General civil engineering applications requiring high performance
- Polyamide 3D filament core, filter heat bonded to core over entire surface, thickness 10 to 20mm

Enkadrain Wide

- Used for waste containment & draining poor quality fills used for constructing embankments
- 5m wide, core and filter tailored for specific application, filter is stitched to core at closely-spaced intervals longitudinally

Enkadrain Standard

- Suitable for non-specific applications with excellent price performance
- Packaged in small rolls with laying guide included for ease of handling and on-site installation
- Suitable for smaller projects where detail design may not be required

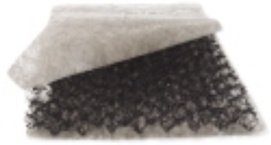
Enkadrain Findrain

- Replacement for a conventional French Drain
- Designed to suit a range of drainpipe sizes, pipe (not supplied) drawn into Findrain by integral cord

Enkadrain CK types

- Specialist applications in building, tunneling & civil engineering
- Supplied with various types of impermeable layer on one side

We would be pleased to advise on the most suitable Enkadrain product to meet your requirements, and if necessary to work with you to produce a tailor-made variant for your specific application.



Enkadrain

Premium

Enkadrain Premium is a high-performance geocomposite offering excellent flow rates at low hydraulic gradients. In vertical drainage applications, Enkadrain Premium is used behind bridge abutments, concrete retaining walls, basements of multi-storey buildings, tunnels etc.

Horizontal applications include sub-surface layers in roof top parking and roof gardens where its high compressive strength, low volume and weight offer significant advantages compared to conventional materials.

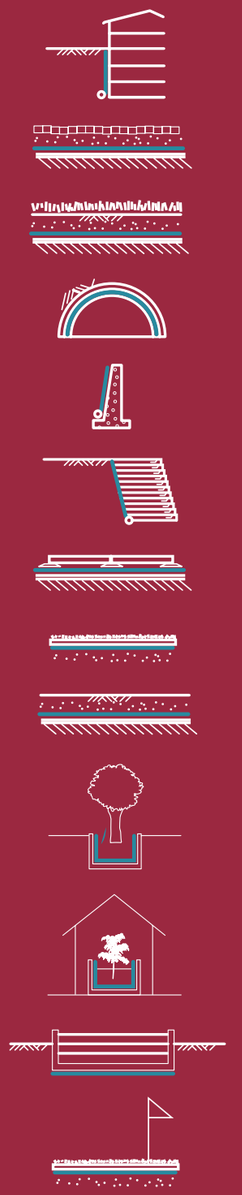
In the heat of the desert sun near Phoenix, Arizona, highway engineers building the Agua Fria highway specified Enkadrain Premium as the drainage layer beneath the concrete lining forming the massive storm drainage channels alongside the highway. Enkadrain has unique free-draining characteristics and withstands installation stresses with an increased safety factor against catastrophic failure.

The geocomposite was chosen in preference to a traditional aggregate filter for its ease of handling and installation on the 1:3 slope of the channel sides. Rebar or wire mesh was placed directly on the Enkadrain mat before the low-slump concrete was poured. Over 36,000 square meters of Enkadrain Premium were installed.

Phoenix, Arizona
Water drainage layer

France
Cut & cover tunnel

Applications



Enkadrain

Wide

Enkadrain Wide is a versatile and reliable geocomposite for large areas. For waste containment purposes, Enkadrain Wide is used as a drainage layer on top of the capping membrane and as the gas-venting layer below the capping liner.

Enkadrain Wide has also proven effective for drainage under large embankments, beneath rooftop gardens, parking decks and below foundation slabs.

In one of the largest ever orders for geocomposite drainage material to date, over one million square meters of Enkadrain Wide were laid as a water drainage layer in the capping on the Tsueng Kwan O landfill sites in Hong Kong.

Working to tight deadlines and performance specifications, Colbond engineers designed, tested and supplied a special 6mm thick Enkadrain Wide to meet Swire Sita's specific needs. The specification demanded a high discharge capacity from the composite drainmat with a soil cover load of 35 kPa on a 1:3 slope up to 300m long.

TKO, Hong Kong
Water drainage landfill

Landgraaf, The Netherlands
Water drainage landfill

B ziers, France
Grip layer and leachate drainage

Enkadrain

Standard

For fast, cost-effective insulation, protection and drainage, construction engineers are finding Enkadrain Standard is the solution. Cut lengths from the small rolls can easily be held in place against shuttering or walls and either nailed or bonded in place. Enkadrain Standard delivers high productivity and reliable results.

In many parts of the world, new housing often incorporates basements and cellars that must be protected from water ingress. Enkadrain Standard provides a fast and reliable way of installing effective vertical drainage that also protects the building s external waterproofing layer. It is also tough enough to withstand backfilling and compaction without damage.

In Germany, rolls of Enkadrain Standard are available at selected merchants, proving how easy it is to install effective three-in-one drainage, protection and filtration with low wastage and high performance.

Velp, The Netherlands
Basement wall

Cellar wall

T bingen, Germany
Basement wall

Enkadrain

Findrain

Replacing French Drains, Enkadrain Findrain is a planar geocomposite designed to collect and transport water vertically or horizontally. It is typically nine times more effective than conventional granular fills. Findrain can be used:

- **As an edge drain for dewatering highway surfaces**
- **To intercept infiltration water and groundwater in embankments and ditches to improve stability**

The Spanish customer Mopt chose Enkadrain Findrain for longitudinal drainage on the 34.4 km section of the new Rias Bajas highway between Mombuey and Requejo. In one of the biggest projects of its type, over 24,000 linear meters of Enkadrain Findrain were installed. Excavation and installation was fast and straightforward thanks to Enkadrain Findrain s single pass concept that minimized the number of operations and the need for dedicated construction plant.

On another similar motorway project in Spain, roads contractor Iberpistas installed over 10,000 linear meters of Enkadrain Findrain for lateral drainage.

Highway, Spain
Road edge drain

A29, France
Road edge drain

Oldeberkoop, The Netherlands
Findrain

Enkadrain

CK Types

For specialist applications in tunneling and for complex formwork, Colbond has developed the CK range of geocomposites that feature either an impervious PVC surface layer or coated filter on one side. Enkadrain CK saves space, cuts excavation volume and can act as a thin flexible waterproof drainage and protective sheet between adjacent buildings or on the outside of tunnels. Enkadrain CK can also serve as lost formwork.

When prominent German bankers S dwestLB (now LBBW) built a new eleven-storey banking and business center in the heart of downtown Stuttgart, the construction posed a number of major problems. The site, bordered on three sides by buildings, was very narrow and the three-storey 16 meter deep basement had to be isolated from the adjacent buildings and the nearby road with sufficient drainage for groundwater.

Over 17,000 square meters of Enkadrain CK were installed on the external surfaces of the below-ground construction, ensuring excellent drainage and protection. In addition, the Enkadrain CK geocomposite served as a noise barrier, a shield against electromagnetic interference and as a flexible infill between the adjacent buildings and the piled curtain walling.

Stuttgart, Germany
Lost shuttering

Vannes, France
Underground parking

Enkadrain

The Properties

Easy handling

Simple tools

Fast installation

Handling

Enkadrain is normally supplied in 1 m or 2 m wide rolls of manageable size and weight that are packed in plastic bags to enable them to be stored outside. The filter layers extend 100 mm beyond the core to provide an overlap with adjoining strips. The overlap is folded into the roll during packing.

Enkadrain Wide is supplied in rolls of 5 meters width and 650 - 850 mm diameter on carton cores in a sealed plastic wrapping. Rolls should be stored in the original wrapping, laid flat and not more than three rolls high to avoid deforming the lowest rolls. The rolls should be lifted with a spreader bar and a steel rod or tube through the central core of the roll.

Installation

Enkadrain is light and can be cut easily with a pocketknife or shears. Its flexibility ensures that Enkadrain can be fitted accurately around corners and other structural features with negligible waste.

All Enkadrain types can be installed quickly and easily: non-specialist laborers can achieve rates of 25 to 30 m^2/h for vertical installation (10 to 15 m^2/h for CK types). In vertical drainage Enkadrain is usually installed working from the top of the wall to the bottom and fixed by nailing, tacking, or gluing.

Enkadrain protects the external waterproofing layer from mechanical damage and the collector drain from clogging, allowing the excavated material to be re-used as backfill.

Unrolling Enkadrain Wide requires two men, one on each side of the roll. On slopes, the material should be unrolled from the top of the slope to the bottom. Enkadrain Wide should be unrolled directly into its desired location, as repositioning after unrolling is not recommended.

Transport and storage

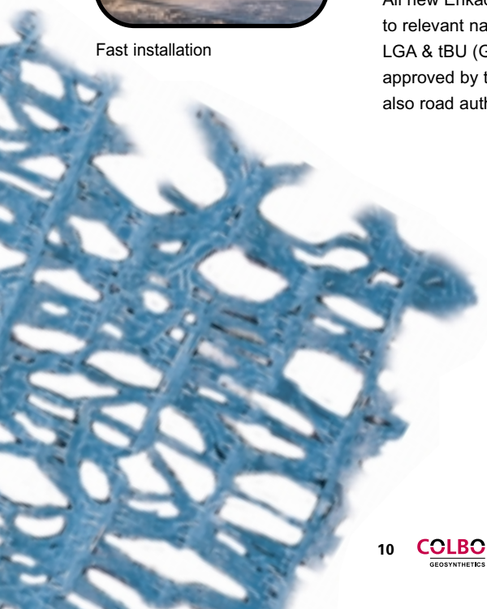
Enkadrain is easy to transport and the rolls can be stacked and stored outside.

Chemical resistance

Since Enkadrain is manufactured using manmade materials (polyamide, polyester and polyolefin) it possesses outstanding resistance to all chemicals in concentrations commonly occurring in the soil.

Testing

All new Enkadrain products are rigorously tested in Colbond's own laboratories. If required, certification to relevant national and international standards is obtained from independent organizations such as LGA & tBU (Germany), EMPA (Switzerland) and CEMAGREF (France). Enkadrain has been tested and approved by the majority of European rail authorities including DB (Germany) and SNCF (France) and also road authorities including CFTR (France).



EMPA LGA tBU

Every Enkadrain product is manufactured to the highest standards, with the assurance of ISO 9001 accreditation (certificate no. 935136). From raw material through manufacture, shipping, on-site storage, installation and service, Enkadrain products benefit from Colbond Geosynthetics years of experience and extensive resources.

Enkadrain

Design Techniques

Example A

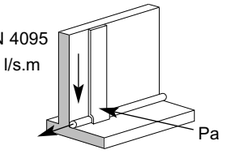
- Vertical wall 8 m high
- Soil unit weight (ɣ) 20 kN/m^3
- Required drain capacity — DIN 4095 is 0.3 l/s.m
- Coefficient of active earth pressure k_a = 0.4

⇨ Pa = 20 x 0.4 x 8 = 64 kPa

For a certain type of Enkadrain at 64 kPa the discharge capacity is:

$$\text{interpolation } 0.47 - \left[\frac{64 - 50}{100 - 50} \times (0.47 - 0.19)\right] = 0.39 \text{ l/s.m}$$

DIN 4095
0.3 l/s.m



Enkadrain Type

kPa	l/s.m
20	1.54
50	0.47
100	0.19

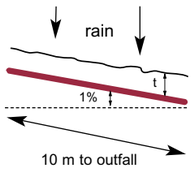
Enkadrain is $\frac{0.39}{0.3}$ = 1.3 times more permeable than required

Example B

- Roof garden hydraulic gradient equals 1% over 10 m drain length
- Soil cover 0.4 m with unit weight of 18 kN/m^3
- Rainfall 20 mm in one hour. 20 mm/hr = 20 l/hr.m^2 = 0.0055 l/s.m^2
  Over 10 m drain length = 10 x 0.0055 = 0.055 l/s.m

⇨ P = 0.4 x 18 = 7.2 kPa

For a certain type of Enkadrain at 7.2 kPa the discharge capacity is:



Enkadrain Type

kPa	i = 1%
5	0.34
10	0.18
15	0.11

$$\text{Interpolation } Q_{0.01,\ 7.2\ kPa} = 0.34 - \left[\frac{7.2 - 5}{10 - 5} \times (0.34 - 0.18)\right] = 0.27 \text{ l/s.m}$$

Discharge capacity is $\frac{0.27}{0.055}$ = 4.9 times higher than required

1. Determine the required discharge of groundwater at the base of a wall or the seepage flow per m^2 into the drain layer of roof garden in a horizontal application by either:

   a) Use of a combination of flow net, soil permeability and hydrological information

   b) Relate to equivalent gravel drainage layer;
   K_v gravel = 10^{-3} m/s => 0.3 m gravel column = 0.3 l/s.m

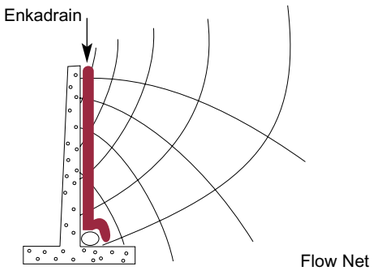
   c) Refer to German Standard DIN 4095; gives detailed information on drainage to structures

   Seepage in vertical plane = 0.3 l/s.m
   Seepage in horizontal plane = 0.03 l/m^2
   Under foundation slabs = 0.005 l/m^2

2. Calculate maximum active earth pressure on Enkadrain;
   For vertical wall $P_a = ɣ \cdot k_a \cdot h$ kPa
   For horizontal roof $Pa = ɣ \cdot h$ kPa
   ɣ = weight of soil kN/m^3

   k_a = coefficient of active earth pressure
   h = height of wall or soil thickness

3. Compare required discharge capacity with specific Enkadrain product specification



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