

TECHNOTES

Vertical Drainage Installed from Pontoons in the Bremerhaven Storage Depot

Rapid dewatering can improve the efficiency of storage depots. During the extension of the quay and the site at a storage depot in the Bremerhaven Osthafen, Cofra BV installed the vertical drainage system BeauDrain-S from floating pontoons. The 17-metre-long vertical drains were then fitted with HDPE hoses and connected to vacuum pumps to carry off pressurised groundwater, increasing capacity and making the site available for use much earlier. In recent years, the system has been developed and extensively tested at many projects in the Netherlands for accelerating the settlement process of sites and roads. The system is also being used for a mega-project (350,000 m²) at Bangkok airport in Thailand.

INTRODUCTION

Residues that are not suitable for reuse are often placed in depots. An example of such a material is "mine tailings". These consist of the residue left after refining metallic ore such as lead, tin or copper and they are stored in large depots. Ever stricter safety and environment requirements mean that it is necessary to concentrate mine-tailing storage at acceptable costs. Many countries, like Spain, Finland and Romania, want to dewater these depots rapidly to increase capacity. Large quantities of dredging material are also produced during the dredging of harbours and channels in Rotterdam, Bremen, Hamburg and Antwerp. The contaminated part of the dredged material is stored in special depots. Sometimes these depots are temporary. Often an alternative is sought. After filling, they may be developed as permanent nature islands, industrial sites, dike cores, or dunes. A rapid and reliable dewatering method helps to reduce costs and shorten building times.

DEVELOPMENT AND OPTIMISATION OF VERTICAL DRAINAGE

Around 1927 in California, sand drains were developed to accelerate subsoil consolidation in raised ground. In the Netherlands, the first sand drains were used in 1950. Dutch soil consists largely of clay and peat strata that contain a great amount of water and can be compressed. Vertical drainage makes it possible to carry off pressurised water,

resulting in rapid settlement. Pre-fabricated drains were used for the first time in Sweden in 1937. The first synthetic drains were introduced in the Netherlands in 1972 for the construction of the Hemweg power plant in Amsterdam, after which their use became increasingly popular.

Synthetic drains are quick and easy to install. In addition, they work better as they result in better and more reliable filtering. Synthetic drains soon became a formidable competitor of sand drains, which have now become almost obsolete. In response to the high level of demand for high-quality synthetic drains, Geotechnics Nederland (now Geotechnics bv) developed the Mebra Drain in 1978. Since then, this drainage system has developed into the world's most widely used vertical synthetic drain. Today more than 300 million metres of Mebra Drain can be found in 48 different countries.



Figure 1. Installation BeauDrain-S from pontoons in the Osthafen depot in Bremerhaven.

BREMERHAVEN PROJECT

On instructions from the Bremerport port authority, Heinrich Hirdes GMBH built a depot for dredged material in the Osthafen which is scheduled to become a car storage site. A combined steel-piling wall was sunk down around the depot to a depth of roughly -25.00 m NN. The depot already contained a layer of silt from about NN -5.50 to NN-17 m. Pontoon cranes then dredged the harbour outside the sheet piling to NN -10.00 m and a positive displacement pump filled the depot with dredged material to about NN +0.80 m.

Cofra BV offered the Bremerport port authority the BeauDrain-S drainage system as an alternative to the vacuum consolidation system that was listed in

Project portfolio BeauDrain-S vertical synthetic drainage systems.

Project description	Client	Number of m ²	year
Culemborg service area	Tango Netherlands	3,600	2004
Hatterem (roundabout) Vinkeveen	NTP infra	600	2004
Alphen aan de Rijn	Boskalis Infra	6,300	2004
Sliedrecht RW15	comb. Nederwaert	1,100	2004
Gorinchem, Betuwe railway	HBSC	4,800	2004
Vinkeveen (building site)	Van der Werff	3,000	2005
Ter Aar, waste collection station	Cyclus NV	1,800	2005
Delft parking lot	Ikea Netherlands	3,700	2005
Bangkok (Svarnabhumi airport)	CH.Karnchang Public Company	350,000	2005/6
Reeuwijk (building site)	Boskalis Infra	600	2005
Pijnacker (2 stages)	Boskalis Infra	2,500	2005
Geertruidenberg	Grondbank Netherlands	13,000	2005
Schiedam (Schieveste)	Boskalis Infra	1,250	2005
Sloelijn	Comb. Boskalis KWS	2,500	2006
Bremerhaven (storage depot)	Heinrich Hirdes GMBH	62,000	2006
Singapore (Circle line)	Nitsumashu	600	2006

the specifications. The port authority accepted this alternative because BeauDrain-S had proven more effective and flexible in various international projects.

When the depot had been filled with material, a double layer of Naue sand mats – I Type Terrafix B 301G31 – was placed on the waterbed to distribute the forces from a subsequent sand layer. Then the trailing hopper *Waterway* from Boskalis Westminster in Papendrecht spread sand in 20 cm layers.

However, because of the low bearing capacity of the dredged material, even a sand layer of some 80 cm resulted in pressure rises. That made the planned sand layer of 400 cm impossible. In consultation with the client, the procedure was modified and Cofra BV suggested installing the drains from floating pontoons (Figure 1). For this purpose a new subprocedure was drafted describing the operating method, the equipment to be used and the safety regulations.

INSTALLATION IN OSTHAFEN DEPOT

The drains were prefabricated in a special container. In this sheltered setting the synthetic drains (MD 88 H) were cut to length and fitted with a coupling, a 3.5 m HDPE hose (Figure 2). The 17-metre-long prefabricated drains were placed into the water bottom from floating pontoons. A crane monitoring system based on DGPS NovAtel was used for positioning. The positions and depths of the drains were recorded during the work and later recorded on

drawings.

When the drains had been placed, the water level in the depot was lowered to the waterbed, so the drain hoses could be interlinked into strings. The line strings were linked up to a header connected to a container unit housing a vacuum pump system. The pump system was linked to a GSM signalling device to report any malfunctions. The pumps operated 24/7 during the consolidation period.

A total of 10 container units were used (2 pumps per unit) at the Osthafen depot: 4 on shore and 6 on pontoons floating in the depot. The pumped up water was fed back into the site. The water was discharged into the harbour at one central location.



Figure 2. Close-up of the BeauDrain-S with attachment hoses.



Figure 3. Osthafen depot after the HDPE hoses of the BeauDrain-S system had been pumped dry.

Settlement monitoring

A total of 22 settlement monitors were placed in the depot when the site had been pumped dry. Measurements from them are taken every week to provide an accurate image of settlement in the depot. The results showed that, despite the moderate load of 80 cm, the vacuum system resulted in settlement of no less than 50 cm during the first six weeks.

Experience and further development

The installation of the vertical drainage system and dewatering in the Osthafen depot went off very well, even though the work had to be carried out during the winter (Figure 3). A special light vehicle that can operate on a thin sand layer for the installation of BeauDrain-S in depots is presently being developed. This will allow for even faster installation and connection of the drains. This vacuum drainage system could also save time and money at depots, for instance, in the Netherlands (Slufter, Ketelmeer and Haringvliet), Germany (Hamburg, Bremen) and Belgium (around Antwerp).

CONCLUSIONS

A number of product innovations have been introduced to improve the effectiveness of vertical drainage. In addition to the BeauDrain system

(a combination of horizontal and vertical synthetic drainage curtains connected to vacuum pumps), the BeauDrain-S system was developed in late 2003. In this system, the vertical synthetic drains are connected above the ground to a hose system and vacuum pumps. It is highly effective and can also be installed on surfaces with less bearing capacity, such as storage depots, without disturbing the topsoil.

One of the latest developments is the application of BeauDrain-S in a depot for dredged material. Polluted dredging material must be stored in sealed depots. This material contains water that takes up a considerable proportion of the available expensive storage space. In addition, it takes quite a long time before the depots become accessible again or suitable for building. Vacuum consolidation accelerates the settlement of the dredged material.

Depending on the composition of the material (i.e. sand and sludge content), the BeauDrain-S system can achieve a considerable level of settlement over a period of some 3 to 6 months.

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<http://www.cofra.com/papers/MebraRapportNL-2002.pdf>