SOIL CONSOLIDATION
SOLUTIONS

PVD & STRIP DRAINS

PREFABRICATED DRAINAGE SOLUTIONS

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2023 WICK

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THE PROBLEM :: Historically, the design of structures on soft compressible soils (such as clays) has created problems for civil engineers. Construction without some sort of soil treatment is usually impractical due to unpredictable long-term settlement. Simple surcharging as a soil consolidation method increases pore water pressure, but settlement can take considerable time (years), as the water lacks an easy path to leave the soil.

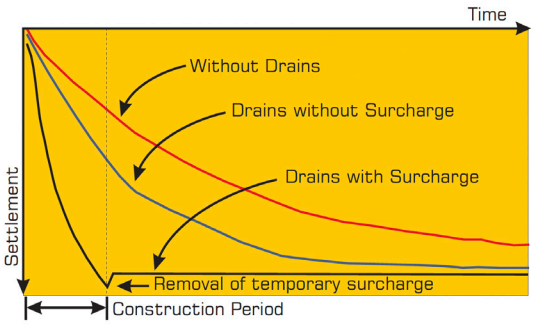

Figure 1

THE SOLUTION :: Soil consolidation using prefabricated vertical drains (PVD), also commonly referred to as "wick drains" or "band drains", can reduce settlement times from years to months. Most settlement can occur during construction, thus keeping post-construction settlements to a minimum.

Consolidation of saturated fine-grained soil occurs very slowly because the low permeability of these soils impedes the escape of pore water from the soil voids. Even under large temporary surcharge loads, settlements can take years because of this slow water movement and the great distance the water must travel to exit the soil. The installation of PVDs greatly reduces the distance the water must travel to reach a free drainage path, and therefore greatly increases the rate of settlement (***Figure 1***). PVD spacing may be adjusted to meet the required settlement time.

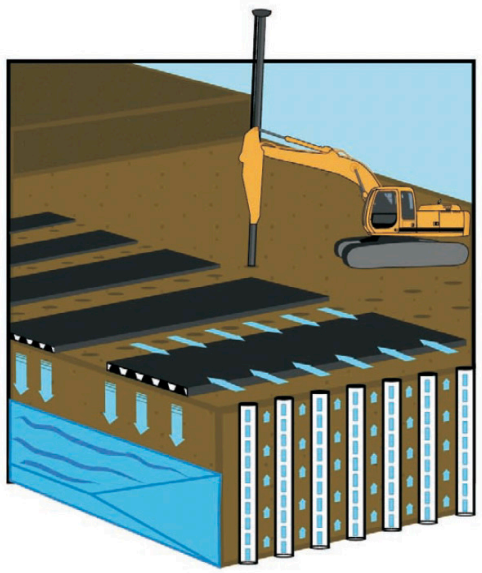

Figure 2 - Typical vertical installation

PVDs are installed vertically (***Figure 2***) to depths as great as 50 meters (164 feet). The water, under pressure in excess of hydrostatic, flows through the filter and into the channels where it is led vertically out of the soil. This may be either up or down to intersecting natural sand layers or to the surface where a sand drainage blanket or prefebricated strip drains are provided. The water in the soil only has to travel the distance to the nearest drain to reach a free drainage path. The drains are usually placed in a triangular configuration of 1 to 10 meters (3 to 33 feet) depending on the desired consolidation time. As a result of this method of accelerating the consolidation process, uneven post-construction settlement can be virtually eliminated.

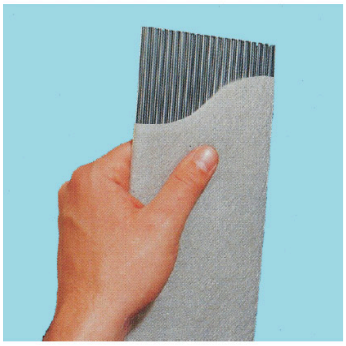

Figure 3 - AMERDRAIN-W Prefabricated vertical soil drain

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PREFABRICATED VERTICAL DRAINS WORLDWIDE

The innovative design of PVDs have found acceptance with engineers and contractors worldwide. PVD has been successfully installed in most countries throughout the world, including:

HORIZONTAL STRIP DRAINS

Prior to the 1980's, most vertical drain installations were accompanied by a horizontal sand blanket for lateral drainage. This technique was reasonably effective, but sand blanket installation was slow and expensive. In addition, the sand was subject to clogging from the infiltration of fines from the surcharge.

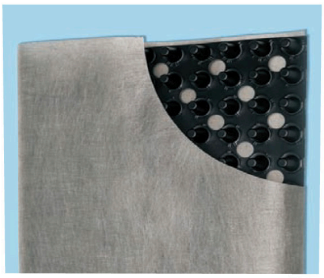
Figure 6-A

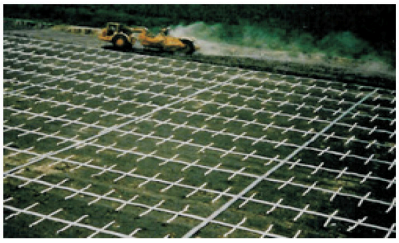
Figure 6-B

In the late 1980's, larger prefabricated drains called "strip drains" were developed (***Figure 6-A***). Prefabricated strip drains are significantly thicker and wider than PVDs, allowing them to provide high flow capacity. Strip drains can be used with or without a sand blanket in soil consolidation applications. (***Figure 6-B***). Strip drains offer three primary advantages over a sand blanket for providing lateral drainage. First, strip drains are less expensive. Material, freight and installation costs are usually lower for prefabricated strip drains. Second, strip drains may be installed more quickly and with less manpower and equipment. And third, strip drains provide better drainage as their flow capacity is more predictable and less subject to clogging.

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HOW PREFABRICATED VERTICAL DRAINS FUNCTION

PVDs have two components - a core which serves as a water conduit and a geotextile filter fabric which allows water to pass into the core while restricting the movement of soil particles which might clog the core (***Figure 3***).

THE FABRIC

PVD incorporates a high-strength, high-survivability polypropylene filter fabric designed for subsurface drainage applications. Its continuous filaments are arranged preferentially in the length and width directions of the sheet and thermally bonded. PVDs filter fabric resists mildew, rotting, insects and chemicals normally encountered in a subsurface drainage system. It is dimensionally stable, wet or dry, has good tear and puncture resistance and will not shrink, grow or unravel.

PVD filter fabric has a unique structure (***Figure 4***) that enhances its function as a filter fabric. It has a large number of openings with a range of opening sizes throughout its structure instead of a few openings of fixed size such as found in woven fabrics. Its bonded fibers create a tortuous pathway resembling that of a well graded aggregate filter rather than a simple, straight line exit for soil particles. Because of its unique structure, the filter fabric has both high permeability and the ability to restrict the movement of most soil particles, while allowing fines to flow into and out of the drain. The initial removal of very fine silts from the soil is beneficial because this leaves the larger particles to form a highly permeable soil network (***Figure 5)*** against the fabric. The soil network restricts the further movement of fine soil particles and helps to develop a graded soil filter. This soil filter effectively stops piping of soil and prevents other fine particles from entering the drain. The filter fabric, being more permeable than the soil filter and the natural soil, does not restrict the flow of water into the drain.

Figure 4

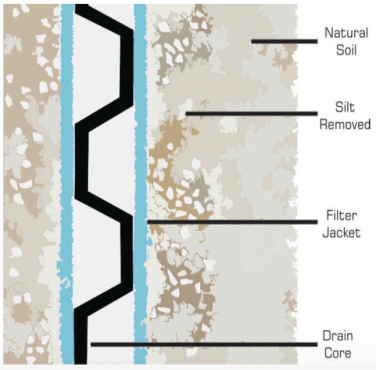

Figure 5

The effectiveness of the filter fabric has been proven in civil and commercial projects in a wide range of soil types. Its effectiveness has also been confirmed by extensive laboratory tests at the Colorado State University Engineering Research Center. Test were run with soil mixtures of fine sand, silts and clays which simulated actual systems. Under these conditions, the tests confirmed that, after the initial passage of fine silts through the filter there was:

(a) No measurable migration of soil fines within the soil filter or into the drain, and
(b) No measurable pressure drop across the filter indicating no reduction of water flow through the fabric.
Scanning electron microscopy confirmed that there was no clogging of the fabric.

THE CORE

PVD is a strong, tough structural member extruded from 100% polypropylene specifically designed for vertical drain systems. Longitudinal grooves distributed on both sides of the core provides discharge passages for water flowing to the surface. The core is dimensionally stable when wet, has good puncture and collapse resistance and will not shrink or rot.

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TYPICAL APPLICATIONS

EMBANKMENT CONSTRUCTION

PVD may be used to accelerate settlement of embankments for roadways, railroad tracks, runways, or bridge approaches which must be put into operation soon after construction is completed. Presettlement can greatly reduce long-term maintenance costs that would result from extended periods of settlement during the life of the project.

TANK FARM FOUNDATIONS & MATERIAL STORAGE AREAS

Because of high unit loadings, liquid storage tanks are subject to settlement in soft soils. PVD used in conjunction with horizontal strip drain can provide rapid soil consolidation prior to construction. Storage sites for solid materials - coal, ore, paper - also can benefit from PVD prior to use.

UNDERWATER CONSOLIDATION

PVD may be used to accelerate settlement of soil below water level. The differential pressure created by the surcharge is as effective under water as on land. This technique can be used in preparation for placing tunnel sections in a river bed, for example.

LANDFILL AREAS

Fill is often placed behind sheet piling walls or cofferdams for use as docks or industrial sites. The use of PVD is an effective method to accelerate settlement thereby making the site available for use in the shortest possible time.

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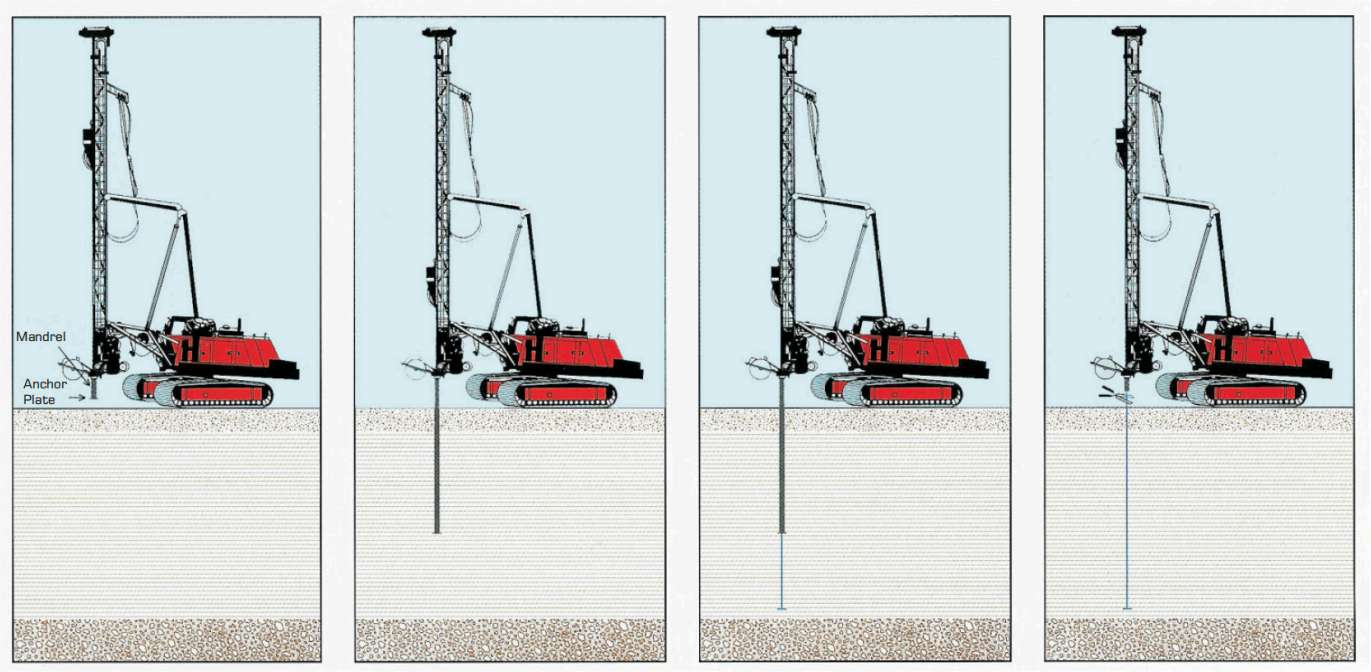
INSTALLING PREFABRICATED VERTICAL DRAINS

PVD may be installed by employing either vibratory or static crowd methods. In either case, the drain is enclosed in a tubular steel mandrel of small cross-sectional area (usually 2 x 5 inches). A small steel anchor plate is attached to the PVD at the bottom of the mandrel. The mandrel is then driven into the soil either with a static crowd or vibratory rig. When the design depth is reached, the mandrel is extracted. The anchor plate retains the drain in the soil. When the mandrel is fully extracted, the PVD is cut off, a new anchor plate is installed and the process begins again.



American Wick Drain Corporation (AWD) is America's largest full-line producer of prefabricated vertical, sheet and strip soil drain material. The company was established in 1982 to design, manufacture and market advanced geocomposite materials for subsurface drainage applications. The objective was to combine new geotextiles with specially designed drainage cores in order to offer new drainage materials having significant advantages over aggregate drains.

AWD manufactures PVD and strip drain products with flow capacities to meet virtually all soil consolidation requirements. Design assistance is available through our network of preferred designers/installers.