

PREFABRICATED VERTICAL DRAINS Ground Improvement Technique

Technical Reference No. M06/00

PREFABRICATED VERTICAL DRAINS (PVD)

In construction of various structures on compressible, saturated soils like soft clay, excessive settlement is a common problem to deal with. The ground improvement technique using prefabricated vertical drains (PVD) is one of the most suitable methods to overcome this problem. The sole purpose of vertical drain system is to shorten the drainage path of the pore water from a low permeable layer to free water surface or to pre-installed drainage layer, thereby accelerating the rate of primary consolidation or the process of settlement. Application of ground improvement method using prefabricated vertical drains (PVD) coupled with surcharge or pre-loading can significantly shorten the period of primary settlement.

TYPICAL APPLICATIONS

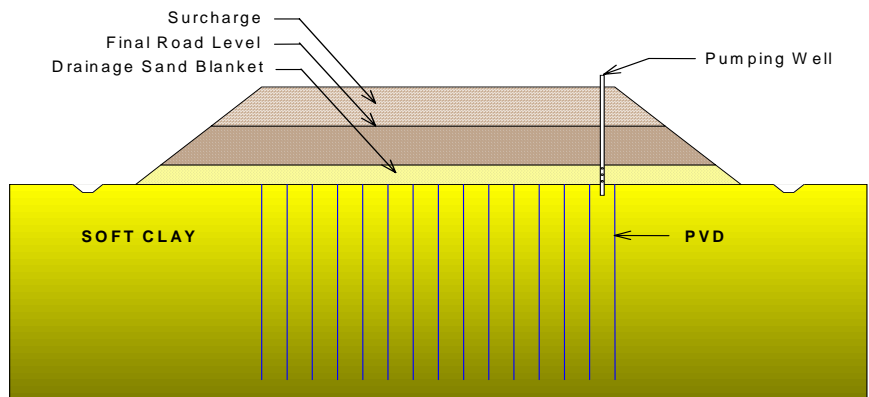
PVDs with surcharge as pre-loading method has been successfully applied in various projects. PVDs are typically used as ground improvement system in -

- Construction of road, railway, embankment, airport and ports
- Industrial projects
- Land reclamation projects

CHARACTERISTICS OF PVD

PVD is a prefabricated material consisting of a plastic core covered by synthetic geotextile "filter jacket". Two main components of PVD serve the following functions;

- Core serves as a longitudinal flow path along the drain
- Filter jacket allows water to pass into the core while restricting intrusion of soil particles



Application of PVD with surcharge loading for ground improvement work of road embankment

EQUIPMENT

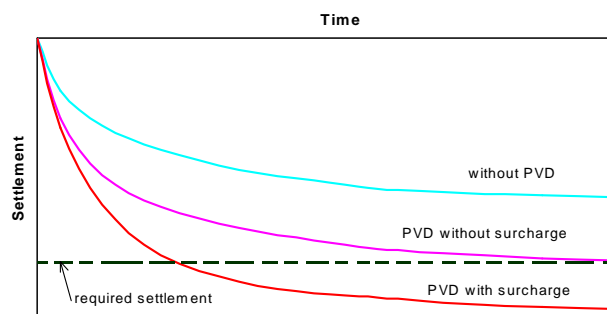
PVD installation equipment can be developed to suit the soil condition, installation depth, specified scope of work and required production rate. Technical data of typical medium-sized PVD installation equipment and accessories are shown below.

Installation Rig

Type of Base Machine	: Excavator of suitable model CAT EL200B or larger model
Size (CAT EL200B)	: 3.18m x 4.45m
Weight (CAT EL200B)	: 20 ton
Pushing Force	: 5.5 – 20 ton
Mandrel Lifting and Pushing	: Hydraulic gear drive
Mast Height	: 8m

Typical Mandrel Dimensions

Weight of Guide and Mandrel	: 1.5 to 4 ton
Length of Mandrel	: 12 to 20m
Cross-sectional Area of Mandrel	: 60 to 70 cm ²
Maximum Installation Depth	: 11 to 19m

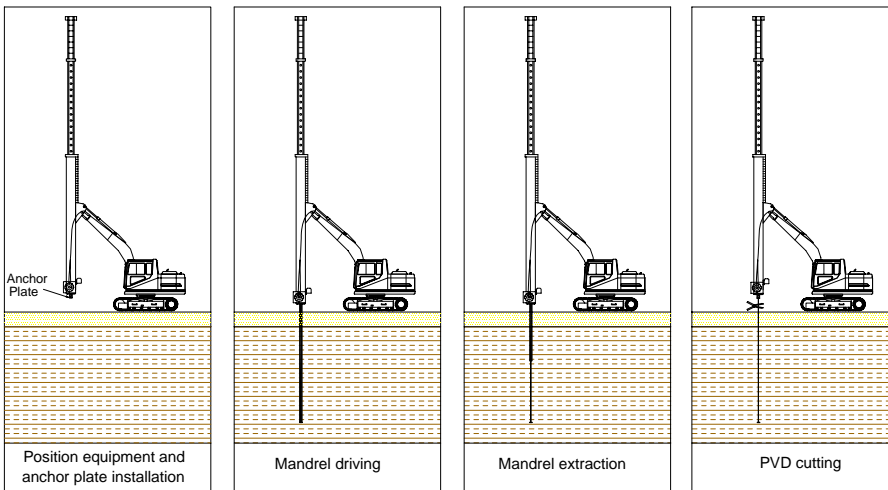


Time settlement curve of soft clay showing significant time reduction achieved by applying PVD with surcharge loading



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Installation sequence

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LAYOUT CONFIGURATION AND DRAIN INFLUENCE ZONE

PVDs are installed in either square or triangular patterns. A square pattern is more simple for setting out in the field. Triangular pattern however provides more uniform consolidation between drains.

Relationship of drain influence zone (D) to drain spacing (S) can be expressed by;

For square pattern $D = 1.13 S$

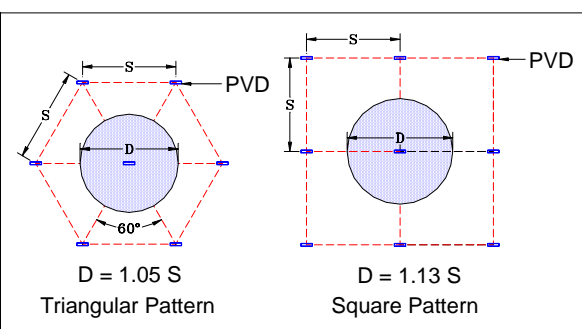
For triangular pattern $D = 1.05 S$

QUALITY CONTROL IN INSTALLATION

- Use appropriate size of Mandrel and anchor plate to minimize soil disturbance
- Use Mandrel with adequate stiffness to maintain verticality
- Apply appropriate penetration rate to avoid significant bending
- Check verticality during installation



PVD equipment in operation



Typical PVD layouts and drainage influence



Close-up view of PVD installation

QUALITY CONTROL TEST FOR PVD MATERIAL

- Apparent opening size
- Puncture resistance
- Burst strength
- Trapezoidal tear strength
- Grab tensile strength
- Discharge capacity (plain and triaxial)
- Density of filter fabric



Reference:

- Hansbo, S. (1993), "Band Drains", Ground Improvement, Blackie Academic Professional, U.K
- Center for Civil Engineering Research and Code (1996), Building on Soft Soils, A.A. Balkema, Rotterdam, The Netherlands