

## **Prefabricated Vertical Drain(Pvd)**

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**Abstract:-** At times, engineers are required to build on sites containing soft compressible soils in the construction of buildings, infrastructures and other structures. In such instances, it would be necessary to improve the soft compressible soils before constructing any structures on them. In saturated soils such as clay and silty clays, which have a large percentage of voids or pores usually filled with water, large settlements will occur over a long period of time.

During this process called consolidation, the load is gradually transferred to the soil particles as the volume of the voids are reduced and this culminates in the form of settlement.

Presently, there are various methods available to improve the soft compressible soils. Soil improvement with Prefabricated Vertical Drains (PVD) or sometimes known as wickdrains, is among the most economical method to expedite the consolidation process.

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### **I. PVD A SOLUTION FOR SLOW CONSOLIDATION CONSOLIDATION**

occurs very slowly in saturated, fine grained soils 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 many years because of this slow water movement and the great distance the water must move to exit the soil. Without some sort of soil treatment construction is usually impractical due to unpredictable long-term settlement. To achieve rapid consolidated settlement it is necessary to create shorter paths for movement of the water.

### **II. THE SOLUTION**

Since early 1970s prefabricated vertical drains (commonly called PVD, band drains or wick drains) have been used all over the world to accelerate the consolidation of fine-grained soils. In India also PVDs have been used in several projects especially in ports and infrastructure projects in coastal areas. The installation of PVD creates artificial drainage paths, thereby reducing the distance the water must travel to exit the zone of ground subjected to excess pore-pressures and thus greatly accelerating the consolidation rate.

### **III. INSTALLATION OF PVD**

A vertical drainage system can be installed in order to accelerate the consolidation process and help to improve discharge of excess pore pressure in the sub soil. In this way, a stable situation is reached more quickly, thus shortening the filling time dramatically. At the same time, the settlement process is accelerated to such an extent that earthwork finishing off processes can be started earlier. All of this results in a substantially shorter construction time which may be important both economically and socially.

The installation of vertical PVC drains is usually done with the aid of a dragline fitted with tams along which the lance can move up and down vertically. The length of drain to be installed determines the minimum length both of the equipment and of the lance. The drains are wrapped around a coil which is placed in a housing in the rig. From there, the drain passes over a travel roller until it feeds into the top of the rig and then via a second travel roller through the lance downwards. Beneath the lance, a small anchor plate is secured to the drain. The lance is then installed to the desired depth either by vibration or with the help of a static pressure and tensioner. Any solid layer encountered can be pre-jetted. The anchor plate ensures that the drain, once to depth, remains at that depth whilst the lance is being withdrawn. The drain is then clipped off above ground level, after which the entire procedure can be repeated all over again at the next drain location. Depending upon soil conditions, the length & width of the drain strip, an output of 2000 to 6000 linear m per eight hour work day per rig can be achieved

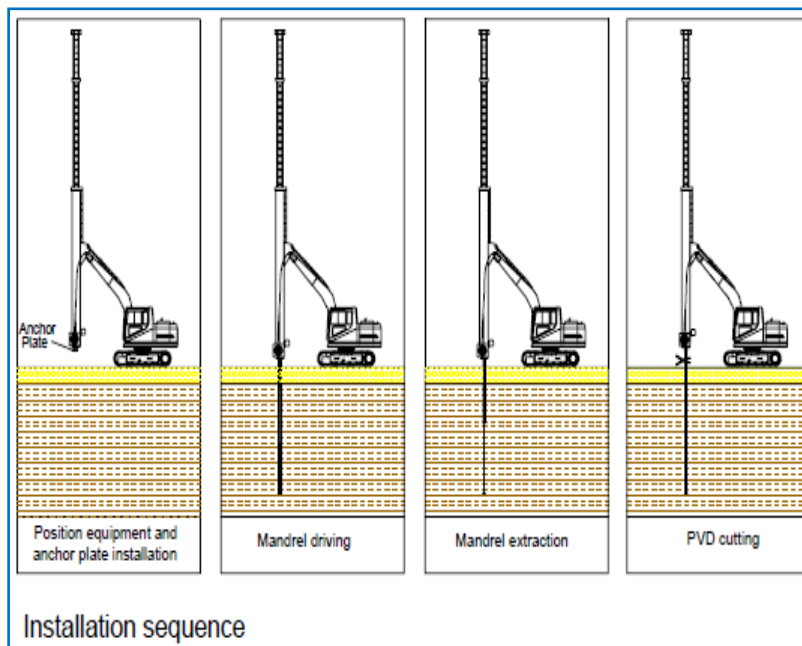
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**Fig. 1 Installation equipment for wick drains.**

### 3.1 Sequence of vertical drainage wick installation

All vertical drainage wicks will go to maximum allowable/anchorable depths or until refusal as per following method :-



Thread the vertical drainage wick off the wick roll/spool, up the wick tube, and over the top wick roller and down through the mandrel.

- b) Place the drainage wick through or around the anchoring device and tuck the loose end of the wick up into the mandrel about 6 to 8 inches (150 to 200 mm). Pull the drainage wick's excess slack tight through the mandrel and vertical drainage wick tube by reversing the vertical drainage wick roll by hand .By reversing the vertical drainage wick spool or wick roll, the anchoring device will retract up tight against the bottom tip of the mandrel. This will prevent dirt or mud from entering the mandrel during the insertion of the mandrel into the ground.
- c) Move the machine/mandrel to the specified vertical drainage wick location and insert the mandrel with anchoring device in place using static force (and /or vibratory force if necessary) into the ground to the desired depth.
- d) Extract the mandrel, leaving the anchoring device and the completed or installed vertical drainage wick in place, uncontaminated and the proper depth.
- e) Cut the vertical drainage wick off the contract-specified length above the working surface.

Check the vertical drainage wick installation machine mast to make sure it is plumb. Use hydraulic controls to correct if not within specification.



**Fig. 2 Installation of drain.**

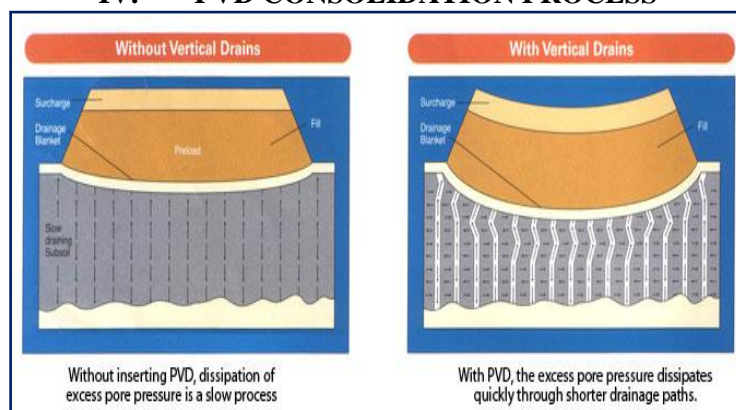
### 3.2 Splicing vertical drainage wick

Vertical drainage wick is supplied on wick rolls. Each wick roll will hold about 1000 ft. of drain or 305 m. Once the wick roll is used off, a splice is necessary to add the next wick roll. To splice, cut the end of the previous wick roll at an angle and stuff it inside the end of the new wick roll. Then staple them both together as shown in figure.



**Fig. 3 Splicing of wick drains**

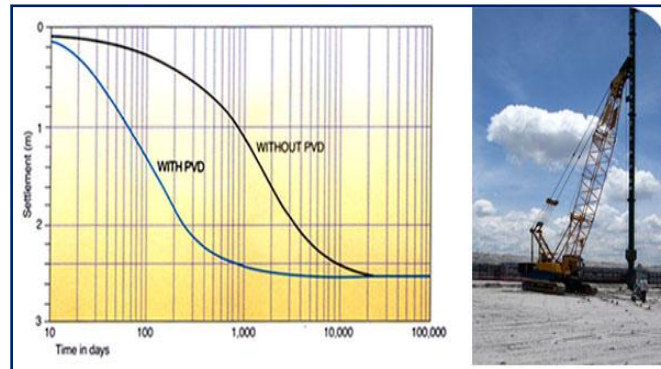
## IV. PVD CONSOLIDATION PROCESS



In saturated soils such as clay and silty clays, which have a large percentage of voids or pores usually filled with water, large settlements will occur over a long period of time when a load such as a road embankment is placed on top of the soil. The load will result in an initial increase in porewater pressure which will dissipate slowly as the porewater drains off.

During this process called consolidation, the load is gradually transferred to the soil particles as the volume of the voids are reduced and this culminates in the form of settlement.

#### 4.1 ACCELERATION OF CONSOLIDATION USING PVD



Due to the very low permeability of clay soil and silty clay soil, the consolidation process will take many years. In order to accelerate and reduce the consolidation time, vertical drains are installed at regular close spacing to the full depth of the compressible layer, to create artificial and shorter horizontal drainage paths for the pore water to drain off. In addition, this will also take advantage of the higher permeability of the soil strata or sand lenses in the horizontal direction. During this accelerated process, the soil will gain an increase in shear strength.

### V. WORKING OF PVD AND ITS MAKE

#### 5.1 How does PVD work?

By installing PVDs at a suitable spacing, the distance that water has to travel through the low permeability soil is reduced considerably and consequently water drains out in a relatively very short period of a few weeks or months.

Band drains can be installed vertically to depths exceeding 65 metres. The drains are usually placed in a square or triangular configuration of 1 to 1.5 m depending on the desired consolidation time. Under excess hydrostatic pressure, water has only to travel the horizontal distance to the nearest drain to reach a free drainage path. Consequently, the higher horizontal permeability of the clay is also taken to advantage. The water flows through the filter fabric of the drain and into the channels of the drain core where it can flow vertically out of the soil. This flow may be either up or down to intersecting natural sand layers or to the surface where a sand drainage blanket or prefabricated strip drains are provided.

Vertical drains are normally used in conjunction with preloading with surcharge embankment or vacuum pressure.

#### 5.2 Prefabricated Vertical Drains (PVD)

Prefabricated vertical PVC drain can be defined as any prefabricated material or product consisting of a synthetic filter jacket surrounding a plastic core. Because of their shape, they are also known as **band** or **wick** drains. They are manufactured in rolls of 200-300 m and are inserted into ground to required depths using special drain stitcher rigs. Generally, installation takes place up to full depth of compressible soils. PVDs have replaced conventional sand drains for soil consolidation due to their easy & speedy installation and unlike sand drains, they act as a integral unit during the process of consolidation.



#### Prefabricated PVC wick drain

#### 5.3 Components of Vertical PV Drains

There are two components of pre-fabricated PV drain namely, core and filter jacket. By combining the features of both core and filter jacket, pre-fabricated PV drain system provides effective, fast and reliable performance for soil improvement.

### **5.3.1 Core**

It is also called drain body which is a unique, corrugated, flexible and made of polypropylene specifically designed to provide high discharge capacity, high tensile and compressive strength.

### **5.3.2 Filter jacket**

It is strong and durable non-woven, thermally bonded polypropylene fabric wrapped around the core. The fabric is of random texture having high tensile strength, high permeability and effective filtering properties. It acts as a filter to allow passage of ground water into the drain core while eliminating movement of soil particles and preventing piping. It also serves as an outer skin to maintain the cross sectional shape and hydraulic capacity of the core channels.

## **VI. BENEFITS OF USING PVD**

- High water discharge capacity to ensure sound safety factor
- The unique and flexible core will not pinch off or flatten when the drains bend and folds during the consolidation of the soils
- High compressive strength of the core to prevent the collapse of the flow path
- Deep installation exceeding 40m depth
- Light weight
- Customized core and filter jacket to suit particular soil conditions
- Minimum disturbance to the soil during installation
- Fast installation
- Short consolidation period
- Well proven performance in many projects under different soil consolidation.

Geoworks PVD has been supplied and installed in various countries in Asia. The type of projects where it has been used successfully are:

- Construction of roads, highways and expressways
- Treatment of ex-mining areas for housing development
- Container yards and harbor construction
- Land reclamation for the construction of airport runways and buildings
- Construction of tank farms
- Commercial development of ex-agriculture land.

## **VII. CONCLUSION**

The technology surrounding the use and application of prefabricated vertical drain is continually growing. The concept of vertical drainage utilizing prefabricated drains has been applied to many non-traditional applications.

The performance of embankments constructed using prefabricated vertical drains (PVDs) and geosynthetic reinforcement has been theoretically examined. A tentative design procedure has been developed to consider the benefits arising from the use of both PVDs and reinforcement. The following conclusions are based on the analyses reported herein. Partial consolidation of the foundation soil during embankment construction is significant because of the drainage improvement provided by prefabricated vertical drains and foundation soils usually become normally consolidated at the end of embankment construction. Consequently, the shear strength gain of soft foundation soil due to partial consolidation can substantially improve the stability of embankments such as those examined. The rate of increase in shear strength of foundation soil is a function of construction rate for a particular reinforced embankment and PVD system. Where PVDs are installed, the strength gain is relatively uniform throughout the thickness of the deposit and can be reasonably predicted using the proposed method. For a foundation installed with PVDs, the embankment design based on assuming undrained conditions and neglecting the shear strength increase in the foundation soil during construction is too conservative.

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