Use of Geosynthetics in Construction Industry

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Infrastructure Development

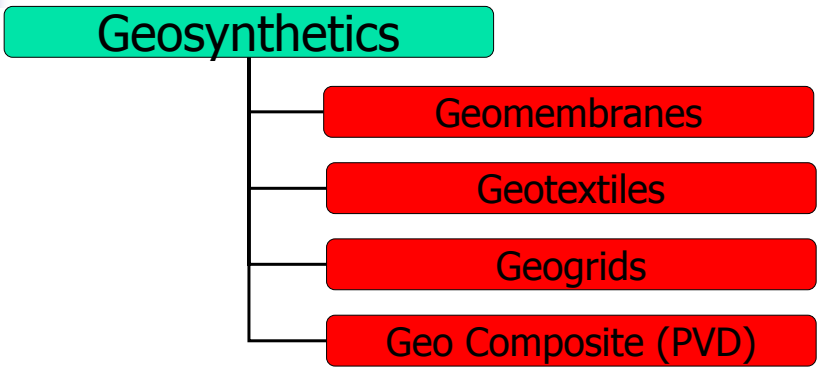
- Today Infrastructure is developing very fast.
- This demands the use of new techniques which will –
  - Time Saving
  - Economic
  - Easy to construct

USE OF GEOSYNTHETHIC HELPS US TO PROVIDE METHODS TO COPE UP SUCH REQUIEMENTS .

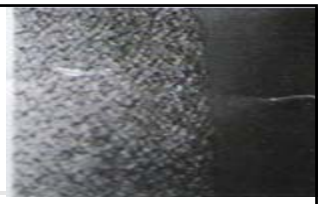
Geosynthetic

- A planar product manufactured from polymeric material used with soil or earth as an integral part of a man-made project, structure, or system.

Geosynthetics – Most Widely Used



Geomembrane



- Made up of HDPE / LDPE
- Used for
  - Water Conservation Projects
  - Water Transport Projects
  - Waste Treatment Projects
  - Landfill Projects (Dumping Ground Rehabilitation Projects)

Geomembrane

- Water Conservation Projects
  - Agricultural ponds.
  - Decorative Ponds.
  - Fire Water Holding Ponds
  - Raw Water Reservoir and Lakes
  - Industrial / Agricultural Reserve Water Storage
  - Golf Course Water Reserve In Contour Lakes

Geomembrane

- Water Transport Projects
  - Canal Lining
  - Drainage Lining
  - Embankment Protection Liner
  - Bio-hazard Collection and Treatment Pond

Coffer Dam

Dam Waterproofing

Swimming Pool

Decorative Pond

Storage Water Tank

Dam Waterproofing

Waste Water Tank

Canal Lining

Dam Waterproofing

Geotextiles

- Woven Geotextiles
  - Used mainly for Reinforcement Function
  - Hence usually made up of Polyester due to High Strength and low creep Characteristics
- Non-Woven Geotextiles
  - Used mainly Drainage & Filtration Purpose
  - Usually made up of Polypropylene

Woven Geotextiles

- Though used as Separator and Drainage Woven Geotextile are mainly used for Strengthening or Reinforcement Purpose.
  - New Roadways / Car Parks / Industrial Units
  - As an erosion control layer under heavy rock armor in coastal defense projects.
  - Reinforced Soil Walls
  - As Basal Reinforcement for embankments on soft soils
  - As Filter layer for Artificial Sports Surfaces or all weather horse riding areas

Woven Geotextiles

Basal Reinforcement for embankments on soft soils

Reinforced Soil Walls

Artificial Sports Surfaces

Non-Woven Geotextiles

- Non-woven Geotextiles are used for filtration, separation and drainage for various applications as –
  - As Separation preventing the intermixing of two dissimilar soil layers
  - As filter surround in the trench drain construction or granular drainage blanket
  - For filtration by allowing the fluids to pass and preventing the passage of soil

Non-Woven Geotextiles

Under railway tracks & in trench drains

As Separation preventing the intermixing of two dissimilar soil layers

Geotextiles - Selection

- Important Properties of Woven Geotextiles
  - Strength - Depending on the loads and allowable elongations
- Important Properties of Non-Woven Geotextiles
  - Permeability - Depending on the rate of Fluid Flow
  - AOS - Depending on the soil particle size

Geogrids

- Uni-axial Geogrids
- Bi-axial Geogrids

Uni-Axial Geogrids

Mainly Used for Reinforcement Walls & Embankments as –

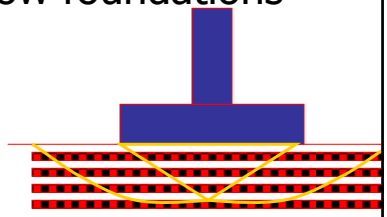
- Slope reinforcement
- Retaining wall reinforcement
- Vegeted retaining walls
- Landfill expansion projects
- Railway embankments

Uni-axial Geogrids

Reinforced Earth Walls

Bi-Axial Geogrids

- Function of Geogrid is to uniformly distribute the loads to the underlying weak strata of low SBC.
- As Reinforcement below the Roads
- As Reinforcement below foundations



Geogrids - Selection

- Selection of Geogrid depends on its function
- Important Properties of Geogrids
  - Strength - Depending on the loads and allowable elongations
  - Creep characteristics

Geo-composites

Prefabricated Vertical Drains (PVD)

- This is widely used material for Ground Improvement Techniques.
- The technique is used to advance the consolidation of soft clays / silty clays / silts i.e. to advance the post construction settlements prior to commencement of the actual working loads.

Prefabricated Vertical Drains (PVD) - Applications

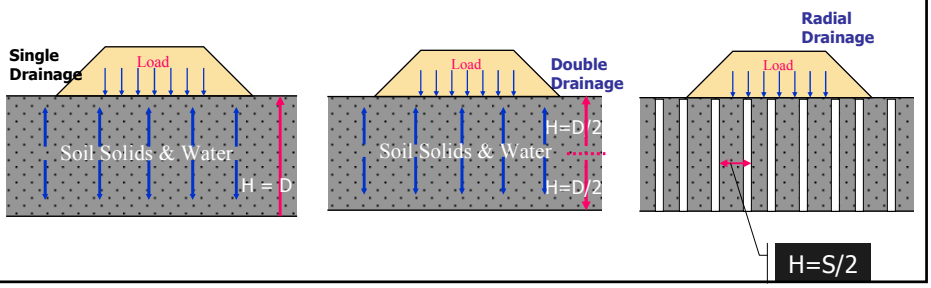
Extensively used in Areas –

- Ports
- Airports
- Highways
- Railways
- Stack-yards

Principle of technique – Consolidation / drainage Path

- $t = T_v \times H^2 / C_v$

where, t = time for consolidation
H = drainage path
T_v = time factor = $C_v \times t / H^2$
C_v = coefficient of vertical consolidation



Time Period Using PVD

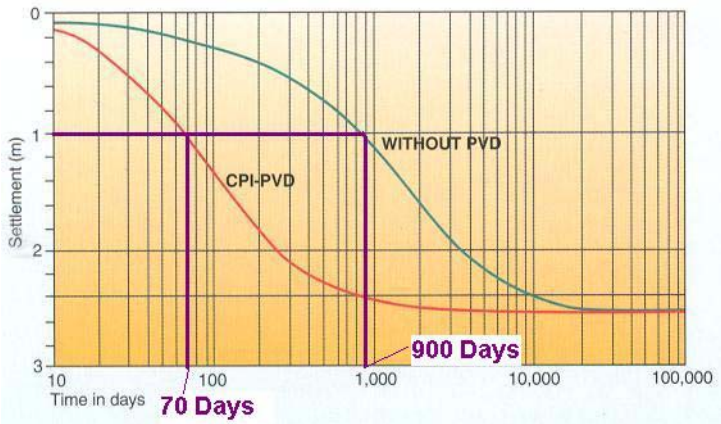


Fig. Accelerated Consolidation Using Vertical Drains

Prefabricated Vertical Drains (PVD)

- PVD's band shaped (rectangular shaped) material consisting synthetic geotextile jacket surrounding inner plastic core.
- Jackets are of non woven polyester or polypropylene geotextile.

Functioning of Drain

Functions of filter jacket-

- To prevent soil particles and allow water to flow in
- To provide the cover to internal drain flow

  i.e. function of filter jacket mainly filtration, to some extent separation

Functions of the core-

- To provide internal flow path for water along the drain
- To provide support to filter jacket
- To provide the resistance to longitudinal stretching as well as buckling of the drain

Physical Properties of PVD

- Weight of Drain
  - Weight of band drain does not have any impact on design aspect.
  - Weight or mass per unit length related to stiffness of filter.
  - This property important when geotextile is to lay on very soft soil whereas PVD mechanically pushed into soil.

Properties of PVD

- Grab tensile strength & elongation of filter and drain
  - Tensile strength of filter and drain adequate to sustain tensile load applied to drain during installation.
  - Filter and drain shall have tensile strength of 0.50 KN at 10% elongation.
- Pore size of filter
  - Important to prevent soil particles and allow water to flow in
  - Hence apparent opening size or O95 of filter ≤ (2 to 3) D85
  - Hence O95 specified as maximum 75 μ.
  - Soil particles may sometimes be trapped in filter and clog it.

Properties of PVD

- Permittivity of filter
  - Water to flow from soil to filter, permeability of filter shall be greater than soil.
  - Normally considered that permeability of filter ≥ 10 times permeability of soil.

Properties of PVD

- Discharge capacity of drain (straight)
- Discharge capacity of drain (buckled)

- Generally PVD is tested for the above properties. However for proper evaluation; sufficient data shall be available for Discharge Capacity of band drain tested along with clay.

Discharge Capacity

- Discharge capacity depends on –
  - Lateral stress
  - Deformation of drain
  - Hydraulic gradient
- Discharge capacity of drain decreases with increase in lateral pressure. This is due to reduction in cross-section as drain compressed under pressure and filter penetrates into drain groove.
- During Consolidation of clay, drain deforms or buckles inside soil. Buckled drain smaller discharge capacity compared to straight drain.
- Discharge capacity smaller when hydraulic gradient higher.

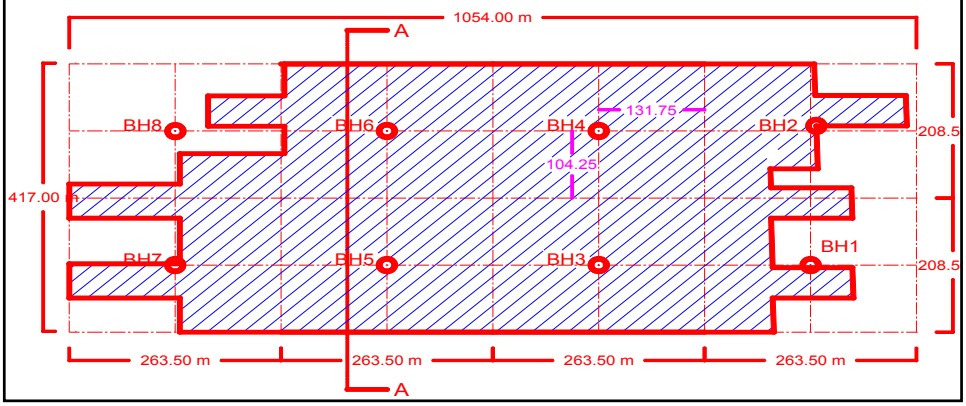
Case Study

- Client : **Gangavaram Port Ltd**
- Project

  Development of backup facilities for Port
- Location : **Visakhapatnam, AP**

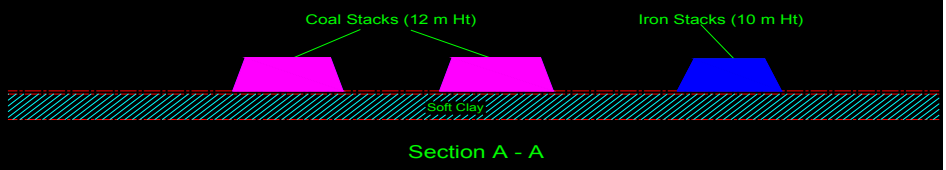
Project Details

Area = 1054 * 417 ~ 435000 sqm



Project Details

- Loading Details
  - Load Height — **Coal Stack : 12 m**; **Iron Stack : 10 m**
  - Load Intensity : — **10 ~ 25 T/m²**



Section A - A

Project Details – Sub Soil Conditions

Depth of Soft Clay :
8 ~ 10 m

Natural Mositure Content : 80 %
Liquid Limit: 78 %
Plastic Limit : 38 %
Density : 1.40 g/cc
Cohesion: 1.50 T/sqm
Friction NAgle : 00 Deg
Compression Index : 0.70
Initial Void Ratio: 1.80
Coefficient of Consolidtaion: 1.60 m2/year

Project Details – Sub Soil Conditions

- Shear Strength of Soil or Safe Bearing Capacity : **6 ~ 7 T/m²**
- Time required for 90% consolidation without Treatment : **42 years**
- Settlements : **700 - 800 mm**

Ground Treatment using PVD

- PVD Material Properties
  - Weight : **70 gms**
  - Filter Grab Tensile Strength : **600 N**
  - Filter Elongation : **25 %**
  - Filter AOS : **< 120 microns**
  - Permittivity : **0.50 s^{-1}**
  - Discharge Capacity of Drain : **90 x 10^{-6} m^3/s**

Ground Treatment using PVD

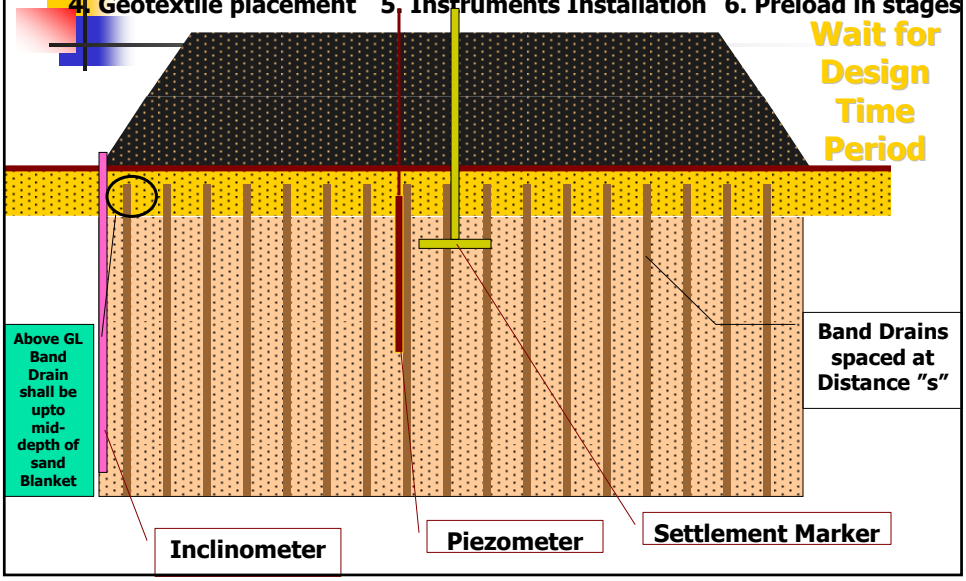
- PVD Scheme Details
  - Spacing :
    Below Stacks: 1.00 m c/c Triangular
    Other Area: 1.50 m c/c Triangular
  - Pre-load Applied :
    4.00 – 4.20 m Height
  - Observed Settlements :
    450 – 600 mm

Execution of Ground Improvement By PVD with Preload

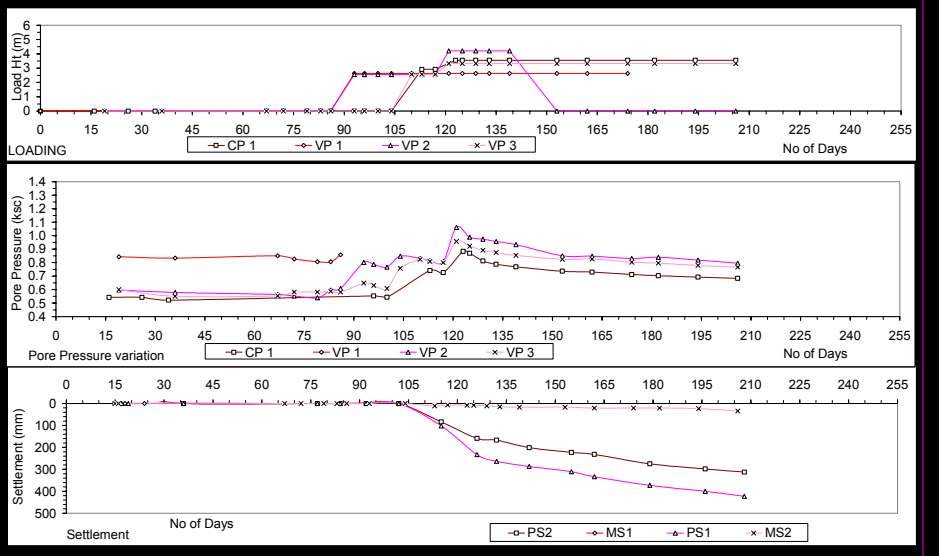
- Site preparation
- Installation of working platform
- Drain installation
- Drainage blanket

BAND DRAINS WITH PRELOAD

1. Marking of Points
2. Installation of PVD
3. Sand Blanket
4. Geotextile placement
5. Instruments Installation
6. Preload in stages



Ground Treatment using PVD



THANK YOU