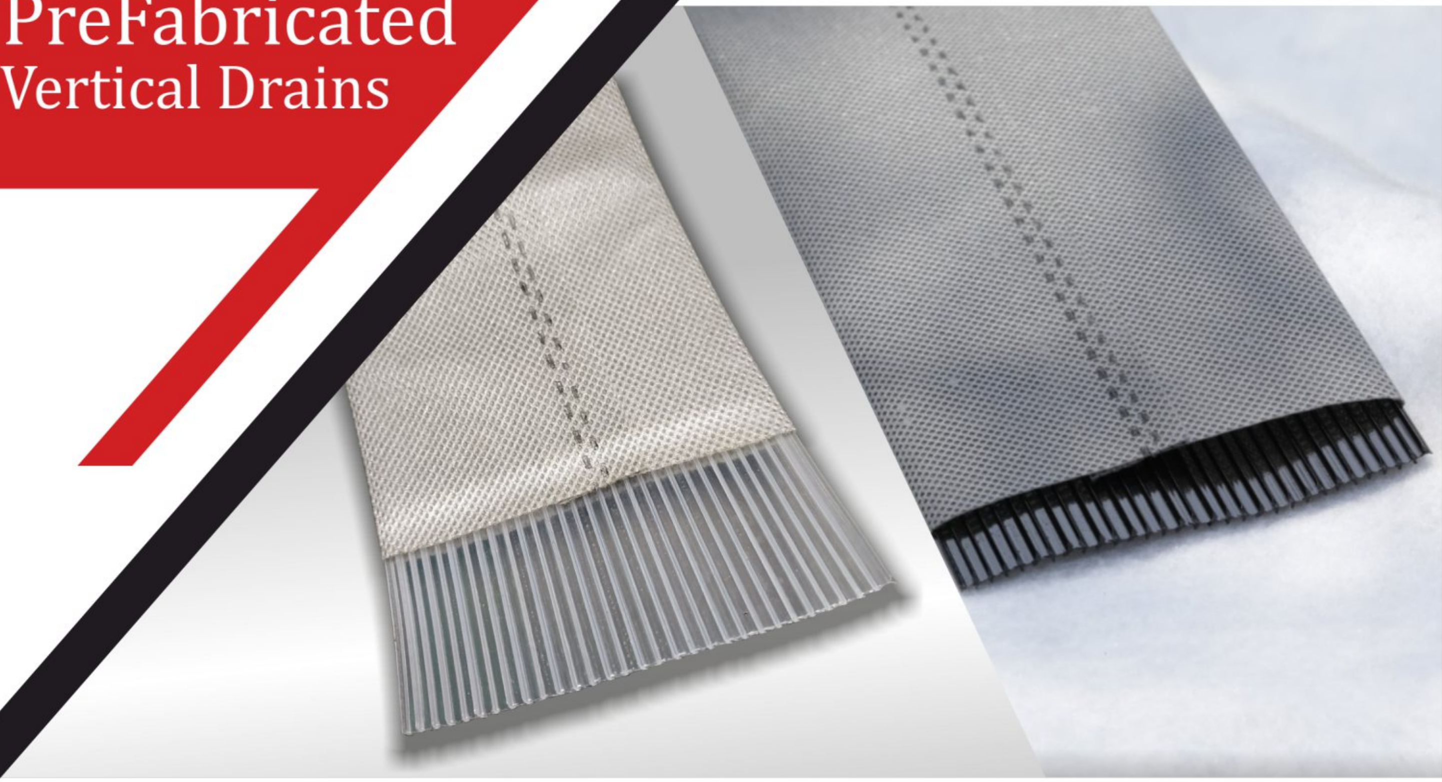
TECHFAB INDIA

At the heart of geosynthetic activity

TechDrain
PreFabricated
Vertical Drains

TechDrain
PVD



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Range of Products of TechDrain PVD

- High Performance PVD which can be installed > 30 meters depth
- Having Tensile Strength > 7 kN/m
- Core structure can be Corrugated type & Fish Bone type
- TFI team can design and supply PVD product as per client site requirements or project specific technical specifications
- Manufacturing Capacity 162 million linear meters per annum

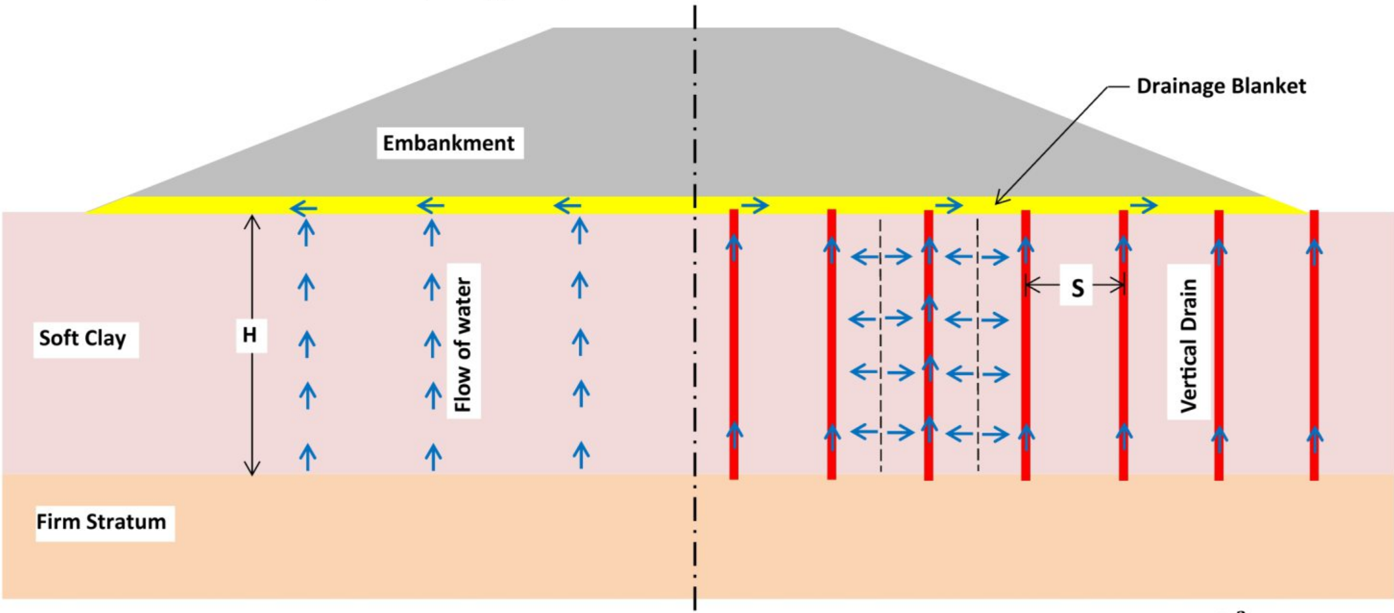
Loads applied on saturated soils are initially resisted by an increase in pore-pressures within the soil. With time the water flows out from the loaded zone to the surrounding regions and the excess pore-pressures are dissipated and the soil consolidates and settles. In the case of coarse-grained soils like sands and gravels with high permeability the process of consolidation is very fast. However, in the case of fine-grained soils like silts and clays which have low permeability, consolidation is slow and it could take several years or decades.

The slow progress of consolidation in fine-grained soils has two major implications:

- When external loads are applied, total stresses and shear stresses within the soil increase. However, effective stresses and shear strength of the soil remains same and hence factor of safety with respect to shear failure is low. With time as consolidation progresses, shear strength increases and factor of safety improves. However, if during or at the end of construction, the shear stresses become equal or more than the shear strength, a shear failure will occur. Failure could be bearing failure, deep seated rotational failure, lateral sliding or lateral extrusion of soft soil.
- Very little consolidation occurs during the construction period and hence bulk of the settlement will happen after the construction of the structure or facility is completed. Large magnitudes of post construction settlement could damage the structure or facility and affect its serviceability.

Vertical Drains :

The time required to achieve a certain degree of consolidation in a fine-grained soil stratum is directly proportional to the square of the length of the drainage path and inversely proportional to the coefficient of consolidation. Vertical drains can be used to accelerate the consolidation process by reducing the distance through which water has to flow within the soil with low permeability. In addition, the flow is predominantly in the horizontal direction and for many soils the horizontal coefficient of consolidation (c_h) is appreciably higher than the vertical coefficient of consolidation (c_v). Thus, by installing vertical drains at sufficiently close spacing, the process of consolidation can be accelerated.



Time for consolidation, $t \propto \frac{(H)^2}{c_v}$

Without Vertical Drains

Time for consolidation, $t \propto \frac{\left(\frac{S}{2}\right)^2}{c_h}$

With Vertical Drains

The use of vertical drains to accelerate consolidation of fine-grained soils has a history of almost 100 years starting with the introduction of sand drains in the 1920s and subsequent development of cardboard wick drains in the 1930s and 1940s. Large scale use of pre-fabricated vertical drains (PVDs) or band drains with a polymer core and a polymer geotextile filter jacket started in the 1980s.

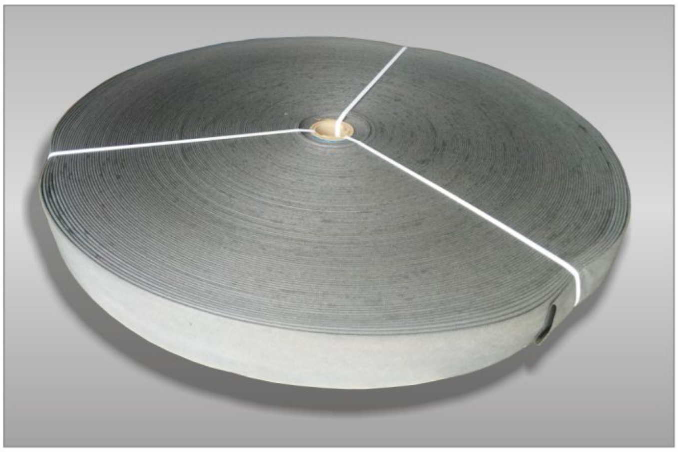
TechDrain PVD is a band shaped geocomposite comprising an inner polymer drainage core which is enveloped by a geotextile filter jacket or sleeve. The core is a solid extruded polymeric corrugated profile with excellent dimensional stability, tensile strength and discharge capacity. The geotextile filter jacket/sleeve is a nonwoven geotextile with superior mechanical and hydraulic characteristics with the edges joined by special ultrasonic welding.

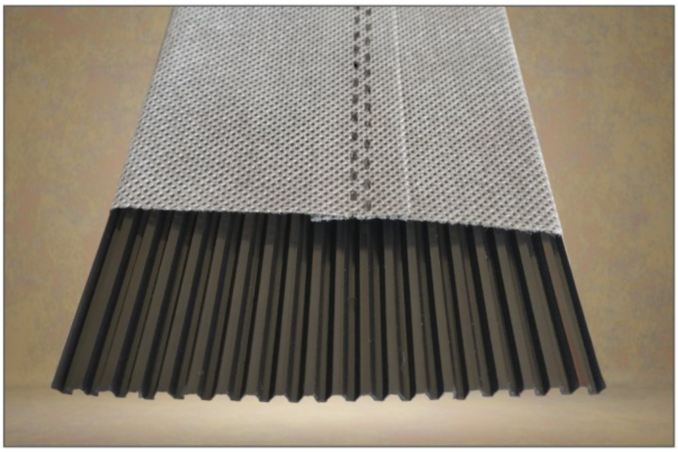
The primary function of the core is to convey the water entering into the core from the surrounding soil through the filter jacket, to the ground surface or to pervious strata below the fine-grained soil stratum. The most important property of the core is its discharge capacity. The large lateral stresses imposed by the soil tend to compress the core and reduce its discharge capacity. As the soil stratum consolidates, relatively large settlements may occur and the PVDs may get folded or kinked. Even in the deformed condition, the core should have the required discharge capacity and should continue to function effectively.

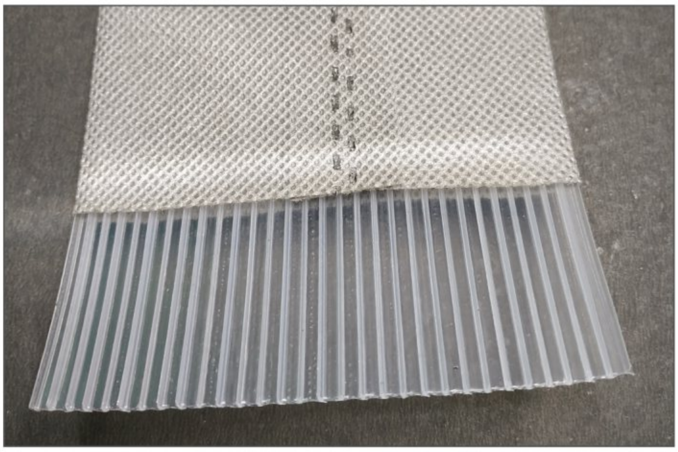
The geotextile jacket/sleeve prevents the surrounding soil from squeezing into the flow channels of the core and also serves as a filter which retains the soil particles and allows water to flow across. The geotextile should have suitable mechanical and hydraulic properties to efficiently perform these functions. The seam should have sufficient strength to resist the stressed applied during installation and when the PVD is deformed during consolidation of the soil.

Both the core and geotextile jacket should be able to withstand the tensile and shear stresses imposed during installation. The core, the geotextile and the seam of the geotextile jacket should not break, tear, abrade or deform excessively during the installation.

TechDrain is engineered to easily survive the rigors of the installation and to retain its integrity and ensure adequate discharge capacity even when it is subjected to large deformations as the soil strata consolidates and settles. The performance of the product has been proven through its outstanding performance in numerous challenging projects worldwide.







Materials and Manufacturing :

TechDrain PVD is manufactured at TechFab India's state-of-the-art, **ISO 9001:2015** certified plant in Daman, using high quality materials and advanced processes. The core is manufactured from select grades of polypropylene. The configuration of the core is designed to ensure high dimensional stability, high compressive strength and excellent discharge capacity even under high compressive stresses and in a deformed condition.

The filter jacket is made of a polypropylene or polyester nonwoven geotextile with a superior combination of mechanical and hydraulic properties. The geotextile has high stiffness to minimize the intrusion of soil into the flow channels of the core and high tensile, tear and puncture strength to resist the stresses during installation. The geotextile has high soil retention capacity and excellent permeability and clogging resistance.

In-house Quality Control Testing :

The raw materials and finished products are regularly tested in our state-of-the-art in-house quality control laboratory which is accredited by the ***National Accreditation Board for Testing and Calibration Laboratories (NABL)*** and the ***Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP)***. The laboratory has facilities for conducting all tests which are required for PVD including discharge capacity in crimped condition.

Certifications and Testing at Independent Laboratories :

TechDrain PVD has ***CE certification*** for factory production control. The properties of TechDrain has been verified by testing at reputed independent accredited laboratories like ***SAGEOS Canada and Singapore Laboratory Services***.

CERTIFIED BY :

TESTED AT :

Proven Performance :

The excellent performance of TechDrain PVD has been consistently proven in a large number of ground improvement projects wherein millions of linear meters of TechDrain have been installed.

Acceleration of consolidation using PVDs is one of the most cost-effective methods of ground improvement for relatively weak and compressible silts and clays. PVDs do not reduce the settlements, but only accelerates the settlement. The idea is to minimize the post construction settlement. As the soil consolidates, the shear strength also increases.

Two approaches are most commonly used :

- Consolidate the ground under a temporary preload and then construct the structure
- Construct the structure in stages allowing sufficient time for consolidation between the stages

The first approach is used in the case of structures which cannot tolerate large settlements like light buildings, storage yards etc. Here the PVDs are installed to the required depth and at the designed spacing. A temporary preload which is equivalent to the load which would be imposed by the structure is applied on the ground. Once the desired degree of consolidation is achieved the temporary preload is removed and the structure can constructed or permanent loads can be applied.

In the case of earth structures like embankments etc. which can tolerate relatively large settlements, the PVDs are installed and the embankment constructed in stages. The height of embankment which can be constructed in the first stage is decided based on the shear strength of the ground. Sufficient time is allowed for the dissipation of the excess pore-pressures and once the desired degree of consolidation is achieved, then next stage is constructed. Often it is possible to reduce the number of stages by using basal reinforcement techniques (e.g. using TFI 3000 High Strength Polyester Woven Geotextiles). Additional temporary surcharge may be applied to compensate for the effects of traffic live load in the case of highway and railway embankments

Applications of TechDrain PVDs

- ***Roads:*** Highway embankments including approaches to bridges, flyovers, ROB's and underpasses
- ***Railways:*** Railway embankments including approaches to RUB's and rail flyovers
- ***Ports:*** Land reclamation, storage yards, container yards, heavy duty roads and paved areas
- ***Power and Heavy Industry:*** Site filling and development on soft ground
- ***Land Reclamation:*** Near shore and offshore land reclamation for air ports, terminals, artificial islands and other facilities.
- ***Liquefaction mitigation***

Design of Ground Improvement using TechDrain PVD

- The first step in design is a through geotechnical investigation to evaluate the subsurface conditions including sequence and thickness of soil strata, undrained shear strength, compressibility characteristics and the horizontal coefficient of consolidation (ch) of the fine-grained soil strata.
- Based on the loading applied by the structure and subsurface conditions, stability and settlement analysis is carried out to assess the need for ground improvement.
- The depth of PVD is decided based on the depth of the influence zone of the structure and the thickness of the weak/compressible soil stratum.
- The spacing of the PVD is decided based on the time available for consolidation and the value of (c_h). Minimum spacing of PVD has to be limited based on considerations of smear. PVDs are usually installed in a square or triangular pattern.
- The type of PVD is selected based on the depth of installation and type of soil.
- The stage construction sequence is an important aspect of design. The allowable loading for each stage and the waiting period for each stage have to be carefully evaluated based on the subsurface conditions and verified by careful monitoring of the actual performance.
- It may be possible to reduce the number of stages and the construction period by using basal reinforcement. TFI 3000 High Strength Woven Polyester Geotextiles are ideal for basal reinforcement.
- A drainage blanket to collect and drain out the discharge from the PVDs is very important. It is always advisable to provide a geotextile filter below and above the drainage blanket.
- Where there are constraints in applying surcharge by placing fill or where excessive lateral displacements are a concern, use of vacuum consolidation could be considered.

Installation of TechDrain PVD

- A working platform comprising a layer of compacted sand or gravel may be required to support the rigs used for installation of PVD. This can also serve as the drainage blanket which is required to drain out the water flowing out through the PVDs. A geotextile separator/filter is usually provided at the bottom of the working platform / drainage blanket.
- The rig used for installing PVDs comprises a special mast (stitcher) attached to a track mounted excavator or crane. The required capacity of the machine and length of the stitcher depend on the maximum length of PVD to be installed.
- The PVD with an anchor at its end is passed through a mandrel which is attached to the stitcher. The mandrel along with the PVD is pushed into the ground by the stitcher to the required depth. The mandrel is then withdrawn and the PVD is held in place by the anchor. Once the mandrel is fully withdrawn the PVD is cut with a length of about 200 to 300 mm projecting above the drainage blanket.
- The mandrel protects the PVD from damage during installation. It usually has a rectangular or rhombic cross-section. The mandrel should be sufficiently strong and stiff so that it can penetrate to the required depth. At the same time its dimensions should be as small as possible to minimize soil disturbance and smear effects. Anchor may consist of a flexible metal plate or a steel rod.
- Installing the PVD by using continuous static push causes the least disturbance. When it is required to penetrate intermediate layers of stiff materials, vibratory methods may have to be used. When there is a hard crust near the ground surface, pre-boring may be done to facilitate the installation of PVD.
- Once the installation is complete, the portion of the PVD projecting above blanket is folded horizontally. If required additional granular material is placed. A geotextile is placed on top of the drainage blanket and fill is placed and compacted.

Ground improvement using PVDs is a very good example of the observational method of design in geotechnical engineering. At most sites, the soil strata may show appreciable variability and there are significant difficulties in accurate determination of compressibility characteristics of soil. Hence, the magnitude and rate of settlements predicted in the design phase are only approximate estimates.

However, by carefully monitoring the actual progress of consolidation and making suitable adjustments in the stage construction sequence and waiting periods, it is possible to overcome the limitations in design. Hence instrumentation and monitoring should always be an essential component of ground improvement using PVDs. Instrumentation usually include:

- Settlement gauges to measure settlement
- Piezometers to monitor the dissipation of excess pore pressures
- Open standpipes to measure hydrostatic groundwater levels
- Inclinometers to monitor lateral displacements

Why TechDrain PVD?

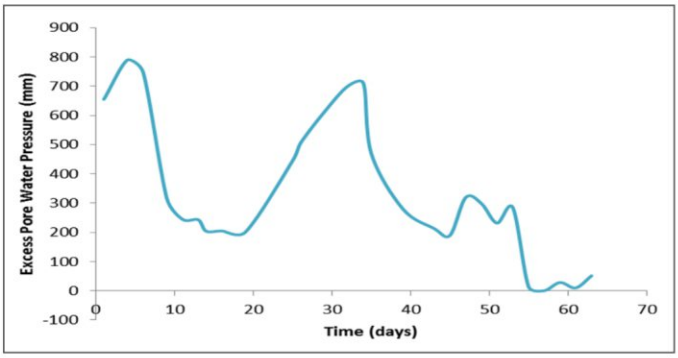
- World-class product from TechFab India Industries Ltd., India's largest manufacturer of geosynthetics
- Range of products to meet site requirements
- Quality assured product tested extensively in our **NABL** and **GAI-LAP** accredited in-house lab and several independent laboratories
- Easy and fast to install even in difficult ground conditions
- Excellent performance proven in large number of projects worldwide
- Large production capacity to meet tight delivery schedules
- Efficient sales, design and technical support
- Complete range of world-class geosynthetics available from TechFab India

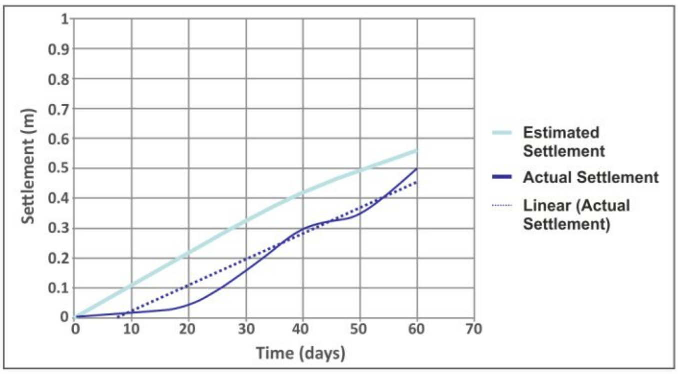
Range of Products of TechDrain PVD

- TechDrain TD-3520U
- TechDrain TD-3540T

TechDrain PVD – ***the most cost effective solution for consolidation of soft ground***

TechFab India – ***the Preferred Geosynthetics Technology Partner for Ground Improvement Projects***



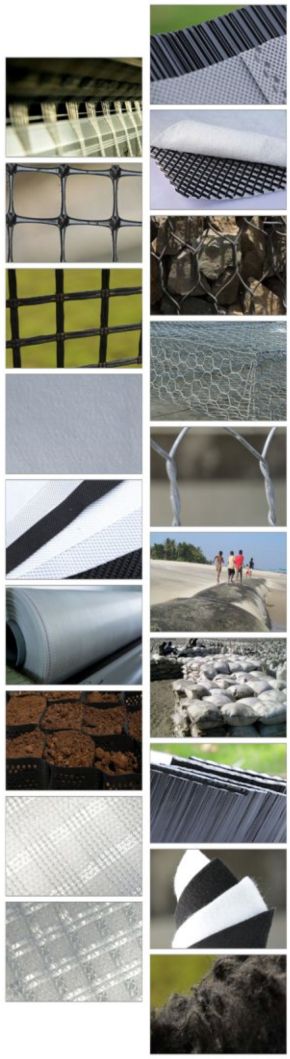


TechDrain PVD supplied extensively in:

- India
- Bangladesh
- Egypt
- Mexico
- Singapore Lab Approved

About TechFab India Industries Ltd

TechFab India was founded in 2003 with the objective of providing world class geosynthetic products and services to serve the needs of manufacturing development in India. From a modest beginning with the setting up of a manufacturing facility for woven geotextiles in Silvassa, we have rapidly grown to become the largest manufacturer of geosynthetics in India. Today, we manufacture a wide range of products at our factories in Silvassa and Daman. Details are as under:



- TechGrid Knitted and polymer coated Polyester Geogrids (CE Marked & BBA Certfied)
- TechGrid-Base Reinforcement Geogrids (CE Marked)
- Techlink
- TechGlass AIC (Asphalt Interlayer Composite)
- TechGeo Needle Punched Nonwoven Geotextiles (CE Marked) AASHTO NTPEP evaluated
- TFI 3000 Woven PET (CE Marked)
- TGC Reinforced Nonwoven
- TechPave Paving Geotextiles (CE Marked)
- TechFab Metal Gabions (CE Marked)
- TechDrain - Prefabricated Vertical Drains (CE Marked)
- TechTube Geotextile Tubes & Bags
- TechDrain Drainage Composites
- TechGrid PP Biaxial Geogrid (CE Marked)
- TechCell GeoCells (CE Marked)
- TechStrap Polymeric Strip (CE Marked)
- Tech Fibre - PP Staple Fibre
- TechGeo Mattress

Accreditation #: GAI-LAP-…-17

TECHFAB (India) Industries Ltd.
Daman

Is granted accreditation for designated geosynthetic test methods in accordance with the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP), as published in its annual directory. This accreditation is valid until June 30, 2021.

Jamie Roth Koerner, General Manager — George R. Koerner, Ph.D., P.E. & CQA, Director

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

TECHFAB (INDIA) INDUSTRIES LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

SURVEY NO.-147/2 & 3,1 & 4, VILLAGE DABHEL, DAMAN, DAMAN AND DIU, INDIA

in the field of

TESTING

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

World-class Geosynthetics Manufactured in India by Techfab India Industries Ltd.													
TFI WovenGeotextiles		TechGrid Geogrids	TGC Reinforced Nonwoven Composites	TechDrain PVDs	TechDrain Drainage Composite	TechGlass AIC	Tech Geo Mattress	TechGeo Nonwoven Geotextile	TechFab Metal Gabion Double twist wire mesh products	TECHTUBE & Geotextile Bags	TechGrid PP Biaxial Geogrids	TechStrap Polymeric Strip	TechCell Geocell
Polypropylene Multifilament	Polyester Multifilament							TechPave					

TechFab In house laboratory is NABL accredited with ISO/IEC - 17025:2017 & GRI-GAI-LAP

TECHGRID | tech glass | TFI Woven Geotextiles | TechDrain PVD | TechCell | TECHSTRAP

TechFab-Metal Gabion | TechGrid PP Biaxial Geogrid | TECHGEO | TECHTUBE | TechDrain DRAINAGE COMPOSITE

TECHFAB INDIA
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