About Us

GEOfabrics Limited is the UK’s leading manufacturer of geotextiles. Since its formation in 1992, millions of square metres of HPS geotextile have been deployed along coastlines and watercourses beneath rock armour and prefabricated concrete units.

The company’s ethos is to continually exceed the expectations of both existing and future customers with innovative and effective products supported by an established technical service. Successful product development is achieved by understanding the customer’s problem, determining the necessary properties and functions that are required, manufacturing the solution and then rigorous quality testing to demonstrate that the product meets those requirements. GEOfabrics has a dedicated and experienced team of personnel that cover both commercial and technical departments and that work in unison to provide the necessary attributes to meet our global challenges.
For many years GEOfabrics have developed and provided a broad spectrum of tailored engineering HPS products that are specifically manufactured to address the many problematic challenges of coastal/river defence and erosion.

**HPS Geotextiles Coastal Applications**

- Artificial Islands
- Beaches
- Bridge Abutments
- Revetments
- River Protection
- Flood Bunds
- Harbours
- Lagoons, Lakes & Reservoirs
- Land Reclamation Offshore
- Wind Generators
- Rock Groynes
- Scour Control
- Submerged Breakwaters
- Coastal Defence

GEOfabrics HPS filter/separators have been designed to provide sustained permeability whilst maintaining structural stability. They provide excellent filtering efficiency, a high level of stress absorption and are highly resistant to abrasion.

**Quality in Manufacturing**

GEOfabrics Limited is the UK’s leading manufacturer of geotextiles. Since its formation in 1992, millions of square metres of HPS geotextile have been deployed along coastlines and watercourses beneath rock armour and prefabricated concrete units. Their use is due to the quality of the products, their cost effectiveness and the comprehensive help provided to design engineers and contractors at every stage of a project.

**Quality in Service**

The HPS products have been designed and are manufactured to meet the most demanding performance levels. Using a modern computer-controlled plant, all products are manufactured in an ISO9001 environment and sampled and tested to the appropriate standards.

Typical primary rock armour revetment installation directly on HPS geotextile. Location: Colwyn Bay.
The insidious effects of wave action and high-velocity water flow are a permanent reminder that the environment cannot be tamed. HPS geotextiles offer long-term protection against erosion in some of the most aggressive environments.

On one hand, storms and flash flooding cause high-profile failures, but a slow-moving, low-level stream is just as capable of undercutting its banks and causing slope instability.

Protection to combat erosion currently tends towards soft and natural solutions including beach nourishment and rock armour, the size of which is determined by the anticipated wave or erosional scour action. Filter layers are required beneath rock armour to prevent erosion of the underlying soil. Otherwise, the armour would progressively drop into the increasing void and its effectiveness would be diminished.

Historically, graduated granular filter layers, with progressively larger grain size, were used to prevent this type of erosion.

Installation was time-consuming and they could be difficult to install, particularly if this involved inter-tidal working.

A high strength HPS geotextile replaces a multilayered stone filter system and is quicker to install when battling the tides.

The environmental impact of importing thousands of tonnes of stone of the required gradings, often with restricted access, and their expense, meant that there was scope for alternative solutions.

Revetments constructed from rock armour or pre-cast concrete units require a filter to prevent mobilisation of underlying soil and to allow the free movement of water in both directions.

Without the ability to provide these functions over the entire life of the revetment, there is the potential for the armour to be undermined, as beach material is progressively eroded, or for a build up in hydrostatic pressure.

Of equal importance is the ability of the HPS filter/separator to withstand the rigours of installation and the in-service conditions. Materials susceptible to puncture, tearing and abrasion would exclude them from consideration.

HPS needlepunched, non-woven geotextiles provide all of the required functionality at the levels demanded for erosion prevention applications.
Coastal and River Defence Systems: Design Guidance

Case Study: Yas Island Race Track Marina, Abu Dhabi, UAE.

- High static and dynamic puncture resistance.
- High elongation to break.
- Superior abrasion resistance.
- Excellent filtration characteristics at all strains.
- UV resistance – 1% carbon black.
- Light weight and easy to handle.

Our established HPS range of materials for construction consists of high performance geotextiles manufactured from high quality, high tenacity, 100% virgin polypropylene fibres.

Oxidation tests indicate in excess of 150 years durability, as demonstrated on our product CE declarations.

With a capability to manufacture up to a maximum width of 6m, GEOfabrics’ HPS needlepunched geotextiles are specified by engineers due to their longevity and proven ability to work in the most demanding installations.
Selecting the Most Appropriate HPS Grade

There is a diversity of geotextile types available. To make the appropriate selection a design engineer needs to match their functions and properties with the requirements of the project, to ensure the selected geotextile is both fit for purpose and will function as intended for the design lifetime.

Permeability

Classic filter rules state that each layer of a filter system must be more permeable than the layer beneath. Similar rules developed for geotextiles suggest a coefficient of permeability 10 to 100 times greater than that of the filtered soil. It is important that the geotextile should maintain or exceed its index permeability whilst under load, i.e. any re-orientation of the fibres should not increase or decrease permeability.

Filtration

The characteristic pore size of the geotextile has to be less than the average grain size of the soil to be filtered in order to prevent loss of material through the geotextile. Established design rules for reversing flow applications and a non-cohesive soil state that the geotextile’s $O_{90}$ should be less than the $d_{50}$ of the soil to be filtered. For a cohesive soil, $O_{90} < 10 \times d_{50}$.

Both the permeability and filtration rules apply factors of safety to allow for reductions in these properties by soil particles clogging within the geotextile. A filter will be regularly flushed if the system is subject to reversing flows, thus minimising any reduction in filtering efficiency.

Static and Dynamic Puncture Resistance

The geotextile must be able to withstand puncture loads imposed during installation and service. The rock weight, its angularity and the drop height all contribute to puncture load. This can be further intensified if due care is not taken during installation. Ideally, it will also possess isotropic (square) tensile properties in order to spread load consistently in all directions.

Elongation

Rock armour functions by virtue of its dead weight being transmitted over as wide an area as possible to consolidate the underlying soil and minimise particle movement. The load imposed on a geotextile by large rock is not evenly distributed. The highest stress concentration will be at the point of intimate contact which in turn will impose high localised strains. The geotextile needs to be sufficiently extensible to enable it to adapt to point loads without puncturing and without loss of hydraulic properties.

Thickness

Thickness is required to cushion potentially penetrating point loads and also to provide a lateral drainage path around any compressed areas. Lateral drainage capacity is defined by the geotextile’s in-plane flow under load.

A needlepunched, non-woven geotextile’s unique set of properties

- Resist sand upthrust between rocks
- High elongation of HPS geotextile under aggressive rock armour loading
- Key function of the armour unit: to surcharge the sand
- Extensibility without puncture
- Intimate contact without spanning allows efficient load transfer to sand
- Lateral drainage (in-plane flow) dissipates pore water pressure
- Dissipates pore water pressure

Classic filter rules state that each layer of a filter system must be more permeable than the layer beneath. Similar rules developed for geotextiles suggest a coefficient of permeability 10 to 100 times greater than that of the filtered soil.
Whilst standard index tests do not exactly simulate the performance of the filter/separator there needs to be some rationale for the specification. HPS geotextiles are manufactured such that the following key properties are maximised for coastal and river applications. A model specification should address the following properties:

- **Water Flow Normal to the Plane**
  Closely linked to permeability. Very important in dynamic, high-flow applications.

- **Pore Size**
  Defines the opening size of a geotextile and its ability to trap particles and prevent their passage.

- **Minimum Tensile Extension**
  Placing rock is potentially the greatest cause of damage and the extensibility of a geotextile is important to avoid localised damage.

- **Static Puncture Resistance (CBR)**
  Simulates the in-situ punching effect of rock, normal to a geotextile, during service.

- **Dynamic Perforation Resistance (Cone Drop)**
  Indicates the ability of a geotextile to accommodate dynamic puncture during rock placement.

- **Coefficient of Permeability**
  Related to the thickness of a geotextile. Expresses water flow as a $k_g$ value allowing comparison with soil values ($k_s$).

- **Tensile Strength**
  Simulates a geotextile’s ability to be handled on-site using heavy excavators. It is common for operators to spread and unroll the geotextile using the bucket of an excavator.

- **Push-through Displacement**
  Simulates biaxial strain caused by rock placed on the geotextile, and the capacity to resist localised damage.

- **Thickness Under Load**
  Ensures that there is a water path beneath the stone allowing dissipation of pore water pressure.
Raw Material

Fabrics can be produced from both post-industrial and post-consumer recycled fibres. Such fibre types can be of different thicknesses, and volume to surface ratios. Some types of degradation, such as oxidation and UV exposure, are dependent on surface area, whilst others such as diffusion and absorption are inversely related to thickness. It is strongly advised that the use of post-industrial/post-consumer fibre is avoided.

Another polymer fibre that is used within geotextile manufacturing is polyester, of which the most common type is polyethylene-terephthalate (PET) which is produced using condensation polymerisation. PET can offer good mechanical properties and is suitable for some applications, however the ester group can be hydrolysed in the presence of water which is accelerated by alkaline conditions such as salt water. Although polyester can have advantages over other polymers the alkaline sensitivity of this polymer through hydrolysis under long-term loadings, should be a major concern in coastal geotextile applications.

GEOFabrics’ HPS range is manufactured from 100% virgin, staple length, high tenacity polypropylene fibres which have a high resistance to acids, alkalis and most solvents. Polypropylene can be considered as inert to acid and alkali attack and is suitable for most geotextile applications.
The Design Mechanism

The type of polymer and the fibre, together with the production process, define the inherent properties of a geotextile. GEOfabrics’ needlepunched, non-woven geotextiles are manufactured using specially engineered fibres and these are bound to each other by mechanical needling.

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Filtration d50 (mm)</th>
<th>Permeability ( k_s ) (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clayey silt</td>
<td>0.02</td>
<td>( 1 \times 10^{-4} )</td>
</tr>
<tr>
<td>Sandy silt</td>
<td>0.02</td>
<td>( 1 \times 10^{-7} )</td>
</tr>
<tr>
<td>Fine sand</td>
<td>0.30</td>
<td>( 1 \times 10^{-5} )</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>0.50</td>
<td>( 1 \times 10^{-4} )</td>
</tr>
<tr>
<td>Mixed sand &amp; shingle</td>
<td>2.00</td>
<td>( 1 \times 10^{-3} )</td>
</tr>
</tbody>
</table>

Design methodology will consider whether the primary armour is to be placed directly or indirectly on the filter/separator. Armour can be placed directly on top of the HPS products so there is no need for an intermediate bedding layer of stone.

Step by Step Specification Procedure

**STEP 1**
Establish the primary armour weight from wave height predictions.

**ROCK WEIGHT EXAMPLE:**
4t Maximum Armour Size.

**STEP 2**
Establish the type and permeability of the underlying soil.

**STEP 3**
Provisionally select an HPS grade based upon its permeability e.g. if soil permeability is \(10^{-4}\)m/s then the grade must have a permeability >\(10^{-4}\)m/s.

**PERMEABILITY EXAMPLE:**
Beach material is fine sand with a permeability \(k_s = 1 \times 10^{-5}\)m/s.
The filter/separator should have a permeability \(k_g > 10 \times \text{permeability of soil}\).
Therefore, geotextile \(k_g\) should be > \(1 \times 10^{-4}\)m/s.

GEOfabrics’ HPS filter/separators are in the range 3 \(\times\) 10\(^{-1}\) m/s to 10 \(\times\) 10\(^{-3}\) m/s.
STEP 4
Check that the grade’s $O_{90} < d_{50}$ of the subsoil.
This requirement is satisfied by most of the HPS product range.

**FILTRATION EXAMPLE:**
$d_{50}$ of fine sand is typically 0.3mm (see Table 1). The filter/separator $O_{90}$ must be $< d_{50}$.
For $d_{50}$ of 0.3mm – required $O_{90}$ must be $< 0.3$mm.
- GEOfabrics’ geotextiles have an $O_{90}$ in the range 0.2mm to 0.07mm.

STEP 5
Check that the selected grade can withstand installation loading without puncture.

**INSTALLATION DAMAGE RESISTANCE EXAMPLE:**
FOS against damage = 3.0.
Maximum likely drop height = 1.5m.
Maximum rock size in contact with geotextile = 4000kg.
Rock drop energy = $1.5 \times 4000 = 6000$kgm. From installation damage graph below.
- GEOfabrics HPS14 would be suitable in this instance.
STEP 6

Check that there is sufficient design elongation for the fabric to function without tearing. Assuming rock diameter is approx. 1.5m, and the rock is depressed into subsoil to a third of its depth, i.e. 0.5m, the localised elongation in the geotextile due to the friction between subsoil and rough edges of the rock could be as much as 20%. To allow a FOS = 3, a minimum tensile extension would therefore be 60%.

ELONGATION EXAMPLE:

FOS against damage = 3.0.

Maximum likely rock diameter = 1.5m (OD).

Depression depth 0.5m (1/3rd OD).

Elongation approx. 20% x FoS 3.0 = 60% elongation required (Tensile Extension).

**GEOfabrics’ HPS14 would be suitable in this instance.**
Specification Considerations

A well-written specification for a filter/separator is of paramount importance as there are many geotextile types available with widely varying physical characteristics and production qualities. Testing and quality assurance is as important for geotextiles as it is for other materials incorporated in the works.

British Standard (BS) and European (EN) index tests are available to enable engineers to compare one geotextile with another. These tests and quality control schemes need to be referenced in the specification (see example specification below).

The tests should then be used to assess the suitability of a proposed geotextile for the works. The manufacturer’s Quality Control procedures should be made available and a Certificate of Conformance should cover each consignment. Additional samples may be taken from each consignment, by the contractor, to be tested as directed by the engineer.

As an example, a performance specification is provided based on HPS14 – the product identified in the worked example.

### Specification Considerations

#### 2.1 Physical Properties:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Test Method</th>
<th>Units</th>
<th>Typical Value</th>
<th>Allowable Tolerance to 95% Confidence Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness @ 2kPa</td>
<td>EN ISO 9863-1: 2005</td>
<td>mm</td>
<td>7.8</td>
<td>n/a*</td>
</tr>
</tbody>
</table>

#### 2.2 Mechanical Properties:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Test Method</th>
<th>Units</th>
<th>Typical Value</th>
<th>Allowable Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static puncture strength (CBR)</td>
<td>EN ISO 12236</td>
<td>kN</td>
<td>14</td>
<td>-10%</td>
</tr>
<tr>
<td>Push-through displacement</td>
<td>EN ISO 12236</td>
<td>mm</td>
<td>65</td>
<td>n/a*</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>EN ISO 10319</td>
<td>kN/m</td>
<td>75</td>
<td>-10%</td>
</tr>
<tr>
<td>Tensile elongation</td>
<td>EN ISO 10319</td>
<td>%</td>
<td>80</td>
<td>+/-30%</td>
</tr>
<tr>
<td>Cone drop perforation hole diameter</td>
<td>BS EN 13433</td>
<td>mm</td>
<td>0</td>
<td>+3mm</td>
</tr>
</tbody>
</table>

#### 2.3 Filtration Properties:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Test Method</th>
<th>Units</th>
<th>Typical Value</th>
<th>Allowable Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water flow normal to the plane of the geotextile @50mm head</td>
<td>EN ISO 11058</td>
<td>l/s/m²</td>
<td>25</td>
<td>-30%</td>
</tr>
<tr>
<td>Characteristic opening size: 90% finer [O90]</td>
<td>EN ISO 12956</td>
<td>μm</td>
<td>&lt;69</td>
<td>+/-30%</td>
</tr>
</tbody>
</table>

* Indicates property not used for quality control as part of harmonised testing within EN 13253.

#### 2.4 Durability (according to annex B: EN 13253):

| Metric | Test Method | Retained Strength | |
|--------|-------------|-------------------||
| Resistance to weathering (UV) @ 50MJ/m² radiant exposure | EN 12224 | Retained strength | >80% |
| Resistance to oxidation (150 years) | EN 13438 | Retained strength after 84 days | >80% |
| Microbiological resistance | EN 12225 | Retained strength | >80% |
| Resistance to liquids | EN 14030 | Retained strength | >80% |

* Durability test data can be supplied by the manufacturer – test frequency must not exceed 3 years.

Model specifications are available to download from www.geofabrics.com
Performance Specification

- The geotextile to be used as a filter/separator beneath the rock armour shall be a non-woven fabric manufactured by needlepunching virgin, staple fibres of polypropylene incorporating a minimum of 1% by weight active carbon black. Geotextiles manufactured from fibres of more than one polymer will not be permitted.

The geotextile shall have the following properties:

- Geotextiles shall be delivered to site in packaging, which will protect the rolls from ultra-violet light degradation. The labelling shall clearly identify the product supplied in accordance with BS EN 10320:1999. Geotextiles shall be protected at all times against physical or chemical damage. Geotextiles shall be kept in the wrappings provided by the manufacturer until required for use in the works.
- The geotextile manufacturer shall provide production test certificates at the rate of one set of certificates per 6,000m² delivered to site and a minimum of one set per contract. Test methods employed shall be in accordance with the requirements of BS EN ISO 13253:A1 2005 and be accredited by UKAS to carry out the required tests. Certificates relevant to a batch of geotextile shall be furnished to the engineer prior to that batch of geotextile being incorporated in the works.
- The rolls of geotextile shall be stored on level ground and stacked not more than five rolls high and no other materials shall be stacked on top of the geotextiles.
- The geotextile shall not be exposed to direct sunlight for longer than thirty days.
- The geotextile shall be laid and installed in the positions and to the line and levels described on the drawings. Material, which will be in contact with the geotextile, shall not have protrusions which are likely to damage the geotextile during installation or in service. Construction plant must not operate directly on the geotextile.
- Joints shall be formed by overlapping by a minimum of 1000mm. A reduction in overlap to 300mm may be considered by the engineer where the sub-layer is firm and above water level.

The following definitions shall apply when considering test results:

A set of test results shall be those results derived from specimens cut from one sample. The mean value for any set of test results shall be the arithmetic mean of that set of results.

The characteristic value is the value below which not more than 5% of the test results may be expected to fall. This represents the value at 1.64 standard deviations below the mean value.

Rock armour Groyne installation to inhibit ‘Long Shore Drift’ and protect the coastline.
Installation Guidance

The high strain capacity of the HPS products may be used to advantage when designing anchoring and edge details. Wrapping around a run of small stone or bedding stone, if available, is a proven toe detail. At the top of the revetment the geotextile should be anchored in a trench or fixed to a structure such as a sheet-piled wall. The sides should be treated in a similar fashion for the permanent works and suitable precautions taken to protect them at high tides during the progress of the works.

Joints

HPS geotextiles are produced up to 6m wide to minimise overlaps. Unbonded overlaps should be between 300mm and 1000mm (at the discretion of the engineer) depending upon the firmness of the underlying soil and the relative ease of working. 300mm overlaps are acceptable for above-water working on firm subsoil and 1000mm overlaps are recommended for under water working on soft silts.

Contractors placing the HPS products under water often prefer to joint and re-roll the product onto a metal core. This enables widths up to 12m to be pre-fabricated prior to installation. Joints can be made by sewing a prayer seam using a bag-closing, handheld sewing machine. This procedure can achieve joints with 60% of the geotextile's strength.

Typical HPS installation details. For further site specific installation details, please contact the GEOfabrics’ technical team for assistance.
Quality and Development

GEOfabrics continue as one of the main geosynthetic innovators in the industry with our highly active Research and Development department.

Our continued success in new products is as a result of an experienced team and our ongoing relationships with an expanding list of professional clients who partner with us to produce bespoke geosynthetic solutions.

GEOfabrics’ priority is to manufacture a high quality end product that provides the exact needs of our customers, in line with function, durability, value and in accordance with all current legislation and design standards.

HPS: Long-Term Durability

GEOfabrics manufacture from 100% virgin staple polypropylene fibre including 1% carbon black. Such fibres are generally considered chemically and biologically inert, in all but the most aggressive environmental applications.

GEOfabrics’ HPS geotextiles are resistant to chemical and biological clogging, have UV stability to prevent degradation when exposed to sunlight and provide long-term strength without reduction in performance or function.

GEOfabrics’ innovative products are produced using the latest manufacturing technology and UKAS accredited testing facilities.

Should you require any information or assistance in relation to this support service please contact us on +44 (0)113 202 5678.

GEOfabrics has an extensive laboratory and test facilities. We have a wide range of UKAS accredited tests used for quality control and research and development.

Mechanical testing equipment for tensile strength and elongation.

The ISO 9001 Management system uses customer feedback, continuous assessment and independent auditing to drive both improvement and the control required for a professional and quality based environment.

Acknowledgements given to Ciria C683 ‘The Rock Manual’:

GEOfabrics Limited manufactures CE Marked products that meet the construction products directive.

Accreditations
Further literature, in the form of case studies, design guides, installation procedures, product data sheets and model specifications can be downloaded from www.geofabrics.com