Black Masterbatch Selection Guide for Geosynthetics
Introduction

This “Black Masterbatch Selection Guide for Geosynthetics” provides detailed information about Cabot’s range of black masterbatches designed for use in applications collectively known as Geosynthetics.

Geosynthetics have found widespread use in the building industry for environmental engineering, geotechnical applications and water containment. They have many functional uses including sealing, as a barrier layer, filtration, drainage, reinforcement and protection. Applications covered include Geotextiles, Geogrids and Geomembranes.

Detailed information is given about each application area. Tables are used to assist in the selection of the correct Cabot masterbatch, which depends on requirements of the final product. Performance information is given for each masterbatch.
**Geotextiles**

Geotextiles are permeable polymeric materials usually in sheet form and can be either woven or non-woven.

Their main functions are:

- **Stabilisation/Reinforcement**: woven geotextiles on soft substrates spread applied loads and improve structural stability.
- **Separation**: keeping apart two layers of a different nature, such as gravel and a soft sub-base material.
- **Drainage**: due to the filtering effect geotextiles allow sub-surface water to flow into drains whilst preventing clogging.
- **Protection**: mechanical protection of geomembranes against abrasion and puncture.

**Woven** geotextiles are based on polypropylene slit films and are mostly used in road building and embankments. They provide good mechanical strength at low cost.

**Non-woven** geotextiles are either heat bonded or needle-punched to form continuous mats. They have particularly good water flow performance and filtering characteristics and can be found in most drainage systems or as highly permeable separation layers.

**Geogrids**

Geogrids are uni- or bi-axially oriented matrix structures of very high strength. They provide stability in earth retention systems. Examples are retaining walls in railway or highway projects. They are also used in various construction foundations such as reinforcement of embankments on soft substrates.

The most important characteristics of geogrids are high water drainage combined with exceptional mechanical strength and long term creep resistance.

Fig 1. Typical earth retention system
Geomembranes

Geomembranes are flexible or semi-rigid sheets offering high barrier resistance to water and gases.

They can be found in different application areas such as:

- Landfill liners and covers
- Pond liners
- Tunnel liners
- Water containment/storage
- Storage of chemical products or animal waste

The most commonly used materials are HDPE, VLDPE or PVC.

Landfill Liners and Covers

Municipal waste landfills are one of the most important and demanding applications for geomembranes and geotextiles. Their role is to protect the environment, in particular the groundwater, from both leachate and landfill gas.

Multi-barrier concept

Landfill designs vary from country to country and depend on the characteristics of the solid waste as well as the geologic and hydrologic conditions at the landfill site. Most are based on a multi-barrier concept with a HDPE/MDPE geomembrane as a barrier for water and any type of polar substance including heavy metals. Non-polar or chlorinated hydrocarbons that may permeate through the geo-membrane are retained at the surface of a compacted clay layer acting as a second barrier.

The lining system also includes a drainage layer above the geomembrane. It is composed of gravel or crushed stones. To avoid local strains that would eventually result in the perforation of the membrane, a heavy protective geotextile mat is used (typically a non-woven HDPE or PP geotextile of > 1200 g/m²).

For landfills with steep sided slopes, a high tensile geogrid reinforcement is needed to ensure stability and prevent excessive straining of the geomembrane.
Requirements

HDPE membranes for landfill caps and base liners have exceedingly long life expectations of 10, 20, 30 or sometimes 50 or more years with a warranty provided by the supplier/producer. In most cases national standards must be met such as GRI-GM13 (USA & UK), BAM standards (Germany) and KIWA (Netherlands). This puts severe technical requirements on the material, especially with respect to the following:

- **Environmental stress cracking resistance (ESCR):** resulting from the combined presence of surface active substances encountered in the leachate of municipal or hazardous waste landfills and stresses induced by deformation of the soil or waste layer.

- **Tensile properties:** appropriate long-term tensile properties (especially elongation at break limit) are essential. This requires selection of a suitable polyethylene type as well as a thermal and ultra violet (UV) stabilisation package. Severe uniaxial and bi-axial tensile or break tests need to be satisfied.

- **Weldability:** excellent weld strength is needed to ensure the tightness of the membrane. Short-term strength but even more long-term weld strength (for example, after ageing for 800 hours in an aggressive media) is a key requirement.

- **Barrier properties:** to maintain separation of different chemicals present in landfills, such as polar substances, high crystallinity is required combined with excellent chemical resistance.

**Pond Liners**

Pond liners are another application area for geomembranes in polyethylene, PVC, EPDM or butyl rubber and normally incorporate carbon black as the UV stabiliser package.

**Tunnel Liners**

Another demanding application for geomembranes is tunnel liners. These are required to be waterproof, chemically inert and non-porous to protect construction work in the tunnel. They also need to be resistant to breakdown by underground deposits of methane gas and hydrocarbons. Tunnel liners normally require a certain degree of UV protection.
A typical tunnel lining construction is concrete-geomembrane-concrete. The outer layer of concrete holds the tunnel open during construction until the waterproofing geomembrane is installed. The inner layer of concrete is then put over the geomembrane and forms the main structure of the tunnel.

**Water Containment/Storage**

Geomembranes for water containment and storage, such as canal and reservoir liners, need to have excellent UV resistance, stress cracking resistance, chemical resistance and mechanical properties. This type of geomembrane is normally produced from polyethylene for its superior stress crack resistance.

**Storage of Chemical Products and Animal Waste**

Increased environmental awareness has made it necessary to find environmentally acceptable ways of containing chemical and animal waste products to prevent contamination of ground water.

Geomembranes are used to line holding lagoons, anaerobic treatment ponds and evaporation ponds in waste facilities. Geotextiles can be used in combination with the geomembrane to provide additional cushioning and protection.

For chemical storage, the essential technical requirements are chemical resistance, durability, stress cracking resistance and UV resistance. Animal waste requires very low permeability, excellent UV resistance, stress cracking resistance and resistance to methane gas. Therefore this type of geomembrane is usually produced from HDPE.

**Cabot Masterbatches for Geosynthetics**

Geotextiles

<table>
<thead>
<tr>
<th>Application</th>
<th>Suggested Cabot grades</th>
<th>Key characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill liner and protection stabilisation</td>
<td>PE2642</td>
<td>Standard weathering grade</td>
</tr>
<tr>
<td></td>
<td>LL4752</td>
<td>Improved compatibility with LLDPE/HDPE</td>
</tr>
<tr>
<td>Earth retention systems</td>
<td>PE2642</td>
<td>Standard weathering grade</td>
</tr>
<tr>
<td></td>
<td>LL4752</td>
<td>Improved compatibility with MDPE/HDPE</td>
</tr>
<tr>
<td></td>
<td>PP6190</td>
<td>Suitable for PP based geonets/ geotextiles</td>
</tr>
</tbody>
</table>
Geogrids

<table>
<thead>
<tr>
<th>Application</th>
<th>Suggested Cabot grades</th>
<th>Key characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth and embankment retention</td>
<td>HD4708</td>
<td>Maximum protection against UV</td>
</tr>
<tr>
<td></td>
<td>PP6190</td>
<td>Excellent UV protection with long term stabilisation</td>
</tr>
</tbody>
</table>

Geomembranes

<table>
<thead>
<tr>
<th>Application</th>
<th>Suggested Cabot grades</th>
<th>Key characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill liners and caps</td>
<td>PE2642</td>
<td>Standard weathering grade. Good process and long term heat stability</td>
</tr>
<tr>
<td></td>
<td>PE2747*</td>
<td>Good long term heat stability and ease of dilution</td>
</tr>
<tr>
<td></td>
<td>LL4752</td>
<td>Improved compatibility with MDPE/HDPE, high performance long term stabilisation</td>
</tr>
<tr>
<td>Pond liners and waste water lagoons</td>
<td>PE2642</td>
<td>Standard weathering grade</td>
</tr>
<tr>
<td></td>
<td>PE2747*</td>
<td>Good long term heat stability and ease of dilution</td>
</tr>
<tr>
<td></td>
<td>LL4752</td>
<td>Improved LL/HDPE compatibility</td>
</tr>
<tr>
<td></td>
<td>UN2016</td>
<td>For compatibility with PVC. Additional UV stabilisation recommended</td>
</tr>
<tr>
<td>Tunnel lining</td>
<td>PE2272R</td>
<td>Good colouration and opacity</td>
</tr>
<tr>
<td></td>
<td>PE2824</td>
<td>Low cost alternative</td>
</tr>
</tbody>
</table>

* PE2747: only available in Asia-Pacific

The geomembrane industry has traditionally used pre-coloured compounds but increasingly the geomembrane manufacturers are adding masterbatches to the base polymer. The role of the masterbatch and carbon black is to provide optimum UV and thermal protection of the membrane. In Europe many landfills for municipal waste remain open for periods of several years. This high exposure would cause severe degradation to the polyethylene alone and the resulting deterioration of physical properties could eventually lead to failure.

It is therefore of paramount importance that the correct masterbatch designed to fulfil these severe performance requirements is selected.
**High UV absorption capacity:** Carbon black is one the most effective and most widely used UV light stabilisers for plastic materials. Significant research work at Cabot Corporation has demonstrated the link between carbon black morphology (surface area and structure) and dispersion level on weatherability. All black masterbatches for geosynthetic applications with high UV weathering demands are based on high performance carbon blacks.

The following graph compares the weathering performance of 650 µm sheet containing LL4752, a weathering type carbon black masterbatch with that of a similar sheet containing general purpose carbon black masterbatch, PE2272R.

Both sets of sheet contain carbon black at a 2% loading:

**Thermal stabilisation:** due to its unique surface chemistry, carbon black limits the degradation process that occurs in the polymer. Most of the masterbatch types however contain additional antioxidant packages that provide long term heat ageing protection as well as processing safety.

Oxidation induction time (OIT) measurements are used as a measure of thermal stability by several major standards and testing Institutes. By the selection of an appropriate stabiliser package the OIT can be significantly improved. The masterbatch can therefore contribute to meeting the expected service life expectations.
**Ease of dilution:** to achieve optimum efficiency the masterbatch must be homogeneously diluted in the base polymer. Poor blending can lead to weak points in the membrane as well as delamination at high strains. Depending on the customer’s extrusion equipment and the base polymer characteristics CABOT can propose masterbatch types that respond to each specific requirement and provide an optimum homogeneity level.

**Compatibility with dilution polymer:** whilst the role of the masterbatch is to provide long term protection it should have a minimum influence on the mechanical properties, chemical resistance and stress-crack behaviour of the geosynthetic structure. All masterbatches are carefully designed to minimise the loss in properties of the dilution polymers.

**Cabot Laboratories and Technical Support**

State of the art testing equipment at the CABOT Application Development Centre laboratories enables determination of the key properties of geosynthetic products as follows:

- Weathering performance
  - Natural: outdoor facilities in several locations covering a wide range of irradiation levels
  - Artificial: QUV + ATLAS Ci65A

- Colouration and opacity

- Viscosity: Capillary rheometer, melt indexer, Brabender

- Thermal stability (OIT, oven tests, multiple extrusion)

- Mechanical properties

Our Application Development Centre team provides excellent technical service, combining processing and application expertise with extensive analytical services.
### Characteristics of PLASBLAK® Masterbatches for Geosynthetics

<table>
<thead>
<tr>
<th>Grade</th>
<th>% carbon black</th>
<th>Carbon black type</th>
<th>MFI (g/10 mins)</th>
<th>Test conditions</th>
<th>Carrier</th>
<th>Density (kg/m³)</th>
<th>Stabilisation package</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE2642</td>
<td>40</td>
<td>Premium weathering</td>
<td>14</td>
<td>21.6kg/190°C</td>
<td>LL/LDPE</td>
<td>1150</td>
<td>Yes</td>
</tr>
<tr>
<td>LL4752</td>
<td>40</td>
<td>Weathering</td>
<td>49</td>
<td>21.6kg/190°C</td>
<td>LLDPE</td>
<td>1150</td>
<td>Yes</td>
</tr>
<tr>
<td>HD4708</td>
<td>40</td>
<td>Premium weathering</td>
<td>8</td>
<td>21.6kg/190°C</td>
<td>HDPE</td>
<td>1180</td>
<td>Yes</td>
</tr>
<tr>
<td>PP6190</td>
<td>35</td>
<td>Weathering</td>
<td>9</td>
<td>5kg/230°C</td>
<td>PPH</td>
<td>1100</td>
<td>Yes</td>
</tr>
<tr>
<td>PE2272R</td>
<td>50</td>
<td>General purpose</td>
<td>12</td>
<td>10kg/190°C</td>
<td>LDPE</td>
<td>1230</td>
<td>No</td>
</tr>
<tr>
<td>PE2747 *</td>
<td>35</td>
<td>General purpose</td>
<td>35</td>
<td>10kg/190°C</td>
<td>LLDPE</td>
<td>1100</td>
<td>Yes</td>
</tr>
<tr>
<td>PE2824</td>
<td>40 equivalent</td>
<td>Not specified</td>
<td>37</td>
<td>21.6kg/190°C</td>
<td>LDPE</td>
<td>1560</td>
<td>No</td>
</tr>
<tr>
<td>UN2016</td>
<td>50</td>
<td>Medium colour</td>
<td>41</td>
<td>10kg/190°C</td>
<td>Universal</td>
<td>1220</td>
<td>No</td>
</tr>
</tbody>
</table>

* PE2747: only available in Asia-Pacific
EMEA
Cabot
Interleuvenlaan 15 i
B - 3001 Leuven
BELGIUM
Tel.: +32 16 39 24 00
Fax: +32 16 39 24 44

ASIA-PACIFIC
Cabot (China) Limited
558 Shuangbai Lu
Wujing, Shanghai 201108
CHINA
Tel: +86 21 6434 6025
Fax: +86 21 6434 5532

SOUTH AMERICA
Rua do Paraíso, 148 - 5th floor
Paraíso CeP 04103-000 São Paulo SP
BRASIL
Tel: +55 11 2144 6400
Fax: +55 11 3253 0051
Tel: 0800 199959 (Customer Service)

Notice and Disclaimer. The data and conclusions contained herein are based on work believed to be reliable; however, Cabot cannot and does not guarantee that similar results and/or conclusions will be obtained by others. This information is provided as a convenience and for informational purposes only. No guarantee or warranty as to this information, or any product to which it relates, is given or implied. CABOT DISCLAIMS ALL WARRANTIES EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AS TO (i) SUCH INFORMATION, (ii) ANY PRODUCT OR (iii) INTELLECTUAL PROPERTY INFRINGEMENT. In no event is Cabot responsible for, and Cabot does not accept and hereby disclaims liability for, any damages whatsoever in connection with the use of or reliance on this information or any product to which it relates.

© Cabot Corporation, MA-U.S.A. All rights reserved 2010.

www.cabot-corp.com/Masterbatches
PLASBLAK® is a registered trademark of Cabot Corporation.