MASTERBATCHES

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Masterbatch Selection Guide for Geosynthetics

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Introduction

This “Masterbatch Selection Guide for Geosynthetics” provides detailed information about Cabot’s range of black and additive 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.

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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

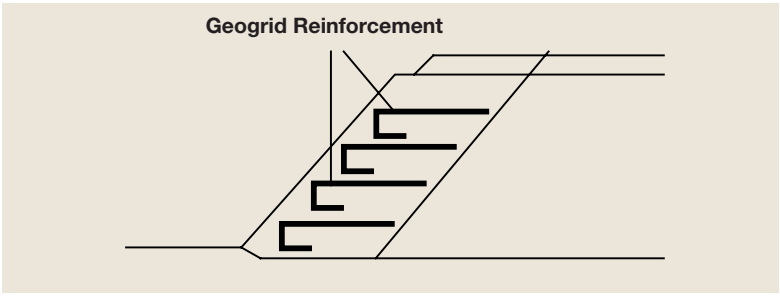
Woven geotextiles are based on polypropylene slit films and are mostly used in road building and embankments. They provide good mechanical strength at low cost.

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.

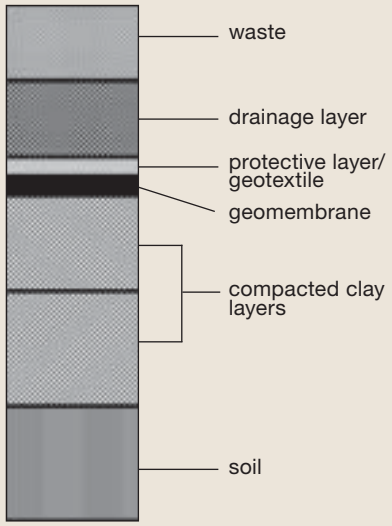
Multi-barrier concept

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/m^2).

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

Fig 2. Cross-section of typical landfill multi-barrier concept



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

Application	Suggested Cabot grades		Key characteristics
Landfill liner and protection stabilisation	Black	PE2642	Standard weathering grade
		LL4752	Improved compatibility with LLDPE/HDPE
Earth retention systems	Black	PE2642	Standard weathering grade
		LL4752	Improved compatibility with MDPE/HDPE
		PP2631	Suitable for PP based geonets/ geotextiles

Geogrids

Application	Suggested Cabot grades		Key characteristics
Earth and embankment retention	Black	HD2670	Maximum protection against UV, process and long term stabilisation
		HD4844	Maximum protection against UV, process and extra long term stabilisation for critical applications
		PP4766	Excellent UV protection with process and long term stabilisation

Geomembranes

Application	Suggested Cabot grades		Key characteristics
Landfill liners and caps	Black	PE2642	Standard weathering grade. Good process and long term heat stability
		PE2747*	Good long term heat stability and ease of dilution
		LL4752	Improved compatibility with MDPE/HDPE, high performance long term stabilisation
	UV additive	PE9365 PE9373	High molecular weight HALS UV package
Pond liners and waste water lagoons	Black	PE2642	Standard weathering grade
		PE2747*	Good long term heat stability and ease of dilution
		PE6034	Combi-batch with premium weathering black and high level of antioxidant
		LL4752	Improved LL/HDPE compatibility
		UN2016	For compatibility with PVC. Additional UV stabilisation recommended
Tunnel lining	Black	PE2272	Good colouration and opacity
		PE2824	Low cost alternative

* PE2747: only available in Asia-Pacific

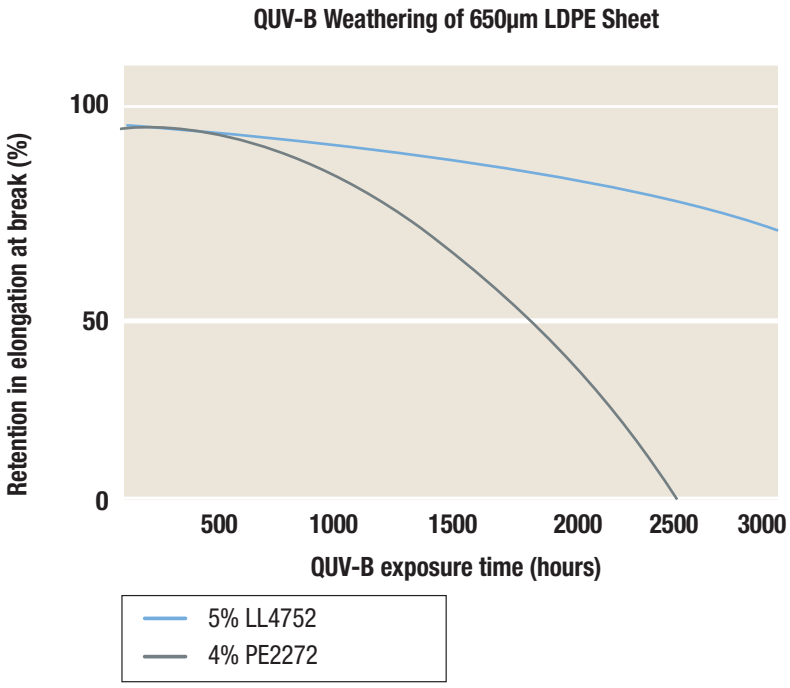
The geomembrane industry has traditionally used pre-coloured compounds but increasingly the geomembrane manufacturers are adding masterbatches to the base polymer. The role of the masterbatch and carbon black is to provide optimum UV and thermal protection of the membrane. In Europe many landfills for 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, PE2272.

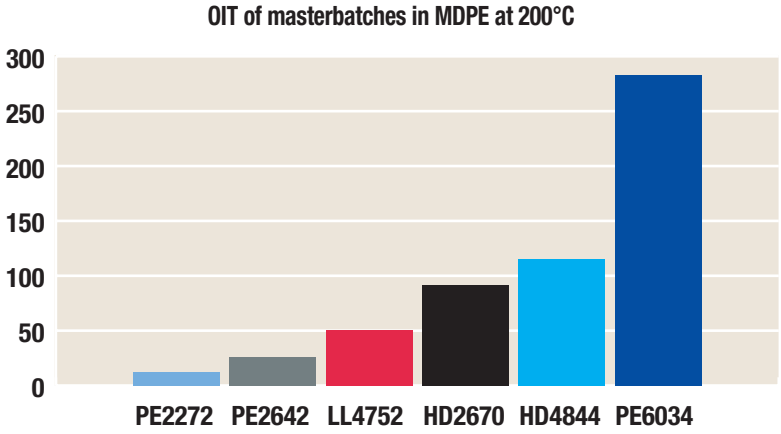
Both sets of sheet contain carbon black at a 2% loading:



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.

The following graph compares the OIT of a number of black masterbatches for geosynthetics added to MDPE to give 2.5% carbon black:



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 product and manufacturing support laboratories enables determination of the key properties of geosynthetic products as follows:

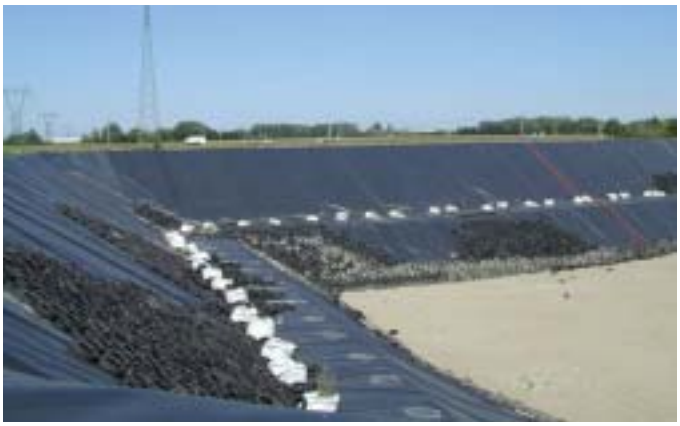
- Weathering performance
  - Natural: outdoor facilities in several locations covering a wide range of irradiation levels
  - Artificial: QUV + ATLAS Ci65A
- Colouration and opacity
- Viscosity: Capillary rheometer, melt indexer, Brabender
- Thermal stability (OIT, oven tests, multiple extrusion)
- Mechanical properties

Our Product and Manufacturing Support team provides excellent technical service, combining processing and application expertise with extensive analytical services.

Characteristics of PLASBLAK® Masterbatches for Geosynthetics

Grade	% carbon black	Carbon black type	MFI (g/10 mins)	Test conditions	Carrier	Density (kg/m³)	Stabilisation package
PE2642	40	Premium weathering	17	21.6kg/ 190°C	LL/LDPE	1150	Yes
LL4752	40	Weathering	50	21.6kg/ 190°C	LLDPE	1150	Yes
PE6034	40	Weathering	38	10kg/190°C	LDPE	1170	Yes
HD2670	40	Premium weathering	14	21.6kg/ 190°C	HDPE	1190	Yes
HD4844	40	Premium weathering	16	21.6kg/ 190°C	HDPE	1180	Yes
PP4766	40	Weathering	15	10kg/230°C	PPH	1130	Yes
PP2631	35	Weathering	4.5	5kg/230°C	PPH	1100	Yes
PE2272	50	General purpose	13	10kg/190°C	LDPE	1230	No
PE2747 *	35	General purpose	35	10kg/190°C	LLDPE	1100	Yes
PE2824	40 equivalent	Not specified	41	21.6kg/ 190°C	LDPE	1560	No
UN2016	50	Medium colour	38	10kg/190°C	Universal	1220	No

* PE2747: only available in Asia-Pacific



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