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GEOSYNTHETICS : GEOTEXTILES, GEOTEXTILES RELATED-PRODUCTS AND GEOMEMBRANES

The geosynthetics are synthetic man made materials which may be sheet or strip-like used in geotechnical and civil engineering applications.
Geotextiles and geotextiles-related products are permeable geosynthetics while geomembranes are water and gasproof.
This paper describes the functions and applications of the geosynthetics. The types of products, the products characterization and their design and recommendations methods are given.

1. INTRODUCTION

Geotextiles made from man-made fibres were for the first time developed in the Netherlands. It all began in 1953 almost directly after the catastrophal flood of february 1953 inudating 150.000 hectares of South-Western part of the Netherlands. Hand woven sheets made of nylon 6 extruded strips of about 100 mm wide and of about 1 mm thickness were produced to stabilise the ballast materials of the sea fences.

Later in France (1968), non-woven needle punched textiles were used to improve soil characteristics. Their membrane type continuity authorized their use as separator between two soils of different granulometrics, as filter or as reinforcement of soft soil.

After a period of hesitation the geotechnical and civil engineers recognized the opportunities offered by these fabrics.

In 1977, J.P. GIROUD suggested the neologism GEOTEXTILE to qualify this new generation of man-made fibres materials.
GEOTEXTILES are now defined by ISO [4] as a permeable polymeric material which may be woven, non woven or knitted used in geotechnical and civil engineering applications

GEOTEXTILES - RELATED PRODUCTS

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are those permeable geosynthetics developed during the seventies and eighties offering alternative solutions to the use of geotextiles or complementarities of functions when associated with the geotextiles.

ISO [4] defines the geotextiles-related products as permeable polymeric construction materials which may be sheet or strip-like used in geotechnical and civil engineering applications.

Geogrids, geowebs,... geocomposites that will be presented later are geotextiles-related products.

Waterproofing membranes or geomembranes are used since more than 60 years.

Applications of PVC swimming pool liners were described in the 1930's. Since that period, many applications of geomembranes have been performed and the variety of the available products became enormous.

The basic difference between geomembranes and geotextiles is that geomembranes have very low permeability. Geomembranes are only subjected to a small amount of seepage as a result of permeation.

To all intents and purposes geomembranes may be considered bo be impermeable to both gases and fluids. This makes them ideal for forming waterproof or gasproof barriers between adjacent bodies of soil or soil and fluids.

2. FUNCTIONS AND APPLICATIONS OF THE GEOSYNTHETICS

2.1. Functions [8]

Geotextiles and related products are materials which can fulfil the following functions when in contact with water, soil and/or stone :

- separating : the geotextile to a great extent separates layers of different grain size (figure 1);
- filtering : the geotextile retains some particles and allows others to pass through (figure 2);
- reinforcing : the geotextile increases the stability of the soil body (figure 3);
- draining : the geotextile, itself, functions as a drain because it has a higher water transporting capacity than the surrounding materials (figure 4);
- water/particle proofing : the geomembrane separates two layers in such a way that neither particles from either layer nor water can pass through (figure 5).

Figure 1 Separation of two granular materials using a geotextile.

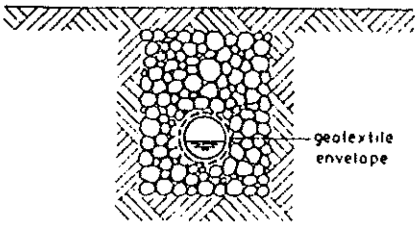

Figure 2 Separation of grains from the discharge element of a drain-pipe, using a geotextile envelope.

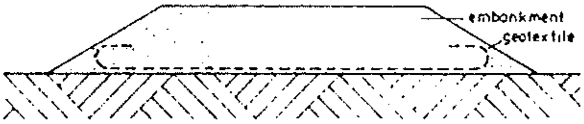

Figure 3 A geotextile sheet used as reinforcement in an embankment.

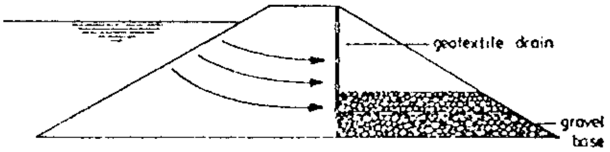

Figure 4 A geotextile employed as a drain in a dike.

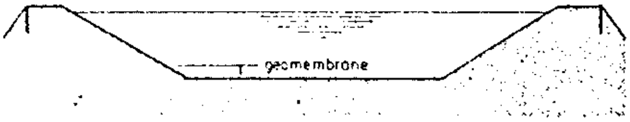

Figure 5 A geomembrane covering the bottom of a basin.

2.2. Typical applications

Geotextiles and geomembranes can be applied in the following situations :

2.2.1. Bank and bed protection

Geotextiles can be used in construction to :

- maintain the profile within certain limits by retaining the bank and bed material and
- protect the bank and bed against any influence which could shorten the lifetime of the structure.

Geotextiles can also be used in constructions connected with :

- ecological, landscaping and recreation functions;
- visual navigational aids;
- water discharge, influenced by the bottom roughness.

In these applications the geotextile retains the underlying material without allowing unacceptable excess water pressures to develop. The filtering material is water permeable during the lifetime of the construction without unacceptable loss of any of the underlying material, and functions in a subsidiary way as a separating sheet and reinforcement.

2.2.2. Embankments, slopes and foundations

Geotextiles can be used in :

- foundations for road construction on (weak) soils;
- foundations of breakwaters;
- retaining walls (steep slopes).

In these works geotextiles function as reinforcement to increase the resistance of soils to shear stresses and as separation and filter media.

2.2.3. Reservoirs and linings

Geomembranes can be used in constructions for :

- the storage and/or protection of materials;
- the treatment of polluted soils, and
- a watertight revetment.

In these applications the geomembrane acts as a separation membrane between two layers which should not be allowed to mix, as a reinforcement, and as a watertight separation membrane between fluids in a reservoir and in the subsoil.

2.2.4. Vertical drainage

Geotextiles can be used to increase the rate of consolidation in order to reduce the time for a specific settlement to occur or to increase the stability.

In this case the function of the geotextile is to accelerate the reduction of the excess pore water in the surrounding soil which can be achieved with drains with a low entrance resistance and a large discharge capacity.

2.2.5. Horizontal drainage

Geotextiles can be used as subsurface drains in order to :

- drain reclaimed areas, construction areas, dike toes, etc...
- infiltrate reclaimed areas;
- increase consolidation in order to improve the accessibility and the crop yield of agricultural fields.

In these applications geotextile envelopes serve as selective filters which prevent soil particles exceeding a certain size, being carried into the drainage medium (usually corrugated pipe), and a means of lowering the entrance resistance in connection with the discharge of water.

2.2.6. Road and railway construction

Geotextiles are mainly used in foundations. In this connection the function of the geotextile is to separate the subsoil from the road foundation material, to increase the bearing strength of weak subsoils, and to drain surface water into the subsoil.

2.2.7. Road repair

Geotextiles may be used as container of bitumen to realise stress absorbing membranes interlayers between old structures to be repaired and new overlay.

3. GEOTEXTILES AND GEOTEXTILES-RELATED PRODUCTS

3.1. Types of products

In order to fulfill the hereabove described functions and applications different fabric structures and polymers are available. Basically three types of thermoplastic polymers are used : polyethylene, polypropylene and polyester.

In general, the manufacturing process of a geotextile comprises at least three stages : the production of the polymer with its various additives; the production of a component; and the conversion of the component into the finished geotextile. The polymer is generally made in a chemical processing plant and is supplied to the manufacturer in the form of pellets or granules which are reheated for conversion - usually in two stages - into the geotextile. The first of these two stages is the formation of a basic component.

The physical forms of these components can vary but they generally fall into one of three broad categories : [3]

- a continuously extruded circular cross-section filament having a diameter generally measuring a fraction of a millimetre, and a indefinite length;
- a continuously extruded flat tape having a breadth of several millimetres, a fraction of a millimetre thickness, and an indefinite length;
- an extruded sheet or film of width up to several metres and thickness varying from a fraction of a millimetre (film) to several millimetres (sheet).

The manufacturing processes used can result in many different geotextile structures. Since each particular structure, and the polymer used to form this structure will control the mechanical properties, hydraulic properties and durability of the geotextile, it is useful to list these structures before giving more detailed consideration to the manufacturing processes leading to their formation. The basic structures are : woven fabrics, non-woven fabrics, knitted fabrics, meshes and grids.

The three basic components used to make these structures are often subject to subsidiary processing before final conversion. For instance, continuous filaments can be twisted into yarn, aligned into parallel groups to form a multifilament. Similarly, the flat tapes, formed either by direct extrusion or by slitting extruded film can be used directly or twisted together to form a tape yarn. In the latter case, a single wide tape may be used and this is often nicked with short discontinuous cuts running down the length of the tape, to produce a fibrillated tape. In the manufacture of extruded tapes, it is quite common practice to stretch or draw the tapes directly after extrusion to align or orient the polymer molecules, thereby giving higher strength and axial tensile stiffness.

3.1.1. Woven fabrics

Woven fabrics are obtained by conventional weaving processes, using a mechanical loom. In this process, an array of parallel elements - the warp - is beamed into the loom and transverse elements - the weft - are threaded over and then under alternate warp elements. The woven product emerges from the loom and is wound into rolls. The type of weaving described is plain weave of which there are many variations such as twill, satin and serge; however, plain weave is the one most commonly used in geotextiles.

The elements used are either flat tapes (extruded or slit film), tape yarn, multifilaments (generally as low twist yarn) or single monofilaments. Resulting structures are typically one millimetre thick with a comparatively regular distribution of pore or mesh openings which vary in dimension over a reasonably small size band. Wovens may be made up entirely of one element - for example, a tape warp and tape weft - or of two element types, one warp and one weft.

A typical woven structure is illustrated by the photomicrographs in figure 6, which give an indication of element sizes and pore sizes. There are no rigid criteria relating polymer type to structure; however, tapes are most commonly polypropylene, and monofilaments are most commonly polyethylene, whereas the finer multifilaments or multifilament yarns are commonly polyester.

Figure 6 : monofilament-on-multifilament geotextile [3]

3.1.2. Non-woven fabrics

These structures are obtained by processes other than weaving. In the case of non-wovens, continuous monofilaments are usually employed; these may, however, be cut into short staple fibres before processing. The first step in processing involves continuous laying of the fibres or filaments on to a moving conveyor belt to form a loose web slightly wider than the finished product. This passes along the conveyor to be bonded. The bonding process used falls into one of three broad categories : mechanical bonding (fig. 7), thermal bonding (fig. 8) or chemical bonding.

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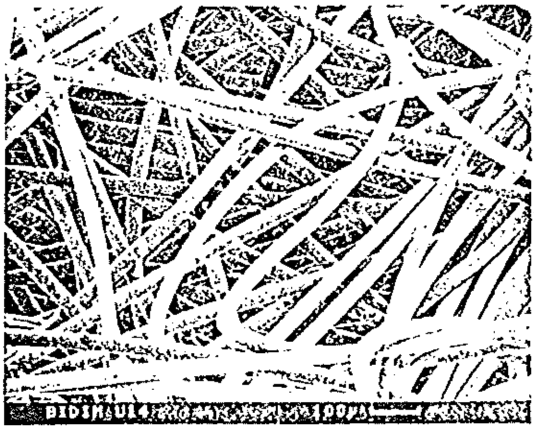

Fig.7 : needlepunched continuous filament geotextile [3]

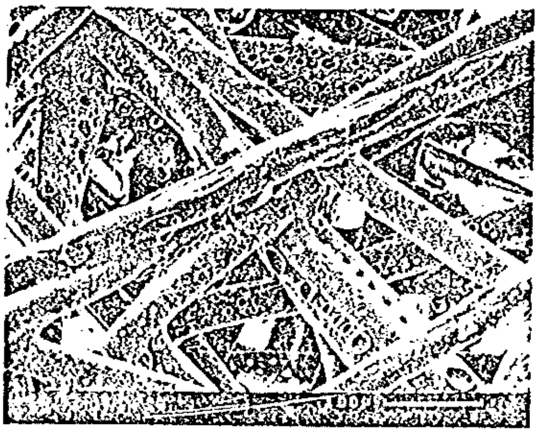

Fig. 8 : heat bonded continuous filament geotextile [3]

3.1.3. Knitted fabrics

At present, simple knitted structures have no apparent application as geotextiles, as they tend to suffer excessive elongation under tension. However, the technique of warp knitting can be employed to impart high unidirectional strength. This process involves laying high strength multifilament yarns into an extensible knitted base, which acts as a carrier or substrate for the high strength component. The end result is a fabric which exhibits high strength and low elongation in the longitudinal (warp) direction.

3.1.4. Meshes

Meshes are not textile fabrics; however, as they can perform functions associated with geotextiles, they may be deemed geotextiles. In essence, meshes have openings or pores which are larger in dimension than the two sets of members which combine to form the mesh. For civil engineering applications, meshes are produced by a process of continuous integral extrusion, using rotating die (figure 9).

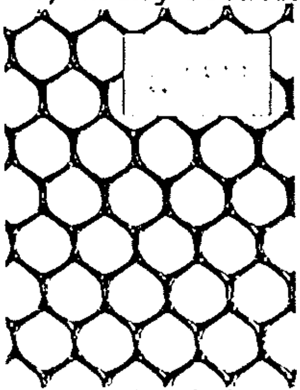

Figure 9 : extruded mesh [3]

3.1.5. Grids

Grid structures, often termed geogrids, are characterised by openings which can be larger in dimension than the sets of members making up the solid component of the grid. Pseudo textile grid structures can be formed using special weaving techniques such as leno weave, which produces large orthogonal pores, or by heat bonding two orthogonal sets of strands or tapes. The method employed for the production of Tensar grids involves a patented method of processing sheet polymer. Two or three stages are involved in the manufacturing process, which is illustrated diagrammatically in figure 10. The first stage involves feeding a sheet of polymer, several millimetres thick, into a punching machine, which punches out holes on a regular grid pattern. Following this, the punched sheet is heated and stretched, or drawn, in the machine direction. This distends the holes to form an elongated grid opening. In addition to changing the initial geometry of the holes, the drawing process orients the polymer molecules in the direction of drawing. The degree of orientation will vary along the length of the grid; however, the overall effect is an enhancement of tensile strength and stiffness.

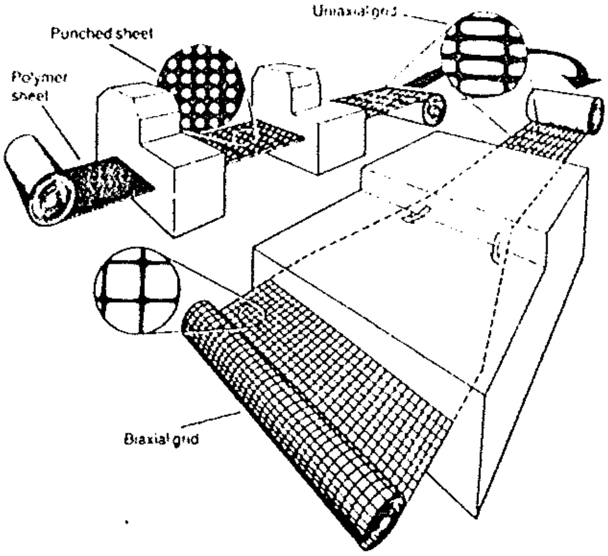

Figure 10 : Tensar manufacturing process [3]

3.2. Products characterization

In civil engineering applications, the main geotextile properties of interest are the physical, mechanical and hydraulic properties. These will largely be a function of the polymers used and of the manufacturing process which creates the structure of the textile.

Great care must be taken in quantifying these properties by testing, as the perceived properties of geotextiles, somewhat like soils, are a function of the test method and procedure employed. It is for this reason that much effort is being expended in developing standards that will lead to consistency in testing. In assessing geotextile properties, due regard must be given to the effects of degradation. Geotextiles, in common with all building materials, are prone to a progressive deterioration in properties. The rate and severity of this degradation are dependent on many factors, such as the environment, the polymer of the geotextile and the state of stress in the geotextile. Perhaps one of the most publicised modes of degradation is irradiation by ultra-violet light. However, as geotextiles are usually not exposed to the sun once installed any potential problems can usually be avoided by planning construction to minimise exposure.

Characteristics may be related to the functions according to the scheme presented at figure 11.

Standards are now progressively harmonized through ISO (International Standard Organization). More recently CEN (European Committee for Standard) created a new technical committee in order to harmonize the test.

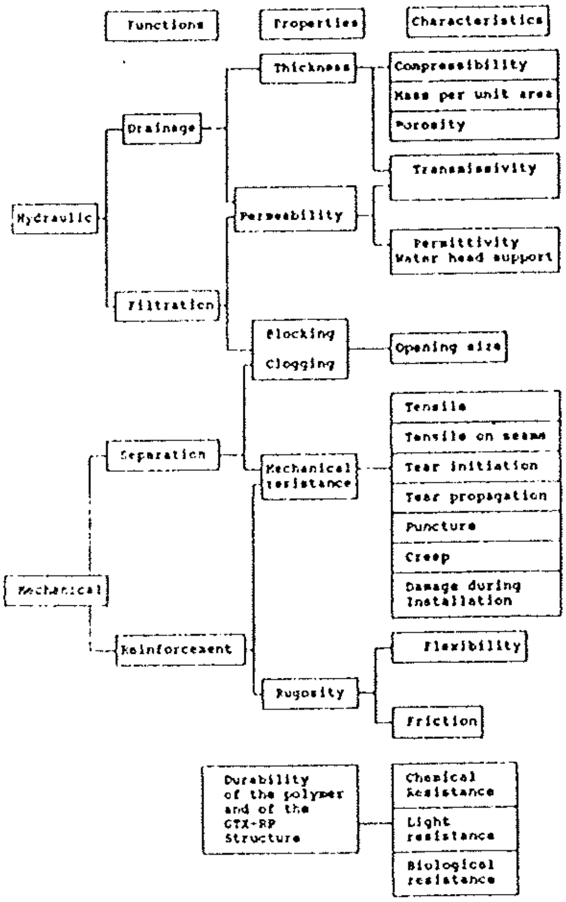

Figure 11 : relations between functions and characteristics [1]

Methods available in West-Europe and in the European Free Trade association (Austria, Switzerland, Finland, Sweden, Norway and Iceland). The author has been appointed as chairman of this committee. The TC's objectives also include the harmonization of the design methods and specifications of use. This will lead to an European manual on geotextiles.
On behalf of the IGS, the author recently prepared an "Inventory of test methods on geotextiles". A computer version of this book is also available.

3.3. Design and specifications

Basically two main approaches of the geotextiles design are possible :

1. whenever possible, adapted design methods originated from the soil mechanic may be used. The exact transposition to the geotextiles is not possible because these materials offer a deformability that is far greater to the one of the soil.
   Some deformations compatibility are to be taken into account;
2. for a lot of cases, the experience accumulated on site permitted to set up recommendations for uses. Minimum values of the geotextiles characteristics are evaluated in function of the cases parameters.

In West-Europe, recommendations are available in Belgium, France, the Netherlands, Switzerland and Austria. Unfortunately, up to now, these recommendations are based on different test standards and also expressed versus different geotextiles characteristics.

A research group leaded by the author is actually realising a computer programme where the above mentionned recommendations would be intergrated.

4. GEOMEMBRANES

4.1. Types of products [6]

The waterproofing barrier can be rigid, flexible or a combination of the two. The flexible membranes are essentially characterized by great deformability and inertia versus the environment.
The geomembranes can be classified versus the nature of the constitutive material and the way they are prepared.
Following the last criteria, two classes can be pointed out :

- membranes realised on site;
- prefabricated membranes.

In each of these classes, one can find :

- homogeneous;
- composites;
- reinforced and
- multilayer membranes.

It must be noticed that some raw materials may be used for both on site fabrication and prefabrication in manufacture. The polymer modified bitumen is a raw material of that category.

Low and high molecular mass thermoplastics, homo or copolymers thermosetting and elastomers are used for flexible geomembranes.

For technical, economical, technological and durability reasons most of the geomembranes are constitued of polymers or rubber including a great variety of admixtures. Without these additives the membranes should not be used.

The mechanical flexibility of these membranes in a range of ambient temperature from - 20 to + 80°C is an important and well appreciated characteristic. This requests polymers, elastomers and rubbers with a very low glass transition temperature (Tg). This flexibility must be compatible with the in-plane mechanical resistance of the geomembrane. It is possible to improve the mechanical properties by the incorporation of woven or non-woven reinforcement. These are made of organic or glass fibers. This induces a significant increase of the maximum stress together with a significant decrease of the allongation at maximum stress.

During the manufacturing process, the raw material is transformed under its liquid state. Depending of the nature of the material, the solid state is obtained by :

- decrease of temperature or
- chemical reaction or
- solvant evaporation or
- emulsion rupture or
- a combination of these.

The geomembrane production process is better controlled in a factory where ambient conditions are rather constant.

4.1.1. Thermoplastics

- Polyethylene (PE) (Tg - 120°C)

This is one of the most used polymer in geomembranes applications, specially in the U.S. It is very well known for its chemical resistance but requires specific admixture for U.V. protection.

It can be classified in :

- H.D.P.E. : high density polyethylene; these membranes are non reinforced;
- H.D.P.E.A. : high density polyethylene alloy;
- L.L.L.D.P.E. : linear low density polyethylene; non reinforced and in very thin (0,25 mm);

- Polyvinyl chloride (PVC) (Tg = function of the plastification).

This is a thermoplastic generally used in combination with plasticizers or with other copolymers. Its durability and its mechanical characteristics are function of the quality and quantity of plasticizers. The PVC membranes can be reinforced or not.

- Polypropylene (PP) (Tg - 70°C)

This is a polyolefine thermoplastic. It is available under 3 structural presentations : atactic, isotactic and syndiotactic. It has been used at the beginning of the uses of flexible geomembranes. It is actually more used for textiles applications, textiles to be used as geomembrane reinforcement.

Polypropylene is also used in combination with bitumen in certain applications of geomembranes.

- Bitumen

The bitumen is constitued of saturated hydrocarbonated elements with a low molecular mass. It is very sensitive to the temperature. This thermal sensitivity can be decreased by treatment with mineral extenders, oils and thermoplastics like polypropylene, polyethylene, PVC or else epoxy resines. The obtained mixes must be stable permanentely at high and low temperature.

Bitume is used in the composition of thermoplastic or thermoset geomembranes. It's also used in the substrat preparation or as adhesive between substrat and membrane. The bitumen based membranes are always reinforced.

4.1.2. Elastomeric thermoplastes

- Chlorosulfonated polyethylene (CSPE) (Tg - 70°C)

This is obtained by chlorination of PE in presence of sulphur oxydes. The chloride content is about 20 %; the sulphur content is about 2 %.

The chlorosulfonyl groups permit a cross-link like an elastomer. This product has the characteristics of an elastomer and has a very good environment resistance.

The CSPE membranes are reinforced.

- Chloronated polyethylene (CPE) (Tg - 100°C)

This is obtained by chloronation of polyethylene. It behaves like an elastomer. The CPE membrane can be reinforced or not.

- Ethylene-propylene diene monomer (EPDM) (Tg - 70°C)

The use of coordination catalysis permits to built up macromolecule structures with elastomer character. The addition of an ethylene molecule to a propylene one gives a structure similar to the isoprene and further to the natural rubber. The incorporation of a diene permits a cross-link. The EPDM has a very good oxydation resistance. The EPDM membranes can be reinforced or not.

4.1.3. Elastomer rubber

- Polyisobutylene (IIR) (Tg - 70°C)

In function of its degree of polymerisation, it takes the aspect of an adhesive paste for the low molecular weight or of a rubber for higher molecular weight.

In presence of a small amount of isoprene (2 %), the polyisobutylene can be cross-linked. After cross-link, the butyl (IIR) behaves like a rubber and has a remarkable environment stability. IIR membrane can be reinforced or not.

- Chloroprene (Tg - 50°C)

Also called neoprene, this elastomer has, after cross-link, a better chemical resistance to ozone, heat, oils greace and U.V. than the natural rubber. These membranes can be reinforced or not.

4.1.4. Thermosetting resines

The thermosetting membranes to be applied on site are made of :

- epoxy;
- non saturated polyester;
- polyurehtane;
- acrylic resines.

These types of membranes are mostly used to achieve the waterproofing properties of rigid systems like concrete, mortar or masonry.

These can adhere to their substrate but they must be able to bridge cracks of their substrate.

In principle, this requirement can be fulfiled only when suffisant thickness and flexibility of the membrane are adopted. The progressive suppression of the adhesion on the edges of the cracks permits a given elongation of the membrane.

Polyamide, polyester or polypropylene fibers can be used to reinforce these types of membranes in these cases.

4.2. Geomembranes characterization [5] [7]

In order to estimate correctly the geomembranes characteristics, tests procedures have been developed but generally in a very specific way in function of the types of products and the types of applications. The complete characterization of a given product requires two major steps :

- identification tests;
- performance tests :
  - . on the geomembrane;
  - . on the joints;
  - . durability.

The type of geomembrane will have a particular influence on the choices of procedures for the identification tests whilst performance tests shall be influenced by the application. If the membrane is included into a "system", the testing programme should also include analysis on each component of the system and analysis on the complete system.

On the other hand, chemical and physical compatibilities of the various components must also be insured.

If a complete information on the characteristics of the products is needed for a technical agreement or a correct design, a reduced programme is necessary for the reception of the products on site.

Certain test procedures on geomembranes may be applied to all types of geomembranes, no matter the nature of the constitutive materials. Whilst other procedures are closely associated to the physical and chemical nature of the geomembrane. We have classified all these procedures in function of their first objectives.
The test procedures applicable specifically to certain type of products are clearly identified as such.

4.2.1. Identification tests

In order to identify the material or the element of the system some simple tests can be performed. They permit to insure that the products delivered on site are similar to what is expected. They also permit a good manufacture quality control.
Table 1 hereafter gives the list of the identification tests.

Table 1 : identification of the geomembranes

- Thickness
- Density
- Tensile test
- Flexibility at low temperature
- Infra-red spectroscopy
- Differential scanning calorimetry
- Thermogravimetric analysis
- Thermomechanical analysis
- Chromatography
- Melt index
- Extractables
- Ash
- Hardness
- Chemical analysis
- Ring-ball (bitumen)
- Penetration (bitumen)
- Dehydrochlororation (PVC)
- Carbone content (HDPE)
- Carbone dispersion (HDPE)

4.2.2. Performance tests

Performance testing covers three different aspects :

- performance tests on the geomembrane;
- performance tests on the joints and
- durability tests.

Performance tests on the geomembrane must demonstrate the ability of the membrane to play its waterproofing function taking the sites stresses and conditions into account (table 2).

Performance tests on the joints refers to the ability of the geomembrane to be well placed and welded on site or into the factory conditions. Problems can be met at the placement when very low temperature conditions occur (table 3).

The objectives of the durability tests are to control the ability of the geomembrane or of the system to resist to the mean and long term stresses. Theses stresses can result from the placement or from the environment of the geomembrane. In general, these stresses are of mechanical, chemical, physical or biological origin. These stresses are applied single or in combination.

So as to accelerate the ageing process, concentrations, temperature or stresses are increased (for laboratory studies). This is not without danger because in general the ageing process is influenced by the environment parameter. On the other hand, to realise tests with constant parameters does not represent reality. In spite of that accelerated tests give precious informations on the sensibility of the geomembranes versus the ageing factors.

After ageing, the wright characteristics of the materials must be checked. Control tests must be choosen in order to point out the specific changes in the material due to ageing. These tests are choosen in the identification or performance tests described before (table 4).

Table 2 : peformance tests on geomembranes

- Tear test
- Bursting strength
- Puncture resistance
- Dynamic puncture
- Cyclic movements
- Friction
- Creep
- Thermal expansion
- Dimensional stability
- Water permeability
- Vapor permeability
- Remanent elasticity (bitumen)
- Melt temperature (bitumen)

Table 3 : performance tests on joints

- Tensile tests on seam
- Peel test
- Non destructive testing :
  . mechanical point stress
  . pressurized dual seam
  . air lance
  . vacuum chamber
  . ultrasonic impedance plane
  . ultrasonic pulse echo
  . electric wires
  . electric fiel

Table 4 : performance test on durability

- Volatiles
- Abrasion
- Thermal ageing
- Frost-thaw ageing
- Xenotest
- Liquids resistance
- Biological resistance
- SO_2 ageing (PVC)
- Ozone ageing (elastomeric)
- Stress-cracking (HDPE)

4.3. Design and specifications of geomembranes

The success of the use of geomembranes in waterproofing constructions is depending of :

- the conception of the project;
- the quality of the materials;
- the quality of the placement of the system;
- the use of the construction.

All the above presented tests are not necessary to give a good idea of the behaviour of the membrane to the conceptor. Each case is different from an other.

Two important points [2] are to be considered in the choice of a geomembrane :

- the chemical nature and
- the mechanical properties of the geomembrane.

The chemical nature of the geomembrane influences its :

- ageing resistance;
- thermal stability;
- thermal expansion;
- chemical resistance;
- mechanical resistance when the membrane is not reinforced;
- ability to be welded on site.

The selection of a geomembrane at its mechanical point of view depends from the type of problem to be solved.

"The best membrane is not necesseraly the strongest one" said GIROUD [8].

In fact, sollicitations on the geomembranes can be applied in stresses (than a reinforced membrane shall be used) or in deformation (than a nonreinforced membrane with high elasticity is to be used).

The table 5 summarizes the types of actions that are to be supported by the geomembrane during its installation and use.

The authors actually develope at GRC a computer programme for the design of geomembranes.

Table 5 : actions on the geomembranes

1. Mechanical actions of gas and liquids

- Wind
- Gas below the membrane
- Liquids on the membrane
- Liquids below the membrane

2. Strains of geotechnical origins

- Slope stability
- Slope deformations due to waves
- Local settlements and cracks
- Settlements
- Differential movements

3. Agressions on the geomembrane

- Agregates and angular objects
- Construction elements
- Vegetation
- Chocs

4. Fabrication and installation of geomembranes

- Bungles during manufacturing
- Accidents during transportation
- Errors during installation
- Errors during welding
- Connections to the constructions
- Accident during installation of materials on the membrane

5. Membrane evolution

- Aging
- Physical evolution of the membrane
- Chemical reaction with the contained liquids
- Mechanical evolution of the membrane

5. CONCLUSIONS

Geosynthetics were developed during the last fiftien years. In fact, they were invented earlier but they really were engineered recently.

The new functions induced by the use of these materials permitted original, cheap and save solutions in geotechnical and civil engineering applications.

Various (too many) test methods and design or specification rules were proposed.

The users are quite puzzled when faced to this multiplicity.

International associations tend to harmonize the various approaches : ISO and CEN namely. Based on the ISO work, the CEN Technical Committee just started the European (18 countries) standards and recommendations harmonization on geotextiles.

This would lead to an easier diffusion of the materials and ideas.

The very important growth rate make it necessary.

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GEOSYNTETYKI: GEOTEKSTYLIA, GEOTEKSTYLNE PRODUKTY POKREWNE I GEOMEMBRANY

Geosyntetyki są syntetycznymi produktami stosowanymi warstwowo albo liniowo w geotechnice lub w budownictwie. Geotekstylia i geotekstylne produkty pokrewne są przepuszczalnymi geosyntetykami, podczas gdy geomembrany są zarówno wodo jak i gazoszczelne. Artykuł opisuje przeznaczenie i zastosowanie geosyntetyków. Podaje ponadto rodzaje i charakterystyki tych produktów oraz zalecane metody ich projektowania.

ГЕОСИНТЕТИКИ: НЕТКАНЫЕ МАТЕРИАЛЫ И ИХ ПРОИЗВОДНЫЕ, ГЕОМЕМБРАНЫ

Геосинтетики являются синтетическими продуктами, которые применяются в геотехнике и строительстве линейным или слоевым образом. Нетканые материалы или их производные продукты являются проницаемыми геосинтетиками, в то время, как геомембраны как водонепроницаемы, так и газонепроницаемы. Статья описывает назначение и применение геосинтетиков. Притом в ней даются виды и характеристики тех продуктов, а также рекомендуемые методы их проектирования.

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