TRISOPLAST®

Soil & Groundwater Protection by Polymer Enhanced Mineral Barrier

RemTech Banff 2009

Dipl.-Geol. Mike Naismith
Contents

1. Introduction Trisoplast®

2. Why do we need Innovation? - Relevant Fields of Examinations
   - Cation Exchange, Desiccation und Root Penetration (Laboratory & Field Investigations)
   - Shear Strength / Slope Stability
   - Differential Settlement / Deformation
   - Properties / Durability
   - Functional Lifetime / Aftercare Costs

3. Conformity with European Directive

4. Examples

5. Conclusions
Trisoplast developed in the Netherlands

Environmental protection is crucial!
What is Trisoplast?

Trisoplast is a polymer modified mineral barrier

![Diagram showing the composition of Trisoplast]

- 1000 kg Granular material (e.g. sand)
- 130 kg Bentonite
- 2.6 kg Polymer
Trisoplast®: Schematic Presentation of the Interaction between Bentonite und Polymer

Legend
- Mineral filler
- Bentonite
- Pore water
- Air
- Monovalent Cations
- Bivalent Cations
- Polymer
- Carbon
- van der Waals Forces
- Cationic Binding
- Anionic Binding
- Hydrogen Bridge-Binding
- Specific Binding
Mobile Mixing plant Setup in Swanscombe, UK
Trisoplast Installation Process
Trisoplast Installation Process
Standard Equipment and Handwork for Small Projects
Compaction with Roller on Slopes
Compaction with Vibrating Plates
Trisoplast®: Surface Finish
±10 Million m² of Trisoplast installed

Trisoplast application 1995-2009
(in m² and in % of total)

- Landfill liners: 2.055.458 m² (21%)
- Landfill covers: 443.432 m² (5%)
- Remediation: 157.280 m² (2%)
- Industry: 6.159.213 m² (63%)
- Infrastructure & construction: 810.635 m² (8%)
- Landscaping: 97.147 m² (1%)
Trisoplast world-wide today

- Argentina
- Belgium
- Bulgaria
- Croatia
- Dubai
- France
- Finland
- Germany

- Ireland
- Italy
- Malaysia
- Mexico
- Portugal
- Romania
- South Africa
- Serbia

- Singapore
- Spain
- Sweden
- The Netherlands
- Ukraine
- United Kingdom
Trisoplast® is a polymer modified mineral Barrier

- **Produced / installed on site:**
  - Local personnel
  - Local Materials (only polymer delivered from NL)
  - Conventional machinery

- **Quality Controlled System:**
  - (Trisoplast Manual)

- **Know-how, Training and Support from the Netherlands:**
  - Field lab equipment and mobile mixing plant can be supplied from NL (for first references)
Properties of Trisoplast®

- **Sealing performance**: Factor 100 to 1000 better than EU requirement for regular clay. \( (k_f \, 0.1 - 3 \times 10^{-11} \, m/s \text{ versus } 1 \times 10^{-9} \, m/s) \)
- **Strength**: Friction like sand and cohesion like clay. Long term slope stability of 1:2 and more can be constructed.
- **Deformability**: Ability to cope with Differential Settlements due to High Plasticity, Self-Healing ability.
- **Durability**: at chemical, biological and physical influences. High resistance to wet/dry cycles, cation exchange.
- **Retention of contaminants**: 9 cm layer equivalent to the 1 meter natural reference impermeable mineral layer as specified in the EU Landfill directive.
Continuous Research by Independent Institutes
Quality Control Testing Trisoplast®
### Percolation rates of different Landfill Barriers at Installation

<table>
<thead>
<tr>
<th></th>
<th>Trisoplast</th>
<th>GCL</th>
<th>BES</th>
<th>Geological Barrier / CCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier thickness (d) ([\text{m}])</td>
<td>0.07</td>
<td>0.09</td>
<td>0.01</td>
<td>1.00</td>
</tr>
<tr>
<td>Hydraulic conductivity (k) ([\text{m/s}])</td>
<td>(3 \times 10^{-11})</td>
<td>(3 \times 10^{-11})</td>
<td>(1 \times 10^{-10})</td>
<td>(1 \times 10^{-9})</td>
</tr>
<tr>
<td>Hydraulic gradient (i) ([-])</td>
<td>14.3</td>
<td>11.3</td>
<td>94.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Percolation rate (q) ([\text{mm/a}])</td>
<td>14</td>
<td>11</td>
<td>89</td>
<td>15</td>
</tr>
</tbody>
</table>

According Darcy (0.3 m hydraulic head, -0.63 m below barrier = field capacity)
Desiccation Damage Clay Dominated Liners

Compacted Clay Liner (CCL)

Geosynthetic Clay Liner (GCL)

Melchior October 1995,
Excavations Field Trial Georgswerder, Hamburg

Research and field excavations by Albrecht, Benson, Melchior, Holzlöhner, Philip, Döll, etc.
Damage by tools, larger particles or whilst installing the cover materials (Bonaparte and Gross 1990)

- Average (study 1990): 14 holes /ha
- Good QA/QC: 2 to 3 holes /ha
- Typical area leak: 1 cm²
- Leakage “best practice” liners 200 litres per hectare per day (73 m³/ha/year)
Landfill Hamburg-Georgswerder

Field Trials

Melchior 1993
Field Trial Georgswerder in October 1995
Annual Leakage Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Bentofix D3000</th>
<th>NaBento</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994/95</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1995/96</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>1996/97</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>1997/98</td>
<td>200</td>
<td>250</td>
</tr>
</tbody>
</table>

Melchior 1995
Cation Exchange in Geosynthetic Clay Liners:
Field Test Georgswerder

Melchior 1998, 2002

Bentofix D3000

NaBento

Melchior 1998, 2002

Montmorillonite structure

Na⁺ / Ca²⁺ ➔ Swell
Carbonate Coating on Bentonite aggregates
Geosynthetic clay liner (GCL): Field Trial Georgswerder
## Annual percolation rates through four different mineral liners used in a cap

<table>
<thead>
<tr>
<th></th>
<th>TRISOPLAST®</th>
<th>GCL</th>
<th>CCL</th>
<th>BES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barrier thickness d [m]</strong></td>
<td>0.07</td>
<td>0.01</td>
<td>1.00</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Hydraulic conductivity k [m/s] as installed</strong></td>
<td>$3 \times 10^{-11}$</td>
<td>$3 \times 10^{-11}$</td>
<td>$1 \times 10^{-9}$</td>
<td>$5 \times 10^{-10}$</td>
</tr>
<tr>
<td><strong>likely increase factor after 10 to 100 years</strong></td>
<td>1-2</td>
<td>10-100,000</td>
<td>2-10,000</td>
<td>2-100</td>
</tr>
<tr>
<td><strong>Percolation rate q [mm/a]</strong></td>
<td>8 / 8-16</td>
<td>52/ &gt;400</td>
<td>35/ 70-&gt;400</td>
<td>26/ 52-&gt;400</td>
</tr>
</tbody>
</table>

(calculation using Darcy’s equation assuming a total hydraulic head of 1 m (0.5 m suction tension, 0.5 m hydraulic head above the mineral liner) over a period of 200 days directly after installation and after 10 – 100 years (based on experiences and independent research results))
Percolation rates Geomembrane

10 holes (1cm² big) per ha

Sand 10-5 m/s

>4000 m³/ha/year

Calculation using Giroud, Badu-Tweneboah & Bonaparte’s equations

GeoMembrane

Good Intimate contact

Soil 10-7 m/s

230 m³/ha/year

1 m Hydraulic head

0,3 m Levelling layer

GeoMembrane

Water
### Annual Percolation rates through a geomembrane

Intimate contact to subgrade and permeability subgrade of high influence on percolation rates:

<table>
<thead>
<tr>
<th>GM= Geomembrane</th>
<th>GM over 0.3 m soil @ 10^{-7} m/s</th>
<th>GM over 0.3 m soil @ 10^{-6} m/s</th>
<th>GM over 0.3 m soil @ 10^{-5} m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>good intimate contact (not likely)</td>
<td>23</td>
<td>127</td>
<td>&gt;400</td>
</tr>
<tr>
<td>poor intimate contact</td>
<td>121</td>
<td>&gt;400</td>
<td>&gt;400</td>
</tr>
</tbody>
</table>

Percolation rates through 10 round holes (1cm² big) per ha in a geomembrane (calculation using Giroud, Badu-Tweneboah & Bonaparte’s equations and a total hydraulic head of 1m (0.5 m suction tension, 0.5 m hydraulic head above membrane) overlying a 0.3 m thick levelling layer of different permeability
# Leachate Treatment Cost

**TRISOPLAST**

- **Formula:** \( T = P(1+R)^a \)
- **Total Net Value \((T)\)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TRISOPLAST</th>
<th>GCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>3.0%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Installation Cost per m²</td>
<td>10 €</td>
<td>5 €</td>
</tr>
<tr>
<td>Installation costs (I)</td>
<td>200,000,00 €</td>
<td>100,000,00 €</td>
</tr>
<tr>
<td>Interest Rate ((R))</td>
<td>4.50%</td>
<td>4.50%</td>
</tr>
<tr>
<td>Surface Area</td>
<td>20,000 m²</td>
<td>20,000 m²</td>
</tr>
<tr>
<td>Leachate in mm</td>
<td>10 mm</td>
<td>200 mm</td>
</tr>
<tr>
<td>Leachate Treatment Cost</td>
<td>10,00 €/m²</td>
<td>10,00 €/m²</td>
</tr>
<tr>
<td>Yearly Leachate</td>
<td>200 m³</td>
<td>4,000 m³</td>
</tr>
<tr>
<td>Yearly Leachate Treatment Cost</td>
<td>2,000 €</td>
<td>40,000 €</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct Cost TRISOPLAST</th>
<th>Interest gain TRISOPLAST</th>
<th>Direct Cost GCL</th>
<th>Morecosts GCL</th>
<th>Morecost GCL / m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200,000,00 €</td>
<td>0</td>
<td>100,000,00 €</td>
<td>-100,000 €</td>
<td>-5,00 €</td>
</tr>
<tr>
<td>1</td>
<td>202,060,00 €</td>
<td>-4,500,00 €</td>
<td>141,200,00 €</td>
<td>-65,360 €</td>
<td>-3,27 €</td>
</tr>
<tr>
<td>2</td>
<td>204,181,80 €</td>
<td>-7,441,20 €</td>
<td>183,636,00 €</td>
<td>-27,987 €</td>
<td>-1,40 €</td>
</tr>
<tr>
<td>3</td>
<td>206,367,25 €</td>
<td>-8,700,62 €</td>
<td>227,345,08 €</td>
<td>12,277 €</td>
<td>0,58 €</td>
</tr>
<tr>
<td>5</td>
<td>210,936,82 €</td>
<td>-5,646,18 €</td>
<td>318,736,40 €</td>
<td>102,163 €</td>
<td>5,11 €</td>
</tr>
<tr>
<td>10</td>
<td>223,615,59 €</td>
<td>41,495,69 €</td>
<td>572,311,83 €</td>
<td>390,192 €</td>
<td>13,51 €</td>
</tr>
<tr>
<td>30</td>
<td>298,005,36 €</td>
<td>1,302,612,99 €</td>
<td>2,080,107,13 €</td>
<td>3,064,715 €</td>
<td>153,24 €</td>
</tr>
<tr>
<td>50</td>
<td>432,361,55 €</td>
<td>6,911,953,80 €</td>
<td>4,747,230,93 €</td>
<td>11,220,823 €</td>
<td>561,34 €</td>
</tr>
</tbody>
</table>

_(simplified fictive Prices!)_
### Aftercare Costs (if allowed for right from the start-excluding the reoccurring earthworks/excavation!!!)

#### TRISOPLAST

<table>
<thead>
<tr>
<th>Time (year)</th>
<th>Lifetime of Barrier (year)</th>
<th>Real Installation Costs (€)</th>
<th>Required Individual Investment today (€)</th>
<th>Required Total Investment today (€)</th>
<th>System Cost (€/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
<td>10,00</td>
</tr>
<tr>
<td>105</td>
<td>200</td>
<td>3,843,726</td>
<td>47,111</td>
<td>247,111</td>
<td>12,36</td>
</tr>
</tbody>
</table>

Maximum Cost Eternity: 261,628

#### GCL

<table>
<thead>
<tr>
<th>Replacement Period (year)</th>
<th>Lifetime of Barrier (year)</th>
<th>Real Installation Costs (€)</th>
<th>Required Individual Investment today (€)</th>
<th>Required Total Investment today (€)</th>
<th>System Cost (€/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>15</td>
<td>100,000</td>
<td>100,000</td>
<td>100,000</td>
<td>5,00</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>155,797</td>
<td>83503</td>
<td>105,503</td>
<td>9,03</td>
</tr>
<tr>
<td>30</td>
<td>45</td>
<td>242,226</td>
<td>64908</td>
<td>245,211</td>
<td>12,27</td>
</tr>
<tr>
<td>45</td>
<td>60</td>
<td>378,160</td>
<td>52172</td>
<td>297,404</td>
<td>14,87</td>
</tr>
<tr>
<td>60</td>
<td>75</td>
<td>589,160</td>
<td>42001</td>
<td>339,840</td>
<td>16,97</td>
</tr>
<tr>
<td>75</td>
<td>90</td>
<td>917,892</td>
<td>33912</td>
<td>373,206</td>
<td>18,66</td>
</tr>
<tr>
<td>90</td>
<td>105</td>
<td>1,430,947</td>
<td>27320</td>
<td>400,516</td>
<td>20,03</td>
</tr>
<tr>
<td>105</td>
<td>120</td>
<td>2,227,966</td>
<td>21913</td>
<td>422,429</td>
<td>21,12</td>
</tr>
</tbody>
</table>

Maximum Cost Eternity: 512,741

Total Cost Saving Trisoplast: 251,113 €  
Saving per m²: 12,56 €

(simplified fictive Prices!)
## Gain of Void Space

Price of Waste: \[ 100 \text{ €} \]

Size of Project: \[ 20,000 \text{ m}^2 \]

Density of Waste: \[ 1 \text{ t/m}^3 \]

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Trisoplast</th>
<th>Trisoplast + Attenuation Layer</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>gained Voidspace in m²</td>
<td>0.91</td>
<td>0.50 (0.09 m + 0.41 m)</td>
<td>1 m</td>
</tr>
<tr>
<td>cost savings in € per m²</td>
<td>91.00</td>
<td>50.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Total cost saving in €</td>
<td><strong>1,820,000 €</strong></td>
<td><strong>1,000,000 €</strong></td>
<td>0.00</td>
</tr>
</tbody>
</table>

*(simplified fictive Prices!)*

**Trisoplast**

**Mineral Liners**
Root Penetration Experiments with Barley on Trisoplast and the Georgswerder Cohesive Soil Barrier Melchior et al. 2001
Percolation Test Cells

- Inflow
- Load plate
- Glas beads
- Vertical displacement meter
- Ventilation with unsat. air
- Outflow
- Trisoplast barrier
- Marl barrier

6 year without damage
Results of wet/dry cycles

- **Clays and GCLs:** Strong influence of drying cycles
  - Glacial Marl (18% clay) fails completely after one drying cycle, visual cracks.
  - Schlieper Ton (36% clay): extremely high initial permeability after two cycles. Original permeability never reached again.
  - Both Calcium and 7kg Na-bentonite GCL have extremely high initial permeability after drying cycles. After saturation (4 - 10 weeks) factor remains 10 to 100 higher than initially. Na-bentonite mat shrinks 5 mm and loses swelling capacity.

- **Trisoplast:** Saturation and desiccation processes take place extraordinarily slowly. Low permeability remains unaffected after several drying cycles (even after 5 years testing) with desiccation stresses of up to 1500 hPa.
### TRISOPLAST®: PERMEABILITY AFTER DEFORMATION

#### BOELS & VAN DER WAL (1999)

**Deformation without damage**

<table>
<thead>
<tr>
<th>Deformation (%</th>
<th>Permeability ((x 10^{-10} \text{ m} / \text{s}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated</td>
<td>Unsaturated</td>
</tr>
<tr>
<td>0</td>
<td>0,06</td>
</tr>
<tr>
<td>1</td>
<td>0,09</td>
</tr>
<tr>
<td>2</td>
<td>0,11</td>
</tr>
<tr>
<td>3</td>
<td>0,16</td>
</tr>
<tr>
<td>5</td>
<td>0,23</td>
</tr>
<tr>
<td>7,5</td>
<td>0,21</td>
</tr>
<tr>
<td>10</td>
<td>0,21</td>
</tr>
</tbody>
</table>

\[
\left(\frac{l_1}{l_0} - 1\right) \times 100
\]
Shear characteristics of Trisoplast

Recommendation for slope stability calculations for preliminary design planning for landfill covers according to AK Trisoplast, 2002

<table>
<thead>
<tr>
<th>CONSTRUCTION PHASE</th>
<th>LONG TERM SHEAR PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of failure</td>
<td>State of failure</td>
</tr>
<tr>
<td>( \varphi' = 35^\circ )</td>
<td>( \varphi' = 30^\circ )</td>
</tr>
<tr>
<td>( c' = 20 \text{ kN/m}^2 )</td>
<td>( c' = 10 \text{ kN/m}^2 )</td>
</tr>
<tr>
<td>State of sliding</td>
<td>State of sliding</td>
</tr>
<tr>
<td>( \varphi'r = 30^\circ )</td>
<td>( \varphi'r = 30^\circ )</td>
</tr>
<tr>
<td>( c' = 10 \text{ kN/m}^2 )</td>
<td>( c' = 10 \text{ kN/m}^2 )</td>
</tr>
</tbody>
</table>
Main Conclusion: → These highly accurate tests confirmed that the actual polymer is marginally or totally non-degradable for a very long time even under very extreme conditions.
Excavations Trisoplast sites (build 1995 - 1996)
2001: Alterra (Uni Wageningen NL) and Melchior & Wittphohl (Hamburg)

Investigation of any negative influences caused by:
- Roots
- Desiccation
- Cation Exchange
- Cracking
- Aggregate Forming
- k-value changes
Excavations Trisoplast Seals in The Netherlands (September 2000)
Braambergen, Almere (130,000 m²)
VBM Rotterdam
Trisoplast Barrier (no Geomembrane)
Results of the Excavations:

- All the excavated Trisoplast seals were intact.
- The permeability remained unchanged at its low level (2.2 to 3.1 *10^{-11} m/s).
- No crack formations or other irregularities could be observed.
- The Trisoplast layers were homogeneous, moist and the plasticity was unchanged.
- Even the layers protected by only very thin cover soils and roots penetrating the layer showed no damage, a good placidity and had a low permeability.
Acceptance of Trisoplast/Compliance with the European Directive

- 0.07 m of Trisoplast can be regarded as equivalent to much thicker Clay (e.g. Germany: 0.5 m at 1 * 10^{-10} m/s)

- 0.09 m Trisoplast + 0.41 m of an existing Subsoil generally offer a better protection than the 0.5 m thick artificially reinforced Geological Barrier as specified in the European Directive

- Trisoplast has already been approved as Mineral Barrier for Landfill Capping and Basal Lining in a number of European & Non-European Countries
Landfills and Remediation

- covering layer
- drainage layer
- waste
- TRISOPLAST
- subgrade
Engineered barriers for Dutch landfills (e.g. basal liners)

Trisoplast (9cm), clay (50cm) or sand-bentonite (50cm)

Reference mineral layer municipal waste landfill
NL: 0.5 m; k-value < 2.3 x 10^-10 m/s
EU: 1 m; k-value < 1.0 x 10^-9 m/s
1998-2001

- Clean up and Isolation Constructions 155 Mio €
- Estimation of full modern liner and capping construction max 40 Mio €
Landfill bottom liner
Hengelo, the Netherlands 2007
Basal Lining Landgraaf 1/2 (60.000 m²)
Basal Lining Landgraaf 2/2 (60,000 m2)
Landfill Cap
Trisoplast® handling by -10 ° Celsius
Capping Zevenbergen (215,000 m²)
Trisoplast® Landfill Capping Netherlands
VBM Rotterdam: Re-capping 10 year old BES with Trisoplast
Capping Frizzi-Au, Italy 12,500 m²
Basal Lining Italy Steep Slope Application

Slope Angle:
1:1.5 = 34

Slope length:
65 mtr
Basal Lining with Trisoplast, Landfill Frizzi Au 2005
Steeper than you can walk!!!
Landfill bottom liner
Kuching, Sarawak, Malaysia 2003
Trisoplast® using Foundry Sand
Tailing ponds at Baia Mare project
Maramures, Romania 2004
Tailing ponds at Baia Mare project
Maramures, Romania 2004
Industry

- concrete / gravel
- drainage layer
- TRISOPLAST
- subgrade
Tank park
Liner for (benzene) tank park Shell
Singapore 2008
Liner for (benzene) tank park Shell Singapore 2008
Remediation Buyskade, capping of polluted area
Amsterdam, Netherlands 1996
Remediation former gas plant, capping polluted area + pond construction
Westergasfabriek Amsterdam, Netherlands 2004
Trisoplast® for Industrial Sites
Trisoplast® for Industrial Sites
Infrastructure and Construction

- covering layer
- drainage layer
- waste
- TRISOPLAST Mineral Liners
- subgrade
Highway construction
Oss Paalgraven, Netherlands 2005-2006
Highway construction
Oss Paalgraven, Netherlands 2005-2006
Canal Orléans, France 2007
Canal
Orléans, France 2007
Landscaping

covering layer

drainage layer
Private pond
Tanques, France 2006
Ponds Golf course Prise d’eau
Tilburg, Netherlands 2007
Ponds Golf course Prise d’eau
Tilburg, Netherlands 2007
Ponds Golf course Prise d’eau
Tilburg, Netherlands 2007
Ponds in public park
Thiais, France 2007
Ponds for Recultivation at Former Mining Area
Drocourt, France 2007
Ponds for Recultivation at Former Mining Area
Drocourt, France 2007
Ponds for recultivation at former coal mining area
Drocourt, France 2007
Ponds for Recultivation at former Coal Mining Area
Drocourt, France 2007
Ponds for Olympics 2012 Development
Swanscombe, London, UK 2008. 170,000 m²
Private pond
Nuenen, Netherlands, 2006
Private Pond
Nuenen, Netherlands, 2006
Private Ponds Duysels Hof Estate
Duizel, Netherlands 2002-2003
Private ponds Duysels Hof Estate
Duizel, Netherlands 2002-2003
Private Ponds Duysels Hof Estate
Duizel, Netherlands 2002-2003
Private pond
Kaatsheuvel, Netherlands 2002
Pond Crayenstein estate
Vught, Netherlands 2005

TRISOPLAST
MINERAL LINERS
Ponds at Fauna Overpass De Borkeld
Rijsen, Netherlands 2003
Summarising Main Advantages Trisoplast:

- **Sealing** like the highest quality of clay, self-healing ability
- **Strength** like sand (durable slopes up to 1:1.5)
- **Flexibility** like chewing gum, no stress cracking
- **Durability** robust natural materials improved by modern polymer technique
- **Quality** simple installation of homogeneous mixtures, simple sealing to structures and penetrations, not damaged by sharp particles
Thank you