Exclusive advantages of Précontraint Serge Ferrari® technology

The worldwide patented Precontraint Serge Ferrari® technology confers unique properties to the Precontraint® composite materials compared to conventional coated fabrics.

**Precontraint composite materials**
- Tensioned in both directions during the coating process.
- More consistent from batch to batch.
- Balanced in both directions:
  - Straight yarns
  - Low crimp
  - Low elongation
  - Far smoother surface

**Conventional coated fabrics**
- Tensioned only in warp direction.
- Less consistent from batch to batch.
- Non balanced, in weft:
  - Non straight yarns
  - Higher crimp
  - Higher elongation
  - Uneven surface

**240 microns Top coat**
- Better protection of the yarn against UV, weathering and abrasion

**80 microns Top coat**
- Less protection of the yarn against UV, weathering and abrasion

**Proven consistency**

Comparative bi axial testing of 4 different batches demonstrates:
- A balanced elongation between warp and weft,
- An homogenous elongation under load of 4 different batches.

This allows reasonable and **consistent compensation levels** from one batch to another, and a better control of the installation.

"Results are virtually 100% the same for the different batches. We therefore conclude that this material is very uniform".

Blum Laboratory

**Limited creep**

 Précontraint Serge Ferrari® technology enables a limited creep, balanced between warp and weft.
For conventional textiles, the weft creep is 3 to 4 times higher than the warp creep.

Elongation in the weft direction under a 200 daN/m load over a period of 100 hours. Then residual elongation without load.
Mechanical longevity

The thicker surface coating of Serge Ferrari Précontraint composite materials provides greater protection to the base cloth and much higher mechanical resistance characteristics over time - critical to the lifespan of your installations.

An independent ENKA study was conducted on 3 fabrics with different thicknesses. The tensile strength was measured annually over 10 years, in Florida USA. The graph dramatically demonstrates the benefits of thicker coatings on the residual strength of the fabric.

> High residual strength on long term exposed buildings: The following results, measured on actual material sampled from the building, under different worldwide climate, reveal very high residual strengths values. It confirms the durability of Précontraint composite based on technical advances in polymer formulation, thread and surface treatments.

- **Airbus hangar – 1982**
  - Bremen - Germany
  - Précontraint 1302
  - Tensile resistance after 22 years:
    - Warp 97% - Weft 84%

- **Exhibition hall – 1982**
  - Port-Gentil - Gabon
  - Précontraint 1302
  - Tensile resistance after 18 years:
    - Warp 86% - Weft 76%

- **School covered playground - 1994**
  - Kerikeri - New Zealand
  - Précontraint 702
  - Tensile resistance after 14 years:
    - Warp 96% - Weft 98%

- **Les Halles Carpark Facade - 1994**
  - Avignon - France
  - Précontraint 392
  - Tensile resistance after 12 years:
    - Warp 90% - Weft 80%

- **Car dealership - 2000**
  - Johannesburg - South Africa
  - Précontraint 1002
  - Tensile resistance after 12 years:
    - Warp 80% - Weft 85%

- **Walkway Cover – 1989**
  - Paris - France
  - Précontraint 1002
  - Tensile resistance after 11 years:
    - Warp 97% - Weft 86%

- **Ladies Pavilion – 1996**
  - Abu Dhabi - U.A.E
  - Précontraint 1202 Fluotop
  - Tensile resistance after 10 years:
    - Warp 89% - Weft 98%

- **Radisson Hotel – 1996**
  - Cape Town - South Africa
  - Précontraint 1002
  - Tensile resistance after 10 years:
    - Warp 99% - Weft 100%
Aesthetic longevity

**Resistance to microbial attacks of Fluotop treatment**

Resistance to micro-organisms development is tested in compliance with ISO 846 Method A. The material is exposed for 4 weeks at 29°C in a solution containing various micro-organisms. The material is classified on a scale from 0 (inert: no micro-organisms development) up to 5 (100% of the material surface colonised by micro-organisms).

<table>
<thead>
<tr>
<th>Fluotop Treatment</th>
<th>ISO 846 Method A Description</th>
<th>Class 0 (inert)</th>
<th>Class 2 (25% of the surface colonised)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Précontraint 1202 Fluotop T</td>
<td>• Brand New</td>
<td>Class 0 (inert)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• After 10 years (Abu Dhabi)</td>
<td>Class 0 (inert)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• After 13 years (Malaysia)</td>
<td>Class 0 (inert)</td>
<td></td>
</tr>
</tbody>
</table>

Ladies Pavilion - Abu Dhabi, UAE
Average relative humidity: 65%

Sukan Negara Train Station - Kuala Lumpur, Malaysia
Précontraint 1202 Fluotop T - Installation: 1997 - Sampling: December 2010
Average relative humidity: 80%

**“Low Wick” thread treatment**

The high-tenacity polyester threads are protected with “Low Wick” (anti-capillarity treatment) at the Serge Ferrari Group’s spinning facility. This treatment prevents moisture rising up the threads, mainly from the exposed edge of the weld. This results in a far better membrane appearance due to uniform translucency.

**Effective and durable surface treatments**

A 4 000h exposure to an accelerated weathering test, in compliance with EN ISO 4892-3, simulates approximately a 3 year-ageing through outdoor exposure to UV, heat and humidity in Florida.

Fluotop T2 and S2 surface treatments behave very well in front of combined action of UV, heat and humidity. The Fluotop T2 formula, with high PVDF concentration, remains white for a longer period of time. This is proven in its 15 years of experience in applications around the world.

**White colour evolution**

<table>
<thead>
<tr>
<th>Précontraint 1002 S2</th>
<th>Précontraint 1002 Fluotop T2</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔE = 5.5</td>
<td>ΔE = 3.5</td>
<td>CIE Lab</td>
</tr>
</tbody>
</table>

**Surface treatment adhesion**

<table>
<thead>
<tr>
<th>Précontraint 1002 S2</th>
<th>Précontraint 1002 Fluotop T2</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>No peeling</td>
<td>No peeling</td>
<td>Scotch tape test</td>
</tr>
</tbody>
</table>

* These values are obtained after tests on at least 20 batches.

ΔE: In colorimetric space, a colour is expressed as \( l^*a^*b^* \) along 3 axes: \( l^* \) = clarity; \( a^* \) = red/green axis; \( b^* \) = yellow/blue axis

A colour change is expressed by a variation of \( l^*a^*b^* \) values (coordinates)

ΔE is the colorimetric distance between a sample and a reference: the higher its value, the more distant the compared colours are.
Uniformity of colour per translucency

The Serge Ferrari Group has designed innovative tools for accurately measuring and controlling the color translucency (VISU SERVICES); where in the past the standard practice was to measure only the reflection. Thanks to this tool, Serge Ferrari improves uniformity of color per translucency within batch and from batch to batch. VISU SERVICES is a daily help to choose the most ideal production mix for a given project.

Thermal performance: Textherm exclusive tool

Textherm is a preliminary calculation software for an air-conditioning unit (AC unit):
It calculates the required electrical power of the AC, depending on the nature of the envelope in a given context. Thereby allowing the simulation of various material options prior to construction—including translucent, opaque, LowE membranes as well as single and double layer skins.

Case Study

<table>
<thead>
<tr>
<th>Location</th>
<th>Abu Dhabi</th>
<th>Indoor activity</th>
<th>Sports</th>
<th>Membrane surface</th>
<th>2 000 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside temperature</td>
<td></td>
<td>Indoor activity</td>
<td>Sports</td>
<td>Membrane surface</td>
<td>2 000 m²</td>
</tr>
<tr>
<td>Inside target temperature</td>
<td></td>
<td>Outdoor activity</td>
<td>Number of people</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Single membrane translucent</td>
<td>Précontraint 1002 Fluotop T2</td>
<td>Required electric power = 245 kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double membrane translucent</td>
<td>Précontraint 1002 LowE (int.) + Précontraint 1002 LowE (ext.)</td>
<td>Required electric power = 131 kW</td>
<td>-46%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Précontraint 702 LowE (int.) + Précontraint 1002 LowE (ext.)</td>
<td>Required electric power = 109 kW</td>
<td>-55%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Serge Ferrari sustainability policy

Texyloop®: unique and operational recycling process

Thanks to an organised collection network, end-of-life materials are recycled at Texyloop® facility at Ferrara, Italy since 2008.

### Overall process

<table>
<thead>
<tr>
<th>PVC COMPOSITE MEMBRANES AND TEXTILES</th>
<th>2nd generation raw materials for multi-applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GRINDING</td>
<td>Non woven</td>
</tr>
<tr>
<td>2. SELECTIVE DISSOLUTION</td>
<td>Kedar: extruded PVC</td>
</tr>
<tr>
<td>3. FIBERS’ SEPARATION</td>
<td>Polyester yarn and woven fabric</td>
</tr>
<tr>
<td>4. PRECIPITATION OF PVC</td>
<td>Liner: laminated PVC</td>
</tr>
<tr>
<td>5. SOLVENT REGENERATION</td>
<td></td>
</tr>
<tr>
<td>PVC + SOLVENT</td>
<td></td>
</tr>
<tr>
<td>FLEXIBLE PVC</td>
<td></td>
</tr>
<tr>
<td>POLYESTER FIBERS</td>
<td></td>
</tr>
</tbody>
</table>

### Why is recycling so efficient?

- The Life Cycle Assessment shows that the greatest environmental impacts in our industry (80% on average) are generated by raw material extraction and production.
- The Texyloop® recycling process avoids incineration and landfill disposal.
- By creating second generation raw materials, Texyloop® avoids further extraction of resources from the earth.

The second generation raw materials of high intrinsic value are used by Serge Ferrari Group’s or other industries’ production chains.
Life Cycle Assessment (LCA)

The Life Cycle Assessment (LCA) is measuring the environmental impacts of any product from raw material extraction to the end of the life cycle. Our Life Cycle Assessment has been conducted on the whole Précontraint range by an external environmental consultant, EVEA France, in conformity with ISO 14040 series and submitted to a peer review made by CIRAIG (Canada).

Impact measurements are converted into common denominator equivalent, chosen among well-known substances and standard units (kg Antimony eq, kg CO2 eq, ...).

The overall impacts of Serge Ferrari Précontraint composite materials are significantly reduced when recycled by means of Texyloop®.

Comparative analysis depending on end-of-life scenarios

<table>
<thead>
<tr>
<th>Type of impacts</th>
<th>Texyloop® recycling</th>
<th>Landfill</th>
<th>Incineration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource depletion</td>
<td>0.024</td>
<td>0.151</td>
<td>0.151</td>
</tr>
<tr>
<td>Global warming</td>
<td>2.572</td>
<td>4.104</td>
<td>4.757</td>
</tr>
<tr>
<td>Human toxicity</td>
<td>0.679</td>
<td>1.326</td>
<td>1.414</td>
</tr>
<tr>
<td>Water consumption</td>
<td>139.6</td>
<td>339.6</td>
<td>341.3</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>59.7</td>
<td>103.3</td>
<td>103.3</td>
</tr>
<tr>
<td>Bulk waste</td>
<td>0.081</td>
<td>1.358</td>
<td>0.252</td>
</tr>
<tr>
<td>Hazardous waste</td>
<td>0.0011</td>
<td>0.0029</td>
<td>0.0029</td>
</tr>
</tbody>
</table>

Complete LCA reports, including other types of impacts, are available on request.

LEED certification

Heat Island Effect

The LEED credits requires a Solar Reflectance Index (SRI) >78 for flat roofs and >29 for sloped roofs.

Précontraint membranes help fighting the Heat Island effect, and therefore provide 1 full point under the credit SSc7.2/GIB C9 (roof) and 2 full points under the credit SSc7.1 (non roof).

Additional contributions

Précontraint composite materials can also contribute to the following credits:

• Credit SSc8 - Light pollution reduction
• Credit IEQ 8.1 - Daylight
• IDc1 - Innovation and design

Detailed LEED reports are available on request.

Solar reflectance index (SRI)

<table>
<thead>
<tr>
<th>Précontraint 1002 Fluotop T2 &amp; S2</th>
<th>ASTM 1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref 8341: Champagne</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>Ref 1076: Beige</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Ref 2152: Red</td>
<td>&gt; 30%</td>
</tr>
<tr>
<td>Ref 2158: Green</td>
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</table>

Environmental communication in conformity with ISO 14021

In september 1999, the ISO published the ISO 14021 standard concerning self-declaration on environmental issues, also called Type II declarations.

The main objective of this standard is to clarify the environmental communication, where the best can be found next to the worst.

ISO 14021 requires the environmental communication to be: exact, precise, verifiable, pertinent and not misleading.

More information: www.texyloop.com
Sustainability case studies

Lord’s Cricket Club – London – UK

• Architect: Michael HOPKINS
• Engineer: OVE ARUP
• Serge Ferrari composite material: Précontraint 1002 T2
• Material area: 1200 sqm

Membrane changed after 19 years in service
> Dismantled in December 2005 in 1 Day
> Re-installed in December 2005 in 7 Days
The original membrane was recycled with Texyloop®.

German Pavilion – Shanghai 2010 Universal Exhibition

• Architect: Schmidhuber + Kaindl (Munich)
• Serge Ferrari composite material: Stamisol FT 371
• Material area: 21 000 sqm

Building dismantled after exhibition
> Recycling via Texyloop® offers a viable end of life solution for temporary buildings and reducing the impact on the environment.

Comparative LCA depending on end-of-life scenarios
Functional unit: 1 sqm Stamisol FT 381

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>ENERGY CONSUMPTION</th>
<th>RESOURCES DEPLETION</th>
<th>GLOBAL WARMING</th>
<th>HUMAN TOXICITY</th>
<th>BULK WASTE</th>
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<tr>
<td>Landfill in China</td>
<td>100 Megajoule eq.</td>
<td>0,100 Kg Sb eq.</td>
<td>5 Kg eq. CO₂</td>
<td>5 Kg eq.</td>
<td>1.4 DB eq.</td>
</tr>
<tr>
<td>Incineration in China</td>
<td></td>
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Contact
• Headquarters: + 33 (0)4 74 97 41 33
• Your local representative: www.sergeferrari.com

→ TEXYLOOP®
• The Serge Ferrari operational recycling chain
• Secondary raw materials of high intrinsic value compatible with multiple processes
• A quantified response to combat depletion of natural resources

www.texyloop.com