3D WARP INTERLOCK FABRIC
FROM GENERAL DEFINITION TO
VARIOUS TRANSPORTATION
APPLICATIONS

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2nd WORLD CONFERENCE
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ENSAIT (www.ensait.fr)

Since 1881
National Textile Engineer College
Plan

• Definition of 3D warp interlock fabric

• 3D fabrics as fibrous reinforcement for transportation applications
General definition of 3D warp interlock fabrics

### Different types of textile architectures

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Axis</th>
<th>0 Non-axial</th>
<th>1 Mono-axial</th>
<th>2 Biaxial</th>
<th>3 Triaxial</th>
<th>4 Multi-axial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1D</td>
<td></td>
<td>Roving yarn</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2D</td>
<td></td>
<td>Chopped strand mat</td>
<td>Pre-impregnation sheet</td>
<td>Plain weave</td>
<td>Triaxial weave knit /12/</td>
<td>Multi-axial weave, knit /13/</td>
</tr>
<tr>
<td>3D</td>
<td>Linear element</td>
<td>3-D braid /14/</td>
<td>Multi-ply weave</td>
<td>Triaxial 3D-weave /15/</td>
<td>5-Direction construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plane element</td>
<td>Laminate type</td>
<td>H or I Beam /16/</td>
<td>Honeycomb type</td>
<td>Integral throat exit for nuclear missile /17/</td>
<td></td>
</tr>
</tbody>
</table>
3D FABRICS AS FIBROUS REINFORCEMENT FOR TRANSPORTATION APPLICATIONS
# MAPICC Solutions (EUROPEAN Project) pilot scale development

<table>
<thead>
<tr>
<th>End Users</th>
<th>MAPICC solutions (pilot scale)</th>
<th>Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO-MAPICC</td>
<td><img src="AUTO-MAPICC.png" alt="Image" /></td>
<td>MECAPLAST</td>
</tr>
<tr>
<td>TRUCK-MAPICC</td>
<td><img src="TRUCK-MAPICC.png" alt="Image" /></td>
<td>VOLVO TRUCKS</td>
</tr>
<tr>
<td>RAIL-MAPICC</td>
<td><img src="RAIL-MAPICC.png" alt="Image" /></td>
<td>ALSTOM</td>
</tr>
</tbody>
</table>

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*MAPICC Solutions (EUROPEAN Project)*

*End Users*
- AUTO-MAPICC
- TRUCK-MAPICC
- RAIL-MAPICC
AUTO-MAPICCC solution

AUTO-MAPICC solution

Automotive oil pan

Metallic part

Composite part
AUTO-MAPICC solution

Composite solution

3D warp interlock fabric

Thermocompression

Folding

Corner

Yield

842 Tex

% E-glass / % Polypropylene (% volume)

46% / 54%

Diameter E-glass/polypropylène filaments

14.5 μm / 43.0 μm

Young modulus

10.5 GPa

Elongation at strength

3.22%

Tensile Tenacity

20.78 cN/tex

Commingled yarn

AUTO - MAPICC solution
AUTO-MAPICC Solution

3D Thermoplastic (E-glass and polypropylene) textile fabric

IR heating system

Mold
AUTO MAPICC Solution
Production of 3D warp interlock fabrics

3D warp interlock fabric made with E-glass and Polypropylene commingled yarns

3D warp interlock A-L 6 2-2 Twill 2-2
AUTO MAPICC Solution

Different dry preform shapes (hemispherical and gusset) have been done in one step production.
# Measurements of 3D forming parameters

<table>
<thead>
<tr>
<th>Material drawing-in</th>
<th>Warp and weft yarns shearing</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Material drawing-in" /></td>
<td><img src="image" alt="Warp and weft yarns shearing" /></td>
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<table>
<thead>
<tr>
<th>Thickness variation</th>
<th>Sliding between external layers</th>
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<td><img src="image" alt="Sliding between external layers" /></td>
</tr>
</tbody>
</table>

Cabin truck seat reinforcement

Metallic part

Composite solution

Lightweight

Crash resistant
TRUCK MAPICC Solution

Composite solution

3D warp Interlock fabric

Commingled yarn

Yield: 842 Tex
% E-glass / % Polypropylene (% volume): 46 % / 54 %
Diameter E-glass /polypropylène filaments: 14,5 μm / 43,0 μm
Young modulus: 10,5 GPa
Elongation at strength: 3,22 %
Tensile Tenacity: 20,78 cN/tex

Thermo-compression

Gluaing

Bolting
TRUCK MAPICC Solution

Weight reduction

3.46 Kg → 1.54 Kg

Crash test resistant
RAIL MAPICC Solution

Metallic pat

Commingled yarn

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>960 Tex</td>
</tr>
<tr>
<td>% E-glass / % Polyamide</td>
<td>41 % / 59 %</td>
</tr>
<tr>
<td>Diameter E-glass / polyamide filaments</td>
<td>16,7 μm / 31,6 μm</td>
</tr>
<tr>
<td>Young modulus</td>
<td>10,5 GPa</td>
</tr>
<tr>
<td>Elongation at strength</td>
<td>3,22 %</td>
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<td>Tensile Tenacity</td>
<td>20,78 cN/tex</td>
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</tbody>
</table>

Composite solution

3D warp Interlock fabric

Thermo-compression
RAIL MAPICC Solution

Version 1

Version 2
Thank you for your attention

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