Core Below the Waterline

enabling performance

LANTOR

COMPOSITES

Improving all aspects of boat hull construction using Lantor core materials

enabling performance

LANTOR

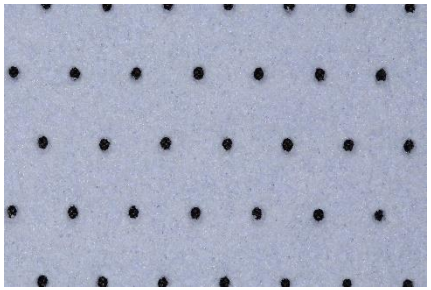
Introduction to Lantor

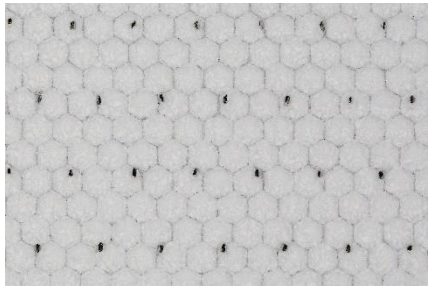
- Dutch company, location Veenendaal
- Founded 1959, 140 FTE's
- Four product groups
- Production, Development and Sales all together
- Supplying composite industry worldwide

LANTOR

Lantor Coremat®

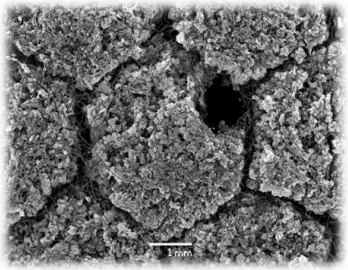
- Polyester Nonwoven with hollow microspheres & binder system
  - Resin cannot go where microspheres are

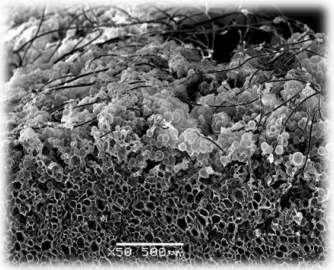


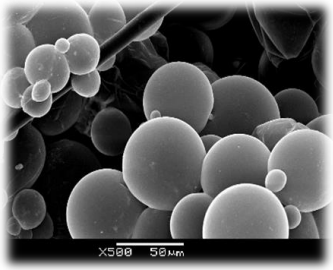


- Flexible Structure

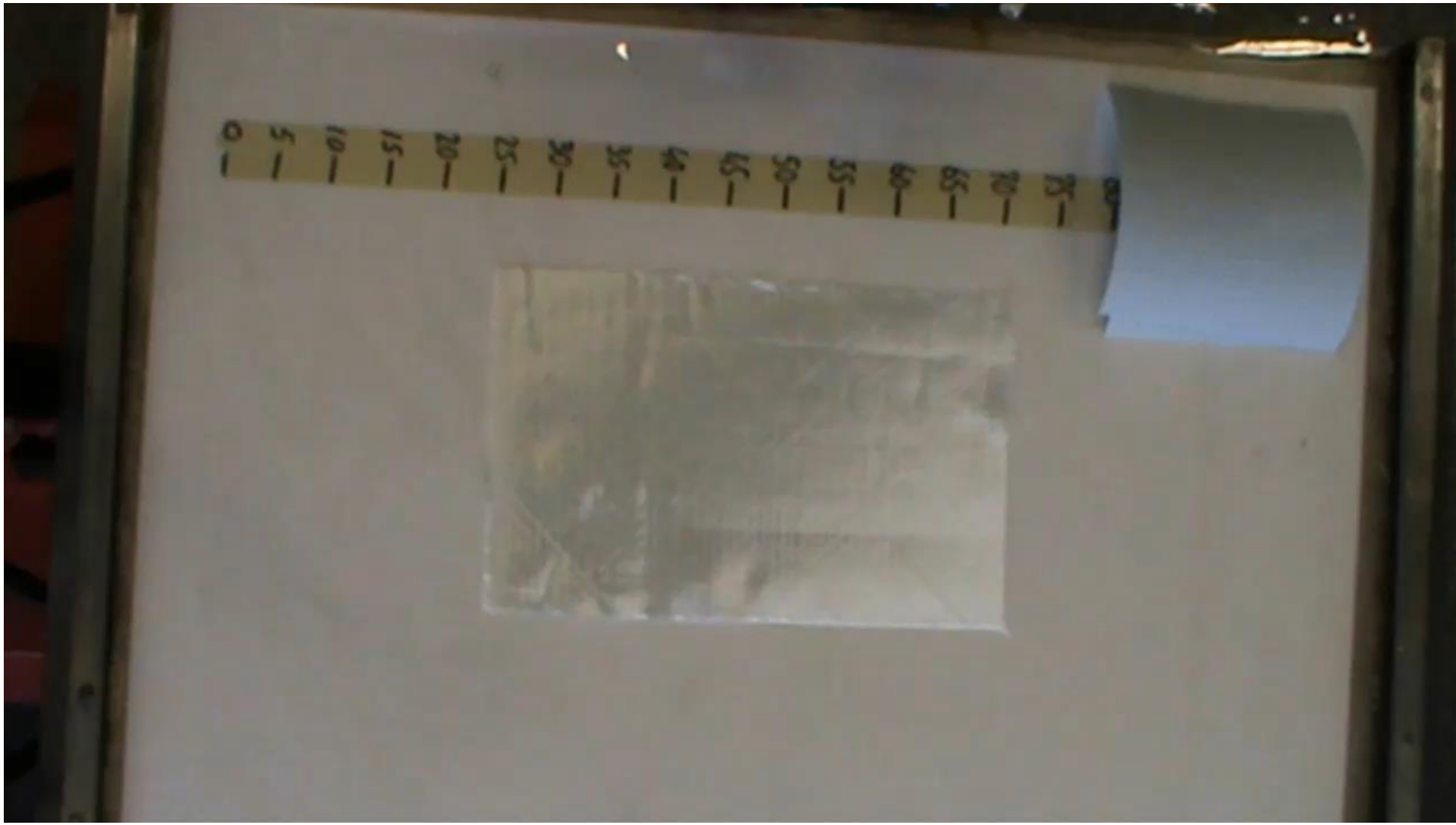
- Very shape compliant







LANTOR



Lantor Coremat®

Application of Coremat as a printblocker

Gel coat
2 X CSM
Coremat Xi
Reinforcements
Core
Reinforcements

Copyright Schoechl Yachts

Gel coat
3 X CSM
Coremat Xi2
Reinforcements
Reinforcements

LANTOR

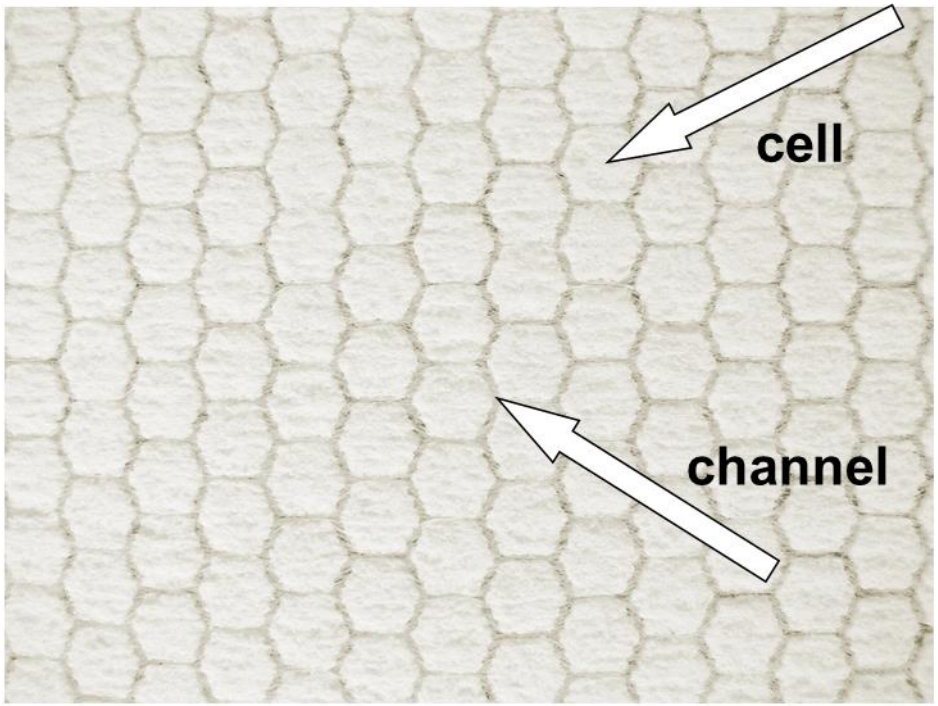
Lantor Soric®

- Polyester Nonwoven with hollow microspheres & binder system
  - Resin cannot go where microspheres are
- Flexible Structure
- Pressure resistant

LANTOR

Lantor Soric®

A polyester nonwoven + cells filled with micro spheres



LANTOR

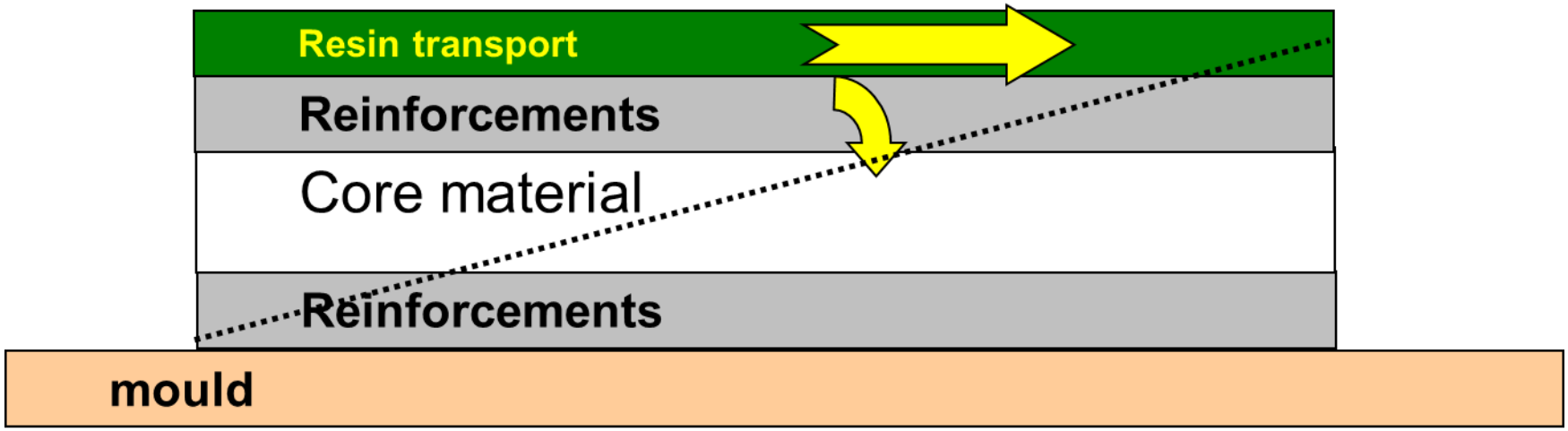
Lantor Soric®

- Cells:
  - Filled with microspheres
  - Low compressibility
  - Compensates thickness loss → Stiffness
- Channels:
  - No microspheres
  - Allow resin transport
  - Realize bonding between the skins

Lantor Soric®

Solid core material infusion

- Resin transport on the top side of the laminate
- Impregnation from top down.

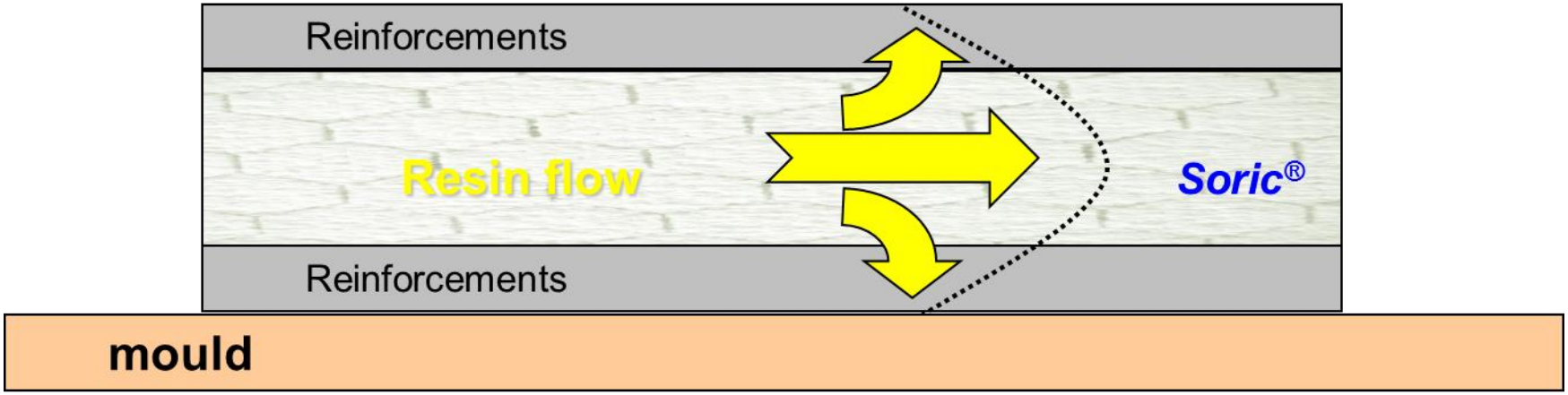


LANTOR

Lantor Soric®

Infusion with Soric®

- Interlaminar infusion medium and core
- The channels allow resin transport in the laminate
- Reinforcements are impregnated from the inside

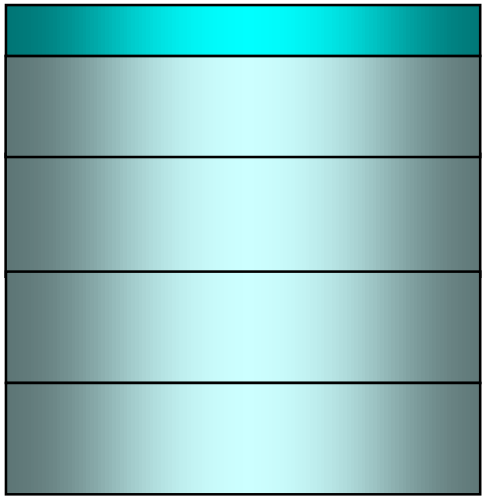


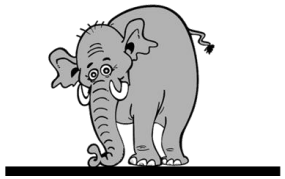
Lantor Soric®

LANTOR

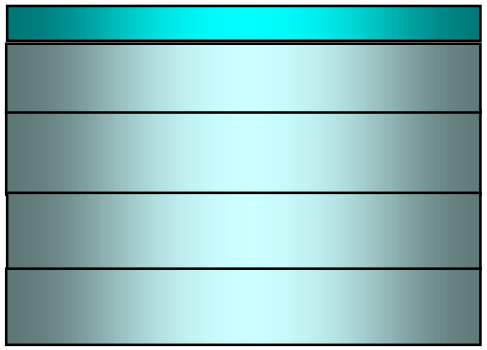
Lantor Soric® application

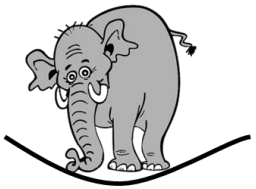
hand lay up → vacuum infusion





stiff enough



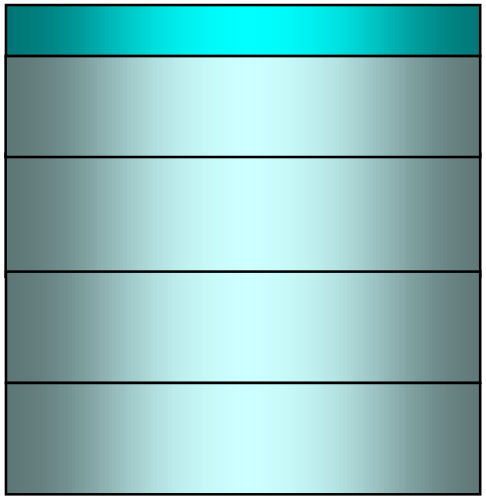


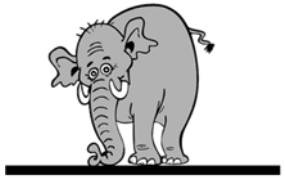
not stiff enough

LANTOR

Lantor Soric®

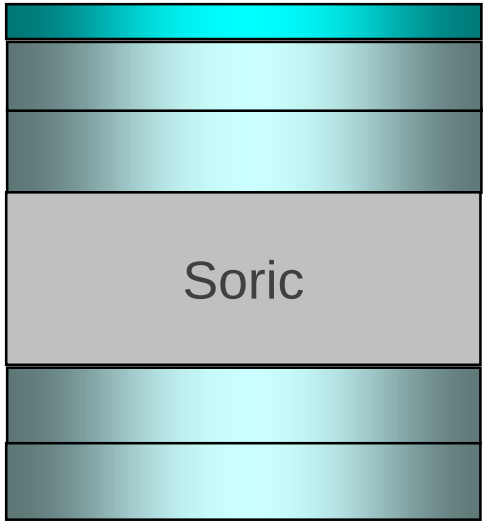
hand lay up → vacuum infusion

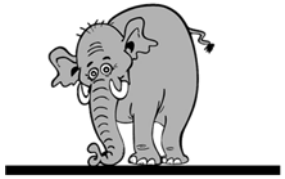




stiff enough

→





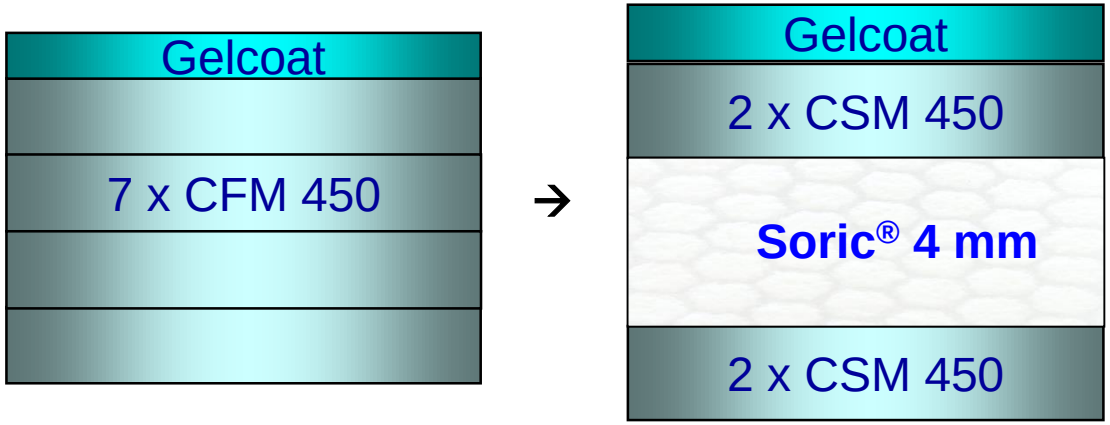
stiff enough

LANTOR

Soric® as flexible core

- Saves fibres & resin
- Creates thickness → Stiffness without adding weight
- Higher mechanical properties with Soric®

- example laminate build with Soric® :



Stiffness	**+10%**
Weight	**-25%**
Glass	**-15%**
Resin	**-30%**

LANTOR

Grades of Soric®

- **Soric SF**
  - For better drapeability and thin laminates
  - 2 - 3 mm thickness
- **Soric XF**
  - For high flow rates
  - 2 - 3 - 4 - 5 - 6 mm thickness
- **Soric TF**
  - Print blocker
  - 1,5 - 2 - 3 mm thickness
- **Soric LRC**
  - Low Resin Consumption for extra weight reduction
  - 1.5 - 2 - 3 mm thickness

LANTOR

Grades of Soric®

[redacted]

Soric® as a co-infusion medium

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Soric® as a co-infusion medium

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Soric® as a co-infusion medium

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Changes to ISO12215-5

INTERNATIONAL STANDARD

ISO 12215-5

First edition
2008-04-15

Small craft — Hull construction and scantlings —

Part 5:
Design pressures for monohulls, design stresses, scantlings determination

LANTOR

Changes to ISO12215-5

From ISO12215-5:2008:

— if the total thickness is 1,15 *t*, the bulking material thickness shall be 0,33 times the total laminate thickness, i.e. a bulking thickness 0,383 *t* and each skin 0,383 *t*;

— if the total thickness is 1,30 *t*, the bulking material thickness shall be 0,50 times the total laminate thickness, i.e. a bulking thickness 0,65 *t* and each skin 0,325 *t*.

New text in 2017 draft:

A.10.1.2 Resin-saturated foam / felt and syntactic foam

Resin saturated foam or felt shall be analysed using annex H, as per H 1.3.10.2 i.e sandwich with a core effective in bending. The mechanical properties of resin saturated foam/felt and syntactic foam shall be the ones given by the product manufacturer or derived from tests.

H.3.2 Core effective in bending

Where using core carrying bending loads, like bulking material, plywood or red cedar planks, the sandwich theory does not apply. A table similar to Table H.4 should be used and one should check that the stress at the outer face of the core –with and E value >> than sandwich core- is not greater than the design direct stress σ_d.

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Lantor Design Values

Important general design values for analysis:

- See product datasheet for type specific values
- Values are in combination with Unsaturated Polyester

- Shear strength > 3MPa (>430psi)
- E Modulus >800MPa (>116,000psi)
- G Modulus >20MPa (>2900psi)
- Tensile Strength 5MPa (725psi)
- In-Plane ultimate strain 0,6%
- Out-of-plane Compressive Strength >4MPa (>580psi)

ABS TYPE APPROVED PRODUCT

Soric XF
Soric TF
Coremat XI

APPROVED LR TYPE APPROVAL SCHEME

Soric XF
Soric TF
Coremat XI
Coremat XM

Lantor Design Application

Sandwich in Bending

- Deformation is linear and zero at neutral axis
- PVC core Ultimate Strain (ε_{ult})= >6%
- Coremat/Soric ε_{ult} = 0.6%
- Glass fibre ε_{ult} = 1.1 - 3%

Maximum strain in adjacent Glass fibre layer is the lesser of the Fibre strain or Core strain

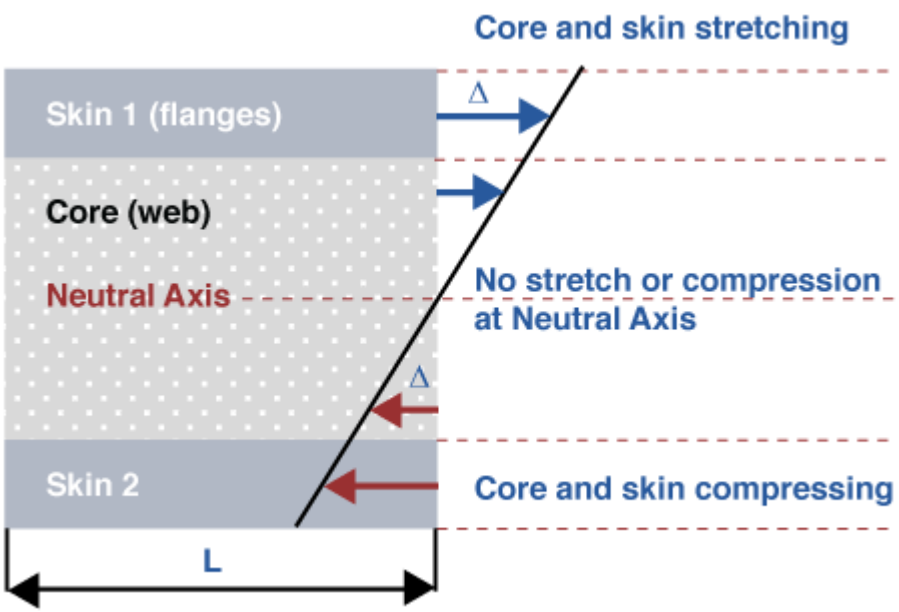

Image credit: Whitecap Composites

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Lantor Design Application

Application into Table H4 of ISO12215-5

The ultimate strain is not a parameter in table H4.

Therefore, in the column 32,

The maximum stress $\sigma_{tu} = E * \varepsilon_{tu}$

In this example, for layer 4 the σ_{tu} = 11290 * 0,006 = 67,74 N/mm^2

And for layer 6 σ_{tu} = 10772 * 0,006 = 64,63 N/mm^2

Adjust design factor accordingly.

25	31	32
Ply N°	Ei N/mm²	σ_{tu} or σ_{cu} sandwich N/mm²
	----- Tables C7 or C8	
1 outer	8 626	112
2	8 626	112
3	11 290	147
4	11 290	147
5	56	0,70
6	10 772	135
7 inner	15 455	216
	1 211	**16**
	Average	$\Sigma(\sigma_i t_i)/\Sigma t_i$

LANTOR

Design Example

Example taken from ISO12215 draft table H3 and H4

- All calculations made in H4 for comparison
- Hand Laminated Single skin laminate is the basis.
- Existing hull T= 7 mm (9/32 Inch)

Design Pressure P kN/m^2	Panel short dim b mm	Panel longt dim l mm
37,0	500	750

Ply N°	Definition	Compl factor σ_d/σ_i (35)/(48)	Shear compl factor τ_d/τ_i * (36)/(56)
1 outer	Mat 225	1,26	22,7
2	Rovmat 800/300	1,45	4,8
3	QX 600	2,75	4,0
4	QX 600	6,42	3,9
5	QX 600	-3,83	4,2
6	QX 600	-2,13	5,1
7	Rovmat 800/300	-1,29	

LANTOR

Design Example

Example taken from ISO12215 draft table H4

- Hand Laminated Single skin laminate is the basis.
- Existing hull T= 7 mm (9/32 Inch)
- Optimize using thin core
- From ISO12215-5:2008:

Design Pressure P kN/m^2	Panel short dim b mm	Panel longt dim l mm
37,0	500	750

— if the total thickness is 1,15 t, the bulking material thickness shall be 0,33 times the total laminate thickness, i.e. a bulking thickness 0,383 t and each skin 0,383 t;

— if the total thickness is 1,30 t, the bulking material thickness shall be 0,50 times the total laminate thickness, i.e. a bulking thickness 0,65 t and each skin 0,325 t.

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Design Example

Example taken from ISO12215 draft table H4

- Hand Laminated Single skin laminate is the basis.
- Existing hull T= 7 mm (9/32 Inch)
- Optimize using thin core

Design Pressure P kN/m^2	Panel short dim b mm	Panel longt dim l mm
37,0	500	750

Thickness of 7mm *1,30 = 9,1mm,

max core thickness under bulker trend = 0,65 * 7 = 4,6 mm

Lantor offers 4mm and 5mm core materials.

To be safe we use a 4 mm core.

This principle also removes two layers of QX600

Design Example

Example taken from ISO12215 draft table H4

- All calculations made in H4 for comparison
- Hand Laminated Single skin laminate is the basis.
- Existing hull T= 7 mm (9/32 Inch)

Ply N°	Definition	Compliance factor σ_d/σ_i [35]/[51]	Shear compliance factor τ_d/τ_i [36]/[58]
1 outer	Mat 225	2,24	39,21
2	Rovmat 800/300	2,37	7,48
3	QX 600	1,42	6,37
4	Coremat XM4	-1,27	1,38
5	QX 600	-1,14	8,21
6 inner	Rovmat 800/300	-2,06	

Design Pressure P kN/m^2	Panel short dim b mm	Panel longt dim l mm
37,0	500	750

LANTOR

Design Example

Example taken from ISO12215 draft table H4

- All calculations made in H4 for comparison
- Hand Laminated Single skin laminate is the basis.
- Existing hull T= 7 mm (9/32 Inch)

Design Pressure P kN/m^2	Panel short dim b mm	Panel longt dim l mm
37,0	500	750

Ply N°	Definition
1 outer	Mat 225
2	Rovmat 800/300
3	QX 600
4	QX 600
5	QX 600
6	QX 600
7	Rovmat 800/300

Ply N°	Definition
1 outer	Mat 225
2	Rovmat 800/300
3	QX 600
4	Coremat XM4
5	QX 600
6 inner	Rovmat 800/300

Weight	**-3,5**%kg
Fibre	**-24,9**%kg
Resin	**11,2**%kg
Cost	**4,5**%

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Design Example

Example taken from ISO12215 draft table H4

- All calculations made in H4 for comparison
- New, bigger Hull

Design Pressure P kN/m²	Panel short dim b mm	Panel longt dim l mm
37,0	500	750

Design pressure P kN/m²	Panel short dim b mm	Panel long dim l mm
37	750	1000

Ply N°	Definition	Compliance factor σ_d/σ_i [35]/[51]	Shear compliance factor τ_d/τ_i [36]/[58]
1 outer	Mat 225	0,61	15,10
2	Rovmat 800/30	0,67	3,16
3	QX 600	1,26	2,58
4	QX 600	2,79	2,51
5	QX 600	-1,71	2,71
6	QX 600	-0,99	3,27
7 inner	Rovmat 800/30	-0,60	

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Design Example

Single skin laminate is the basis. New, bigger Hull

Two options:

- Add more glass layers
- Use a Core

Ply N°	Definition	Compliance factor σ_d/σ_i [35]/[51]	Shear compliance factor τ_d/τ_i [36]/[58]
1 outer	Mat 225	0,61	15,10
2	Rovmat 800/30	0,67	3,16
3	QX 600	1,26	2,58
4	QX 600	2,79	2,51
5	QX 600	-1,71	2,71
6	QX 600	-0,99	3,27
7 inner	Rovmat 800/30	-0,60	

Design pressure P kN/m²	Panel short dim b mm	Panel long dim l mm
37	750	1000

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Design Example

Single skin laminate is the basis. New, bigger Hull

Two options:

- Add more glass layers (2x Mat600) t = 9,6mm (23/64 inch)
- Use a Core

Ply N°	Definition	Compliance factor σ_d/σ_i [35]/[51]	Shear compliance factor τ_d/τ_i [36]/[58]
1 outer	Mat 225	1,20	29,11
2	Rovmat 800/300	1,26	5,47
3	QX 600	1,72	4,21
4	QX 600	2,29	3,76
5	2x Mat 600	-3,71	4,73
6	QX 600	-1,89	4,53
7	QX 600	-1,50	5,78
8 inner	Rovmat 800/300	-1,15	

Design pressure P kN/m²	Panel short dim b mm	Panel long dim l mm
37	750	1000

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Design Example

Single skin laminate is the basis. New, bigger Hull

Two options:

- Add more glass layers
- Use a Core

ISO12215 2008 version:

— if the total thickness is 1,15 *t*, the bulking material thickness shall be 0,33 times the total laminate thickness, i.e. a bulking thickness 0,383 *t* and each skin 0,383 *t*;

— if the total thickness is 1,30 *t*, the bulking material thickness shall be 0,50 times the total laminate thickness, i.e. a bulking thickness 0,65 *t* and each skin 0,325 *t*.

Design Example

Single skin laminate is the basis. New, bigger Hull

Two options:

- Add more glass layers
- Use a Core

Thickness of 9.2mm *1,30 = 12mm,

max core thickness under bulker trend = 0,65 * 9,2 = 6 mm

Lantor offers 3mm core materials.

We use 2x 3mm core.

Design Example

Single skin laminate is the basis. New, bigger Hull

Two options:

- Add more glass layers
- Use a Core, Lantor core, t= 13mm (33/64 Inch)

Design pressure	Panel short dim	Panel long dim
P	b	l
kN/m²	mm	mm
37	750	1000

Ply N°	Definition	Compliance factor σ_d/σ_i [35]/[51]	Shear compliance factor τ_d/τ_i [36]/[58]
1 outer	Mat 225	1,99	47,54
2	Rovmat 800/300	2,03	8,44
3	QX 600	2,40	6,30
4	QX 600	1,24	6,00
5	2x Coremat XM3	-1,07	1,30
6	QX 600	-1,04	7,26
7	QX 600	-2,08	8,67
8 inner	Rovmat 800/300	-1,83	

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Design Example

Single skin laminate is the basis. New, bigger Hull

Two options:

- Add more glass layers
- Use a Core, Lantor core

Ply N°	Definition
1 outer	Mat 225
2	Rovmat 800/300
3	QX 600
4	QX 600
5	2x Mat 600
6	QX 600
7	QX 600
8 inner	Rovmat 800/300

Ply N°	Definition
1 outer	Mat 225
2	Rovmat 800/300
3	QX 600
4	QX 600
5	2x Coremat XM3
6	QX 600
7	QX 600
8 inner	Rovmat 800/300

Weight	**-5,0**	%kg
Fibre	**-19,9**	%kg
Resin	**2,6**	%kg
Cost	**5,9**	%

LANTOR

Lantor Design Values

Important general design values for analysis:

- See product datasheet for type specific values
- Values are in combination with Unsaturated Polyester

- Shear strength > 3MPa (>430psi)
- E Modulus >800MPa (>116,000psi)
- G Modulus >20MPa (>2900psi)
- Tensile Strength 5MPa (725psi)
- In-Plane ultimate strain 0,6%
- Out-of-plane Compressive Strength >4MPa (>580psi)

ABS TYPE APPROVED PRODUCT

Soric XF
Soric TF
Coremat XI

APPROVED LR TYPE APPROVAL SCHEME

Soric XF
Soric TF
Coremat XI
Coremat XM

Soric® Top Finish

- Soric® with a random dotted pattern
- Developed for optimal cosmetics
- Soric TF blocks fibre print through and core print through

Gelcoat
2 x CSM/CFM
Soric TF
Reinforcements
Core
Reinforcements

or

Gelcoat
Skin coat
Soric TF
Reinforcements
Core
Reinforcements

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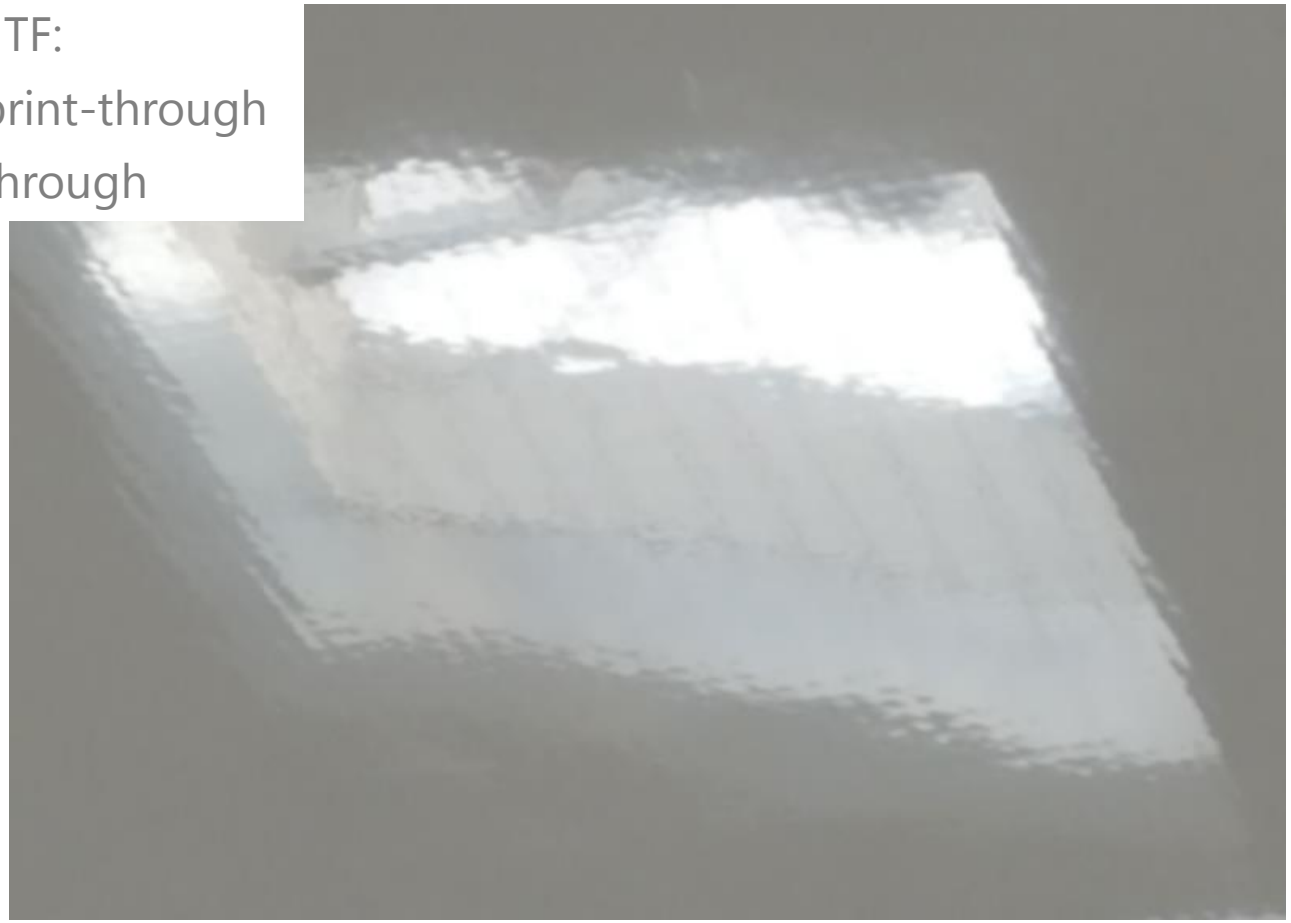
Soric® Top Finish

Without Soric TF:

- Glass fibre print-through
- Core print-through



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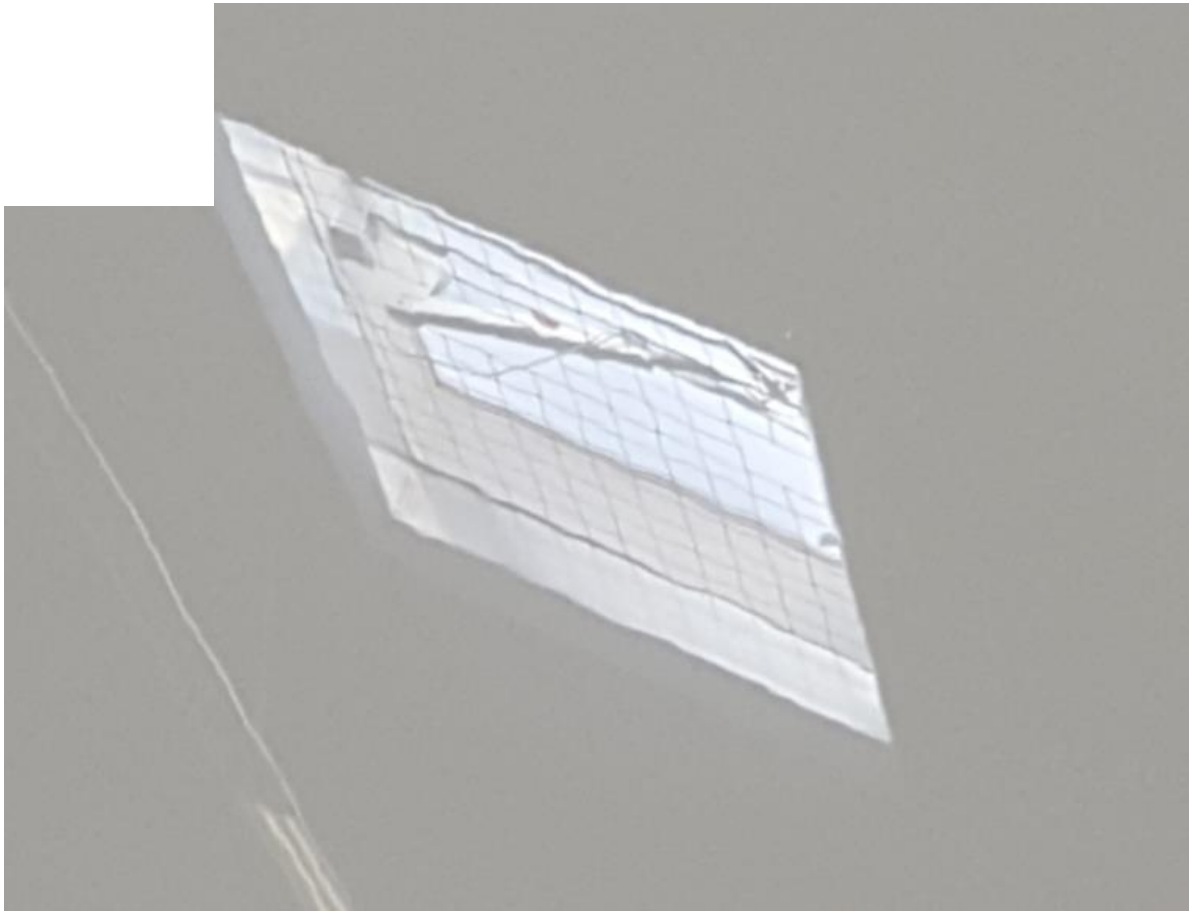
Soric® Top Finish

With Soric TF:

- Smooth surface
- No print



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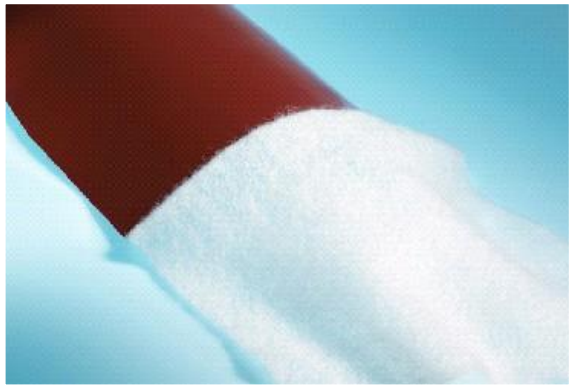
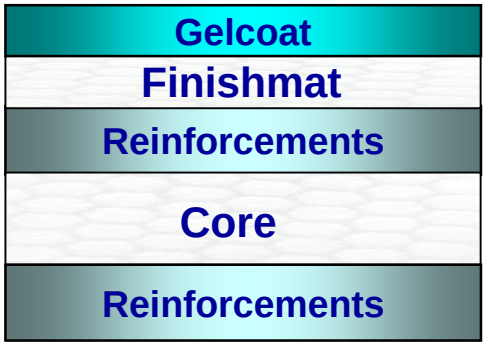
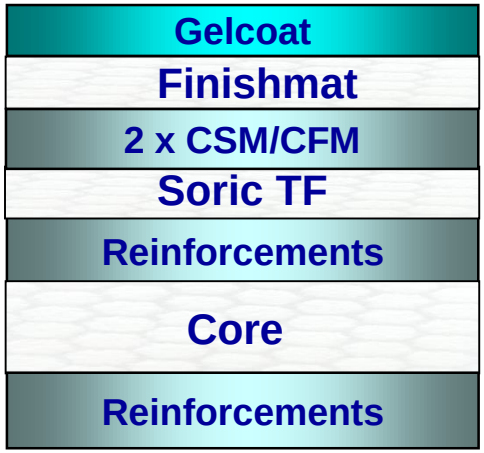
Finishmat®

- Polyacrylic, needled veil
- Blocks fibre print through of first layer
- Prevents osmosis (Hydrolysis)
- 0,3 or 0,4 mm thickness (1/80 or 1/60 inch)







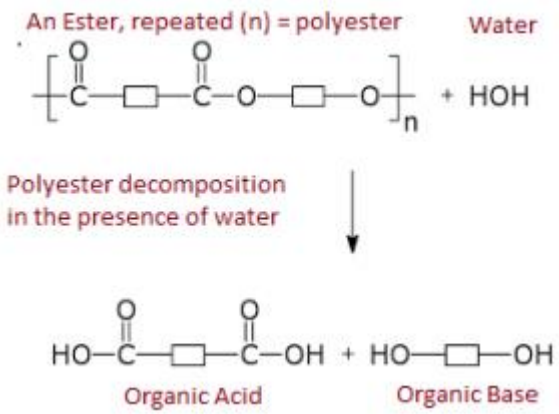
LANTOR

Finishmat®

A glass fibre laminate will suffer a number of external effects in its lifetime:

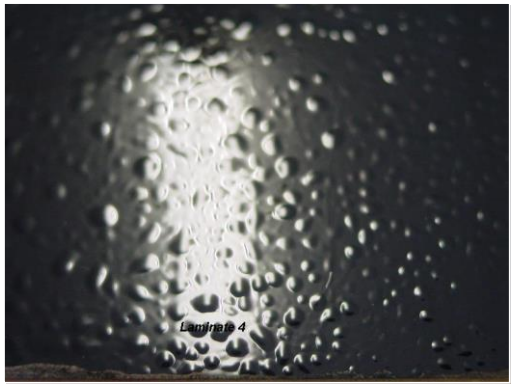
- Structural effects:
    - Osmosis
    - Weather influence
    - Ultra violet degradation
- Cosmetic effects
    - Resin shrinkage

Osmosis (Hydrolysis)



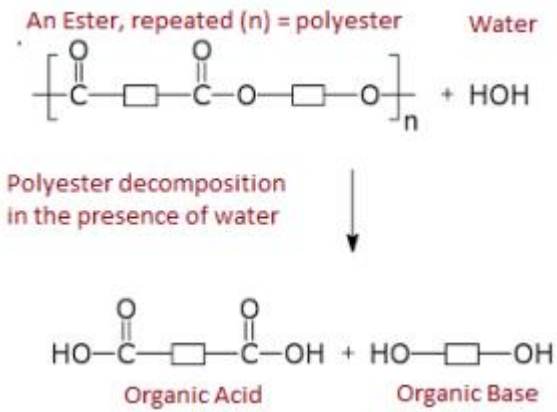
LANTOR

Finishmat®



- Post-cured Laminate
- NO additional protection,
- Hydrolysis / blistering

Osmosis (Hydrolysis)



Reflection of TL light in Gelcoat

- Results after 2 weeks in water at (60 °C/140°F)

LANTOR

Finishmat®

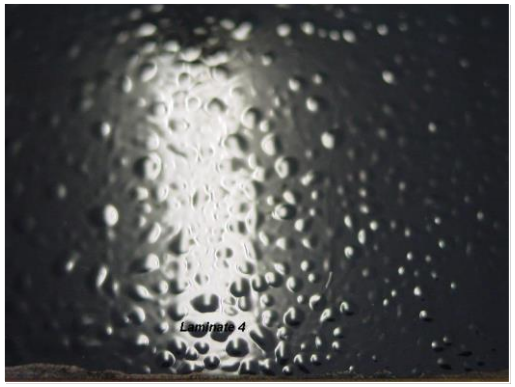
Barrier coat

- Solid Layer of specially prepared resin
- Blocks weather influences
- Unreinforced layer
- Typically 1mm thickness
- Spray up after gelcoat
- Machine & mould preparation time
- Waiting time for cure

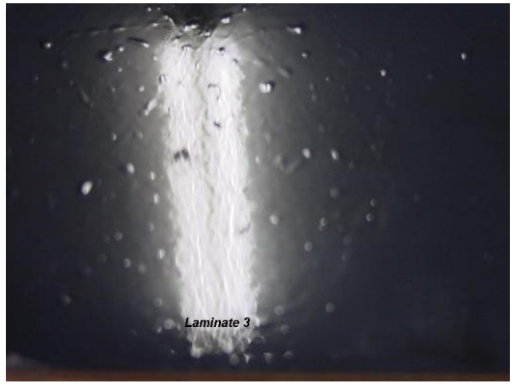
Skin Coat

- One or multiple layers of chopped strand glass fibre
- Blocks print-through of reinforcement layers
- Hand lay-up after gelcoat/barrier coat
- Typically 2mm thickness
- Additional personal protection gear required for laminators
- Waiting time for cure

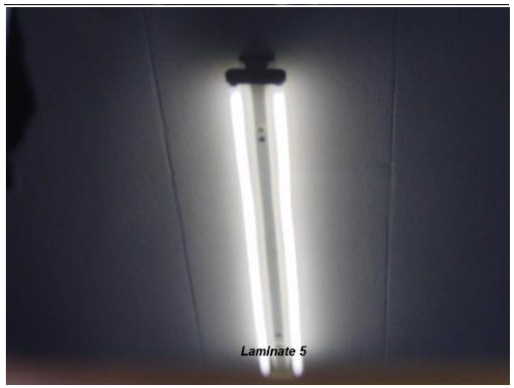
Finishmat®



- NO skin coat,
- NO D7760
- Osmosis / blistering



- skin coat only,
- NO D7760
- Osmosis / blistering



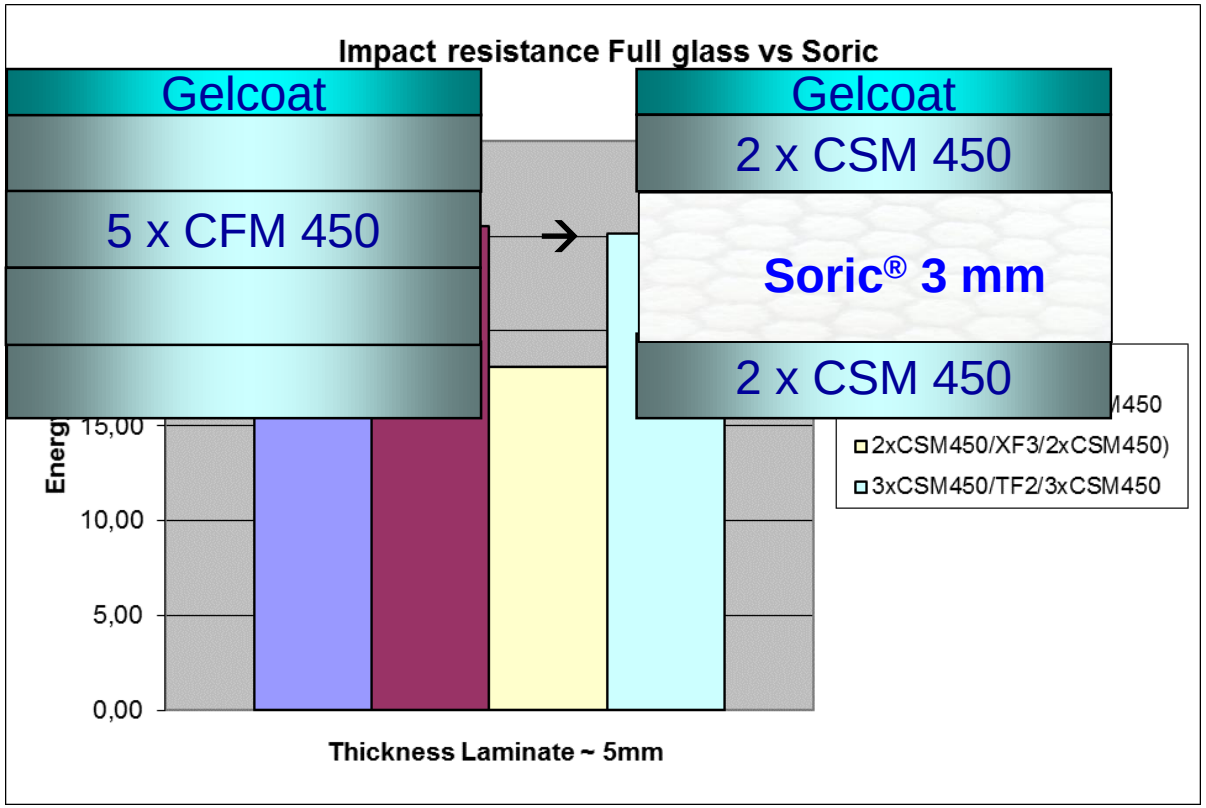
- WITH D7760

Reflection of TL light

- Results after 2 weeks in a water tank (60 °C)

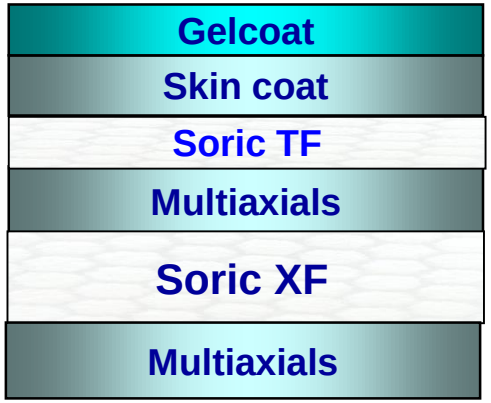
LANTOR

Impact and Damage

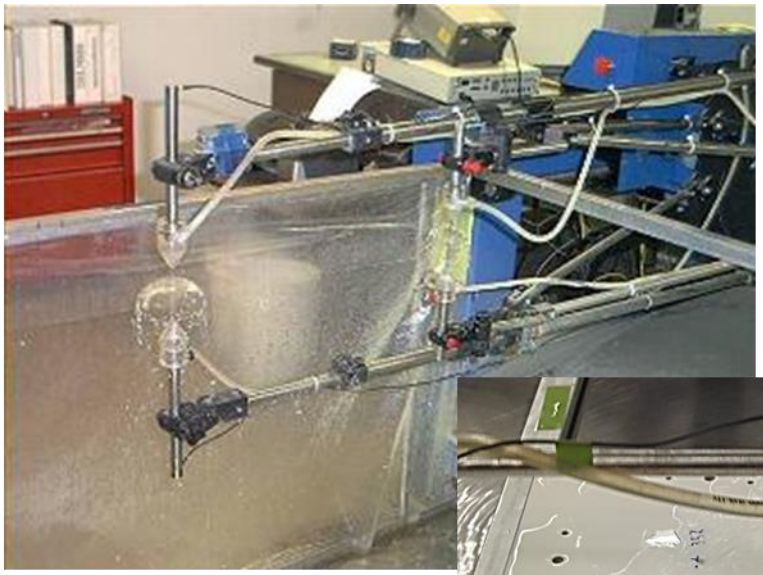


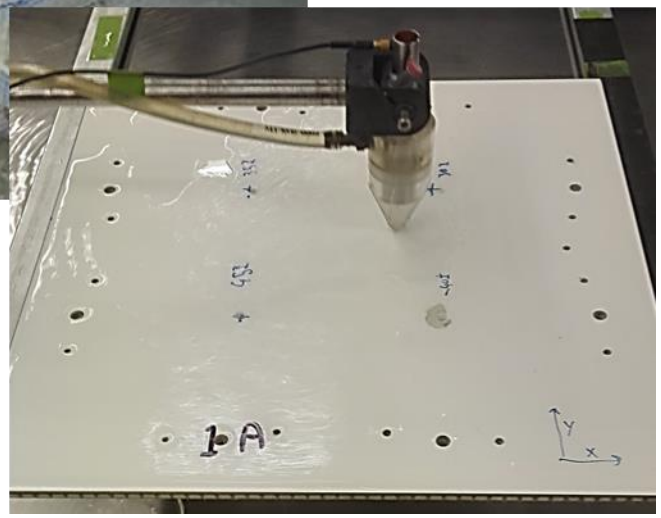
LANTOR

Impact and Damage



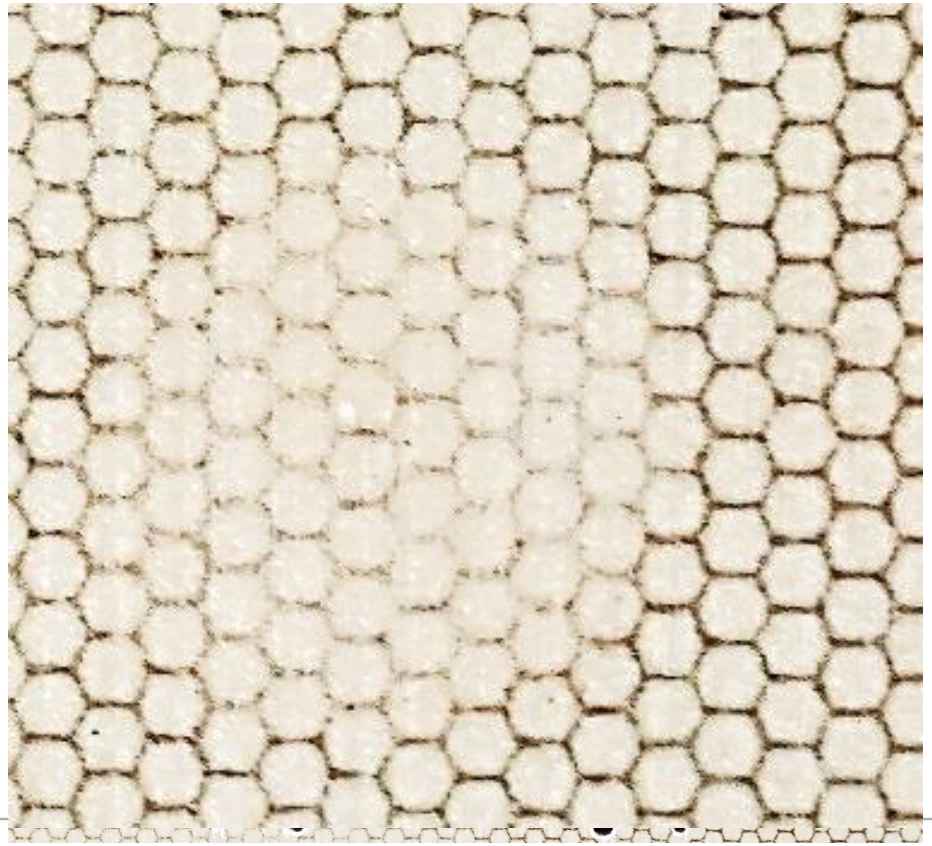
Impact and Damage





Impact and Damage

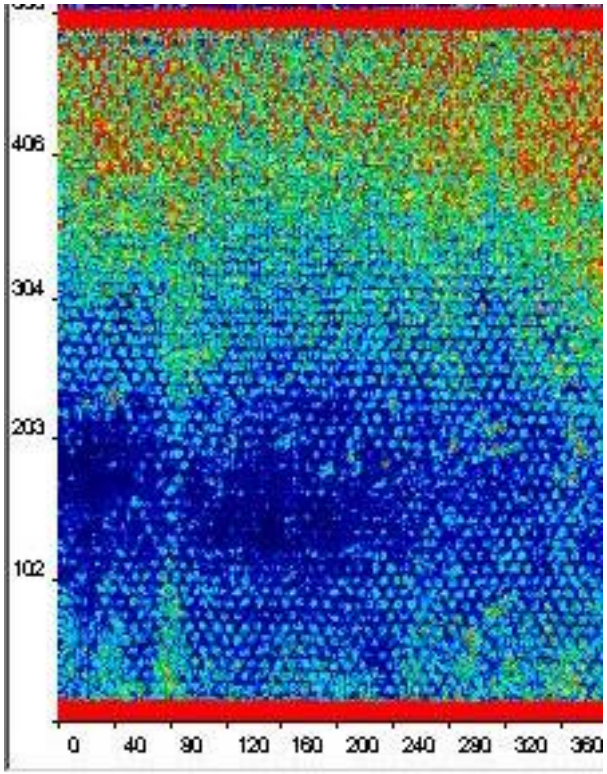
Impact of 27 Joule on ø5mm (13/64 Inch)

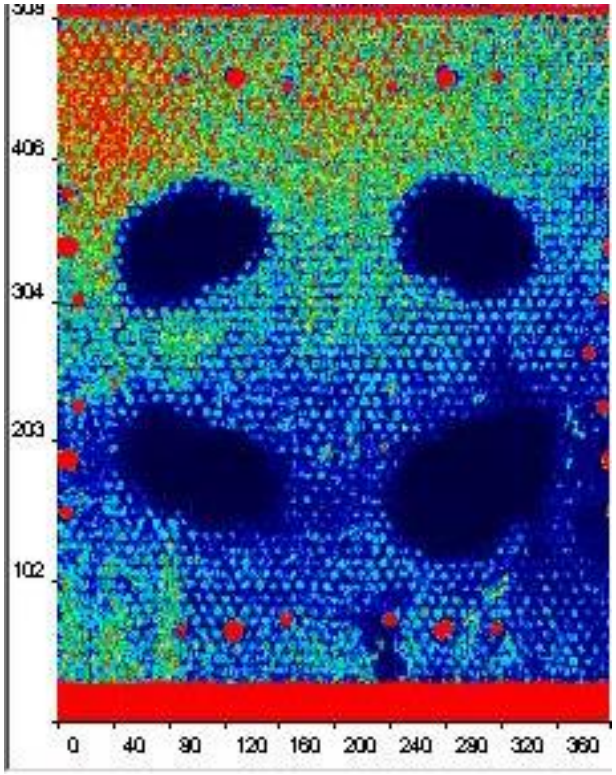


LANTOR

Impact and Damage

Impact of 27 Joule on ø5mm (13/64 Inch)

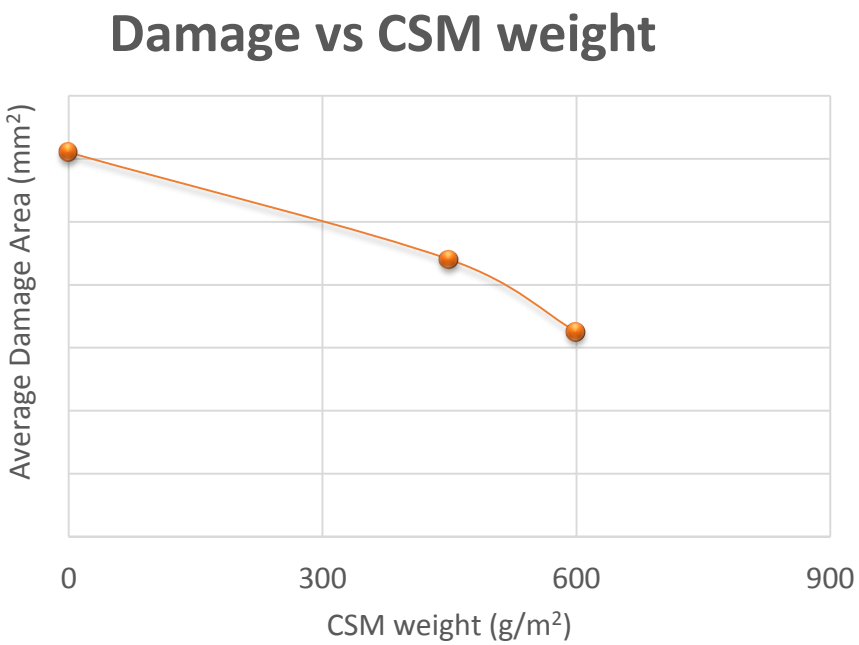


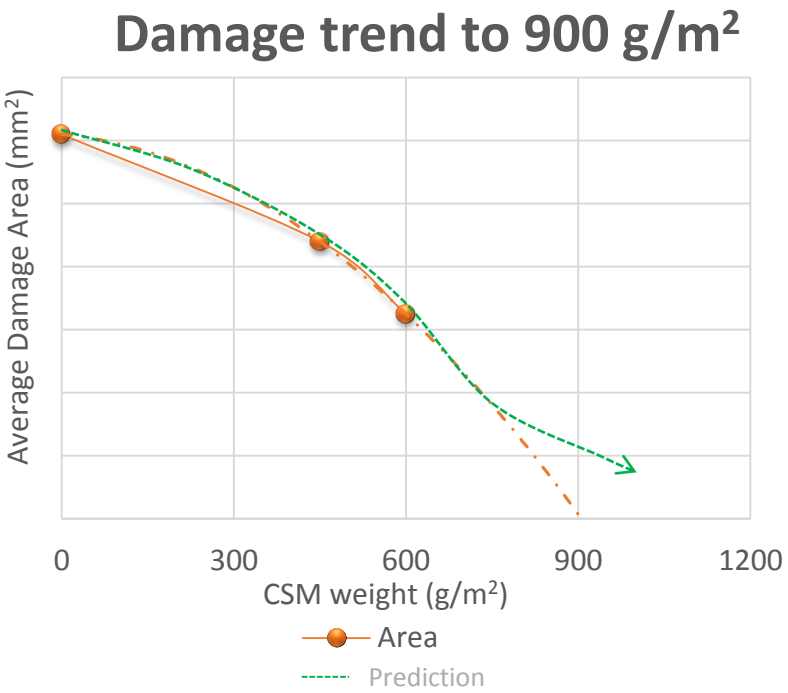


LANTOR

Impact and Damage

Impact of 27 Joule on ø5mm (13/64 Inch)





LANTOR

Impact and Damage

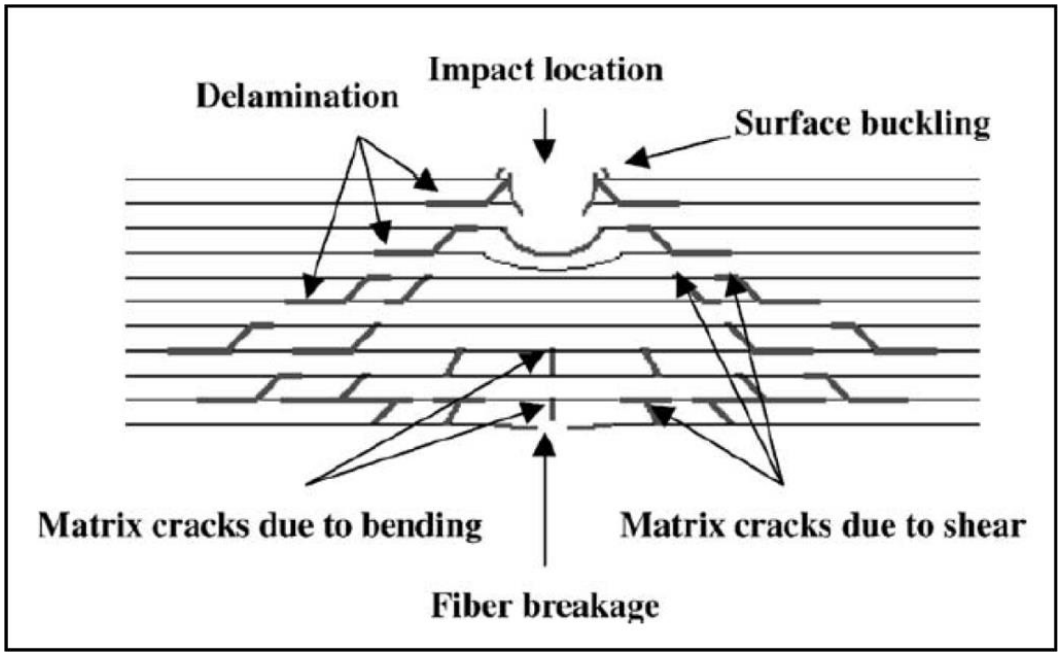


Image Credit: Tien-Wei, S.; Yu-Hao, P. Impact resistance and damage characteristics of composite laminates. Compos. Struct **2003**, 62, 193–203

LANTOR

Impact and Damage

Impact of 67 Joule on ø5mm

LANTOR

Impact and Damage

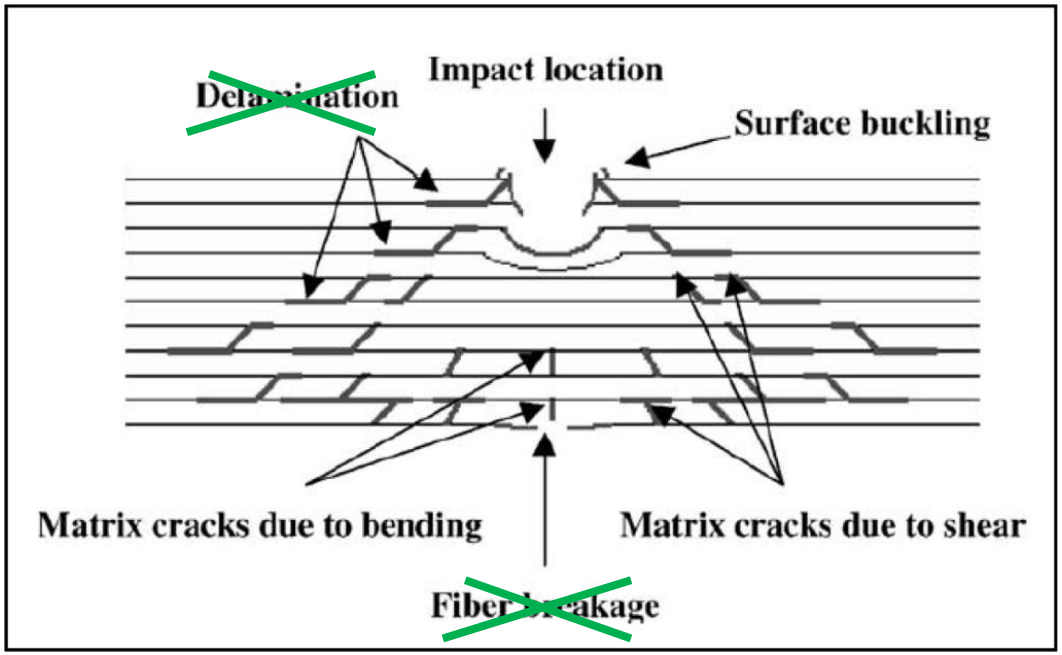


Image Credit: Tien-Wei, S.; Yu-Hao, P. Impact resistance and damage characteristics of composite laminates. Compos. Struct **2003**, 62, 193–203

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Impact and Damage

- Even after a substantial impact, a laminate with Soric TF and Soric XF will keep fibre layers intact and bonded.
- This prevents water or other unwanted substances from penetrating the lay-up and degrading the composite from the inside out.
- Main mode of failure is breaking (fracturing) of the resin.
- A laminate should start with a layer of Chopped Strand Mat behind the gelcoat.

Examples

France: Ocqueteau, Beneteau

U.S: Formula Thunderbird,
Dragonfly Boatworks

Great Britain: C-Fury, Fairline

18ft Hull

LANTOR

18ft Hull

LANTOR

18ft Hull

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18ft Hull

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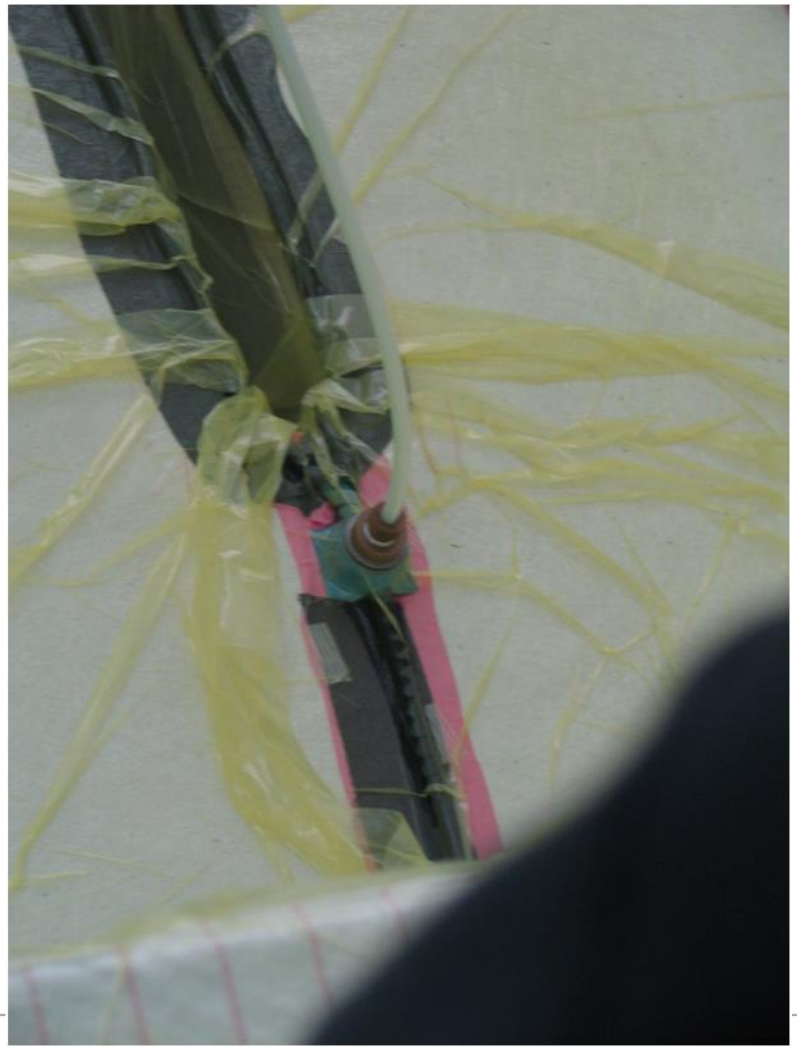
18ft Hull



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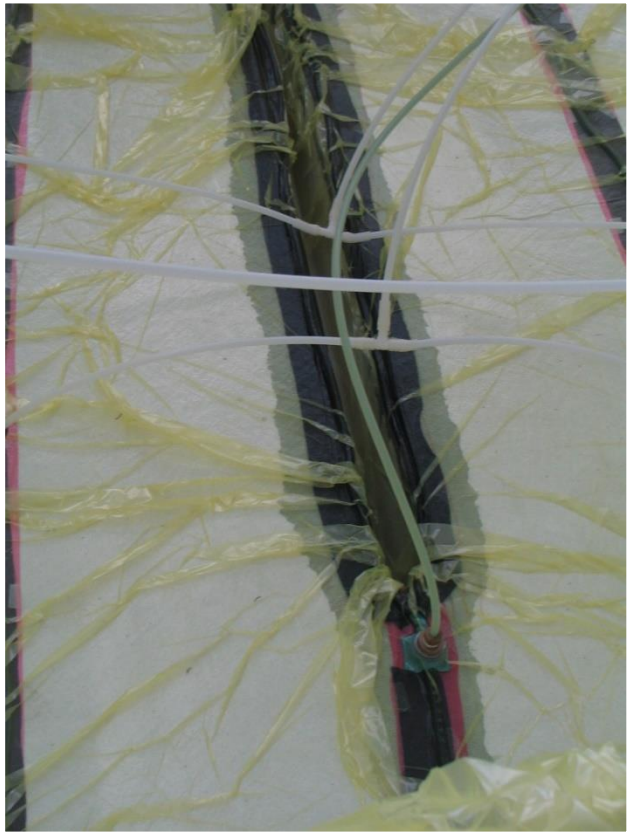
18ft Hull



LANTOR

18ft Hull

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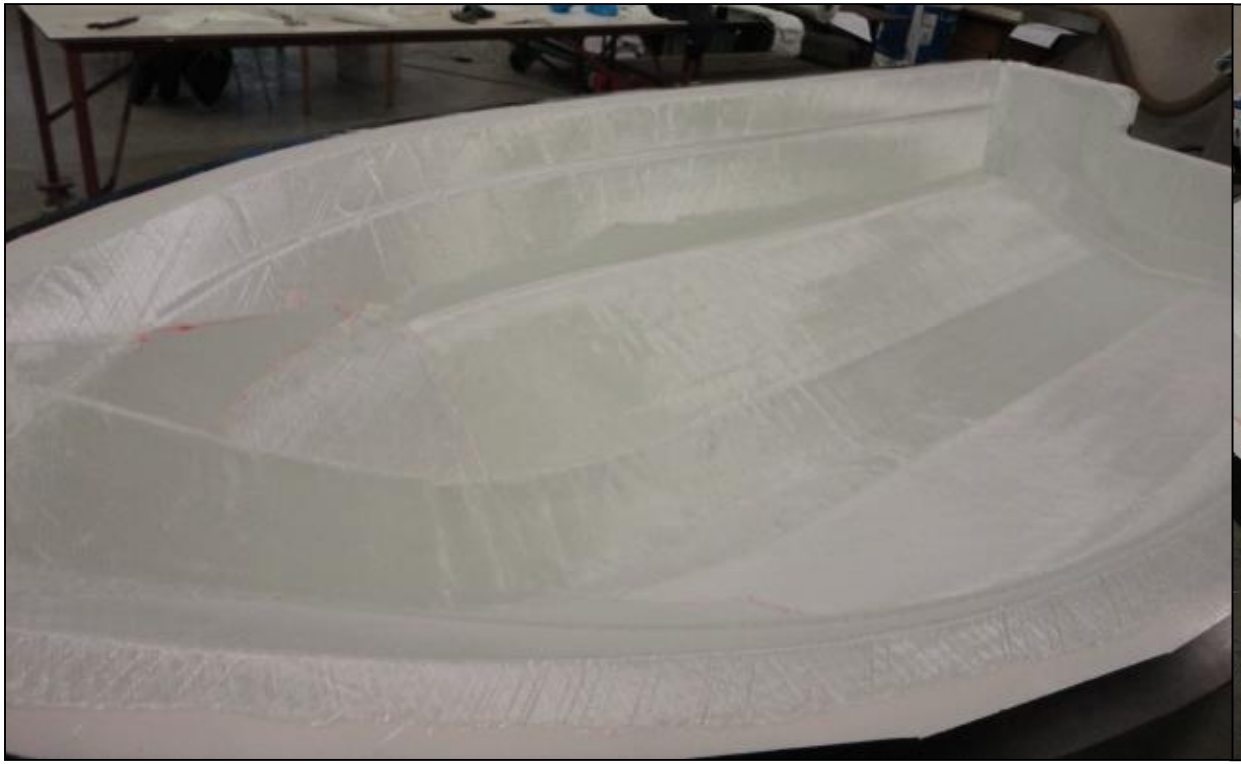
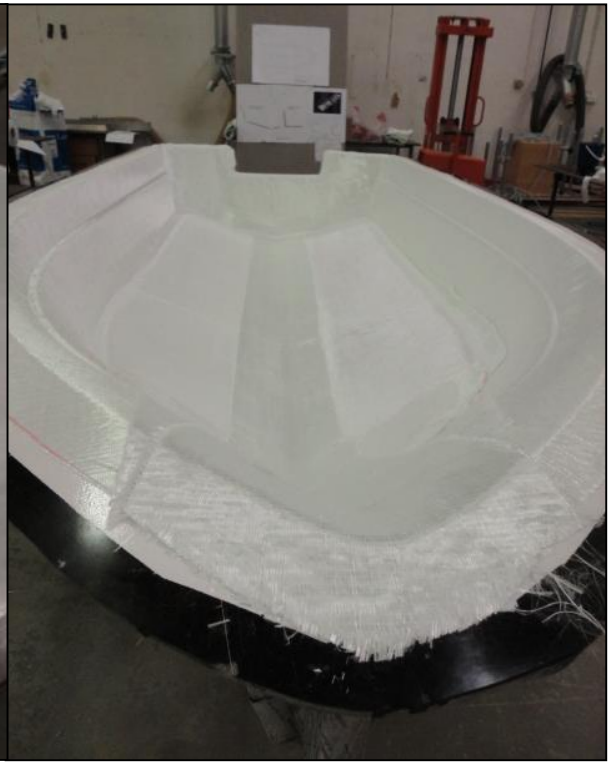
12ft Hull

LANTOR

12ft Hull





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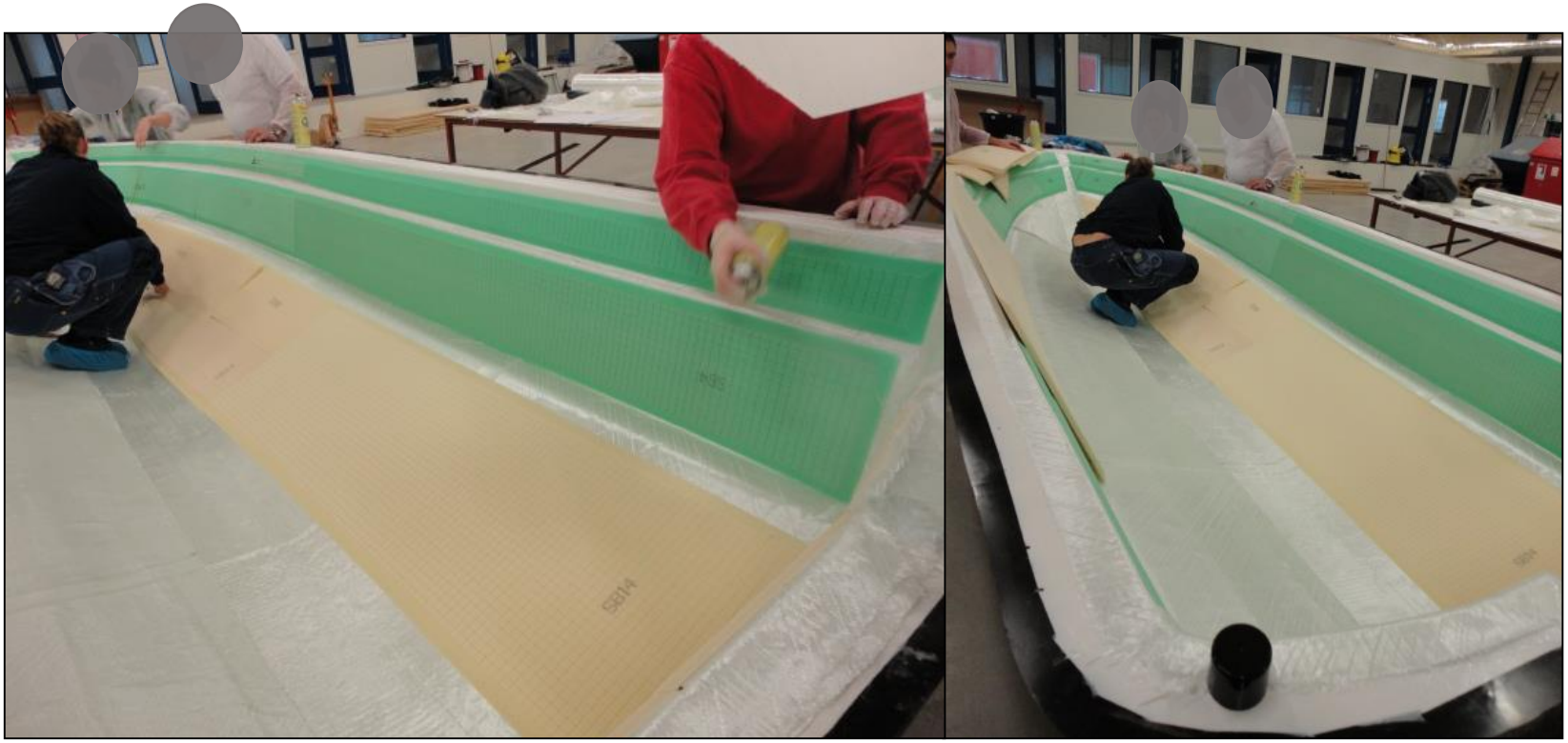
12ft Hull



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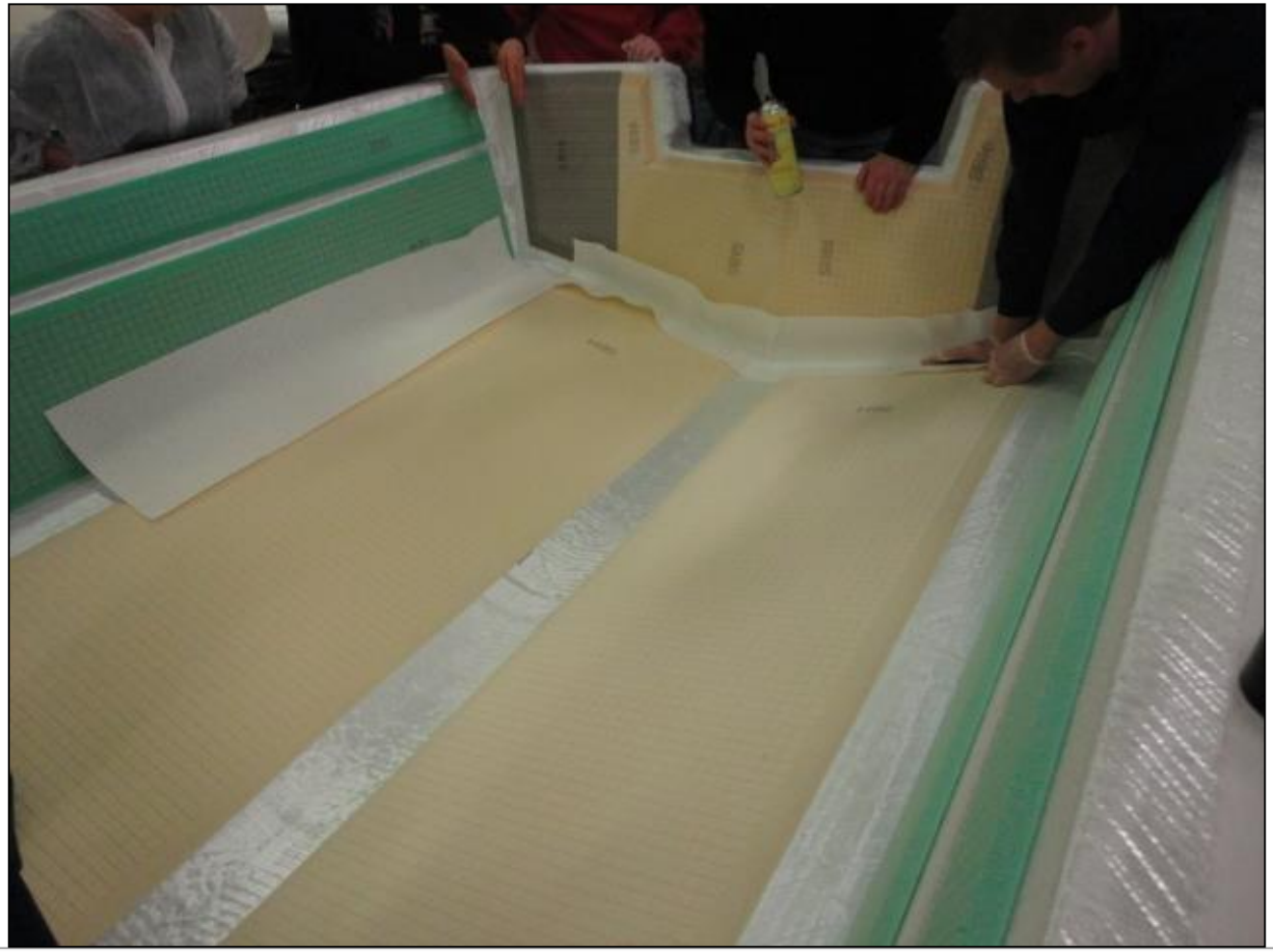

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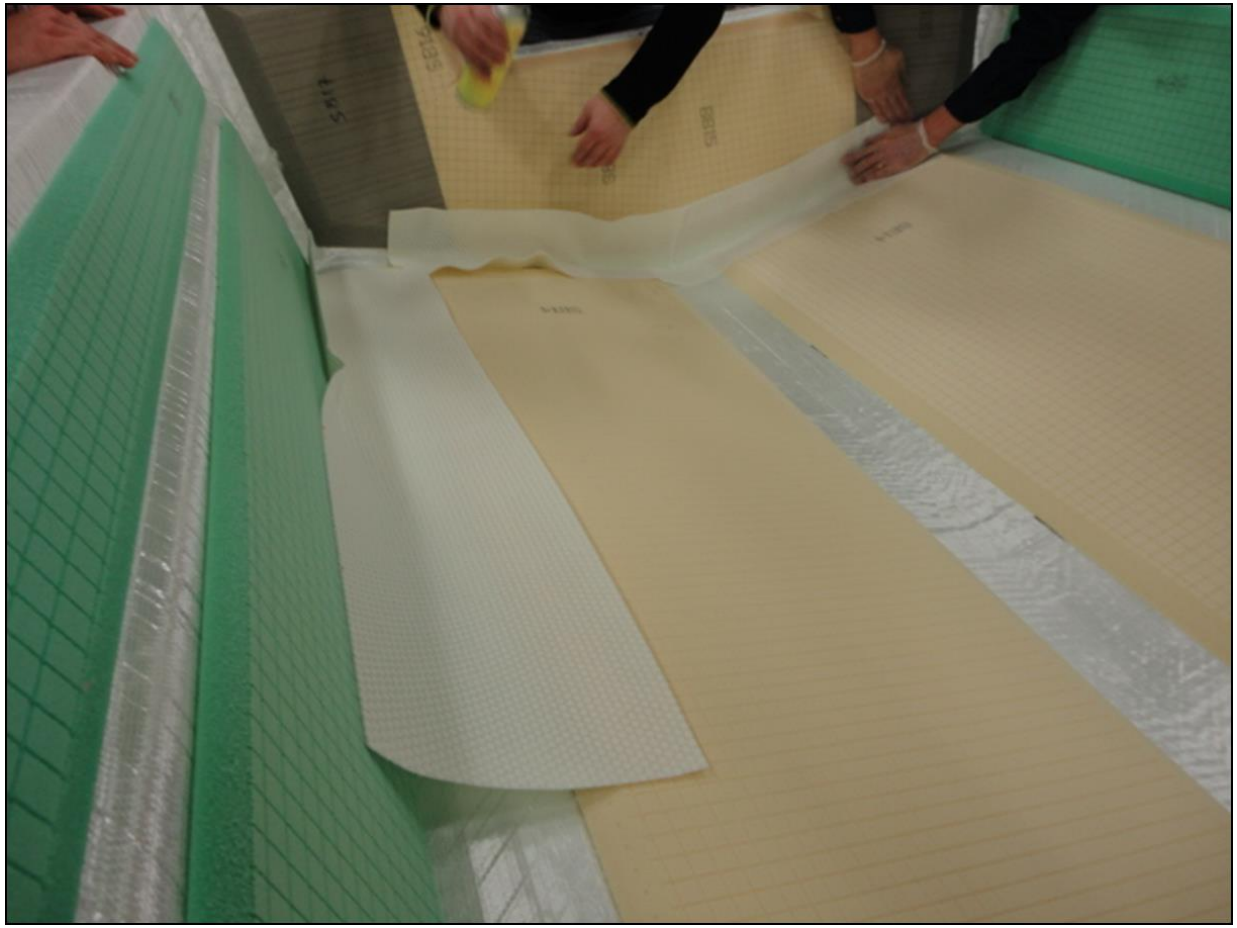

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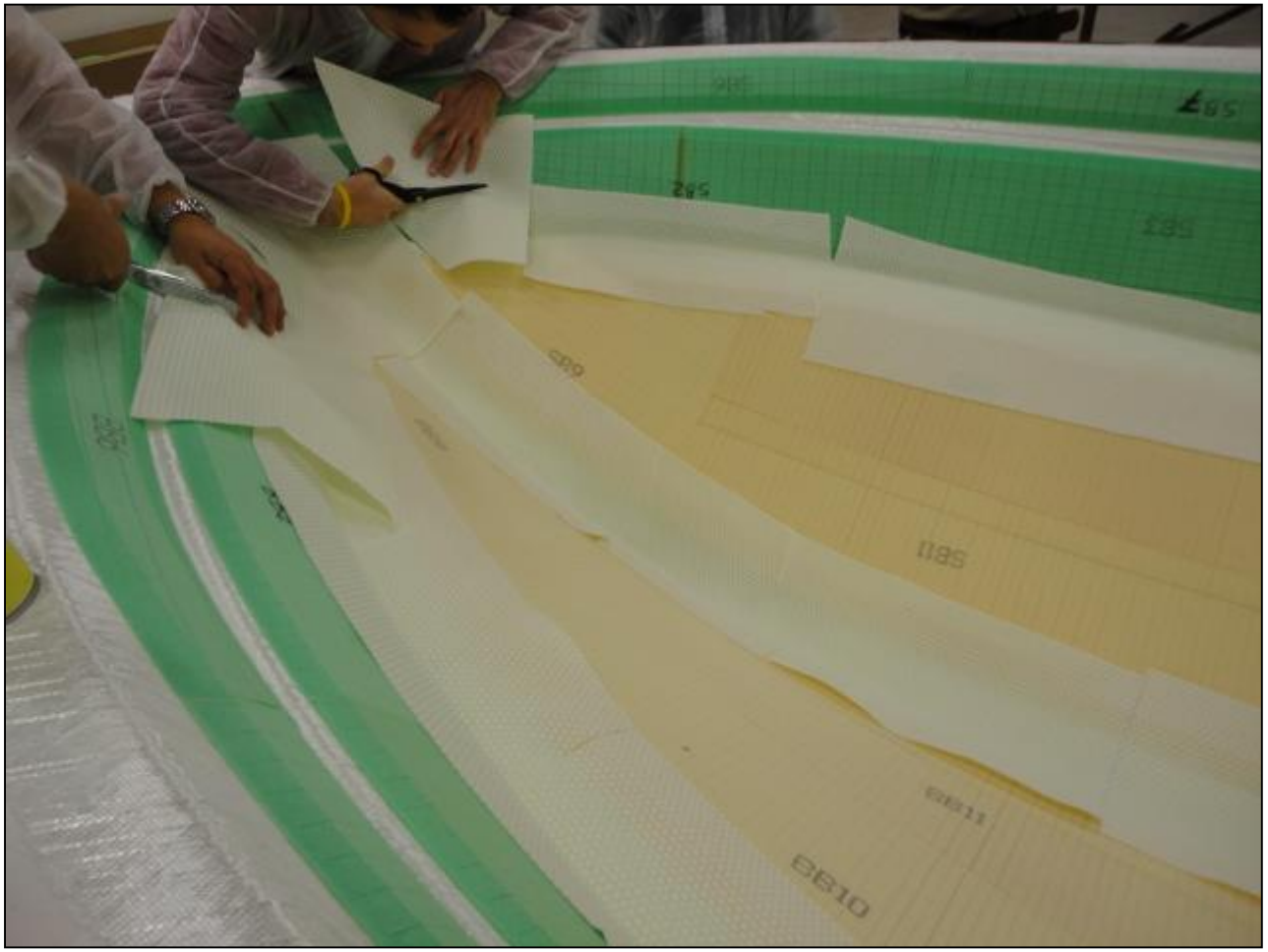

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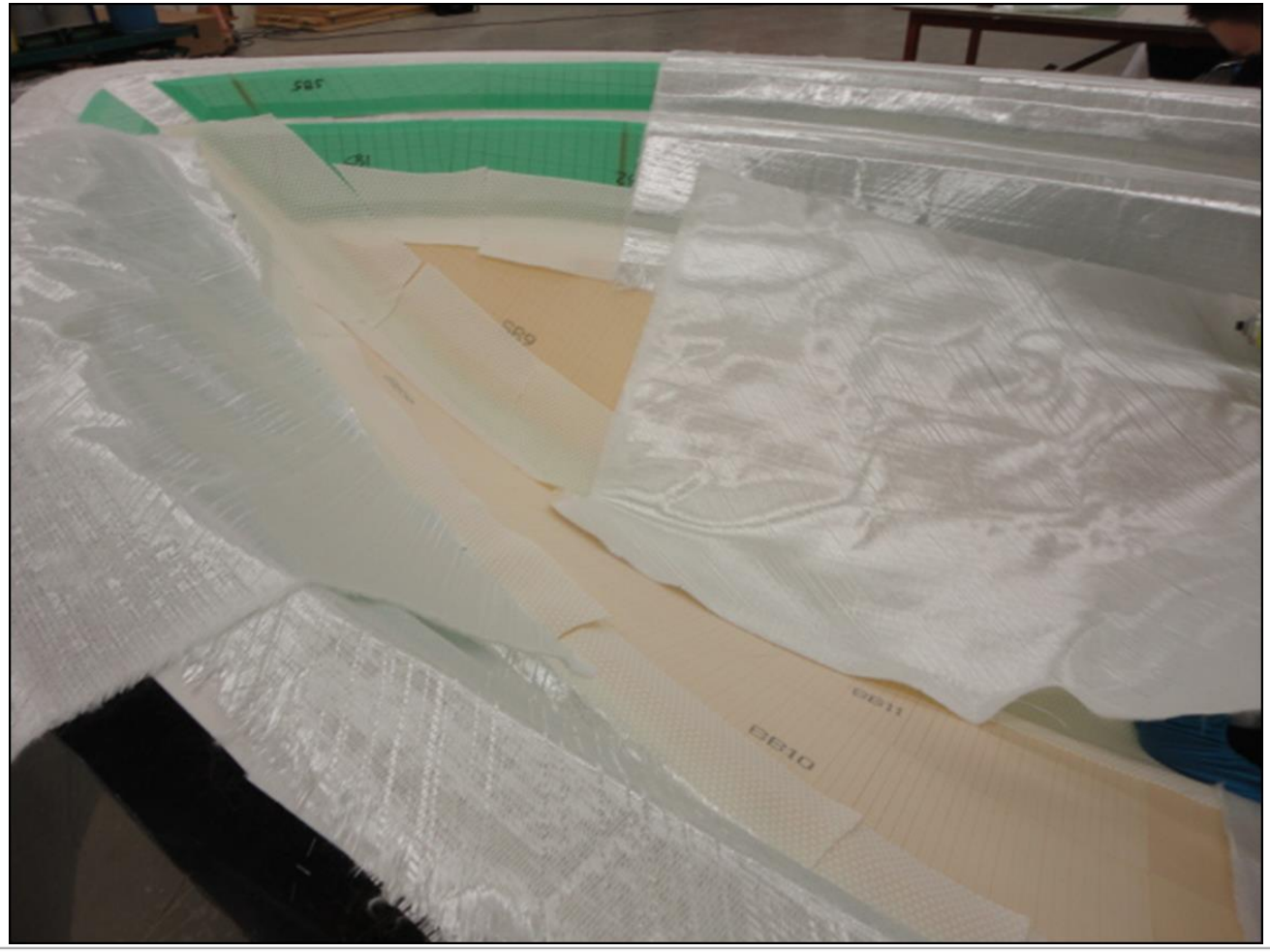

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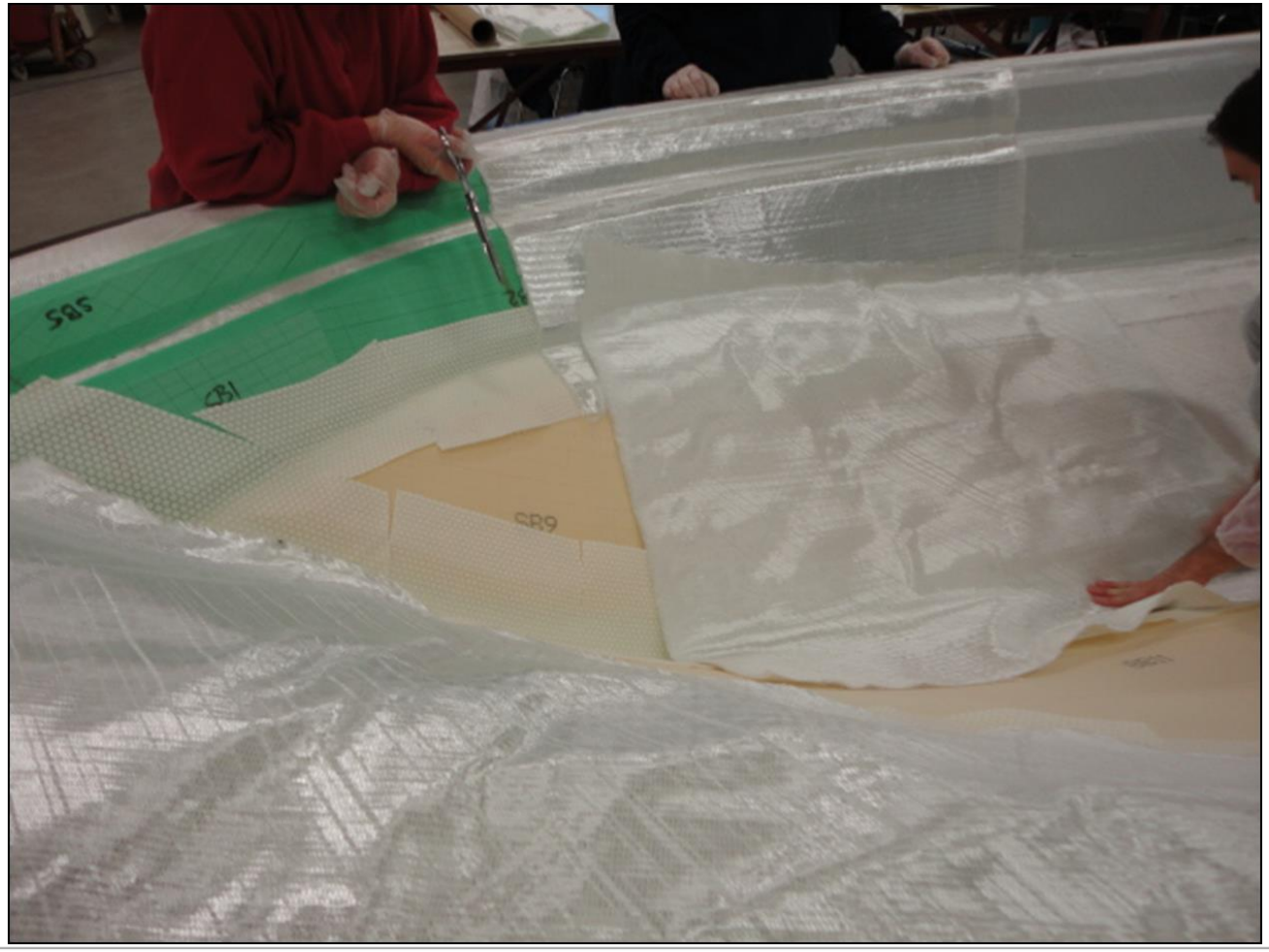

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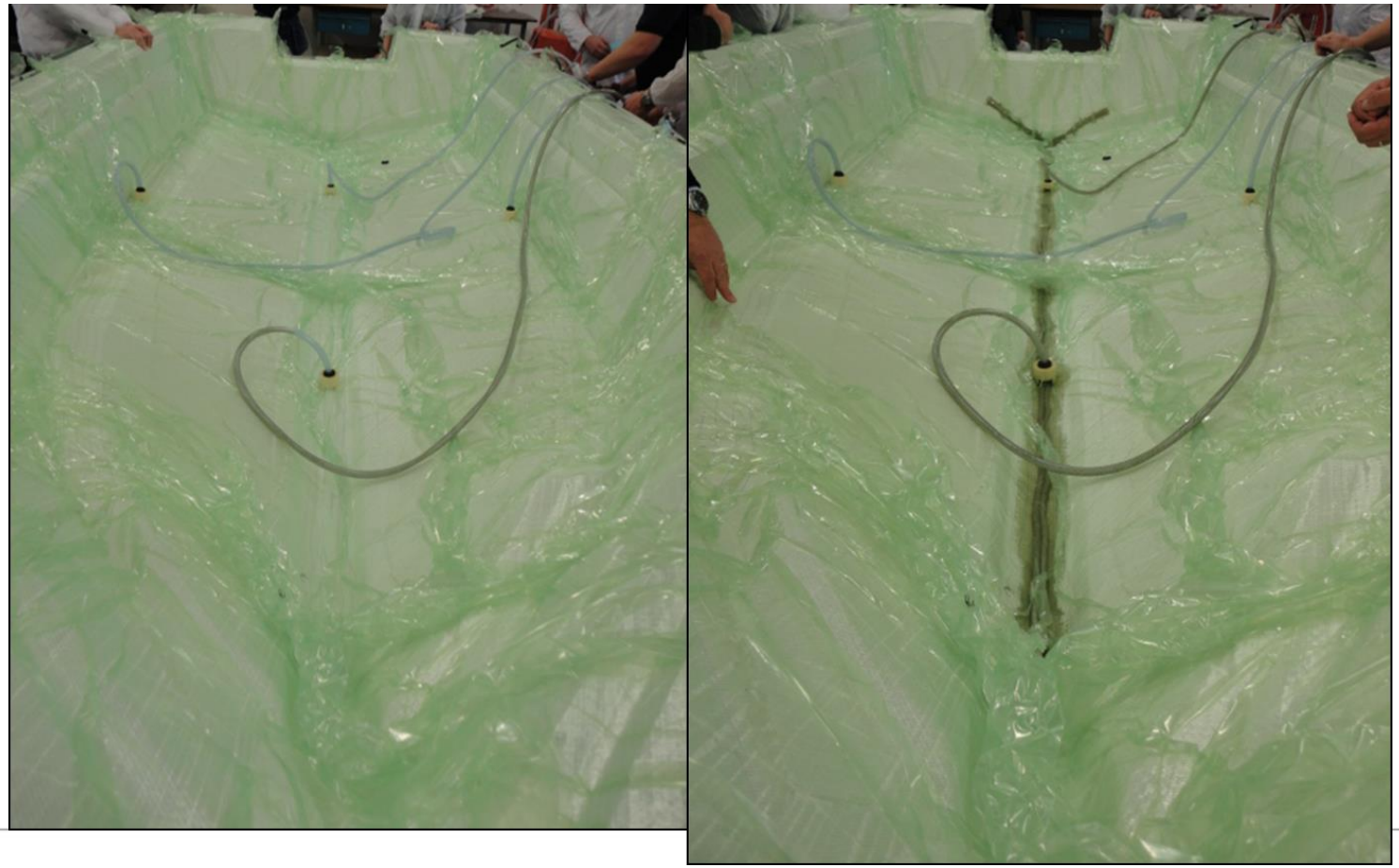

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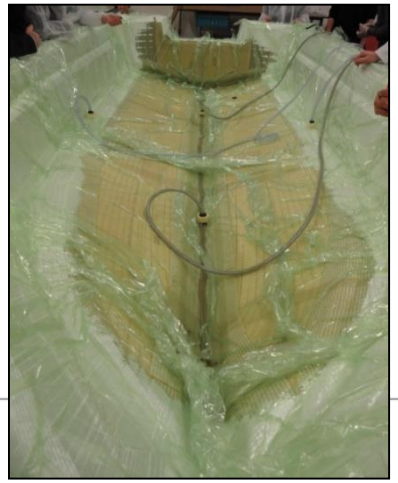

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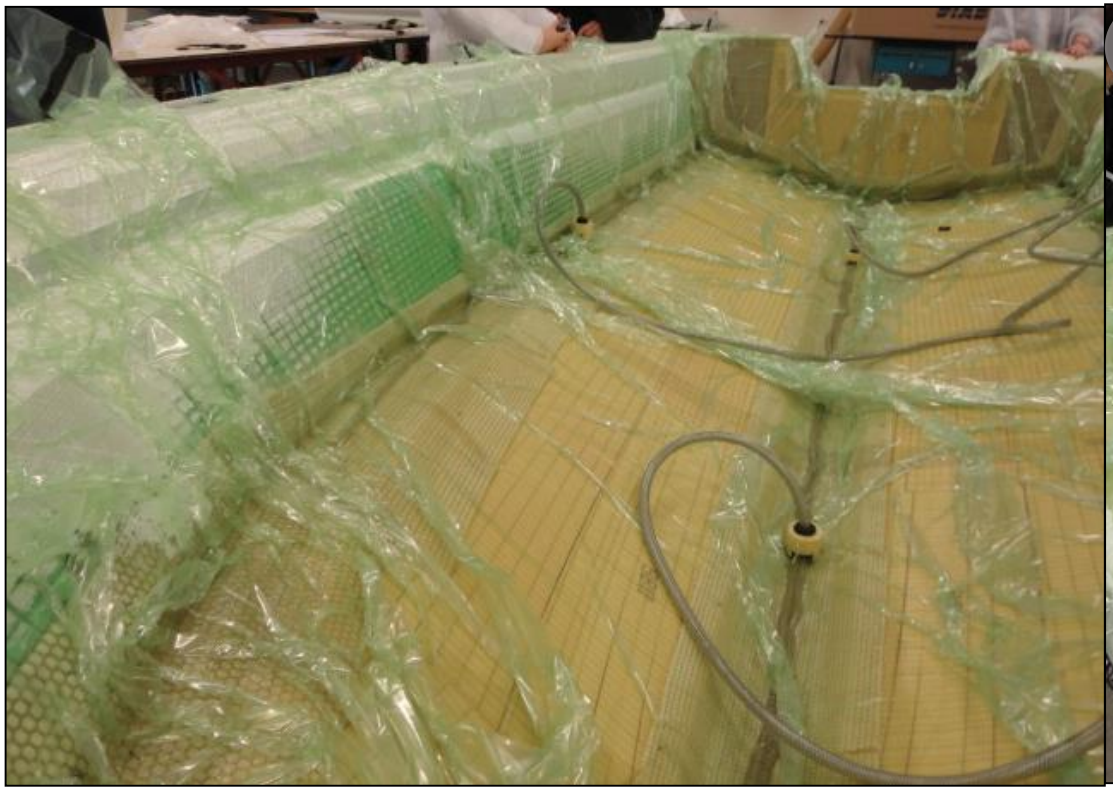
12ft Hull