

Pultrusion Conference 2021

Higher Performance Composites: The Material Matters

Patrick Haller

Owens Corning

The Material Matters

- The Material Matters
- Higher Performance Composites
- Composite Performance
- Designing for Higher Performance
- Applications
- What's Next?

Speaker Information

Patrick Haller

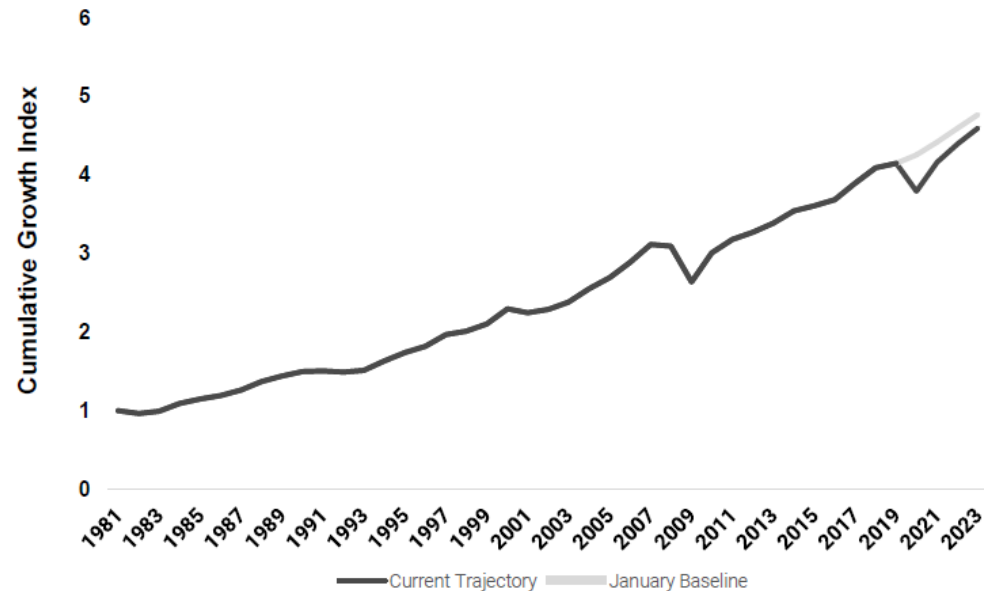
Owens Corning

patrick.haller@owenscorning.com

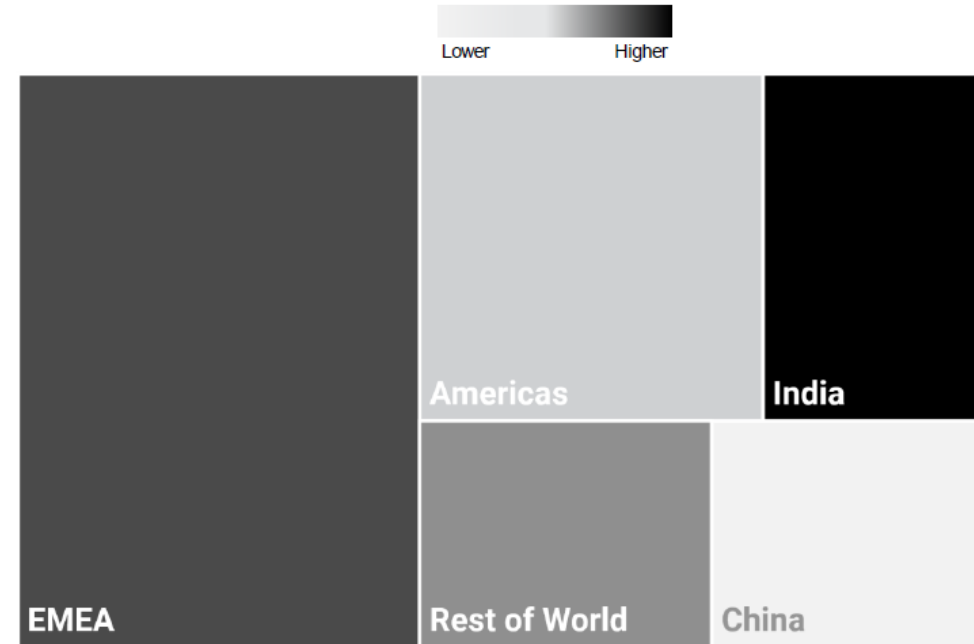


The Material Matters – in the Market

Global Glass Fiber Demand 40 Years of Robust Growth



2020-2023 Demand Growth by Region



Emerging Markets projected to be a significant growth driver

Sustained industry growth shows the value of Higher Performance materials

The Material Matters – in Applications



Higher Performance materials are valuable in numerous applications

Higher Performance Composites = OC HP Glass

Property	OC HP	Next Generation OC HP
Modulus GPa	88.9-89.9	91.1-91.4
Density g/cc	2.61-2.62	2.61-2.62
Tensile Strength MPa	4650-4800	TBD
Annealing Point °C	740	714
Refractive Index	1.557	TBD

Multiple generations of OC HP glass in the works, with more to come

Composite Performance - Mechanicals

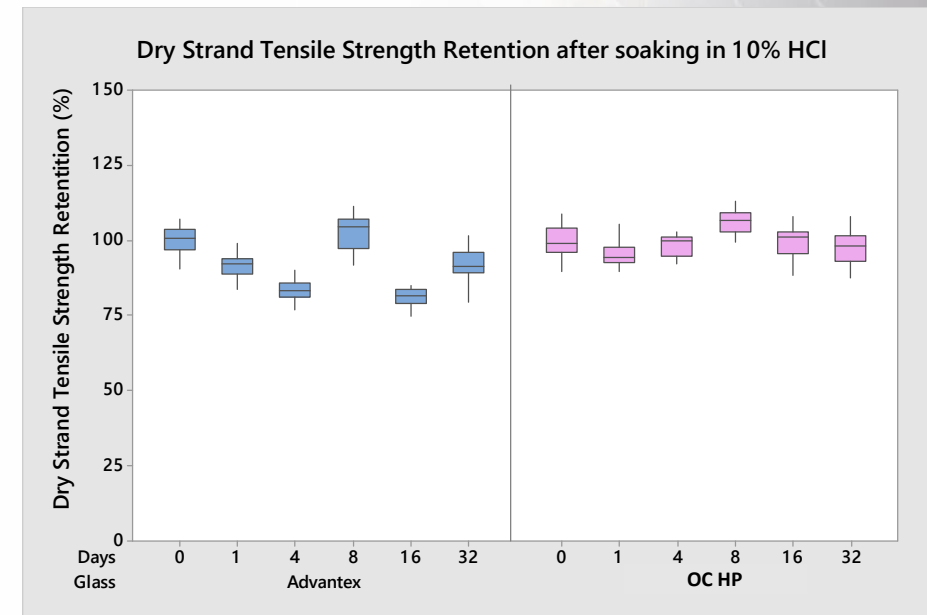
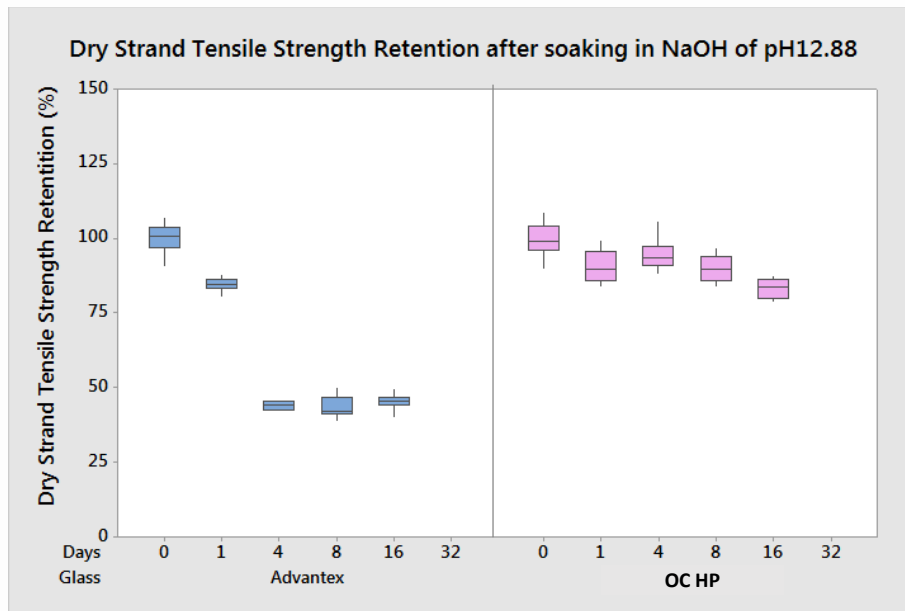
1" x 1/8" flat stock	Advantex®	OC HP	Improvement	Resin
Flex Modulus Msi (GPa)	7.5 (51.7)	8.3 (57.2)	11%	Polyurethane and Unsat. Polyester
Tensile Modulus Msi (GPa)	7.7 (53.1)	9.1 (62.7)	18%	Polyurethane and Unsat. Polyester
Flex Strength Ksi (MPa)	215 (1482)	240 (1655)	11%	Polyurethane

OC HP glass improves properties in composites

Composite Performance – Corrosion

Soaking Solution	OC HP	OC Advantex®	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5
NaOH pH 12.88	✓	✗	✗	✗	✓	✓	✗
10% HCl	✓	✓	✓	✓	✗	✓	✓
10% H ₂ SO ₄	✓	✓	✓	✓	✗	✓	✓

Note: Performance based on $\geq 75\%$ strength retention after 32 day soak



OC HP glass performs well in acids and bases

Designing for Higher Performance Composites

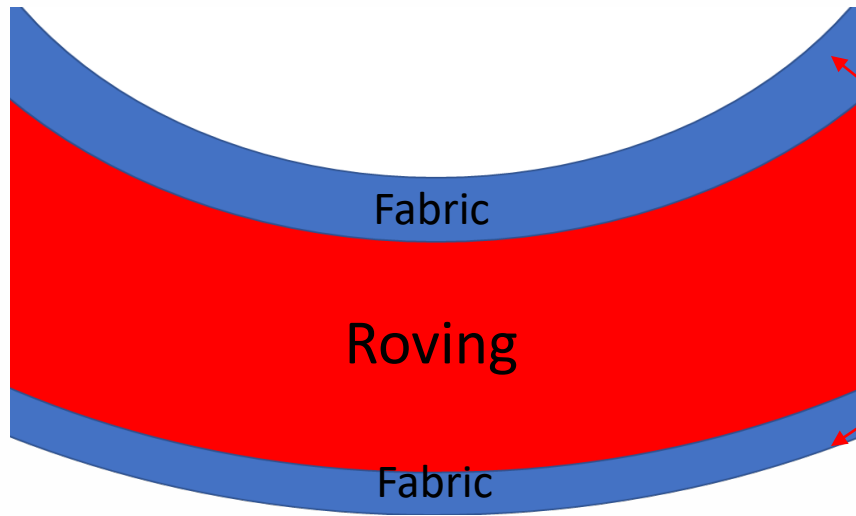
Through modeling and design, the benefits of Higher Performance Composites can be predicted for given end uses.

Two paths to improved results with Higher Performance Composites:

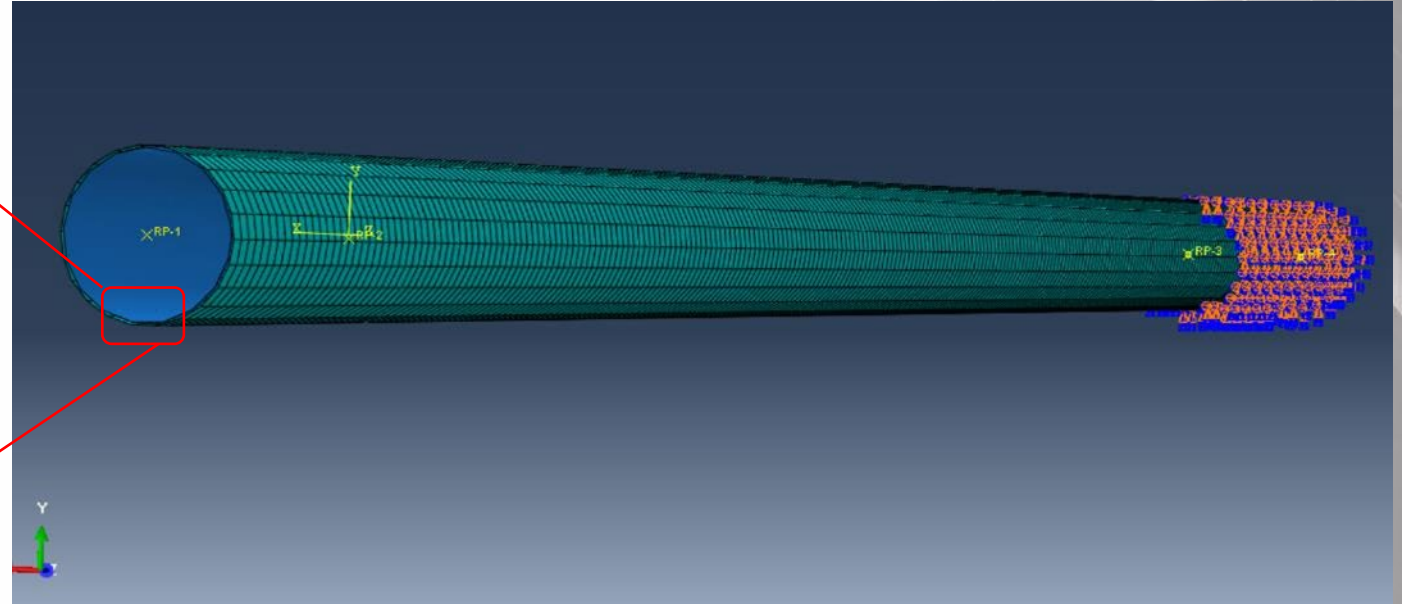
1. One to one substitution from Advantex[®] rovings to OC HP leads to higher performance pultrusion applications.
2. Part/design optimization utilizing OC HP to achieve light weighting and productivity gains.

OC can design pultruded parts with OC HP to meet customer and application specific needs

Applications - Poles



Schematic cross section pultruded laminate structure



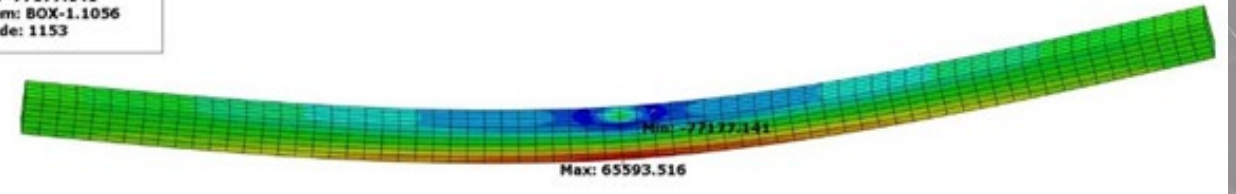
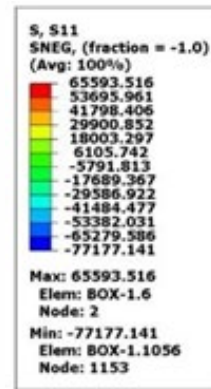
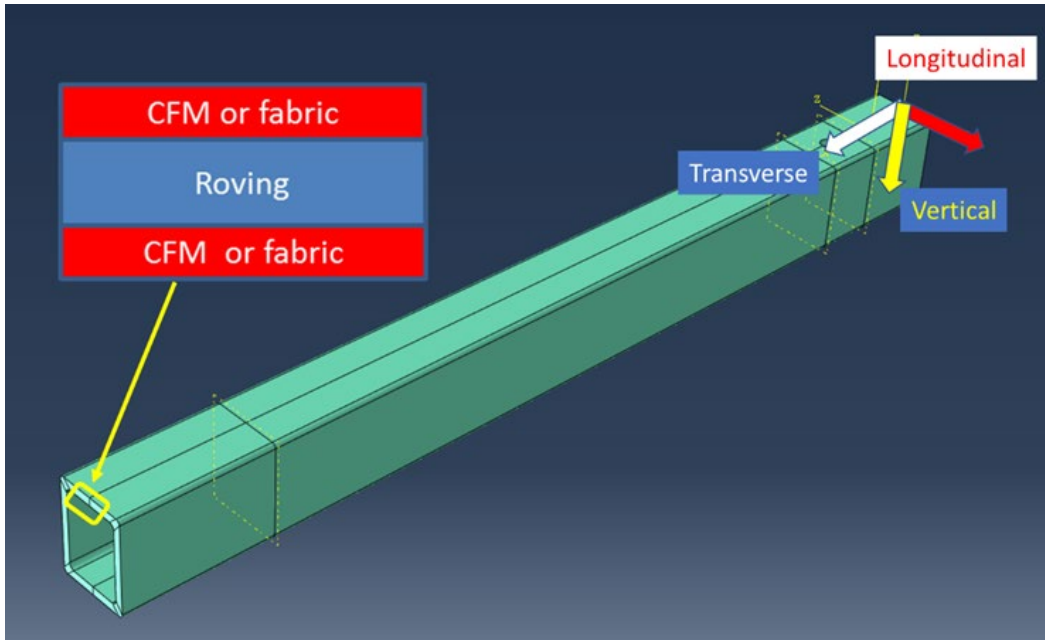
Schematic representation of in-line pole deflection test of a composite pole

Scenario 1: Same profile, OC HP glass replacing Advantex® - tensile modulus -> **8.3%** increase

Scenario 2: Reduced roving thickness using OC HP glass, same fabric -> **8.1%** total thickness savings.

Utility poles can reach a higher pole rating or optimize for material savings

Applications – Cross Arms



Example of stress distributions in a cross arm bending test from finite element analysis

Results suggest that replacing Advantex® with Higher Performance glass in cross arms could reduce the deflection ~8.5% under same loading conditions

Cross arms can hold a larger load or optimize for material savings

Applications - Structural

- Pultruded parts with different cross sections were modeled using ECR and high performance glass
- Cross sections included a tube, rod, i-beam, c-channel and flat plate
- Results showed improvement with high performance glass, independent of cross section

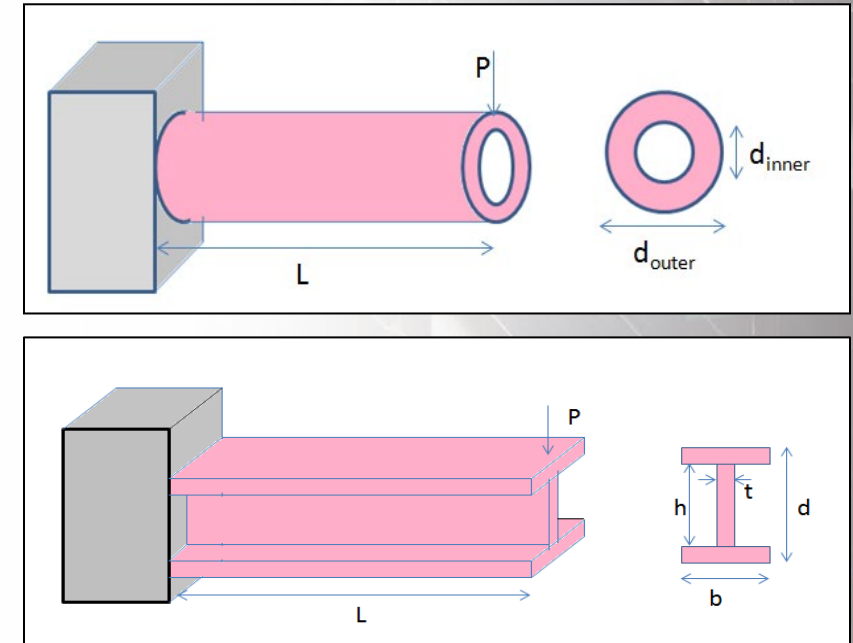
Deflection Decrease with Switch to Higher Performance Glass

	Unsaturated Polyester	Polyurethane
% Improvement	6	12

Model details

- 80% FWF, unidirectional, no CFM
- Identical parts made with high modulus and ECR glass compared

Representative Part Profiles



Structural parts can increase load factors, lengthen spans, or optimize for material savings

Applications - Rebar

- Composite rebar is already only $\frac{1}{4}$ the weight of steel
- High performance glass enables further weight and diameter reduction
- Expands application space for composites rebar
 - Bent bar
 - 60 Gpa structural → higher with next generation OC HP
- Cost reduction enables more competitive bidding
- Improved corrosion performance against NaOH further drives separation from steel



Reduced cost and weight improves composite rebar performance in application

What's Next?

- Material improvements in reinforcement and resin drive productivity and performance improvements in composites
- Improvements in composites drive material conversion and industry growth
- As an industry, we must continue to innovate
 - Materials
 - Designs
 - Standards/specifications
 - Downstream marketing

Speaker Information

Patrick Haller

Owens Corning

patrick.haller@owenscorning.com

