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American Composites Manufacturers Association

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Composites Recycling Conference 2020 | Online

May 19 – 21, 2020

Case Studies for Carbon Fiber Recycling

Andrew Maxey | Founder & CEO

Vartega Inc

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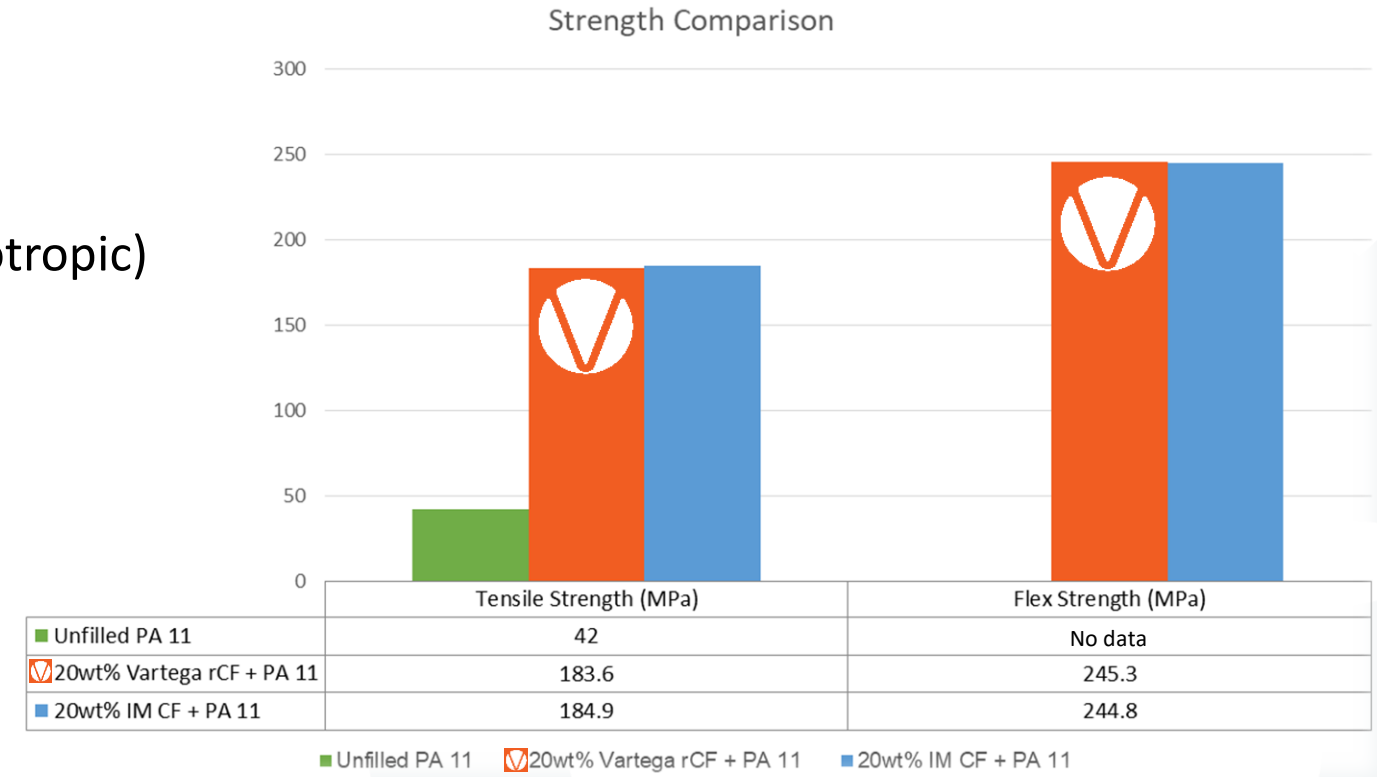
DiFTS (Discontinuous Fiber Thermoplastic Sheet)

CNAM Proprietary Process

- Suited for recycled carbon fiber
- Highly aligned fiber orientation (anisotropic)
- Optimized fiber length retention

CNAM
Composite and Nanocomposite
Advanced Manufacturing Center



	Tensile Strength (MPa)	Flex Strength (MPa)
Unfilled PA 11	42	No data
20wt% Vartega rCF + PA 11	183.6	245.3
20wt% IM CF + PA 11	184.9	244.8

Blackbird Clara Concert Ukelele

DiFTS

- 30% IM rCF / PA11
- Black ebony wood replacement
- Stiff, light, and sustainable
- Pleasing aesthetic when combined with Ekoa biobased linen composite

Blackbird

X-Hurl

DiFTS

- 30% IM rCF / PA11
- Ash wood replacement
- Performance optimization via lamination and layup geometry

IACMI Fender Project

Injection Molding Vertical Body Panel

- 10% rCF / PA66
- Metal replacement
- Vehicle lightweighting – fuel economy improvement & emissions reduction
- 2020 RE|FOCUS Sustainability Innovation Award Winner
- Ford, Dow, Michelman, Techmer PM, Michigan State University, IACMI-The Composites Institute, Colorado School of Mines, Oak Ridge National Laboratory and the University of Tennessee

Vartega Recycling-in-a-box

Modular Recycling Subscription

- On-site or local recycling
- Reduced transport
- No waste disposal fees
- Scrap valorization for internal reuse or external sale
- Closed-loop recycling is an enabling technology to create circular supply chain solutions

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CRTC- Applications for Uncured Composite Prepreg Waste

Composite Recycling Technology Center

Erik Poulin: Materials and Process Engineer

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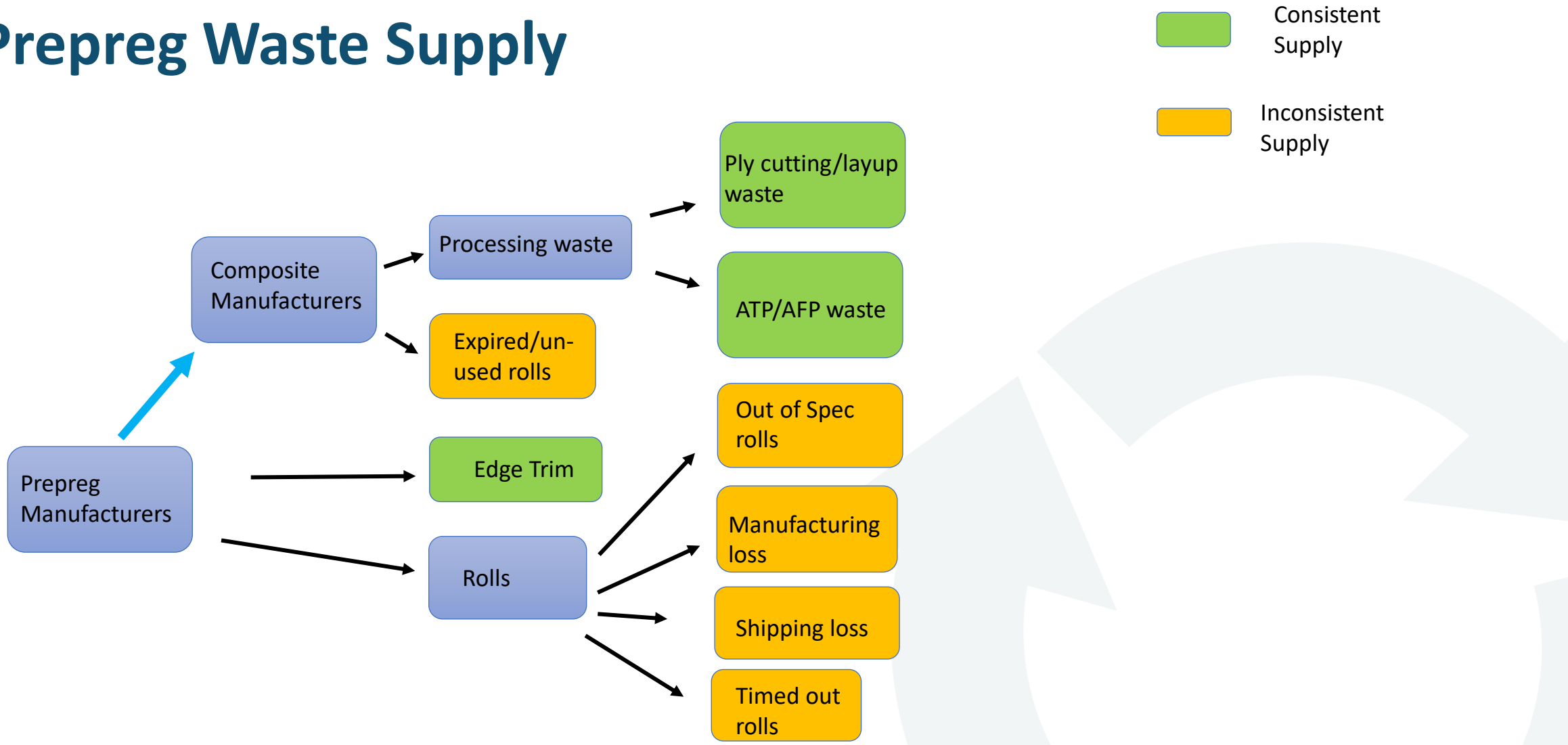
The CRTC Approach and Supply Chain

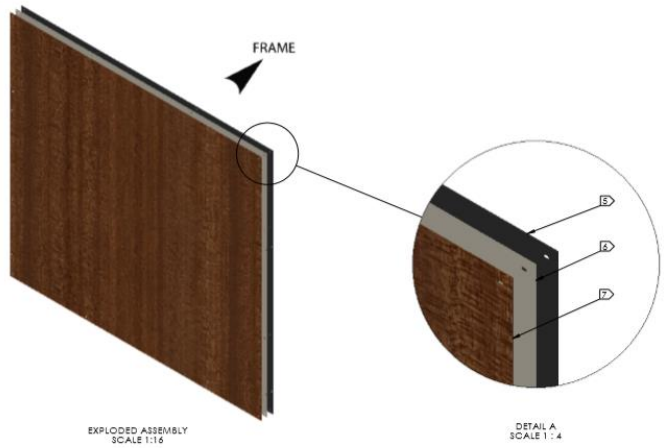
- Maximize usage of continuous fibers, uncured high value resins, high fiber volume %
- Material aging and quality has limited effect on stiffness
    - Potential loss of strength can be compensated with over design and safety factor
- Repurposed materials allows for a competitive option to low cost labor competitors
- Challenges facing a repurposed material supply chain
    - Various tiers of quality, volume, and supply chain predictability
    - Development of local supply chains
    - Creating demand
    - Social attitude around repurposing materials

Prepreg Waste Supply



Architectural Paneling

- Benaroya Symphony Hall, Octave 9 music center (LMN Architects) movable structure/space transformation
- 13 Large 10’x10’ curved sheet metal panels were replaced with thin carbon laminates and wood veneer
- Panels provided ultra-light weight backing with matching walnut aesthetics to serve as backing for a hi-resolution surround video system
    - Structurally rigid, but flexible enough to meet design criteria
    - Weight reductions allowed existing support structure
    - Project remained within budget despite last minute material change
- Approach enabled CRTC to meet and exceed customers aesthetic requirements
- Application proved to be invaluable for other products
    - Excellent bonding/backing media for cosmetic materials
        - CF Core
        - Wood or metal skins
        - Interior or Exterior
    - Significant weight savings
        - Lower freight costs
        - Less supporting structure
        - Faster and simpler installation



Wood and metal faced, CF core, cosmetic panels

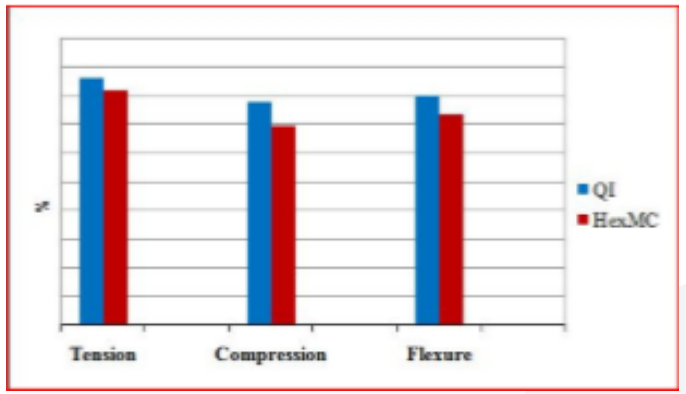
Modern lobby concept using metal carbon cosmetic panels

Strong, low profile, interesting design possibilities

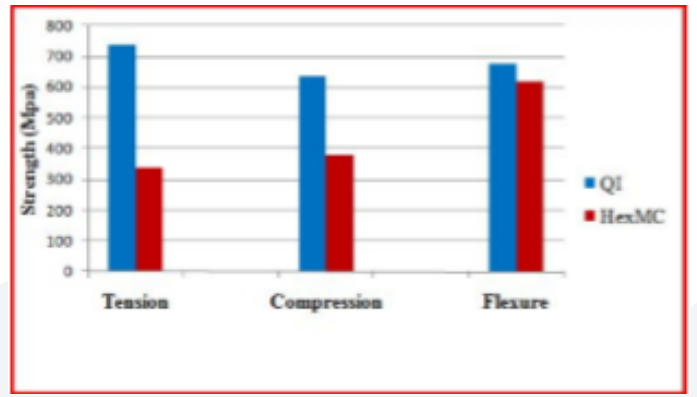
Discontinuous Fiber Composites

- High performance alternative to SMC/BMC
- Replacement for complex geometry Al parts
- Core/ bulk material to compliment continuous fiber waste
- Consistent and predictable material supply
- Existing market for virgin DFC
- Excellent avenue for timed out/crispy material
- DFC do not behave structurally like a CFC
  - Work is continually being done to fully characterize

Modulus Comparison [1]



Strength Comparison [1]



Age Effect on Mechanical Properties [2]

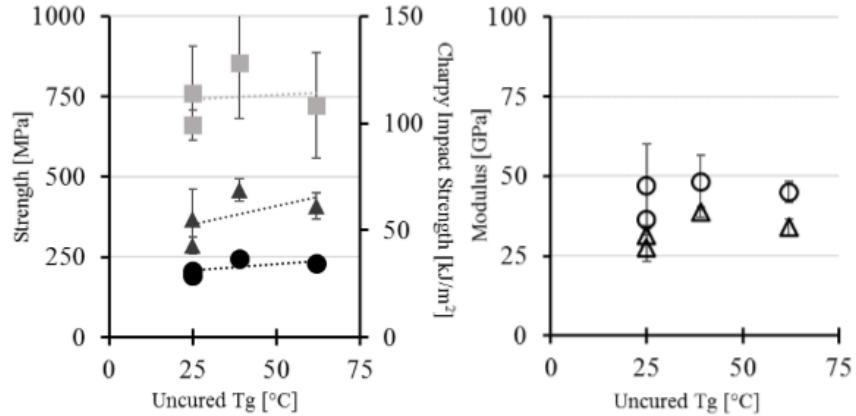
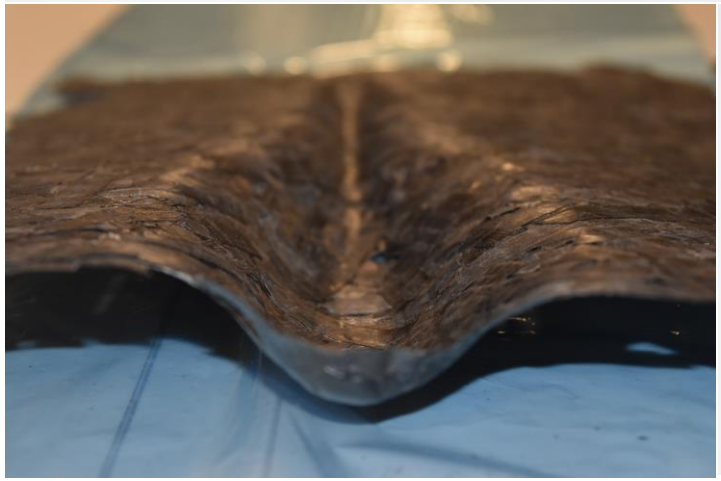


Figure 6. Uncured Tg vs a) tensile strength (●), flexural strength (▲), and Charpy impact strength (■) (left), and b) tensile modulus (○) and flexural modulus (△) (right). Trend lines are only intended to guide the eye.

[1] Boursier B, Lopez A. Failure Initiation and Effect of Defects in Structural Discontinuous Fiber Composites. Hexcel Research and Technology.

[2] George P, Rutz B, Nguyen F, Kamae T. High-Performance, Low-Cost, Discontinuous Fiber Molding Compound Based on Reclaimed Carbon Fiber-Epoxy Prepreg. CAMX 2019.

Example DFC Parts and Preforms



Questions?

Big thanks to ACMA for the opportunity to be a part of this panel!

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ELG Carbon Fibre Ltd.
RECYCLED CARBON FIBRE

Camille Seurat
ELG Carbon Fibre
Technical Services Engineer

Content

- ELG Carbon Fibre Introduction
- Case Study in the Railway Industry

Introduction

- ELG Carbon Fibre established in 2011. Based in the United Kingdom.
- Capable of processing in excess of **2000 metric tons** of carbon fibre composite **waste each year.**
- Able to recycle various carbon feedstock: **dry**, **uncured prepreg**, **cured laminates**.
- Feedstock sources:
    - Mainly **Aerospace** – **High quality** material from **long term contracts** assuring **stability in supply chain.**
    - Public contract with Boeing.
- Fibres recovered via pyrolysis: Thermal breakdown of the resin matrix into gaseous, oily and solid fractions.

Good retention of the mechanical properties post pyrolysis.

- Fibres converted into semi-products:
    - **Nonwoven** for the **composite** industry.
    - **Chopped** and **milled** fibres for the **compounding** industry.

Case Study in the Railway Industry: CaFiBo Project

Challenges

- Demonstrate an **optimised, lightweight rail bogie frame** using **recycled carbon fibre**
- **Fully compliant with railway standards**
- Meeting **mechanical**, **fatigue** and **fire requirements**

Project Objectives

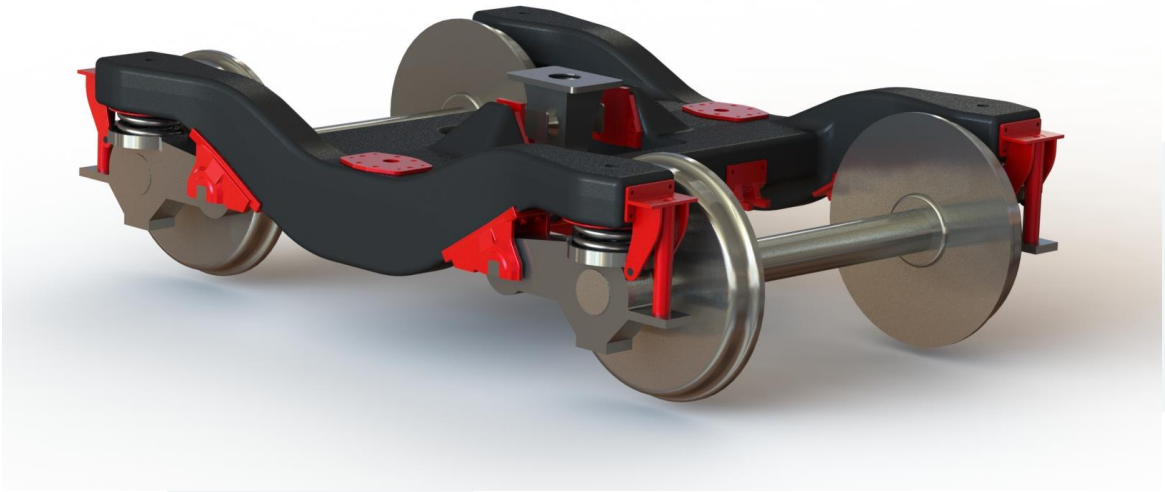
- **Reduce** bogie frame **weight by 50%**
- **Reduce transverse loading by 40%**
- Provide through **life condition monitoring**
- Produce a **commercially viable** product.

Reasons for Using Recycled Material

- **Lower material cost** compared to virgin carbon fibre
- **Higher stiffness** compared to glass
- **Ease** of manufacturing **thick** sections

Case Study in the Railway Industry: CaFiBo Project

- Achievements so far:
  - Bogie **fully manufactured** with embedded **sensors** and **fittings** attached
  - Total weight **715kg** with steel fittings vs **1468kg** for a steel bogie – **50% weight savings**
  - **Fire** retardant performances **achieved** (HL3 achieved) following EN 45545-2
  - **Fatigue** performances have been proven **similar to virgin** carbon fibre and **better than** structural **steel**



Case Study in the Railway Industry: CaFiBo Project

- Next Steps:
  - **Full scale testing** of the prototype bogie frame.
  - Follow on project to **develop** and **track-test** an **optimised prototype**.
  - Identification of **commercial application** on which to base the optimised design.

Summary

- Carbon fibre composites can deliver significant **weight savings**, and **economic** and **environmental benefits**, to the rail industry.
- The use of **recycled materials** contributes to the **economic and environmental business case**.
- Concerns regarding **mechanical properties**, **fire** and **fatigue** performance have been addressed.
- **Full scale testing** to validate **design concept, modelling methods and condition monitoring system.**

ELG Carbon Fibre Ltd.
RECYCLED CARBON FIBRE

Thank you for your attention

Questions?

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RECYCLED CARBON FIBRE

Backup slides

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Case studies for Carbon Fibres recycling

Overview of other applications

Oil Pan made using Injection Overmoulding

Seat Back made using Compression Moulding

Car Bonnet (Hood) made using Prepreg Compression Moulding

IC Carrier Trays made using rCF Reinforced Thermoplastic Compound

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