Enhancing the Understanding of Biochar to Allow the Incorporation into Tufted Carpet Tiles for a Reduction in the Carbon Footprint.

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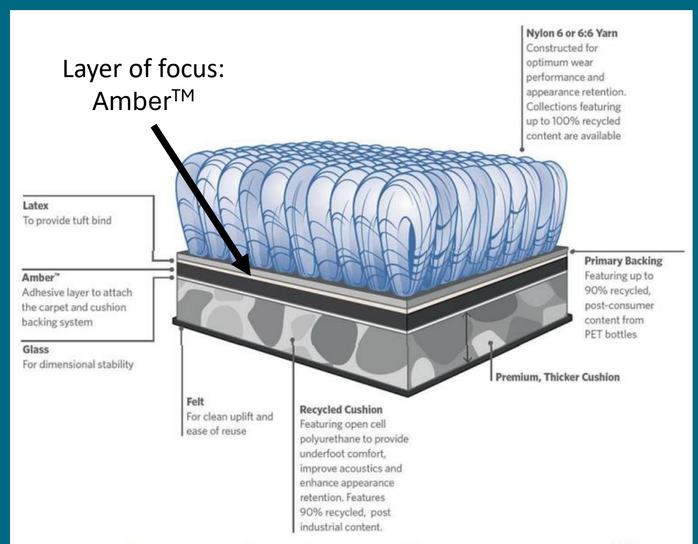
Priority Topic Area: **Responsible Production, Innovation and Industry**

1 – Aim/planned deliverables for the project

Over 17 million kg CO_2 per annum is created by Milliken's UK manufacturing sites alone, the aim is to reduce the overall CO_2 footprint. Carpet is designed not to be completely recyclable/biodegradable, as this defeats the longevity of the desired product. To tackle this, an idea to embody carbon within the tile by swapping/alterations the current carbon positive raw materials and corresponding recipe. Other factors need to be considered are implementation into the current production line and processes. Additionally, analysis for the Cost vs Carbon Reduction argument needs to meet stakeholder requirements in profitability and sustainability as an organization.

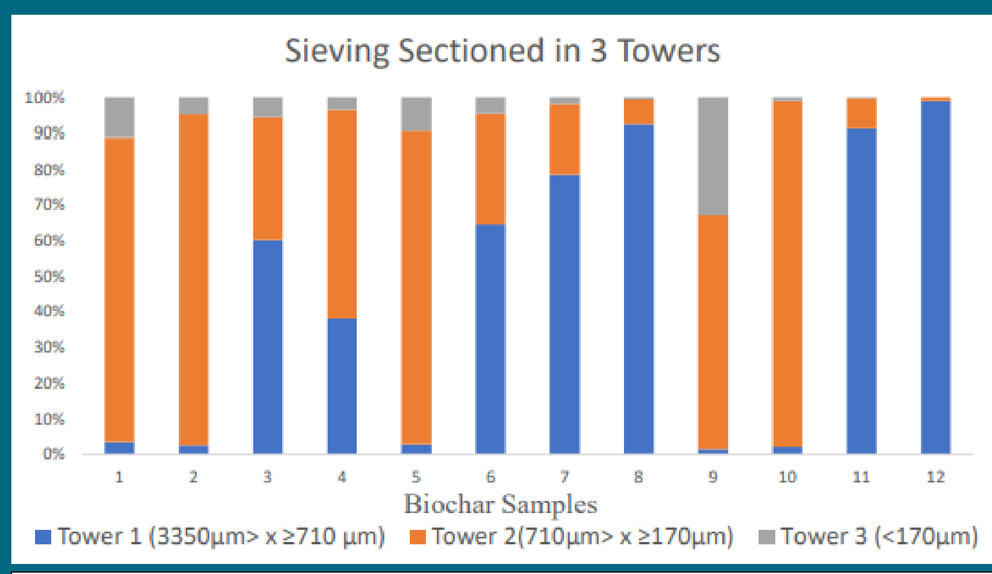


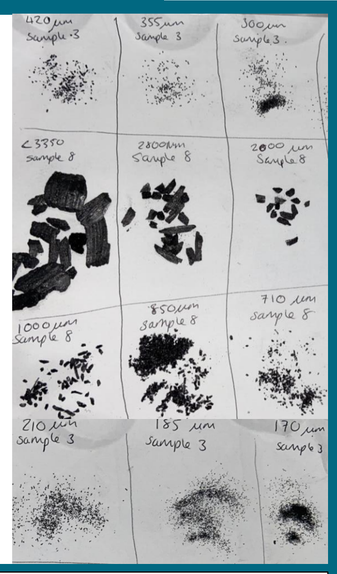
^ Tufted Milliken Carpet Tile Cross-Section [3]

Experimental Tests: Top Table Raw Material Analysis. Bottom Table Amber Analysis

Method	Purpose
Sieving	Particle Sizes
Microscope	Particle Shapes
Bulk & Tapped Density	Bulk & Tapped Density
Pycnometer	Absolute Density

Method	Purpose
Ashing	Filler Percentage
Mars IQ	Viscosity
Ring & Ball	Softening Point
Slide	Runability





^Raw Material (Biochar) Result along with pictures of biochars at different size splits

2 – Methodology

I opted to embody biochar into the Amber™ layer of the carpet tile, by swapping out carbon positive materials. Raw material analysis was completed including sieving, microscopy and pycnometer. I used a set of 12 biochar samples from multiple sources. A selection of 4 samples for the next lab scales phase of Amber™ testing. Adjustments to the Amber™ recipe including over 20 alterations were achieved. This gave a final optimum recipe, which passed procedural tests. This recipe was used in the scale up to pilot trial, giving an opportunity to produce full carpet tiles for testing against the industry standards.

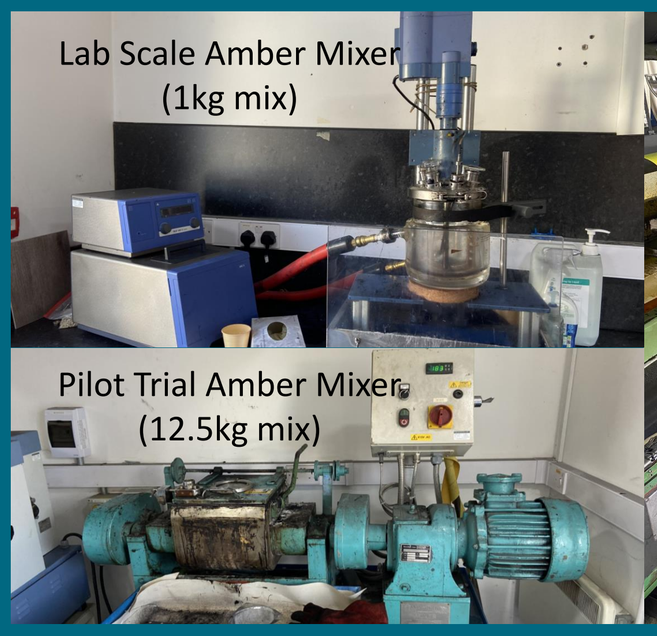
3 – Outputs/Results/findings

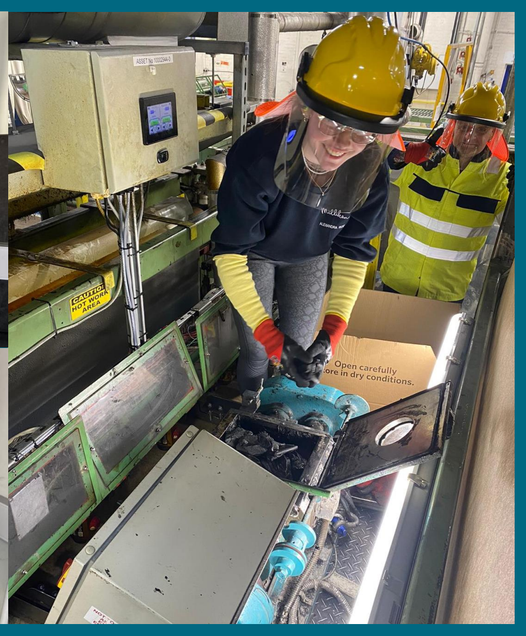
Raw material analysis allowed the reduction of 12 differing samples to 4. This allowed for a cost-effective characteristic comparison at lab-scale Amber™ mixes for the viability.

These mixes were split into sets where the previous results made up the control variables in the next sets. This included variables of mass/volume swap, venting, straight material swap, particle size, liquid fraction and optimization. Overall results indicated that material adjustments are required on a volume basis to incorporate the densities into the recipe calculations. Additionally, the integration of higher biochar levels requires alterations to liquid fraction to ensure product runability.

The optimum mix using Carbuna's biochar was scaled up to the pilot trial. The resultant product gave a carbon footprint a 36% reduction against the current emissions. The manufacturing costs increased but justified using the cost:carbon ratio analysis.

The mix was put onto the production line under standard machine settings. The resultant tiles demonstrated a partial lamination. Analysis on this, focused on the specific gravity, which highlighted either the amount of Amber™ applied needed to increase or a reduction in the marriage roller height to further squeeze the layers. This analysis provided improved results in a lab-scale tile trial.





^ Photos of Amber experimental equipment and myself during the pilot trial on site.

Myself with the finished lab-scale tile >

ᵛ Pilot Trial Product Information

	Biochar %	ΔCost/m²,£	Δ Tile GWP
Pilot Mix	30.7	+81%	-1.96 kg CO_2-eq

4 – Benefit to society

Currently, building and construction industry is responsible for 30% of carbon emissions globally; Milliken introduced their M/PACT program to tackle its carbon footprint. The purpose of a carpet tile is to be durable to withstand large amounts of foot traffic etc, means it's difficult to fully biodegrade. An alternative solution has been evidenced by swapping carbon positive materials for biochar, resulting in environmental benefits of over 5.5 million kg reduction in CO_2 production per annum. Linking, the economical, social and ethical improvements in proactive measures by Milliken in accordance with the 'Global Warming of 1.5ºC' Report by IPCC in 2019.

5 – Next steps

The next phase of this project is to recreate the carbon footprint reduced Amber™ into full tiles that withstand and pass all industrial standardised testing. Further optimisation adjustments, could be considered to the Amber™ to increase efficiency whilst reducing the carbon footprint before being introduced to the commercial market.

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References/Acknowledgements

Thank you to Milliken and Company for allowing me to test my theories on your plant site and further thanks to companies who provided the biochar samples particularly Carbuna for the further work I completed following the successes of the lab scale trials.

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