Centre of Excellence
for Decarbonising Roads

ECOFLAKES PRO LIVE TRIAL EVALUATION REPORT

Live Labs 2 North Campus

This report presents the findings of a live trial evaluating EcoFlakes Pro, a recycled plastic polymer additive for asphalt. The findings demonstrated an 8.38% reduction in cradle to construction (A1-A5 lifecycle stages) carbon emissions when compared with HRA 35/14F PMB mix, then when used in a warm mix demonstrated a 21.29% reduction in A1-A5 emissions when compared to a standard AC10 mix (FyfePave). While constructability and short-term performance were consistent with standard asphalt practices, for EcoFlakes Pro wider adoption requires extended performance monitoring, end-of-life recyclability testing and scaled UK supply for business-as-usual procurement.

Department for Transport
ADEPT LIVELABS2 Decarbonising Local Roads
NORTH LANARKSHIRE COUNCIL
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Contents

STATUS/AMENDMENT	PREPARED	REVIEWED	APPROVED
1.0 First Trial	Name: Annabelle Farrington Signature:  Date: 03/02/2026	Name: Aditi Subramanian Signature:  Date: 24/02/2026	Name: Matthew Wall Signature:  Date: 14/08/2026
2.0 Second Trial	Name: Annabelle Farrington Signature:  Date: 28/07/2026	Name: Aditi Subramanian Signature:  Date: 30/07/2026	Name: Matthew Wall Signature:  Date: 14/08/2026

Executive Summary

This report evaluates a live trial conducted as part of the Live Labs 2 project, which aims to test innovative highway solutions to improve road performance, reduce maintenance needs, and enhance safety. This trial focused on EcoFlakes Pro manufactured by EcoPals. EcoFlakes Pro is described by the manufacturer as a recycled-plastic polymer additive for asphalt that replaces some of the virgin polymer bitumen.

The purpose of this carbon appraisal is to focus on the carbon performance of EcoFlakes Pro within this live trial. EcoFlakes Pro was trialled along a 100m stretch of Chapelknowe Road, North Lanarkshire. EcoFlakes Pro was first trialled within a hot rolled asphalt (HRA) contributing to 0.5% of the total asphalt mixture. EcoFlakes Pro was trialled for a second time during the Strathclyde Park Car Park trial in February 2026. In this trial EcoFlakes Pro was added to a warm mix asphalt (WMA) mix at a percentage of 0.4%. The findings, limitations, and recommendations presented in this report aim to inform the potential rollout of EcoFlakes Pro across UK local councils.

This report assesses carbon emissions across cradle to construction lifecycle stages in accordance with EN 15804, covering product stages A1-A3 of this standard (raw material extraction, transportation to processing facilities and manufacturing) and construction stages A4 to A5 (transportation of the finished material to site and installation). EN 15804 classifies carbon and establishes a modular, transparent approach to lifecycle assessment that assigns emissions to defined stages. Using EN 15804 ensures that this live trial is in line with the recognised European standard, follows accepted boundaries and allocation rules, and enables results that are comparable, auditable and consistent across products and projects. EcoFlakes Pro is considered a small and medium enterprise (SME) based in Berlin, Germany and therefore has not yet obtained a verified Environmental Product Declaration at this stage of the trial. However, EcoPals have commissioned Utech to carry out third-party-verified Life Cycle Assessments (LCAs) for both the EcoFlakes Green and EcoFlakes Pro products. This independent verification strengthens confidence in the emission factors provided by the supplier.

The findings from the first trial demonstrated that EcoFlakes Pro demonstrated a reduction in carbon intensity when compared to HRA with 35/14F Polymer-Modified Bitumen (PMB) binder, with trial results showing an 8.38% reduction in A1-A5 carbon emissions. The findings from the second trial demonstrated a reduction in carbon intensity when compared to AC10 FyfePave (a standard AC10 mix produced to a EN 13108-1 AC recipe mix), with results showing a 21.29% reduction in A1-A5 carbon emissions. The primary driver of the carbon savings can be attributed to the materially lower A1-A3 embodied emissions associated with the use of recycled plastic within the EcoFlakes PMB binder.

Introduction

This Evaluation Report provides a high-level assessment of EcoFlakes Pro, an emerging sustainable material in highways, construction and maintenance, focusing on its environmental impact, product viability, and alignment with future infrastructure needs. EcoFlakes Pro is a recycled-plastic polymer additive for asphalt, that replaces a proportion of the polymer modified bitumen binder.

Live Labs 2 is a three-year UK-wide programme funded by the Department for Transport (DfT), followed by a five-year monitoring and evaluation period, focusing on how to decarbonise local highways infrastructure and assets. As part of this initiative, North Lanarkshire Council (NLC) are working alongside Transport for West Midlands (TfWM), to establish the UK Centre of Excellence for Materials Decarbonisation in Local Roads.

The Centre of Excellence will act as a central hub within Live Labs 2, supporting research, innovation, and best practices to accelerate low-carbon solutions in road construction and maintenance. By collating findings from Live Labs 2 trials into a single accessible location, the centre will drive sustainable advancements, enabling Local Authority Highway sectors across the UK to adopt more efficient and environmentally responsible materials and methodologies.

The purpose of this report is to present key findings from a comprehensive evaluation of sustainable materials, including their carbon intensity, potential application, and overall benefits by examining carbon appraisals, lifecycle benchmarks, and various factors such as scalability, compliance, durability and supply chain viability. The report aims to provide decision-makers with valuable insights into the material's capacity to meet sustainability goals while maintaining construction quality and durability. The evaluation will inform ongoing efforts to balance environmental considerations with operational efficiency in infrastructure development.

The carbon profiles of materials have been calculated using the Future Highways Research Group (FHRG) tool Carbon Leadership Profiler Toolkit (previously known as Carbon Analyser), an Excel-based tool developed in collaboration with local highway authorities to provide a simple, standardised method for quantifying carbon emissions associated with transport and highways activities, and the OneClickLCA database where embodied carbon data is otherwise unavailable. All carbon profiles have incorporated a local and sector-wide baseline material to benchmark carbon savings. The EcoFlakes Pro trial has been evaluated against HRA with 35/14 PMB binder in the first trial and evaluated against AC10 FyfePave surface course (a standard AC mix) in the second trial.

The carbon evaluations for EcoFlakes Pro incorporate whole lifecycle assessments which consider:

- Embodied Carbon;
- Transportation emissions of materials and people;
- Operation of plant and equipment during construction period;
- Operational electricity, fuel and water emissions;
- End of life emissions including deconstruction and waste processing.

Feature	Description	Carbon Intensity	Product Prospects
Material Summary	**Description of material**	**Specific emissions data (CO_2e per unit of material)**	**Brief product potential overview**
EcoFlakes Pro - EcoPals	EcoFlakes Pro is a PMB alternative produced from recycled plastics. The recycled polymer additive replaces a proportion of the virgin PMB binder, claiming to reduce carbon emissions while maintaining the durability and composition of the road surface. The recycled polymer additive is formed of post-consumer and post-industrial recycled materials. The waste stream of these is verified and traceable.	In the first trial, the introduction of EcoFlakes Pro into the asphalt mixture at 0.5% produced a 12.13 $kgCO_2e/m^2$. Demonstrating an 8.38% reduction in carbon emissions when compared to HRA with 35/14 PMB binder produced at the same Blantyre Quarry plant. In the second trial, the introduction of EcoFlakes Pro into the asphalt mixture at 0.4% produced 9.39 $kgCO_2e/m^2$. Demonstrating a 21.29% reduction in carbon emissions when compared to a standard AC10 mix (FyfePave) also applied at the Strathclyde Car Park site.	In this trial, it is considered that EcoFlakes Pro has demonstrated its potential for use on highway projects in the UK, particularly on projects where carbon reduction and sustainability are key focuses. The additive reduces the reliance on conventional virgin PMB binder while promoting circular economy principles through incorporating recycled consumer and industrial plastics.

Methodology

Trial Design

The EcoFlakes Pro car park trials were designed to evaluate the performance, durability, and environmental impact of the material. The first trial of EcoFlakes Pro was applied to a 100m stretch of Chapelknowe Road, Motherwell, North Lanarkshire. While the second trial was a part of larger trials at Strathclyde Park Car Park at the Water sports Centre, Bellshill, North Lanarkshire.

Carbon emissions have been assessed based on the whole lifecycle stages A1-A5 (cradle to construction) in accordance with EN 15804. EN 15804 is the European standard that defines the rules and reporting format for Environmental Product Declarations (EPD) for construction products, providing a consistent, auditable framework for quantifying carbon impacts across a product's lifecycle. These stages cover raw material extraction, transport to and manufacture at the factory, delivery to site and on-site installation, see Figure 1. This clear separation of stages enables precise attribution of emissions to each segment of the supply chain, helping to identify areas for potential reduction measures and ensuring comparability across all trials.

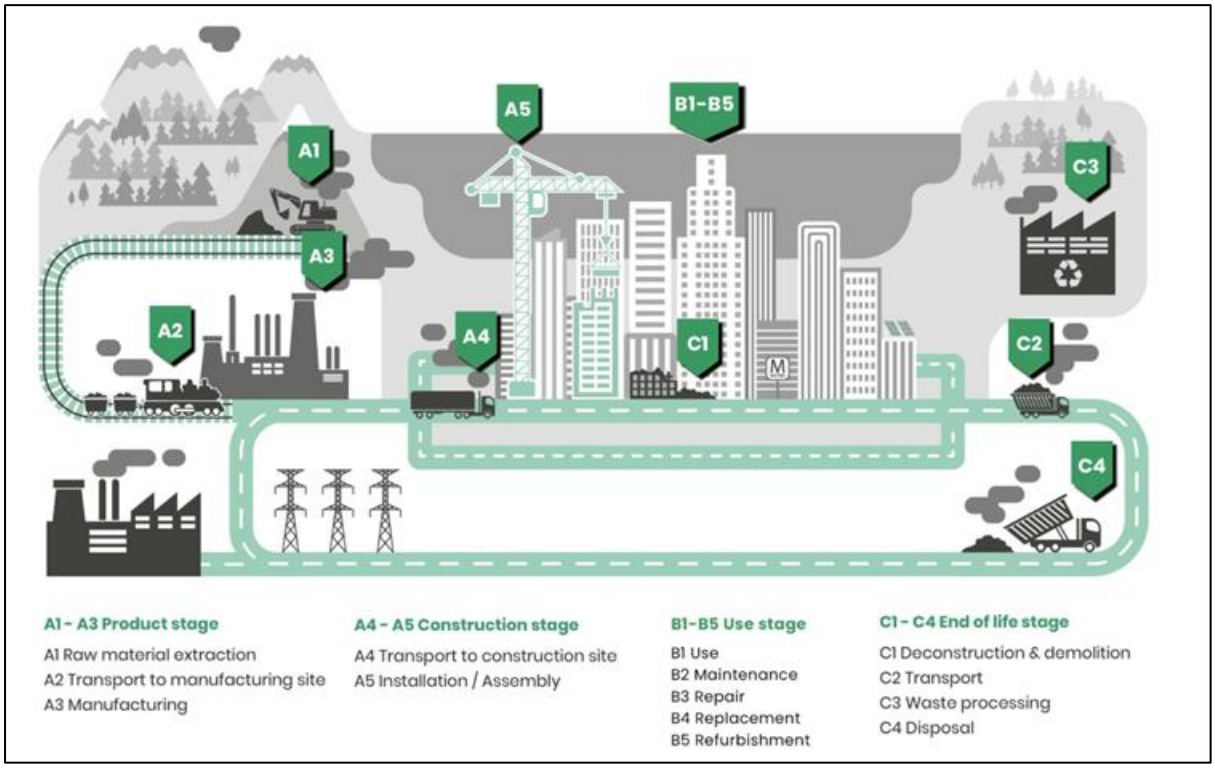

Figure 1: Carbon Lifecycle Stages[1]

[1] https://help.oneclicklca.com/en/articles/275901-life-cycle-stages

Site Selection

The trial sites were chosen based on the following criteria:

- **Traffic Volume:** The site was chosen as it experiences high loads of light and heavy vehicles allowing for the assessment of the material's performance under differing stress conditions.
- **Environmental Conditions:** The carpark sites were selected due to its varying weather conditions (e.g., temperature, humidity) to evaluate the surfacing material's resilience.
- **Surface Type:** Sites were all originally laid with an asphalt surface course and had severely deteriorated, requiring urgent maintenance.

Data Collection Plan

The following data items were collected to ensure a thorough evaluation of EcoFlakes Pro during site trials:

DATA ITEM	UNIT(S)	RESPONSIBLE	LOCATION OF DATA	PURPOSE
Trial Location	Road name, Coordinates of location of EcoFlakes Pro trial	Operational Staff	Site Diary	Technical comparisons
Conditions at the time of lay	Temperature (℃) Conditions (rain, dry, etc)	Operational Staff	Site Diary	Operational considerations and technical comparisons
Coring	Pen Softening Point DSR	University of Nottingham	Site Diary	Technical Evaluation
Road Surface Temperature	Temperature (℃)	Inspector	Site Diary	Technical Evaluation
Quantity	m^2 of EcoFlakes Pro used	Operational staff & Carbon Lead	Site Diary	Cost and Carbon Evaluations
Cost	Cost for EcoFlakes Pro Cost for conventional resurfacing	Amey Procurement and Suppliers	SAP	Purchase cost and whole lifecycle cost evaluation
Operational Experience – ease of installation	Subjective – any concerns or benefits experienced by Operations Team	Project Manager to collect on-site data with Operations Team	Case Study in knowledge bank	Scalability Evaluation
Health & Safety	Ease of installation on-site Temperature required for installation	Operational staff and supplier information	Site Diary	Health and Safety Assessment
Operational Data	Time to complete (hh:mm)	Operational Staff	Site Diary	Operational considerations and carbon evaluation
Fuel Usage	Litres of petrol used Type of plant/fleet used (electric, diesel, model)	Operational Staff	Site Diary	Carbon evaluation

Table 1: Data collection plan

Trial Location Plan

The primary aim of the EcoFlakes Pro trials is to undertake a comparison analysis of EcoFlakes Pro with the benchmark, conventional HRA with 35/14 PMB binder at the first site and then undertake a comparison analysis of EcoFlakes Pro in WMA with the benchmark, AC10 FyfePave (a standard mix with no additives).

In the first trial, EcoFlakes Pro content was 0.5% of the total hot asphalt mix. HRA with 35/14 PMB binder produced by Holcim will serve as the benchmark for EcoFlakes. This mix was manufactured at the same plant at Blantyre Quarry by Holcim, ensuring energy use and production conditions are comparable. Using this as the baseline provides a clearer comparison and highlights the carbon savings achieved through incorporating recycled materials.

In the second trial, EcoFlakes Pro content was 0.4% of the total warm asphalt mix, with AC10 FyfePave serving as the benchmark for this trial. The EcoFlakes Pro mix was manufactured in plant at Duntilland Quarry while the standard AC10 FyfePave mix was manufactured at Blantyre Quarry. While these are different plants, both are owned and operated by Holcim therefore it can be assumed that the same production process were used at both plants.

The trial areas are as defined in the table below. Preference was given to locations which experience high traffic loads.

TRIAL SITE	SITE	TRIAL LOCATION
1	100m of Chapelknowe Road	Motherwell

Table 2: EcoFlakes Pro Chapelknowe Road Trial information

TRIAL SITE	SITE	TRIAL LOCATION
2	Strathclyde Park Car Park	Bellshill

Table 3: EcoFlakes Pro Strathclyde Park Trial information

Procedure

Site Preparation: The selected sites were cleaned, prepared and planned for the application of EcoFlakes Pro. Loose debris and water were removed to ensure proper adhesion.

Material Application: Roads were prepped as per manufacturer's instructions prior to the product's application. EcoFlakes Pro asphalt mix was applied by M1 Contracts at site one on behalf of Hochtief and by Hochtief themselves at site two, via a paver following conventional asphalt processes.

Monitoring and Data Collection: The trial sites were monitored over a period of 12 months. Data on surface condition, material performance, and environmental impact were collected at regular intervals.

Performance analysis: The performance of EcoFlakes Pro was evaluated based on criteria such as durability, resistance to traffic stress, and environmental impact. Comparisons were made versus conventional resurfacing for NLC to benchmark performance.

Data Analysis

The collected data at the first trial was analysed to assess the effectiveness of replacing a proportion of the PMB binder in HRA with EcoFlakes Pro, compared to conventional HRA containing PMB binder. Performance was evaluated by comparing the EcoFlakes Pro mix against a control section (standard HRA) produced at the same Holcim quarry plant in North Lanarkshire. For the second trial, the same process was followed, with the control and benchmark material used being AC10 FyfePave. FyfePave is a standard AC mix with no additives, typically used for lower traffic applications such as car parks and is the brand name for Holcim's AC mix in North Lanarkshire.

The analysis focused on:

- **Durability**: Assessing the longevity of the treated site and resistance to traffic and environmental stress;
- **Environmental Impact:** Evaluating the reduction in carbon emissions and use of recycled materials; and
- **Cost- Effectiveness:** Comparing the costs associated with EcoFlakes Pro, including material, application, and maintenance costs.

The embodied carbon factors for trialled materials have been developed using supplier product data and supported by carbon factors sourced from OneClick LCA where required. An Environmental Product Declaration (EPD) had not been produced at the time of this trial. EcoPals have obtained a third-party verified LCA from Utech for EcoFlakes Pro. This independent verification increases confidence in the emission factor supplied.

Holcim have provided A1-A3 carbon value for the manufacturing of the EcoFlakes Pro mix at Blantyre Quarry, the third-party verified LCA has been used in the calculation of this value. Holcim provided A1-A3 carbon figures from manufacturing HRA with PMB binder at Blantyre Quarry from previous works in North Lanarkshire. This figure has been used as the baseline figures to benchmark EcoFlakes Pro against.

Holcim's internal carbon tool was used to calculate these values. This tool follows the principles of EN 15804 and has been third party verified by Circular Ecology Ltd. The tool uses primary activity data from Holcim operations, secondary data coming primarily from the UK Government GHG emission factors and Inventory of Carbon and Energy v4.0 by Circular Ecology and University of Bath, with additional data supplied by Carbon Trust.

This existence of third party verified LCA for EcoFlakes and the use of a third party verified carbon calculation tool provides objective verification that EcoFlakes Pro's carbon reduction claims are based on transparent, independently validated, and whole-life carbon data. EcoPals are in the process of obtaining a third-party verified EPD, with access to the preliminary EPD being given for this carbon analysis. The addition of a formal EPD in the future will further enhance this level of confidence.

Carbon Appraisal

Carbon appraisal

Drawing on data collected through trials; a carbon assessment has been undertaken. Table 4 establishes the parameters of the model, defines assumptions and outlines product specifications.

ASSUMPTIONS	JUSTIFICATION
All transportation is undertaken via diesel HGV.	Based on standard modelling assumptions from similar schemes.
Unit of measurement used is '$kgCO_2e/ m^2$'.	Based on the best available data used to conduct carbon appraisals.
Traffic management activities were not included within this carbon assessment.	Traffic management differs between sites and local authorities so requires separate capturing, as part of standard practice.
GHG-conversion-factors-2025-full-set has been used for delivery vehicle emission factors when the fuel usage is unknown.	Based on the best available data at the time of this carbon appraisal.
This carbon analysis does not incorporate planing activities within this assessment.	This is a BAU activity therefore is not influenced by this innovative process.
Where specific machine hour carbon emission factors were unavailable emission factors have been selected based on average kW power, sourced from OneClick LCA.	Based on the best information available at the time of the carbon appraisal.
To calculate the CO_2e emissions per tonne of aggregate from each quarry, Holcim utilised the total energy consumption from the quarry over the previous 12 months. Each quarry's energy use was converted to an equivalent CO_2 emission value then divided by the total tonnage of aggregate sold in that same period.	Based on the most up to date information Holcim (the main contractor) had available at the time of this carbon analysis.
Holcim utilised Eurobitume's 2025 carbon emission factor for bitumen, 530$kgCO_2e$/ tonne for the EcoFlakes Pro mix.	This figure is the most recent bitumen emission factor and is considered the industry standard.
Fuel consumption of dryers has been calculated by the amount of fuel used divided by the tonnage of asphalt supplied. Giving the CO_2e value per tonne of asphalt mixed can vary plant to plant based on tonnage supplied, fuel type, efficiency etc.	Based on the best available data at the time of this carbon appraisal.
The emission factor used for fibre pellets was sourced from ASPECT.	Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follow the principles EN 15804.
The emission factor used for limestone filler was sourced from ICE v.3 2020.	Based on the most recent emission factors available to Holcim for emission factor calculation. Holcim's internal carbon calculation tool has been externally verified by Circular Ecology and follow the principles EN 15804.

ASSUMPTIONS	JUSTIFICATION
Application rate of bondcoat is assumed to be 0.35/m^2.	Based on application rate stated in Colas Colbond 50 product data sheet.
Application rate of chippings in the first trial is assumed to be 10.4/m^2.	Based on average application rate recorded on site.
Machine hours at the first site were assumed based on laying records on site as recorded by M1 Contracts. Machine hours at the second site were assumed based on laying records on site as recorded by Hochtief.	Based on the best available data used to conduct the carbon appraisal.
Vehicles transporting materials are assumed to travel fully laden to site and return empty.	The assumption that vehicles travel fully laden to site and return empty reflects standard haulage practice for material deliveries. Applying this assumption ensures carbon calculations accurately represent typical operational behaviour and avoid artificially reducing transport-related emissions.
Baseline comparison material for the first trial was not produced as part of the Live Labs 2 trials. EcoFlakes Pro and HRA with PMB binder were both manufactured at Blantyre Quarry.	Both materials were manufactured at the same quarry owned and operated by Holcim. It can be assumed that the plant at this quarry follow the similar production methodology, energy consumption and fuel use. This was the best available data at the time of this carbon appraisal.
The carbon modelling for HRA 34/14F with PMB binder assumes equivalent material quantities and construction activities to those recorded for EcoFlakes Pro trial, ensuring a like for like comparison.	This approach controls key variables, reducing modelling uncertainty and making the carbon impact of the benchmark directly attributable.
Fuel usage for HGVs on site at Strathclyde Park has been calculated based on the assumption 0.05l/minute.	Based on typical on-site HGV operations where vehicles are largely idling or moving at low speeds.
Number of operatives on site has been assumed to be 10 for the trial at Strathclyde Park.	Based on average number of operatives on similar surfacing trials as part of Live Labs 2.

Table 4: Carbon appraisal matrix

Carbon Modelling

The carbon modelling for the trials was conducted using the Future Highways Research Group (FHRG) Carbon Leadership Profiler Toolkit to collect primary carbon data from the trials, detailing emissions from materials, transport, construction activities and equipment use. Using this information the tool generated carbon profiles that identified emission hotspots and using the toolkit's emission database, which provides verified emissions factors to improve data accuracy.

One Click LCA was also utilised in modelling to support the FHRG Carbon Leadership Profiler Toolkit due to its large database of emission factors supported by Environmental Product Declaration (EPD). The carbon emission factor for EcoFlakes Pro has been supplied by Holcim as the manufacturer of the asphalt mix. This value was calculated using a third party verified LCA of EcoFlakes Pro and a third-party verified carbon calculator.

Indicative results from carbon modelling for the EcoFlakes Pro trial, expressed in $kgCO_2e/m^2$ and $kgCO_2e/t$ are presented below. This presentation of emissions enables direct comparison across different low-carbon innovations, to highlight carbon-efficient options and support-data driven decision making for reduction strategies. Results for the first trial at Chapelknowe Road are presented graphically in Figure 2, Figure 3 and Figure 4:

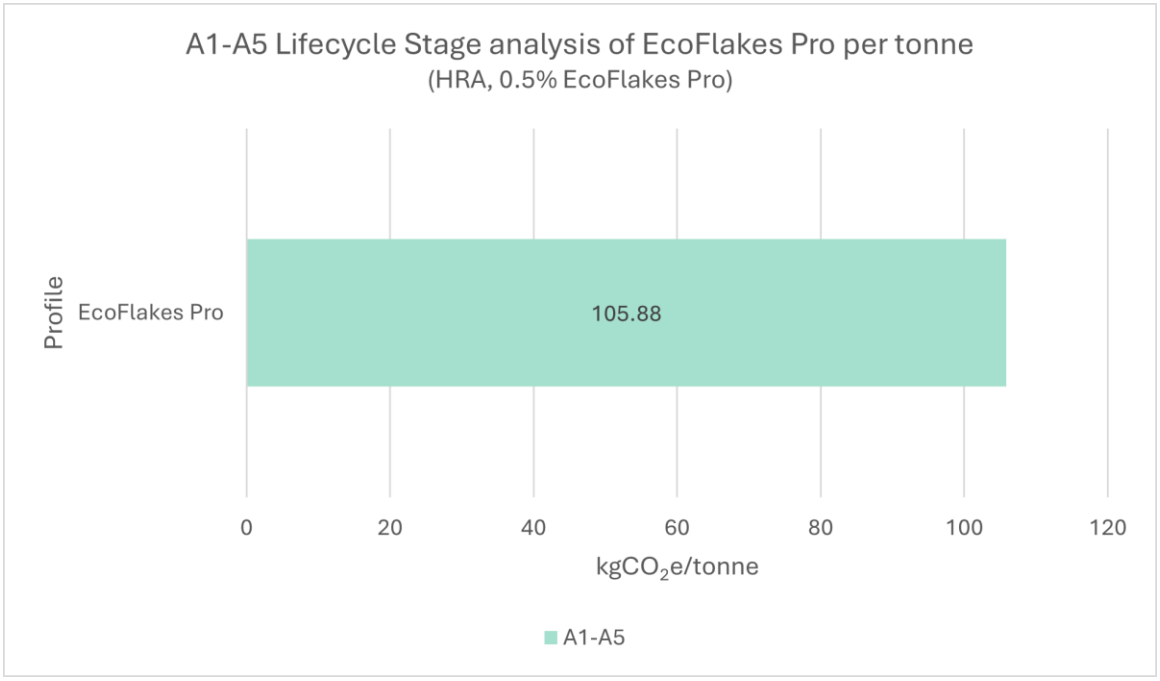

Figure 2: Carbon analysis of EcoFlakes pro (HRA, 0.5% EcoFlakes Pro) per tonne

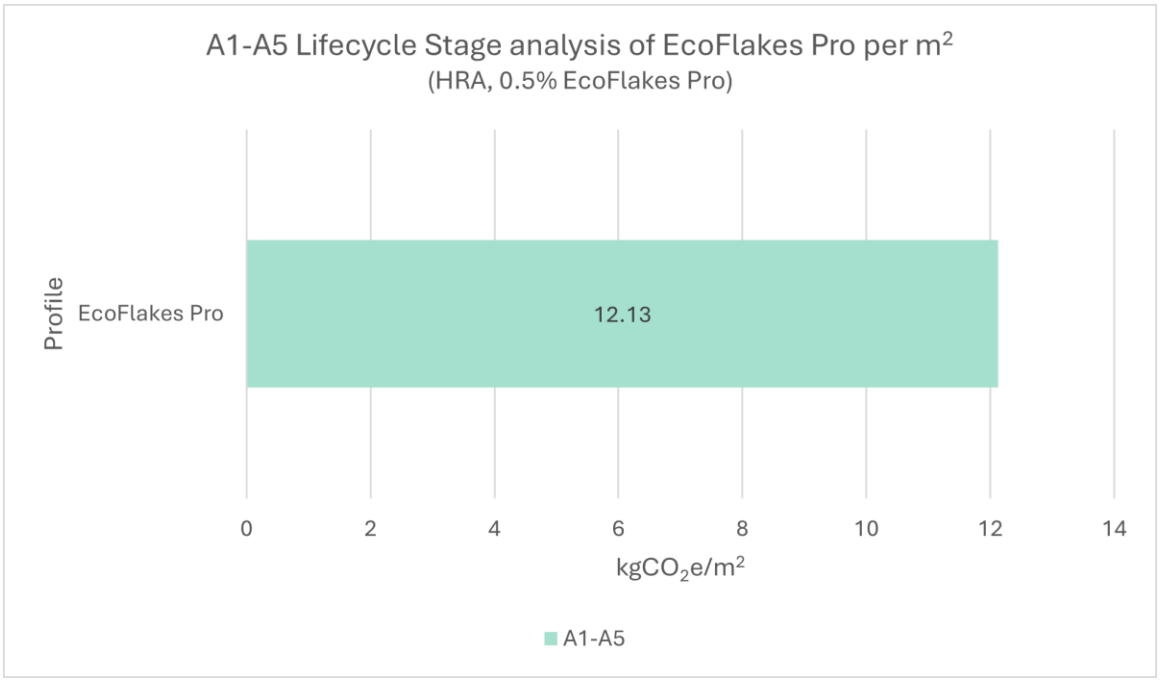

Figure 3: Carbon analysis of EcoFlakes Pro (HRA, 0.5% EcoFlakes Pro) per m²

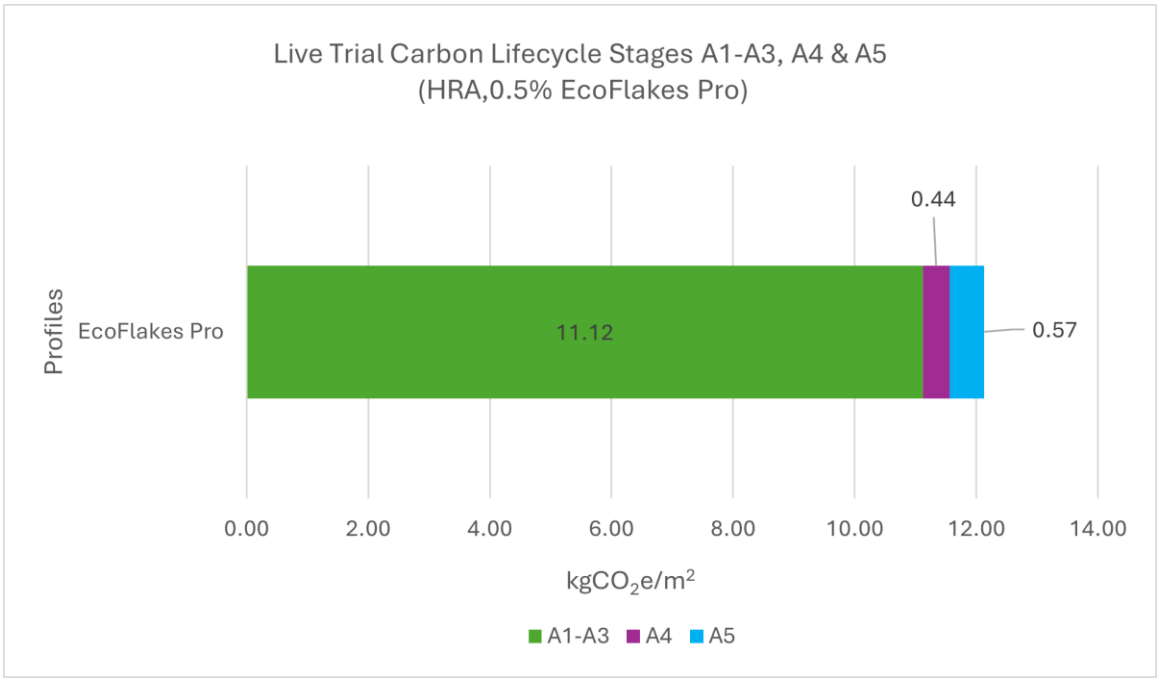

Figure 4: Carbon analysis of EcoFlakes Pro (HRA, 0.5% EcoFlakes Pro) lifecycle stages A1-A3, A4 & A5 per m²

Results from the second trial at Strathclyde Park were represented graphically below in Figure 5, Figure 6 and Figure 7:

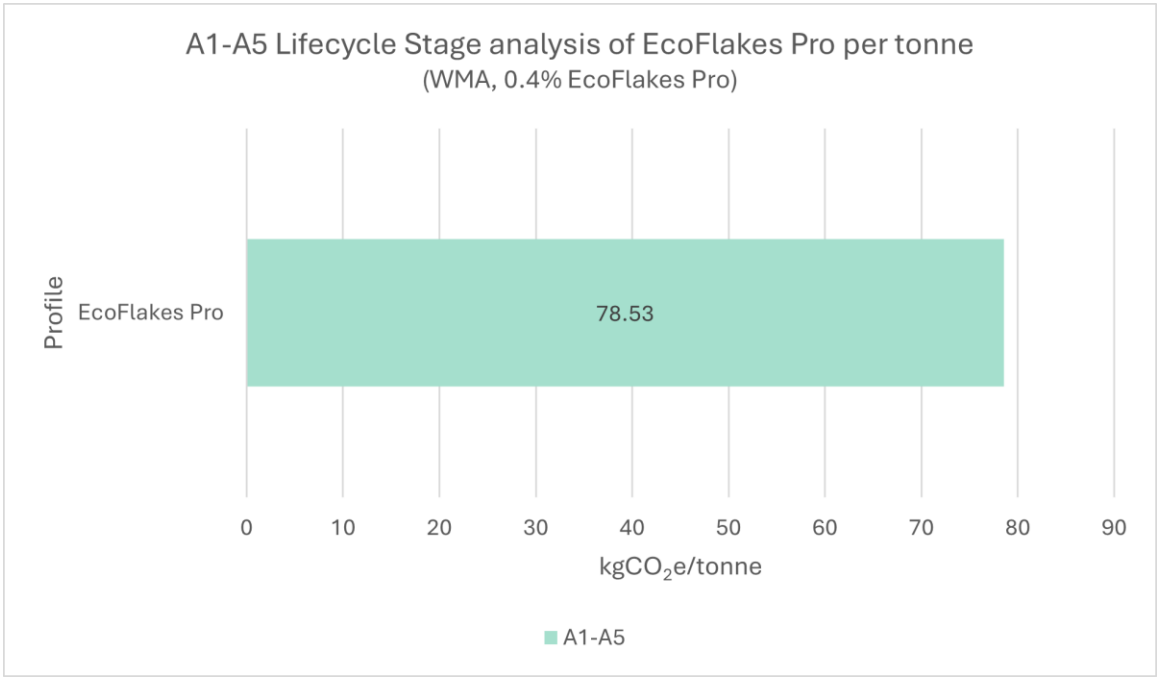

Figure 5: Carbon analysis of EcoFlakes pro (WMA, 0.4% EcoFlakes Pro) per tonne

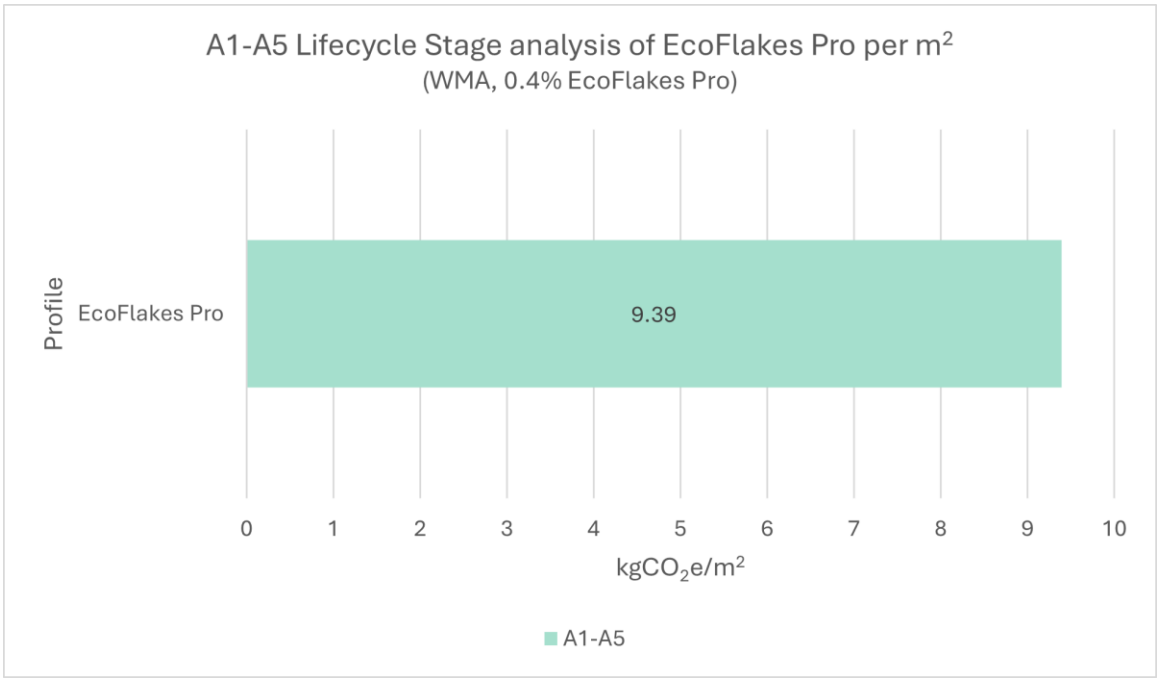

Figure 6: Carbon analysis of EcoFlakes pro (WMA, 0.4% EcoFlakes Pro) per m^2

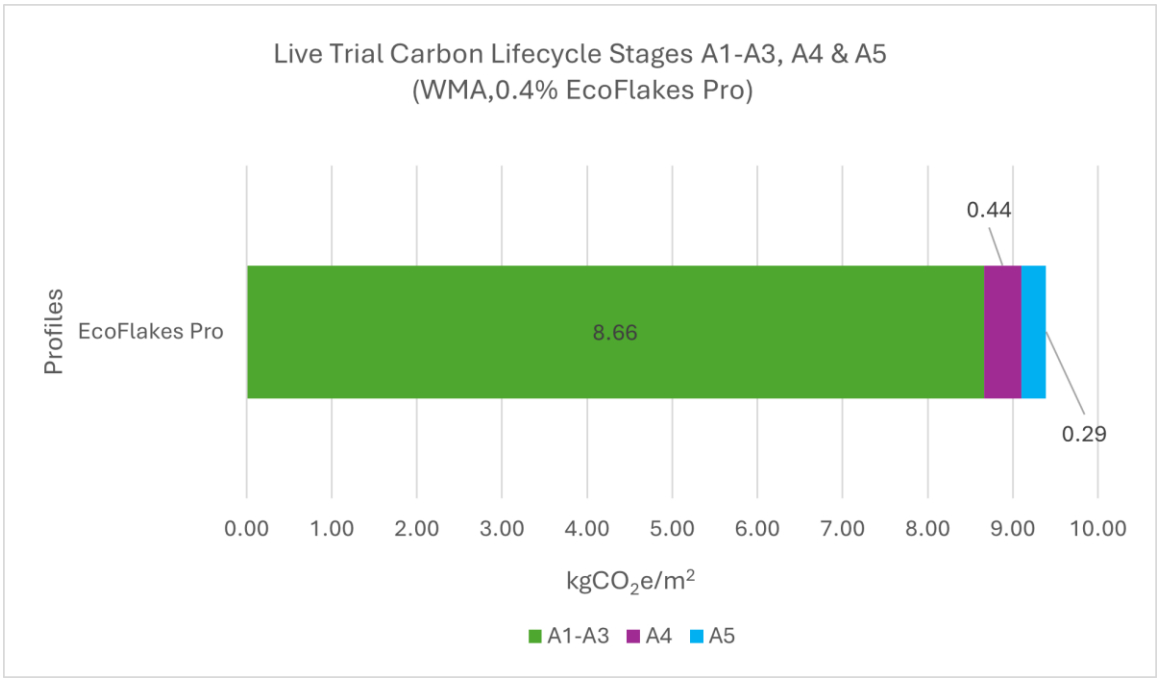

Figure 7: Carbon analysis of EcoFlakes Pro (WMA, 0.4% EcoFlakes Pro) lifecycle stages A1-A3, A4 & A5 per m^2

Benchmarking

EcoFlakes Pro is yet to be fully evaluated against traditional Hot Rolled Asphalt (HRA) and Warm Mix Asphalt (WMA) in terms of performance and long-term viability in North Lanarkshire, as prior to this trial EcoFlakes Pro had not been used in the UK. These trials are to allow for comparative analysis of the performance of EcoFlakes Pro in comparison to conventional hot rolled asphalt. These asphalt mixes would be the alternative options for re-surfacing if EcoFlakes Pro was not used. This allows for comparisons between EcoFlakes Pro versus BAU surfacing within the carbon analysis.

For site one, a comparative analysis was conducted to assess EcoFlakes Pro (HRA mix with 0.5% EcoFlakes Pro) versus the benchmark conventional hot rolled asphalt (HRA with 35/14F PMB binder). The EcoFlakes Pro trial in North Lanarkshire compared to previous works completed by Holcim, where both products were mixed at the same plant. The model incorporates A1-A5 lifecycle stages, which represent raw material, transportation to manufacturing, manufacturing, transportation to site and construction associated emissions. This allows for a comprehensive carbon evaluation of EcoFlakes Pro.

Indicative comparative analysis results is presented graphically in Figure 8 and Figure 9 :

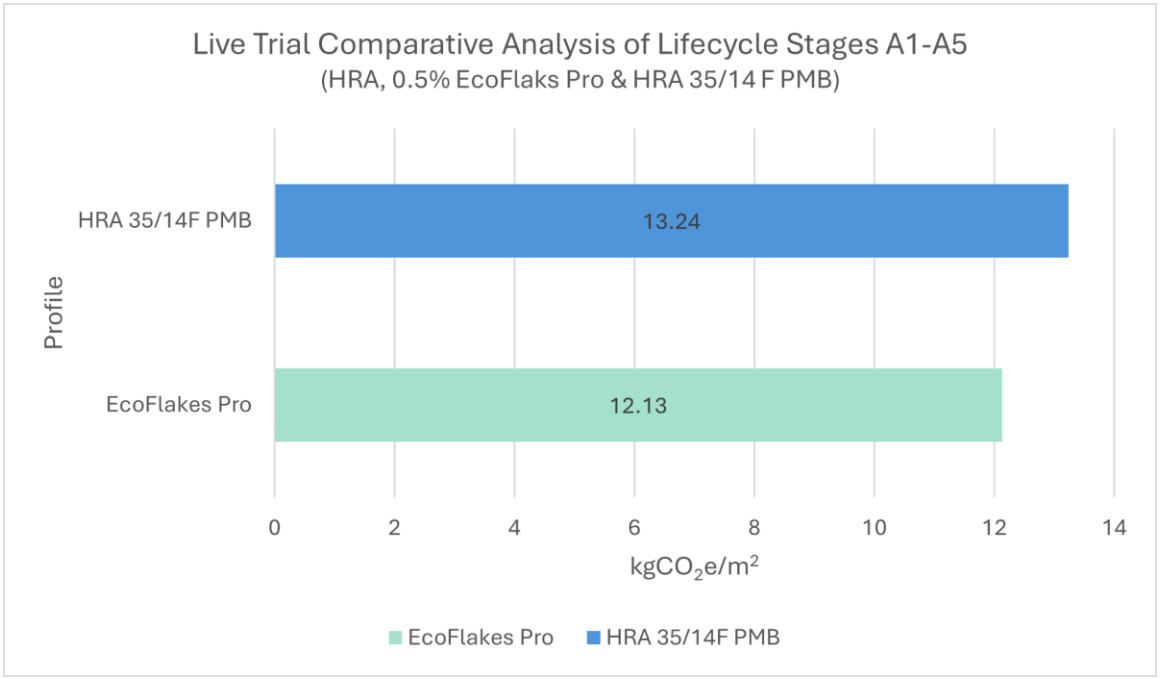

Figure 8: Comparative carbon analysis EcoFlakes Pro versus HRA 35/14F PMB per m^2

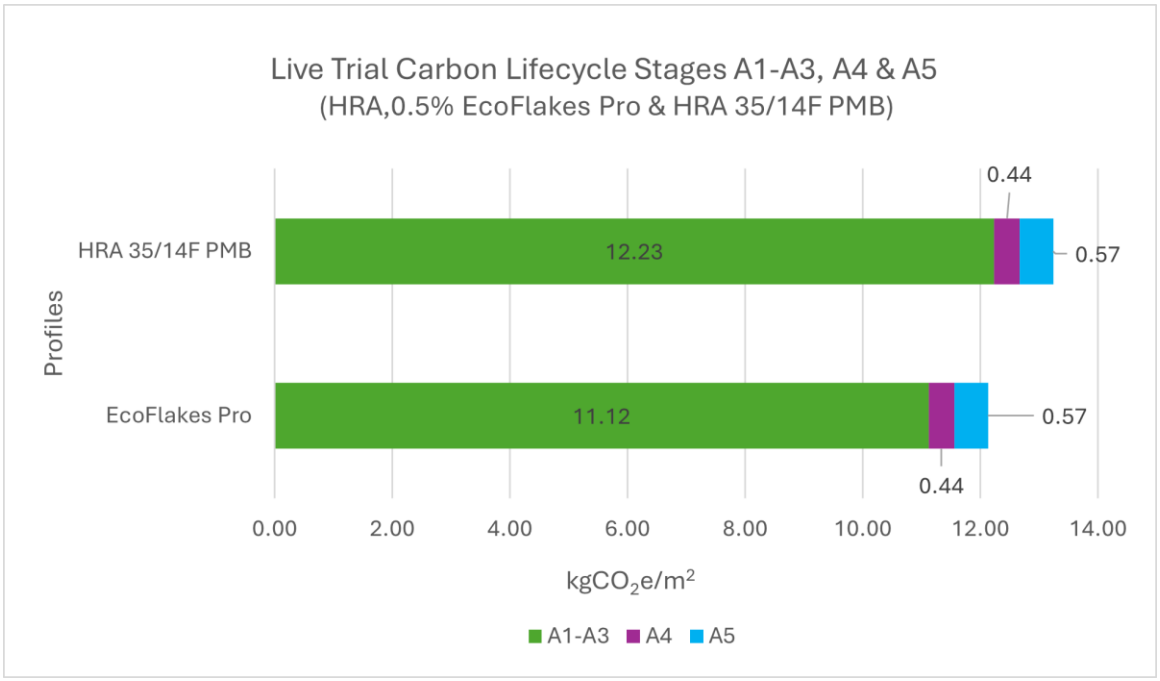

Figure 9:Comparative carbon analysis EcoFlakes Pro versus HRA 35/14F PMB A1-A3, A4, A5 lifecycle stages per m^2

For site two, a comparative analysis was conducted to assess EcoFlakes Pro (WMA with 0.4% EcoFlakes Pro) versus the benchmark AC10 FyfePave (a standard AC mix). Both asphalt mixes were manufactured in North Lanarkshire by Holcim and laid at Strathclyde Park to allow for a side-by-side comparison of the materials. The model incorporates A1-A5 lifecycle stages, which represent raw material, transportation to manufacturing, manufacturing, transportation to site and construction associated emissions. This allows for a comprehensive carbon evaluation of EcoFlakes Pro.

Indicative comparative analysis results is presented graphically in Figure 10 and Figure 11:

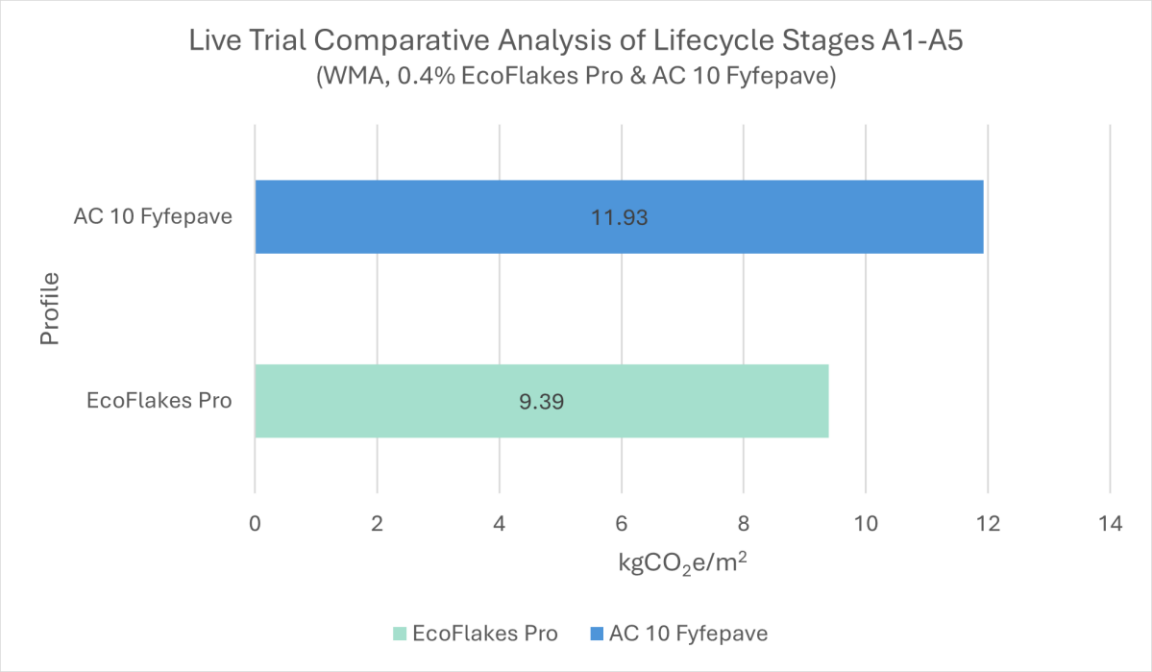

Figure 10: Comparative carbon analysis EcoFlakes Pro versus AC10 FyfePave per m²

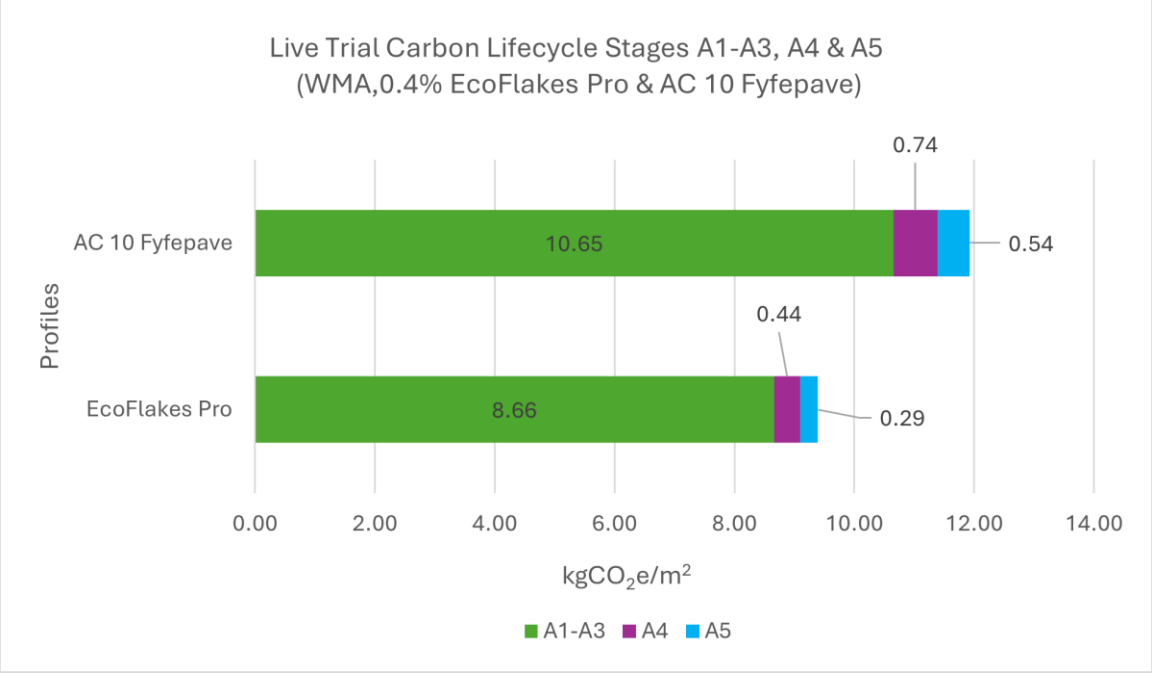

Figure 11: Comparative carbon analysis EcoFlakes Pro versus AC10 FyfePave A1-A3, A4, A5 lifecycle stages per m²

MATERIAL	COMPOSITION	APPLICATIONS	PERFORMANCE	INSTALLATION	SUSTAINABILITY
HRA 35/14F PMB	Hot Rolled Asphalt (HRA) is a mixture of penetration grade bitumen, limestone filler, fine and coarse aggregates. Typically finished with pre-coated chips to provide texture.	HRA PMB is the preferred surface course for heavily trafficked roads. Widely used on motorways and major trunk roads but also suitable for footways, drives and parking areas where high durability is a key area of concern.	HRA 35/14F PMB is characterised by high durability, resistance to permanent deformation, high weather resistance and high skid resistance when chippings are applied. Typical lifespan is 15 to 25 years.	Follows conventional asphalt production methods and is laid to relevant BS standards. Application follows standard asphalt laying techniques.	Uses virgin polymer typically derived from crude oil, producing typically higher carbon emissions.
Standard AC10 FyfePave	FyfePave is a standard AC10 product produced to a standard EN 13108-1 AC recipe mix. It does not include any additives or modification mechanisms. Uses conventional bitumen (100/150 pen) binder.	FyfePave is typically used for low traffic areas such as car parks, footways and access roads.	FyfePave is considered to have moderate durability, fatigue resistance and rutting resistance, hence the typical use in low trafficked areas.	Follows conventional asphalt production methods and is laid to relevant BS standards. Application follows standard asphalt laying techniques.	At the time of this assessment no specific sustainability claims for FyfePave were available. However, as FyfePave follows standard AC mix design, it can be assumed that it predominantly comprises of virgin materials, including aggregates, limestone filler and bitumen binder. FyfePave can incorporate reclaimed asphalt pavement (RAP), with approximately 5% RAP content included within the asphalt mix at the Strathclyde Park car park.
EcoFlakes Pro	EcoFlakes Pro is a polymer modifier composed of recycled plastics. It is an additive for asphalt mixes. It replaces a proportion of conventional bitumen binder at the plant to create claimed PMB equivalent performance. It is composed of recycled post-consumer and post-industrial plastics.	EcoPals claim that EcoFlakes Pro can be used in all asphalt layers and within a variety of asphalt mixes, this includes warm mix asphalt (WMA) and hot rolled asphalt (HRA).	EcoPals claim that EcoFlakes Pro provides PMB-equivalent performance, strengthening surfaces against rutting, cracking and ageing.	EcoFlakes Pro additive allows for asphalt modification at the plant, prior to arriving on site. Application follows standard asphalt laying techniques and operational feedback is positive, focussing on its ease to lay.	EcoFlakes Pro reduces the reliance on fossil-derived polymers, reducing carbon emissions while also using recycled plastic and therefore promoting circular economy principles.

*Table 5: EcoFlakes Pro Appraisal**

*All factors assessed as part of the appraisal of EcoFlakes Pro has been built on supplier provided material and are not drawn from the live trial. Unless otherwise stated.

Life Cycle Stage	Baseline Carbon Emissions (HRA 35/14F PMB) ($kgCO_2e/m^2$)	EcoFlakes Pro (HRA) Carbon Emissions ($kgCO_2e/m^2$)	Difference (%) (Increase/ Reduction)
A1 – A3	12.23	11.12	9.08%
A4	0.44	0.44	0%
A5	0.57	0.57	0%

Table 6: Site One Lifecycle Stage Comparison to BAU

Life Cycle Stage	Baseline Carbon Emissions (AC10 FyfePave) ($kgCO_2e/m^2$)	EcoFlakes Pro (WMA) Carbon Emissions ($kgCO_2e/m^2$)	Difference (%) (Increase/ Reduction)
A1 – A3	10.65	8.66	18.67%
A4	0.74	0.44	40.56%
A5	0.54	0.29	46.23%

Table 7: Site Two Lifecycle Stage Comparison to BAU

Carbon Benefits and Considerations (Matrix)

Table 8 presents the findings of the carbon benefits and considerations matrix for EcoFlakes Pro application as a surfacing material. **All scoring is bold and underlined.**

Technical data used during benchmarking and the carbon benefits and considerations matrix were supplied by the manufacturer and are not derived from the EcoFlakes Pro live trials in North Lanarkshire. While reliance on supplier-provided information may introduce uncertainty in confidence levels, the information and data represents the best available evidence at the time of the appraisal. Data quality has been considered when selecting supplier information and, where possible, supplier values were chosen from manufacturers' standard test reports, specifications and product datasheets that reference recognised test methods and certification.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
Costs	Transport, operational, material procurement	1 - Significant additional costs **2 - Costs approximate baseline** 3 - Costs significantly lower than baseline	Material is new to the UK market and therefore likely to cost above the baseline due to shipping from Germany. However, the material could reduce bitumen demand, reducing costs in the long term if adopted as BAU.
Maintenance	Design life, maintenance burden, on time for plant	1 – Significantly more maintenance/lower longevity **2- Approximately same maintenance/similar longevity** 3 – Significantly less maintenance/higher longevity	The supplier claims performance is equivalent to traditional PMB. This implies similar improved durability and maintenance profile.
Scalability	Manufacturing facilities	1 - Lab testing only **2 - In process of commercialisation w. small scale manufacture** 3 - Already has market presence with developed supply chain	The material has been used in a variety of case studies across Europe, in particular Germany. Material was transported to North Lanarkshire within two weeks of ordering however, scaling to the UK network level would likely require supply chain increases.
Compliance with specifications	Requirements for standards departures	1 - Requires significant departure(s) from standard and has not been used before by end client 2 - Requires some departure from standard, but has been used before by end client **3 - Does not require any departure from standard.**	The trial in North Lanarkshire has not so far reported specification departures. Further monitoring over the next 5 years will expand on whether any departures are experienced.
Environmental	Nature-based solution	1 - Would have significant net disbenefit for environmental factors (noise, AQ, biodiversity, landscape etc) **2 - Would have negligible net benefit/disbenefit or no overall change**	The polymer additive is composed of post-consumer recycled plastics. Reducing reliance on virgin bitumen within the road network. Would have a no change impact on construction noise and air quality as uses conventional paving and laying equipment as traditional HRA.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
		regarding environmental factors 3 - Would have significant net benefit/disbenefit for environmental factors.	EcoFlakes Pro is in keeping with the visuals of the existing highways network. The material is not a nature-based solution.
	Road noise	1 - Would have significant net disbenefit **2 - Would have negligible net benefit/disbenefit or no overall change regarding** 3 - Would have a significant net benefit	EcoFlakes Pro additive would have no overall change on construction and operational noise levels as it follows conventional paving and laying asphalt processing.
	Climate resilience/future proofing	1 - Would have significant net disbenefit **2 - Would have negligible net benefit/disbenefit or no overall change regarding** 3 - Would have a significant net benefit	The supplier claims of PMB equivalent suggests a level of resilience similar to conventional PMB mixes. However, long-term climate resilience data is unavailable at the time of this carbon appraisal.
Risk and safety	H&S impacts, safety testing data	1 - Would present increased risk or safety versus BAU option **2 - Would present no overall risk increase or safety impact versus BAU option** 3 - Would present lower risk or safety impact versus BAU option.	No increased health and safety risks. EcoFlakes Pro follows standard asphalt handling and application procedures.
Technology Readiness Level	Is it commercially available, is there enough R&D?	1 - Not yet commercially available 2 - Commercially available from worldwide suppliers **3 - Commercially available from European suppliers** 4 - Commercially available from UK suppliers 5 - Commercially available from local suppliers	Available in the UK through ACI Group, but the North Lanarkshire trial is the first UK deployment, so large-scale commercial availability is not yet certain. Evidence from a variety of case studies across Europe demonstrates commercial availability.
Constructability	How easy is it to handle on site, install, recover, curing time, specialist equipment/training, storage?	1 - Specialist contractors, time on site and/or equipment required **2 - No considerations required above and beyond baseline solution**	Applied within standard HRA production and laying processes. No specialist plant is required for mixing nor installation.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
		3 - Significant benefits to on-site activity / ease of installation	
Supply Chain	Material availability	1 - Novel materials used with limited supply **2 - Materials are available with some supply restrictions** 3 - Materials are readily available	Available via a UK distributor (ACI Group) but wider UK stock and logistics are still in development. There is potentially supply constraints currently for large programme.
Circular Economy	Recycled content	1 - Virgin materials are used with little or no recycled content **2 - Materials contain a level of recycled content** 3 - Materials are predominantly recycled and/or use novel sources of recycled content that would otherwise be discarded as waste	EcoFlakes Pro is made of post-consumer recycled plastics, diverting waste from landfills. However, it is an additive and replaces a percentage of the PMB so virgin material is still required.
	Ease of recycling	**1 - Minimal recycling of material possible upon removal** 2 - Limited recycling is possible and/or significant reprocessing required 3 - Reuse/recycling is easy and convenient	There is potential for the plastic additive to complicate recycling streams and whether the asphalt can be incorporated into RAP. Further testing is required to confirm ease of reuse/recycling.

Table 8: Carbon benefits and considerations matrix

Long-Term Performance Analysis

The carbon analysis within this report does not contain lifespan analysis. This will be finalised dependent upon the publishing of longevity test results in partnership with the University of Nottingham.

These tests will focus on the following:

- Durability and Aging Resistance,
- Skid Resistance and Surface Integrity,
- Lifecycle Carbon Savings,
- Traffic and Environmental Stress Testing,
- Optimal Reapplication Intervals.

Conclusion & Recommendations

Conclusions

The EcoFlakes Pro live trial provides evidence of the recycled polymers' potential as a lower-carbon additive for HRA mixes. The trial demonstrated that EcoFlakes can be delivered using standard HRA plant and processes, supporting its suitability for integration into existing surfacing operations. Across the two trials, EcoFlakes Pro demonstrated measurable reductions in A1-A5 lifecycle stage carbon emissions, with an 8.38% reduction when incorporated in HRA and a 21.29% reduction when incorporated in WMA. The primary driver of these savings can be attributed to A1-A3 lifecycle stages (raw material, transport to manufacturing and manufacturing/processing) associated with replacing a proportion of virgin material with recycled plastic polymer.

Operationally, the trial found that EcoFlakes can be used as a polymer additive in a hot asphalt mix and warm asphalt mix without special laying procedures. Early operational feedback demonstrated the additive performed well during installation and was easy to work with. Confirmation on the plastic polymer's long-term durability, fatigue resistance, and maintenance implications requires a larger monitoring period and is dependent on the findings of laboratory tests by the University of Nottingham. The successful findings of this initial trial warrant further investigation into higher dosage applications in the asphalt mixture.

It must be noted that the confidence in these carbon results is moderate to high. The EcoFlakes Pro emission factor used in modelling is supported by a third party-verified LCA supplied by the manufacturer and Holcim's verified internal carbon tool. However, an independently published Environmental Product Declaration (EPD) for EcoFlakes Pro was not available at the time of this carbon appraisal and several modelling assumptions introduce a small degree of uncertainty to the reported percentage savings. However, it must be considered that EcoPals is an SME, in the early stages of their development and are currently in the process of obtaining a formally verified EPD with the preliminary EPD being made available for this carbon assessment. This demonstrated that EcoPals are taking robust steps to validate EcoFlakes Pro's carbon savings claims.

The two trials also demonstrated that EcoFlakes Pro is suitable for incorporation within WMA. This is particularly significant as it enables a compounded carbon reduction benefit, combining the reduced carbon emissions of recycled polymer substitution with the lower energy demand associated with WMA production and laying. The results indicate that integrating EcoFlakes Pro within WMA systems represents a high potential pathway for maximising carbon savings, while maintaining alignment with standard construction practices. This combined approach strengthens the case for EcoFlakes Pro as a versatile solution that can contribute to broader decarbonisation strategies within highway surfacing.

While the second trial demonstrated further carbon savings than the first, it must be considered that the WMA mix including the EcoFlakes Pro additive incorporated 8.5% reclaimed asphalt pavement (RAP) while the standard AC10 FyfePave mix does not. The inclusion of RAP may contribute to a percentage of the carbon savings demonstrated. However, this does not take away EcoFlakes Pro's contributions to carbon savings, clearly demonstrated in the first trial, and the percentage of RAP in this mix does not exceed business as usual practice and further demonstrates that EcoFlakes Pro can be used with existing low-carbon technologies to contribute to greater carbon savings.

Overall, EcoFlakes Pro has demonstrated itself to be a promising low-carbon alternative, delivering measurable carbon reductions and integrating smoothly into standard practices. To enable confident promotion for the large-scale adoption of EcoFlakes Pro across UK authorities, the next steps are to scale UK supply, finalise results of long-term performance from the University of Nottingham and clarify end-of-life recycling pathways.

Recommendations

It is recommended that robust long-term monitoring (over 5+ years) be implemented at treated sites to comprehensively evaluate performance and verify lifecycle carbon savings. This further long-term monitoring will allow for more expansive carbon modelling to assess end-of-life scenarios to provide a more comprehensive understanding of whole life carbon emissions.

It is advised that a structured end-of-life validation programme is established that demonstrates the recyclability of EcoFlakes Pro at its end-of-life. Commission recycling trials through typical UK recycling routes, capture material recovery rates, if EcoFlakes can be used in Reclaimed Asphalt Pavement (RAP), and document any reprocessing steps required to meet specification for reuse.

If future trials of EcoFlakes Pro are commissioned, consideration should be given to distinguishing the carbon reduction contribution of EcoFlakes Pro from that of other mix design modifications. Where practicable, future trials should seek to isolate the effects of EcoFlakes Pro from variables such as WMA additives and RAP content, to improve understanding of the additive's specific contribution to overall carbon reduction.

Since the trials have shown positive results in reducing carbon emissions it is recommended that EcoPals take steps to develop their UK supply chain through working with UK partners to establish local or regional supply capacity, reduce reliance on imports due to their associated logistics emissions, to enable programme delivery at scale.

The success of these trials also supports the recommendation to undertake larger and more varied trials such as moving trials from car parks and low traffic roads to A roads within the local road network. With the aim of assessing performance and optimal mix percentage.