



Centre of Excellence
for Decarbonising Roads

ACLA LIVE TRIAL EVALUATION REPORT

Live Labs 2 North Campus

This report presents the findings of a live trial evaluating ACLA, a lower carbon aggregate which replaces a proportion of the conventional mineral aggregate within asphalt mixes. It is produced from biochar and undergoes carbonation through mineralisation. It is designed to sequester carbon permanently, reporting to lock carbon into a mineral form that is stable over the whole life of the pavement. ACLA demonstrated overall lower carbon emissions than conventional AC binder course. Recommendations drawn from this trial include a robust long-term monitoring period to verify carbon permanence statements.

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Executive Summary

This report evaluates a live trial conducted as part of the wider Live Labs 2 project, which aims to test innovative highway solutions to improve road performance, reduce maintenance needs, and enhance safety. This specific trial focused on ACLA manufactured by Low Carbon Materials. ACLA is described by the manufacturer as an aggregate substitute for a proportion of conventional mineral aggregate in asphalt mixes. It is produced from biochar and undergoes carbonation through mineralisation. It is designed to sequester carbon permanently, reporting to lock carbon into a mineral form that is stable over the whole life of the pavement.

The purpose of this carbon appraisal is to focus on the carbon performance of ACLA within this live trail. This evaluation cannot confirm nor deny the sequestration claims due to the short-term nature of the trials, further long-term investigations into carbon permanence would be required to verify that carbon sequestration is permanent.

ACLA was trialled at two carpark sites in North Lanarkshire, St Johns Street Carpark, Coatbridge and Kings Street carpark, Coatbridge. ACLA was trialled within a binder course asphalt concrete (AC) mix. The findings, limitations, and recommendations presented in this report aim to inform the potential rollout of ACLA across UK local councils.

This report assesses carbon emissions across material extraction 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.

ACLA holds a third-party verified Environmental Product Declaration (EPD), obtained in 2024. The presence of a third-party verified A1–A3 lifecycle stage emissions calculation and an independently verified Environmental Product Declaration (EPD) increases confidence in the reported embodied carbon inputs and enables reliable benchmarking across local authorities. ACLA's EPD reports the embodied emission factor (A1-A3) to be $-0.748 \text{ kgCO}_2\text{e/kg}$ with the biogenic element equating to $-0.956 \text{ kgCO}_2\text{e/kg}$.

The findings from the trial have shown that ACLA can offer a reduction in carbon intensity when compared to a conventional asphalt concrete binder course, with trial results showing 58.12% reduction in A1-A5 carbon emissions at the King Street Carpark site and a 43.10% reduction in A1-A5 carbon emissions at the St Johns Carpark site. The primary driver of the carbon savings can be attributed to the materially lower A1-A3 embodied emissions associated with the biochar element of the aggregate.

Introduction

This Evaluation Report provides a high-level assessment of ACLA, an emerging sustainable material in highways, construction and maintenance, focusing on its environmental impact, product viability, and alignment with future infrastructure needs. ACLA is carbon negative aggregate designed to be a drop-in solution for asphalt mixes.

Live Labs 2 is a three-year UK-wide programme funded by the Department of 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 for Live Labs 2, supporting research, innovation, and best practices to accelerate low-carbon solutions in road construction and maintenance. By disseminating findings from Live Labs 2 trials, 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 these reports 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 aim is 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), a 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 ACLA trial has been evaluated against conventional asphalt concrete binder.

The carbon evaluations for ACLA 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 ₂ e per unit of material)	Brief product potential overview
<p>ACLA – Low Carbon Materials</p>	<p>ACLA is marketed as a carbon negative aggregate product developed by Low Carbon Materials (LCM). It replaces a fraction of the conventional aggregate in asphalt mixes and sequesters carbon through mineralisation / carbonation, claiming to lock carbon permanently into the road material.</p> <p>ACLA is used in the binder course of asphalt pavements at a small percentage of the mix (in this live trial 6.5% of the total mix). ACLA can be used in conventional asphalt mixes that also include Reclaimed Asphalt Pavement (RAP).</p>	<p>ACLA at a mix of 6.5% had carbon emissions of 1.70 kgCO₂e/m² at Kings Street carpark and 2.31 kgCO₂e/m² at St Johns Street carpark.</p> <p>This demonstrates a 58.12% reduction in A1-A5 carbon emissions at the King Street Carpark site and a 43.10% reduction in A1-A5 carbon emissions at the St Johns Carpark site, when compared to conventional asphalt concrete lay in North Lanarkshire.</p>	<p>It is considered that in this trial ACLA has demonstrated potential for use on highways projects, particularly on projects where carbon reduction is a key aim. It reduces the reliance on conventional virgin aggregates while reducing carbon emissions due to its carbon negative characteristic achieved through controlled, chemical carbonation.</p> <p>However, this trial is unable to demonstrate the permanent carbon sequestration characteristics claimed for ACLA. Further long-term investigations into carbon permanence will be required to assess this aspect of the material.</p>

Methodology

Trial Design

The ACLA Carpark trails were designed to evaluate the performance, durability, and environmental impact of the material. ACLA was applied to two carpark sites within North Lanarkshire: St Johns Carpark and Kings Street Carpark.

Carbon emissions have been assessed based on the whole lifecycle stages A1-A5 (material extraction 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 products 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.

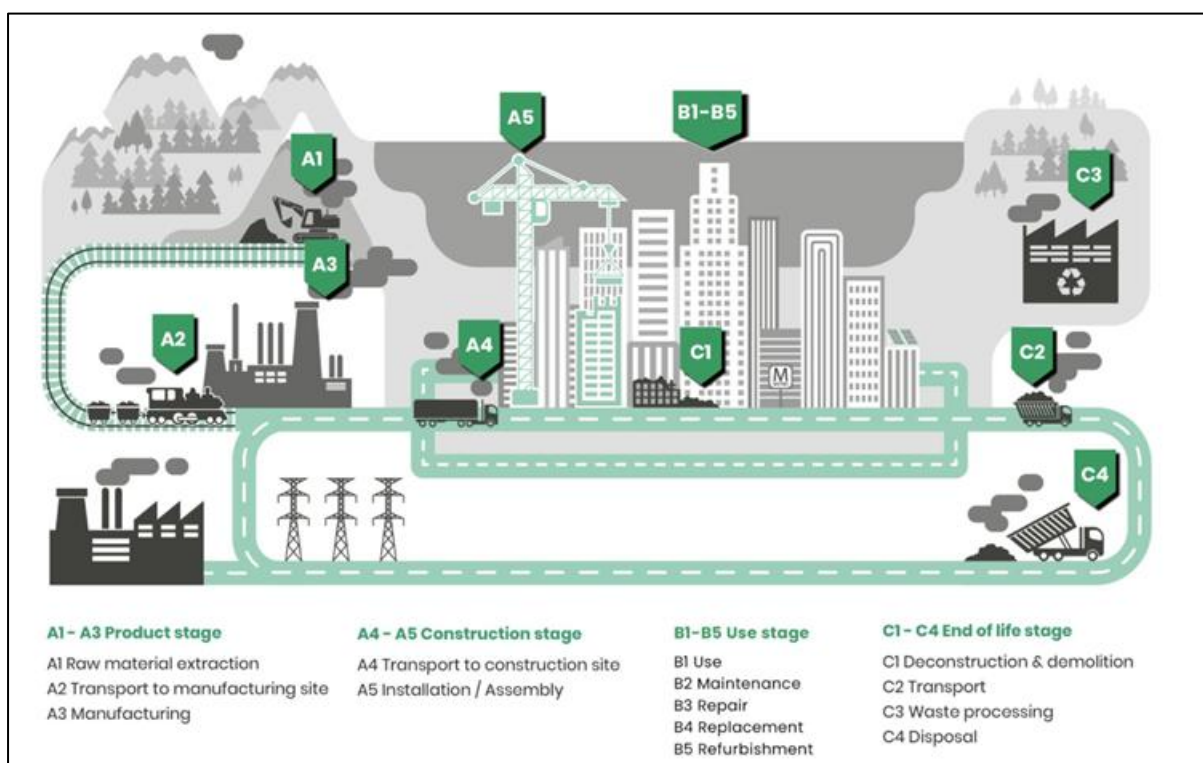


Figure 1: Carbon Lifecycle Stages¹

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 volumes of both light and heavy vehicles allowing for the assessment of the material's performance under differing stress conditions.
- **Environmental Conditions:** The Supersite site was 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 hot-rolled asphalt (HRA) surface course and had severely deteriorated with use and age, to the point where they required urgent maintenance.

Data Collection Plan

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

DATA ITEM	UNIT(S)	RESPONSIBLE	LOCATION OF DATA	PURPOSE
Trial Location	Road name, Coordinates of location of ACLA carparks	Operational Staff	Site Diary	Technical comparisons
Conditions at the time of lay	Temperature (°C) 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 (°C)	Inspector	Site Diary	Technical Evaluation
Quantity	m ² of ACLA used	Operational staff & Carbon Lead	Site Diary	Cost and Carbon Evaluations
Cost	Cost for ACLA 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 ACLA trials is to undertake a comparison analysis of ACLA binder with the current benchmark used by NLC, conventional asphalt concrete binder. In the ACLA binder mix, ACLA content was 6.5% of the total binder mix. There were a total of two trials at two locations: St Johns Street Carpark, Coatbridge and King Street Carpark, Coatbridge. After the ACLA binder course was installed, a conventional HRA surface course was applied on the sites. AC binder course constructed along Castlecary Road, Cumbernauld, North Lanarkshire as a different part of CEDR works will serve as the benchmark for carbon modelling.

The trial area includes two carparks as defined in the table below, with preference being given to locations which experience high traffic loads.

TRIAL SITE	CARPARK	TRIAL LOCATION
1	Kings Street Carpark	King Street Carpark, Coatbridge, North Lanarkshire, ML5 1
2	St Johns Carpark	St Johns Street Carpark, Coatbridge, North Lanarkshire, ML5 3

Table 2: ACLA Trial information

Procedure

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

Material Application: Roads were prepped as per manufacturer's instructions prior to the products application. ACLA binder was applied by Hochtief via a paver following conventional AC 20 binder processes.

Monitoring and Data Collection: The trial sites will be monitored over a period of 12 months for ongoing durability. Data on surface condition, material performance, and environmental impact are to be collected at regular intervals.

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

Data Analysis

The collected data was analysed to determine ACLAs effectiveness as an alternative to conventional materials. Data analysis methods were used to evaluate the performance of the ACLA mix versus a control section (asphalt concrete binder course) from another CEDR trial 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 ACLA, including material, application, and maintenance costs.

The embodied carbon factors for trialled materials have been developed based on supplier product data and supported by carbon factors sourced from OneClick LCA for the same or similar materials where required. An Environmental Product Declaration (EPD) has been produced and third party verified for ACLA. The EPD has been completed by Eco Platform an independent EPD verifier following the principles of EN 15804:2012 + A2:2019/AC:2021 and ISO 14025:2006. This EPD was published 11th October 2024 and is valid until 11th October 2029.

Holcim have provided A1-A3 carbon value for the preparation of the ACLA mix at Duntilland Quarry, the EPD for ACLA has been used in the calculation of this value. Holcim provided A1-A3 carbon figures from manufacturing AC20 binder at Chryston Quarry, from a previous Live Labs 2 CEDR trial in Castlecary Road, Cumbernauld, North Lanarkshire has been used as the baseline figures to benchmark ACLA 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 an EPD and the use of a third party verified carbon calculation tool provides objective verification that ACLA's carbon reduction claims are based on transparent, independently validated, and whole-life carbon data. This positions ACLA as a credible alternative to conventional asphalt.

Carbon Appraisal

Carbon appraisal

Drawing on data collected through trials; a carbon assessment has been undertaken. Table 3 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.
Design life of pavement binder course is 40 years.	Based on PAS 2080 guidance ² . At 40 years the binder course of HRA requires replacing.
Unit of measurement used is 'kgCO ₂ e/ 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.
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 out activities within this assessment.	This is a BAU activity therefore is not influenced by this innovative material.
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 ₂ e emissions per tonne of aggregate from each quarry, Holcim utilised the total energy consumption for each quarry (Duntilland and Chryston) 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 (as the contractor) had available at the time of this carbon analysis.
Holcim utilised Eurobitume's 2025 carbon emission factor for bitumen, 530kgCO ₂ e/ tonne.	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 ₂ e 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.

² [2023-03-29-pas_2080_guidance_document_april_2023.pdf](#)

ASSUMPTIONS	JUSTIFICATION
The default emission factor used for RAP (reclaimed asphalt pavement) 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 EN 15804 principles.
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.
Application rate of bondcoat is assumed to be 1.1 kg/m ² .	Based on application rate in North Lanarkshire for AC40 dense binder course surfacing scheme at Hirst Road.
Machine hours were assumed based on an 8-hour working day.	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 was produced at a different quarry plant. ACLA was produced at Duntilland Quarry and AC 20 binder was produced at Chryston Quarry.	Both these quarries are owned and operated by Holcim. It can be assumed that both quarries follow the same production methodology, however, may differ in energy consumption and fuel use. This was the best available data at the time of this carbon appraisal.

Table 3: Carbon appraisal matrix

Carbon Modelling

The carbon modelling for the trials was conducted using the 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 providing 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 ACLA has been supplied by Holcim. This value was calculated using a EPD and third-party verified carbon calculator.

Indicative results from carbon modelling for the ACLA carpark works at King Street Carpark and St Johns Carpark are expressed in $\text{kgCO}_2\text{e}/\text{m}^2$ and $\text{kgCO}_2\text{e}/\text{t}$. 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 are presented graphically in Figure 2, Figure 3, and Figure 4:

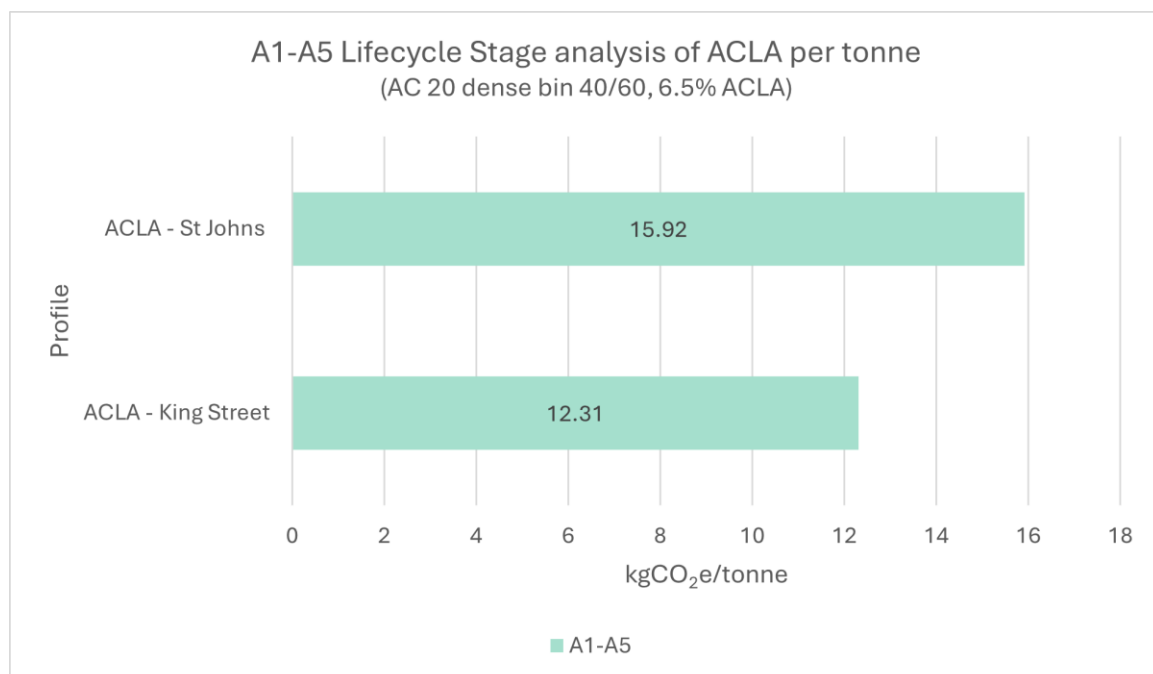


Figure 2: Carbon analysis of ACLA (AC 20 dense bin 40/60, 6.5% ACLA) per tonne

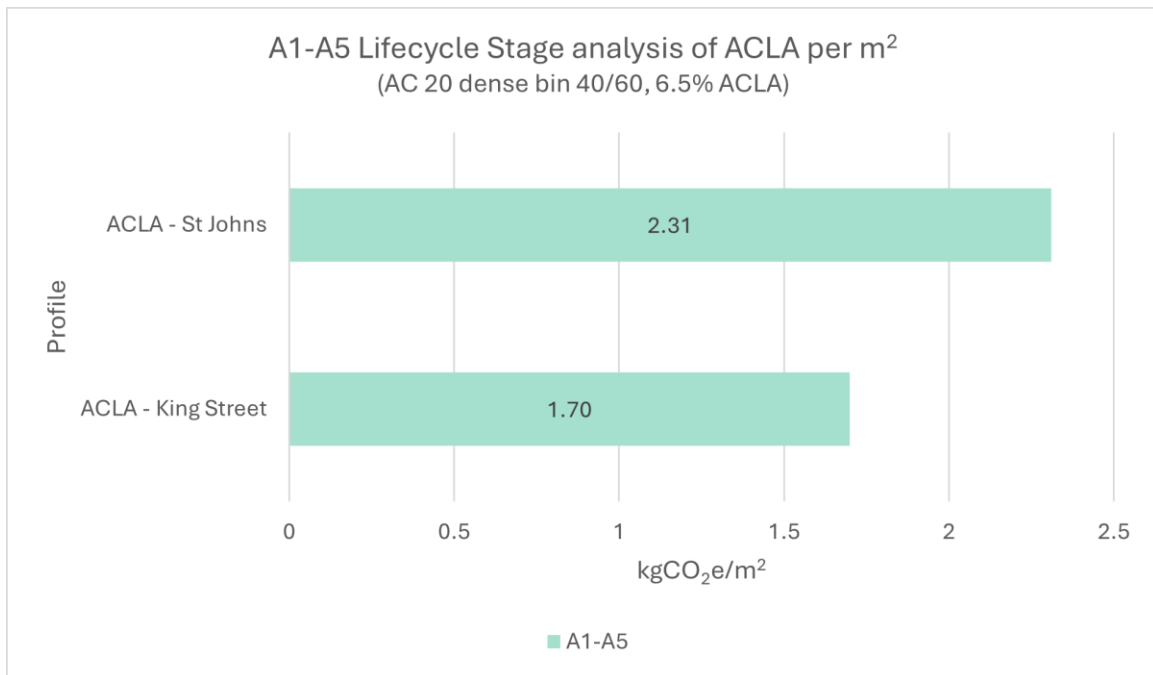


Figure 3: Carbon analysis of ACLA (AC 20 dense bin 40/60, 6.5% ACLA) per m²

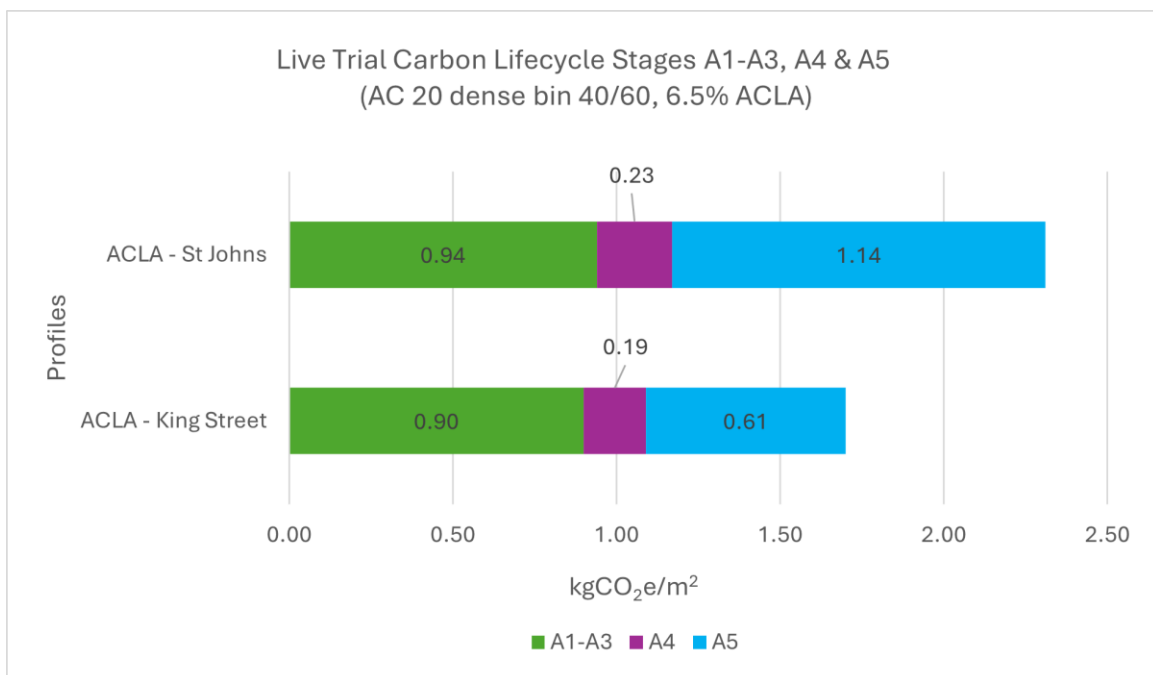


Figure 4: Carbon Analysis of ACLA (AC 20 dense bin 40/60, 6.5% ACLA) lifecycle stages A1-A3, A4 & A5 per m²

Benchmarking

ACLA is yet to be fully evaluated against traditional Asphalt Concrete on terms of performance and long-term viability in North Lanarkshire, as prior to this trial ACLA had not been used on the Local Authority road network. These trials are to allow for an analysis of the performance of ACLA in comparison to conventional asphalt concrete. This would be the traditional option for re-surfacing if ACLA was not used. This allows for comparisons between ACLA versus BAU surfacing within the carbon analysis.

A comparative analysis was conducted to assess ACLA (AC 20 dense binder 40/60, 6.5% ACLA aggregates) versus the benchmark conventional asphalt concrete binder (AC 20 dense binder 40/60) which have both been trialled as part of the CEDR trials in North Lanarkshire as part of Live Labs 2. The ACLA trials at King Street and St Johns carpark are being compared to previous trial on Castlecary Road, Cumbernauld, North Lanarkshire. 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 ACLA.

Due to restrictions in the data collection at Castlecary Road, it is not possible to separate A1–A3 and A4 lifecycle stage emissions with sufficient accuracy. To maintain methodological consistency and avoid introducing unsupported assumptions, the ACLA results have therefore been presented in the same combined format for this comparative analysis. Indicative comparative analysis results is presented graphically in Figure 5, Figure 6, and Figure 7:

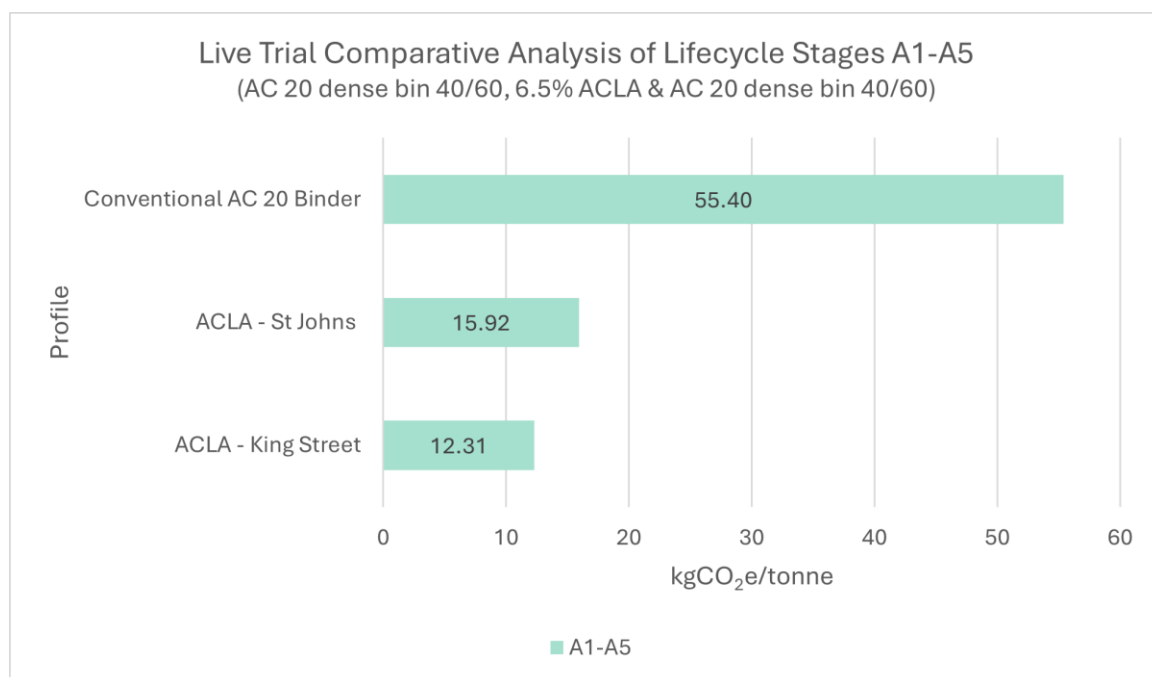


Figure 5: Comparative carbon analysis ACLA to AC 20 Binder per tonne

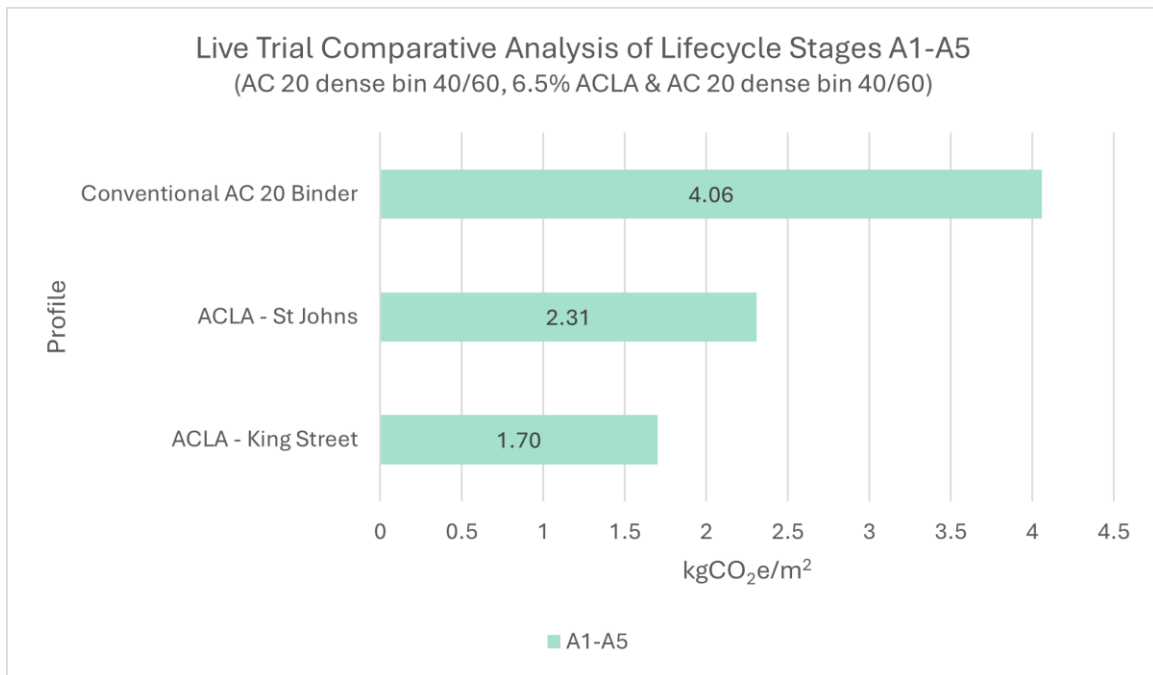


Figure 6: Comparative carbon analysis ACLA to AC 20 Binder per m²

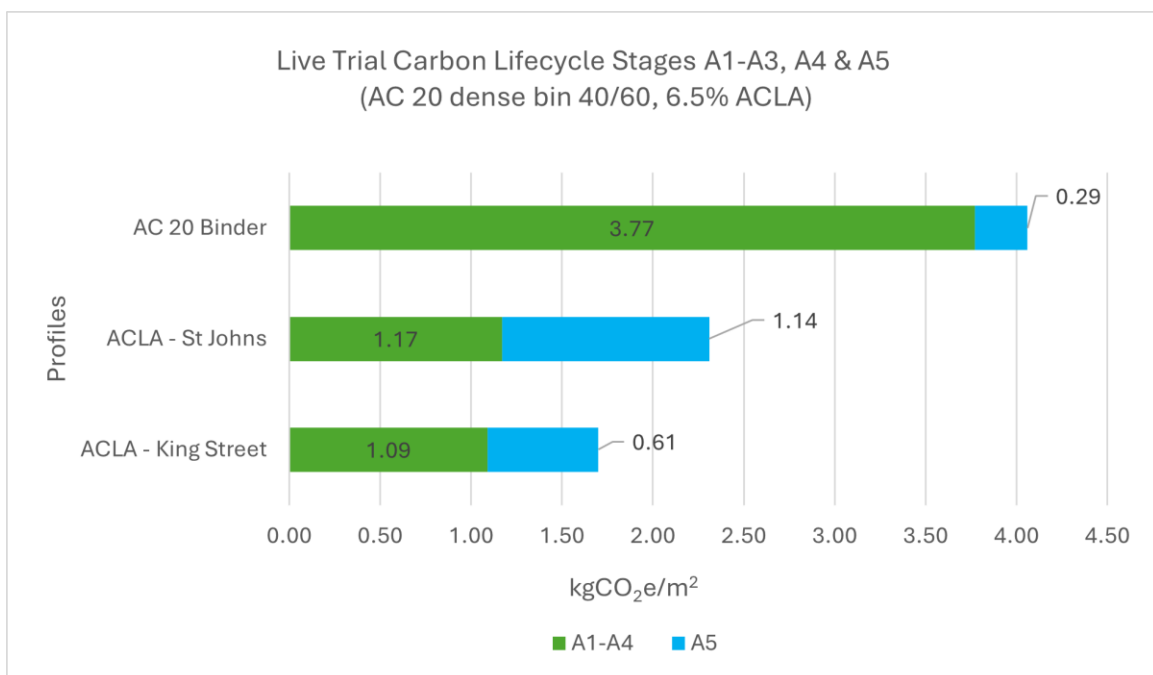


Figure 7: Comparative carbon analysis ACLA to AC 20 Binder A1-A4, A5 per m²

MATERIAL	COMPOSITION	APPLICATIONS	PERFORMANCE	INSTALLATION	SUSTAINABILITY
Conventional AC binder course	<p>The base material consists of hot mix asphalt with mineral aggregate, including natural aggregates (stone, gravel), mineral fillers (stone dust, cement/lime filler) and bitumen binder (typically 4-6% by mass).</p> <p>The asphalt binder coats the aggregate particles to form a dense graded mix suitable for structural support.</p>	<p>The intermediate layer in flexible pavement between the base course and surface course.</p> <p>Provides load distribution, structural support and a layer to bridge between heavy loads and the upper surface course.</p> <p>Considered a standard for UK highways.</p>	<p>Has a well-established performance with predictable structural properties (stability, stiffness, durability) when designed and compacted to specification.</p>	<p>Produced in hot mix asphalt plants and laid using standard paving plant.</p>	<p>Asphalt production is traditionally high in embodied carbon due to bitumen production, heating of aggregates and mixing processes.</p> <p>There is potential for carbon emissions to be offset.</p>
ACLA (AC20 dense binder)	<p>ACLA was added to Asphalt Concrete (AC) binder course.</p> <p>Modified by the partial replacement of mineral aggregate with ACLA carbon negative aggregate (at 6.5% of the total mixture).</p> <p>Is marketed to be a drop-in carbon negative aggregate designed to be used at 5-10% of the asphalt mix by weight.</p>	<p>ACLA can be added to standard AC binder course without effecting its composition, therefore has the same applications as conventional AC binder course.</p> <p>However, it is commonly used in schemes with carbon reduction to net-zero targets such as local authorities and National Highways.</p>	<p>ACLA replaces only a small proportion of aggregate, so stiffness, fatigue and rutting performance are designed to match standard AC binder course.</p> <p>Dense graded AC binders typically have strong rut resistance.</p> <p>ACLA AC does not inherently provide the same impermeability as AC binder, but it remains acceptable within standard pavement designs.</p>	<p>Production temperature is considered the same as standard AC binder.</p> <p>ACLA behaves like conventional material and does not require any special paving or rolling techniques.</p> <p>Uses standard asphalt plant, ACLA is handled as part of aggregate feed.</p>	<p>Low Carbon Materials promotes ACLA to be a carbon negative aggregate which permanently locks carbon into the pavement binder course.</p> <p>ACLA incorporates biochar within its composition and carbonation through mineralisation to achieve this carbon negative characteristic.</p> <p>ACLA can be included within RAP and other recycled material asphalt mixes.</p>

Table 4 ACLA Appraisal*

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

Life Cycle Stage	Baseline Carbon Emissions (AC bin dense 40/60) (kgCO ₂ e/m ²)	ACLA Carbon Emissions (King Street Carpark) (kgCO ₂ e/m ²)	Difference (%) (Increase/ Reduction)
A1 – A4	3.77	1.09	71.09%
A5	0.29	0.61	110.33%

Table 5: Lifecycle Stage Comparison to BAU

Life Cycle Stage	Baseline Carbon Emissions (AC bin dense 40/60) (kgCO ₂ e/m ²)	ACLA Carbon Emissions (St Johns Carpark) (kgCO ₂ e/m ²)	Difference (%) (Increase/ Reduction)
A1 – A4	3.77	1.17	68.99%
A5	0.29	1.14	293.11%

Table 6: Lifecycle Stage Comparison to BAU

Carbon Benefits and Considerations (Matrix)

Table 7 presents the findings of the carbon benefits and considerations matrix for ACLA application as a surfacing material. **All scoring is bold and underlined.**

Technical data used for the benchmark comparator were supplied by the manufacturer and are not derived from site trials. While reliance on supplier-provided information may introduce uncertainty in confidence levels, the information and data represent 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	ACLA is considered to be a newer innovative aggregate product; therefore, unit cost is likely to be higher than conventional aggregate, increasing early project cost compared with 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	ACLA aggregate is not claimed to increase durability and is instead designed to be added to conventional asphalt mixes, replacing a proportion of the virgin aggregate in the mix. This is designed to not effect conventional asphalt performance.
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	Production is commercial with several case studies in the UK but is not readily available across the supply chain. However, supply scaling is underway currently.
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.	Using ACLA is the base and binder course does not depart from asphalt specifications. However, this is currently not confirmed for surface course asphalt.
Environmental	Nature-based solution	1 - Would have significant net disbenefit for environmental factors (noise, AQ, biodiversity, landscape etc) 2 - Would have negligible net	A major component of ACLA is biochar. The source of this biochar is undeclared therefore it cannot be determined if it is from a sustainable source e.g. waste or purpose grown.

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
		<p>benefit/disbenefit or no overall change regarding environmental factors</p> <p>3 - Would have significant net benefit/disbenefit for environmental factors.</p>	
	Road noise	<p>1 - Would have significant net disbenefit</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding</p> <p>3 - Would have a significant net benefit</p>	<p>ACLA makes no claims to reduce road noise. However, ACLA is an aggregate additive to conventional asphalt and therefore it can be assumed that it will have no change impact to road noise.</p>
	Climate resilience/future proofing	<p>1 - Would have significant net disbenefit</p> <p>2 - Would have negligible net benefit/disbenefit or no overall change regarding</p> <p>3 - Would have a significant net benefit</p>	<p>A National Highways case study using ACLA in WARM BIO AC 20 DBM 40/60 DES on the A64 is claimed to show no detrimental effect of the performance of the asphalt.³</p> <p>Therefore, it can be assumed that ACLA will maintain high durability characteristics and deliver robust performance under increased climate stressors.</p>
Risk and safety	H&S impacts, safety testing data	<p>1 - Would present increased risk or safety versus BAU option</p> <p>2 - Would present no overall risk increase or safety impact versus BAU option</p> <p>3 - Would present lower risk or safety impact versus BAU option.</p>	<p>The addition of ACLA into asphalt does not deviate from conventional asphalt production and installation and therefore there is no added health and safety concerns.</p>
Technology Readiness Level	Is it commercially available, is there enough R&D?	<p>1 - Not yet commercially available</p> <p>2 - Commercially available from worldwide suppliers</p> <p>3 - Commercially available from European suppliers</p> <p>4 - Commercially available from UK suppliers</p> <p>5 - Commercially available from local suppliers</p>	<p>ACLA is manufactured in the UK and has been used in a variety of UK trials for local authorities and National Highways. Availability is UK-based through not yet widely distributed.</p>
Constructability	How easy is it to handle on site, install, recover, curing time, specialist	<p>1 - Specialist contractors, time on site and/or equipment required</p>	<p>ACLA is used as a 'drop in' aggregate, replacing a proportion of the virgin aggregate. It follows conventional plant processes and site handling, and</p>

³ <https://lcrig.org.uk/wp-content/uploads/2024/11/Low-Carbon-Materials.pdf>

BENEFIT/LOAD UNDER REVIEW	CONSIDERATIONS	SCORING SYSTEM	JUSTIFICATION
	equipment/training, storage?	<p>2 - No considerations required above and beyond baseline solution</p> <p>3 - Significant benefits to on-site activity / ease of installation</p>	<p>application follow existing asphalt practices.</p> <p>A National Highways case study using ACLA in WARM BIO AC 20 DBM 40/60 DES on the A64 is claimed to show no detrimental effect of the performance of the asphalt.</p>
Supply Chain	Material availability	<p>1 - Novel materials used with limited supply</p> <p>2 - Materials are available with some supply restrictions</p> <p>3 - Materials are readily available</p>	<p>ACLA is only manufactured at a single production site, at Low Carbon Material's Seaham production facility in County Durham, England. This has potential to create supply risks.</p>
Circular Economy	Recycled content	<p>1 - Virgin materials are used with little or no recycled content</p> <p>2 - Materials contain a level of recycled content</p> <p>3 - Materials are predominantly recycled and/or use novel sources of recycled content that would otherwise be discarded as waste</p>	<p>The public detail on ACLA's feedstock is highly limited. The supplier implies the use of mineral substrates/ industrial inputs, but exact content (including recycled content) is not published.</p>
	Ease of recycling	<p>1 - Minimal recycling of material possible upon removal</p> <p>2 - Limited recycling is possible and/or significant reprocessing required</p> <p>3 - Reuse/recycling is easy and convenient</p>	<p>The impact of ACLA on reclaimed asphalt pavement (RAP) processing and future reuse is not yet broadly evidenced. The suppliers claim asphalt including ACLA can 100% be used for RAP and maintain its role as a carbon sink, but this needs verification through real-life scenarios.</p>

Table 7: Carbon benefits and considerations matrix

Long-Term Performance Analysis

The carbon analysis within this report do 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 ACLA live trial provides encouraging evidence of the aggregate's potential as a lower-carbon additive to conventional materials. The trial demonstrated that ACLA can be delivered using standard binder-course plant and processes, supporting suitability for adoption in existing surfacing operations. Carbon analysis of the two trial sites has demonstrated a 58.12% reduction in A1-A5 lifecycle stage emissions at the King Street Carpark site and a 43.10% reduction in A1-A5 lifecycle stage emissions at the St Johns Carpark site, with the majority of these savings being accounted to A1-A3 emissions (raw material, transport to manufacturing and manufacturing/processing).

Lifecycle stage A5 (construction) emissions appear higher for the two ACLA sites compared with the conventional AC 20 binder. This difference is attributable to greater site efficiency achieved over a larger treatment area. Although the A5 value appears high on a per-square-metre basis, it represents only a small share of total emissions. The largest proportion of lifecycle emissions occurs in stages A1–A3. Presenting the data in isolation can therefore overstate its relative impact, particularly as the same plant and processes were used across all three sites and ACLA follows conventional binder-course application methods.

The trial has highlighted a transparency gap in ACLA's current documentation, specifically the absence of clear information on the biochar feedstock used in the material. Providing information on feedstock type, origin, and sourcing practices would support a more complete validation of the product's sustainability credentials and carbon-sequestration claims. Enhancing feedstock provenance is therefore recommended for strengthening the credibility and verification of ACLA's low-carbon status.

Furthermore, short-term data from the following 12-month monitoring period will be insufficient to verify the long-term mineralisation and the creation of a permanent carbon sink. Without multi-year in-situ evidence and independent verification, sequestration claims are unconfirmed, with procurement and policy focus more on the aggregates demonstrated ability to reduce embodied emissions rather than as a carbon sink.

Operationally, the trial found that ACLA can be used as a drop-in aggregate at the 6.5% replacement rate without special laying procedures. Early operational feedback demonstrated the aggregate performed well during installation. Confirmation on the aggregates long-term durability, fatigue resistance, and maintenance implications require a larger monitoring period and is dependent on the findings of laboratory tests by the University of Nottingham.

Overall, ACLA has demonstrated itself to be a promising low-carbon alternative..

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.

Establish a structured end-of-life validation programme that demonstrates the recyclability of ACLA under real-world recovery and reprocessing flows to assess whether carbon re-releasing occurs. Commission recycling trials through typical UK recycling routes, capture material recovery rates, characterise the quality of returned RAP, and document any reprocessing steps required to meet specification for reuse.

Low Carbon Materials are encouraged to confirm and publish the biochar feedstock used in ACLA, including feedstock type and geographic origin, to highlight sustainable sourcing and further reinforce the strength and credibility of its low carbon claims.

Low Carbon Materials have the opportunity to enhance transparency around its carbon sequestration claims through publishing further information on the carbonation through mineralisation process and how this process contributes to long-term carbon storage.