Centre of Excellence
for Decarbonising Roads

POLYPAVE

Technical Note

Abstract

PolyPave asphalt material utilising a carbon-enriched Ultra-Low Density Polyethylene (ULDPE) produced in dedicated recycling facilities to prevent contamination. Although currently unrecyclable, non-exportable, and unsuitable for landfill or incineration, we have developed a process that converts ULDPE into sub-4 mm granules for direct dosing into asphalt plants. With its low density and melting point, PolyPave serves effectively as a bitumen extender, providing a practical use for an otherwise problematic waste material.

Department for Transport · ADEPT LIVELABS2 Decarbonising Local Roads · North Lanarkshire Council · Transport for West Midlands · Amey · COLAS

Contents

Executive Summary

This report documents and evaluates the miss-trial of PolyPave that was set to be laid on the B7029 - Chapelknowe Road, North Lanarkshire (October 2025). The trial assessed carbon savings, lifecycle costs, operational suitability compared with conventional asphalt alternatives and the potential for wider application

Introduction

PolyPave is claimed to be a bitumen enhancing additive which has been engineered from carbon-enriched ultra low-density polyethylene (ULDPE). Traditionally, ULDPE waste is unrecyclable, unsuitable for export, hazardous in landfill, and difficult to incinerate, resulting in substantial stockpiles across the UK with no viable disposal pathway.

Through a specialised recycling process carried out at facilities that handle only ULDPE, the manufacturer SIMA converts the material into fine granules (<4 mm) that can be introduced directly into the asphalt mixing plant. With its low density and low melting point, PolyPave is claimed to rapidly homogenise with bitumen during asphalt mixing, 'seamlessly' integrating into existing production methods without the need for specialist plant, equipment or machinery.

As a result of PolyPave being over 60% less dense than bitumen, 2 kg of PolyPave replaces 5 kg of bitumen while maintaining the same binder volume. SIMA claims that the result of this is a cost-efficient bitumen extension that can deliver savings of up to £1 per tonne of asphalt, without compromising workability and according to manufacturer claims, performance enhancements such as improved stiffness, durability and reductions in deformation.

Beyond performance claims, PolyPave is stated to deliver significant environmental benefits. As stated by the manufacturer, when incorporating 1 kg of PolyPave into an asphalt mix, SIMA claims it prevents 1.27 kg of CO_2e emissions, keeping carbon locked into the road surface and diverting problematic waste from incineration or landfill. As polyethylene, like bitumen, is derived from petroleum hydrocarbons, PolyPave claims to return waste material to its original application. This would represent an ideal circular-economy outcome, provided that the data gathered and analysed supports the manufacturer's claims.

The Live Labs 2 programme, focused in North Lanarkshire, aims to assess PolyPave as a scalable, low-carbon alternative to traditional asphalt binders. The project aims to evaluate installation efficiency, potential durability benefits, and any potential reductions in CO_2 emissions. By comparing an asphalt mix which incorporates PolyPave with conventional mixes, the trial aims to generate robust evidence on lifecycle costs, long-term performance, and procurement considerations. Supporting the shift toward more sustainable and resilient road construction.

Methodology

The Live Labs asphalt trial in North Lanarkshire evaluated the addition of PolyPave to a Hot Rolled Asphalt (HRA) 35/14 surface course containing 7% virgin binder and 10% RAP, with PolyPave introduced via the plant's fibre dosing system. In this designation, HRA 35/14 refers to a Hot Rolled Asphalt surface course in which the coarse aggregate fraction is made up of 35% 14 mm aggregate, with the remainder comprising finer aggregate and sand to achieve the dense, smooth-surfaced matrix characteristic of HRA mixes. A 100-tonne production run was planned for Chapelknowe Road (B7029), using Duntilland Quarry in Dumbarton Scotland as the primary plant and Blantyre Quarry in Blantyre Scotland as the backup.

On 8 October, operatives inspected the dosing systems at both plants to confirm they could correctly introduce PolyPave. Initial testing at Blantyre used a dual-purpose pigment/fibre system with two silos, one for PolyPave and one for fibres. A 1.5-tonne PolyPave-modified HRA batch was produced alongside a standard virgin-bitumen control mix. According to operative's feedback from the mixing plant, although the PolyPave feed rate was slower than normally observed when mixing a conventional material, the plant remained operational.

To confirm the feasibility of incorporating PolyPave into asphalt production, a second controlled trial was carried out at the Duntilland Quarry plant. Issues were encountered early in the process when the PolyPave stopped flowing within the dosing system, causing the hopper to become blocked. A small quantity of material had been loaded into the silo to replicate operational conditions, and the intention was to observe whether it would gravity-feed from the hopper into downstream sections of the system. However, due to the lightweight nature of PolyPave, the material bridged within the hopper and flow ceased. Operators attempted manual agitation to restore movement, but this intervention resulted in a secondary blockage within the cyclone. These outcomes indicate that multiple components of the fibre/pellet dosing system are susceptible to obstruction when handling lightweight materials such as PolyPave.

Throughout the mixing process each stage of the dosing route comprising the hopper, connecting sections, intermediary hoppers, and cyclone, were monitored to assess flow reliability and identify potential failure points. Concurrently, blockages were reported by operatives at the Blantyre plant which reinforced the concern that PolyPave was incompatible with the existing mixing plant/equipment/machinery. Based on the repeated flow failures, the likelihood of further blockages, and the operational risk to production schedules and road reopening timelines, the decision was made to halt the PolyPave trial. As this was trial was labelled as a 'miss-trial' and did not progress to site, and given the absence of an agreed trial design, it is not possible to assess the methodology previously intended for use on site. The repeated mixing failures observed at both Duntilland and Blantyre Quarry strongly indicate that PolyPave, and potentially other materials with similar lightweight characteristics, struggles to integrate effectively within existing asphalt mixing plant systems.

Following submission of this technical note, a second trial is scheduled to take place at Strathclyde Park, Car Park South 4 in Motherwell, between Thursday 26th February 2026 and Monday 2nd March 2026. This trial will benchmark an asphalt mixture containing PolyPave against a conventional AC10 FyfePave mix, which in this context refers to an asphalt concrete (AC) surface course manufactured with a 10mm nominal maximum aggregate size (AC10). This mix type provides a medium-graded, durable wearing course widely used across the local authority network. Laboratory testing has been requested, and the resulting data will support verification of the additive's suitability for wider application and enable a more robust technical assessment.

Upon completion of this technical note and the revised trial, further analysis will be undertaken to validate SIMA's performance claims for the product.

Environmental & Sustainability

Refer to 'Input reference to Carbon Report when I know it' for details of carbon and sustainability findings.

Limitations

As a result of being unable to obtain laboratory or in-situ test results/data that were conducted internally that would provide insight into the structural and performance properties of the material, this has been supplemented by lab testing results provided by SIMA, using 3kg binder removed and 1kg Polypave added, as well as 5kg binder removed and 2kg Polypave added. As this testing was not done internally or 3rd party commissioned as part of the Live Labs 2 initiative, the reliability of this information cannot be confirmed. Refer to Table 1 for results of laboratory tests.

The North Lanarkshire PolyPave trial faced several limitations, primarily driven by the incompatibility between PolyPave and the existing fibre-dosing equipment at the asphalt plants used during the trial. At Duntilland, the dosing system was unable to gravity-feed PolyPave from the hopper into the next stage of the equipment because the flakes were noted to be ‘too light’ by the operatives attempting to mix the batch. Attempts by operators to manually agitate the material to encourage flow only created further blockages within the cyclone section of the system, highlighting how sensitive the plant’s multi-stage hopper and cyclone setup was to handle low-density, lightweight materials. Similar problems occurred at Blantyre, where the PolyPave fed observably slower than expected and later caused blockages in the feed lines. These issues demonstrated that both plants’ dosing systems, designed primarily for heavier fibres or pellets, were not suitable for PolyPave in its current form.

Both plants rely heavily on their fibre systems for standard asphalt production, any risk of blockages carried significant operational consequences. A clogged system would have delayed asphalt deliveries and extended road-closure periods, posing an unacceptable risk to the project timeline. As a result, the team determined that attempting to run full-scale production with PolyPave would likely disrupt operations, ultimately leading to the decision not to proceed with the live road-laying portion of the trial. This meant that, although a small 1.5-tonne batch produced at Blantyre showed promising performance, with the operative’s observed that the PolyPave mix appeared just as rich and workable as the conventional/control mix. The trial could not validate PolyPave’s performance under real conditions. Instead, only a limited understanding of the material’s behaviour was achieved meaning no detailed analysis or observations could be conducted at this stage.

Another limitation of the trial was its heavy dependence on a single type of dosing technology across both plants. Although Blantyre had a dual system for pigments and fibres and Duntilland operated a more complex multi-stage setup, both were fundamentally gravity-fed driven systems. This meant the trial did not explore alternative feeding methods, such as; augmented feed systems, modified hoppers, or temporary mechanical dosing solutions. These may have removed the dependency on gravity flow. In addition, the PolyPave form used during the trial had not been optimised for such dosing systems. The plant operatives only switched to larger, heavier flake sizes after the blockages occurred in an attempt to improve feed consistency. This reactive rather than proactive adjustment further reduced the trial’s potential for success.

Review and Discussion of 3rd Party Laboratory Tests

The Blantyre site reported that after reducing the virgin binder by 5 kg to account for the PolyPave addition, the small, 1.5T batch of modified mix still presented a rich appearance with normal coating and good workability.

As part of this assessment of the material, this technical note has incorporated lab test data supplied within the technical data sheet provided by the supplier SIMA and therefore the validity of the data cannot be confirmed and assessments have been made based on interpretations of the data. For the tests, 3 mixes were made:

Within the dataset supplied by SIMA, three asphalt mix designs were prepared using an AC10 Close Surf 100/150 surface course, which is an asphalt concrete mix containing a 10mm nominal maximum aggregate size and a 100/150 penetration grade binder, providing a medium-graded, flexible wearing course suitable for local roads and car parks. Mix 1 served as the control and consisted of a standard mixture produced in accordance with the baseline specification. Mix 2 followed the same AC10 grading and binder grade but incorporated the PolyPave additive by removing 3 kg of bitumen binder per tonne of mix and replacing it with 1 kg of PolyPave, allowing the effects of partial binder substitution to be evaluated. Mix 3 further increased the level of substitution, removing 5 kg of binder per tonne and replacing it with 2 kg of PolyPave. This stepped substitution approach enabled the trial to compare how increasing PolyPave content influences mix performance while maintaining the same aggregate grading and overall mix structure as the control.

Table 1 – Result of 3rd Party Laboratory Tests

Properties	Type of Test	Mix 1	Mix 2	Mix 3
Bitumen Properties	Penetration Test	43	42	48
	Softening Point	52.6	52.8	52.2
Composition Analysis	Recovered Binder	5%	4.8%	4.6%
Max Density	Max Density (Mg/m^3)	2.532	2.536	2.538
Resistance to deformation	Voids	7.1%	6.7%	7.9%
	WTS Slope	0.3	0.05	0.09
	Rut Depth	4.8	2.1	3.1
	Proportional Rut depth	9.8	4.3	6.2
Stability flow	Bulk density (Mg/m^3)	2.348	2.36	2.378
	Marshall Stability (kN)	7.3	7.6	7.1
	Corrected Stability (kN)	7.3	7.6	7.1
	Flow Value (mm)	3.1	3.7	3.1
	Tangent Flow (mm)	1.1	1.2	1.2
	Total Flow (mm)	12.3	13	12
	Marshall Quotient (kN/mm)	2.5	2.2	2.3
Stiffness	ITS (dry)	1720	1840	1560
Water Sensitivity	ITSR	97.1	95.7	83.3

Based on interpretation of the results from the three asphalt mixes, there appears to be a clear pattern in how reducing binder content and replacing it with PolyPave influences performance. In terms of bitumen properties, the results show that all three mixes maintain very similar softening points, suggesting that the addition of PolyPave does not significantly alter the thermal characteristics of the binder. Penetration test results, however, show subtle differences, with Mix 2 exhibiting the stiffest behaviour and Mix 3 becoming slightly softer than the control. This variation is likely due to the differing proportions of PolyPave and binder in each mix. Mix 2, which contains less binder but a moderate proportion of PolyPave, may experience increased stiffness because the plastic component can act as a stiffening agent when blended in small quantities, restricting binder mobility. Conversely, Mix 3 contains a higher proportion of PolyPave relative to binder. At this increased dosage, the plastic may instead dilute the effective binder phase and disrupt the binder–aggregate matrix, reducing cohesion and resulting in a slightly softer overall response compared with both Mix 2 and the control mix.

When interpreting SIMA's laboratory test data for density and volumetrics, Mix 2 exhibits the lowest air void content at 6.7%. Mix 1, the control, lies in the mid-range at 7.1%, while Mix 3 shows a further increase, reaching 7.9%. Within the previous revision of the 0900 Series MCHW Clause 929, Paragraph 13, stipulated that in-situ air voids should not exceed 7% for asphalt concrete surface course materials. On this basis, both Mix 1 and Mix 3 exceed the historic MCHW upper limit and Mix 2 is positioned only marginally below it. Air void contents at these levels may accelerate oxidative ageing, increase moisture permeability, and ultimately undermine long-term durability, particularly for mixes relying on softer binders or modified additives.

The most notable differences appear in the deformation-resistance results provided by the supplier. Based on interpretation of this test data, Mix 2 appears to show a marked improvement in rutting performance, with reported rut depth reducing from 4.8 mm in the control mix to 2.1 mm. The accompanying Wheel Track Slope (WTS) values supplied also indicate a slower rate of deformation under wheel-tracking. Mix 3 is reported to perform better than the control, though to a lesser extent, and its higher air void content likely contributes to the more modest improvement.

Marshall stability and flow data provided by the supplier follow a similar pattern. According to the test results provided all three mixes achieve comparable stability values, Mix 2 is marginally higher than both the control and Mix 3. The reported flow value for Mix 2 is also the highest, indicating increased flexibility. The Marshall quotient for Mix 2 is slightly lower, reflecting the softer overall behaviour suggested by the data. Based on interpretation of the data, Mix 3 does not demonstrate improvement over the control in these data sets and appears weaker, likely due to the greater reduction in binder content.

Stiffness results Indirect Tensile Strength test in dry conditions (ITS dry) which should have been conducted in accordance with BS EN 12697-23 presents another area where Mix 2 performs well when compared to the control mix and Mix 3 as seen in the dataset supplied by SIMA. It records the highest indirect tensile strength at 1840 kPa, suggesting potential enhanced internal cohesion and improved resistance to cracking at the lower level of modification. Mix 3 shows a reduction in ITS strength, indicating that the larger binder reduction may compromise mechanical performance.

Water sensitivity characteristics were assessed using the Indirect Tensile Strength Ratio (ITSR), a key indicator of long-term durability and the mixture's resistance to moisture-induced damage. The results show that both Mix 1 and Mix 2 achieve ITSR values exceeding 95%, indicating strong cohesion within the binder–aggregate matrix and a low susceptibility to moisture weakening. Mix 3, however, records an ITSR of 83.3%, which, although still above the minimum performance threshold historically referenced in the MCHW 0900 Series, where Table 9/1B previously specified a minimum ITSR requirement of 80% for asphalt concrete binder course mixtures, does suggest a reduction in moisture resistance relative to the other mixes. This reduction aligns with the higher air void content measured for Mix 3, as more open mixtures typically permit increased water ingress, leading to a heightened risk of moisture-related deterioration over time.

Overall, and based solely on interpretation of the supplier's laboratory test results, Mix 2 appears to show the most balanced performance across the majority of parameters assessed. It demonstrates improved rutting resistance, strong moisture performance, enhanced stiffness, and favourable volumetrics relative to the other mixes. In contrast, Mix 3 performs less favourably, primarily due to excessive binder removal leading to higher voids, reduced stiffness, and lower water sensitivity. Within the limits of the supplied data, Mix 2 appears to be the most effective modification level for this AC10 Close Surf blend.

Conclusions & Recommendations

Further trials of this product are expected to be undertaken utilising more suitable mix plant and machinery to progress toward a full field trial. Additional laboratory testing, undertaken to verify the initial results supplied by SIMA, will allow a more robust and evidence-based technical note to be developed. This laboratory testing will be carried out by the University of Nottingham.

For future PolyPave trials, it is recommended that the following assessments are included. Sand patch testing and Pendulum testing in accordance with BS EN 13108 should be undertaken on both the conventional and trial materials immediately after laying and compaction to compare macrotexture and microtexture depth and the associated implications for skid resistance

Structural performance should be evaluated using 1600 Hz Falling Weight Deflectometer (FWD) testing, or Lightweight Deflectometer (LWD) testing where FWD is unavailable, as both are non-destructive methods suitable for comparative assessment.

A rolling straightedge (RSE) survey should also be completed to identify any surface irregularities and help distinguish workmanship-related issues from material behaviour. Where possible, nuclear density gauge (NDG) testing should be used to confirm surface course compaction, although the need for specialist licensing may limit availability.

Core samples should then be taken to visually assess compaction quality and bonding to the underlying binder course, supported by a review of laying records, including temperature data for both laying and compaction.

Following the trial scheduled for February 2026, continued monitoring of the site will be essential to observe long-term performance and validate the laboratory findings under real-world conditions.