Asphalt Solutions Research

TfL Lane Rental Industry Publication

TRANSPORT FOR LONDON

Introduction

Over 25million tonnes of asphalt is produced in the UK every year. Asphalt roads account for over 95% of all roads in the UK. The Transport for London (TfL) road network, commonly known as ‘red route’ comprises of asphalt overlaid on concrete slabs. Over time, the asphalt cracks due to the vertical and horizontal movement that takes place from the weight of vehicle loading, road works and thermal cycles. This process causes potholes.

According to the 2021 Alarm Survey almost 1.7m potholes were filled on local roads in England and Wales in 2020, equivalent to one every 19 seconds. Undertaking reactive maintenance is 20 times more expensive to carry out than planned, preventative maintenance. TfL is always exploring ways to further reduce the number of potholes on London's roads. In addition to cost, potholes pose a danger to the public and are extremely disruptive to road user journeys and traffic operations. Through quarterly customer satisfaction surveys, potholes and the work necessary to remedy them, are frequently one of the biggest complaints from the public.

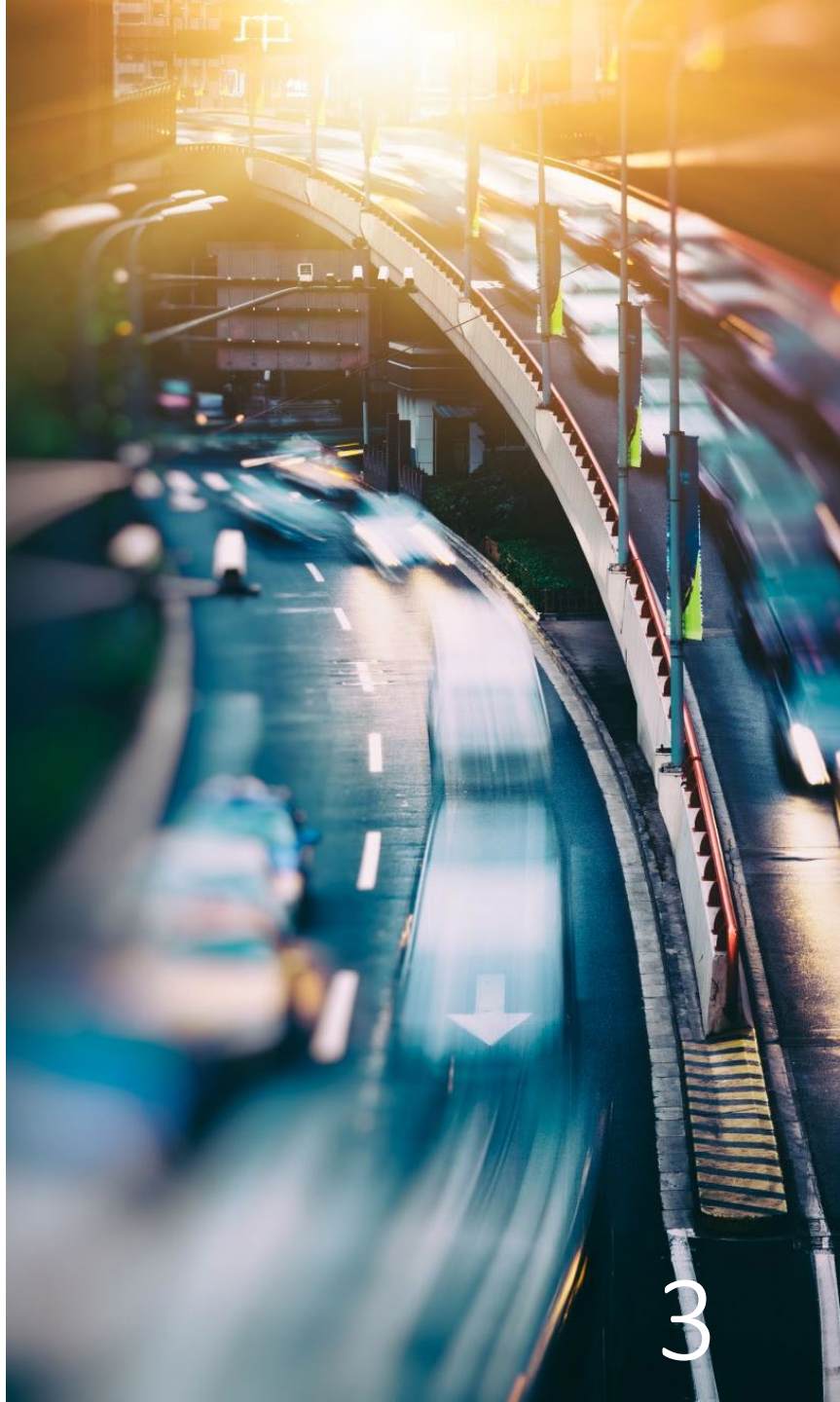
It was therefore proposed that AECOM and TfL would carry out trials to determine optimum asphalt treatment options for London roads, taking into consideration cost, benefit and risk.

The Project

AECOM and TfL designed and ran laboratory analysis to evaluate 10 different asphalt overlays to determine which overlay would best suit the network requirements and prevent reflective cracking at concrete joints. The trials evaluated each material based on performance in reducing pothole formation over the whole life of the asset.

The testing simulated live carriageway conditions with accelerated load applications over several months. Following the recommendations from Phase 1, AECOM was commissioned by TfL in 2018 to perform Phase 2 of the asphalt reflective cracking research project.

Phase 1 of the work included a literature review of available mitigation measures, followed by discussions between the two parties to determine solutions for testing. A pavement model was then used to develop a decision support tool, to evaluate the costs and benefits of each solution for the purposes of whole life cost management.



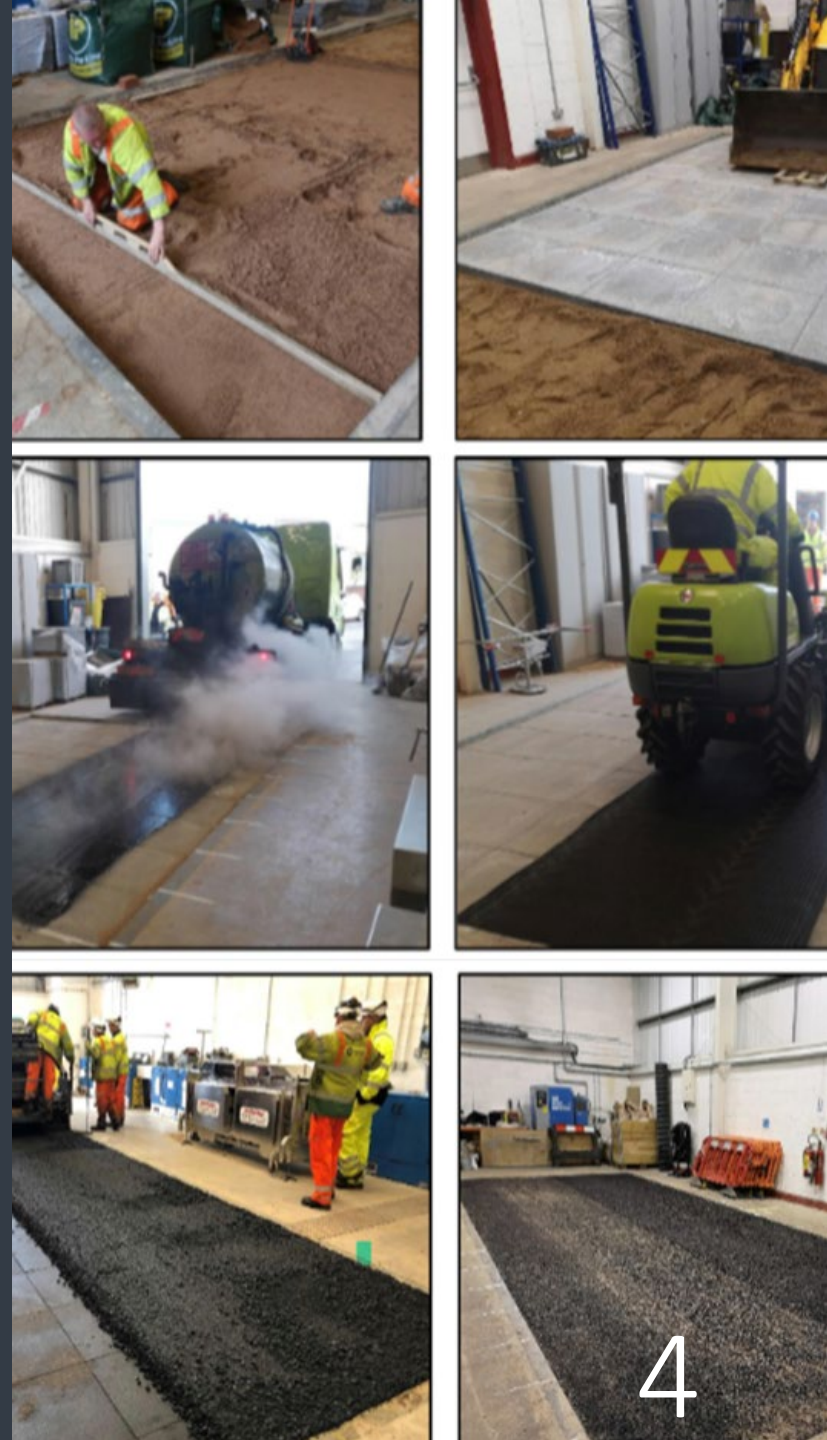
Phase I

The following ten solutions were tested as part of Phase I:

- Conway Asphalt binder layer (SUREPAVE HD bin)
- Hot Rolled Asphalt with 60% 20mm aggregate (HRA 60/20 bin 40/60 des) / with a Geogrid
- Hot Rolled Asphalt with 60% 20mm aggregate and a Polymer Modified Binder (PMB) (HRA 60/20 PMB)
- Dense Bituminous Macadam with 125 Pen (AC20 DBM 100/150 bin des)
- Dense Bituminous Macadam with 50 Pen (AC20 DBM 40/60 bin des) / with a Geogrid
- Stone Mastic Asphalt (SMA 14 bin 40/60 des) / with a Geogrid
- Stone Mastic Asphalt with Polymer Modified Binder (SMA 14 PMB)

The testing was conducted on 300mm x 50mm x 50mm samples of the asphalt solutions, manufactured in the laboratory in accordance with the required specifications, overlaid on a jointed concrete slab. The sample was placed in a bespoke mould with a Perspex side along the length to allow viewing and monitoring of crack development. The sample was tracked by a modified solid rubber wheel tracker.

Laboratory results indicated that the DBM 50 with a Geogrid provided the best resistance to reflective cracking when compared to other options tested. The results also demonstrated that a PMB did not offer a great advantage to standard binders. The Phase I Report (November 2016) highlighted the test limitations such as loading, sample size and mode of failure. The report recommended full scale trials under accelerated loading, such as the Mobile Loading Simulator (MLS).



Phase 2

Following on from the data presented in Phase I, TfL selected three crack mitigation solutions and a standard asphalt concrete as a control option, to be trialled using an Accelerated Pavement Tester (APT). These included:

- Hot Rolled Asphalt with Polymer Modified Binder (HRA)
- Stone Mastic Asphalt with Polymer Modified Binder (SMA)
- Asphalt Concrete (AC20) – Control
- Asphalt Concrete with a Geogrid (AC20 Geo)

This second phase of research proposed to simulate a scaled down, real-life trafficking effect of a unidirectional, pneumatic tyre and subsequent failure of the asphalt, compared with the method developed for Phase I which used a bidirectional, solid rubber tyre.

Outcomes

The research and test results led to the following outcomes:

- The HRA mixture performed the best with a total of 2,469,000 load applications until failure, equivalent to five times the SMA sample and 10 times of the control sample.
- The SMA mixture demonstrates good performance with a total of 450,000 load applications until failure, almost twice that of the control sample.
- The incorporation of a geogrid layer has marginally improved the performance of the Asphalt Concrete sample, with a total of 336,000 load applications until failure.
- A total of 271,000 load applications until failure was recorded for the control sample.
- The use of a PMB within an asphalt mixture provides greater elasticity and therefore greater resistance to reflective cracking.
- With the exception of AC20 Geo, Joint B (where the wheel loaded at the edge slab first) cracked first.

Due to pavement confinement within the test pit, no reflective cracking was observed after a large number of load applications. Therefore, an improved methodology was implemented to accelerate the pavement deterioration. This involved cutting a large sample of 1800 x 750mm incorporating three slabs with two joints from each section and placing the sample in a tray over poor support for testing.

Lessons Learnt

The initial trial methodology highlighted two factors contributing to the prevention of pavement failure from simulated trafficking. For a crack to reflect into an asphalt layer from a joint within concrete slabs below, there needed to be sufficient movement in the concrete to generate high asphalt strains.

The confinement provided by the pit walls prevented the pavement from deflecting and the high foundation stiffness (>100MPa) gave too much support to allow for the required movement to initiate cracking.

The development of any potential bottom- up cracking could not be monitored within the layer as cracks were only visible at the pavement surface.

The improved methodology of sample testing over poor support was successful after a few iterations. This allowed the relative comparison of materials performance, and monitoring crack initiation and propagation under repeated loading.

Conclusion/ Recommendations

Four sections were constructed in the AECOM Test Pit Facility and tested under accelerated loading for asphalt reflective cracking. The following layers were constructed over concrete slabs and tested under repeated Mobile Load Simulator (MLS) loading, a standard Asphalt Concrete (AC20) as a control, Asphalt Concrete with a Geogrid (AC20 Geo), Hot Roller Asphalt (HRA) and Stone Mastic Asphalt (SMA). Both HRA and SMA mixtures incorporated Polymer Modified Binder (PMB).

The main limitations of the testing arrangements were the load magnitude and lack of asphalt ageing. Hence, the in-situ pavement performance under real-life traffic loading, traffic frequency and environmental variations over the design life may differ from that reported in this study.

Further investigation is recommended to test a range of real-life concrete pavements treated with various asphalt solutions, and subjected to actual traffic loading, to confirm the findings from this research.

TfL Lane Rental Scheme

Optimising customer journeys through the delivery of safer, innovative and sustainable roadworks

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