

Whitepaper

Durable, economical, rapid repair and maintenance materials for transport infrastructure

Efficient working and effective results with PMMA resins and mortars



**WORKING
TOGETHER,
SOLVED
TOGETHER.**

Your project, our solution

We make ideas possible and your life easier. We work together to find the best possible outcome for all stakeholders. Our aim is to solve problems with innovative solutions, ensuring a reliable result with complete customer satisfaction.

Areas of application

With Triflex PMMA specialist resins and mortars, you can, not only repair potholes, around manholes, breakouts and dayjoint cracks, but also cover fatigue or reflection cracks and rutting. You can even replace the surface of damaged asphalt with a thin layer surfacing. Slip resistance can be tailored with a choice of embedded aggregates.

Structured solutions

Triflex offers optimally matched cold applied repair and reinstatement resins and mortars for every infrastructure challenge. Solutions are easy to mix and apply, quickly resilient (even at very low temperatures), durable, wear-resistant and are not broken down by water. When it comes to the maintenance of infrastructure, Triflex is your long term partner.

Service

Your project is our project. As a manufacturer and direct seller rather than distributor - Triflex is closer to the products, the project and the end user. Our experienced technical team and field application engineers support you in selecting the right products and installing effectively.



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1 Road networks of outstanding importance to the UK

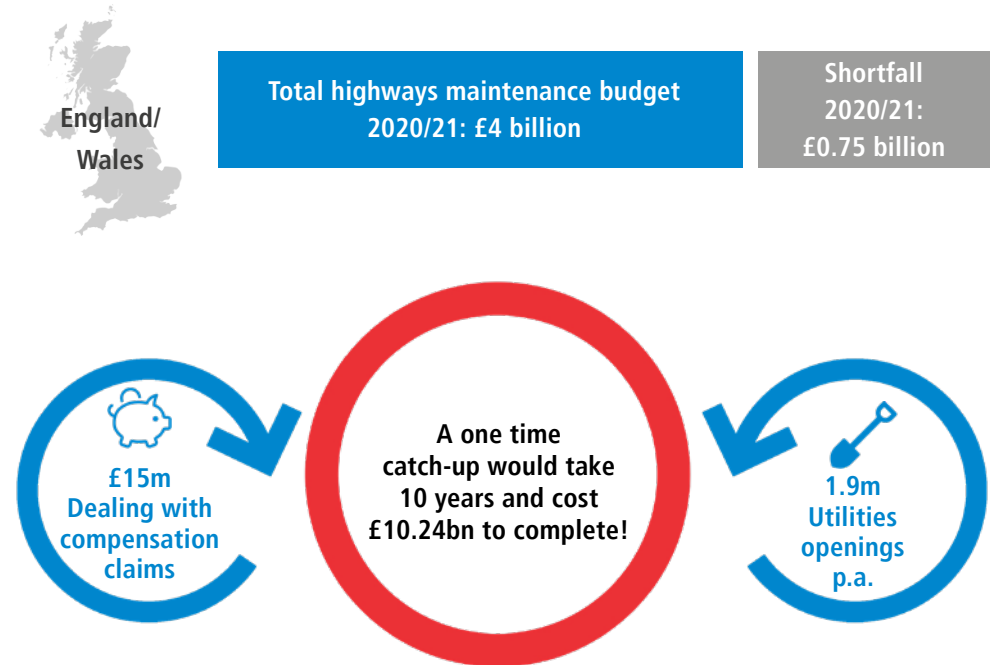
Excluding the consequences of the COVID pandemic, the volume of traffic on UK roads has been constantly increasing. The reasons for this development lie in the increasing mobility of society, economic growth and our ever-increasing reliance on road transport for the products we buy and consume.

According to the Department for Transport, the number of miles travelled in Great Britain increased by approximately 23% between 1999 and 2019 to 356.5 billion miles per annum. The car and vehicle density has also increased significantly over the last 20 years with a more than 38% increase to approximately 38.5 million licenced vehicles by 2019.

The road network is therefore of outstanding importance to the people of the UK for mobility, personal consumption and for business.

High investment backlog

More traffic on the roads means more stress and the need to invest more in maintaining them. Given a road network which covers a total of 247,500 miles, maintenance and refurbishment poses an enormous challenge particularly given the demands of other sectors for public finances.



Reference: AIA's Alarm Survery 2021

It is generally accepted that road and transport infrastructure has one of the highest investment backlogs. Unfortunately, limited financial and personnel capacities often lead to an increase in 'temporary' repair measures with inferior materials. Ultimately the damage is so great that an extensive renovation or full replacement is required to road surfaces.

2 Challenges in maintenance management

Without an intact and efficient road infrastructure, our modern lives simply would not work. There are therefore large expectations placed on those responsible for managing the maintenance of our roads: They are supposed to ensure that road works commence when necessary, are completed after as short a time as possible, pose no major traffic disruptions and can be re-opened again on or before time. In addition, they need to ensure that the measures taken should be economical, lasting and offer best value to those paying. That's the theory. In practice, however, it is not uncommon for the theory to be challenged by circumstances, ranging from a shortage of skilled workers, an ever increasing list of maintenance tasks and a lack of suitable repair materials. Therefore road maintenance management is often purely a matter of course, with traditional processes and materials with known inadequacies continually used as there is nothing else available.

Hot asphalt / macadam properties

Hot asphalt and macadam cannot be used in frost and rain, and for smaller repairs are uneconomical due to the minimum volumes of batching plants together with the need to transport the materials hot. When working with hot asphalt, it is often laid at temperatures of up to 190°C and cannot be allowed to significantly cool down on the way from the asphalt plant to the construction site. This requires a complex transport chain with special vehicles for

delivery, installation and compaction: which for minor repairs, is simply not worth it. In addition, there are significant health and safety risks from using such hot materials and the applications are restricted with limited possibilities for thin layer repairs.

Cold asphalt properties

Often used after the winter where the freeze thaw process has reeked havoc on our roads, cold asphalt can - as the name suggests - be installed in a cold state. But these cold asphalts can only really be considered as a temporary solution. Depending on the level of traffic, the repaired area may require further reinstatement after only a few months, or even weeks, becoming crumbly and breaking down. Individual potholes quickly become permanent construction sites, with a corresponding accident risk for road users and claims for damages.



3 PMMA a quality material: 3.1 Background and benefits

Benefits of PMMA resin repair materials



Substitutes for hot and cold asphalts based on synthetic resins such as PMMA (polymethyl methacrylate) offer decisive advantages: They can be processed at temperatures down to 0°C and are exceptionally fast curing. With high mechanical and physical properties, they are highly resistant to traffic, are compatible with bituminous, cementitious and metallic substrates and are water resistant. Long term repairs can now be realised with a low risk, cold applied solution even in the colder months, and for emergency repairs, without the requirement to open an asphalt plant just for the repair of that incident.

Disruption is minimised as the material can typically be driven over after as little as 45 minutes. Triflex products are perfect for specialist companies and non-specialist contractors alike being

simple to mix and apply using basic tools. With its range of specially developed products, Triflex offers an alternative to the maintenance of our road and highway infrastructure, allowing them to be maintained in a fair and responsible way.

The use of PMMA resins and mortars is not only economical and sustainable, but makes an active contribution to road safety. The term PMMA may not be familiar, but the technology is far from new to the highways sector. Superior PMMA road markings are widely used throughout Europe, where demands for high performance reflective markings are significantly higher as cats eyes are typically not used.



3.2 Proven in practice for decades

With increased elastomeric properties, PMMA was developed from road marking technology as a waterproofing resin for flat roofs. Here it continues to demonstrate significant performance advantages over other synthetic resins. It's seamless nature, high levels of substrate compatibility and exceptional adhesion offer advantages over traditional sheet applied materials. These properties ensure that liquid applied materials remain the highest growth area in flat roof waterproofing in the UK and much of mainland Europe.

PMMA - Waterproofing and protection

Following success as a waterproofing system, with further development PMMA became the market leading technology for waterproofing and surfacing applications from walkways, balconies and terraces to the extreme environment of the concrete multi-storey car park. Here, protection of the building fabric from chlorides in road salts is vital to long term structural integrity.

The unique properties of PMMA have pushed alternative epoxy, polyurethane and polyurea technologies aside. PMMA has demonstrated not only its resistance to the worst weather, but also mechanical, chemical and thermal loads. It offers a low risk, highly durable and economically sustainable solution.

PMMA - the all-rounder

The fields of application for liquid plastics are still growing and becoming more diverse with use in the widest variety of extreme environments. Ever wondered what's used as the waterproofing to offshore wind turbines constantly battered by the weather and the sea? PMMA. How about gluing intelligent road studs into our roads? again PMMA. In fact PMMA is one of the most widely used chemicals that many people have never heard of. Most of us interact in some way with it every day, whether it's the resin used for your shower tray or bath, the screen on your TV or one of the many plastic components used in your car. Not only is PMMA highly functional, but also allows a range of aesthetic finishes to be achieved. For example for walkways and balconies, PMMA offers a solution not just for the main area, but also for the more difficult and high risk areas such as the details and interfaces.



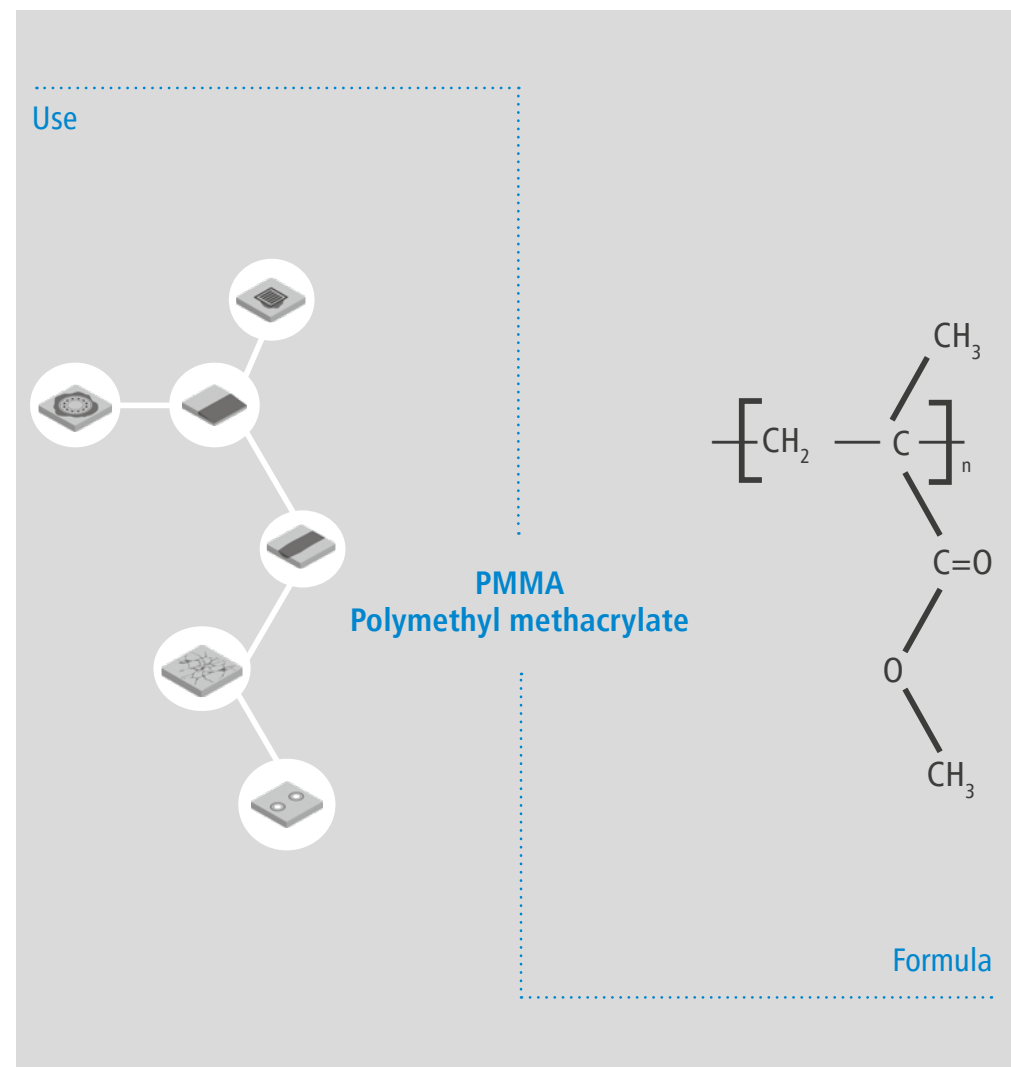
3.3 Reasons for using PMMA in infrastructure

Being totally cold applied and mixed on site, the technology offers huge advantages over traditional hot applied materials. Cookers, hot boxes, road rollers etc. are not required, significantly reducing mobilisation costs and reliance on logistics.

As the system can be applied in thinner layers, it may also mean less preparation and less material sent to landfill or recycling. The fast curing time means the repaired area can also be re-opened to traffic after only a short time.

For most construction chemicals, drying, curing and hardening times are slow and will be significantly extended in cold temperatures, making their use on roads and highways impractical. With PMMA, formulations can be designed to work at temperatures as low as -20°C with no extension of cure times (a Triflex PMMA manhole installation mortar for Scandinavia is designed to do just this), whilst also being able to deal with atmospheric humidity of up to 95%.

All of these properties make PMMA an ideal solution to comply with challenging schedules of repairing roads and highways infrastructure with the added advantage of minimising traffic management costs.



The strengths of the material at a glance:

- Can be used on trafficked areas with substrates made of all types of asphalt, concrete, steel or a combination.
- Specifically designed to deal with adjoining materials with different coefficients of thermal expansion e.g. around manholes and drain outlets
- Adhesive strength to bituminous and cementitious materials is greater than the cohesive strength of the substrate - no other material binds cold-to-cold to bitumen so securely
- Standard materials can be used at temperatures as low as 0°C, with specialist materials available to work at much lower temperatures – all with no significant extension of cure time
 - No large equipment required, only a paddle mixer which can be battery powered for smaller repairs
- Limited requirement for personnel on the construction site – can be mixed and applied by one person if required
- No waiting time between the installation processes
- No machine compaction / rolling necessary – just sufficient pressure to ensure no voids / air pockets
- Short closing times: can be trafficked after 30 to 45 minutes
- Rainproof after 30 minutes
- PMMA is a long term repair and therefore sustainable
- UV-resistant
- Highly resilient
- High wear resistance - tested according to CEN / TS 12697-50
- Does not absorb water
- Solvent, isocyanate, cement and bitumen free



3.4 PMMA systems compared to conventional cold asphalts

Technical characteristics	Triflex Asphalt Repro 3K	Cold asphalt
Resistance to deformation / rut and groove formation	✓	✗
Resistance to deformation under heat / stamp penetration test	✓	✗
Wear resistance	✓	✗
Proof of slip resistance	✓	✗
Resistance to temperature changes	✓	✗
Freeze-thaw cycling with de-icing salt immersion	✓	✗
Capillary water absorption	✓	✗

Scientifically proven ✓

No known evidence ✗

4 PMMA quality tested: Exceptional resistance to deformation and crack formation



As part of a performance test, the Institute for Building Material Quality Assurance (IBQ) in Germany tested Triflex PMMA mortars for lane formation / rutting. At a test temperature of 60°C, Triflex Asphalt Repro 3K passed a defined wheel load and 10,000 wheel cycles with excellent results, which most importantly were significantly better (90% less deformation) than the control sample made of a heavy duty German AC11 DS asphalt; an asphalt for special / high demands.

In another experiment, the scientists tested Triflex Asphalt Repro 3K not as a full build-up, but as a thin layer over asphalt with an applied layer thickness of only 5 mm in a mixing ratio of 1 part resin to 3 parts filler.

The thin layer PMMA mortar achieved great results as after 10,000 wheel cycles, the groove depth was only 1.9mm and therefore still less than the 40 mm thick reference block made of high-quality asphalt. In this test the whole sample is heated to 60°C, whereas in reality only the upper surface would likely reach this temperature as the Triflex Asphalt Repro 3K would reduce some of the solar heat gain through to the substrate.

Deformation in practice is therefore likely to be significantly lower as the majority of the deformation occurs in the thermoplastic asphalt layer rather than the thermosetting plastic Triflex Asphalt Repro 3K. PMMA has therefore proven in the test that the material is highly resistant to the formation of ruts and deformation under load. The scientists also could not determine any cracking under the sustained load of the testing.



Institute for Building Material Quality Assurance - Testing images

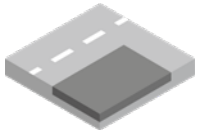


The 40mm thick sample of high-quality AC11 DS asphalt had a groove depth of 2.2mm after the lane formation / rutting test. According to the test specifications, a deformation of up to 8 mm would still have been acceptable. (The Triflex Asphalt Repro 3K sample had a groove depth of 0.2mm or just 2.5% of the allowable deformation)



With Triflex Asphalt Repro 3K in a mixing ratio of 1 : 3 at only 5mm thick, the rutting depth was only 1.9 mm. As can be seen the deformation has primarily occurred in the underlying asphalt, not the thin layer of Triflex Asphalt Repro 3K surfacing.

Application example: Fire damage repair to motorway exit lane

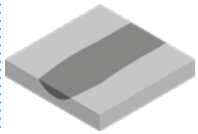


- Only a minimum 10mm of damaged asphalt removed – reducing waste
- Reinstatement material applied in single process by squeegee
- Repair broadcast with durable 1-3mm aggregate to give PTV > 70
- Excellent adhesion to existing asphalt
- Minimal disruption and closure times: rainproof after 30 minutes / able to withstand traffic after 45 minutes
- Exceptional resistance to future deformation and cracking with long term retention of skid resistance
- No requirement for large delivery and installation equipment or hot works
- Sustainable: significant cost savings and waste reduction compared to full or partial removal and reinstatement



The repair also required a much shorter road closure window causing less disruption than a conventional hot asphalt repair.

Application example: Repair and levelling of rutted road surface without complete removal and reinstatement

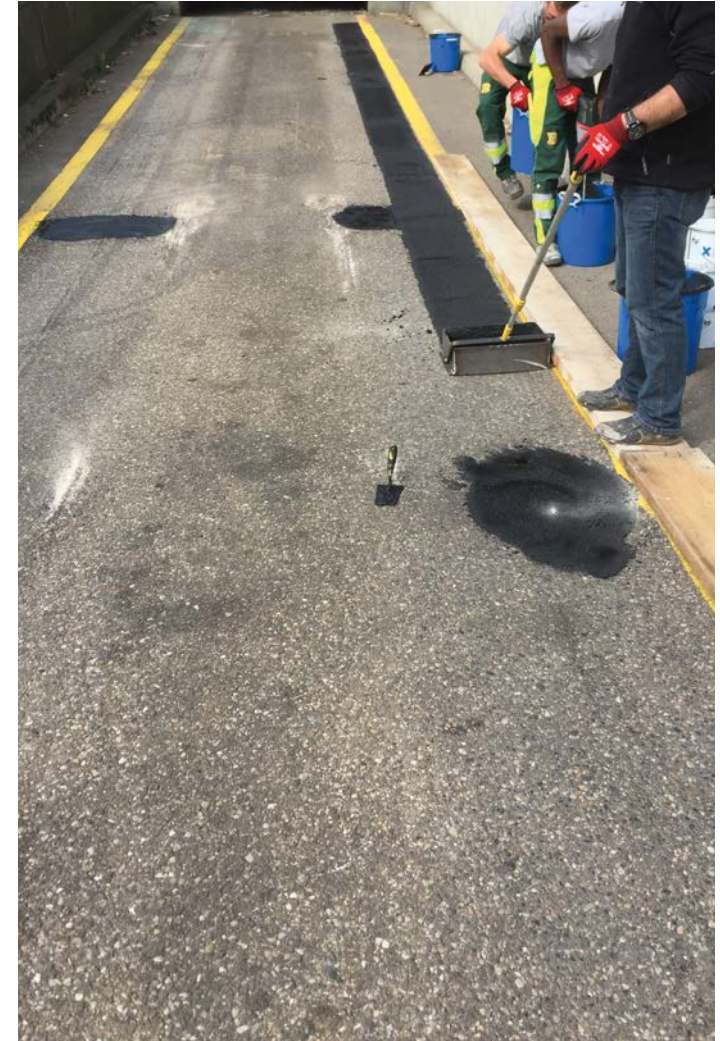


- Tapered levelling from 5 to 50 mm depth in a single application*
- Rapid, simple application by draw box / shoe or trowel
- Excellent adhesion to existing asphalt
- Minimal disruption and closure times
- Exceptional resistance to future deformation and cracking
- No requirement for large preparation and installation equipment or hot works
- Sustainable: significant cost savings and waste reduction compared to full or partial removal and reinstatement

*Can also be multi-layered with no issues with inter-layer adhesion



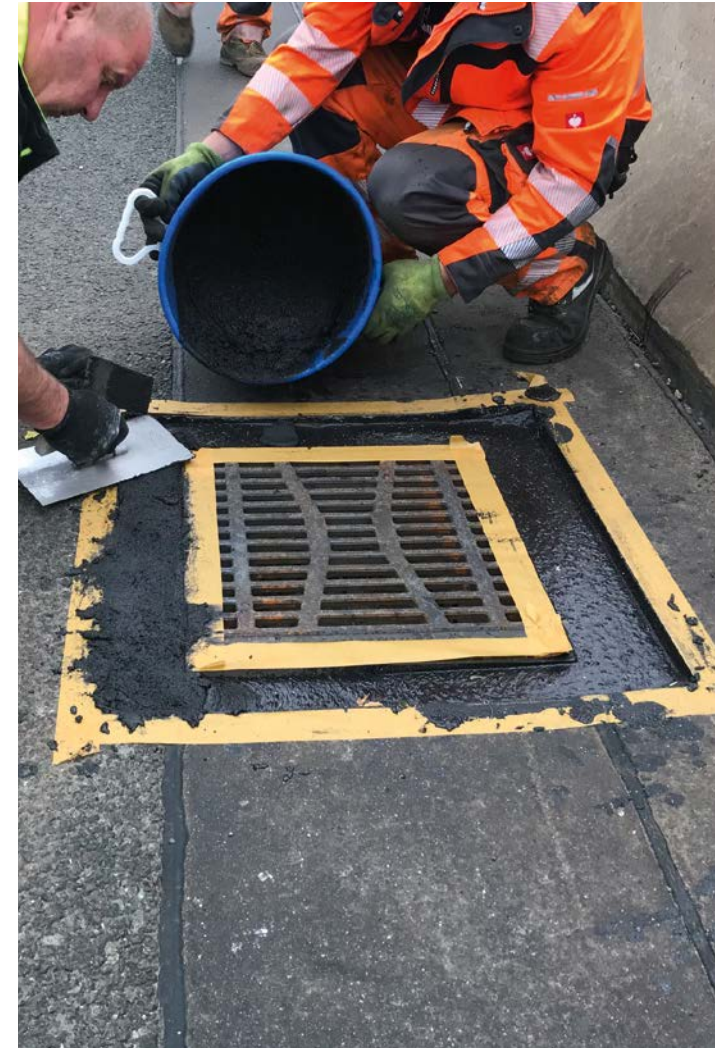
Freight forwarder access ramps.



Application example: Cold applied, resilient setting of drainage outlet frames in asphalt to bridge

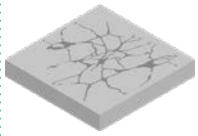


- Rapid installation with no requirement for large equipment and hot works
- Compatible with asphalt, cementitious materials and steel / ironworks
- Highly resilient and impact resistant
- Installation free from cavities without the requirement for heavy compaction
- Wear resistant, anti-skid surface
- Sustainable by extending maintenance intervals

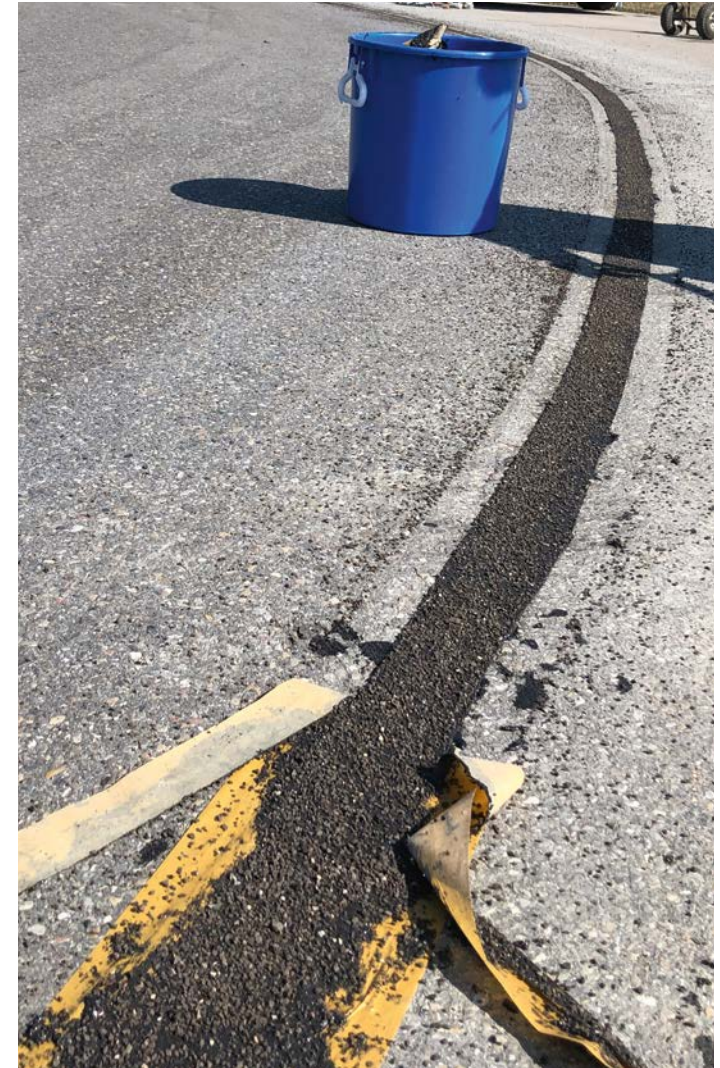


Perimeter fixing of bridge drainage outlet frames

Application example: Crack filling and overbanding

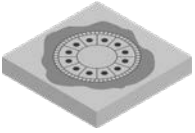


- Excellent adhesion to the asphalt with high resistance to shear forces from turning vehicles
- Impermeable to water (no capillary water absorption)
- Anti-skid
- Minimal requirement for preparation and installation equipment and no requirement for hot works
- Tough and durable
- Sustainable through time and cost advantages and long-term wear resistance



Repair of split asphalt day joint to roundabout.

Application example: Repair of damaged asphalt substrate adjacent to gas inspection cover

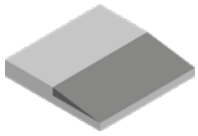


- No hot works – ideal for use around gas and flammable materials
- Seamless connection to the existing asphalt and inspection cover frame
- Rapid installation with minimal disruption
- Fully cured and ready for traffic after 60 minutes
- Road marking / white lining repair carried out with PMMA
- Sustainable through low number of personnel and minimal requirement for equipment



Repair of asphalt to perimeter of gas inspection cover

Application example: Localised repair to subsidence / low spot in new road construction



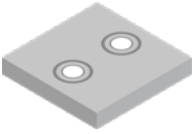
- Repair carried out in just one night
- No requirement for heavy equipment mobilisation and no hot works
- Tapered levelling in a single application*
- Rapid, simple application – simply poured and levelled with a float
- Excellent adhesion to existing asphalt
- Can be applied at temperatures down to 0°C with no significant extension of cure times
- Highly resistant to traffic loads
- Sustainable, with significant cost savings and waste reduction compared to full or partial removal and reinstatement

*Can also be multi-layered with no issues with inter-layer adhesion



New road construction – levelling of subsidence.

Application example: **Kurb bonding** with no need to dig, mill or plane the substrate; just glue



- Kerbs surface bonded with PMMA
- No time-consuming preparation; no digging, milling or planing
- Fast execution and rainproof after only 30 minutes
- Resilient bonding of cementitious kerbs to existing asphalt
- Sustainable due to the low requirement for the transportation and use of large equipment



Installation of traffic islands.



Conclusion

Triflex PMMA mortars have been utilised in a wide and ever-expanding range of practical applications. They have proven excellent solutions for the maintenance of road and traffic infrastructure, adding valuable improvements to safety.

In addition to work carried out in Triflex's state of the art laboratory where we have invested millions in equipment and facilities, the performance of Triflex Asphalt Repro 3K has been independently scientifically substantiated by the Institute for Building Material Quality Assurance (IBQ) in Germany.

PMMA mortars and coatings can be used to repair potholes, make good broken asphalt, fill and consolidate cracks and dayjoints. They can also be applied in thick or thin layers without compromise to their properties or performance, making them an ideal choice for levelling and reprofiling.

The use of PMMA resins and mortars is not only economical and therefore sustainable, but due their high physical and mechanical properties they can actively contribute to improving road safety.



With a high level of long-term protection, further damage from freeze thaw and hydraulic action of standing water being forced into the substrate can be minimised. In the majority of cases the works can be carried out with minimal equipment and mobilisation costs, and only the required material needs to be used – avoiding the issues of hot asphalt getting too cold or the minimum volume from the asphalt plant simply not being fully required.

Triflex PMMA mortar solutions allow more flexibility in terms of time and in most cases the repairs can be carried out more quickly with smaller teams, with less equipment and lower costs for emergency repairs.

The ability for standard materials to be applied at temperatures from 0°C and humidity up to 95% with no significant extension of cure times means they offer an all year round solution. PMMA based materials are more durable than cold asphalt and have numerous advantages over hot asphalt. In addition to the advantage of being applied cold and avoiding the risk of hot works, they are affected much less by temperature. This is due to PMMA being a thermosetting plastic rather than a thermoplastic. PMMA based materials deform less and can be applied in thinner layers.

The application of PMMA mortars requires no specialist skills / equipment training, no cooker or hot box operative, no road roller or no wacker operators – just a mixing paddle, bucket and something to level the materials. Not only are fewer personnel are required, but also less co-ordination of transport and machinery, making the process of repairs easier. This leads to reduction in costs and limits risk from availability, breakdowns and lack of specialist personnel,

contributing to reduced disruption and smaller traffic management works which can be removed sooner.

Ultimately, Triflex offers excellent products with unique properties that are ideal for the long term, efficient maintenance of road infrastructure.





**RAPID
AND
DURABLE
SOLUTIONS.**

As an owner-managed, medium-sized company Triflex are close to our customers and understand the special challenges that can arise. With a wide portfolio of products based on PMMA (polymethyl methacrylate), Triflex has succeeded in offering ideal repair solutions for the vast majority of requirements in transport infrastructure, being simple, quick and, above all long term. Our customers benefit from the close exchange with Triflex as the manufacturer as well as our decades of experience in developing PMMA resins for the widest range of applications. Triflex is a company within the Follmann Chemie Group. Further information is available at www.triflex.co.uk

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