

EVALUATING THE USE OF WASTE PLASTICS AS AN ADDITIVE IN BITUMEN FOR ASPHALT PRODUCTION



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Who am I?

- University of Strathclyde Bachelor of Civil Engineering
- Joined MacRebur in June 2019
- Researching waste plastics in bitumen with MacRebur to obtain Masters degree (MSc) through University of Sunshine Coast





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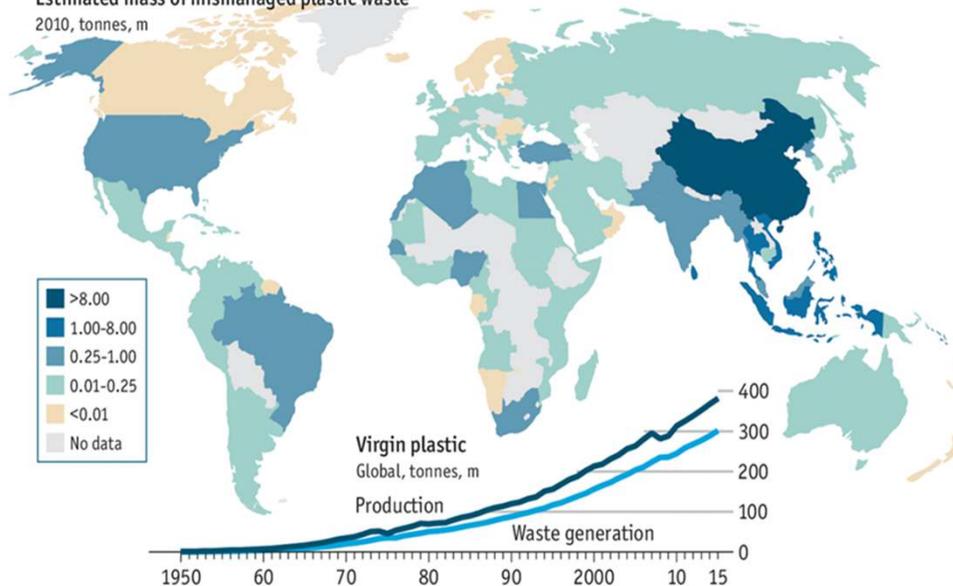
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China as number one

Estimated mass of mismanaged plastic waste
2010, tonnes, m



Sources: "Plastic waste inputs from land into the ocean", by J. Jambeck et al.; *Science*
Economist.com

- Plastics have dominated the manufacturing sector for a century
- "Victim of their own success".
- Plastic pollution - "an environmental problem on a global scale that needs immediate action".







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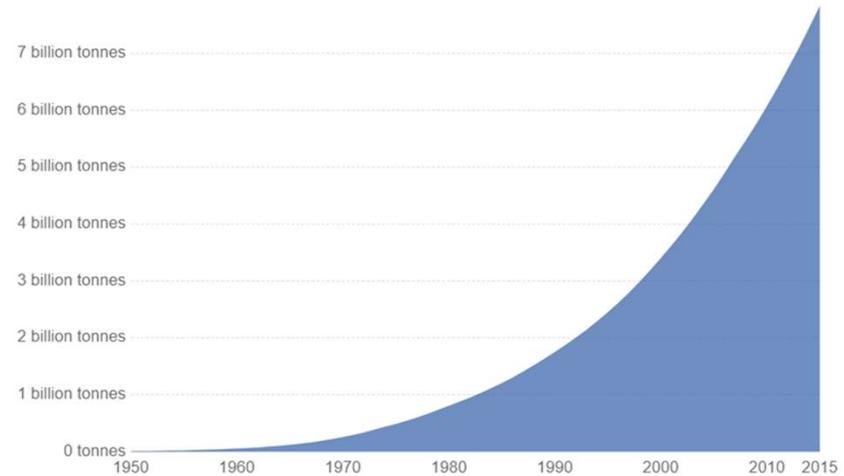


- Single-use plastics are accelerating climate change
- We are now facing an existential threat to our planet

Cumulative global plastics production

Cumulative global production of plastics, measured in tonnes.

Our World
in Data



Source: Geyer et al. (2017)

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#realisticplastic
Plastic is not the problem. It's how we use it.

OVER **400**
MILLION
tonnes of plastic
are produced every year

PLASTIC HAS MANY USEFUL APPLICATIONS

In medicine and science

- Keeps equipment sterile
- Prevents the risk of infections
- For people with medical needs

In manufacturing and logistics

- Used to make appliances and equipment
- Safe transportation
- Storage

BUT SOME PLASTICS ARE AVOIDABLE

Plastic containers Plastic bags Plastic straws Disposable cups

HERE'S WHAT YOU CAN DO

Avoid throwaway plastic use

- Switch to reusables
- Buy products made from recycled material
- Bring your own bags and containers

Reduce, reuse, recycle wherever possible

- Keep plastics clean and dry in your recycling bin
- Use a container deposit scheme to recycle bottles
- Donate items that can be used again

CLEANAWAY **13 13 39**
Making a sustainable future possible cleanaway.com.au

- Plastics were once hailed as a “miracle material”
- Plastics are lightweight and durable and give tremendous marketing advantages
- Plastics have saved millions of lives in use in medicine, as well as in safety equipment (helmets)



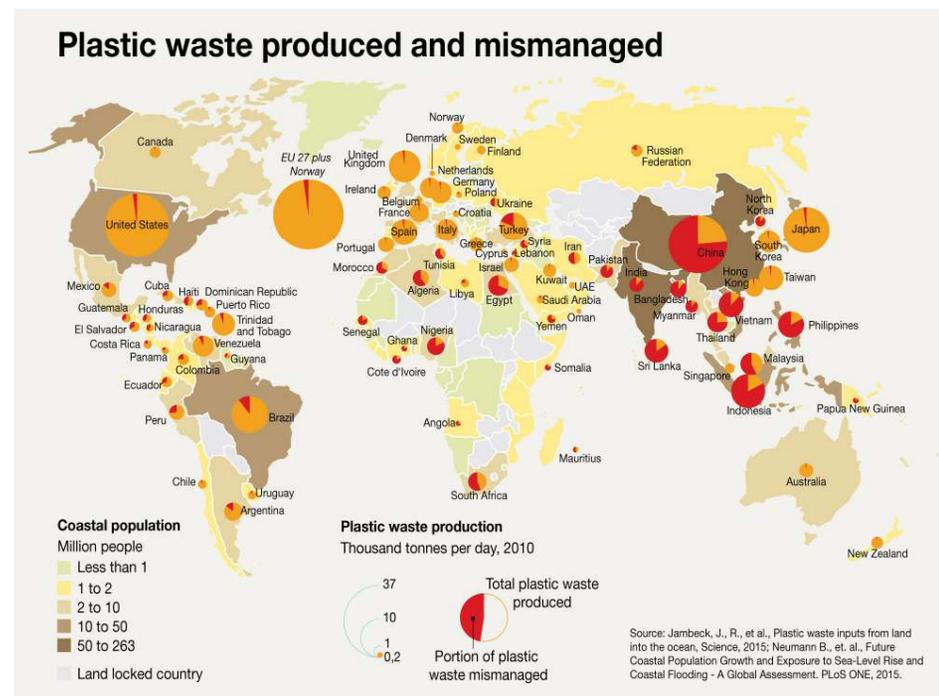
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- Mismanaged waste is the sum of material which is either littered or inadequately disposed.
- Inadequately disposed waste is that which has the intention of being managed through waste collection or storage sites, but is ultimately not formally or sufficiently managed





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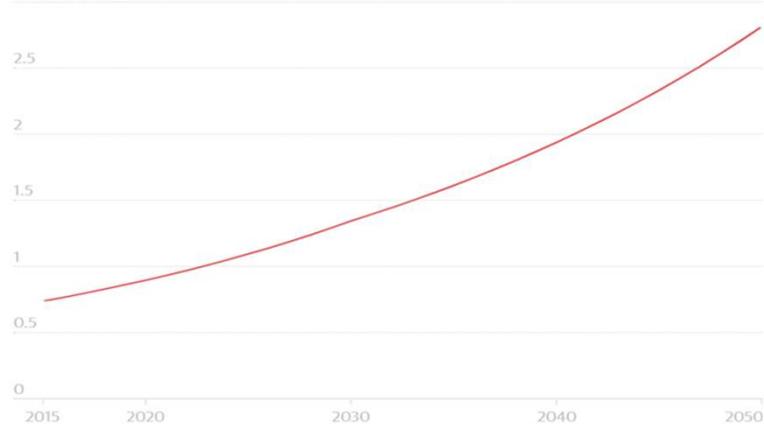
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Annual CO₂ emissions from plastic could grow to more than 2.75 billion tonnes by 2050

Annual CO₂ emissions from the production and incineration of plastic
3 billion tonnes



Guardian graphic | Source: Center for International Environmental Law

- Plans to lower carbon emissions must be made “as urgently as possible”
- Incineration creates the most CO₂ emissions among the plastic waste management methods



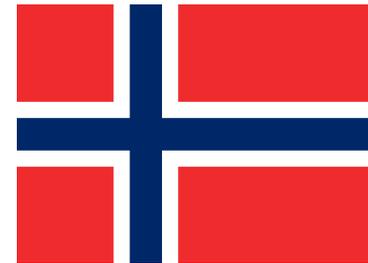
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Oslo- Norway





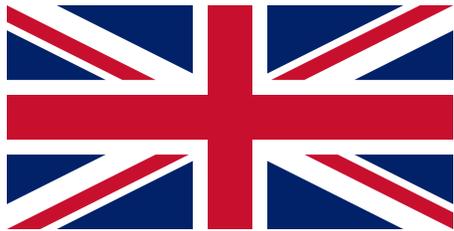
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London- UK





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Athens- Greece





IT'S TIME FOR CHANGE



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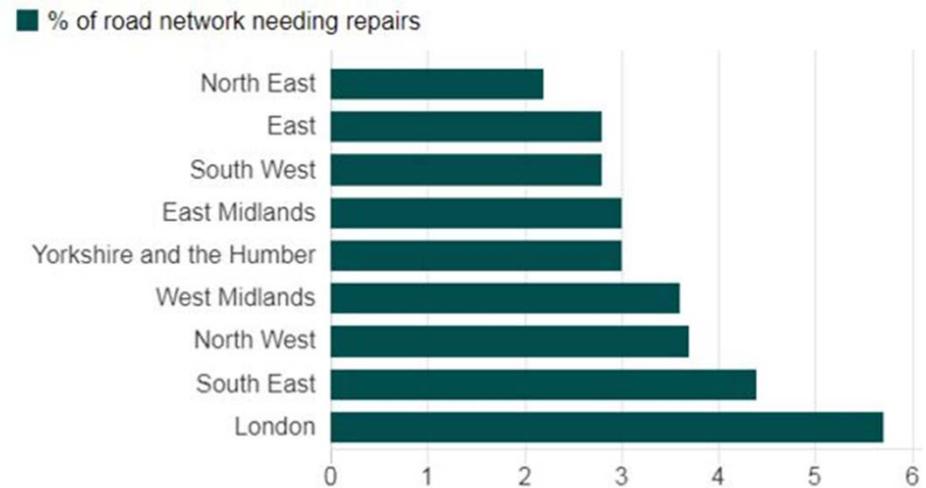
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- “10% of road network in UK in poor condition”.
- It would cost £12billion and take 14 years to repair all roads in UK
- Roads crisis should be addressed as a national priority

How road conditions compare across regions



Department for Transport

BBC



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Rutting



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Alligator cracking



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- The civil engineering industry is making efforts to promote and create more sustainable and environmentally friendly infrastructure
- Reclaimed asphalt pavement (RAP) is commonly used
- Economic benefit of asphalt recycling has become clear





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- Alternate materials have been suggested as a replacement for RAP in asphalt recycling

- Up to 70% reduction in energy cost and greenhouse gas emission



- In order to be sustainable recycled materials must provide equal performance of pavement at no greater cost.



*THERE IS A DEMAND AND MARKET
FOR SUSTAINABLE ROAD TECHNOLOGY*



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Who Are MacRebur?





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- Established in 2015 after inspiration from India
- Use **WASTE PLASTICS** instead of virgin polymers
- Developed a solution to
 - Productively consume local plastic waste
 - Reduce the cost of road maintenance
 - Increase the strength and durability of roads





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MR6

MR8

MR10

MACREBUR PRODUCTS



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DIRECTIONS OF USE

- ***Use in hot mix asphalt***
- ***The products form a homogeneous binder***
- ***Can be blended to make a PMB for use in warm-mix asphalt***
- ***No change in manufacture of asphalt***
- ***No change in laying of roads***
- ***No change in visual appearance of roads***





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Health and Safety

Gas Chromatography testing

As MacRebur products are used in creating hot mix asphalt, they will be subjected to temperatures of up to 180C. Gas Chromatography testing demonstrates the safe use of MacRebur products at working temperatures and determines what substances may be present.

The samples submitted for testing were:

- 100/150 penetration grade bitumen
- 6% MR6 mixed with 100/150 penetration grade bitumen
- 6% MR8 mixed with 100/150 penetration grade bitumen
- 6% MR10 mixed with 100/150 penetration grade bitumen

The four samples were tested at 4 different temperatures. 100C to represent potential laying temperatures of asphalt, 150C to represent the lower mixing temperature of hot mix asphalt, 180C to represent the upper mixing temperature of hot mix asphalt and 200C to represent if things were vastly overheated whilst mixing hot mix asphalt.

The laboratory concluded that no harmful substances were given off from our products. Any potentially harmful substances had originated from the bitumen. Full test certificate is available upon request.



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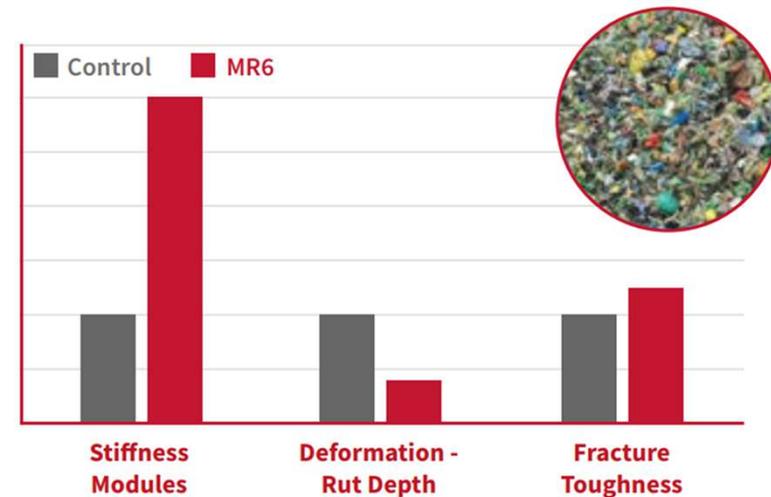
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MR6

- Arrangement of polymers designed for the extension and enhancement of bitumous binder
- Increases stiffness of binder and base course layers to reduce thickness of pavement
- Suited to surfacing intersections, roundabouts and slow moving heavy vehicles areas





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MR6





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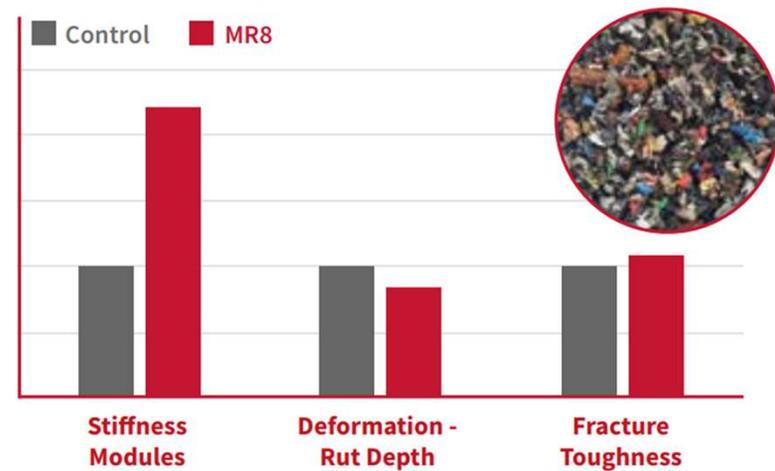
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MR8

- Blend of polymers designed for the extension of bitumous binder
- Selected to extend unmodified bitumen
- Suited for car parks, driveways and local roads
- MR8 designed to reduce rutting failures





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MR8





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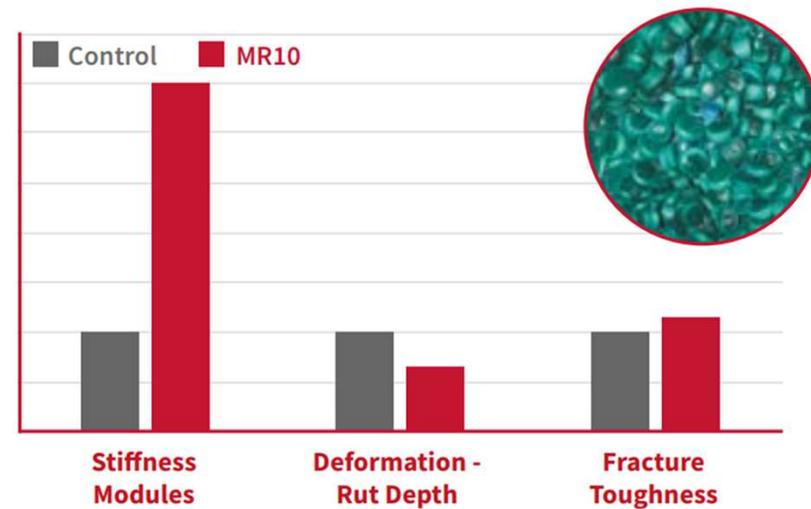
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MR10

- Contains block co-polymer designed for extension and enhancement of bitumous binder
- Increases fracture and cracking resistance without compromising rutting resistance
- Ideal for producing highly crack resistant, stiff course layers for thickness reduction
- Designed to reduce number of cracking failures





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MR10





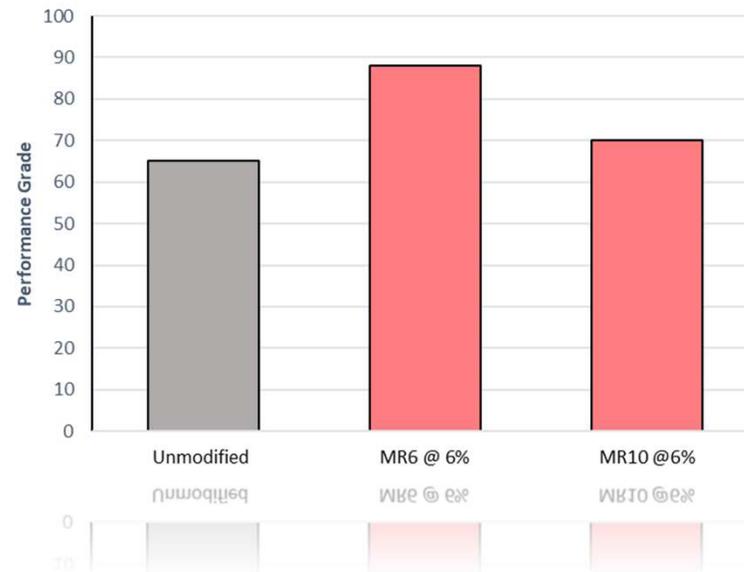
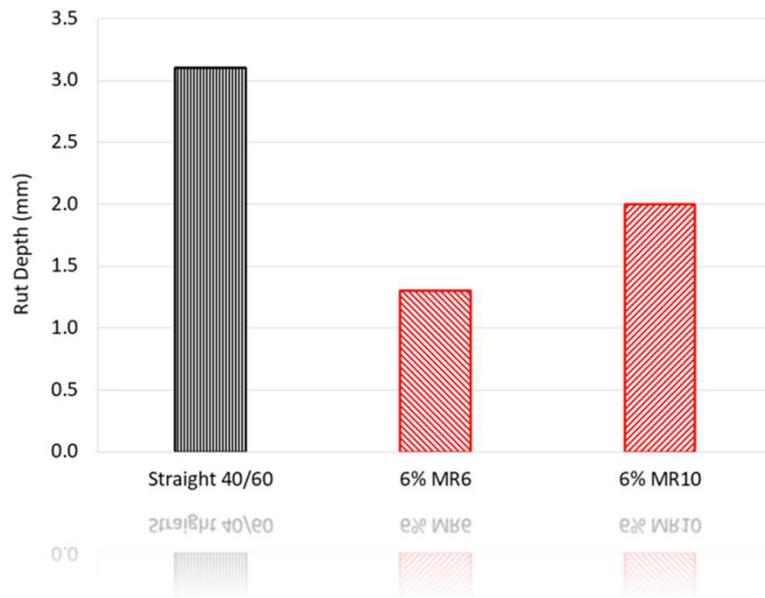
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DEFORMATION RESISTANCE





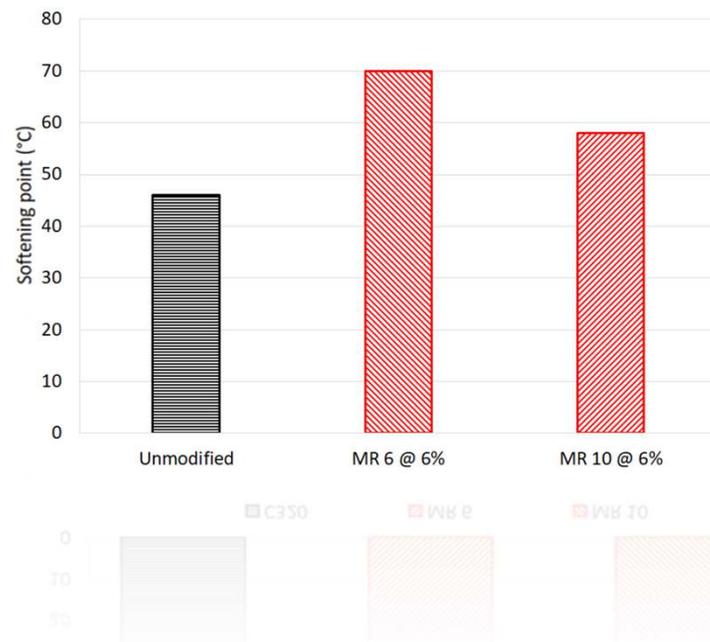
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DEFORMATION RESISTANCE



- Standard softening point tests were conducted on MacRebur MR6 and MR10 modified bitumen
- Results highlight a higher softening point in MR6 and MR10 samples



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FRACTURE RESISTANCE



- Semi- circular bending test was conducted on cores of SMA 40-60 with 6% MR6 Binder and 6% MR10 Binder



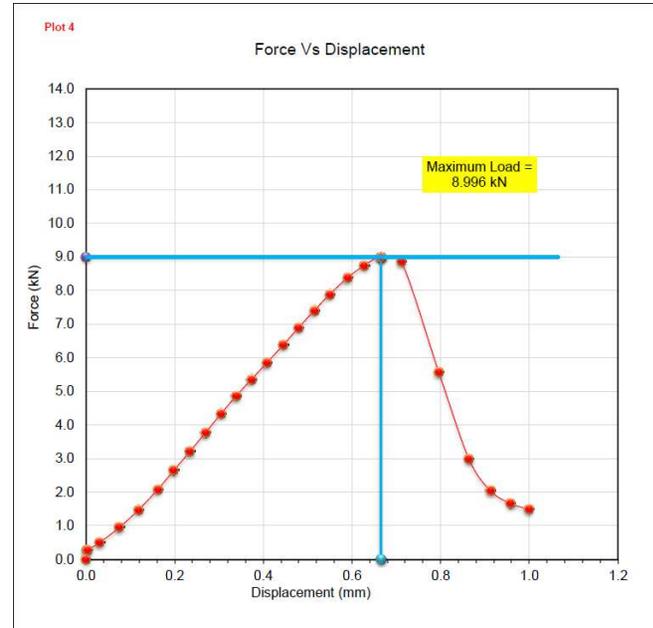
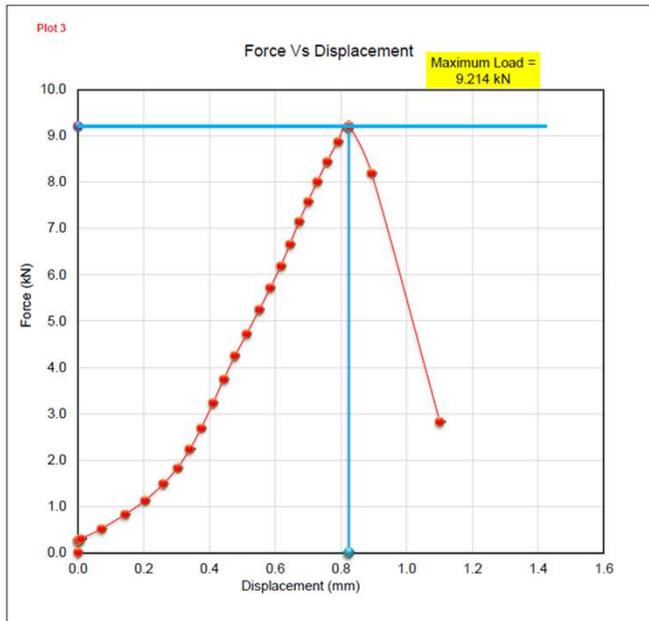
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FRACTURE RESISTANCE





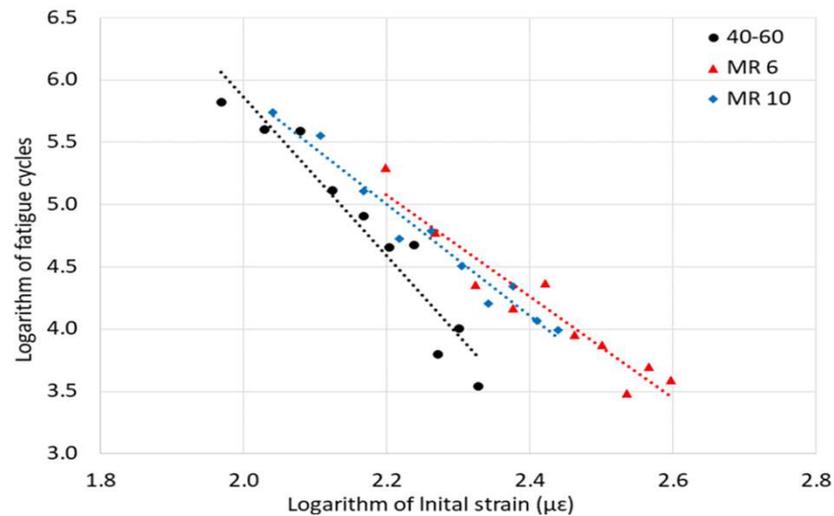
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FATIGUE RESISTANCE



Effect of MacRebur MacRebur MR 6 and MR 10 significantly improve the fatigue resistance of asphalt mixtures compared to unmodified (penetration or viscosity grade) bitumens.



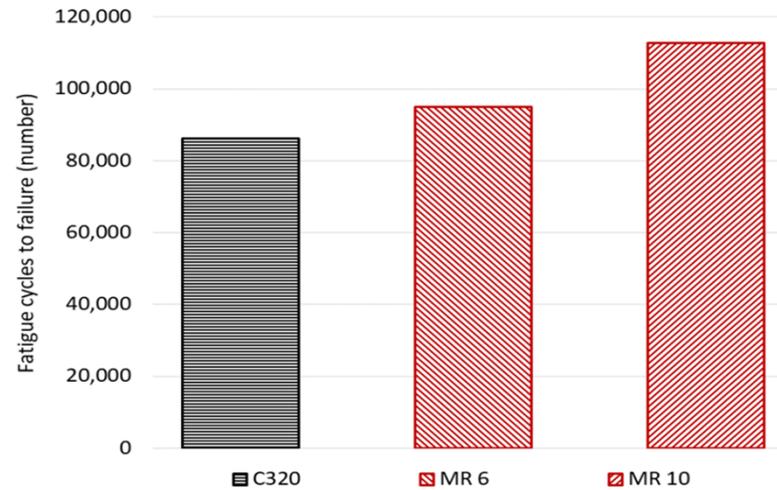
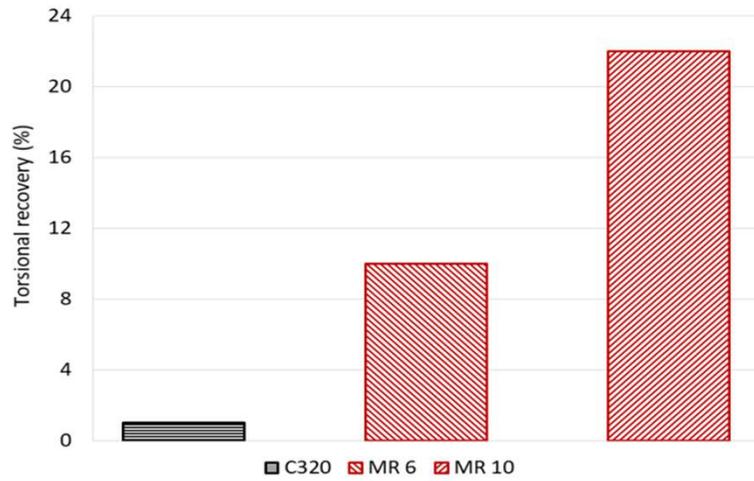
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FRACTURE RESISTANCE





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Fuel Resistance

10mm SMA 65PSV 40/60 SOAKING IN DIESEL (AFTER 32 DAYS)



+ 6% MR6



Control

10mm SMA 65PSV 40/60 SOAKING IN DIESEL (AFTER 8 DAYS)



+ 6% MR6

Control



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Micro-Plastics

This test takes a mixture of our products and unmodified bitumen, saturated in water at 40 degrees.

The decanted solution removed from the sample is then passed through a mass spectrometer. Species are then identifiable.

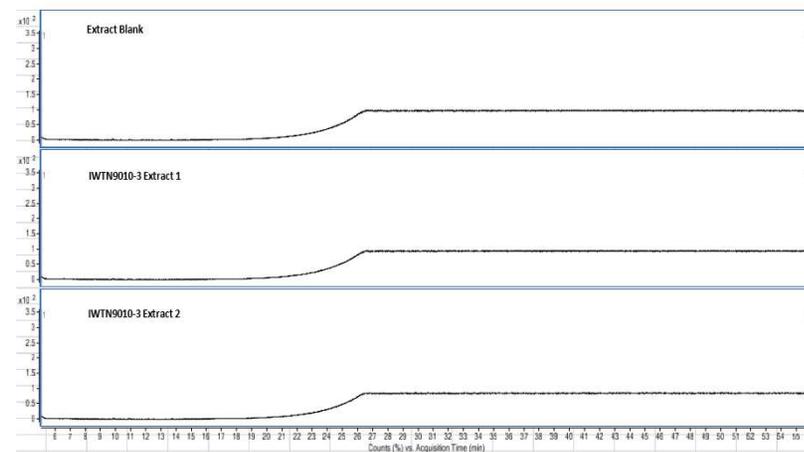


Figure 3: Chromatograms Obtained from Extracts of PEN mrb

Analysis of each of the extracts has not identified any extractable materials. This is the same for all three samples.



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CARBON EMISSIONS

- MacRebur has produced a model that has been validated in conformity with the international standard ISO14064-3
- The initial validated model provides 197kgCO₂e/T of MacRebur product used, however assumes pelletising all products and does not account for some of the carbon savings
- A second assessment is currently underway using more up-to-date data. This will likely illustrate significantly higher savings in the region of 2000-3000kgCO₂e/T



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Meeting Standards & CE Marks

(05/18) Aggregates for Bituminous Mixtures

3 (05/18) Natural, recycled unbound and manufactured (artificial) aggregates shall be clean, hard and durable and shall comply with BS EN 13043:2002 and be CE marked and have a declared performance which demonstrates that the aggregate meets the requirements of the specification. Where recycled coarse aggregate or recycled concrete aggregate is used in bituminous mixtures, it shall have been tested in accordance with Clause 710 and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Reclaimed asphalt shall comply with Clause 902.

4 (05/18) The use of aggregate derived as a by-product during the extraction of china clay is permitted. It shall comply with the requirements of this Clause, BS EN 13043:2002 and the examples of the relevant annex of BSI PD 6691.

5 (05/18) The use of crushed slate aggregate is permitted in base and binder course layers. It shall comply with the requirements of this Clause, BS EN 13043:2002 and the examples of the relevant annex of BSI PD 6691, except for the flakiness category, which shall be subject to prior approval by the Overseeing Organisation. Mixtures of crushed slate aggregate with coarse aggregate of a different geological type shall not be permitted.

CE Mark Certificate	
 1224	
Tynedale Roadstone Ltd, Barton Plant, Barton, Nr Richmond, North Yorks, 11 1224 - CPR - 1069**25	
EN 13108 - 1 AC Asphalt Concrete for roads and other trafficked areas AC Design mix AC 10 OS grt Plastopee+5SPSV Barton PHOENIX plant 1069**25	
General requirements plus empirical requirements	
Grading (passing)	
14mm sieve	100%
10mm sieve	100%
6.3mm sieve	65%
2mm sieve	28%
1mm sieve	20%
63µm sieve	6.5%
Binder Content %	Bmin 4.8 Bact 5.1
Temperature of the mixture	150 to 180°C
Void Content*	
Minimum %	-
Maximum %	-
Stiffness*	
Minimum Mpa	-
Maximum Mpa	-
Resistance to permanent deformation*	
Using Small sized device, procedure B	-
Max Wheel Tracking Slope mm	-
Max Proportional Rut Depth %	-
<small>* Stating test conditions selected in accordance with EN 13108-20 and other standards as applicable.</small>	



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Operations

- SEPA regulates our collection of plastic waste and allows MacRebur to turn this waste into a new product which can then be put back onto the market. Waste Framework Directive repurposing our materials into a product.
- At the end of our asphalts life span it can be reclaimed using Recycled Asphalt Product (RAP). Creating a circular economy, no issues with planing off and reprocessing.



(05/18) **Aggregates for Bituminous Mixtures**

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Monitoring Our Sites





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Starting in 2019 on trial schemes. We are now being used in a huge number of County Durham's roads network with 380 tonnes of Macrebur product used so far, equivalent to carbon saving of 1162.8 tonnes



Following our first use in 2017 we are now led in the £3.2 million LiveLabs funded by the DfT and Adept



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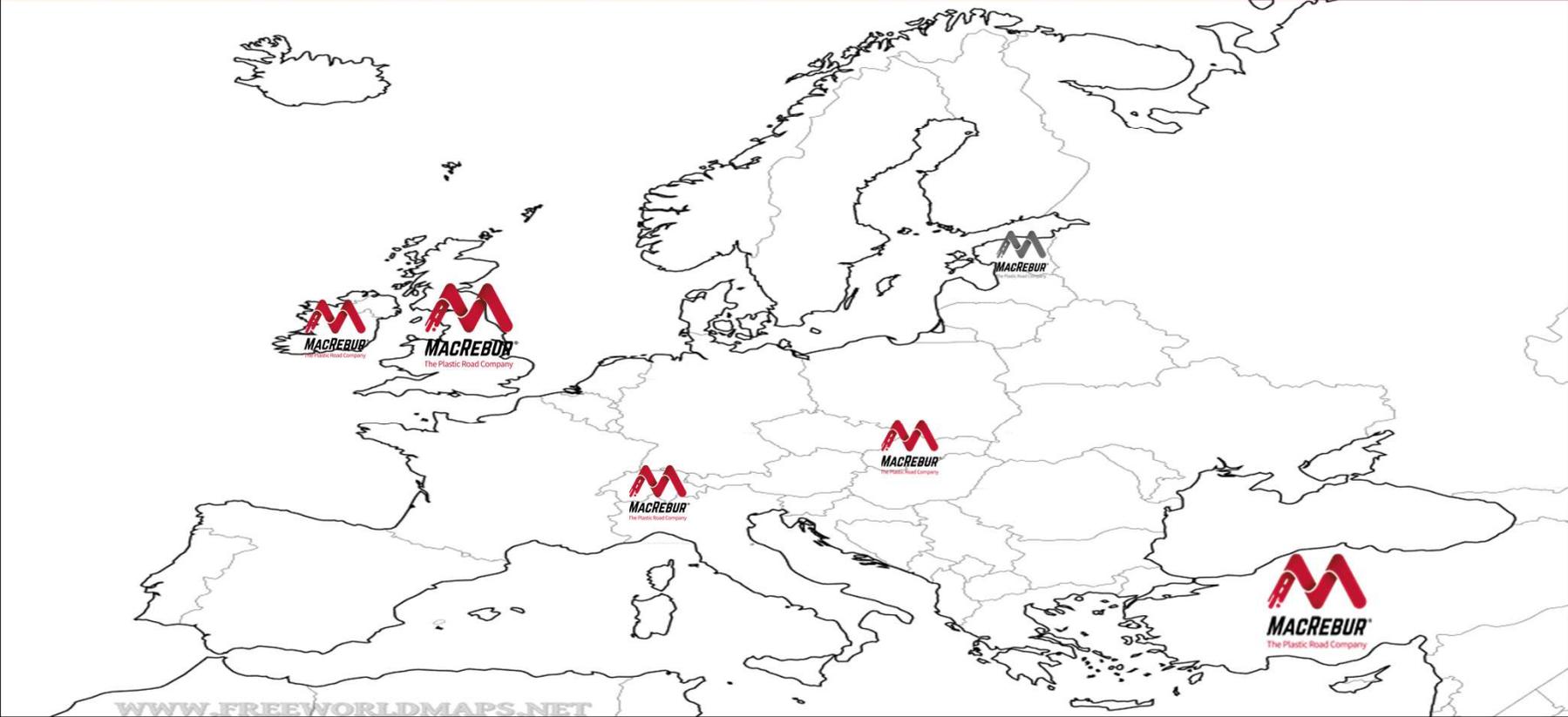
- 20 Local Authorities in the UK
- **600+ sites in the UK mainly in NE England**
- 15 countries outside of the UK



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Zermatt, Switzerland June 2019



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Blank Map With State Boundaries





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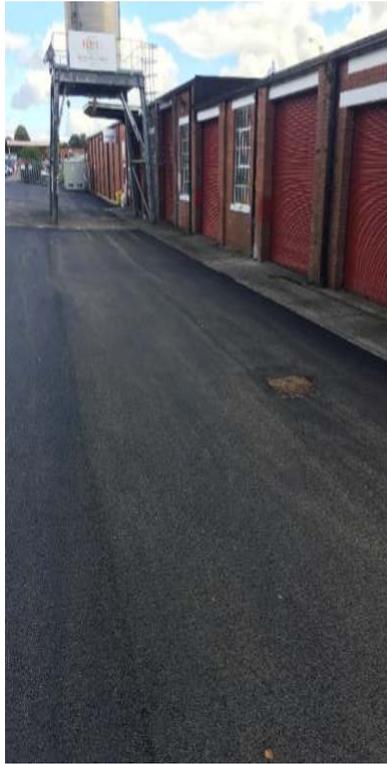
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Private Sector Schemes





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The Richard Branson-backed entrepreneur recycling plastic to rebuild roads globally

Written by Yoana Cnoiteeva on Tuesday, 02 October 2018. Posted in Global

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Meet the innovator who found a way to repair the infrastructure of our roads and the environment with a Richard Branson-approved business idea: MacRebur





STRONGER - GREENER - CHEAPER
GET ON THE PLASTIC RECYCLED MACREBUR ROAD



BE PART OF THE SOLUTION



THANK YOU FOR YOUR TIME





If you are fed up with **potholed roads**, passionate about our **environment** and **recycling**, then **MacRebur®** is the solution for you.

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