

BRIDGING SCIENCE AND ENGINEERING

# POTHOLE

PROPAGATION, PREVENTION, PATCHING

26th September, 2018

Department of Civil and Environmental Engineering  
Brunel University London



This one-day industry focused seminar will address “pothole epidemic”, which has affected the UK over recent years. The Pavement and Ground Engineering Research Group (PAGER) at Brunel University has organised this event to examine recent issues relating to potholes, the advancement in research and development on pothole **propagation** and relevant **patching** technology. This seminar will provide a forum for sharing best practice, and presentation from speakers representing the highway authorities, road users, research community and repair contractors, each giving a wide perspective on the work necessary to eradicate the **problem**.



## PROGRAMME

09:30	Registration and refreshments
10:00	<b>Welcome and Introduction-</b> Mr Alan Ferguson, President, IAT
10.05	<b>Keynote address-</b> Mr Matthew Lugg OBE, President, CIHT
10:20	<b>Road deterioration</b> – Prof Alan Woodside, Brunel University
10:35	<b>Pothole frustration</b> – Mr Jack Cousens, Head of Roads Policy, AA
11:00	<b>Pothole funding-</b> George Lee, CEO, HTMA
11:25	Refreshment break
11:55	<b>Local authority experience-</b> Mr Mark Stevens, Assistant Director Operational Highways, Suffolk Highways
12:20	<b>Pothole formation: tyre-water- pavement interaction–</b> Dr Mujib Rahman, Brunel University
12:45	Discussion
13:15	Lunch and Networking
14:30	<b>Science of durable asphalt patch repair</b> – Professor Denis Chamberlain, Brunel University.
15:00	<b>Innovative repair material- Armaphalt</b> , Mr Hayden Davie, Jobling Purser
15.15	<b>Innovative repair material – Chip fill-</b> Mr Andrew Price, Preformed Markings Ltd.
15.25	<b>Road mole circular repair</b> – Mr Doug Jackson, Road Mole
15:35	<b>Discussion</b>
16:00	Close

## REGISTRATION

**Registration fees:** ICE/CIHT/IAT member: **£135.00**, Non-member: **£150.00**, 2+ delegates: **£100 each**, **Exhibition: £200**

**Booking:** <https://webapps.brunel.ac.uk/apps/event/UI/pages/online-payment.aspx?sysSection=3&event=sDJBBLyuZwk=>

**Contact:** [Mujib.rahman@brunel.ac.uk](mailto:Mujib.rahman@brunel.ac.uk), 07894339752

**Location:** Darwin, Hamilton Centre, Brunel University London

**Direction:** By car: Sat Nav UB8 3PH, By Bus: U3, U1, U4 and U7 (Uxbridge underground station), U3, U1, 222 ( West Drayton railway station) , U3, U2 (Heathrow airport) (**upon arrival please report at main reception for free on-campus parking**)



[www.instituteofasphalt.org](http://www.instituteofasphalt.org)





# **POTHOLE**

**Propagation, Prevention, Patching**

**Keynote Address**

**Matthew Lugg OBE**

**CIHT President**



# What I'll Cover

- **Information about CIHT**
- **My presidential theme Highway**
- **HMEP**
- **Incentivised Funding Self-Assessment**
- **Adopting a risk based approach**
- **The current funding crisis**
- **The Lugg Review**





# About Us - Who we Represent

- All modes of transport
- Public & private sectors
- Members from students to Chief Executives
- A Network of over 14,000 members
- 12 UK Regions & Nations
- Over 85 Countries
- Over 100 Corporate Partners



# About Us - Stakeholders

**CIHT Members** – Regions, Panels, Boards and CIHT Council

Employers – Consultants, Contractors, Government, Academia

CIHT Corporate Partners

Engineering Council

Society of Road Safety Auditors (SoRSA)

Motorway Archive Trust

Highways Term Maintenance Association (HTMA)

CIHT act as Secretariat for:

- UK Roads Liaison Group (UKRLG)
- World Road Association (WRA)

Other Professional Institutions



UK ROADS LIAISON GROUP



# Professional Qualifications

## Engineering

- Chartered Engineer – [ciht.org.uk/CEng](https://ciht.org.uk/CEng)
- Incorporated Engineer – [ciht.org.uk/IEng](https://ciht.org.uk/IEng)
- Engineering Technician – [ciht.org.uk/EngTech](https://ciht.org.uk/EngTech)

## Transport Planning

- Transport Planning Professional – [ciht.org.uk/TPP](https://ciht.org.uk/TPP)

## Road Safety Auditing

- Certificate of Competency (*Society of Road Safety Auditors*) – [ciht.org.uk/SoRSA](https://ciht.org.uk/SoRSA)

Chartered  
Engineer  
(CEng)

Incorporated  
Engineer  
(IEng)

Engineering  
Technician  
(EngTech)

Transport  
Planning  
Professional  
(TPP)



# Presidential Theme 2018/19-

## Delivering better services for people

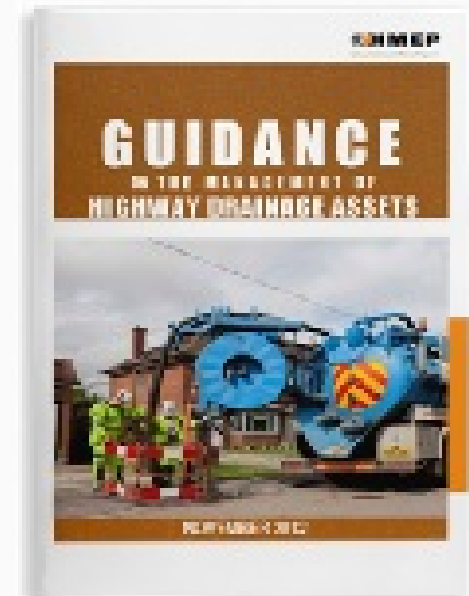
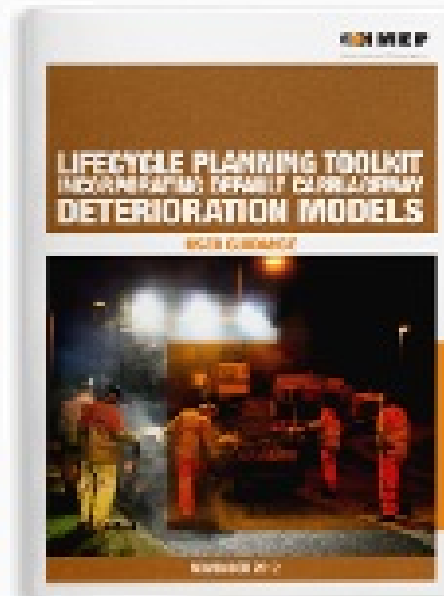
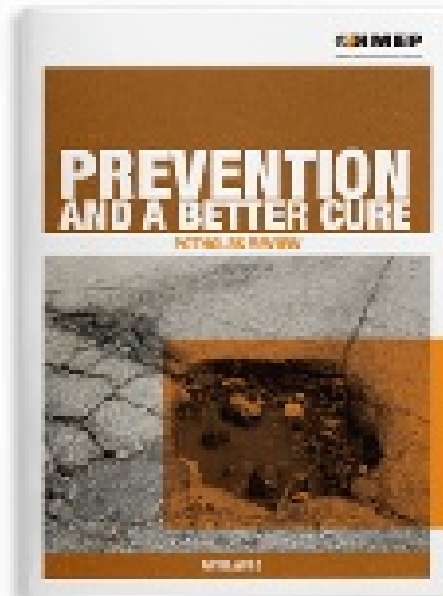
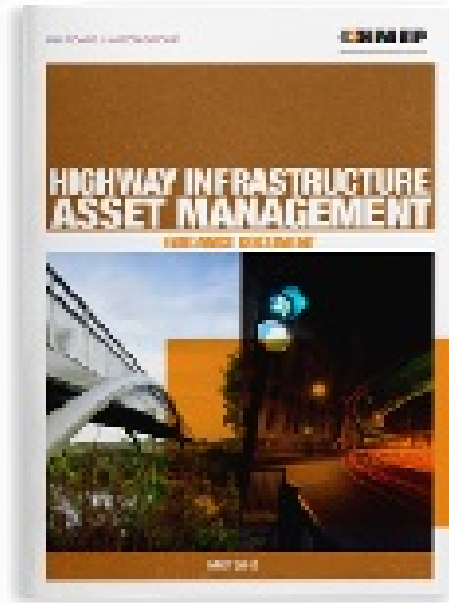
- My whole career both in the public and private sector and focussed on delivering infrastructure and services to local communities
- I recognised the importance of consultation, engagement, communication and listening to help deliver better outcomes
- In the DfT Self Assessment process it was my idea to add the 3 customer focused questions on public satisfaction, communication and customer feedback
- Links to CIHT's first research programme developed following Learned Society Board themes





# Asset Management

**A whole life, asset management approach to road maintenance can provide long term value and efficiency gains.**



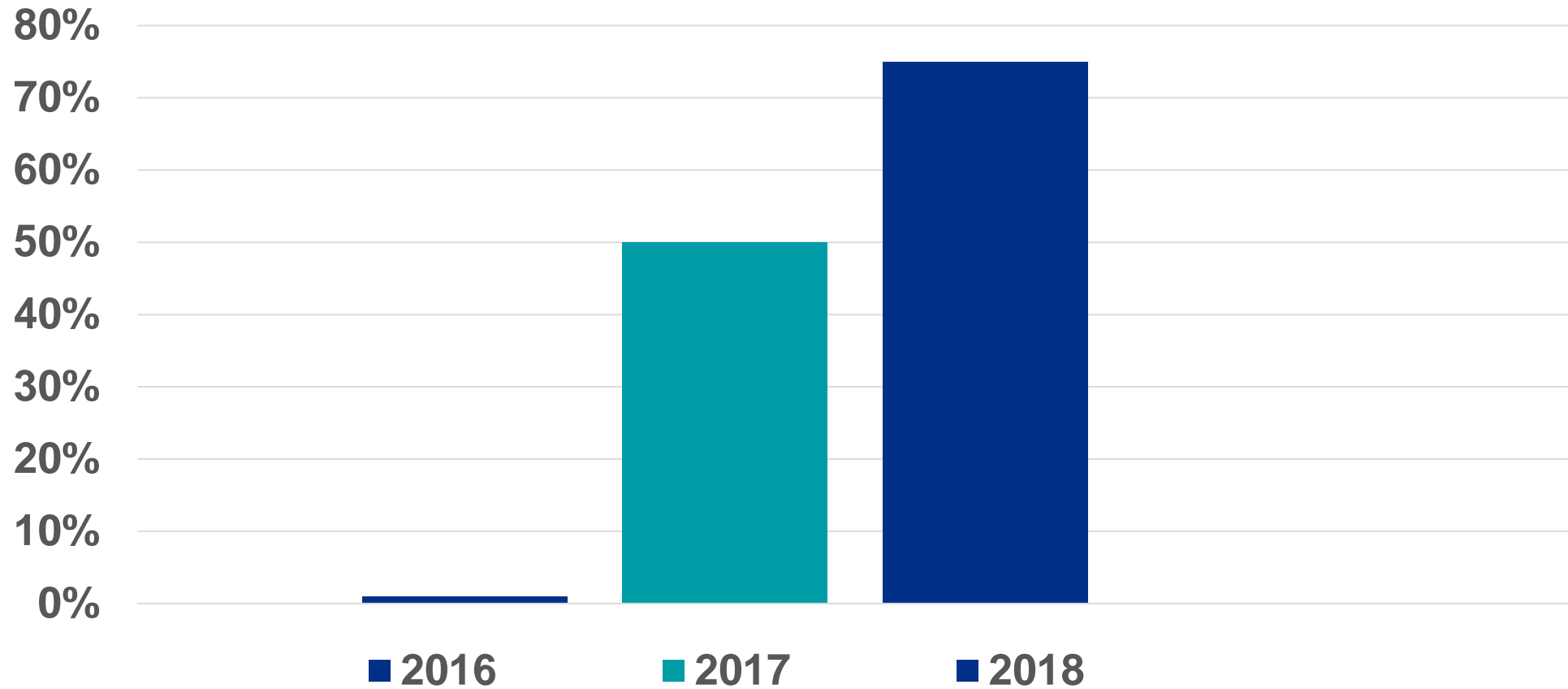
# Incentivised Funding

- Between 2016 – 2021, UK Government will make £6 billion of capital funding available for local highways maintenance
- £578 million of this amount has been set aside to incentivise local authorities to carry out cost effective improvements





# Percentage of Local Highway Authorities that have achieved Band 3 Status



# Adopting a Risk Based



UK ROADS LIAISON GROUP

**WELL-MANAGED HIGHWAY INFRASTRUCTURE:  
A CODE OF PRACTICE**





# Funding Crisis

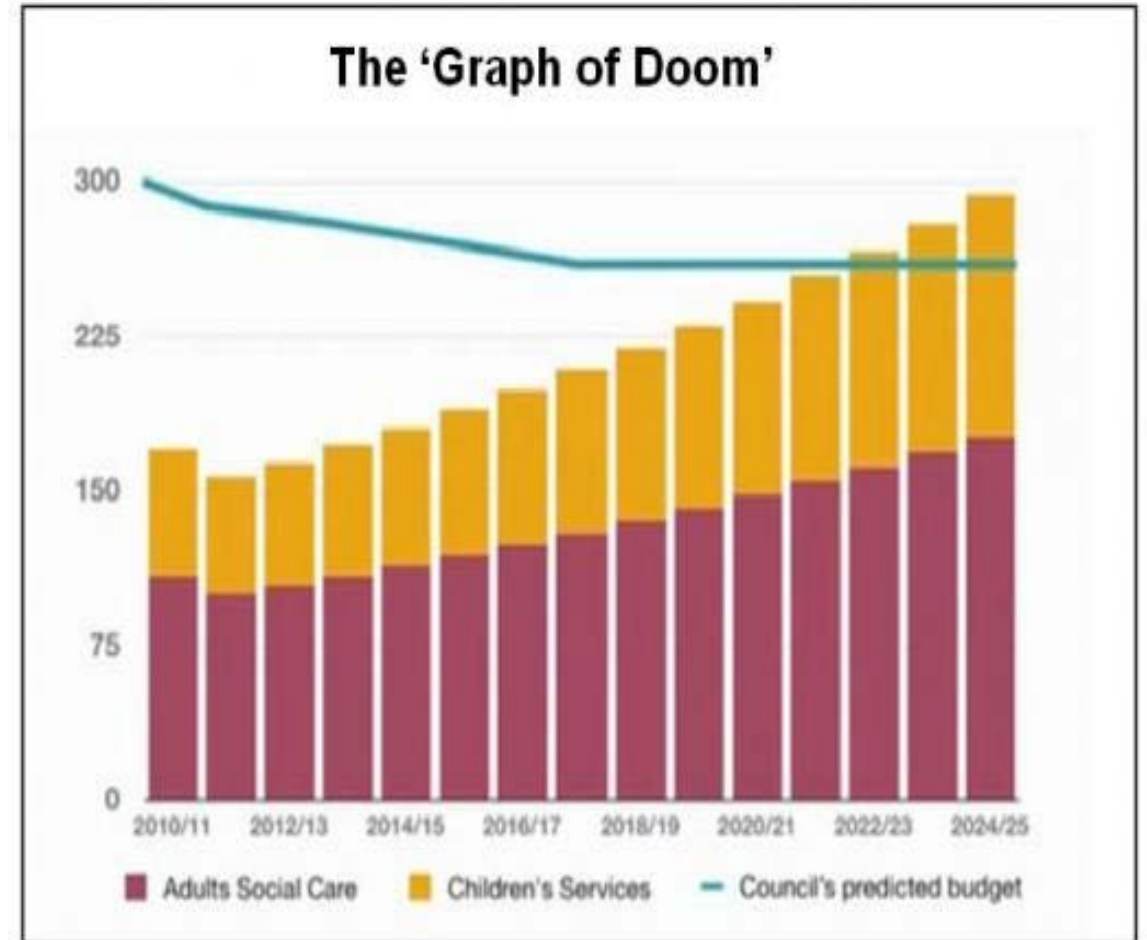
## Revenue poor

Ongoing austerity -

‘Bankrupt’ Northamptonshire county council may cut to legal minimum

## Capital rich

Government investment in infrastructure and housing to support economic growth



# CIHT Lugg review of local authority highway infrastructure

- What is the condition of local highway infrastructure in England?
- What are the economic and social costs of not maintaining local highway infrastructure?
- Does the current approach to the governance, management and funding of local highway infrastructure need to be improved?
- What are the funding requirements of local highway infrastructure and are current funding streams suitable for the future?
- Is there a role for alternative models for local highway infrastructure maintenance and investment?



# 10 Reasons to be a Member

1. Qualifications
2. Industry Recognition
3. Local Regional Support
4. Continuing Professional Development (CPD)
5. Networking community – technical & social events
6. Transport Professional – Members' Magazine
7. Members only on-line area – My CIHT
8. Best Practice & Technical Excellence
9. A voice for the profession
10. Represent CIHT

Find out more: [ciht.org.uk/WhyJoin](https://ciht.org.uk/WhyJoin)

The graphic is a vertical layout. At the top right is the CIHT logo and website. Below it is a large blue box with the text 'Reach out Connect Join' in white. To the left of this box is a list of 10 reasons to join CIHT, each with a small icon. The list includes: 1. Qualifications, 2. Industry Recognition, 3. Local Branch Support, 4. Continuing Professional Development (CPD), 5. Community with 12,000 members, 6. Transport Professional, 7. Members' Magazine, 8. Best Practice & Technical Excellence, 9. A voice for the profession, and 10. Represent CIHT. At the bottom right is a small box with the text 'Membership of the Chartered Institution of Highways & Transportation' and a link to 'inside | benefits | options | criteria'.

CIHT  
ciht.org.uk

Reach out  
Connect  
Join

CIHT is dedicated to benefiting you and society. Join us and drive your career forward at the same time.

Membership of the Chartered Institution of Highways & Transportation

inside | benefits | options | criteria

10 reasons to join CIHT

1. Qualifications – Gain access to high status qualifications such as Chartered Engineer, Incorporated Engineer, Engineering Technician and the Transport Planning Professional qualification.

2. Industry Recognition – Members receive post-nominal letters to recognise their professional knowledge and experience according to their membership grade: Fellow (FCIHT), Member (MCIHT), Associate Member (AMCIHT) or Graduate Member (GRADCIHT).

3. Local Branch Support – The CIHT branch network extends across the UK and overseas. Branches put on a range of technical and social events providing CPD and valuable networking opportunities for members to meet and exchange ideas and information.

4. Continuing Professional Development (CPD) – Through a structured programme of frequent seminars, branch meetings, workshops and other activities, CIHT members continually receive guidance and support towards fulfilling personal career objectives. CPD is a core part of CIHT's ethos and ensures members are kept up to date with all important new developments affecting the rapidly evolving transportation industry.

5. Community with 12,000 members – Events such as technical seminars and the Annual Lunch provide you with opportunity to network with like-minded professionals, which can lead to business development and career moves. Online social media is key too – CIHT is active on LinkedIn and Twitter and members are encouraged to share ideas and develop new connections as often and as effectively as possible.

Continue reading page 14



**Thank you and any  
questions?**



# Road Deterioration

**Professor A.R. Woodside OBE**  
MPhil, CEng, FICE, FIEI, FCIHT, FIAT  
Brunel University

# Introduction



# Faults

- **F** ailure in design
- **A** lteration in specification
- **U** nforeseen circumstances
- **L** imited sampling
- **T**'s ignored
- **S** lackness in supervision



# Failures in bituminous surfacings

- **D**isintegration
- **I**nstability
- **F**racture / fatigue
- **S**kidding resistance loss



**D**isintegration

# Disintegration





# Disintegration





# Disintegration





# Disintegration





# Disintegration



# Disintegration

- Ravelling
- Pitting
- Spalling
- Pot-holing
- Stripping

# Disintegration

- Minimised by high binder contents which thoroughly bind the particles and reduce the rate of weathering of the binder films
- **but** stability may be reduced

# Instability

# Instability





# Instability



# Instability







# Instability





# Instability



# Instability





# Instability





# Rutting Problems



# Instability

- Rutting
- Shoving
- Corrugation
- Deformation
- Flowing

# Highway problems - Java





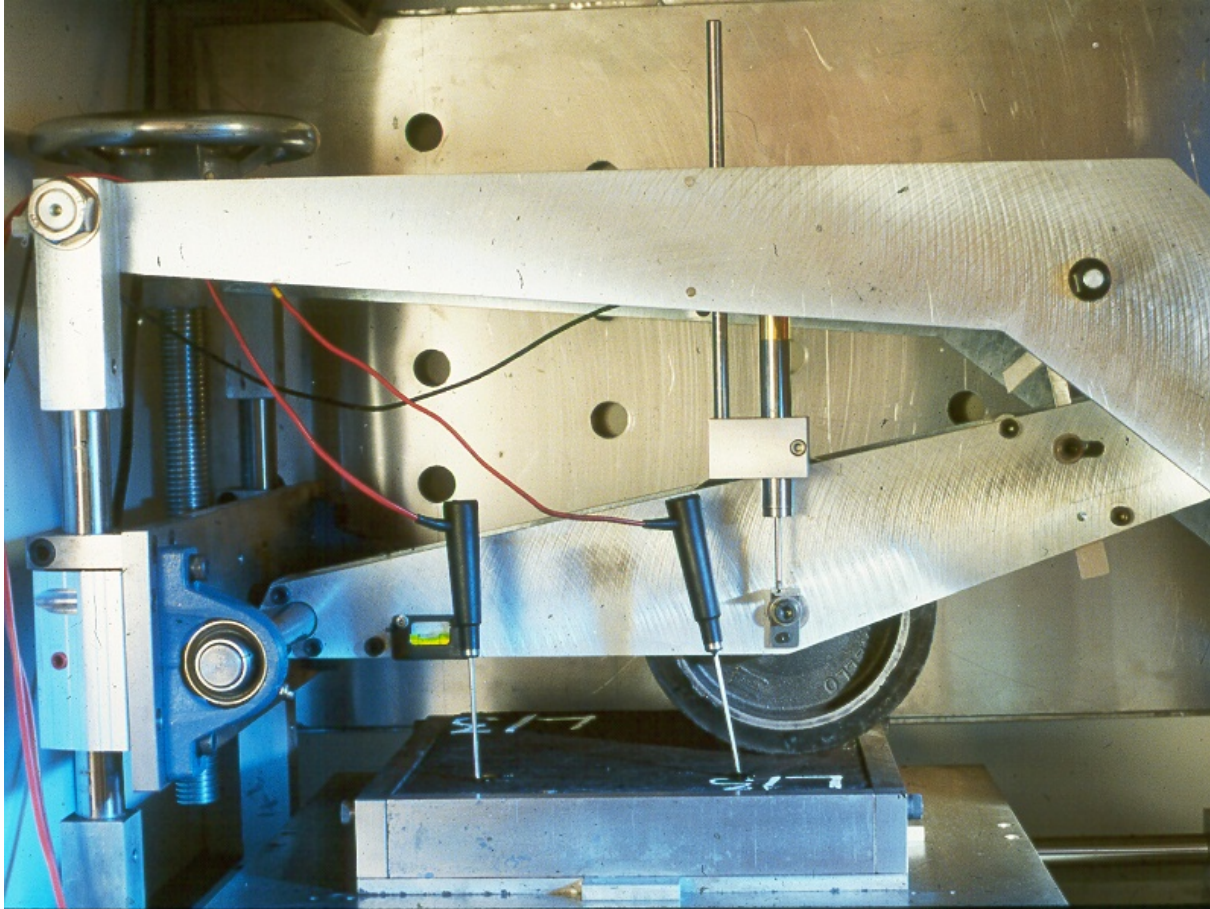
# Stability

- Depends on:
  - Inter-particle friction
  - Binder flow characteristics

# Wheel track samples



# Dry wheel tracking





# Fracture

# Fracture / fatigue

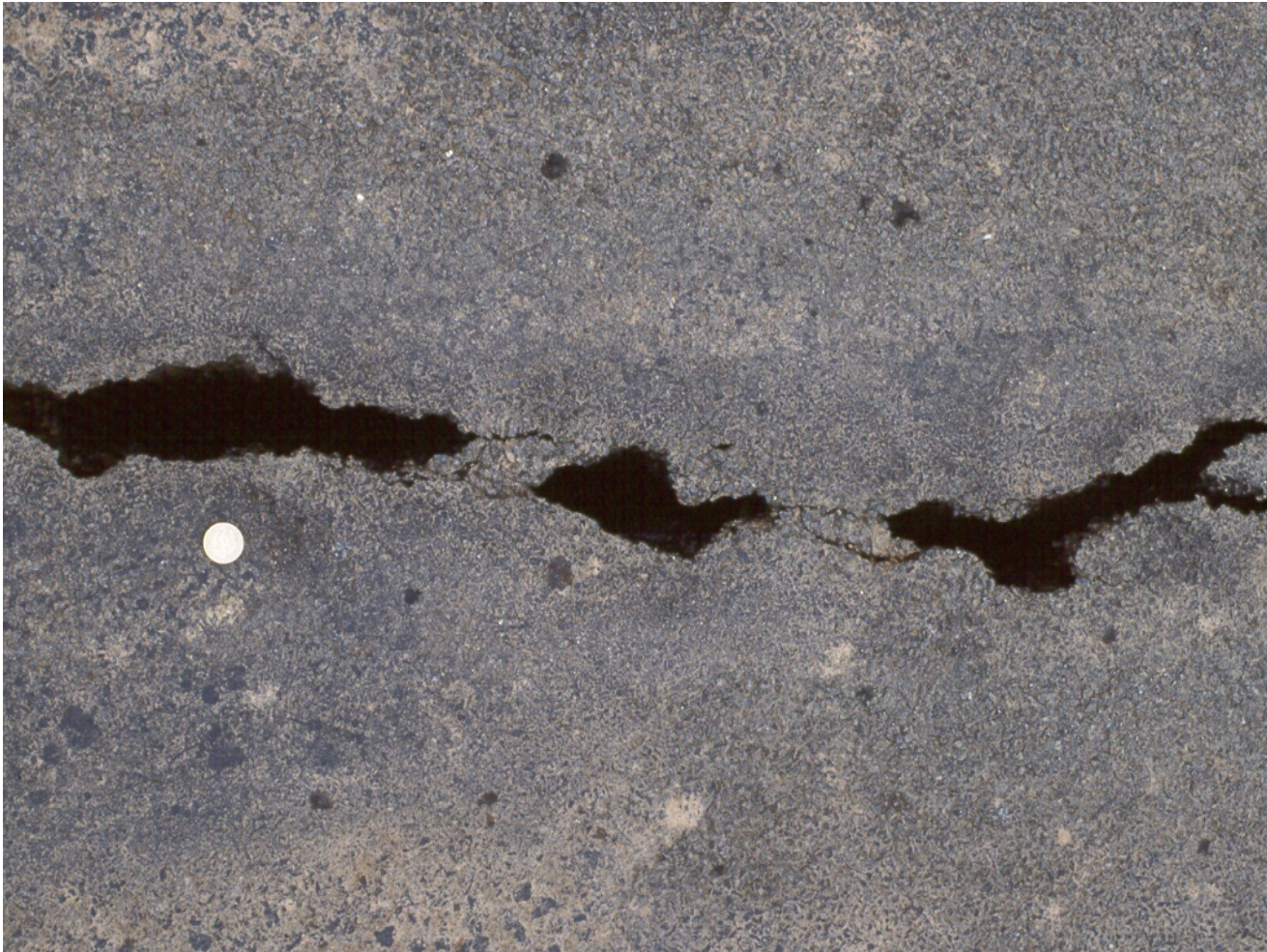
- The resistance of road materials to cracking as a result of repeated loads

# Fracture / fatigue





# Fracture / fatigue



# Highway problems - Canada



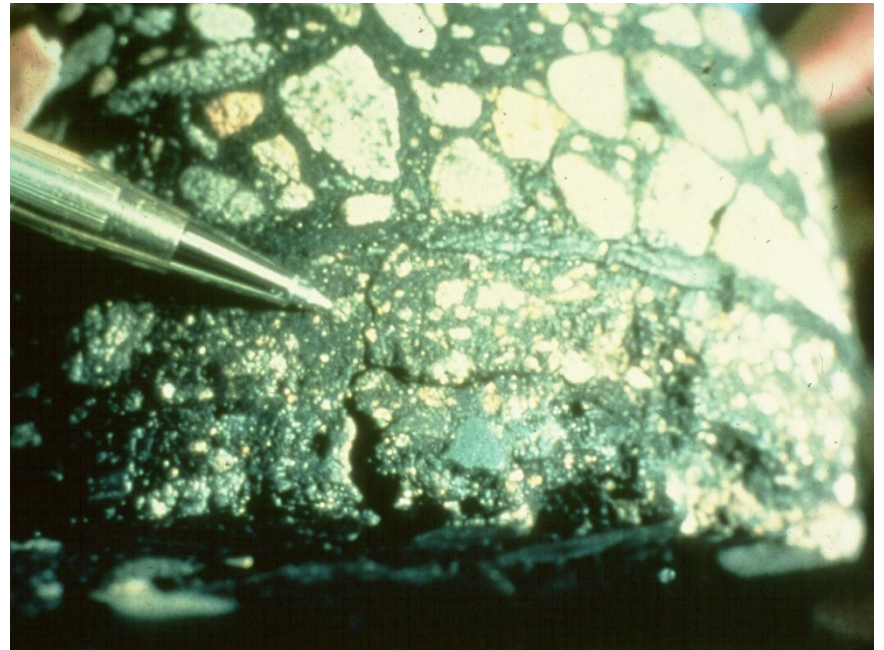
# Fracture / fatigue

- “Crocodile” cracking
- “Chicken-wire”  
cracking





# Use of fabrics to limit reflective cracking





# Fracture / fatigue





# Two main causes of cracking

- Traffic induced stressing
- Thermal stressing

# Fracture / fatigue



**S** kidding resistance loss



# Polishing



# S kidding resistance loss





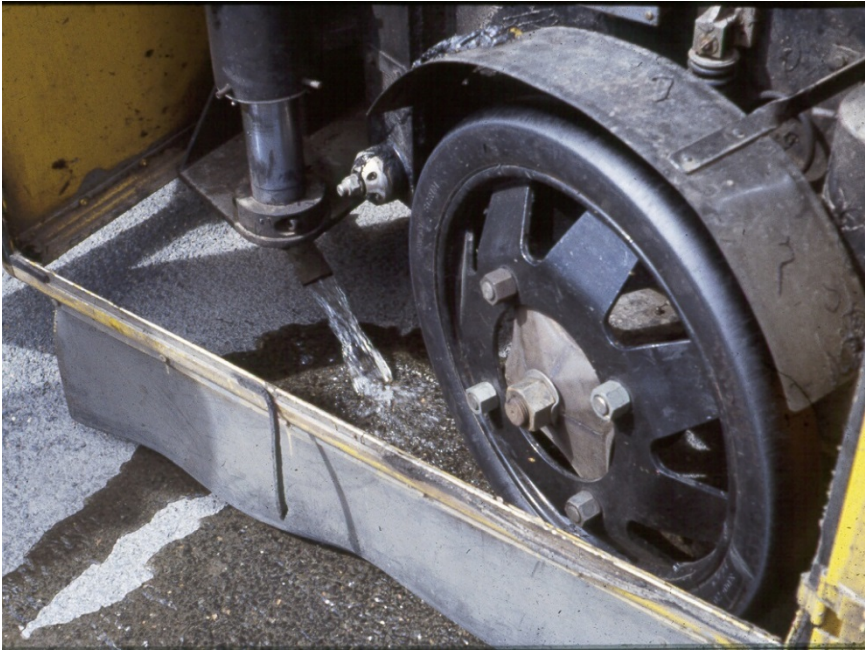
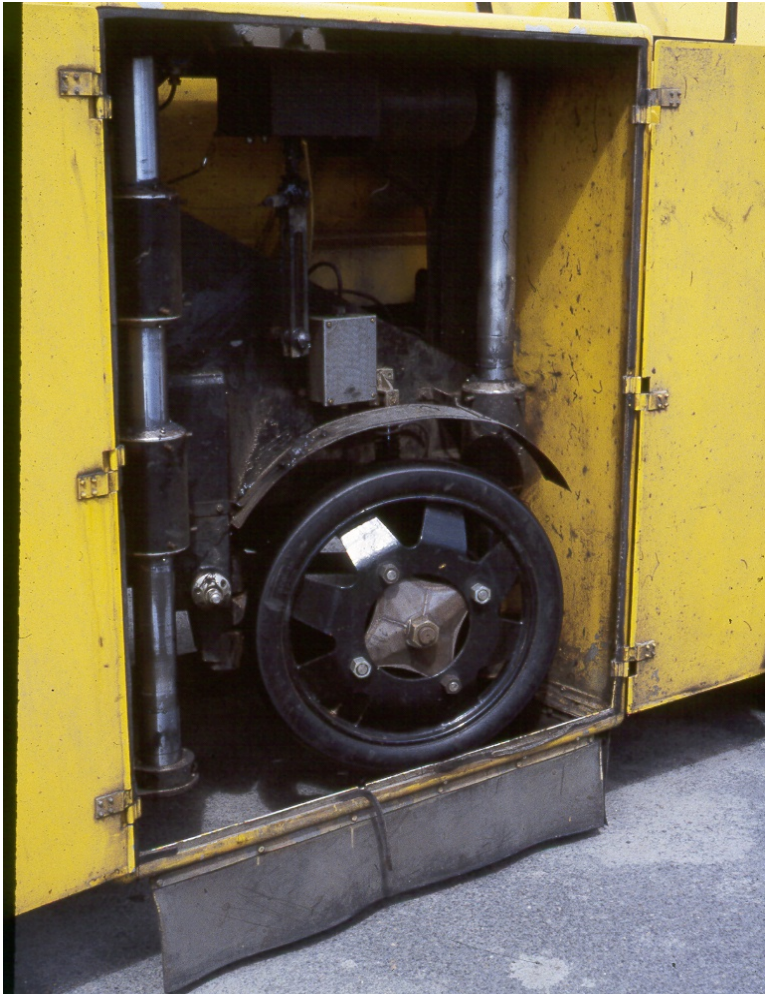
# S kidding resistance loss





# S kidding resistance loss











# Failures in bituminous surfacings

- **D**isintegration
- **I**nstability
- **F**racture / fatigue
- **S**kidding resistance loss

# Two main Questions

Q 1. What Factors cause “Potholes”?

or

What recent changes have “encouraged”  
the growth of Potholes?

Q 2. What can we do to “inhibit” potholes?

# Question 1

Q 1. What Factors cause “Potholes”?

or

What recent changes have “encouraged” the growth of Potholes?

**Traffic** – Armitage Report, 40Tonnes, Super singles

**Water** – Crossfall / Camber 1 in 40

**Low temperatures** – climate change

**De-icing salts** – Na SO<sub>4</sub>

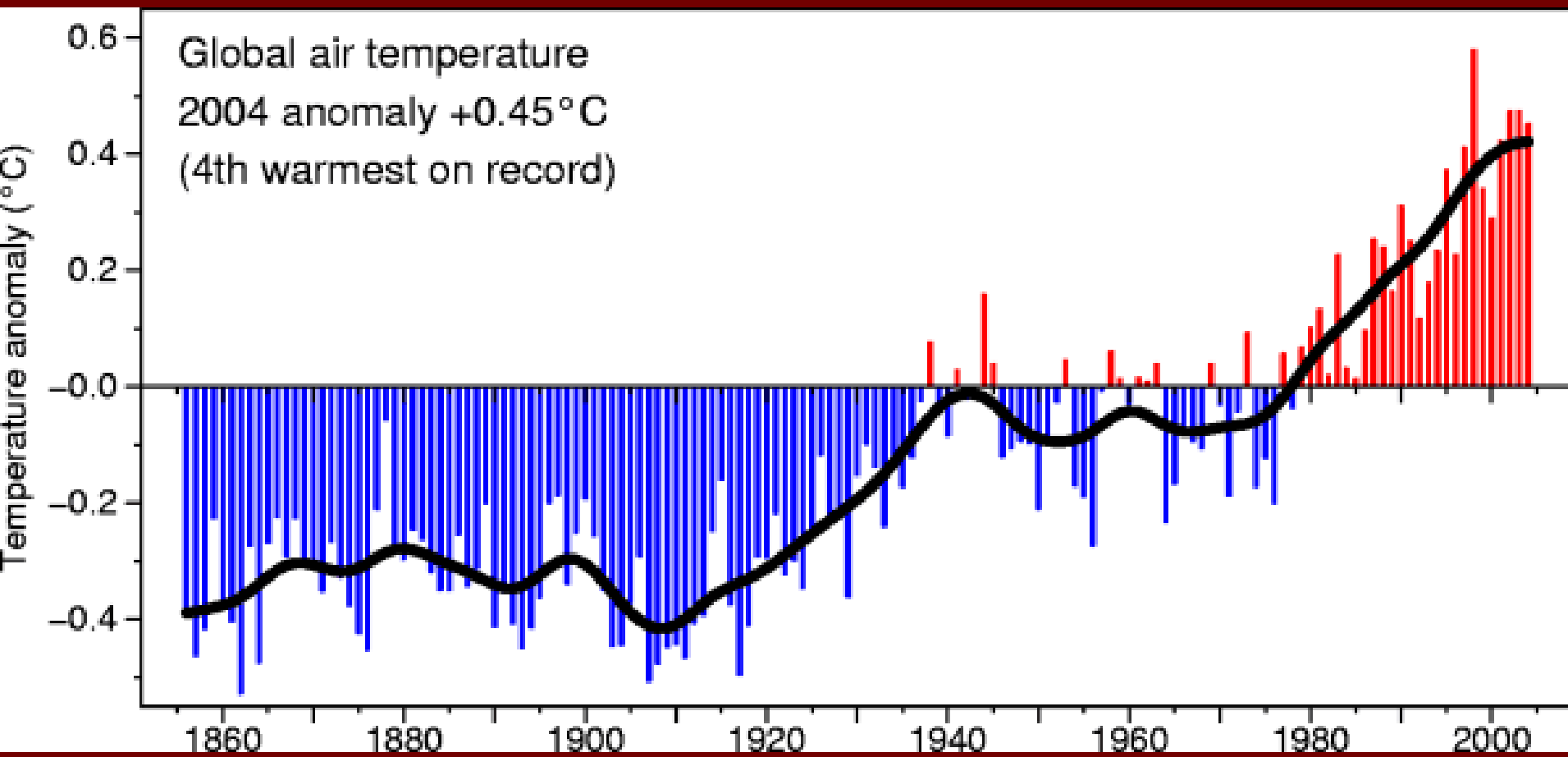
**Poor materials** – Binder / aggregate bond

**Bad Workmanship** – lack of compaction





# Trends!

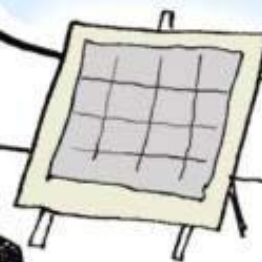




# CLIMATE SUMMIT

WHAT IF IT'S  
A BIG HOAX AND  
WE CREATE A BETTER  
WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- etc. etc.



YOL  
PITT  
12/7/9 USA TODAY















SPRAY – decrease visibility increase risk of collisions.

Can be reduced by adequate drainage / porous materials



TOP  
★ 5 ★

## FEARED NATURAL DISASTERS:

39.4%

Tornado/Hurricane

36%

Earthquakes

34%

Floods

34%

Pandemic or Major  
Economic

32%

Power Outage

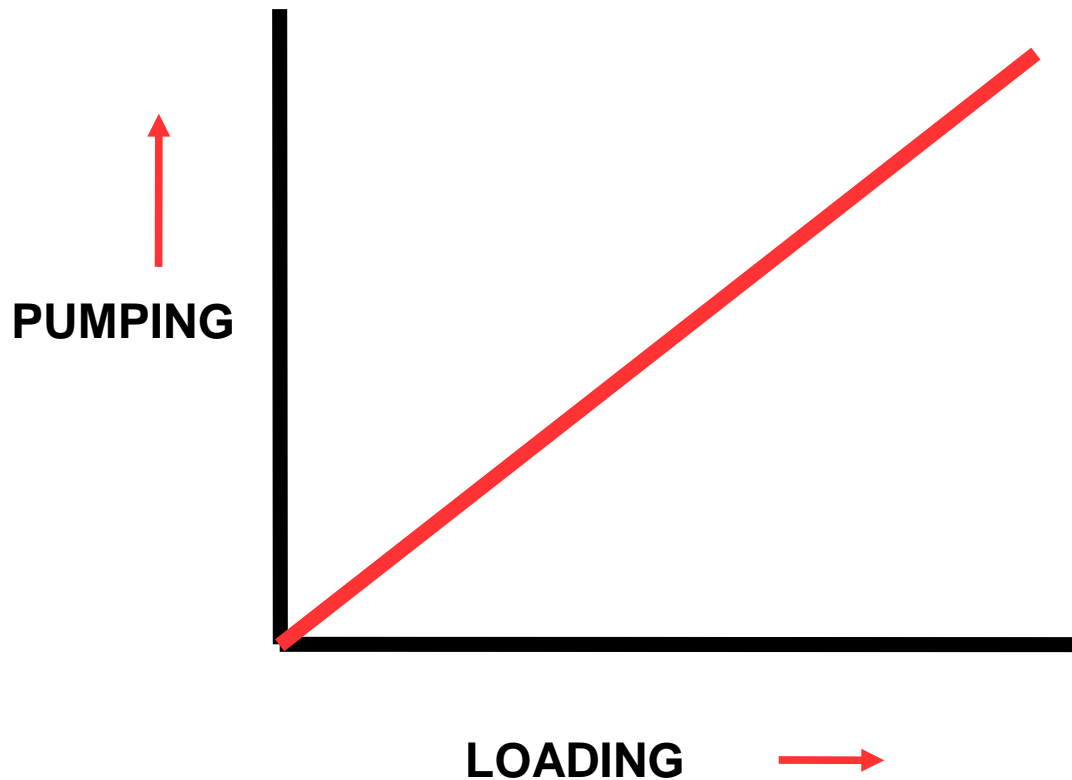


CHAPMAN UNIVERSITY

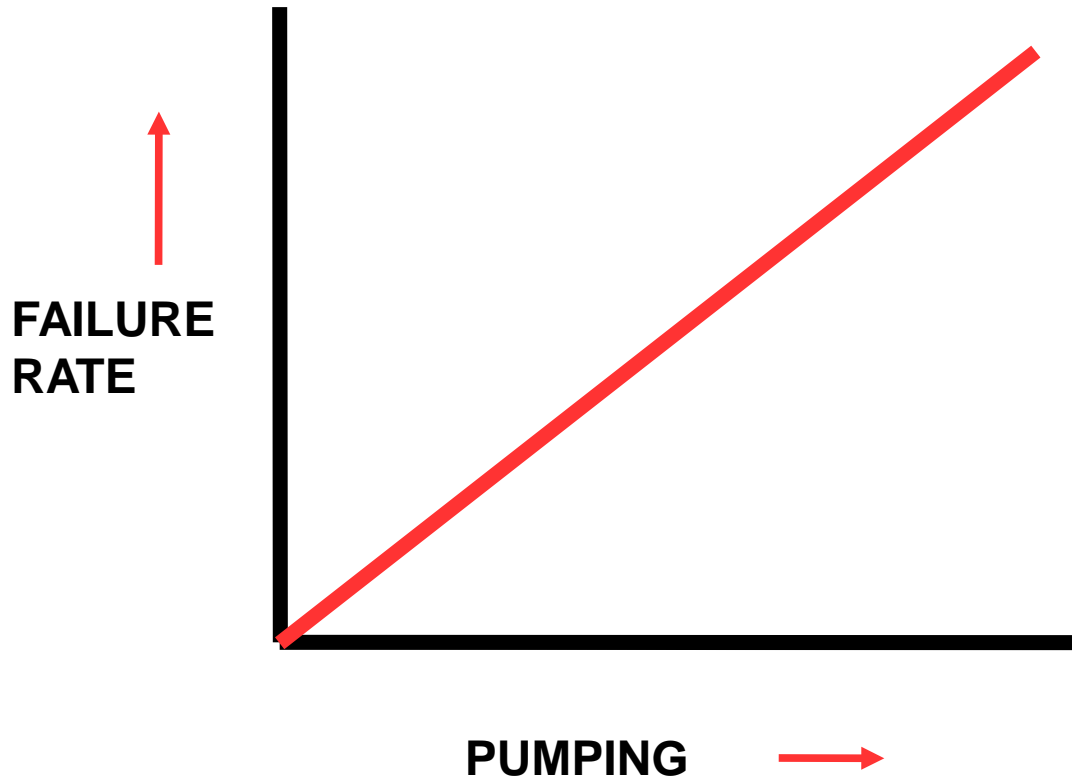
Orange, California



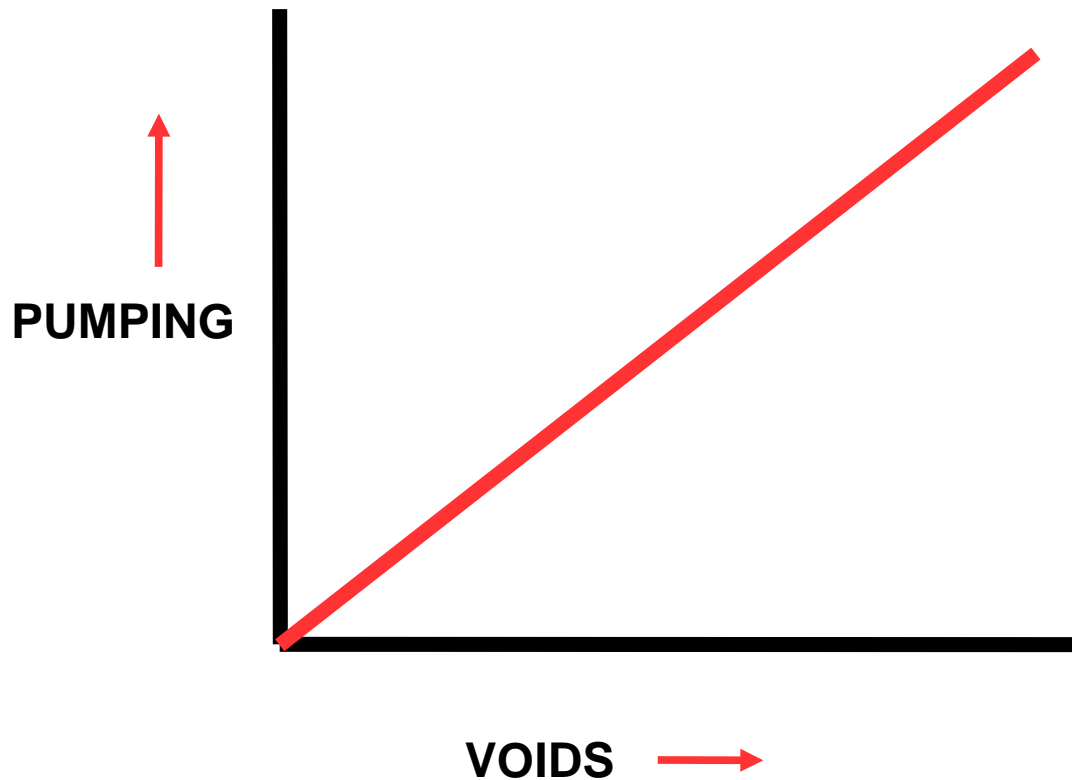
# Pumping v Loading



# Failure Rate v Pumping

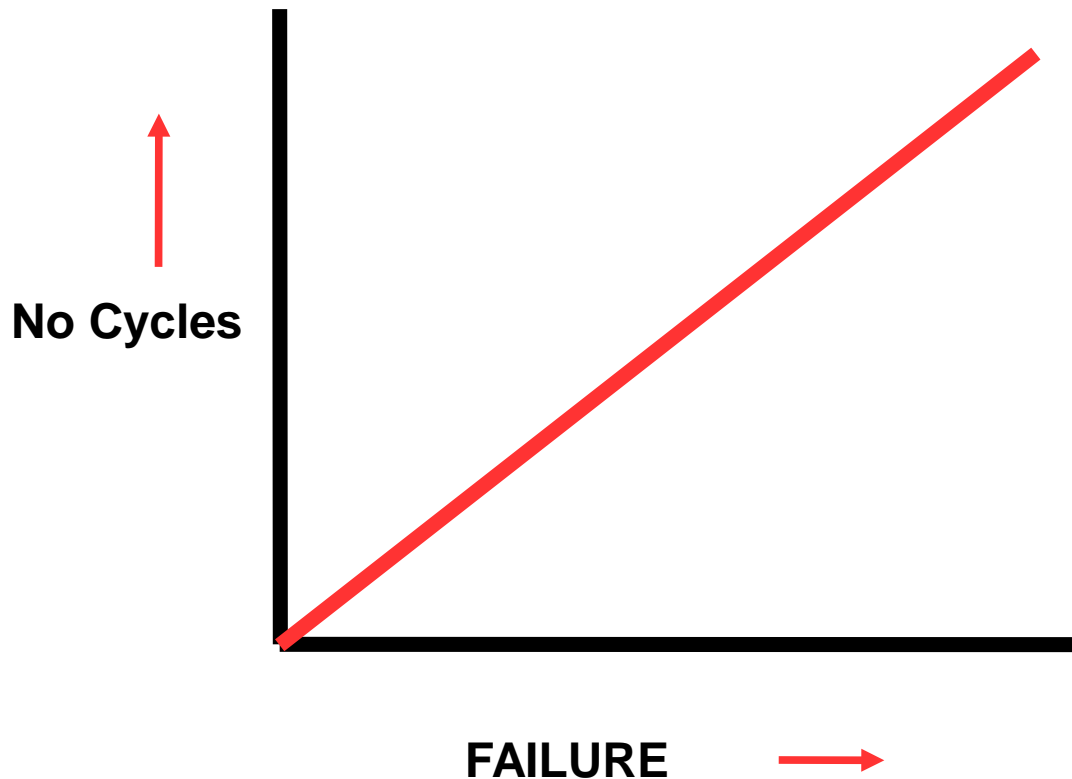


# Pumping v Voids

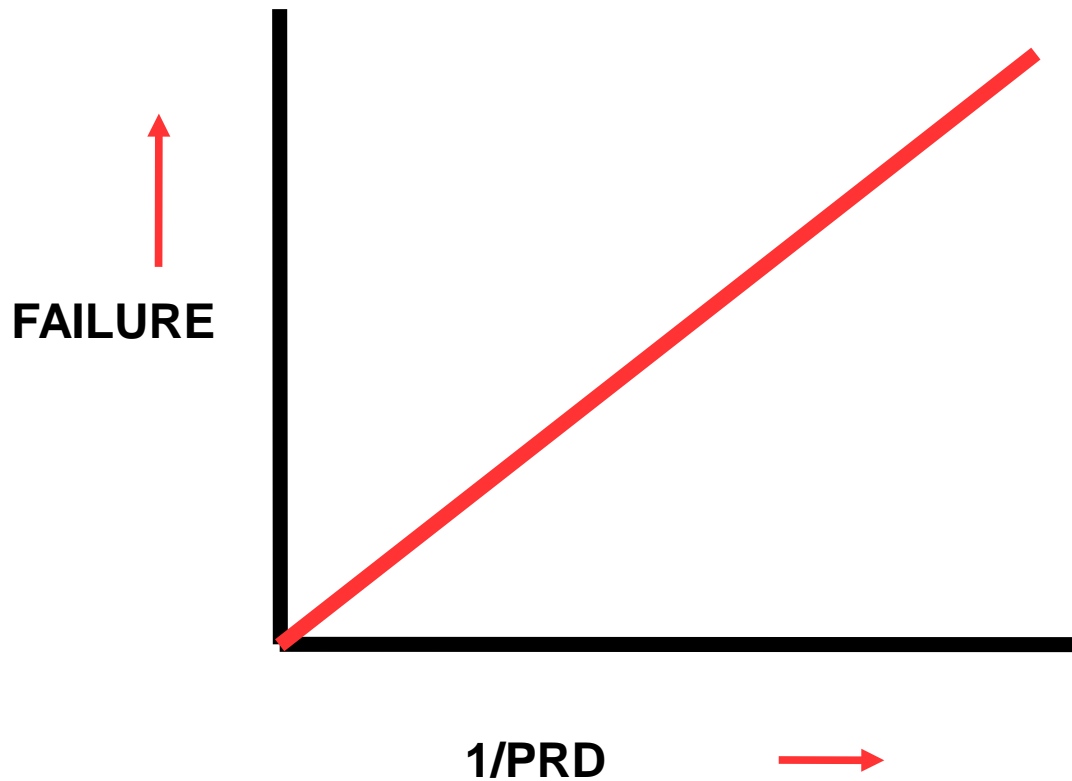




# Number of Cycles (temperature) v Failure



# Failure v PRD



# **Question 2 What steps to “inhibit” growth of Potholes**

- Remove / decrease traffic
- Remove water
- Reduce de-icing salts
- Enhance material performance
- Improve design
- Rapid response



# Question 2 What steps to “inhibit” growth of Potholes

- Remove / decrease traffic
- Remove water
- Warmer climate
- Reduce de-icing salts
- Enhance material performance
- Improve design
- Rapid response





**THE END - Thank you for listening**





# **POTHOLE FRUSTRATION: IMPACT OF POOR ROADS ON DRIVERS AND INSURERS**

Brunel University London  
September 2018

Jack Cousens  
Head of roads policy



# POTHOLE FRUSTRATION: IMPACT OF POOR ROADS ON DRIVERS AND INSURERS

## What we will discuss

- ▶ Headline facts
- ▶ What do drivers think?
- ▶ Impact on insurers
- ▶ AA action & Parliamentary inaction (until now)
- ▶ What happens next?



# Headline facts



# HEADLINE FACTS

## Potholes are not a new phenomenon

- 2011 was the last serious pothole year



# HEADLINE FACTS

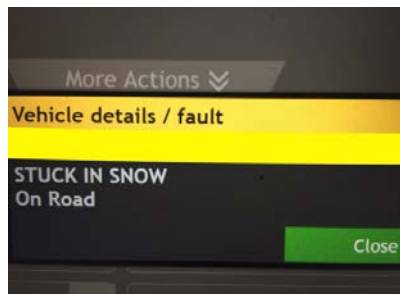
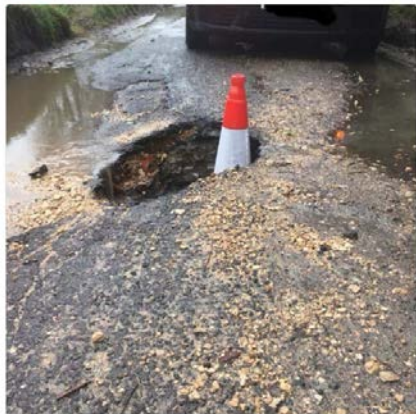
## Potholes are not a new phenomenon

2011 was the last serious pothole year

### 'Beast from the East'

- Dealt harsh blow to UK roads
- Sharp rise in calls for roadside assistance
- Sharp increase in insurance claims

**AA** TheAA\_Patrol @TheAA\_Patrol · Mar 12  
WOW check out this pothole in my home village! #Pothole #Danger #Hole  
#DarrenFail #NoTapeMeasureNeeded #RoadCone #RoadSafety #Pewsey  
#AAAdrian



# HEADLINE FACTS

## Potholes are not a new phenomenon

- ▶ 2011 was the last serious pothole year

- ▶ 'Beast from the East'

- ▶ **Years of under-funding on UK roads**

According to the Asphalt Alliance ALARM report (March 2018) for year 2017/8

- ▶ 1 in 5 roads in UK 'structurally poor' – "We can only afford to keep icing the cake but the cake is crumbling and needs to be remade"

- ▶ £556m annual maintenance shortfall - **£9.3bn\*** one off / 14 years to restore UK roads

- ▶ £7.3 million paid out in compensation last year by local authorities



# HEADLINE FACTS

## Potholes are not a new phenomenon

- ▶ 2011 was the last serious pothole year
- ▶ 'Beast from the East'
- ▶ Years of under-funding on UK roads
- ▶ **Government £100 million pothole fund (March)**
  - In May, Grayling admits '*...not enough spent on the country's roads since the 1980s...*'
  - Councils cash-strapped and have to prioritise
  - AA calls for a **£1 billion** emergency fund



# HEADLINE FACTS

## Potholes are not a new phenomenon

- ▶ 2011 was the last serious pothole year
- ▶ 'Beast from the East'
- ▶ Years of under-funding on UK roads
- ▶ Government £100 million pothole fund (March)
- ▶ **Insurance: backstop for most serious pothole claims**



Picture from Daily Telegraph: £1,200 claim for pothole damage in Sheffield

# HEADLINE FACTS

## Impact of potholes on AA members

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- ▶ Number of calls from AA members for tyre/wheel/suspension damage doubled
- ▶ March-May 2018, AA attended 1,600 tyre/wheel related breakdowns **per day**
- ▶ Local authority compensation has fallen from £35.2m to £7.3m since 2009:  
- not paying out a) 'pothole not known' and b) 'already scheduled for repair' \*
- ▶ Cost to drivers c. £730 million / year \*\*
- ▶ Insurers picking up the brunt of serious pothole damage, c. £1.1m/month \*\*\*

\* Daily Mail FOI request    \*\* Potholes.co.uk    \*\*\* AA Insurance estimate



# HEADLINE FACTS

## Potholes are more than a frustration...

- ▶ Number of calls from AA members for tyre/wheel/suspension damage doubled
- ▶ March-May 2018, AA attended 1,600 tyre/wheel related breakdowns **per day**
- ▶ Local authority compensation has fallen from £35.2m to £7.3m since 2009:  
- not paying out a) 'pothole not known' and b) 'already scheduled for repair' \*
- ▶ Cost to drivers c. £730 million / year \*\*
- ▶ Insurers picking up the brunt of serious pothole damage, c. £1.1m/month \*\*\*
- ▶ **10 years: 22 cyclists killed, nearly 400 injured**

\* Daily Mail FOI request    \*\* Potholes.co.uk    \*\*\*AA Insurance estimate

What do drivers  
think?





# WHAT DO DRIVERS THINK?

## What our members tell us

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- ▶ 41% say: 'Suffered damage to their vehicle caused by potholes' <sup>1</sup>
- ▶ 12% say: 'Suffered damage to tyres, wheels and suspension' <sup>1</sup>
- ▶ 92% say: 'Concerned about damaging their cars from poor roads' <sup>2</sup>
- ▶ 54% say: 'Local streets are in a poor condition' <sup>3</sup>
- ▶ 85% say: 'I Can't remember road surfaces ever being as bad as they are now' <sup>4</sup>

<sup>1</sup> Jan 2018   <sup>2</sup> Feb 2018   <sup>3</sup> March 2018   <sup>4</sup> May 2018

# WALL TO WALL COVERAGE OF WHAT'S BECOME A NATIONAL ISSUE

## UK AND WORLD NEWS

### UK roads are bad – and getting worse

Nine out of 10 (88 per cent) drivers say the condition of UK roads has declined over the last decade, says a survey. An AA poll of 17,500 motorists also found that two-thirds (67 per cent) say roads have "considerably deteriorated" in the past 10 years. Some 42 per cent of drivers rated residential streets as "poor" last month, compared with 34 per cent in March 2017.

## State of roads has declined, say drivers

NINE out of 10 (88%) drivers say the condition of UK roads has declined over the last decade, says a survey. The AA poll of 17,500 motorists also found that two-thirds (67%) say roads have "considerably deteriorated" in the past 10 years. Some 42% of drivers rated residential streets as "poor" last month, compared with 34% in March 2017. A recent survey by the AA indicated that local authorities in England and Wales need to spend £9.3 billion to bring their roads up to scratch. The harsh winter led to a spike in pothole-related breakdowns, such as damaged shock absorbers, broken suspension springs and distorted wheels. AA president Edmund King said: "It is clear that despite all the talk from central and local government, not enough is being done to fix our increasingly dangerous streets. Our potholed roads are in a perilous state. AA breakdown operations are rescuing record numbers of drivers whose tyres or wheels are damaged by potholes."

### Briefing

Most drivers say roads in decline  
**TRANSPORT:** Nine out of 10 drivers say the condition of UK roads has declined over the last decade, a new survey suggests. The AA poll of 17,500 motorists also found that two-thirds say roads have "considerably deteriorated" in the past 10 years. Some 42 per cent of drivers rated residential streets as being "poor" last month, in comparison with 34 per cent in March 2017.

## Dangerous state of roads 'is a national emergency'

Graeme Paton Transport Correspondent

The condition of Britain's roads is turning into a "national emergency", with rising numbers of cyclists seriously injured and cars damaged. Research published today by the AA found that almost nine out of 10 motorists describing the state of local roads as "poor" has risen by a quarter. Edmund King, president of the AA, said this was "little more than papering over the cracks" and that long-term measures were needed. He proposed diverting 2p a litre from fuel duty to create a dedicated £1 billion pothole fund, in effect doubling central government investment in the roads network. "It is clear that despite all the talk from central and local government, not enough is being done to fix our increasingly dangerous streets," he said. "Our potholed roads are in a perilous state. AA breakdown operations are rescuing record numbers of drivers

Roadwork ban to stop potholes

The Times report that Monday on plans to tackle the nation's crumbling streets

recently that another £100 million was being spent to repair roads affected by the severe winter weather. Edmund King, president of the AA, said this was "little more than papering over the cracks" and that long-term measures were needed. He proposed diverting 2p a litre from fuel duty to create a dedicated £1 billion pothole fund, in effect doubling central government investment in the roads network. "It is clear that despite all the talk from central and local government, not enough is being done to fix our increasingly dangerous streets," he said. "Our potholed roads are in a perilous state. AA breakdown operations are rescuing record numbers of drivers

whose tyres or wheels are damaged by potholes

He urged Chris Grayling, the transport secretary, to "commit the Treasury to allow more funds for road maintenance in what is fast becoming a national emergency". The AA surveyed more than 17,500 members and found that 88 per cent thought the roads are worse now than ten years ago. Sixty-seven per cent said that roads had "considerably deteriorated" over the past decade. Official figures show that crumbling roads have contributed to the deaths or serious injuries of 290 cyclists in the past decade. A Department for Transport spokeswoman said: "We are already providing councils in England with over £1 billion to help improve the condition of local highways. While it is for councils to identify where repairs should be undertaken, we are also looking at how innovative technology can help them keep their roads in the best condition and save money." Letters, page 28

# ROADS WORSE THAN 9/10 BELIEVE WORSE THAN 2008

by STEPHEN WILKIE

### MORE than nine out of 10 Scots motorists say roads are worse now than a decade ago

A survey of AA members found 91% of Scottish drivers believe residential streets where they live have deteriorated since 2008. Scotland was the joint worst in the UK, along with north west England and the East Midlands, suggesting that Scotland's roads have deteriorated more than elsewhere. Across the UK as a whole, 88% on average said roads were worse. In Scotland, some 73% said roads had deteriorated "considerably" in terms of surface and potholes compared with 67% across the UK.

Only 2% north of the Border claimed their roads had improved compared with a decade ago while more than half (5%) said they are "terrible". "We're not alone in our problems," says the AA. "The fact that 91% of Scottish drivers believe the condition of main roads and motorways."

Only 1% said trunk roads were "excellent", compared with 16% who said they were "bad" or worse.

### Terrible

Motorways were rated as the roads in the best overall condition, but 4% of Scots said they were "bad" and a further 1% rated them as "terrible". Edmund King, AA president, said: "The AA poll is borne-

ing at the seams with drivers and cyclists becoming the state of roads across the UK". The organisation has now launched the #FlagUpFundIt! campaign to fight what it calls a "national emergency" across the UK.

scottishdailynews.co.uk



HUGE: Potholed street

## Residential streets now suffering from pothole plague, drivers report

◆ The potholes plague facing Britain has spread to residential streets, AA figures have shown. Nine out of 10 drivers surveyed by the organisation said that UK roads had declined in the past decade, while two-thirds said they had "considerably deteriorated". Some 42 per cent of the 17,500 drivers polled rated residential streets as "poor" last month, compared with 34 per cent in March 2017.

Edmund King, AA president, said the organisation was seeing record numbers of pothole-related call-outs. He added: "The current lack of proper investment in local roads means highway authorities are doing little more than papering over the cracks."

Transport Secretary Chris Grayling said in March that English councils would be given £100 million more to tackle potholes and storm damage. But Martin Tet, of the Local Government Association, said funding on the strategic road network was "52 times higher than for local roads". A recent Asphalt Industry Alliance poll found English and Welsh councils needed £9.3 billion to fix their roads.

## NEWS WIRE

### UK roads are getting worse – poll

NINE out of 10 (88%) drivers say the condition of UK roads has declined over the last decade, a new survey suggests.

The AA poll of 17,500 motorists also found that 67% say roads have "considerably deteriorated" since 2008. Around 42% of drivers rated residential streets as "poor" last month, compared with 34% in March last year.

A recent survey by the road-making industry found that local authorities in England and Wales needed £9.3bn to bring their roads up to scratch.

AA president Edmund King said: "It is clear that, despite all the talk from central and local government, not enough is being done to fix our increasingly dangerous streets."

## Poor state of UK roads

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## ASPHALT BUNGL

NEARLY nine in 10 drivers say the state of the roads has worsened over the past decade, an AA poll of 17,500 found.

## Driven to despair: 90% of motorists say streets worse than a decade ago

GEORGE MARR

MORE than nine out of 10 British motorists say roads are worse now than they were a decade ago, according to a study. The survey of AA members found that 91 per cent of the Border believe residential streets where they live have deteriorated since 2008. Scotland was the joint worst in the UK, along with the North West and East Midlands, suggesting that Scotland's roads have deteriorated more than elsewhere. Across the UK, 88 per cent of drivers said roads were worse.

Edmund King, AA president, said: "It is clear that despite all the talk from central and local government, not enough is being done to fix our increasingly dangerous streets." The findings come after it emerged in October that roads in Scotland are plagued with the highest number of potholes in the UK and are in an acceptable condition, with the maintenance budget for trunk roads increasing to more than £190 million in 2017-2018.

Official road condition data shows that the worst roads were rated as "poor" last month, compared with 34% in March 2017. The AA demanded 2p a litre of fuel duty should be ring-fenced for a pothole fund. "We're not alone in our problems," says the AA. "The fact that 91% of Scottish drivers believe the condition of main roads and motorways."

Only 1% said trunk roads were "excellent", compared with 16% who said they were "bad" or worse.

“Not enough is being done to fix our increasingly dangerous streets”

## Nine out of 10 drivers say roads not up to scratch

Nine out of 10 drivers say the condition of UK roads has declined over the last decade, a new survey suggests.

The AA poll of 17,500 motorists also found that two-thirds say roads have "considerably deteriorated" in the past 10 years. Some 42 per cent of drivers rated residential streets as "poor" last month, compared with 34 per cent in March last year.

A recent survey by the Asphalt Industry Alliance found that local authorities in England and Wales needed £9.3 billion to bring their roads up to scratch.

The harsh winter led to a spike in pothole-related breakdowns, such as damaged shock absorbers, broken suspension springs and distorted wheels. AA president Edmund King said: "It is clear that despite all the talk from central and local government, not enough is being done to fix our increasingly dangerous streets."

Our potholed roads are in a perilous state. AA breakdown operations are rescuing record numbers of drivers whose tyres or wheels are damaged by potholes. The current lack of proper investment on local roads means highway authorities are doing little more than papering over the cracks.

Transport Secretary Chris Grayling announced in March that councils would be given £100 million more to tackle potholes and repair storm damage in England.

## MOTORING

### Condition of roads has gone down say nine in 10 drivers

NINE out of 10 (88 per cent) drivers say the condition of UK roads has declined over the last decade, a new survey suggests. The AA poll of 17,500 motorists also found that two-thirds say roads have "considerably deteriorated" in the past 10 years. Some 42 per cent of drivers rated residential streets as "poor" last month, compared with 34 per cent in March 2017. A survey by the Asphalt Industry Alliance found that local authorities in England and Wales needed £9.3 billion to bring their roads up to scratch.



# WALL TO WALL COVERAGE OF WHAT'S BECOME A NATIONAL ISSUE

UK AND WORLD NEWS

## UK roads are bad – and getting worse

Nine out of 10 (88 per cent) drivers say the condition of UK roads has declined over the last decade. An AA poll of 17,500 motorists also found that two-thirds (67 per cent) say roads have “considerably deteriorated” in the past 10 years. Some 42 per cent of drivers rated residential streets as “poor” last month, compared with 34 per cent in March 2017.

## State of roads has declined, say drivers

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### Briefing

Most drivers say roads in decline  
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### MOTORING

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## Dangerous

# WALL TO WALL COVERAGE OF WHAT'S BECOME A NATIONAL ISSUE

## Potholes danger 'a national crisis'

by OLIVER PRITCHARD  
**BRITAIN'S potholed roads are now in such a poor condition they have become a “national emergency”.**  
The AA found almost 90% of drivers think routes have deteriorated in the past decade. Roads are in a “perilous state” after bad winters

ing at the seams with drivers and cyclists bemoaning the state of roads across the UK. The organisation has now launched the #FlagItFundItFixIt campaign to fight what it calls “a national emergency” across the UK.

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# MOTORISTS BLAST ROADS CONDITION /10 believe worse than 2008

TEPHEN WILKIE

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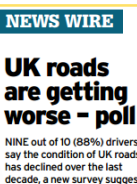
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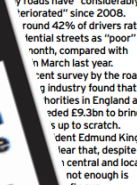
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HUGE: Potholed street



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# WHAT DO DRIVERS THINK?

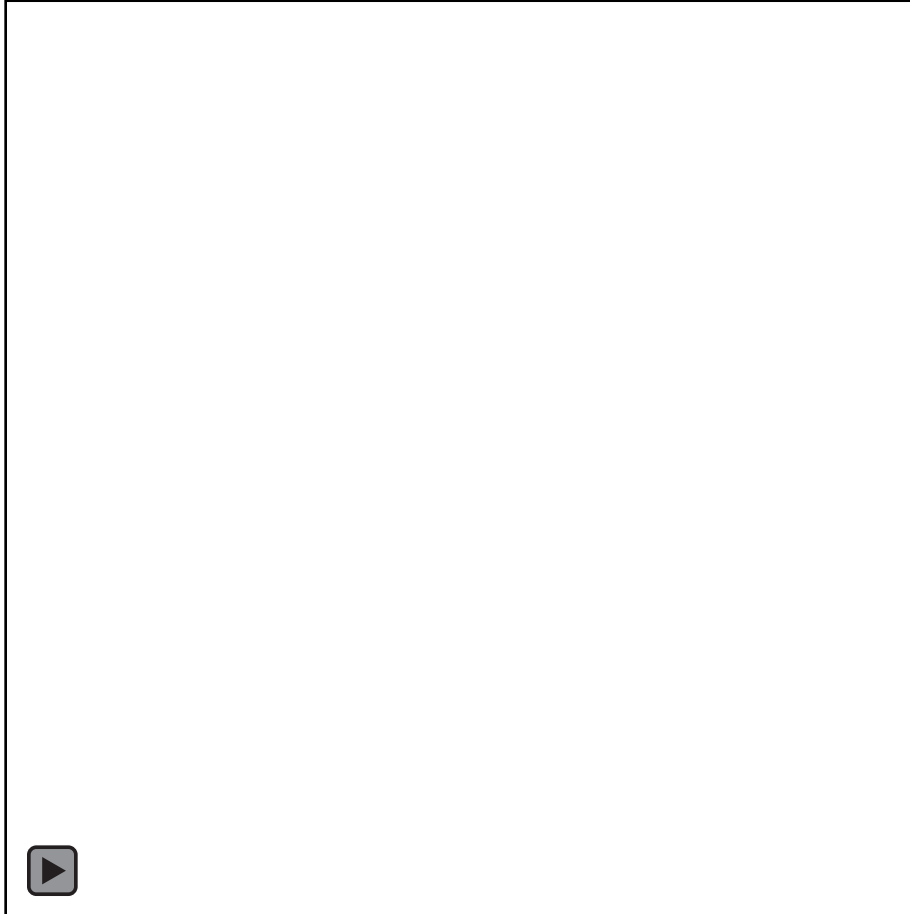
## What our members tell us

Q. Following the 'beast from the East' in early spring, 9 out of 10 panel members said that the condition of local roads (surface/potholes) in their area was the worst it had been for ten years. Which if any of the following best describes the action taken since spring to mend potholes in your local area? (September 2018)

Statement	Result
Some potholes have been repaired, but there seems to be a lot of damage that has been ignored	39%
Some potholes were repaired, but roads have started to break up again	16%
The local authority seems to have been repairing potholes all year, but roads are still bad	14%
Lots of potholes have been inspected/marked with paint, but few seem to have been repaired	13%
Local roads have been extensively and comprehensively repaired in my area	7%
The roads in my area weren't too bad in the spring, so the local authority hasn't had to do much in the way of repairs	6%
Don't know	4%
Other	2%

# Impact on insurers

# IMPACT ON INSURERS

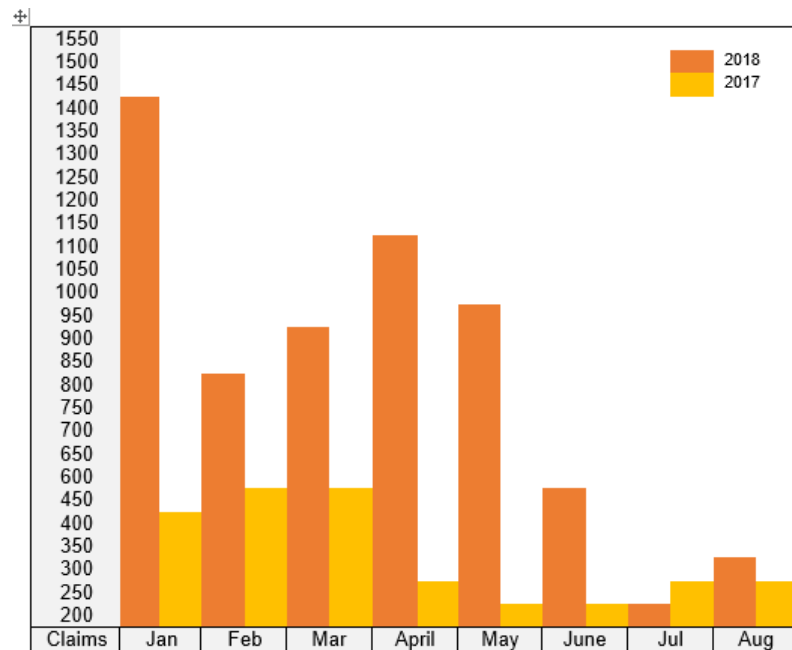




# IMPACT ON INSURERS

## As many claims as they are potholes

- ▶ Most council claims denied leaving victims to pay up or claim
- ▶ End of April 2018: c. 4,200 claims
  - 171% increase over same period last year
  - Approximate cost per claim: £1,000 = £4.2m
- ▶ Year to date: (end August) c 8,000 claims
  - 165% increase over same period last year
  - Approximate cost per claim: £1,000 = £8m
- ▶ Claim rate falling as councils get to grips



AA action &  
Parliamentary  
inaction (until  
now)

# AA ACTION & PARLIAMENTARY INACTION (UNTIL NOW)

## HIGHLIGHTING THE ISSUE IN MEDIA

- ▶ To date, 1,000 interviews and mentions across both national and regional radio / TV
- ▶ Coverage on BBC Breakfast, BBC 2, Sky News, ITV News, Channel 4 and Channel 5 and regionals
- ▶ All major nationals both print and online; insurance media
- ▶ Facebook posts by Sky News, BBC Breakfast, BBC News, The Times and The Sunday Times prompting nearly 2,000 comments

## ACTIVITY HIGHLIGHTS

- ▶ Roadside operations: doubling of puncture, suspension and wheel related faults with hotspots and advice;
- ▶ Insurance: sharp rise in pothole related claims, scaling AA's market share to a national estimate: £1m / month
- ▶ Driving school: damaged driving school cars, abandoned driving lessons and tests
- ▶ Pavements: as bad as roads; 10,600 claims over 12 months; 73% say local pavements uneven / ill maintained



# AA ACTION & PARLIAMENTARY INACTION (UNTIL NOW)

## #FlagitFunditFillit – AA calls for action

---

Campaign launched to highlight pothole problems across the UK

► **Flag it** – call on drivers to report potholes to local councils



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- ▶ **Flag it** – call on drivers to report potholes to local councils
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- ▶ **Fill it** – funds generated for local authorities will enable potholes to be filled



# AA ACTION & PARLIAMENTARY INACTION (UNTIL NOW)

## AA applies pressure on Parliament

### #FlagitFunditFillit: AA calls for action

- ▶ Letter to Chancellor: Ring-fence 2p of 57.95p/litre for pothole fund to raise £1bn in 12 months – rejected
- ▶ Letter to Transport Secretary – Chris Grayling – ‘noted with interest’
- ▶ Letter to Transport Committee – announced inquiry into the funding of local road repairs





# AA ACTION & PARLIAMENTARY INACTION (UNTIL NOW)

## What the Government wants

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### Meanwhile...

- ▶ Government trying to encourage people to walk or cycle short journeys but
  - People are not cycling as much as they used to – down 6% 2016-2017 (but those who do are cycling further)\*
- ▶ Three-fifths of people say roads too dangerous to cycle\*
- ▶ Youngsters walking/cycling to school down from 53% to 51%\* thanks to pavement hazards
  - despite £1.2bn investment target to encourage 55% to walk/cycle

\* British Travel Survey 2018

What happens  
next?

# WHAT HAPPENS NEXT?

Innovation is the key

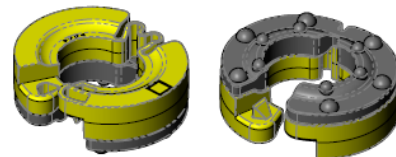
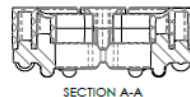
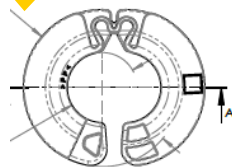
- ▶ 'Multi-Fit wheel – reduces time for Member and the AA



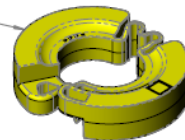
# THE POTHOLE ISSUE

## Innovation is the key

- ▶ 'Multi-Fit wheel – reduces time for Member and the AA
- ▶ **Foam suspension spacer**
  - fits on shock absorber to enable cars with a broken spring to be rescued



SMALL SPACER  
DRG A6001



5mm PU INSERT  
DRG A6012





# THE POTHOLE ISSUE

## Innovation is the key

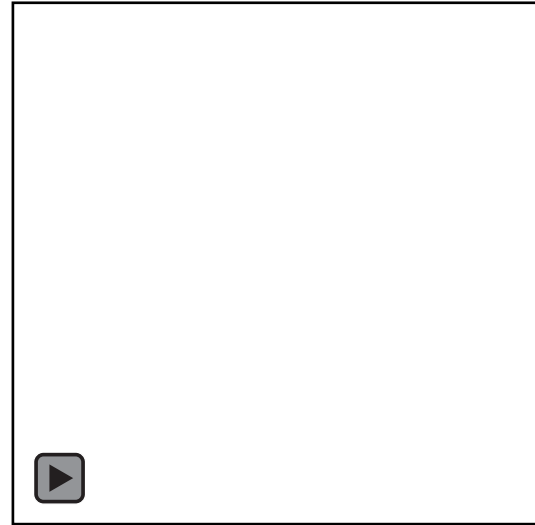
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- ▶ 'Multi-Fit wheel – reduces time for Member and the AA
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- ▶ **Think outside the box...**

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## WHAT HAPPENS NEXT?



**Thank you!**







BRIDGING SCIENCE & ENGINEERING

# POTHOLE

PROPOGATION, PREVENTION, PATCHING

POTHOLE – CHALLENGE, COST &  
FUNDING

George Lee – Chief Executive,  
Highways Term Maintenance Association

George Lee  
Chief Executive  
Highways Term Maintenance Association

# Pothole – Challenge, Cost & Funding

## Members & Associate members



Working together for better roads



## Deliverables for the Sector

- Price adjustment indices
- Guidance on use of legal clauses in contracts
- Invest to save report
- Report on outcome indicators
- Guidance on maximising best value from constrained budgets
- Safety training DVD *Breaking New Ground*
- Guidance documents on:
  - Smart motorways designed for maintenance
  - IPV and traffic management
  - Centre line working
  - Road closures and impact
  - Welfare on transient sites
- Training DVD on People-Plant interface management
- Roadworker Abuse toolkit
- A suite of good safety practices (knowledge sharing by Members)
- Sustainable Highways Maintenance Tool
- Water Toolkit
- Report from Benchmarking on fuel use and CO2 emissions in highways maintenance
- Green driving booklet
- Sustainability Charter
- Guidance on Adaptation to Climate Change
- Sustainable travel plans template
- Training DVD on sustainable highway maintenance
- Winter Maintenance game for school aged pupils
- TUPE template to assist the bidding process
- Career case studies
- Job profiles for different roles within highways maintenance
- Careers video
- Careers presentation for pupils
- Report from benchmarking people data – highways specific

## Strategic Priorities

Leading voice of highways term management and maintenance sector  
Promote innovation, best practice and improved industry standards  
Share knowledge and experience throughout the industry  
Improve & promote overall image of the industry

## Operational Priorities 2018/19

Key Stakeholder engagement and collaboration  
including, Best Practice Group & academic engagement  
Development of cross sectoral submission to Comprehensive Spending  
Review  
Campaign on road worker safety

# Comprehensive Spending Review Britain's Roads.....Britain's Future



## We have a Problem

Identifying the Problem

Quantifying the Problem

Addressing the problem

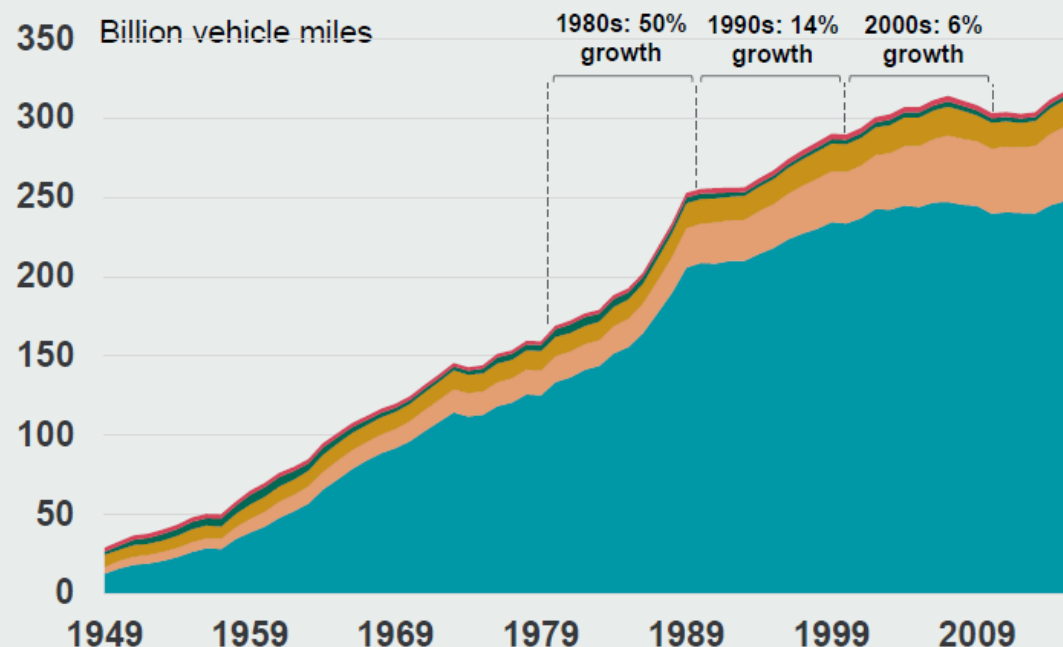
- WHY?
- WHAT?
- HOW?






# Why we have a Problem (1) – Road Use

## Long-term traffic trends

Since 1949 motor vehicle traffic has increased more than ten-fold from 28.9 to 323.7 billion vehicle miles, largely driven by steady growth in car traffic.

Motor vehicle traffic in Great Britain, since 1949

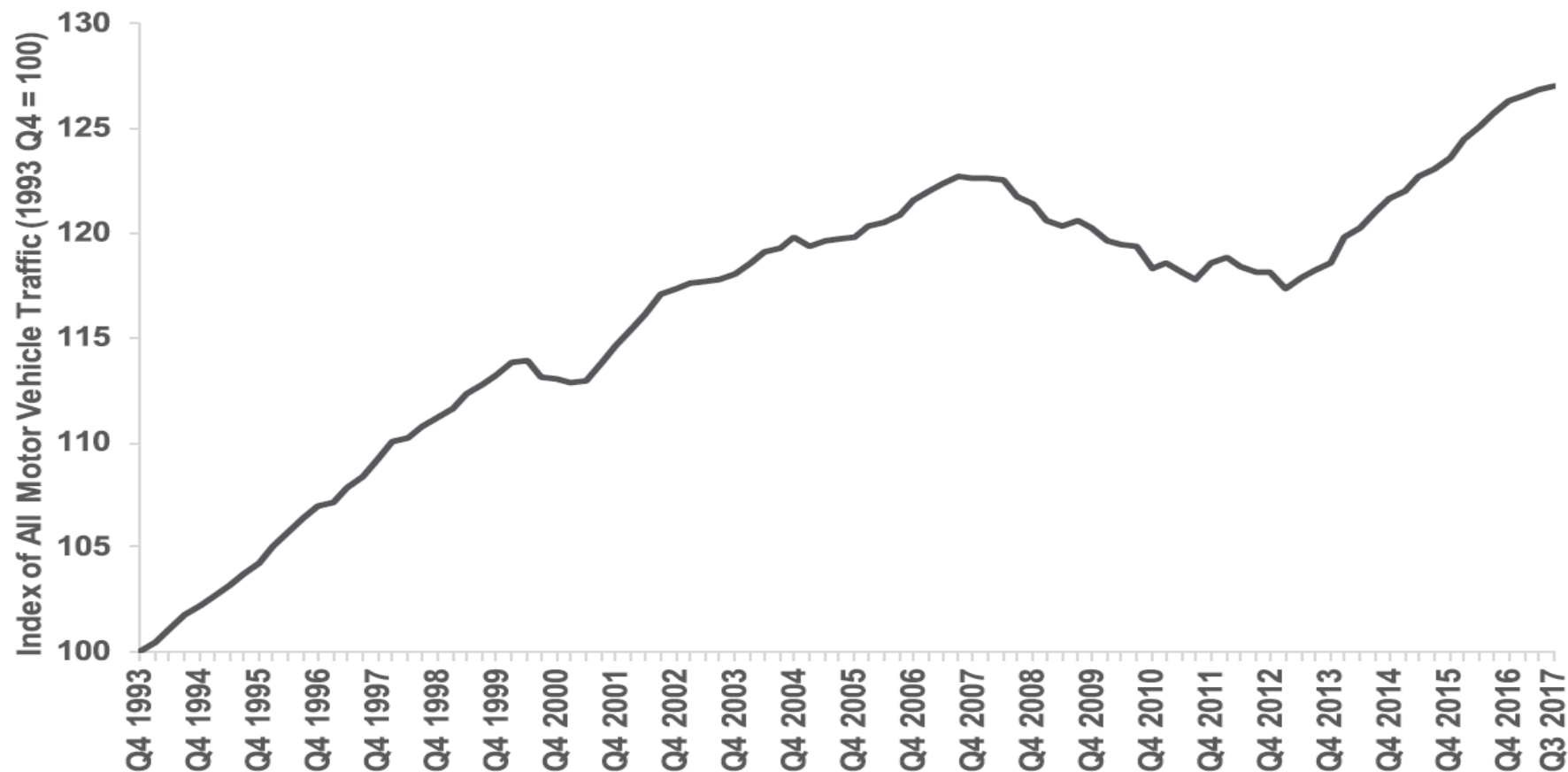


Change 1949 - 2016		
	Buses & coaches	-1.2%
	Motorcycles & scooters	+49%
	Heavy Goods Vehicles (HGV)	+113%
	Light Commercial Vehicles (LCV)	+1098%
	Cars & Taxis	+1905%
All motor vehicles		+1020%



## Why we have a Problem (1) – Road Use

**Chart 1: Rolling Annual Index of Road Traffic in Great Britain, from 1993**



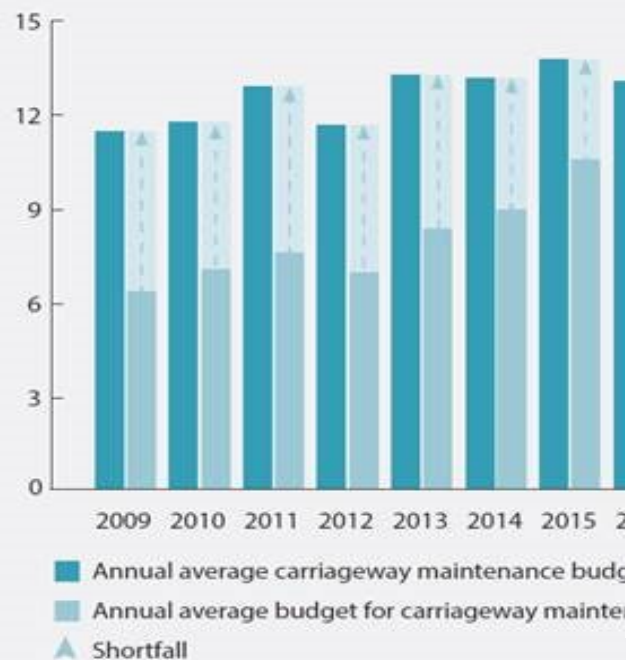
Source: Department for Transport

Working together for better roads

## Why we have a Problem (2) – Resources

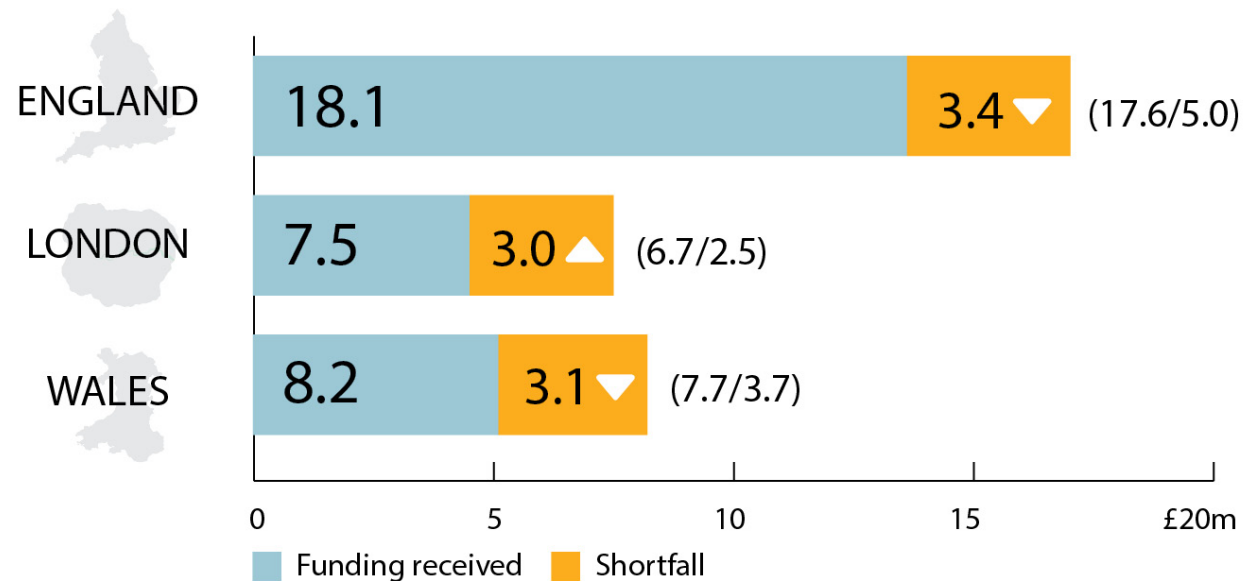
### Carriageway maintenance budget needed

Annual average per authority (£m)



### Budget shortfall

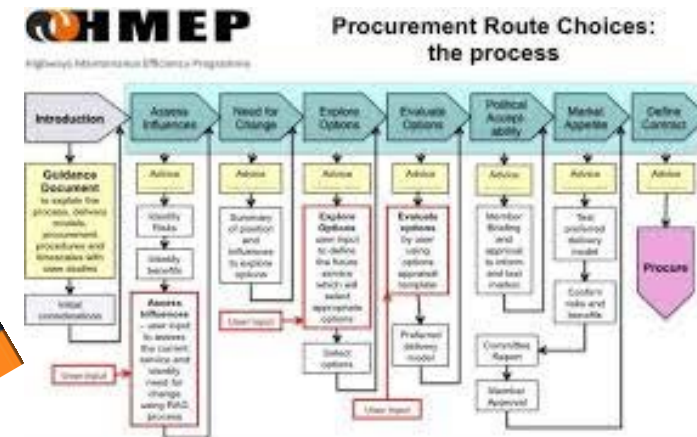
Average annual carriageway maintenance budget received and average shortfall, £m (2016/17 in brackets)



Source: Asphalt Industry  
Alliance ALARM Report 2018

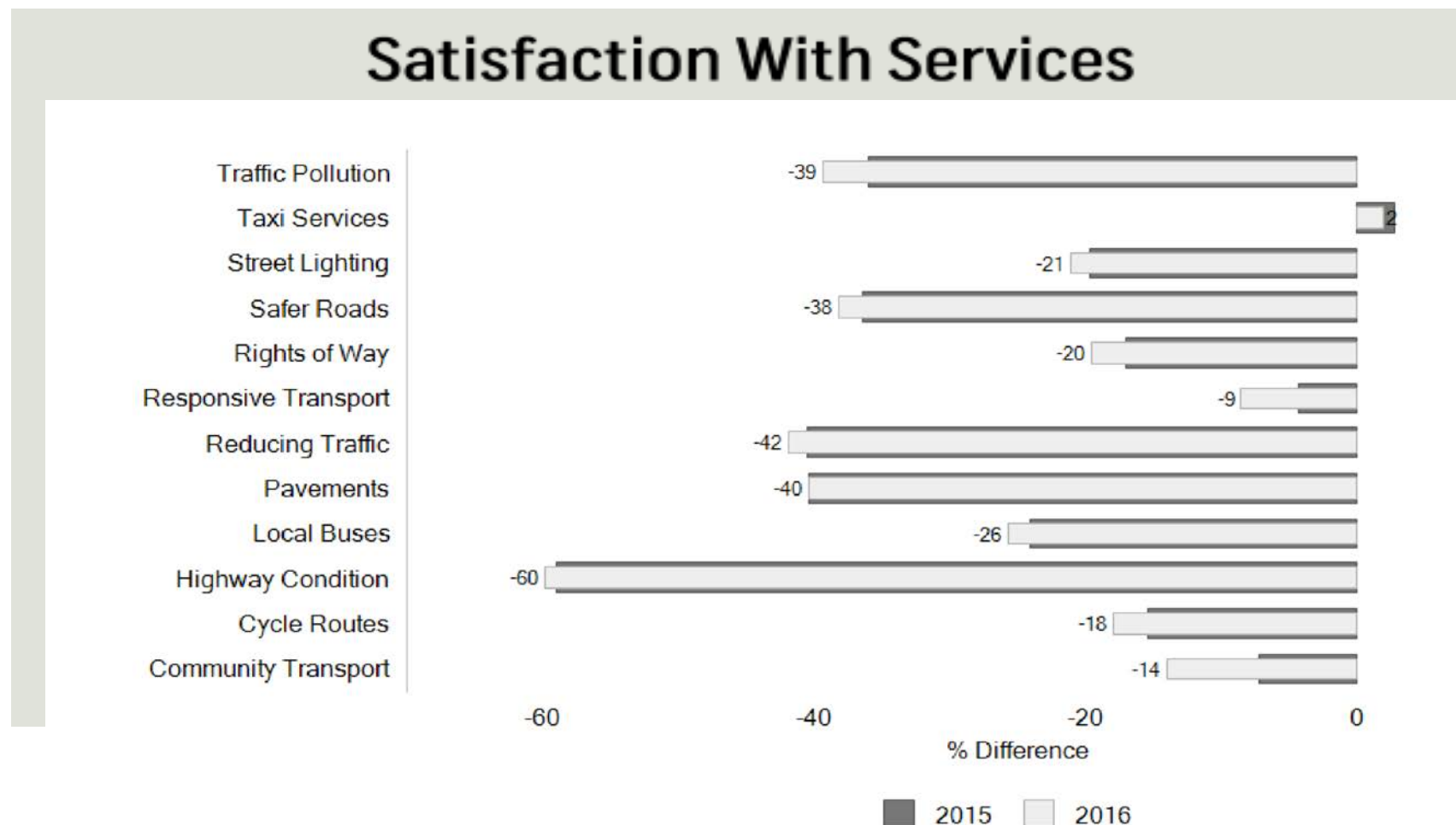
## Why we have a Problem (3) – Structures

- Poor Asset Knowledge
- Lack of strategic & coordinated approach
- (Historically) Slow to adapt to 'new' practices



Working together for better roads

## What is the extent of the problem? (1) – User views



Sources: APSE Service users Survey 2017 & NHT Public Satisfaction Survey 2017

Working together for better roads



## What is the extent of the problem? (1) – User views

### Local Road Users Priorities



Better Roads/Road Surfaces/less potholes

60%

Improve Traffic Flow/less congestion

6%

Less roadworks

3%

### Key Issues Of Public Concern

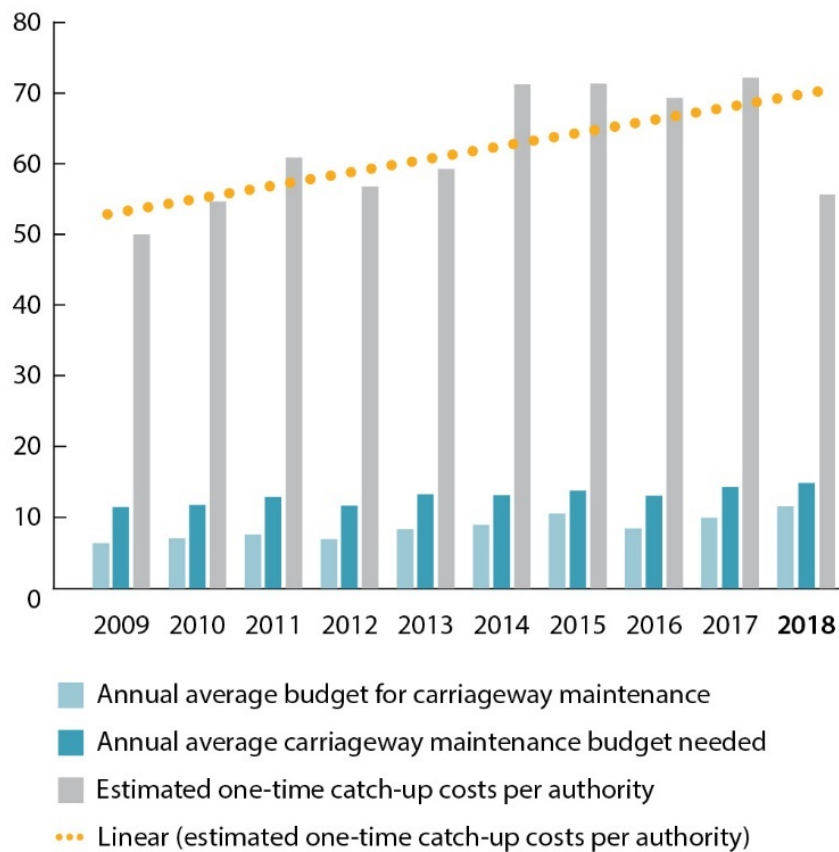
48% Social Care   47% Highways



## What is the extent of the problem? (2) - Resources

### One-time catch-up costs

Estimate per authority (£m)



Source: Asphalt Industry  
Alliance ALARM Report 2018

## What is the extent of the problem? (2) - Resources

### The figures and do they add up?

#### ALARM(ing) SURVEY

1 in 5 roads could fail in  
the next 5 years

Annual Budgetary shortfall  
of £556m

14 years and £9.31bn to  
put things right

Compensation claims in  
England & Wales totalled  
£28.3m

In England average LA Budgets  
increased by 20% to £26.2m

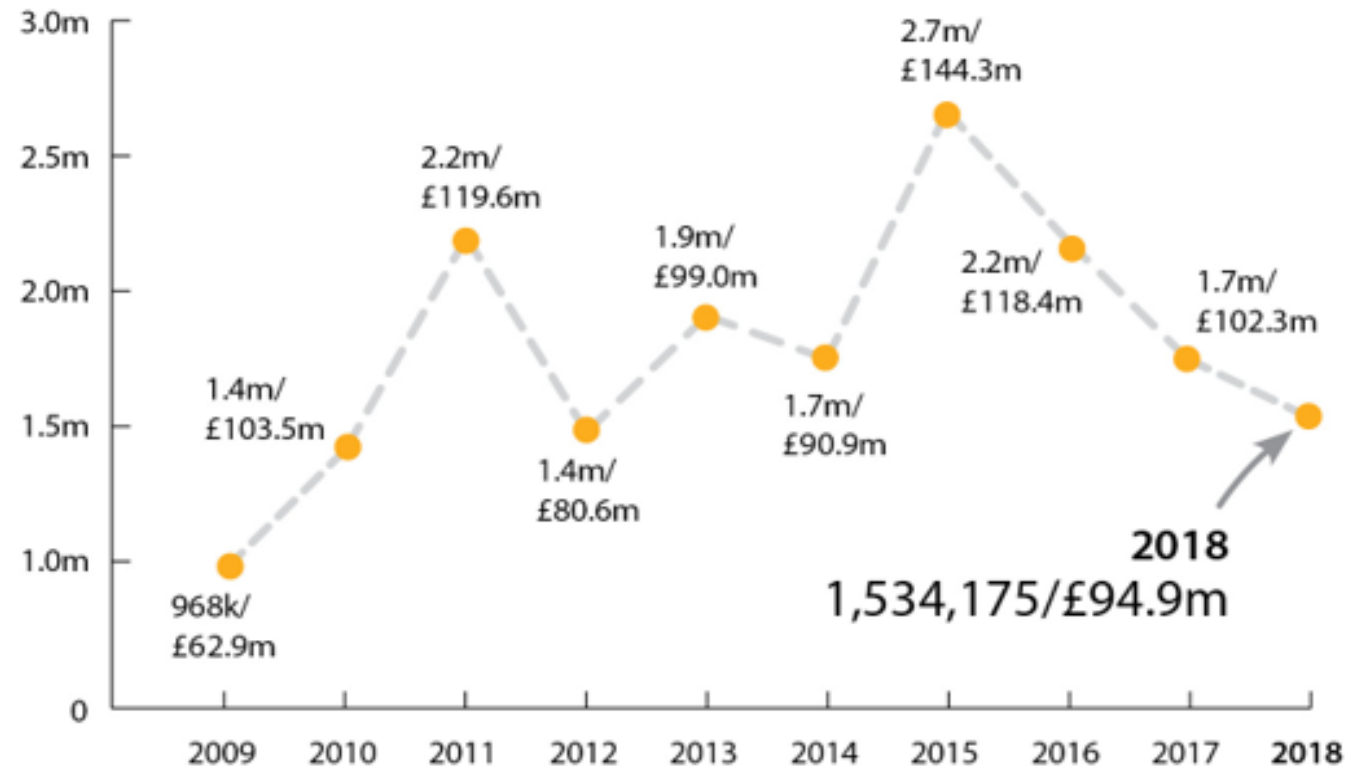
Structural Road Condition as a  
%age of roads that are 'good,  
adequate or poor', stabilised

Catch up cost down 25% to  
£2.75bn

## What is the extent of the problem? (2) - Resources

### Potholes

Number and cost of potholes filled

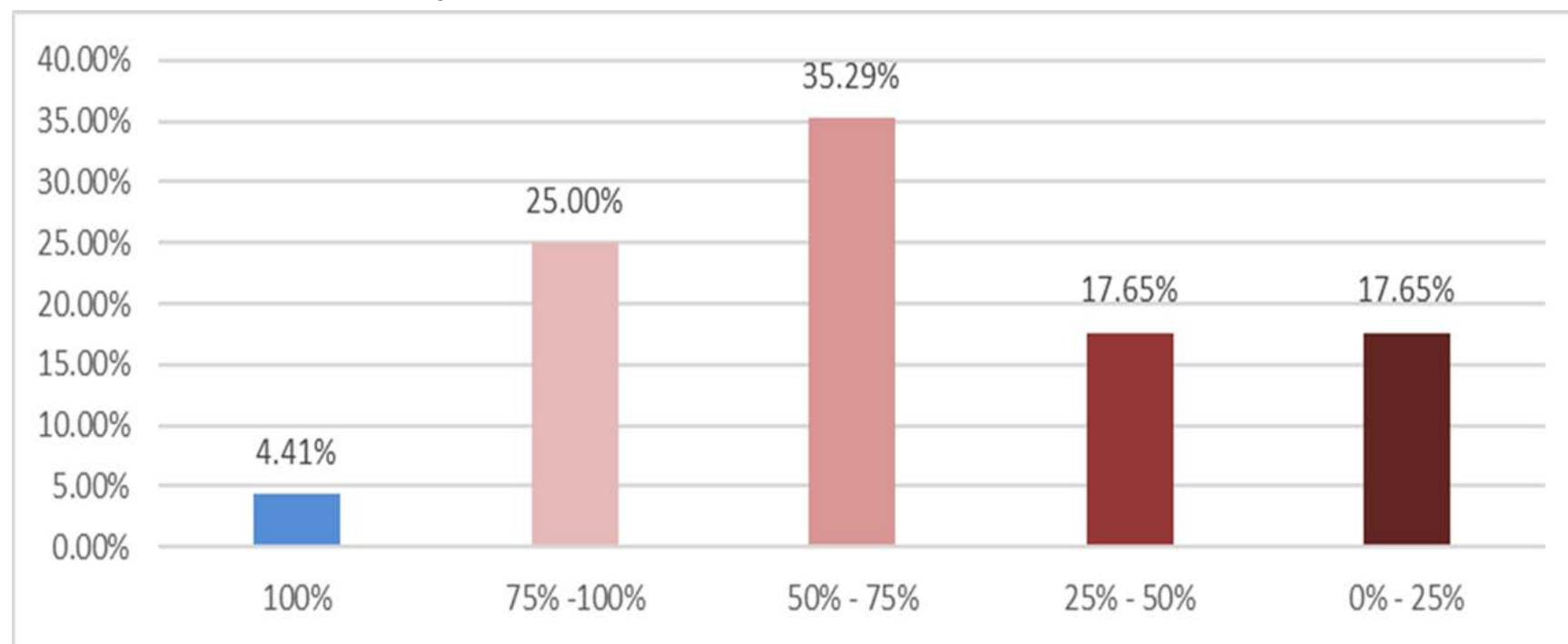


Source: Asphalt Industry  
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## What is the extent of the problem? (2) - Resources

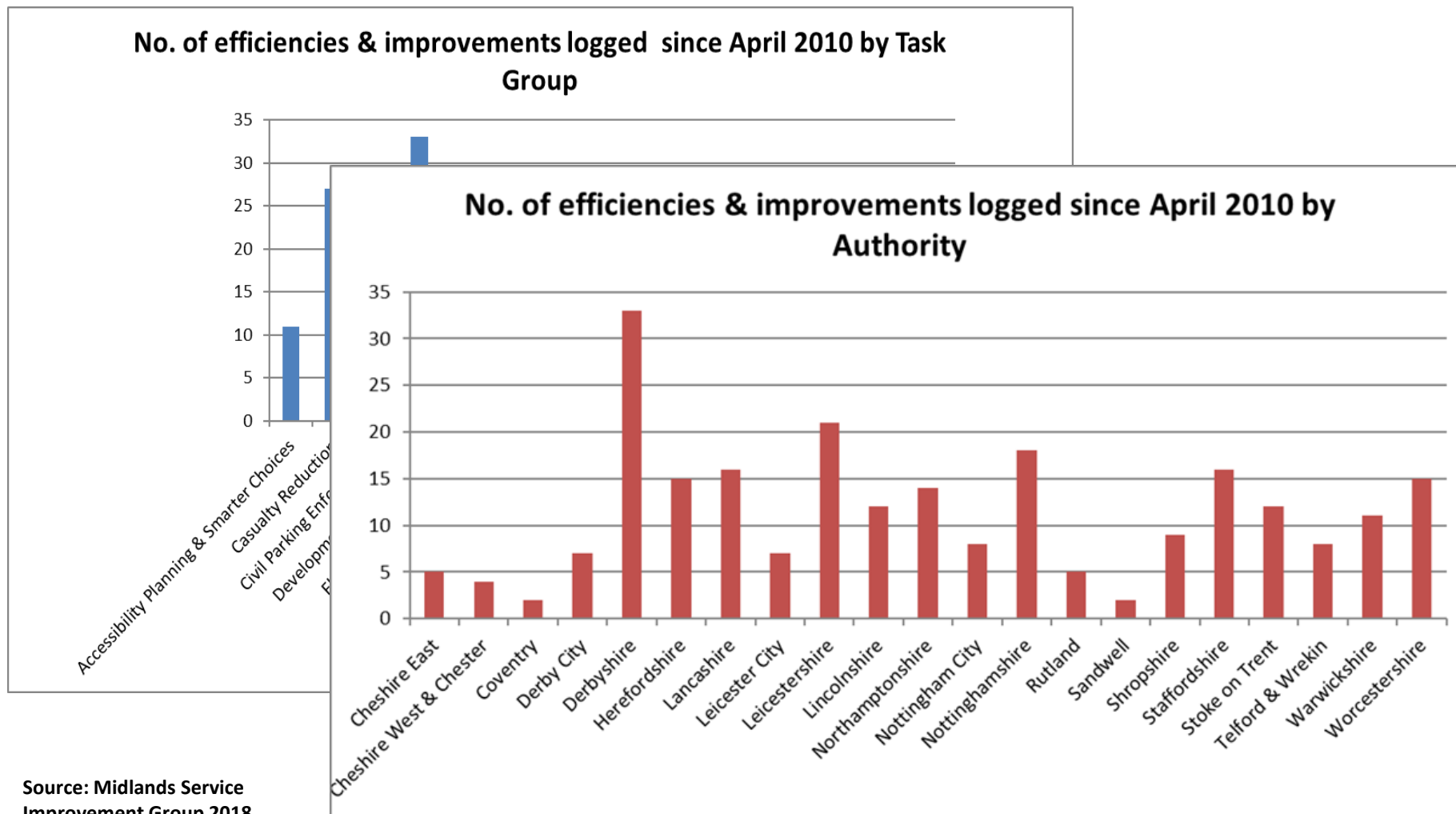
To what extent will your 2017/18 budget for highways maintenance meet the need to fill potholes and resurface where necessary?



Source: APSE Performance Network

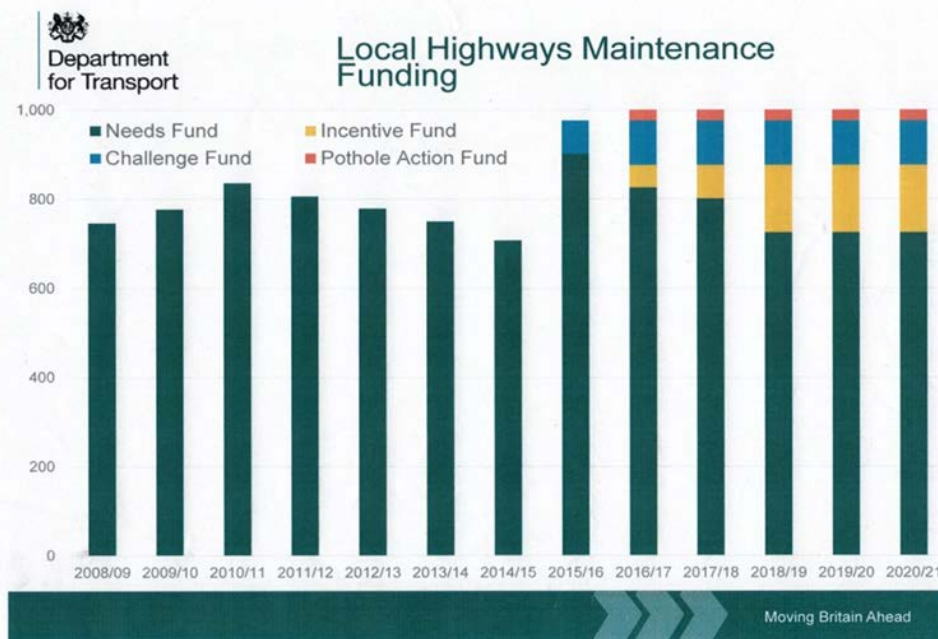
Working together for better roads

## What is the extent of the problem? (3) - Structures



Source: Midlands Service Improvement Group 2018

# How do we solve the problem? (1) - Resources



## DfT funding split

England, excluding London (£)

Local Highways Maintenance Funding – Needs Element

**£801m**

National Productivity Investment Fund (BID FOR)

**£185m**

Challenge Fund (BID FOR)

**£75m**

Pothole Action fund

**£70m**

Local Highways Maintenance Funding – Incentive Element

**£75m**

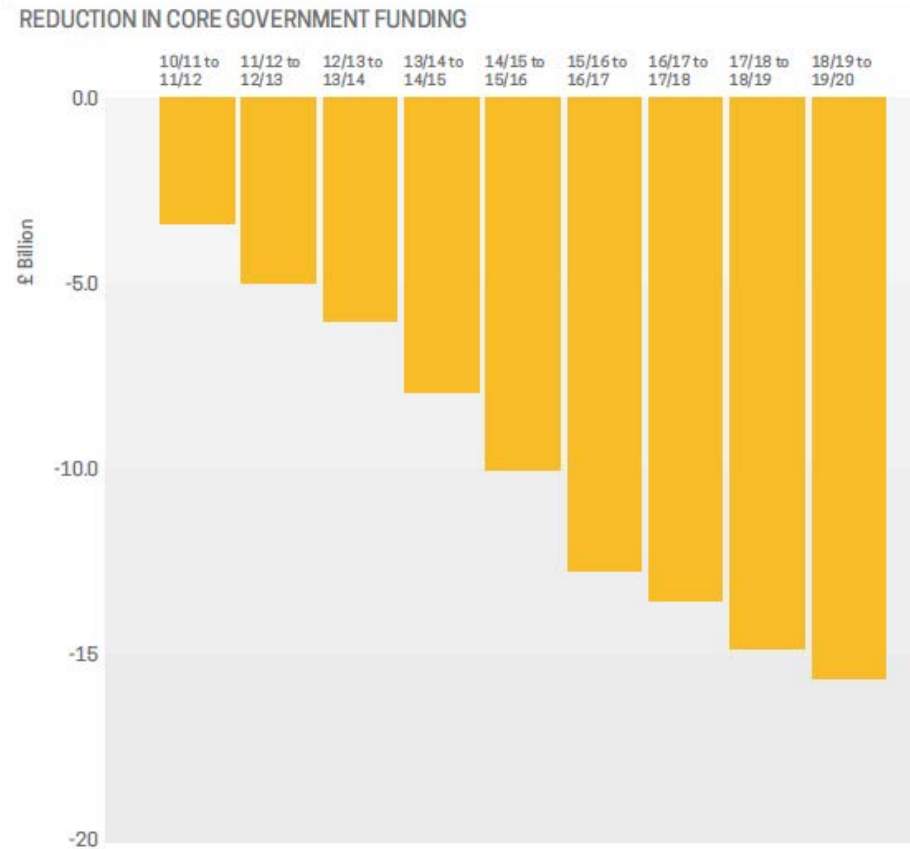
Safer Roads Fund (BID FOR)

**£25m**

Source: Department for Transport 2018

**Working together for better roads**

## How do we solve the problem? (1) - Resources



Source: Local Government Association

Local services in England will face a funding gap of almost £8 billion by 2025.



## How do we solve the problem? (2) - Structures

### Where do you see growth areas for the service over the next 12 months?

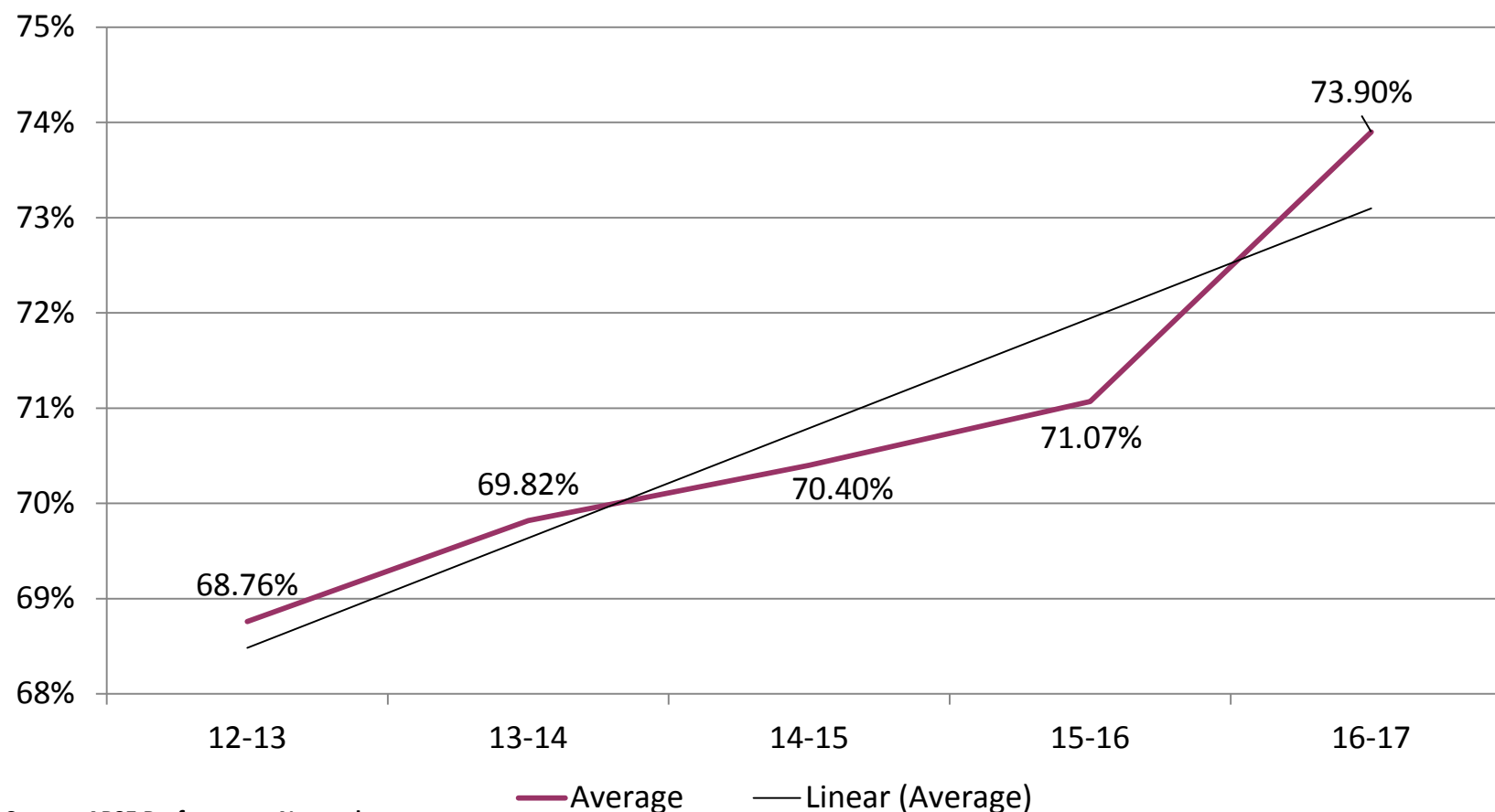
- External Income Streams
- Asset Management
- Air Quality
- Sustainable drainage
- Collaboration with other authorities
- Town Centre Regeneration
- Charging for Specialist Knowledge
- Housing and Industrial Development sites
- Surface Dressing Road Network
- Design and Build using Section 278 and 38

### Where do you see areas where work may decrease over the next 12 months?

- Pothole Repairs
- Structural Highway Maintenance
- Long Term Maintenance
- Cyclic & Routine Maintenance
- Carriageway Surfacing
- Road Reconstruction
- Major Resurfacing
- Street Light Maintenance
- Winter Service

## How do we solve the problem? (2) - Structures

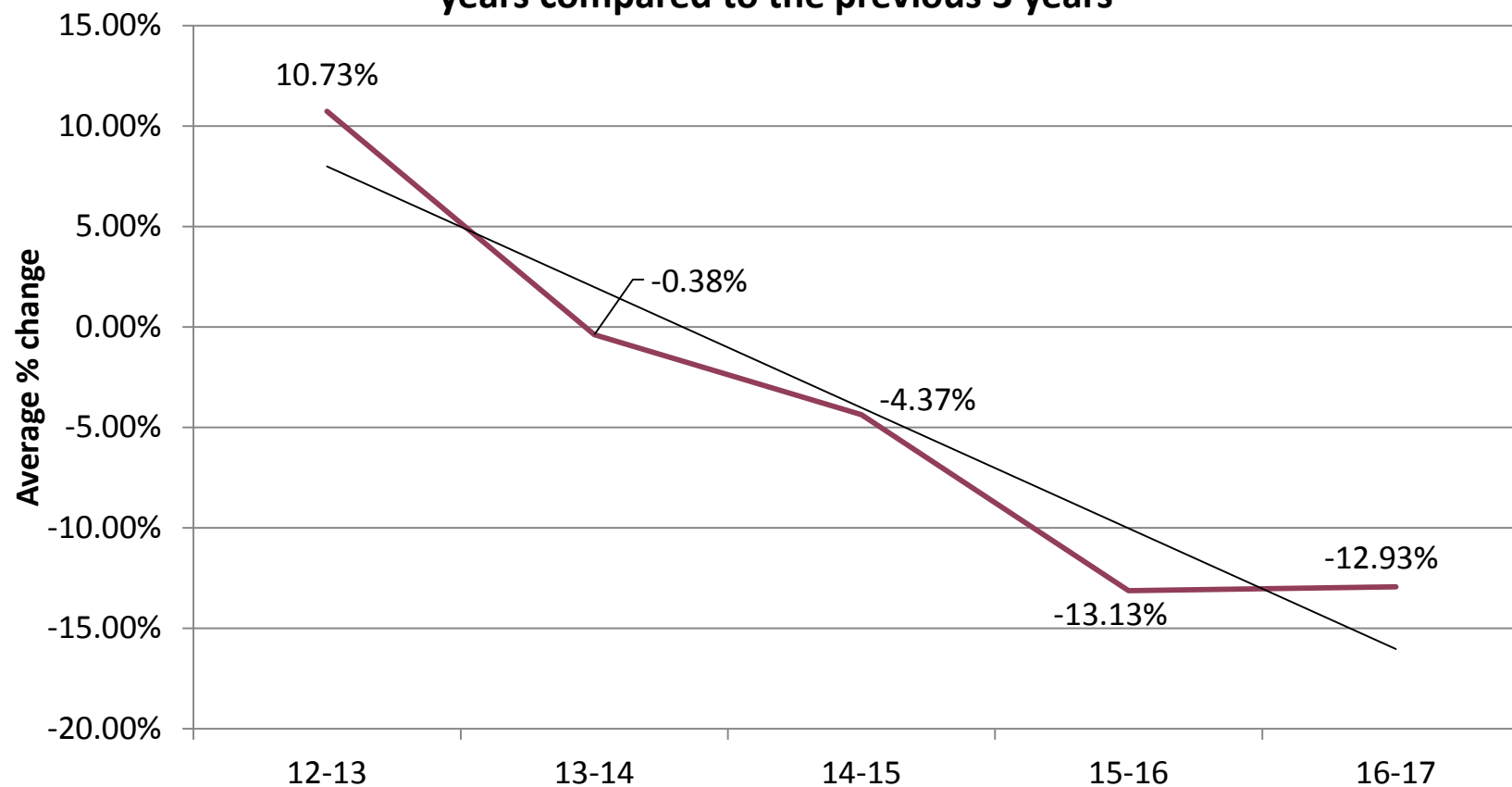
PI 16 percentage of maintenance expenditure planned/proactive



Source: APSE Performance Network

## How do we solve the problem? (2) - Structures

**PI 31 Percentage change in the number of 3rd party claims in last 3 years compared to the previous 3 years**



Source: APSE Performance Network

## How do we solve the problem? (2) - Structures

Investment

Strong asset management

Positive challenge to local authorities

Hypothecation / Allocated funding



# **Pothole formation: Tyre-water- pavement interaction**

**Dr Mujib Rahman**



**Problem statement**

**Concept of water  
movement under tyre**

**Objectives**

**Experimental  
programme**

**Results**

# Pothole formation: Tyre-water- pavement interaction

## Acknowledgements

Fauzi Saeed

Dr Phil Collins

Professor Denis Chamberlain



# Problem Statement



Water >> damage  
( cracking, ravelling,  
pothole etc)

Research >> Material  
degradation

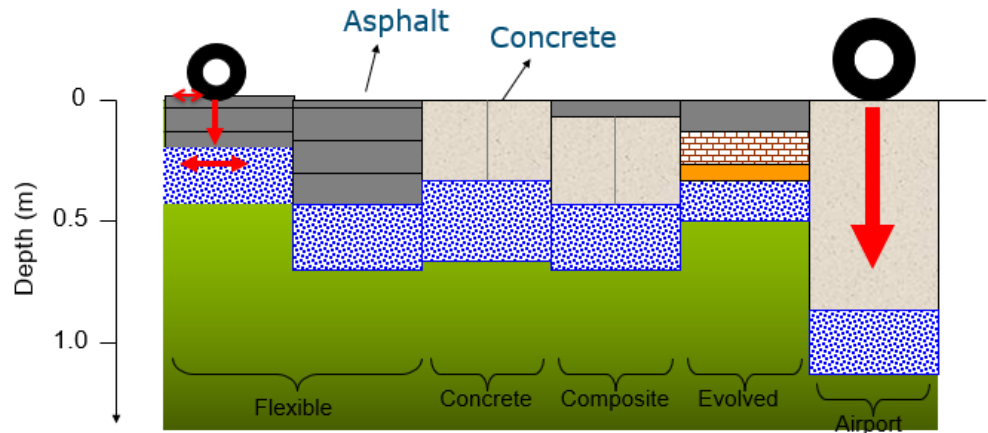
But many new type of asphalt  
surfaces are failing prematurely

**Dynamic pore pressure under traffic loading plays an important role**



# Problem Statement

Measurement of pore water pressure in pavement is complex



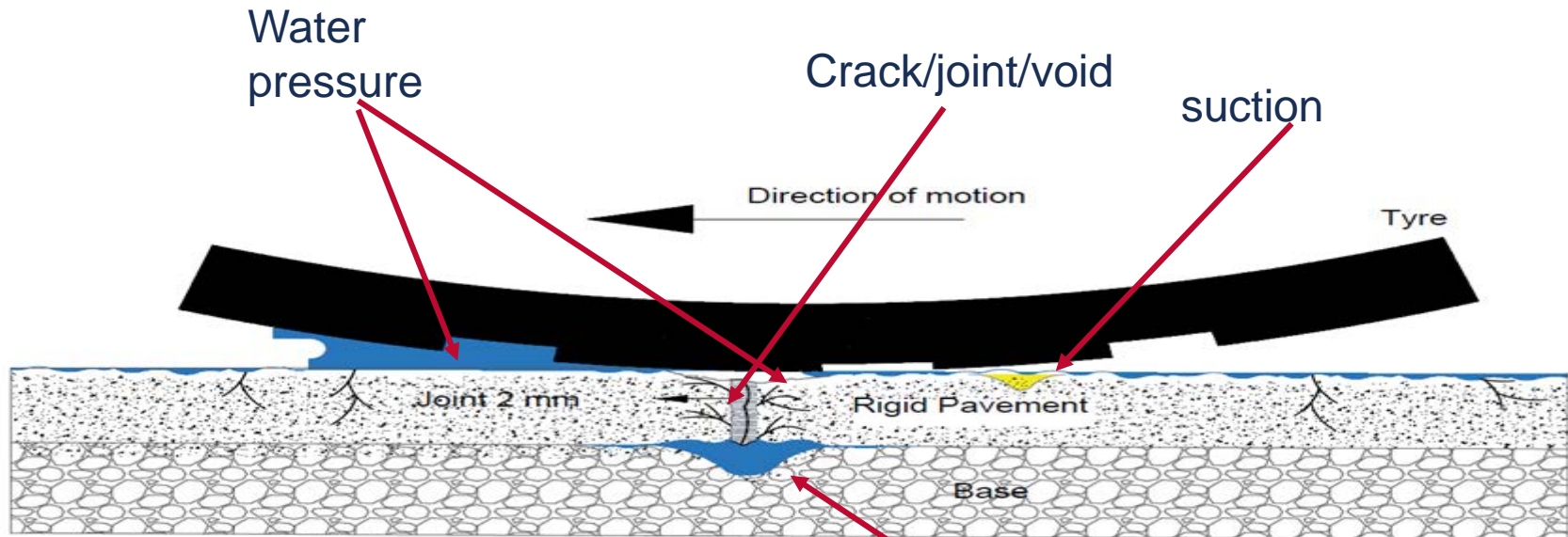
**Need to simplify !**



# Simplified concept of Tyre-water-pavement interaction



Pore pressure =  $f$  ( tyre, vehicle speed, surface water, crack opening etc.)



Pore water pressure can create under slab voids, material loss, reduction in bearing capacity etc.....

# Research Objectives

**Objective 1:** Develop a novel laboratory test method to measure water pressure in the pavement.

**Objective 2:** Investigate the impact of traffic parameters, tyre parameters, and depth of surface water on water pressure in the pavement.

**Objective 3:** Investigate the impact of combined interaction of tyre-water-pavement on formation of surface damage.

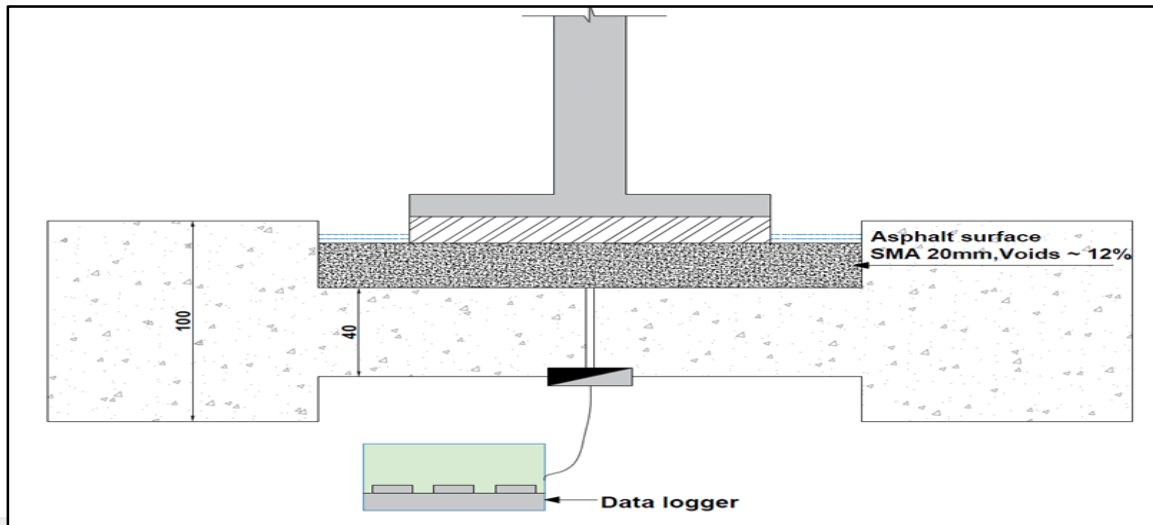
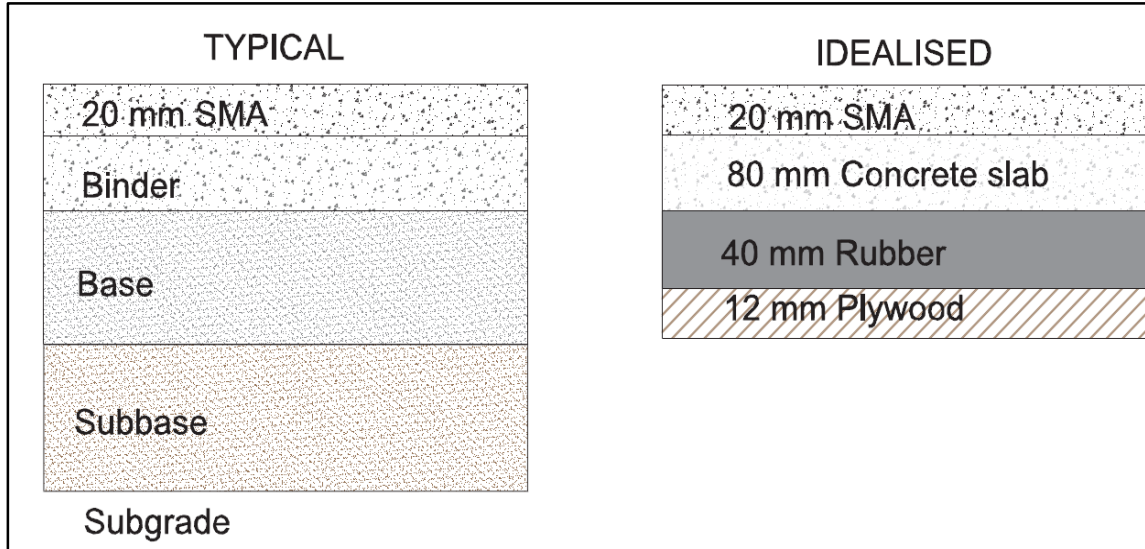
# **Objective 1:** Develop a novel laboratory test method to measure water pressure in the pavement.

# Test Development

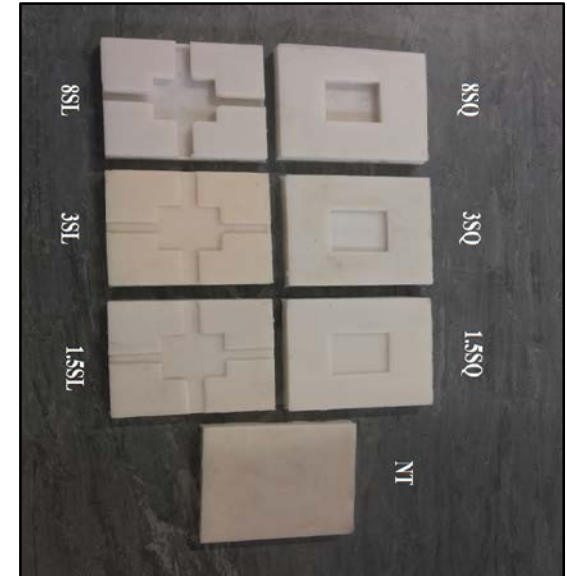
# Repeatability & Reproducibility

# Test Development

## Idealised pavement



## Idealised tread

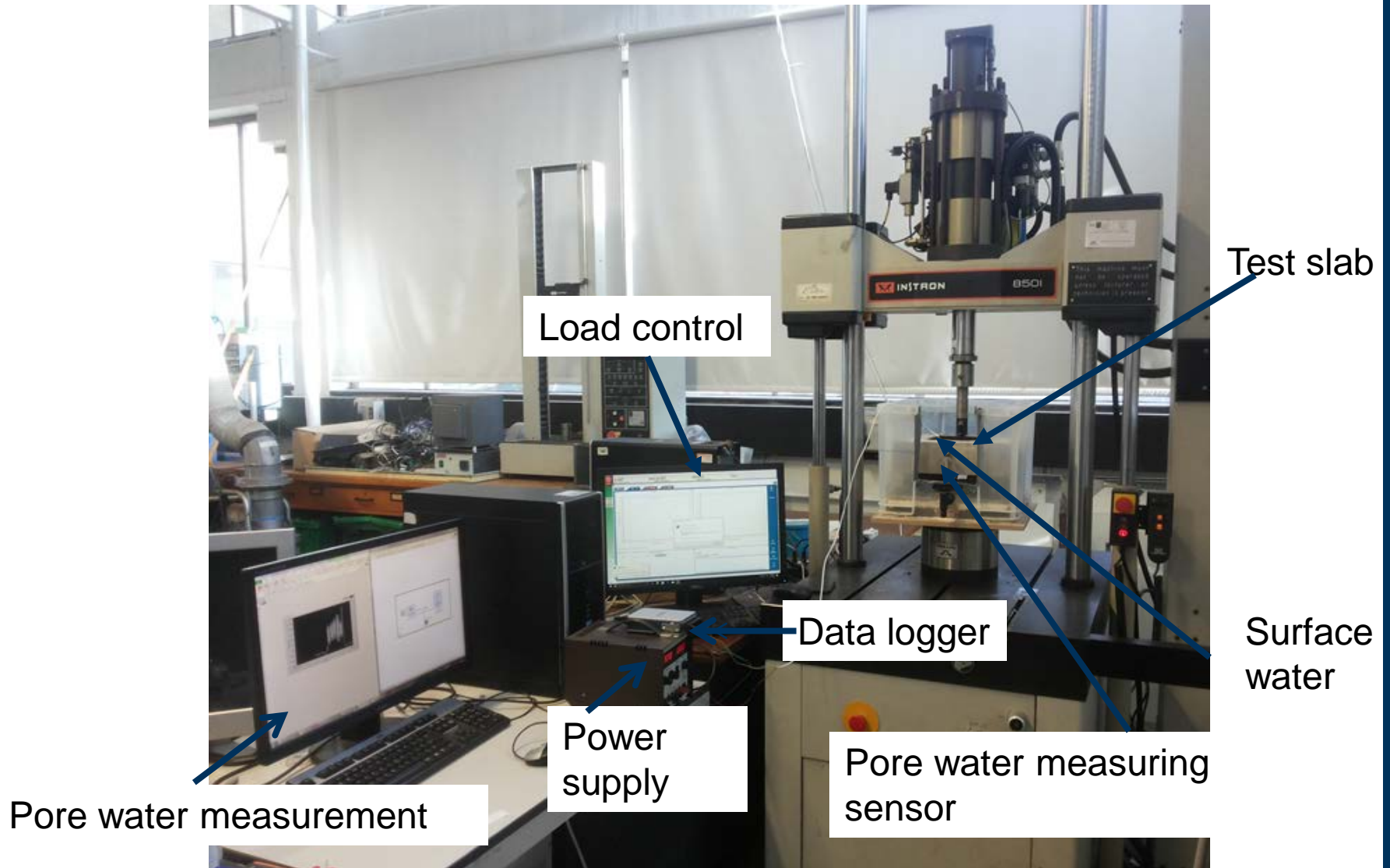


## Load plate





# Test Development



# Repeatability & Reproducibility

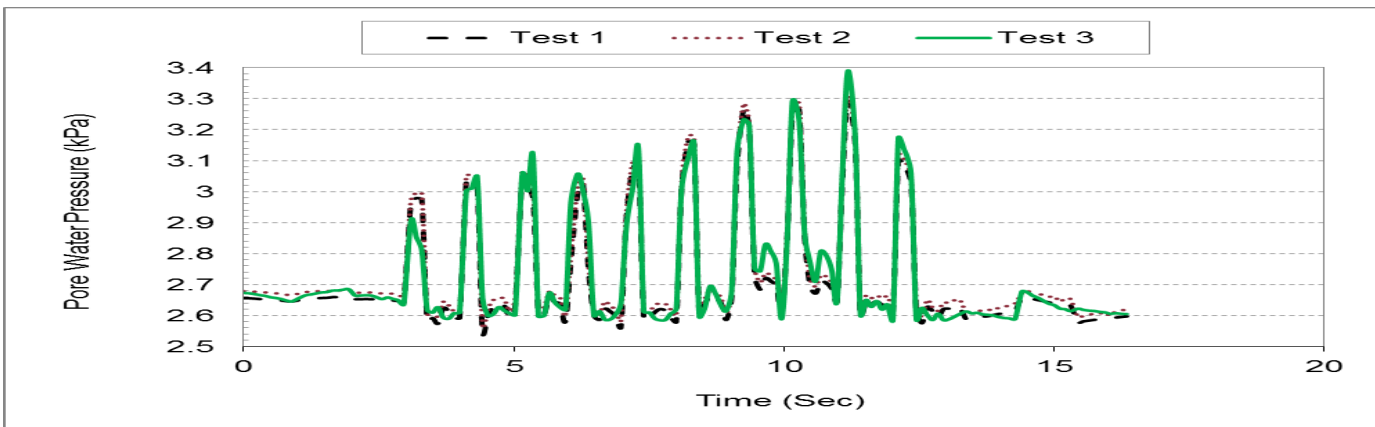
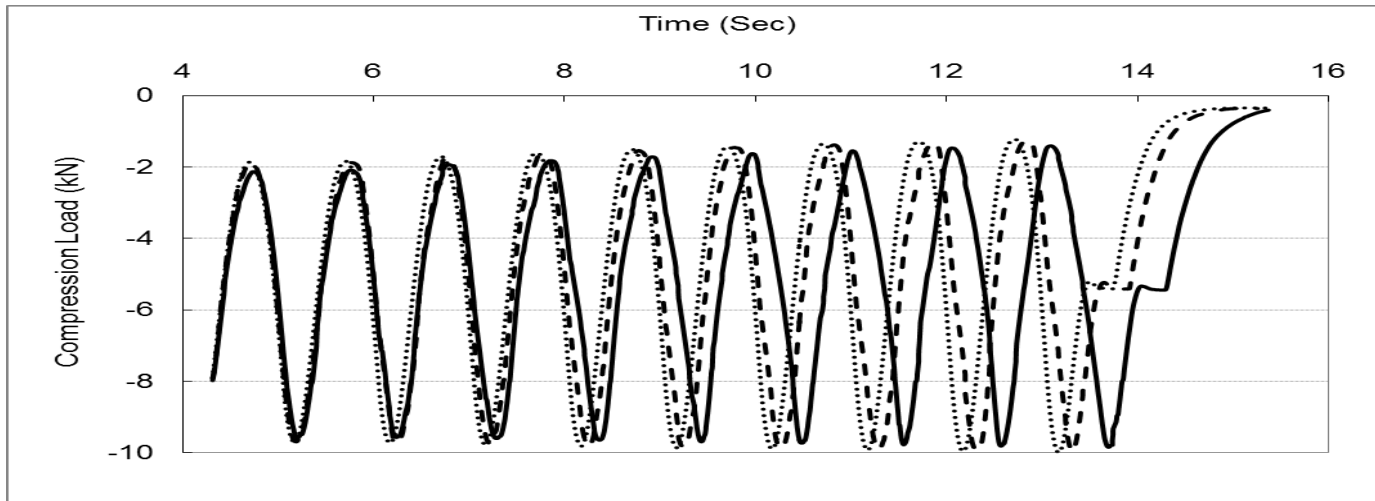
01 October 2018

Repeatability : 3 repetitions of each ease

Reproducibility: same test with different sensor

# Repeatability & Reproducibility

10kN & 1Hz



**Repeatability:** average difference ~ 3%, **Reproducibility:** within 5%

**Objective 2:** Investigate the impact of traffic parameters, tyre parameters, and depth of surface water on water pressure in the pavement.

**Test Specifications**

**Results**

**Observations**





# Test Specifications

Variable	Specifications
Surface water depth (mm)	2, 4
Tyre Tread Type	Square, Slot
Tread Depth (mm)	0, 1.5, 3 and 8
Load (KN)	5, 10
Loading Frequency (Hz)	1, 5, 10 and 15
Loading speed (Km/h) ~	3, 13, 26, 40
Type of Load	Dynamic Compression
Load Duration (Sec)	0.67-10
Sampling Rate	100 Hz

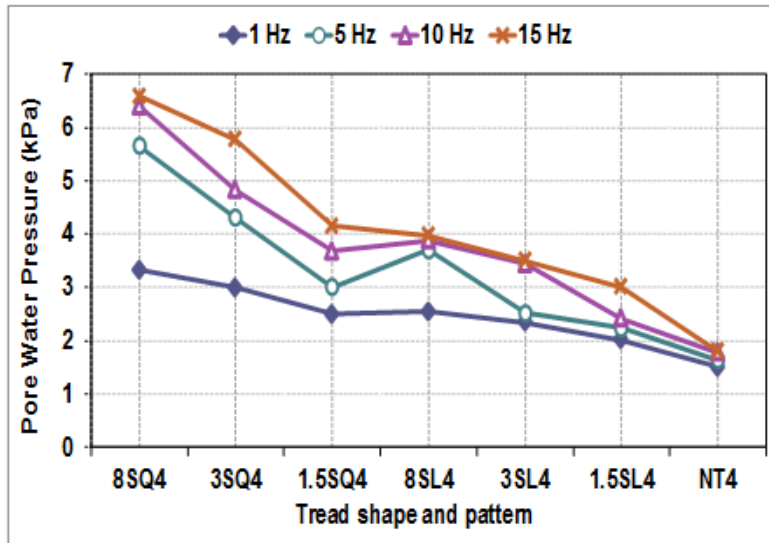
# Results

Influence of tyre characteristics (tread shape and depth) ,

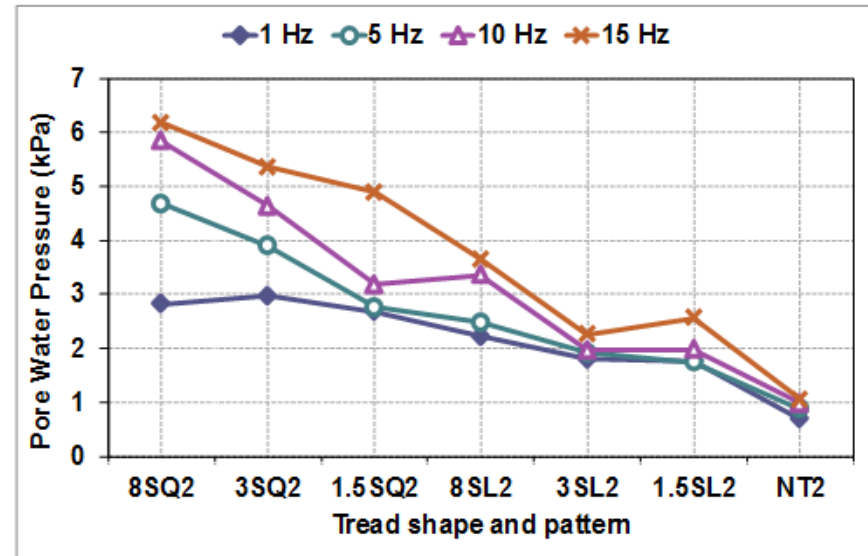
Influence of load magnitude, load frequency

Influence of depth of surface water

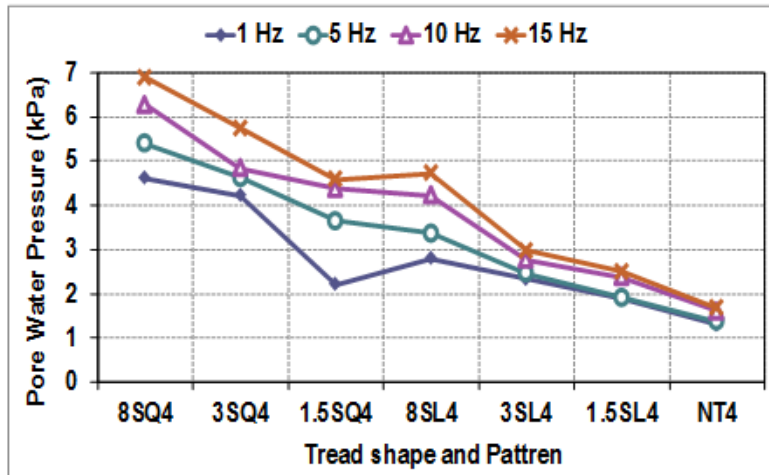
# Influence of tyre characterises, load magnitude, load frequency and depth of surface water



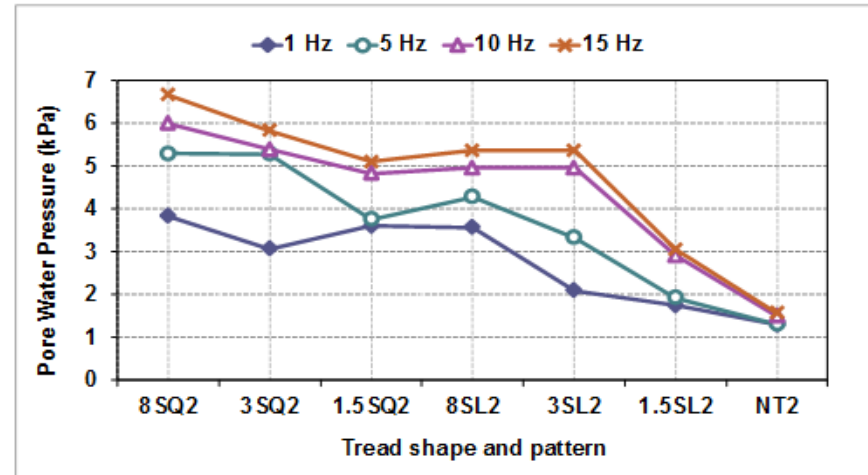
4mm surface water and load 5kN



2mm surface water and 5 kN load

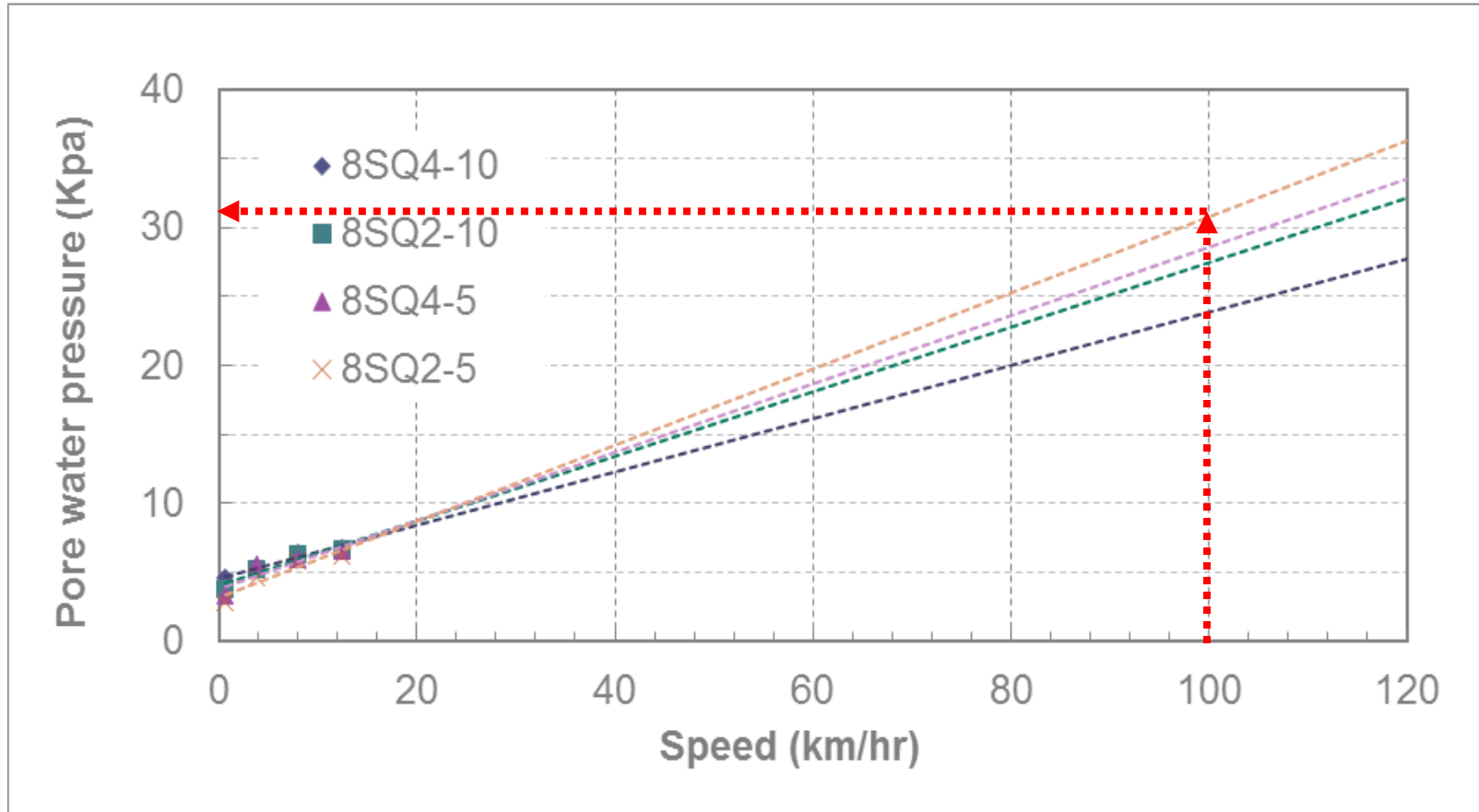


4mm surface water and 10kN load



2mm surface water and 10kN load

# Water pressure @ high speed



At 100 km/hr (~60 mph), the water pressure can be ~ 32 kPa, which is approximately 6.5% of applied contact pressure 500kPa ( $5000/(100^2)$ )



# Observations

## *Tyre characteristics*

Irrespective of tread pattern, 8mm tread thickness showed the highest amount of water pressure, but the pressure reduces significantly in 1.5mm tread thickness.

## *Load magnitude*

Load magnitude has the marginal impact on the pore water pressure. The difference between 5kN and 10kN load was found only range from 3% to 25% in all tread patterns, thicknesses and loading frequencies.

## *Load frequency*

The water pressure increases with increasing frequency. Water pressure was higher in a square tread than slot cut tread shape as more water was possible to drain out during the load plus.

## *Influence of surface water*

Water depth 2mm and 4mm tend to have a marginal impact on increase water pressure in high frequency while is negligible at low frequencies specifically with 1.5SL and NT.

Whilst the magnitude of water pressure was only around 6.5% of the contact pressure, smaller but continuous voids can significantly increase this pressure, which eventually can lead to degradation of foundation material and progressive deterioration to asphalt surface resulting fretting, ravelling or stripping, potholes....

**Objective 3** : Investigate the impact of combined interaction of tyre-water-pavement on formation of surface damage.

**Commonly used Asphalt Surfaces**

**Test Specifications**

**Testing**

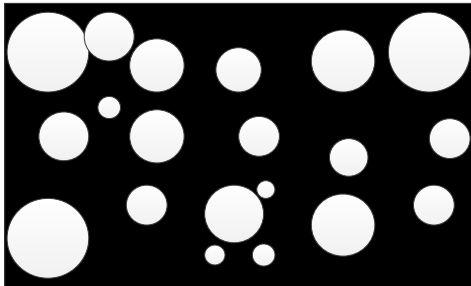
**Results**

**Observations**



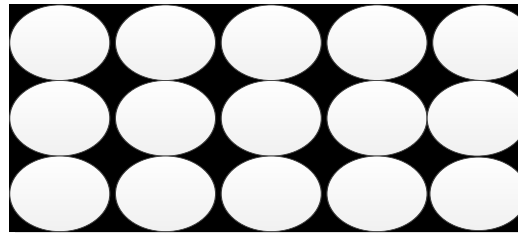
# Commonly used asphalt surfaces

Hot Rolled Asphalt  
( HRA)



Gap graded,  
~ 4-8 % voids

Stone mastic asphalt  
( SMA)



Open graded  
~ 8-12 % voids

Porous asphalt  
( PA)



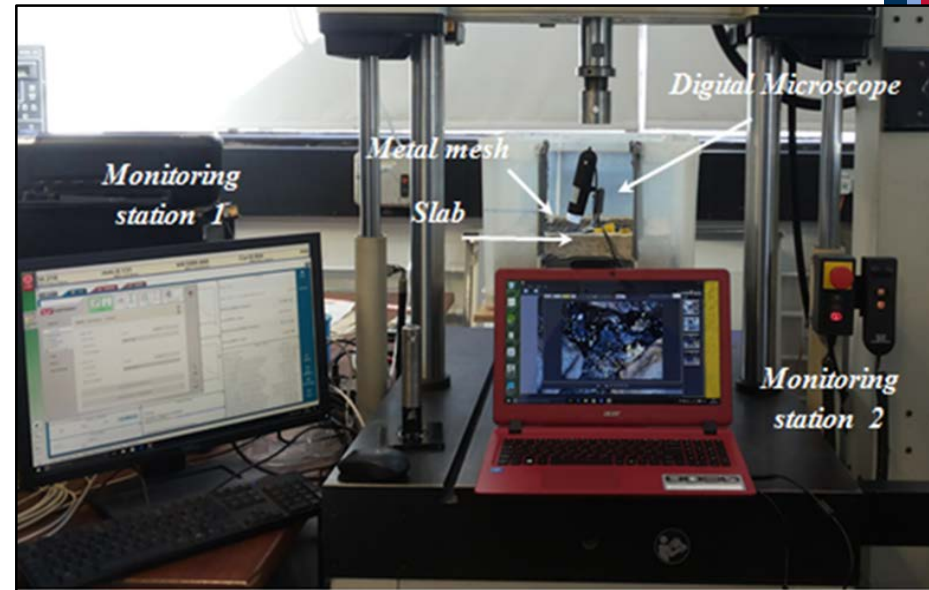
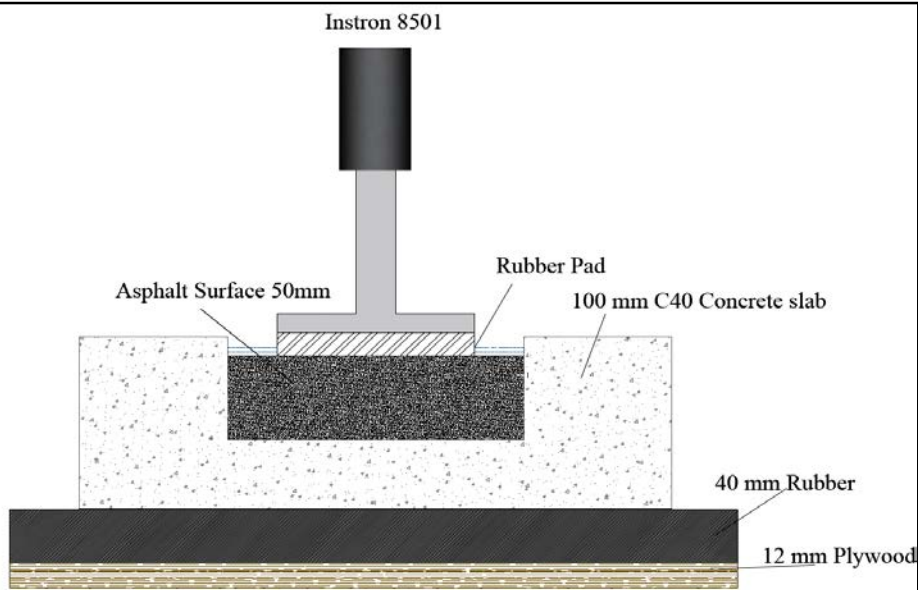
Open graded  
~ 18 % voids

# Test Specifications

Variable	Specifications
Surface water depth (mm)	1-2
Tyre Tread Type and depth	8mm groove
Load (KN)	5
Loading Frequency (Hz)	5
Loading speed (Km/h)	26
Type of Load	Dynamic Compression
Load cycles (k)	20000, 40000
Surface type	HRA, SMA, PA
Aggregate size (mm)	6, 10 & 14
Specimen size (mm <sup>3</sup> )	200X200X50
No of specimen /mix	6
Test condition	Wet and Dry
Distress measurement	Cracking, rutting, ravelling



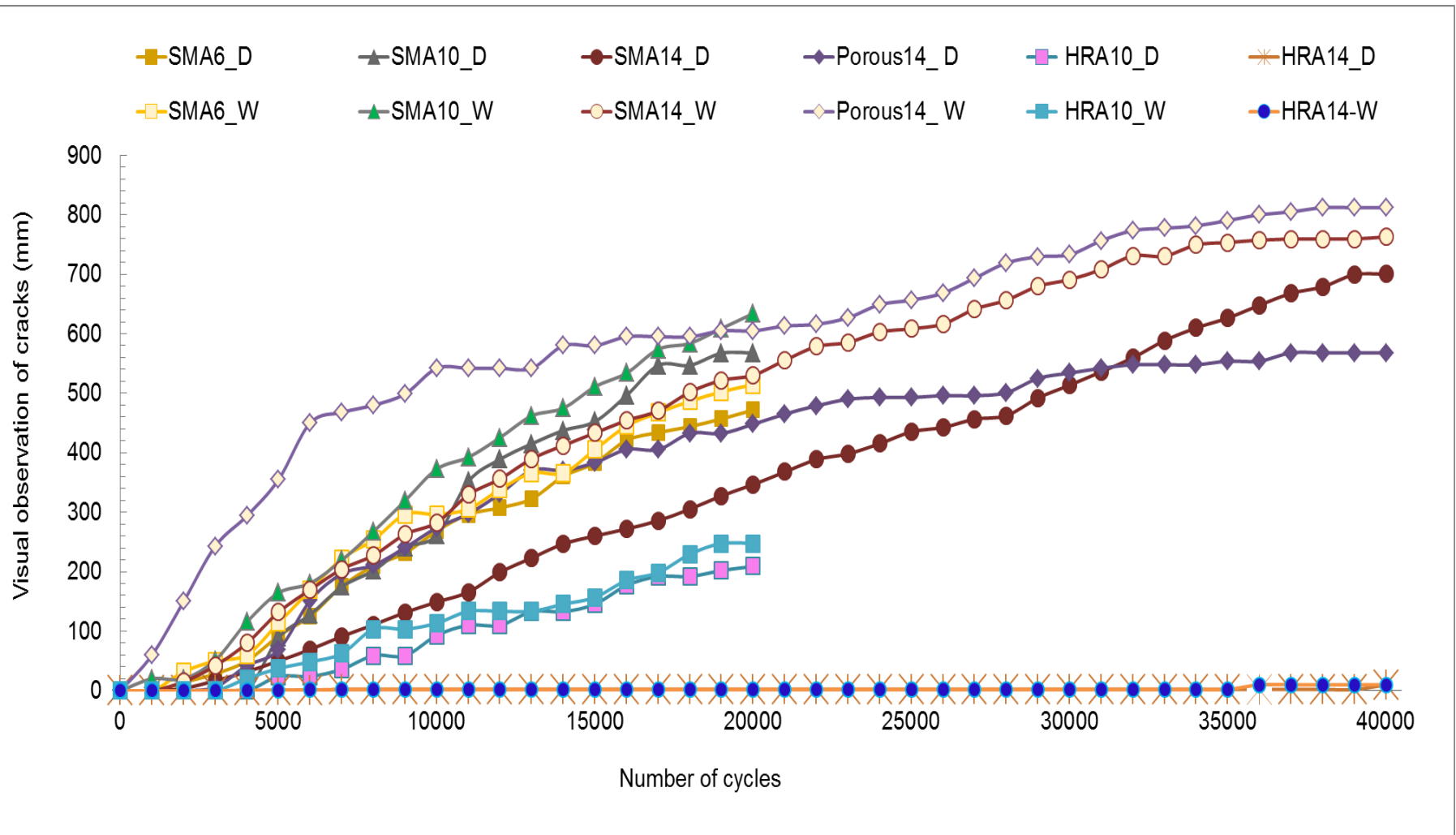
# Testing



# Results

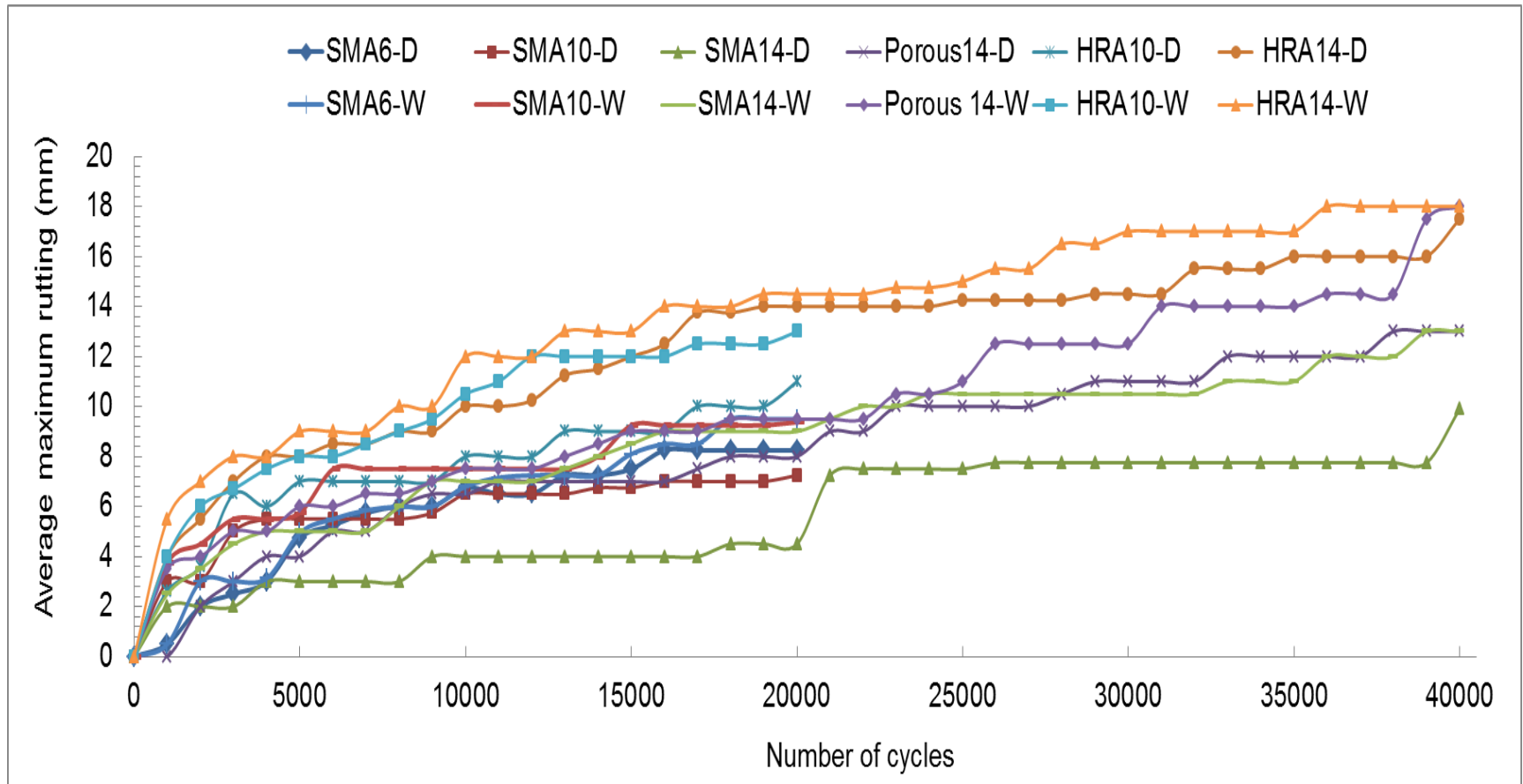
- # Influence of surface water
- # Comparing with design standard

# Cracking- Influence of water



Average cumulative cracking in dry and wet condition at 5 Hz

# Rutting- Influence of surface water



Average cumulative rutting in dry and wet condition at 5 Hz



# Comparing with Design Standard

01 October 2018

**Crack severity ( LTPP criteria):** **Low:** 70 mm to 100 mm with a few connecting cracks, **Medium:** 100 mm to 150 mm with interconnected cracks, **High:** > 150 mm interconnected cracking forming a complete pattern and pieces move with loading

**Rutting (DMRB criteria)** **Low** < 10 mm, 10 mm < **Medium** < 20 mm, **High severity** > 20 mm

# Comparing with Design Standard

Mixture	Cracking: Load cycle				Rutting	
	1 <sup>st</sup> crack	L	M	H	20k	40k
HRA10-D	4042	9320	10236	14664	H	-
HRA10-W	3050	7180	7820	15096	H	-
HRA14-D	6000	40,000*	-	-	H	H
HRA14-W	5000	40,000*	-	-	H	H
SMA6-D	1070	4350	5120	6420	M	-
SMA6-W	1030	4313	4780	5640	M	-
SMA10-D	4012	4785	5192	6448	M	-
SMA10-W	50	3290	3712	4576	M	-
SMA14-D	1250	6037	7360	10001	L	M
SMA14-W	1065	3732	4344	5420	M	H
PA14-D	2160	5025	5400	5960	M	H
PA14-W	17	1110	1432	2000	M	H

# Conclusions

- The influence of combined water and dynamic loading on surface damage was successfully simulated in the laboratory environment. The outcome of the test method has demonstrated a **promising future for further development**.
- Depending on the type of asphalt surfaces, the presence of **water accelerates surface damage** concerning cracking, rutting and other distresses like reavelling.
- The cracking propensity is **severe in highly open graded mixtures** like porous asphalt, then SMA than in gap graded hot rolled asphalt. Compared to dry condition testing, the appearance of surface crack was approximately **seven times** faster in porous asphalt tested in wet conditions.
- All tested SMA mixtures demonstrated good rutting resistance compared to porous and hot rolled mixtures, although their **cracking resistance was significantly reduced in the presence of water**.
- In the presence of water, **the mixture gradation** appeared to have more influence on load bearing capacity than the size of aggregates.

**Thank you**

**mujib.rahman @ brunel .ac.uk**







# Science of durable asphalt patch repair – Professor Denis Chamberlain, Epicuro Ltd (Visiting Professor Brunel University)

Hot Asphalt Repair of Pot holes

Presenter & Inventor of Heater: Denis Chamberlain

Acknowledgement: Majority of the content is extracted from 11 publications authored by Juliana Byzyka, Mujib Raham and myself

# Introduction to Epicuro Ltd

Materials manufacture: cleaning, protection and waterproofing of bridges, buildings and pavement.

Working with Brunel University:

- Materials and equipment

- Research supervision

- Loan of Epicuro pothole heater

# Scope of Presentation

- Pothole repair demand.
- Scope of pothole repair R&D.
- Current practice case study.
- Scientific basis of heated pothole repair.
- Pothole repair heating strategies.
- Investigations and Testing.
- Main Findings.
- Further work: (inc magnetite aggregate)

# Pothole Repair Demand

$$NPR_c = [NPR_{uk} \times 0.89] \times [(TR_c/TR_{uk}) \times (P_c/100) \times (GP_c/GP_{uk}) \times (NP_c/NP_{uk})]$$

SYMBOL	PARAMETER
$TR_c$	Total road network in country
$TR_{uk}$	Total road network in UK
$P_c$	Percentage paved road in country
$GP_c$	GNI per capita (PPP) (US\$) in country
$GP_{uk}$	GNI per capita (PPP) (US\$) in UK
$NP_c$	Number passenger cars per 1000 population in country
$NP_{uk}$	Number passenger cars per 1000 population in UK
$NPR_c$	Annual no. pothole repairs in country
$NPR_{uk}$	Annual no. pothole repairs in UK
$NM_c$	Number of machines for country
$NM_{uk}$	Number of machines for UK

## ANNUAL ESTIMATES

Pothole repairs: 3m UK & 90m WW\*

Annual tonnage asphalt: 108,000 UK & 3,225,000 WW\*

[\*WW-Europe, America and Canada]



# Scope of Pothole Repair R&D

- Fully bonded hot asphalt repairs.
- Repair life same as surrounding pavement.
  - eg basis for 4-5 years contractors warrantee.
- Minimal time and energy repairs.
  - smart heating/new asphalt mixes.
- Any plan shape with common depth range pothole.
  - eg any length with width  $<0.8\text{m}$ .
- Small format, AI driven heater for single lane closures.
- Quality management based on repair sensor measurements.
- Back to base internet monitoring (GPS, SMS, Email).
- Test facility for all pothole repair equipment and methods.

# Current Practice Case Study

Repair 6<sup>th</sup> Aug 2017

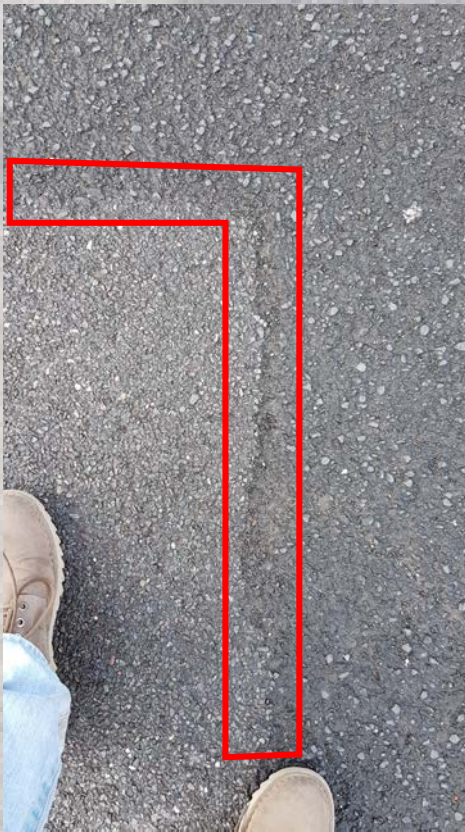


- Rainwater and loose stone brushed out of pothole.
- Hot asphalt fill placed in excavation (105°C).
- Heater placed over fill for approx 5 mins.
- Fill compacted with roller
- Surface temperature measured (125°C)
- Edge sealer applied (gilonsite, mistake?)





# Current Practice Case Study



Examination 11<sup>th</sup> Sept 2018

- 13 months after repair.
- Stones lost on boundary
- Lost fill within repair area

# Current Practice Case Study

## Possible Reasons for Premature Failure

### Practice

- Heat losses during fill delivery.
- Heat loss during patch repair process.
- High moisture content in pot hole.
- Weak perimeter pavement to pot-hole.
- Contaminated fill (mixed with existing).
- Restrained/inadequate heating due lack of control.
- Lack of operator training/ understanding.
- No quality/performance measures.
- Low performance requirement (24 months)

### Asphalt

- Low thermal conductivity (slow heat penetration).
- High thermal capacity (large heat energy required).
- Minimum bond temperature (softens 75-100°C)
- Combustion risk at 150-200°C



# Scientific Basis of Heated Pothole Repair

*“By suitably controlled heating it is possible to make pothole repairs in asphalt pavement having similar life expectancy and performance to that of surrounding pavement.”*

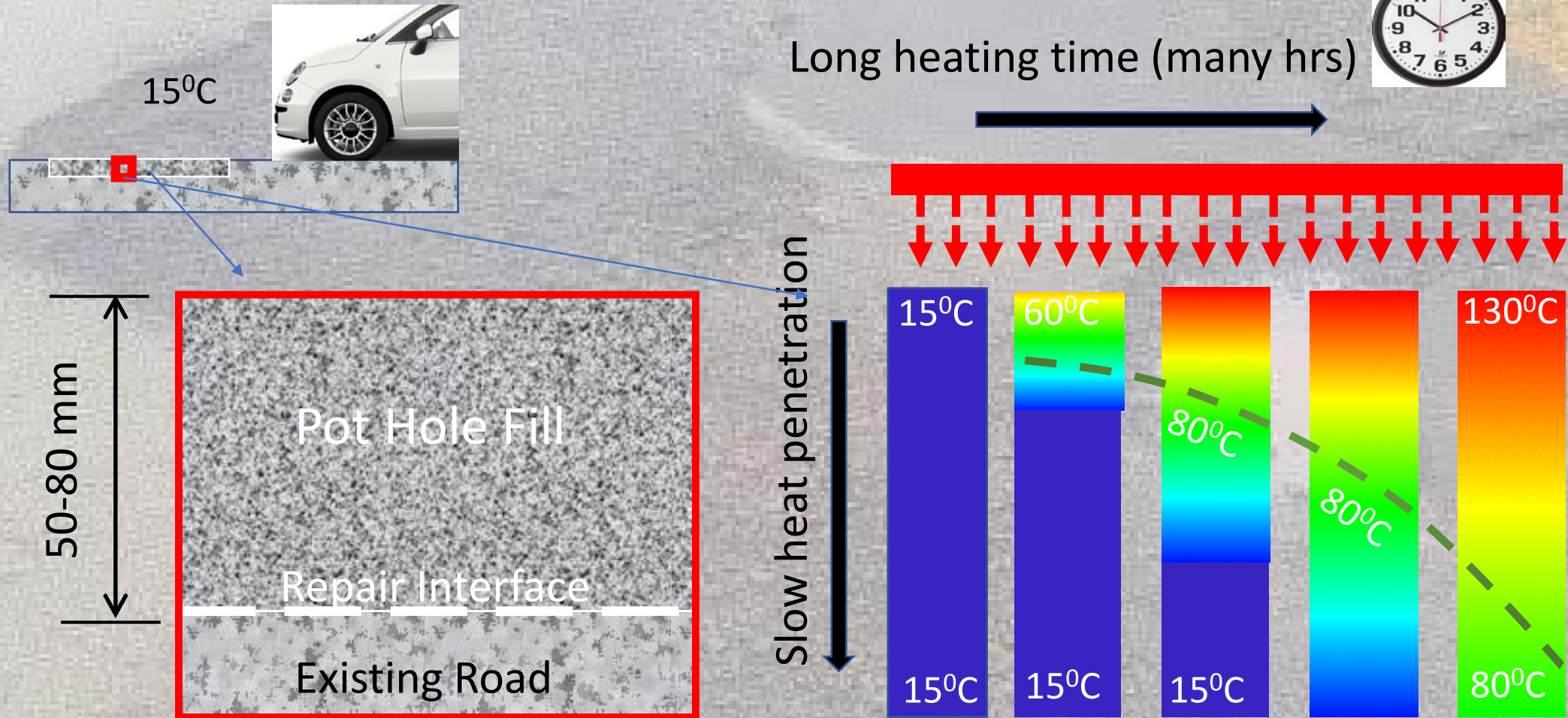
[24 months is the commonly operated current contractual period in pothole repair work.]

# Scientific Basis of Heated Pothole Repair

- Pothole repair heating strategies.
- Thermal modelling of repair process.
- Insitu properties of repair pavement.
- Verifying/calibrating thermal model for repair control.
- Influence of heating patterns on repair time and energy.
- Influences of alternative asphalt fill mixes.
- Accelerated life testing methods.

# Pothole Repair Heating Strategies

Fill heated in cold pothole (cold oven cake baking)



# Pothole Repair Heating Strategies

Hot fill in cold pothole (heat robbing)



Slow heat transfer across repair interface

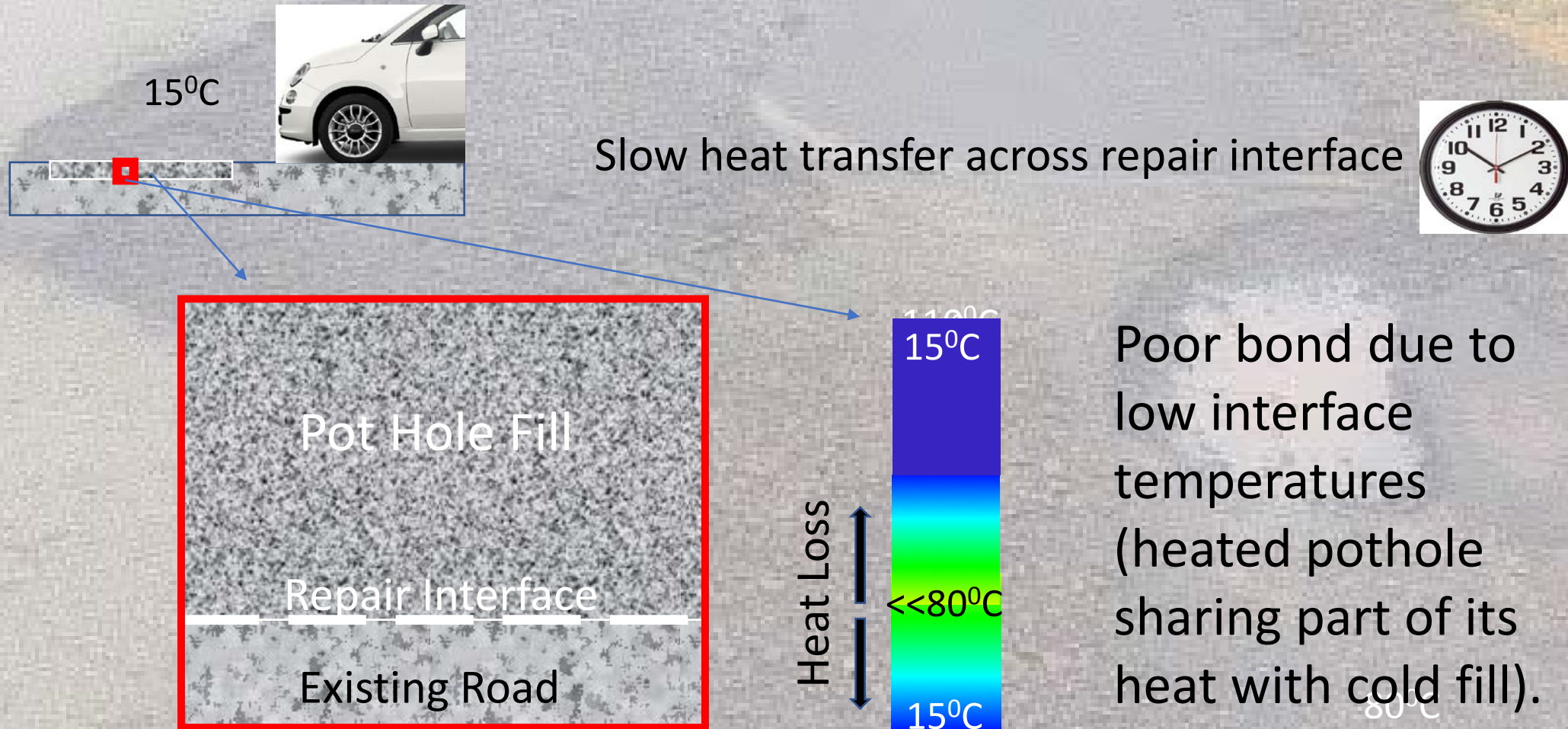


Poor bond due to low interface temperatures (hot fill sharing part of its heat with cold pothole).



# Pothole Repair Heating Strategies

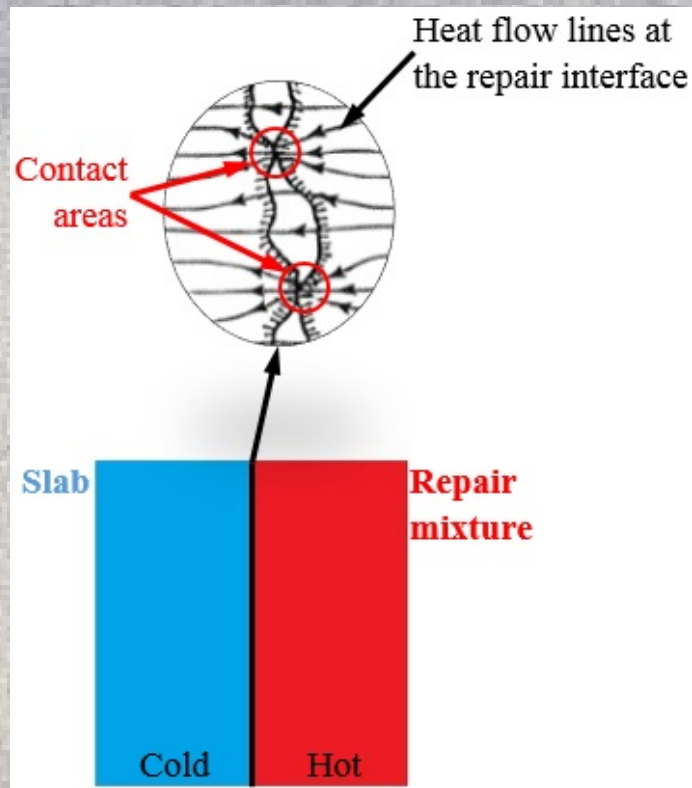
Cold fill in pre-heated pothole (heat robbing)



# Pothole Repair Heating Strategies

Why current heating methods are inadequate

Air voids and incomplete contact reduce heat transfer between fill and host pavement (relying partly on weak convection).



Mass A ( $100^{\circ}\text{C}$ ) adjacent to mass B ( $20^{\circ}\text{C}$ ) gives temperature substantially less than  $< 60^{\circ}\text{C}$  in mass B.

*Dynamic pre-heating of pothole improves interface contact, reduces air voids and enhances heat conduction.*

# Pothole Repair Heating Strategies

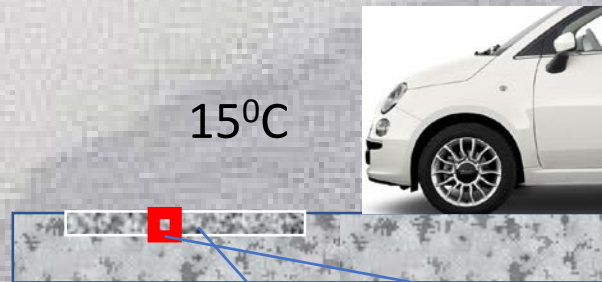
## Why current heating methods are inadequate

- Operators safe surface temperature 120°C-160°C (avoiding fire/explosion risk)
- Asphalt softening at 75°C-100°C necessary for bonding
- Host pavement typically 10°C-25°C
- Heat losses due to climatic conditions (wind/cold) can be very significant
- Asphalt is poor heat conductor.
  - Slow heat penetration/transfer within asphalt mass
- Asphalt has large thermal capacity (specific heat).
  - Raising temperature within asphalt requires substantial heat energy

*Above combine to make it impossible to achieve bonding temperatures at the fill/pavement boundaries unless the pothole is pre-heated in a controlled manner.*

# Pothole Repair Heating Strategies

Hot fill placed in pre-heated excavation (heat balancing)



Short normalising time necessary (mins)



Heat Loss



>80°C Possible

15°C

Bond assured due to adequate heat energy in repair interface region.



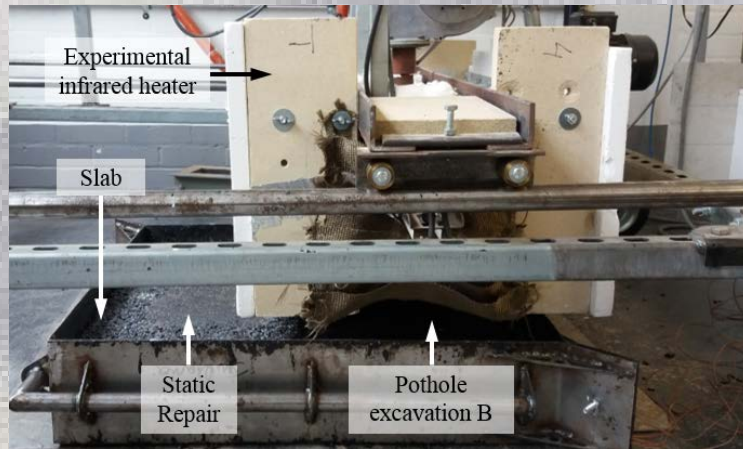
# Investigation and Testing

## Pavement repair investigation

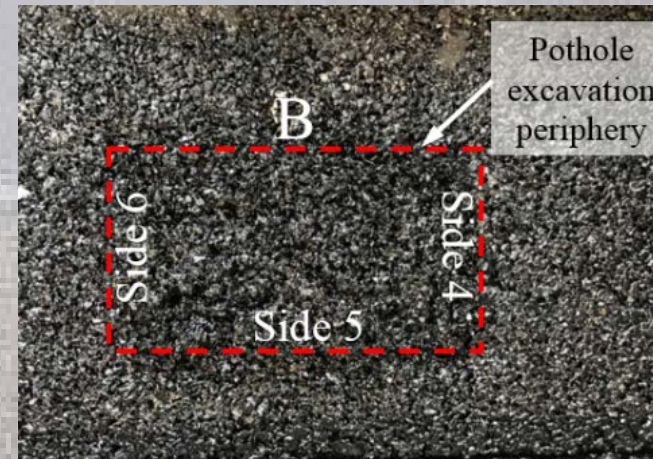
- Mixes used in investigations
  - Host pavement 20 mm DBM (Dense Bituminous Macadam)
  - Fill material AC 14/6 (Asphalt Concrete).
- Repair depths investigated
  - 45mm (most used), 75mm & 100mm
- Hot fill repair
  - 110°C fill compacted in cold pothole excavation.
- Dynamically heated repair
  - 110°C fill placed in pre-heated pothole excavation.
- Thermal properties
  - Heat conductivity and thermal capacity measure insitu.
- Heating unit
  - Gas powered, static/scanning, variable/programmable power, adjustable offset.

# Repair process using heater

## Asphalt temperatures continuously recorded



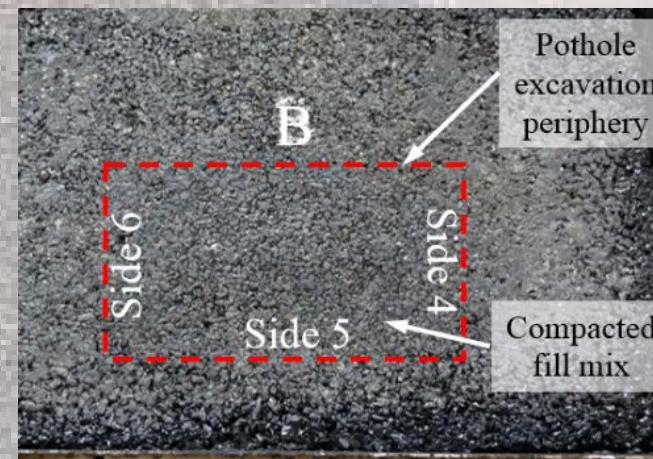
Potholes excavations dynamically pre-heated



Pothole filled with hot asphalt mix (110°C)



Asphalt fill compacted in pothole

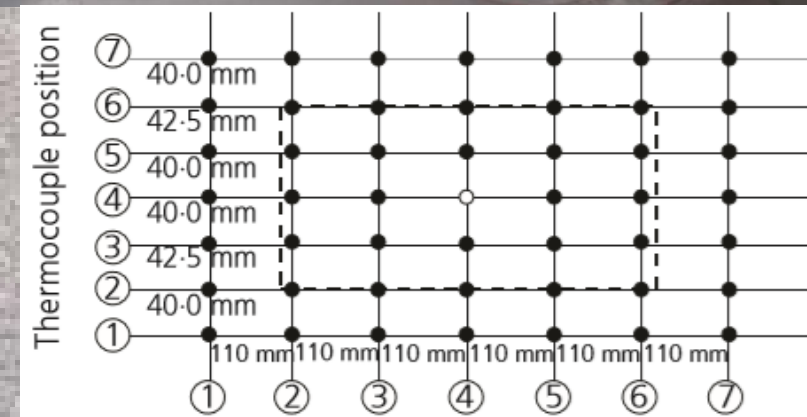
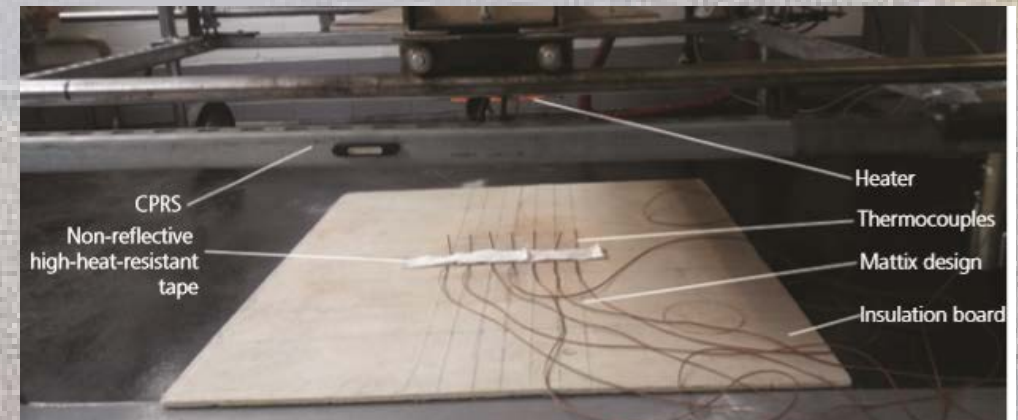
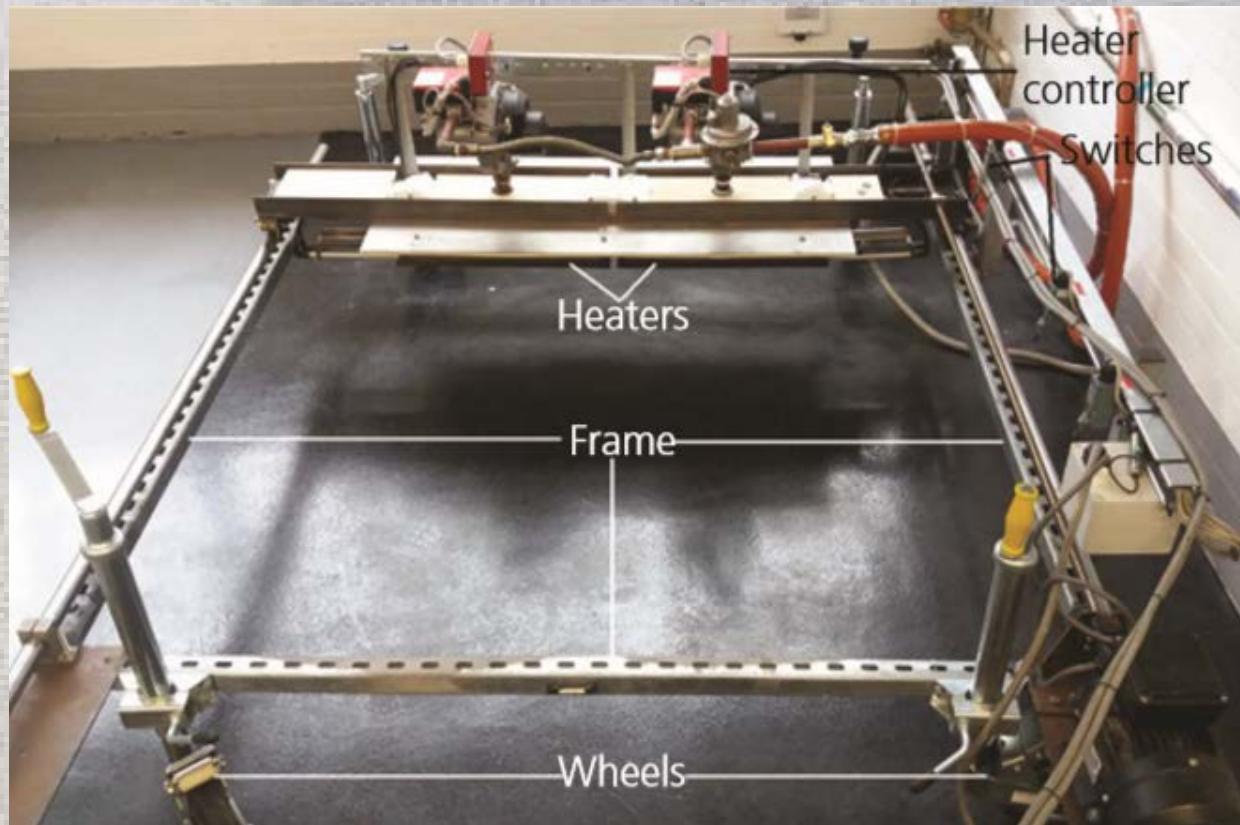


End result (perimeter often undetectable)



# Investigation and Testing

Understanding temperature patterns on heated surface.

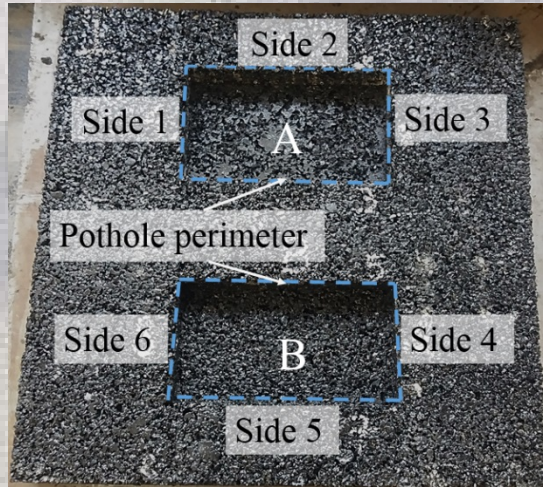


Mobile high precision pothole repair heater

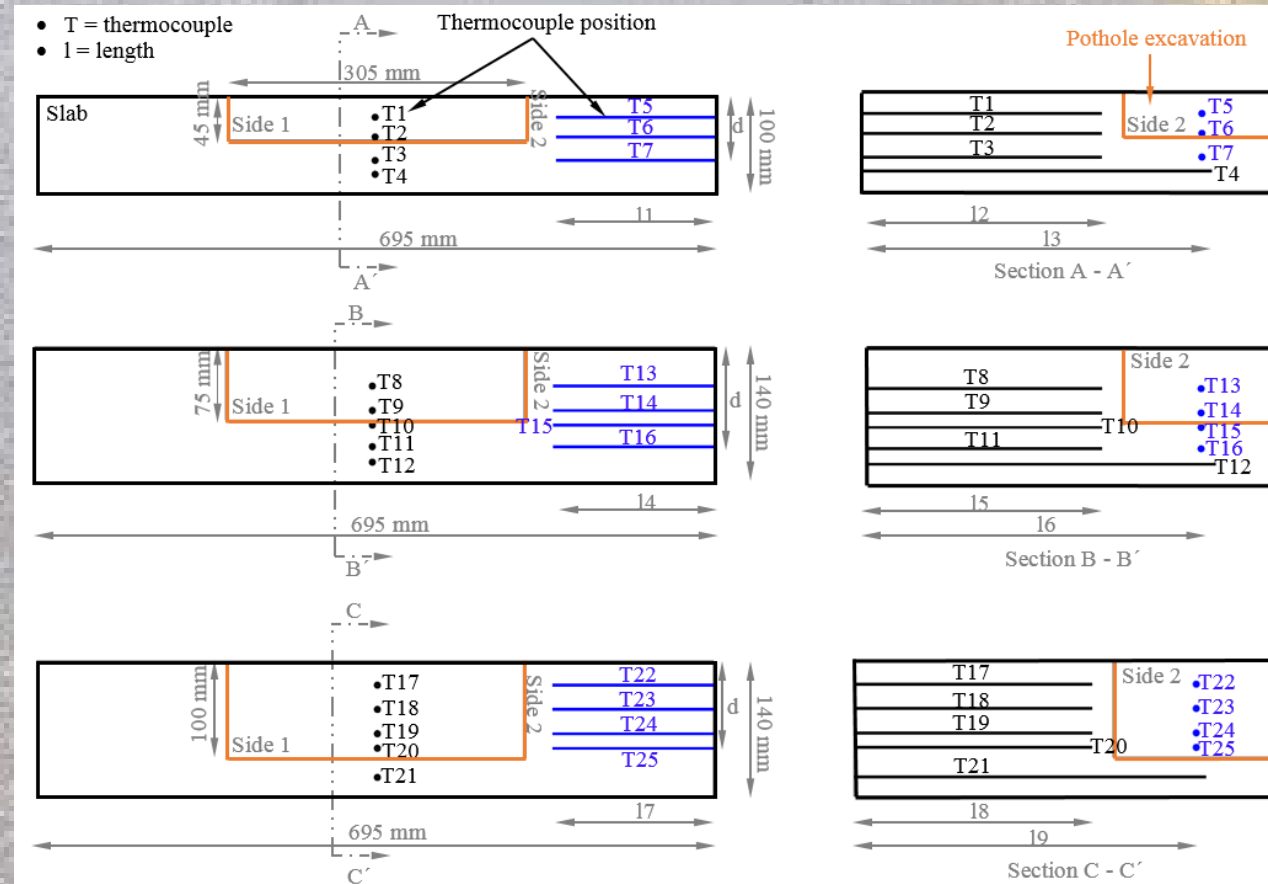
Repair interface temperature sensor matrix.

# Investigation and Testing

## Temperature measurement inside repair



Thermocouples at fill interfaces

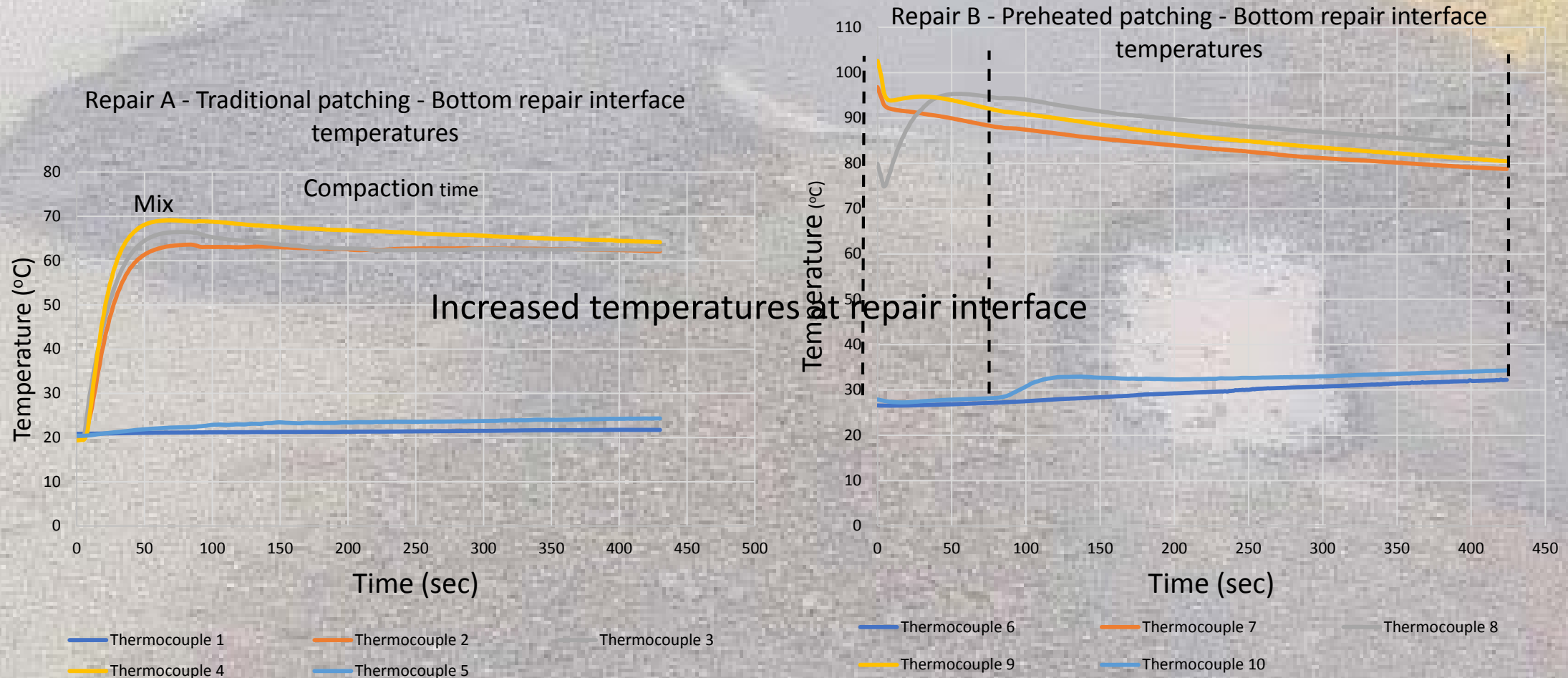


Thermocouples at depth in and host pavement.



# Investigation and Testing

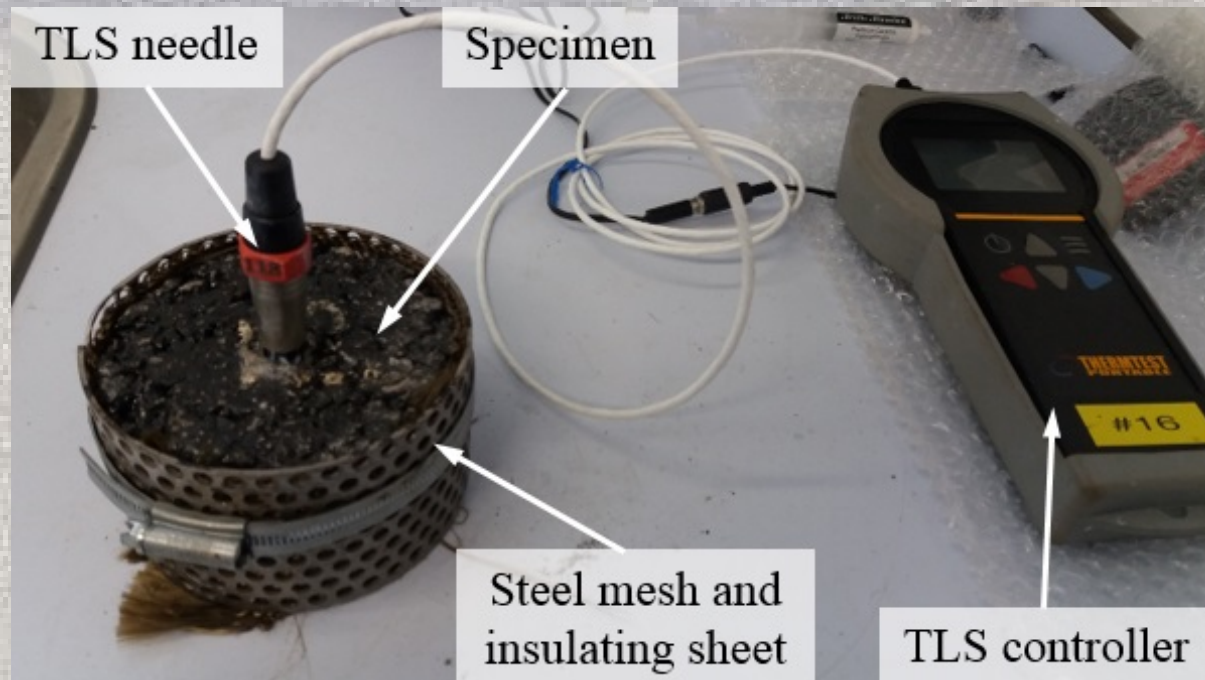
## Temperature measurement inside repair



# Investigation and Testing

## Insitu thermal properties of asphalt

Average thermal conductivity measured at 19 °C, 65°C and 80°C by insitu test. Gives tri-linear relationship for modelling



Detailed topic:  
Properties needed to understand heat power settings.  
Affected by asphalt mix.  
Affected by temperature.  
Limited aging effect.

# Investigation and Testing

Insitu thermal properties of asphalt for control



10 holes of 4 mm (D) × 50 mm (H)  
for  $k$  measurement

Insitu determination of thermal properties during testing



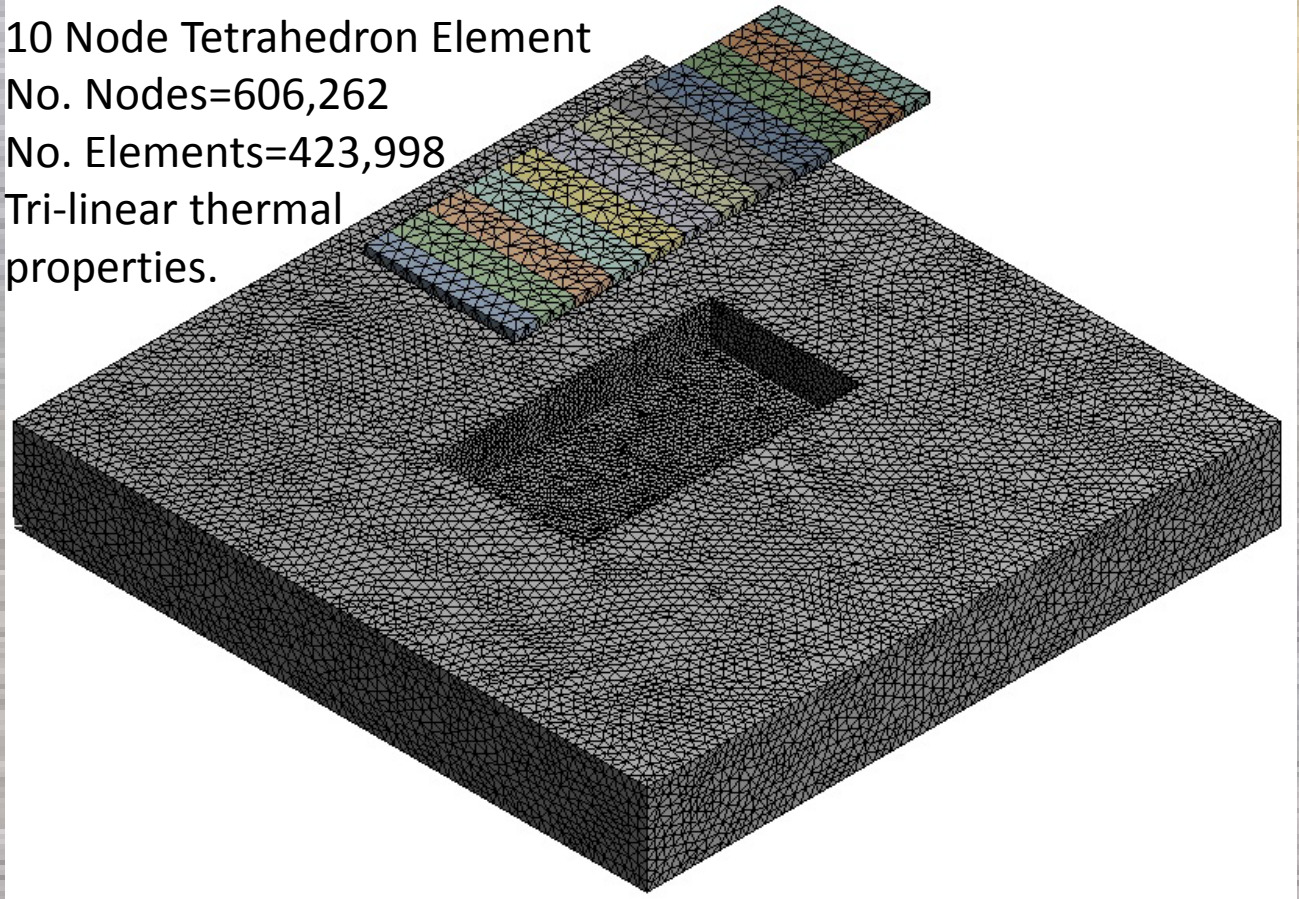
# Investigation and Testing

## Thermal modelling of repair process



160mm x 300mm repair in 450mm  
x 450mm pavement sample

10 Node Tetrahedron Element  
No. Nodes=606,262  
No. Elements=423,998  
Tri-linear thermal  
properties.

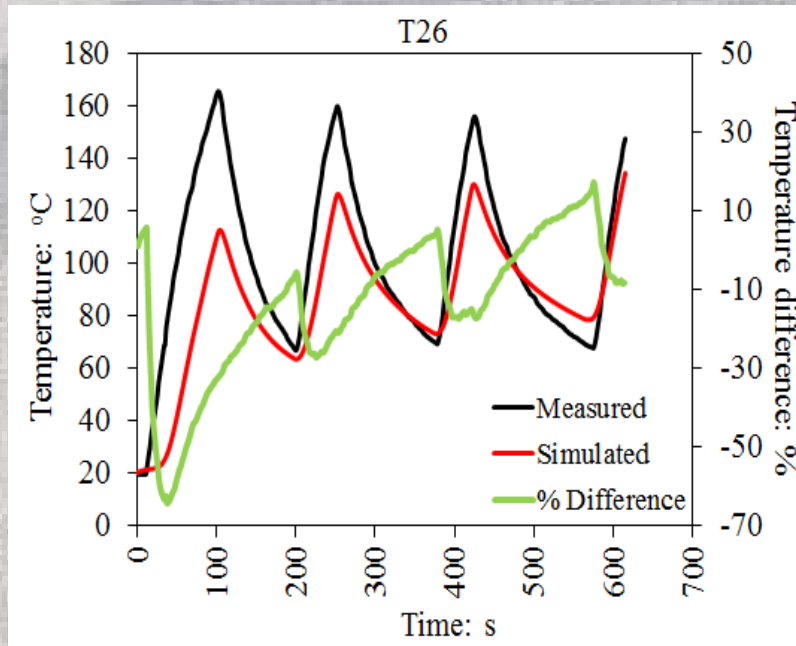


Non-linear dynamic Finite Element thermal model

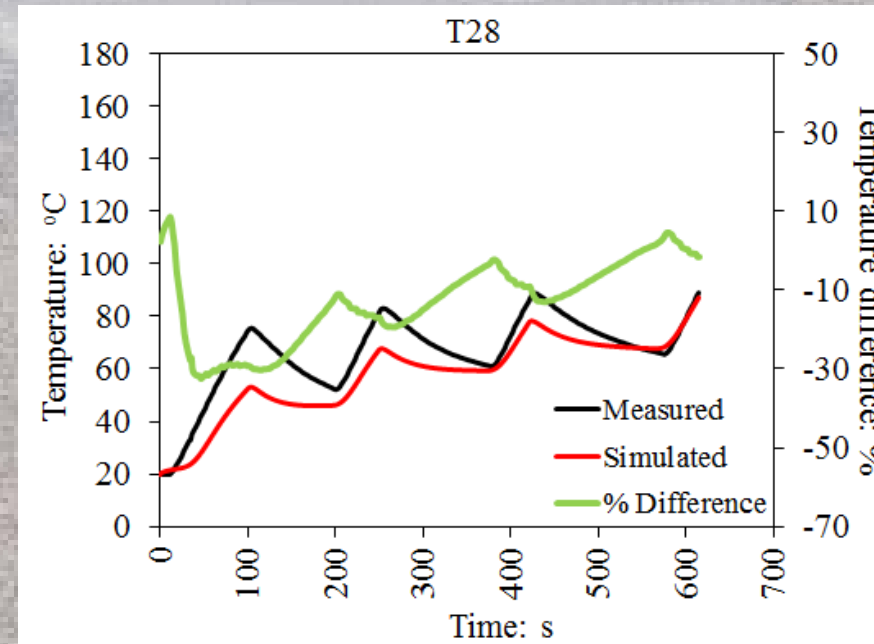


# Investigation and Testing

## Thermal model of pot-hole excavation dynamic pre-heating



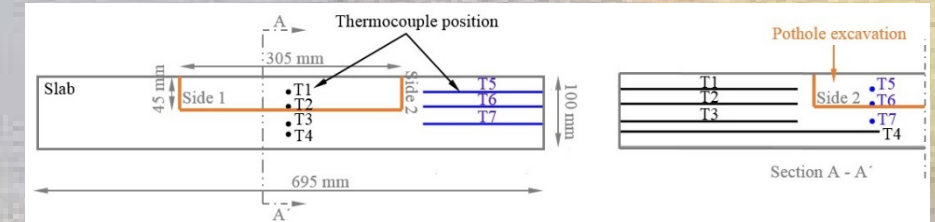
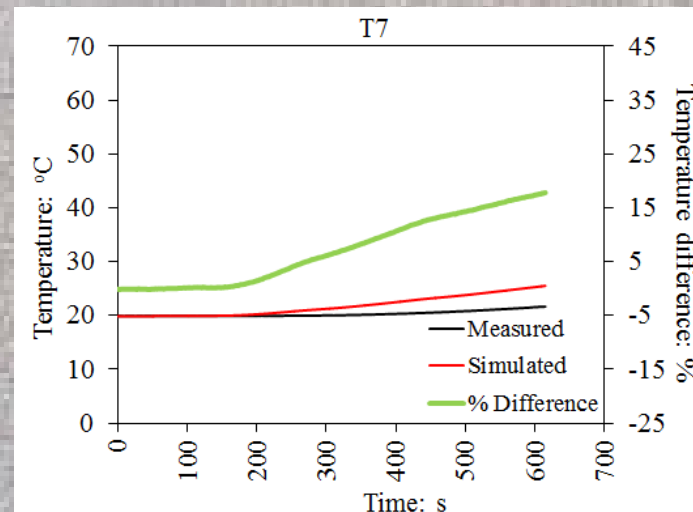
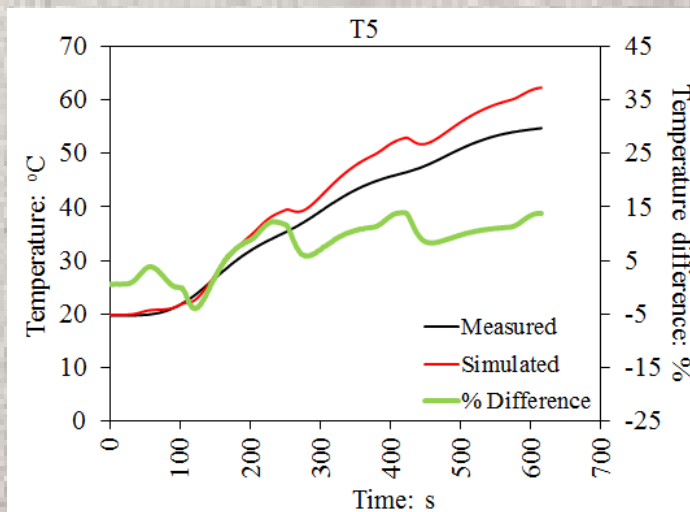
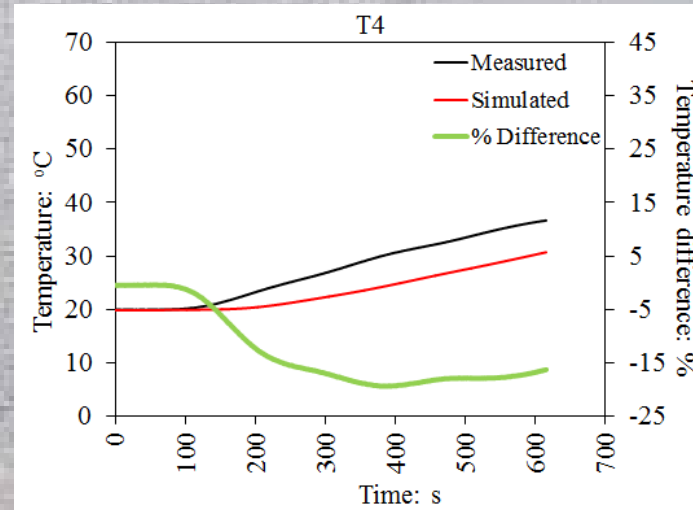
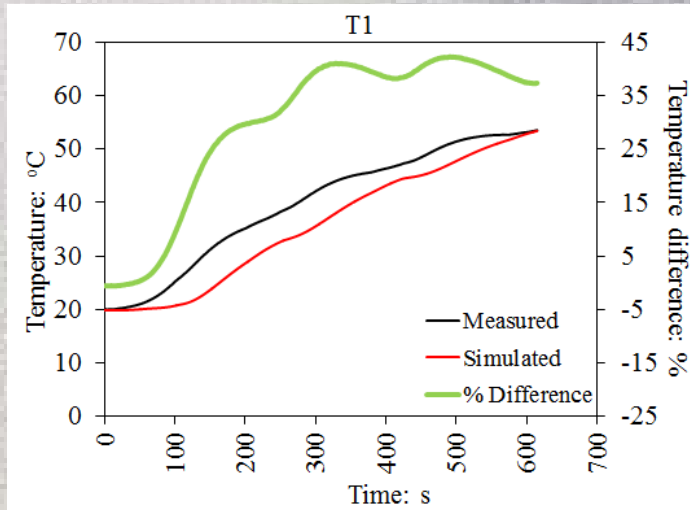
Bottom face of empty pot-hole



Vertical face of empty pot-hole

# Investigation and Testing

## Thermal model of pot-hole excavation pre-heating

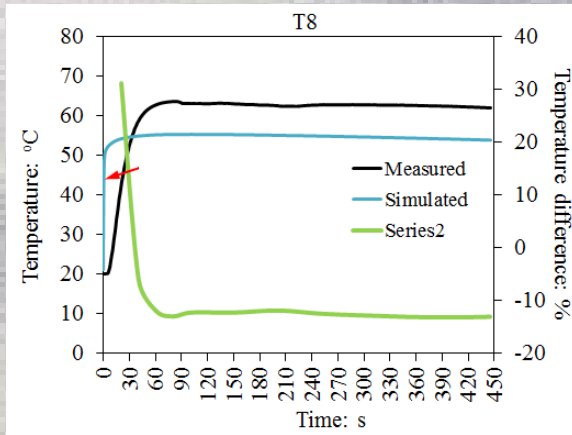


Pre-heating Simulation:  
internal temperatures of  
surrounding pavement during  
pre-heating.

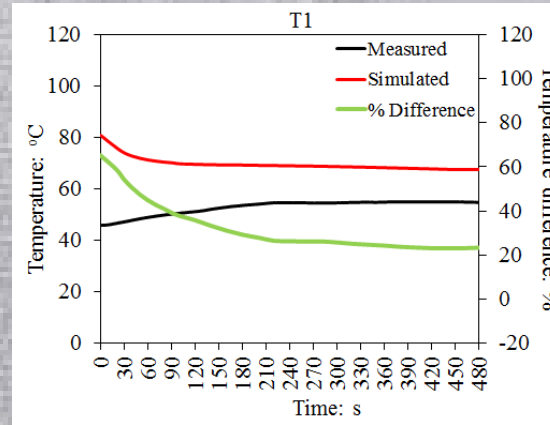
87%-98% average correlation  
between model (red) and  
measured (black)  
temperatures.

# Investigation and Testing

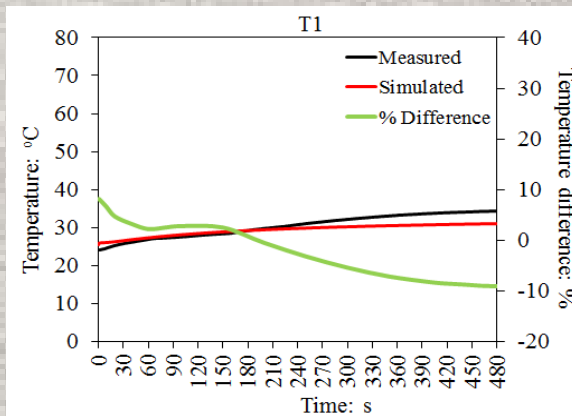
## Thermal modelling of pothole repair



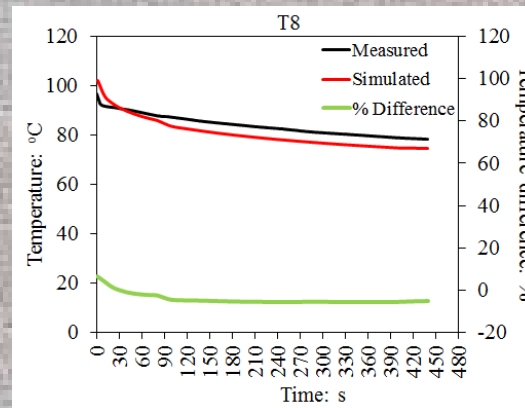
Vertical face: no pre-heating



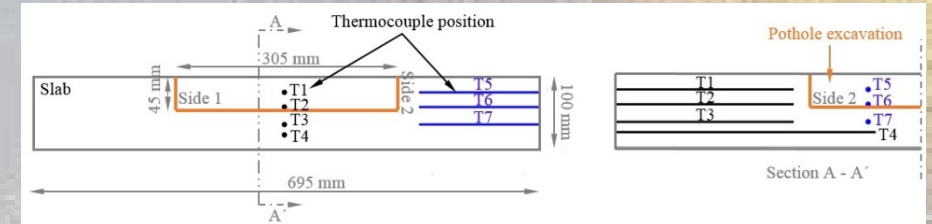
Vertical face: pre-heated



Top face: no pre-heating



Vertical face: pre-heated

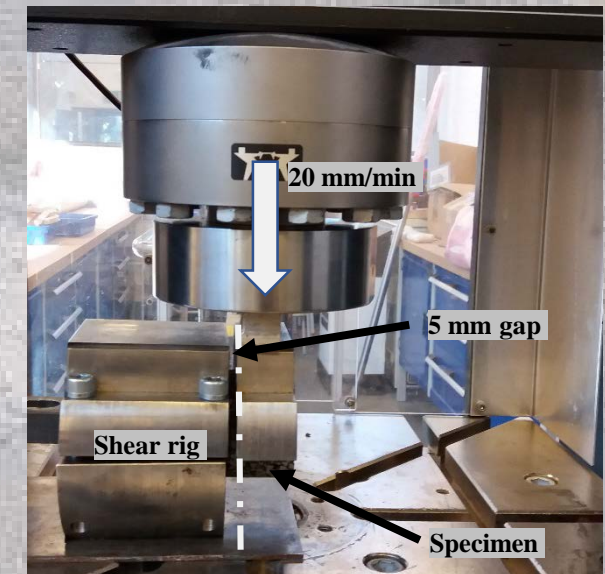
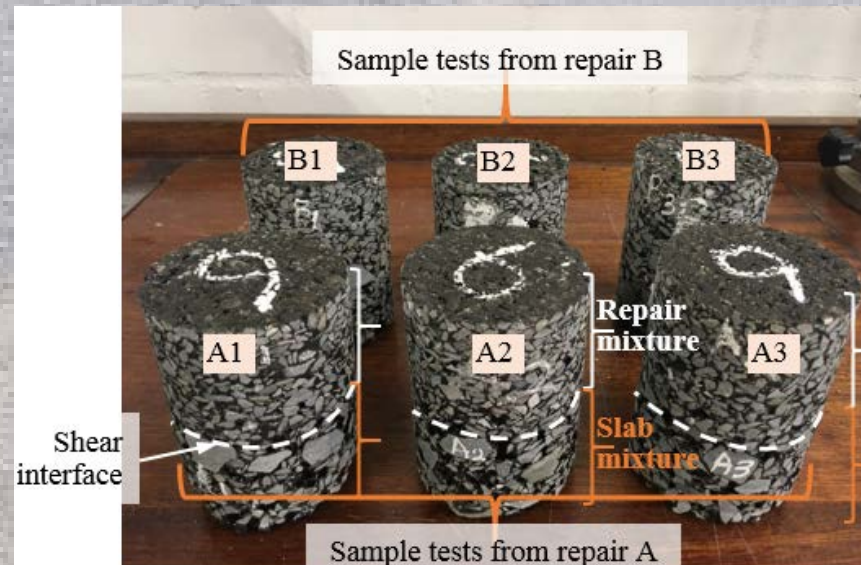
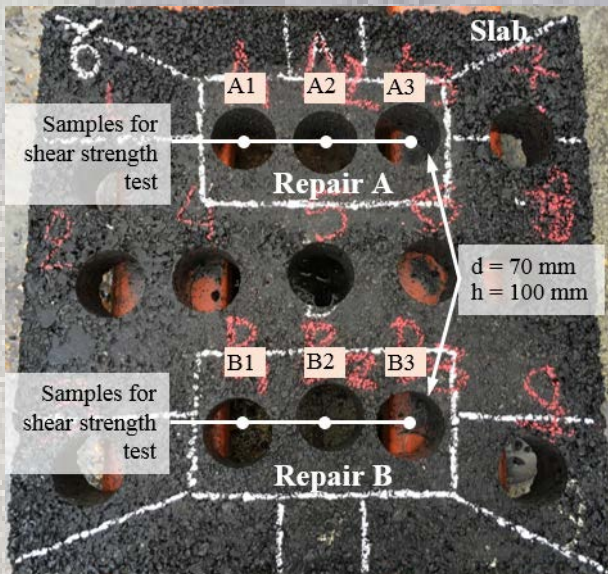


Pre-heating Simulation:  
internal temperatures of  
surrounding pavement during  
repair process.



# Investigation and Testing

## Repair testing: shear bond at bottom of pothole

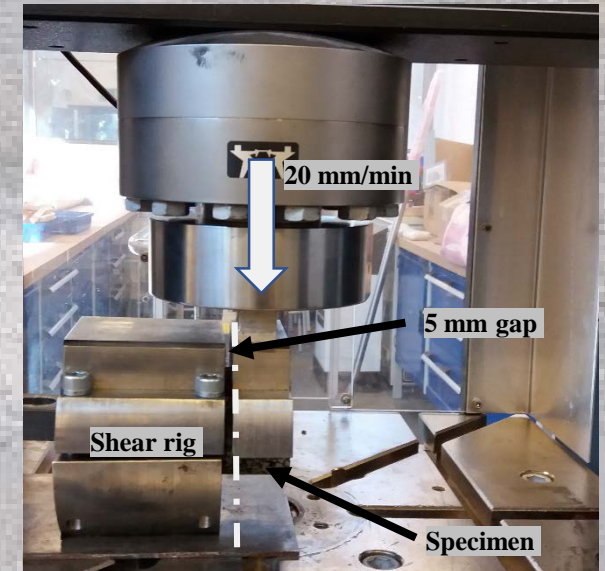
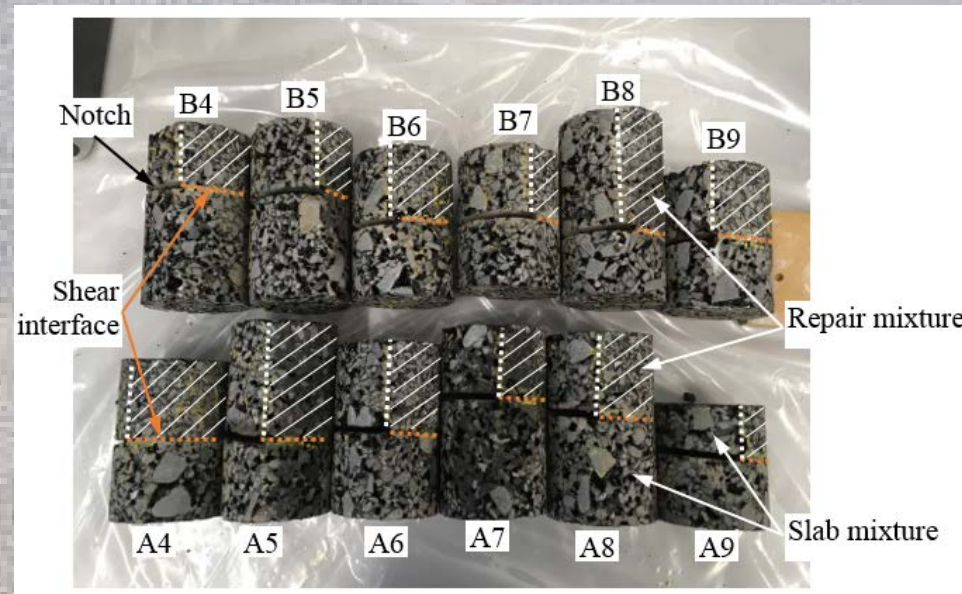
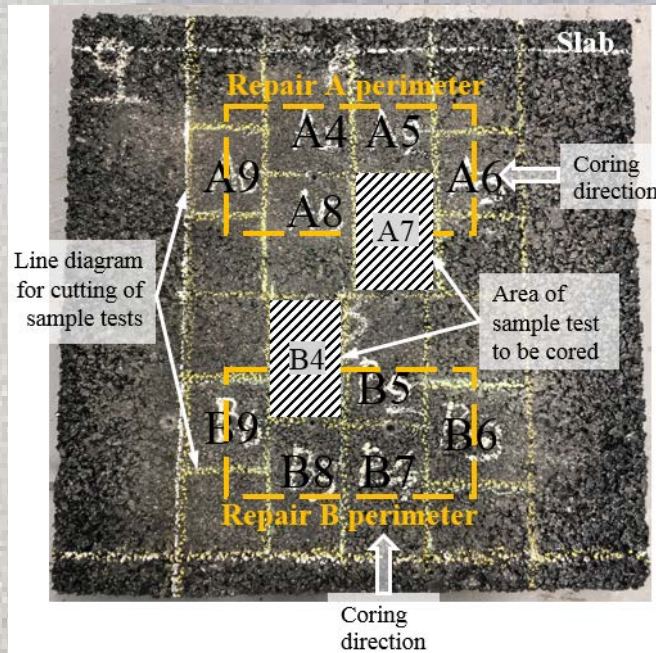


Testing bond of repair fill to base of pothole.



# Investigation and Testing

## Repair testing: shear bond on sides of pothole



Testing bond of repair fill to vertical perimeter of pothole.

# Investigation and Testing

Improved shear bond through dynamic heating

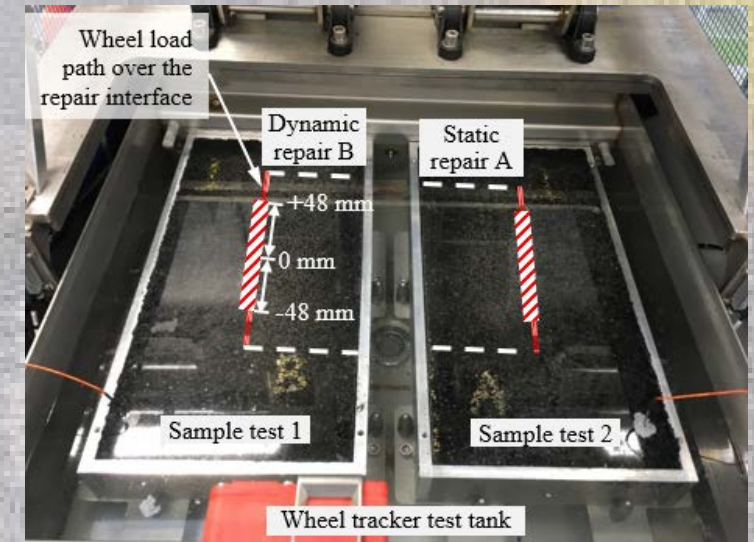
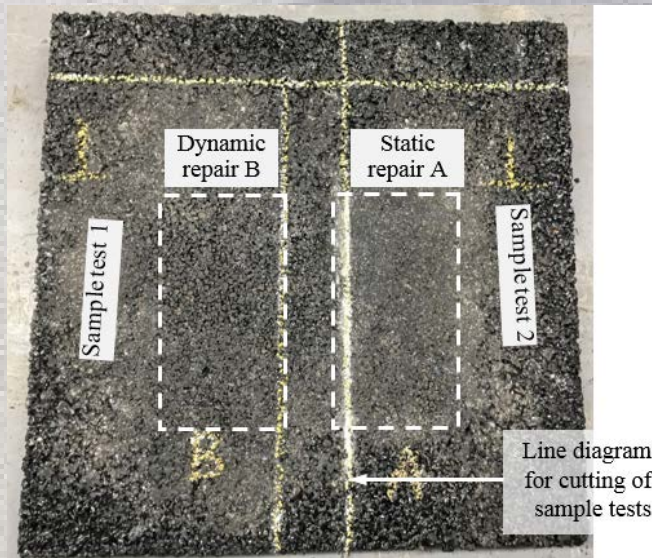
Increase in failure shear stresses

- Average failure shear stress horizontal interface of repair 78.2% higher for 10 mins dynamic pre-heating.
- Average failure shear stress on vertical sides 68.4% for 10mins dynamic preheating and near 100% for 22mins.



# Investigation and Testing

## Repair testing: accelerated life rutting

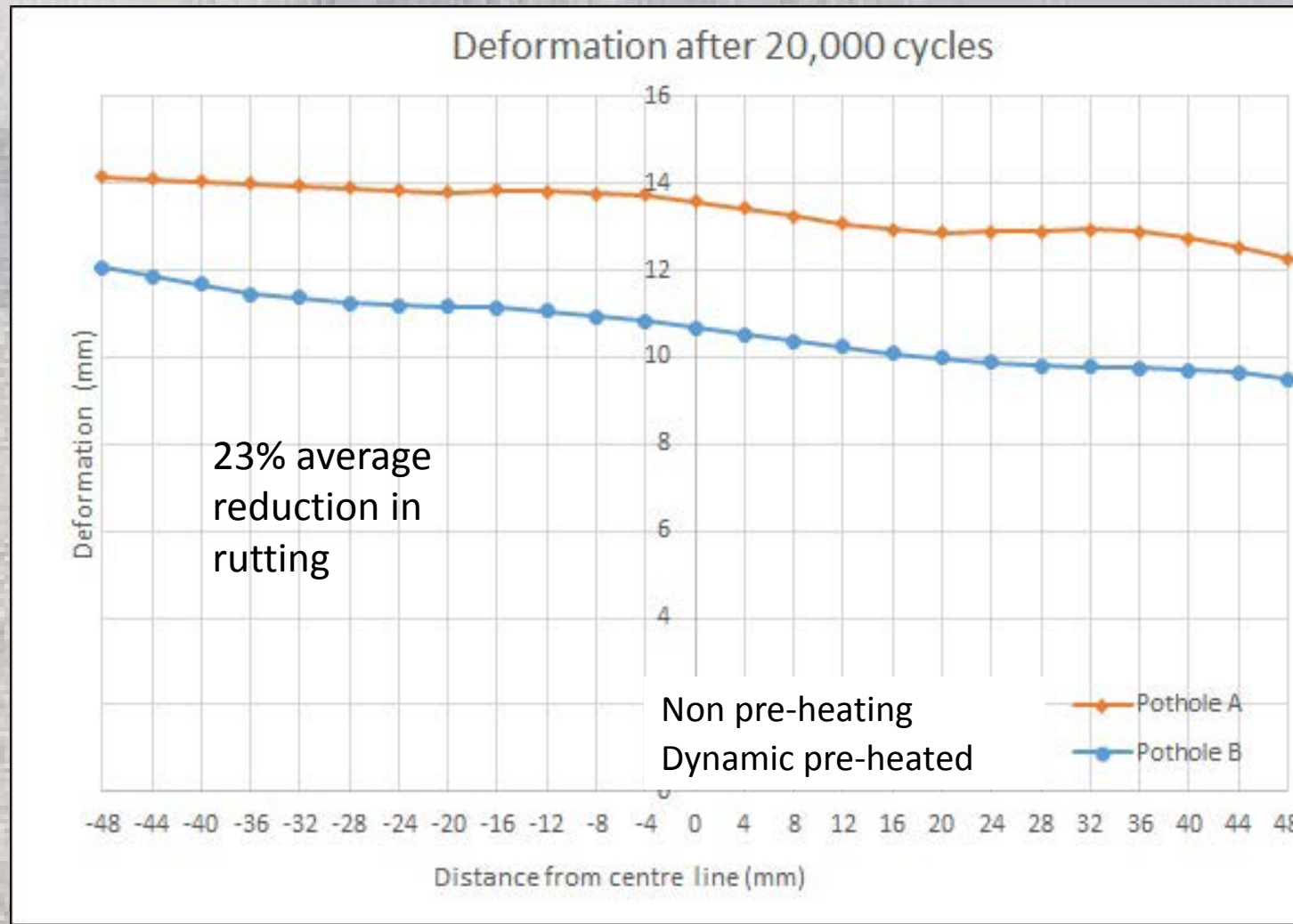


20,000 cycles of twin wheel loading simultaneously applied to assess the affect of pre-heating the pothole excavation.

Rutting depth measured at 4 mm intervals along 96 mm repair interface (ref AASHTO T324-04)

# Investigation and Testing

## Improved rutting resistance through dynamic heating



*Unintentional 60 cycles case: able to remove patch fill from excavation in case of non-pre-heated repair!*



# Main Outcomes

1. Understanding of heat conduction in heated pot-hole repairs.
2. Understanding causes of pot-hole repair failures by current practice.  
Impossible boundary bonding due to low temperatures
3. Prediction of repair temperatures using numerical modelling.  
Agreement between model prediction and actual repair temperatures
4. Ability to increased shear strength and rutting resistance
5. Insitu determination of thermal properties

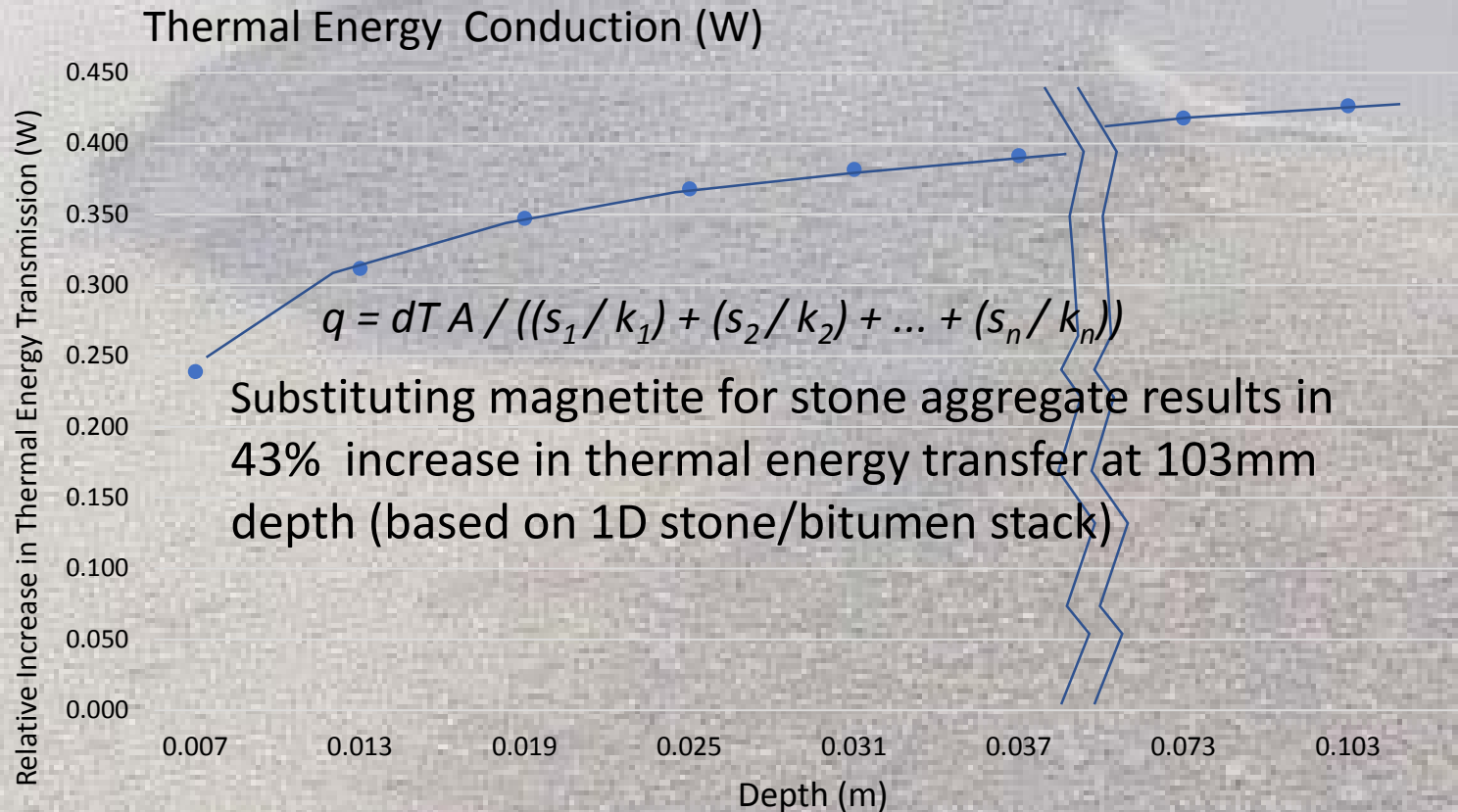
# Further Work

Towards greater value for road operators

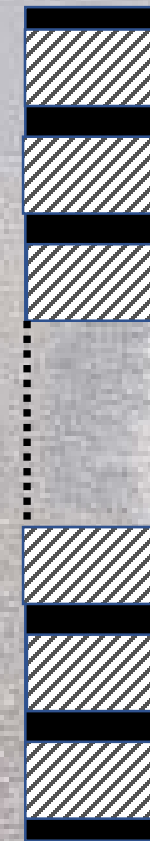
- Minimum time/energy repairs
- Realtime performance quantification sensors system
- Realisation of climatically robust, low voltage Epicuro heater
- Site based trials
- Repair system certification facility (performing standard repair task)
- Accredited training for contractors/operatives
- New high conductivity mixes based on magnetite

# Further Work

Magnetite aggregate mixes: increased conductivity



130°C



80°C

Heat Conduction



Conductivity Values (k)

Bitumen	0.17
Asphalt	0.75
Granite	1.30
Magnetite	6.00
Water	0.606

Thickness Values (s)

Bitumen	1mm
Stone	5mm

Area A 1 sqm

dt 130°C-80°C



5mm Stone/Magnetite



1mm Bitumen

# THANK YOU FOR YOUR ATTENTION

## Contacting Epicuro Ltd

Charlie McDermott  
(Commercial Director)

[charlie@epicuro.co.uk](mailto:charlie@epicuro.co.uk)

M:07808760794

T: +44(0) 2071250071

Denis A Chamberlain  
(Technical Director)

[denis@epicure.co.uk](mailto:denis@epicure.co.uk)

M:07808760796

T: +44(0) 1665 576271

Head Office

Epicuro Ltd:

39-40 Albemarle Street

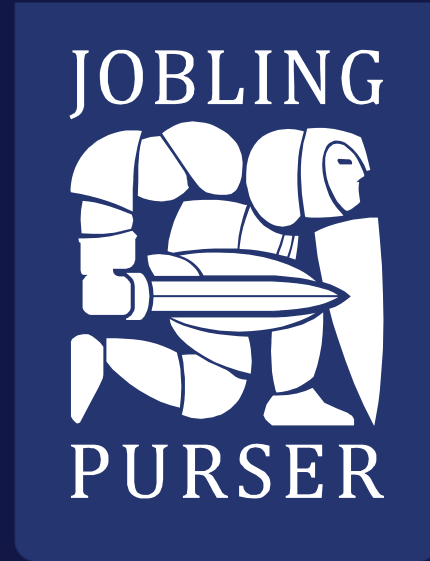
Mayfair

London

W1S 4TE

[sales@epicure.co.uk](mailto:sales@epicure.co.uk)





[www.joblingpurser.com](http://www.joblingpurser.com)

# Introduction

## Armaphalt – Site mix hot asphalt

Innovative Repair Material

Hayden Davie B.sc (Hons)

07793250771

[haydend@joblingpurser.com](mailto:haydend@joblingpurser.com)



# Contents

## Points we aim to cover

- Who are Jobling Purser
- What is Armaphalt
- Benefits of using Armaphalt
- Process of using Armaphalt
- Demonstrations

# Who are Jobling Purser?

We have a long established trading history dating back to the 1830's. We are family owned and operated by the fifth generation of the Jobling Purser family.

We develop and produce a wide range of bituminous and non bituminous based products which are used all around the world.

As specialists in producing highway maintenance solutions we apply our knowledge of bitumen formulating to a wide range of industry applications. Our high quality products make roads safer and play a crucial part in a diverse range of manufacturing sectors.







- Tack Coat
- Bond Coat
- Joint Sealants
- Edge Sealers
- Pre-Coated Chippings
- Delayed Set Macadam
- Bitumen Cleaner
- Rakes
- Brooms
- White Lines

A wide range of packed bituminous materials & surfacing consumables available from Jobling Purser.

# Armaphalt

Site mix hot asphalt

what you want,  
where you want,  
when you want.

# What is Armaphalt?

mix h



Armaphalt is used in conjunction with a mobile low volume asphalt heater and can be offered in any material specification required.

# Benefits of using Armaphalt

- Zero Waste – Anything you don't use is recycled  
No disposing of left over material
- No down time – No wasted time
- Increased productivity – Hot asphalt
- Flexibility – Any site, any location  
repairs in a variety of different  
hotbox.







## Benefits of using A

s – No need for asphalt p  
ks.

maphalt is available in va  
AC10, AC20, HRA(all varia  
s can be produced upon

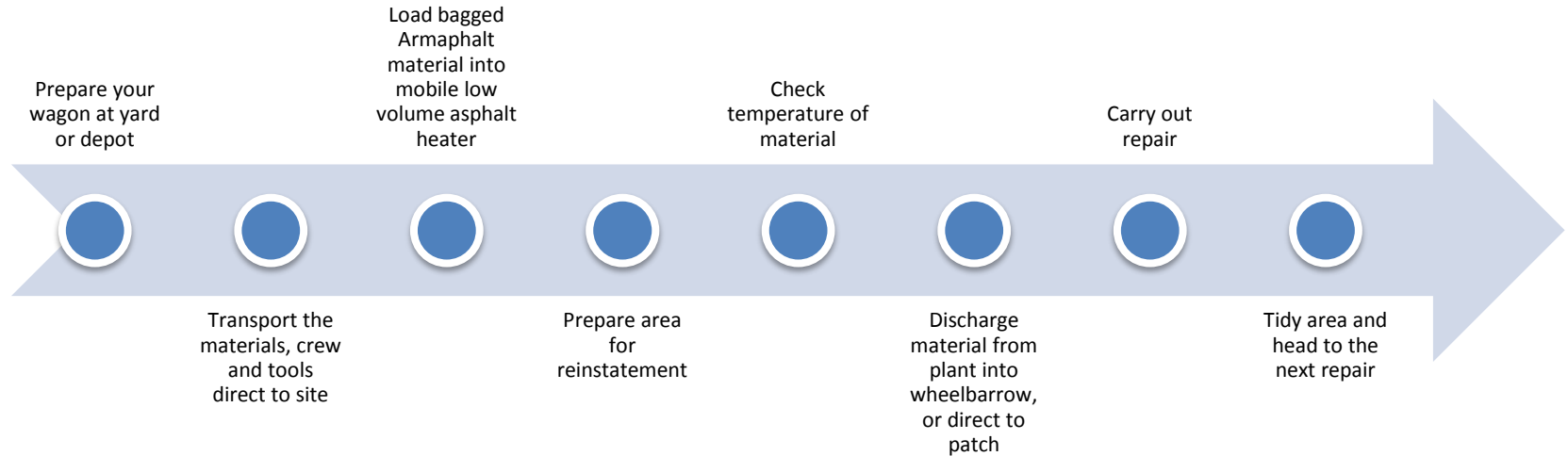
- Reduction in potential for failures – Having opti  
temperatures allows for reduction of air void/co
- Recycling – Allows for the addition of recycled non-hazardous RAP or site won  
material.



night

Most

# Process of using Armaphalt



# Using Armaphalt



[Demonstration Video](#)



# Demonstration

For further information with regards to Armaphalt and to arrange a demonstration please get in touch with:

Hayden Davie

07793 250771

[haydend@joblingpurser.com](mailto:haydend@joblingpurser.com)

Or for further information about other products we are able to offer please contact either Hayden or a member of the sales team at

[sales@joblingpurser.com](mailto:sales@joblingpurser.com)

0191 273 2331





# Any Questions?



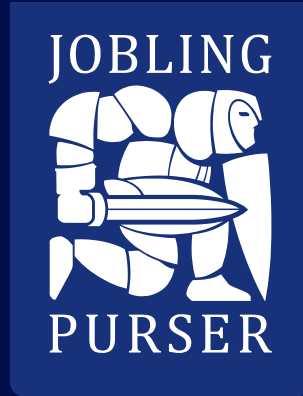
Armaphalt

Site mix hot asphalt

what you want,

where you want,

when you want.



[www.joblingpurser.com](http://www.joblingpurser.com)

# Non-Compressive Surface Defect Repairs



# Firstly, an apology

Please accept my apologies for not being able to attend today.  
Life has an annoying habit of taking you in directions that you don't  
necessarily expect or plan for.  
My contact details are freely available from Mujib Rahman and at the  
end of this presentation, should you have any further questions

Andrew Price  
Regional Sales Manager – Preformed Markings Ltd



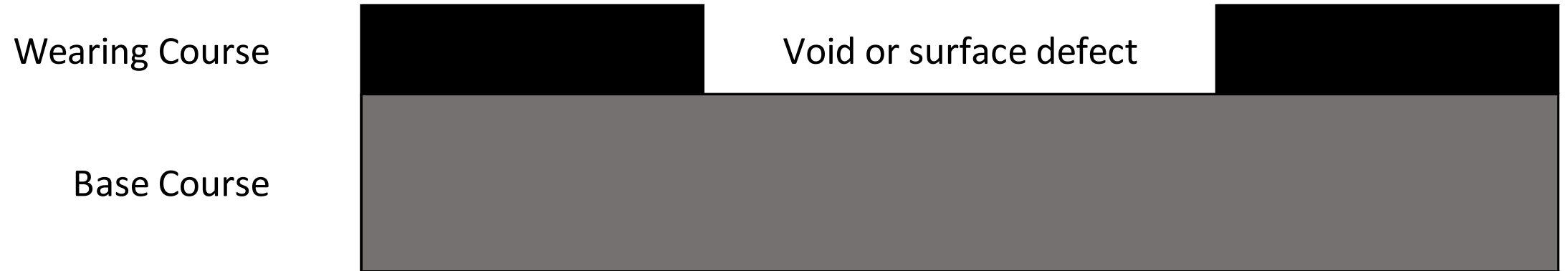


# Who are we?

- Preformed Markings Ltd is a subsidiary of the Geveko Markings group.
- Established in the UK for over 20+ years specializing in preformed thermoplastic road markings, symbols and road safety marking solutions
- Members of the Road Safety Markings Association (RSMA)
- Offices in Byfleet (H.O.), Bury St Edmunds (Suffolk), Runcorn (Cheshire) and Cambuslang (Glasgow)

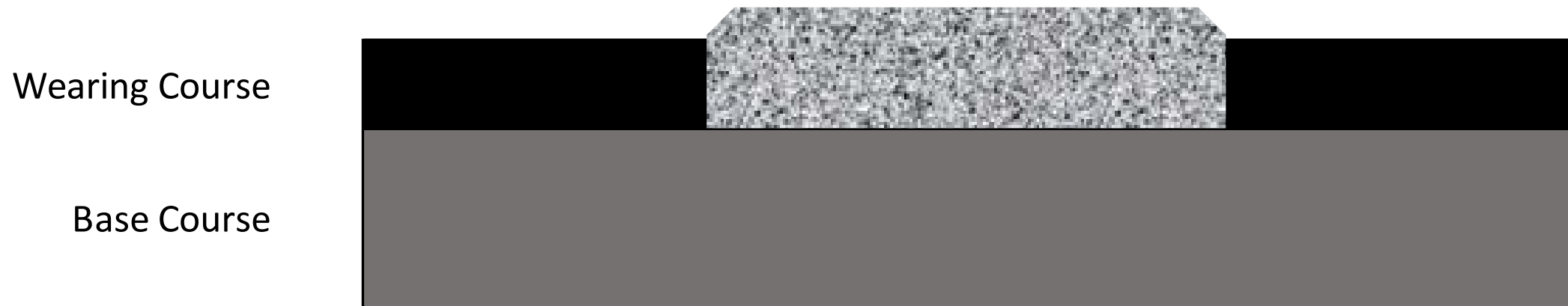


# What are we trying to fix?



# Traditional methods

- Hot asphalt or cold applied system of binder and aggregate, initially 'crowned' and compacted to form a level infill



# Pro's & Cons of current systems

- Traditional, tried & tested methods
- Contractors generally know what they are doing
- Standard civils equipment and tools required
- Usually fast to install and minimal effect on traffic
- HAPAS has provided a degree of expected success
- Compaction can create new stresses on the sides of the void in the wearing course
- Excessive compaction can cause further delamination of the wearing course to base course
- Operating costs and wear & tear on plant and vehicles
- Risk of water ingress at joints between new & old materials





# New Thinking ???

How could we repair the defect without adding in any compressive stress to the opening, plus create a water tight joint between meeting faces (sides and base)?



# What is ChipFill®

- ChipFill® is a preformed material containing a fine irregular shaped aggregate and thermoplastic resin binder.
- Manufactured from 'virgin' and recycled waste materials
- Non-toxic
- No waste
- Self levelling – No compaction required
- Installed with nothing more than a sweeping brush and a gas lance
- Ready to traffic within 20 minutes of installation
- May be combined with other aggregates to create higher SRV's or decorative finishes.



# A short video



# Answers before questions

- It is not HAPAS approved ..... Yet!
- Maximum depth for installation is 40-45mm (wearing course) in layers not exceeding 20mm
- The aggregate broadcast at the end of the process was glass grain, but an aggregate can be used, such as bauxite or coated chippings
- No overbanding is required, as a thermal bond between the asphalt and thermoplastic is automatically created during installation
- Once cured, the material solidifies. Strength tests are currently underway
- It is available in the UK. Please contact us for details.





# Thank You



# Contact

Andrew Price

Regional Sales Manager

Preformed Markings Ltd

Unit 6 Oyster Park, Chertsey Road, Byfleet, Surrey, KT14 7AX

Tel: 01932 359270

Mob: 07798 757675

Email: [andy@preformedmarkings.co.uk](mailto:andy@preformedmarkings.co.uk)

