

IRCA conference, Harpa, Rejkajik, 14th September 2021

An overview of skid resistance in the UK

Dr David Woodward

Reader in Infrastructure Engineering, Ulster University

Chief Scientific Officer, R3 Ltd





A bit about me...

- First degree in geology, Masters in High Friction Surfacing and a PhD in Laboratory prediction of surfacing aggregate performance.
- Work with the quarrying, asphalt and motorsport industries.
- Member of British Standards committee on road surface characteristics.
 - Working groups on high friction surfacing and skid resistance of man hole covers
- Helped supervise over 30 PhD's.
- Two jobs....all about the transfer of specialist knowledge...



This presentation

- Considers skid resistance.
- Examples from research and industry collaboration.
- Illustrates what might be happening at the tire / surface interface.
 - Complex three-dimensional interface.
 - Influenced by many factors.
- Skid resistance is just one of many factors.
- They are not very well understood.

Use of 3d modelling to solve a macrotexture problem

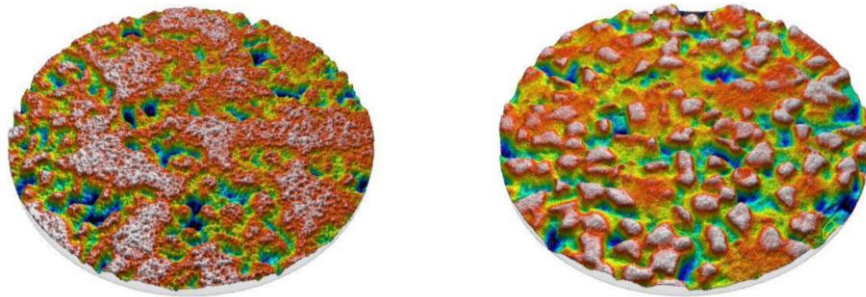


Figure 4: Prepared Model for non-positive (left) and positive (right) locations.

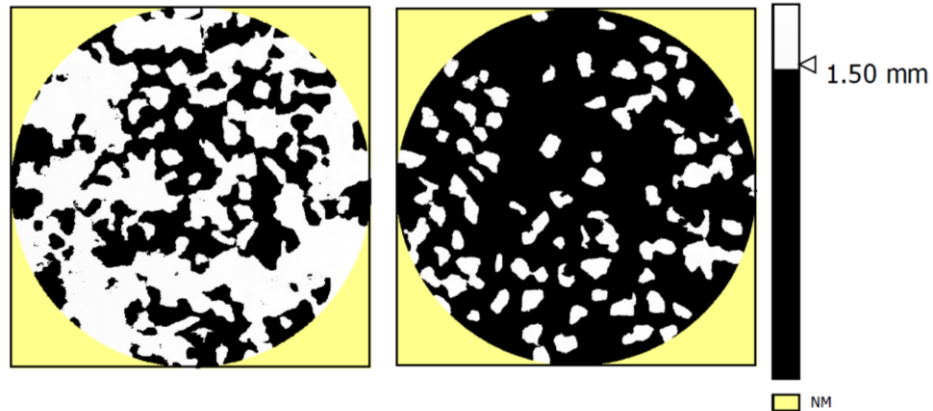


Figure 5: Islands Analysis - Non-Positive (left) and Positive (right) – 1.5 mm Threshold.

The Use of Close Range Photogrammetry to Characterise Texture in a Pavement Surfacing Material

CC-PAV-04010
September 2017

Considers some of these questions

- Requirements for skid resistance.
- How to measure skid resistance in the lab /on the road.
- Relationships between lab and road measurements.
- Control of skid resistance in an operation (surface dressing/bituminous mixture).
- Duties/responsibilities.
- When and how to stop an operation and take actions to prevent a dangerous surfacing.
- How to improve skid resistance after operation.

UK – road performance expectations

- Wet skid resistance to improve road safety
- Low noise generation
- Low spray generation when it rains
- Resistance to permanent deformation
- Resistance to cracking
- Minimise use of imported materials
- Be recyclable
- Use sustainable technologies
- **Nothing on studded tires...**

The UK surfacing industry changed a lot in the last 30 years

- Problems with hot rolled asphalt rutting in the early 1990's
- Led to the development of proprietary thin surfacing materials based on SMA, AC and porous asphalt
- Introduction of a 2 year scheme, known as HAPAS, to prove new products
- Introduction of the EU Construction Products Regulation
 - Aggregate, asphalt, concrete + 30 others
- Standards and specifications re-written to make them CPR compliant
- Introduction of TS2010 with improved durability
- Continues to change in response to challenges...



Formula 1 @F1

WE'RE GOING TO MIAMI 🌴

Starting in 2022, F1 has signed a 10-year deal to race at a circuit around Miami's iconic Hard Rock Stadium 🏆

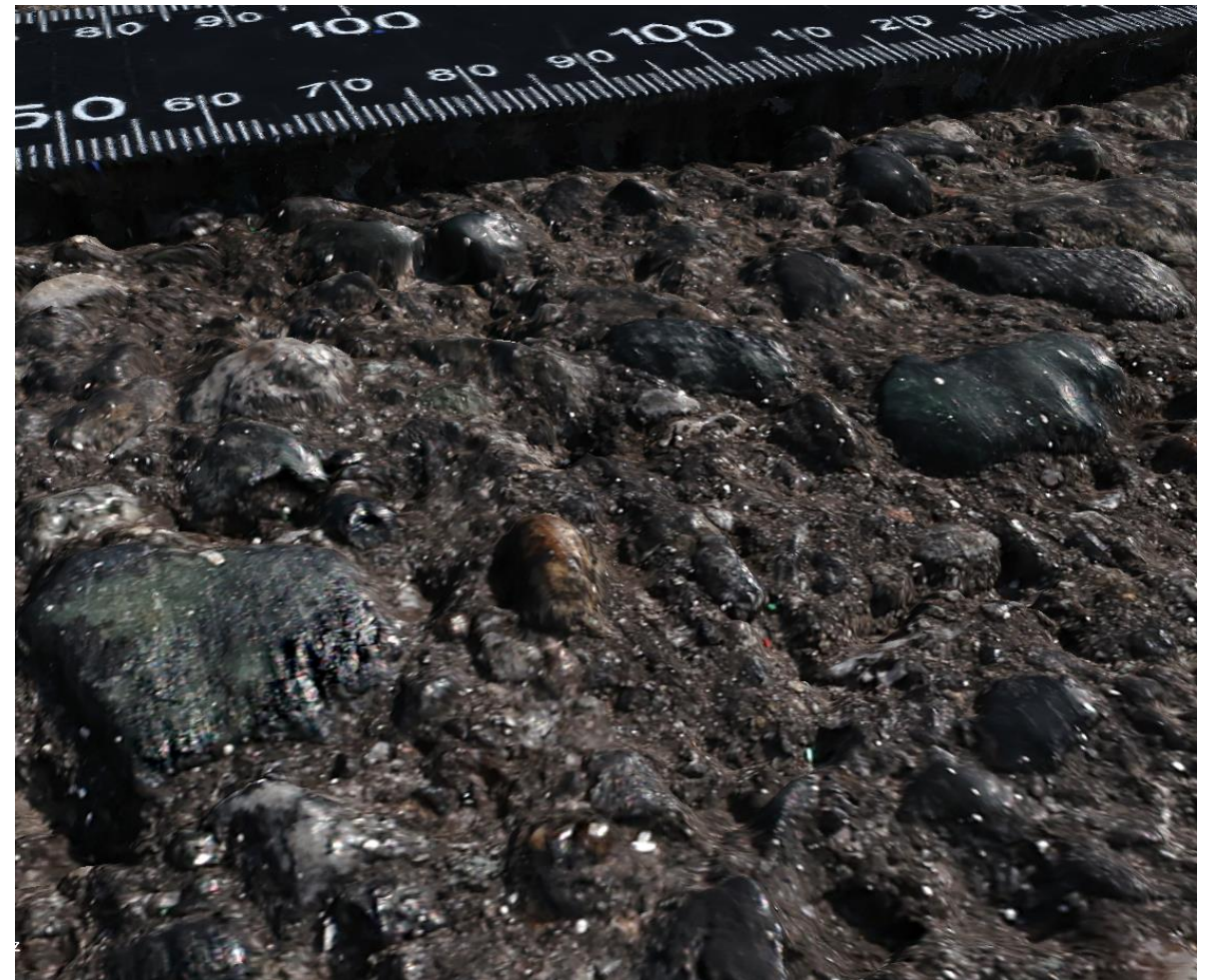
#MiamiGP #F1 @f1miami

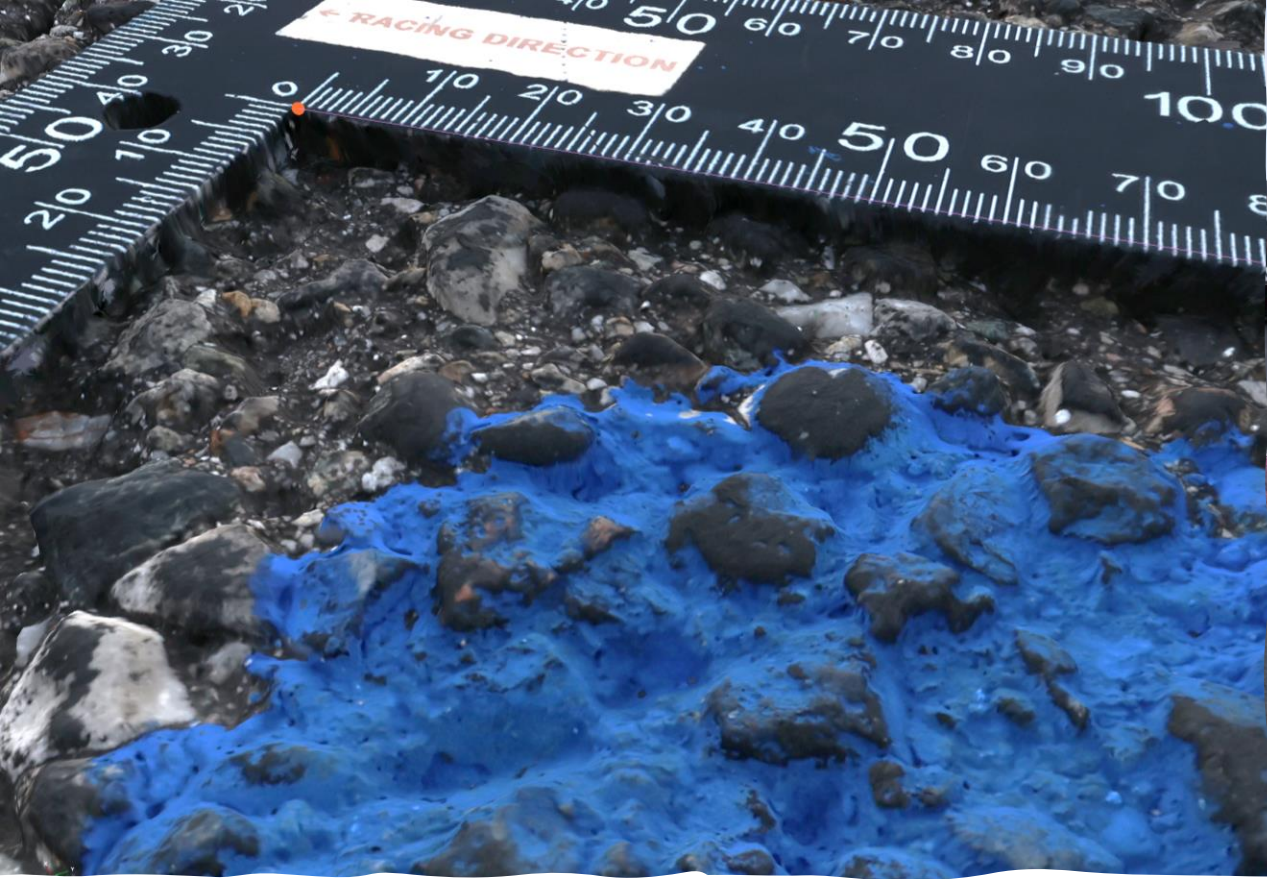


Mandalika motogp circuit, asphalt finished July 2021



Polished aggregates





Tire / surface interface can be less than 0.5 mm deep

The tire / surface interface..

- 3-d dimensional.
- Different scales of texture.
- Keeps changing.
- Predicting in-service performance is difficult.
- Makes understanding difficult / or very interesting...
- Prediction and measurement is fundamental for everyone – **not just the road people...**



Yas Marina

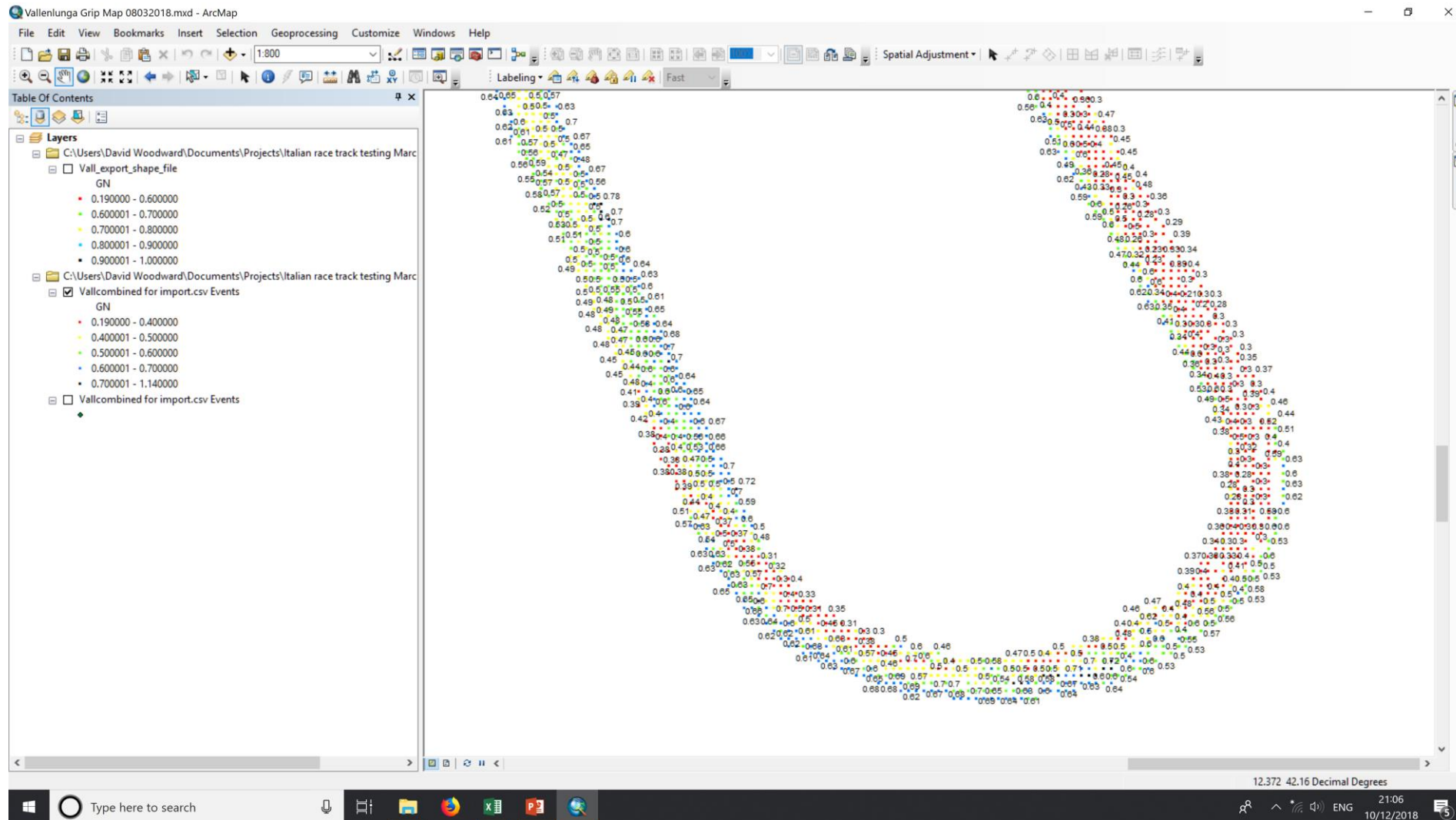




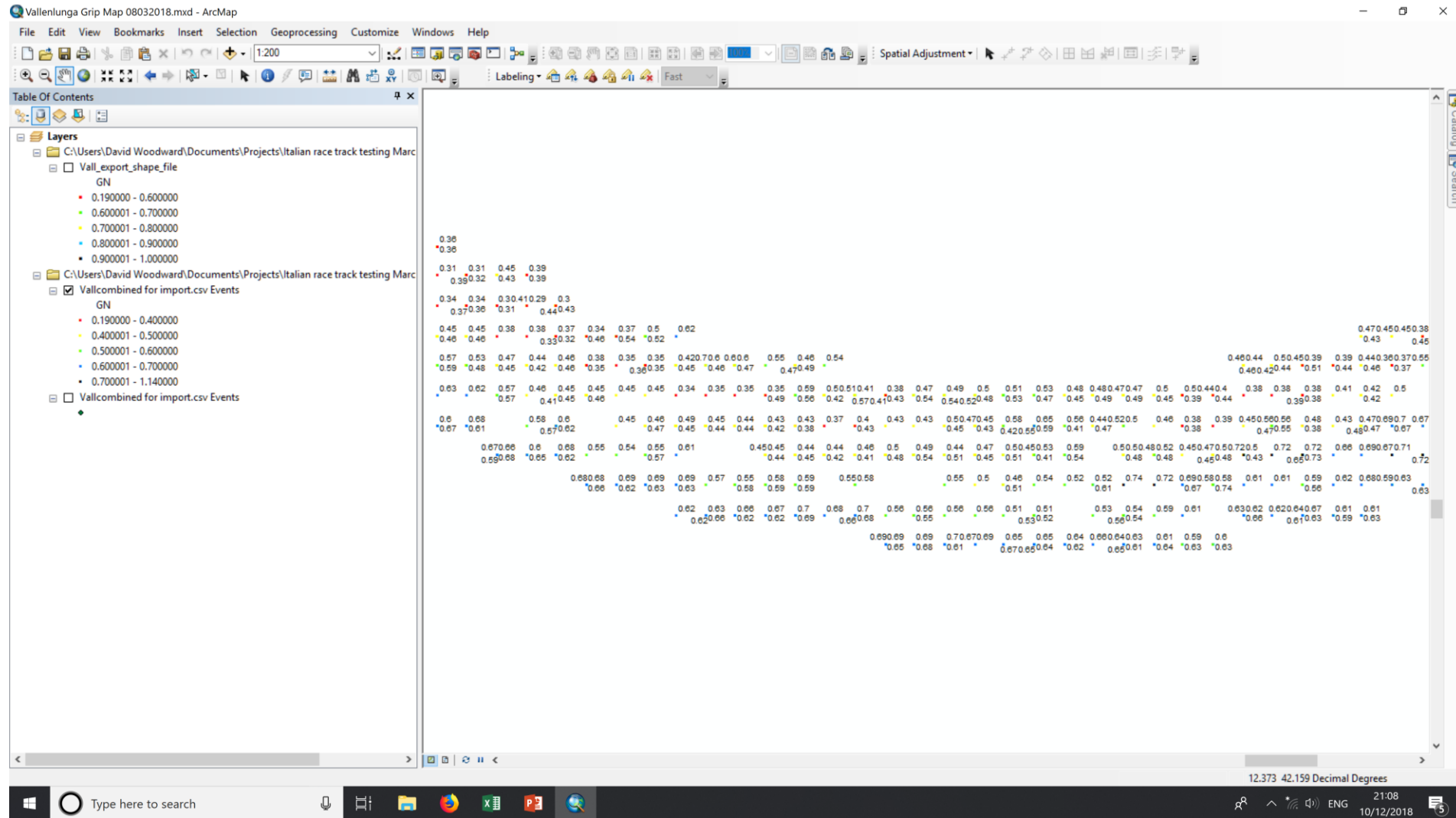




Using grip data to plot a GripMap

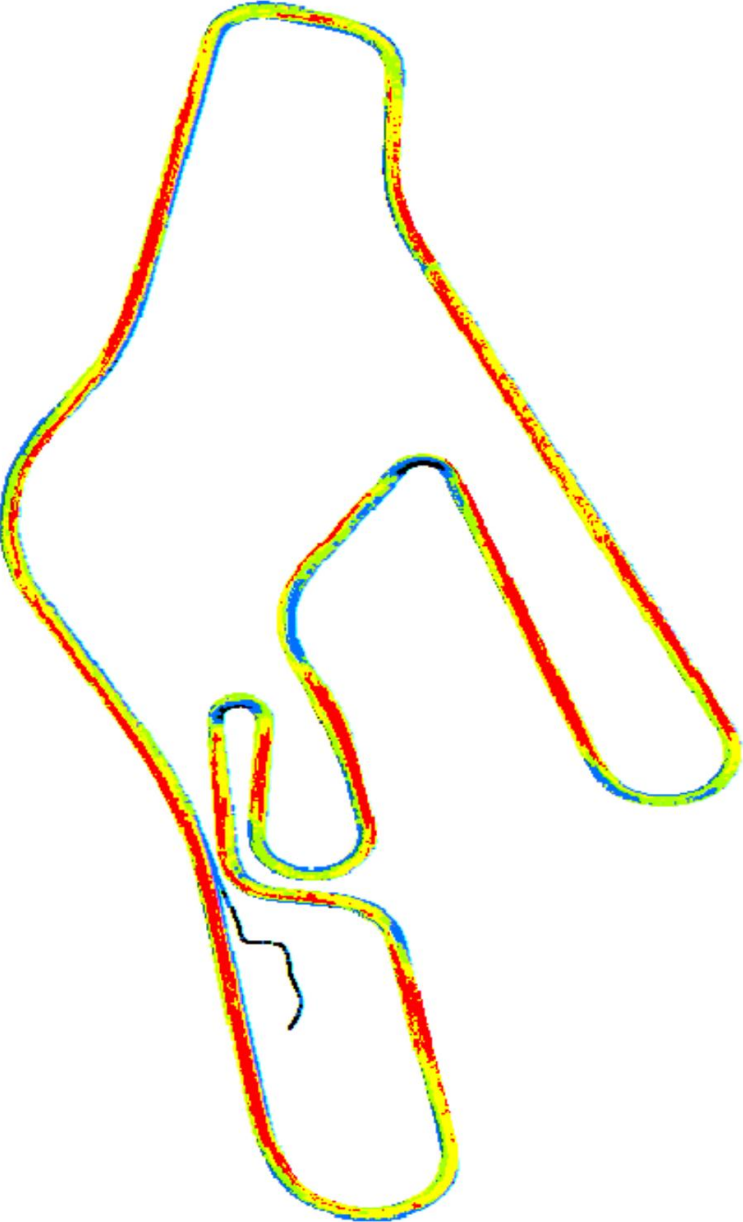


Grid of data points

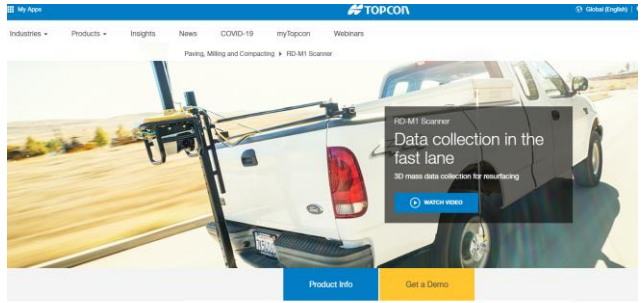


Comparison
of wet and
dry grip...

...transferring
this
knowledge to
roads



Topcon data partner – Cork airport yesterday



Collect data without stopping traffic

The revolutionary RD-M1 scanner collects a constant stream of data as you drive, delivering precise surface conditions. You can quickly scan miles of road without the need for costly lane closures or rework. Normal traffic conditions continue uninterrupted, dramatically



Topcon Smoothride – Singapore / Mandalika

- Proven on circuits like Singapore
- Being used on new circuits like Mandalika
- Starting to be used on UK roads

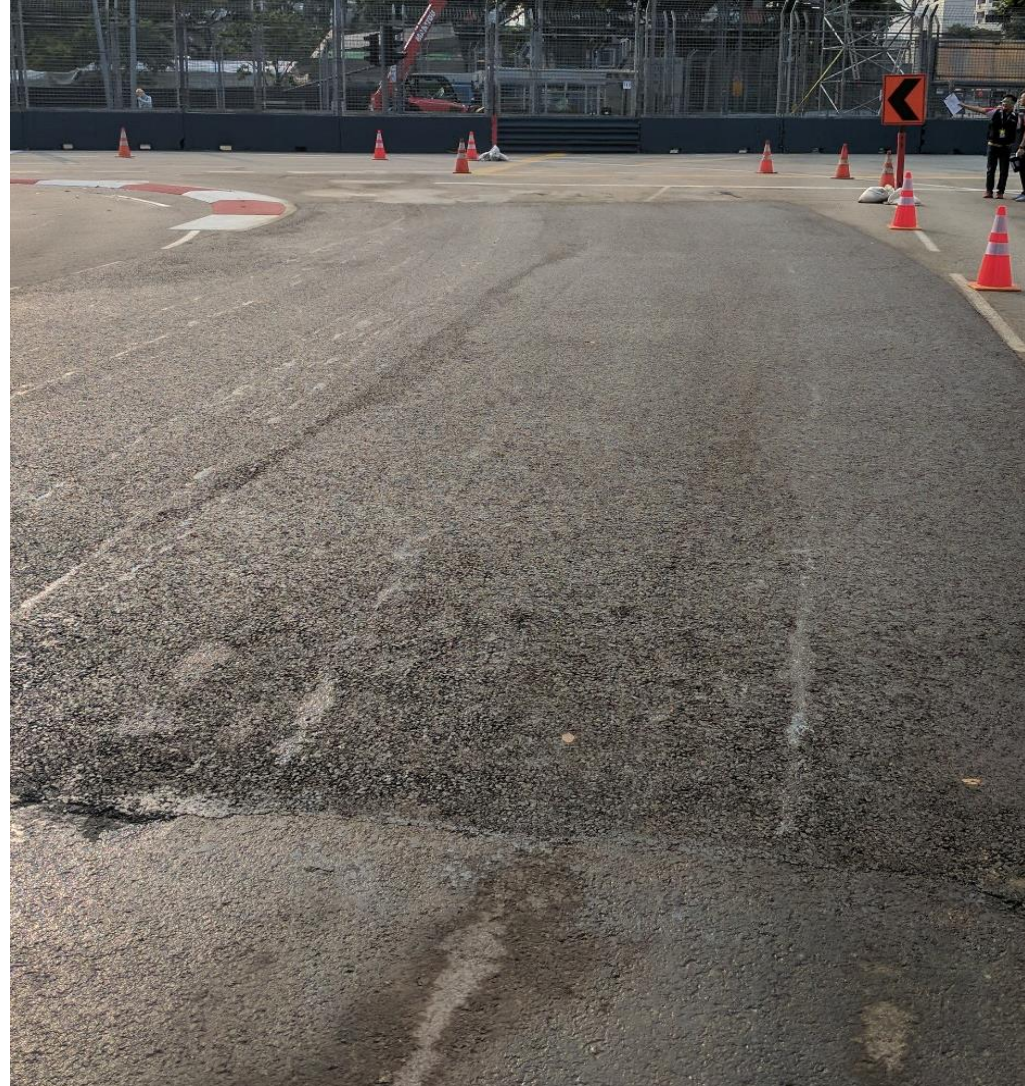


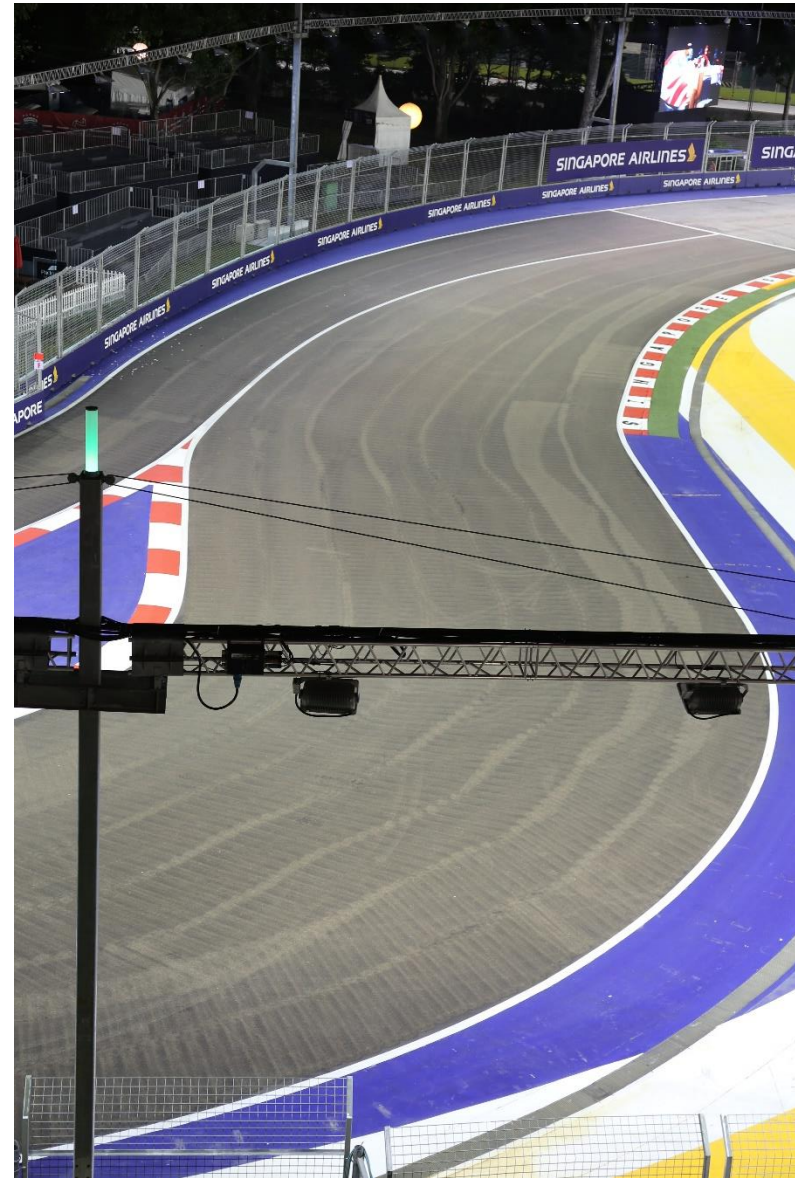
High Pressure Water Retexturing on new asphalt patches



Impact of High Pressure Water Retexturing on new asphalt patch

- This patch had to be re-laid 48 hours before racing
- Previous reinstatement rutted under street traffic
- Treated with high-pressure water retexturing





**Also needs to consider
the vehicles that use
the roads and their
tires**



1930's research using a motorbike and sidecar to 2021

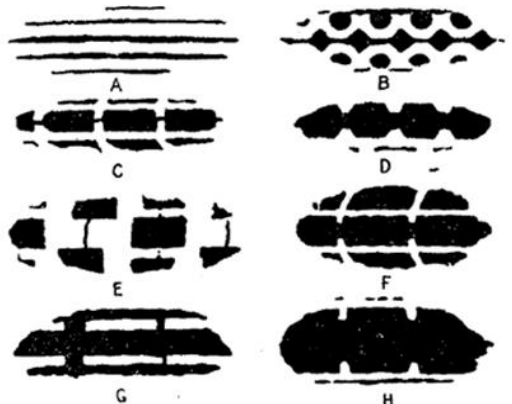
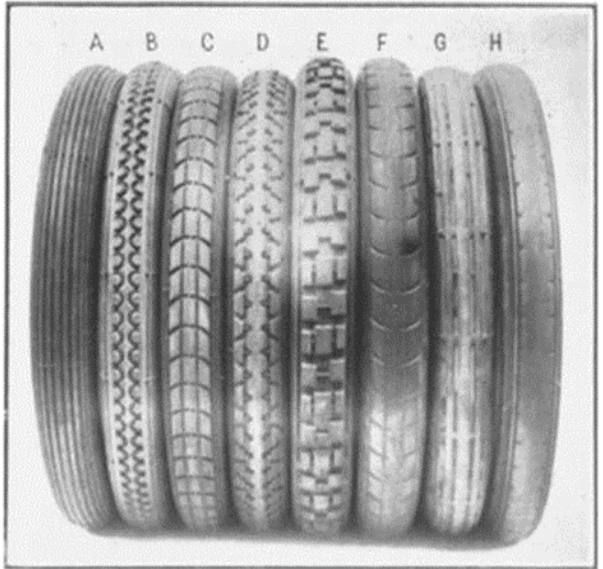


FIG. 11.—Contact Areas of Tyres (710 × 85 mm.).
 Load, 290 lb. Pressure, 30 lb. per sq. in.

Area {	A = 1.7 sq. in.	D = 3.0 sq. in.	G = 5.8 sq. in.
	B = 1.8 "	E = 3.4 "	H = 6.7 "
	C = 2.7 "	F = 4.2 "	



NIRA DYNAMICS

The next level of mobility

With state-of-the-art Vehicle Onboard Analytics and Road Perception, NIRA Dynamics contributes to the next level of mobility.

[READ MORE](#) ▶



OFFICE OF THE
DEPUTY PRIME MINISTER

miro
Mineral Industry
Research Organisation

The Sustainable Use of High Specification Aggregates for Skid-Resistant Road Surfacing in England

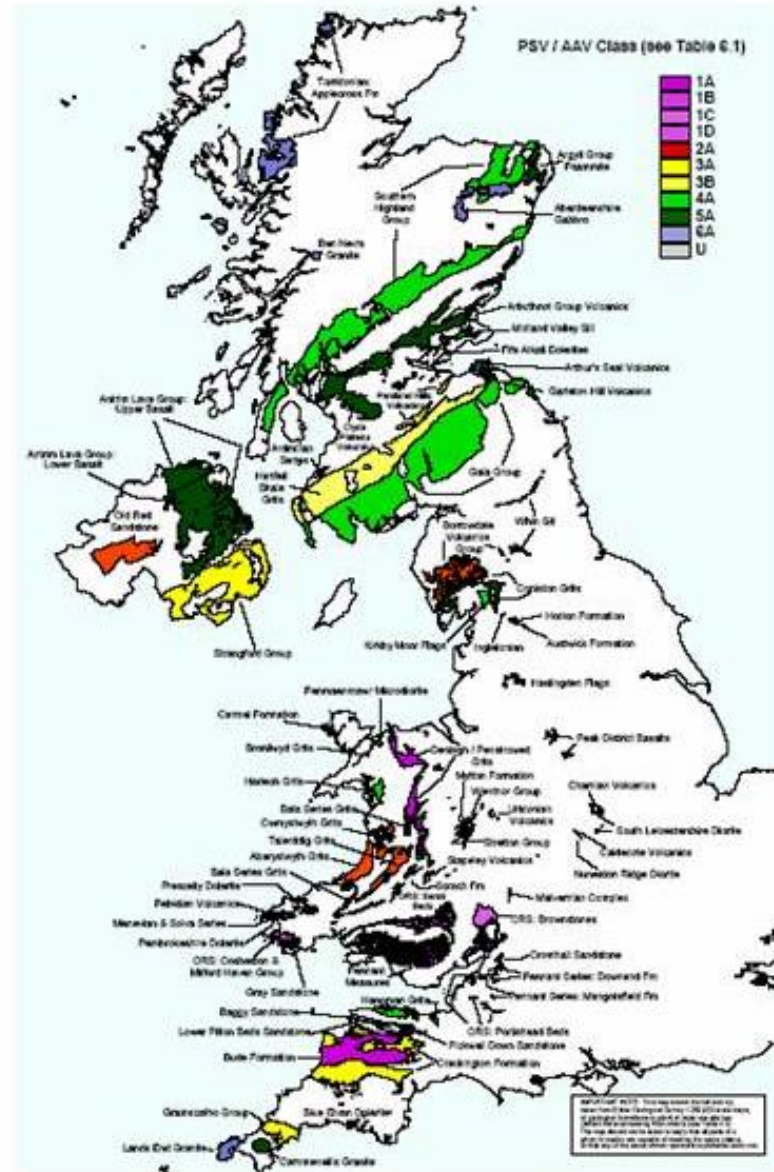


Figure 6.1: The Location of the Formations Listed in Table 6.3, colour coded by PSV/AAV Class

Construction Products Regulation

4.4.2011

EN

Official Journal of the European Union

L 88/5

REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 9 March 2011

laying down harmonised conditions for the marketing of construction products and repealing
Council Directive 89/106/EEC

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE
EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European
Union,

(4) Member States have introduced provisions, including requirements, relating not only to safety of buildings and other construction works but also to health, durability, energy economy, protection of the environment, economic aspects, and other important aspects in the public interest. Laws, regulations, administrative measures or case-law established either at Union or

1. Mechanical resistance and stability
2. Safety in case of fire
3. Hygiene, health and environment
4. Safety and accessibility in use
5. Protection against noise
6. Energy economy and heat retention
7. Sustainable use of natural resources.

Performance for the life of the product from initial design, during in-service life and then when its recycled.

www.standardsforhighways.co.uk

Specification for Highway Works (SHW)

Design Manual Roads and Bridges (DMRB)

CD 236 - Surface Course Materials for Construction

CD 236 Surface course materials for construction

Design Manual for Roads and Bridges



Pavement
Design

CD 236

Surface course materials for construction

(formerly CD 236 (rev. 3 inc. HD 36/06 and IAN 156/16), HD 37/99, HD 38/16, IAN 157/11, TA 81/16)

Revision 4

Summary

This document provides requirements for pavement surfacing for both flexible and rigid pavements

PSV requirements (from CD 236)

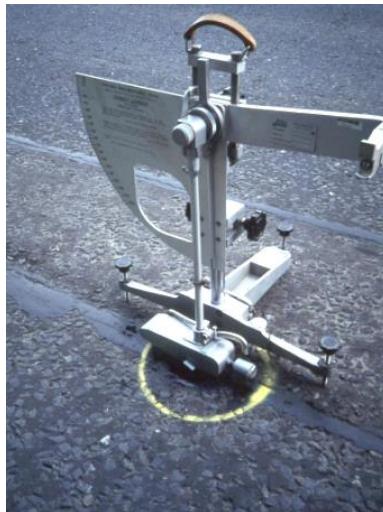
10

Table 3.3a PSV for chippings or coarse aggregate in surfacings excluding thin surface course systems complying with clause 942 (2019) and pavement quality concrete complying with clause 1026 (2019) of the Specification (MCHW1)

Site category	Site description	IL	PSV required for given IL, traffic level and type of site									
			Traffic (cv/lane/day) at design life									
			1 - 250	251 - 500	501 - 750	751 - 1000	1001 - 2000	2001 - 3000	3001 - 4000	4001 - 5000	5001 - 6000	Over 6000
A	Motorway	0.30	50	50	50	50	50	55	55	60	65	65
		0.35	50	50	50	50	50	60	60	60	65	65
B	Non-event carriageway with one-way traffic	0.30	50	50	50	50	50	55	55	60	65	65
		0.35	50	50	50	50	50	60	60	60	65	65
		0.40	50	50	50	55	60	65	65	65	65	68+
C	Non-event carriageway with two-way traffic	0.35	50	50	50	55	55	60	60	65	65	65
		0.40	55	60	60	65	65	68+	68+	68+	68+	68+
		0.45	60	60	65	65	68+	68+	68+	68+	68+	68+
Q	Approaches to and across minor and major junctions, approaches to roundabouts and traffic signals	0.45	60	65	65	68+	68+	68+	68+	68+	68+	HFS
		0.50	65	65	65	68+	68+	68+	HFS	HFS	HFS	HFS
		0.55	68+	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS
K	Approaches to pedestrian crossings and other high risk situations	0.50	65	65	65	68+	68+	68+	HFS	HFS	HFS	HFS
		0.55	68+	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS
R	Roundabout	0.45	50	55	60	60	65	65	68+	68+	68+	68+
		0.50	68+	68+	68+	68+	68+	68+	68+	68+	68+	68+
G1	Gradients 5-10% longer than 50m	0.45	55	60	60	65	65	68+	68+	68+	68+	68+
		0.50	60	68+	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS
G2	Gradient >10% longer than 50m	0.45	55	60	60	65	65	68+	68+	68+	68+	68+
		0.50	60	68+	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS
		0.55	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS
S1	Bends radius <500m – carriageway with one-way traffic	0.45	50	55	60	60	65	65	68+	68+	HFS	HFS
		0.50	68+	68+	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS
S2	Bends radius <500m – carriageway with two-way traffic	0.45	50	55	60	60	65	65	68+	68+	HFS	HFS
		0.50	68+	68+	68+	HFS	HFS	HFS	HFS	HFS	HFS	HFS
		0.55	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS	HFS

On-site measurement

- About 20 + different methods
- See the **Tyrosafe** reports
 - SCRIM
 - GripTester
 - Locked wheel tester
 - Pendulum tester
 - VBox
 - microGT



Example specification for aggregate for specialist surfacings (taken from PD 6682-2:2009+A1:2013)

Annex B (informative) Example specification for aggregates for specialized surfacings

An example format of a preferred specification for aggregates for specialized surfacings, e.g. thin surfacings, is given in Table B.1.

Table B.1 Example specification for aggregates for specialized surfacings

Property	Category
Grading	To meet the grading requirements appropriate for the end product
Fines content (coarse and fine)	To meet the grading requirements appropriate for the end product
Flakiness index	Fl_{20}
Resistance to fragmentation	LA_{30}
PSV	Site specific ^{A)}
AAV	Site specific ^{A)}
Durability:	
– Water absorption to BS EN 1097-6, pyknometer method	WA_{242}
– For $WA > 2\%$, magnesium sulfate soundness	MS_{25}

NOTE Specifying values for all other properties described is not necessary because they are not appropriate to the particular application at end-use or origin of the aggregate.

^{A)} Insert appropriate category from BS EN 13043.

Can you guess which aggregate test relates to which development in vehicle?



1830 – Age of enlightenment



1930 - Austin Seven Swallow



Victorian horse drawn omnibus




1960 – Morris Minor



Iceland 2004

FT with salt

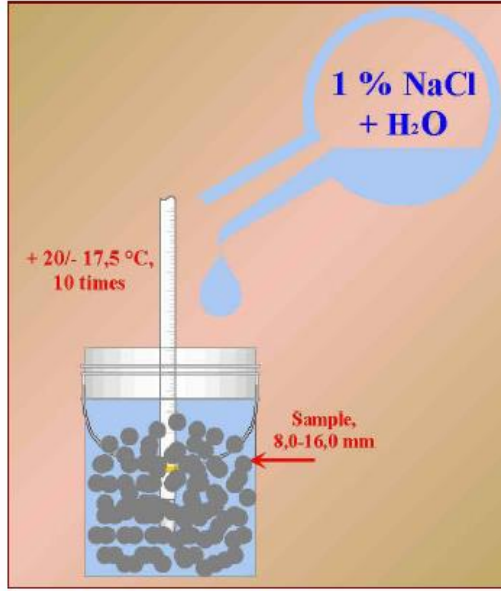


Project no.
NT 1624-03

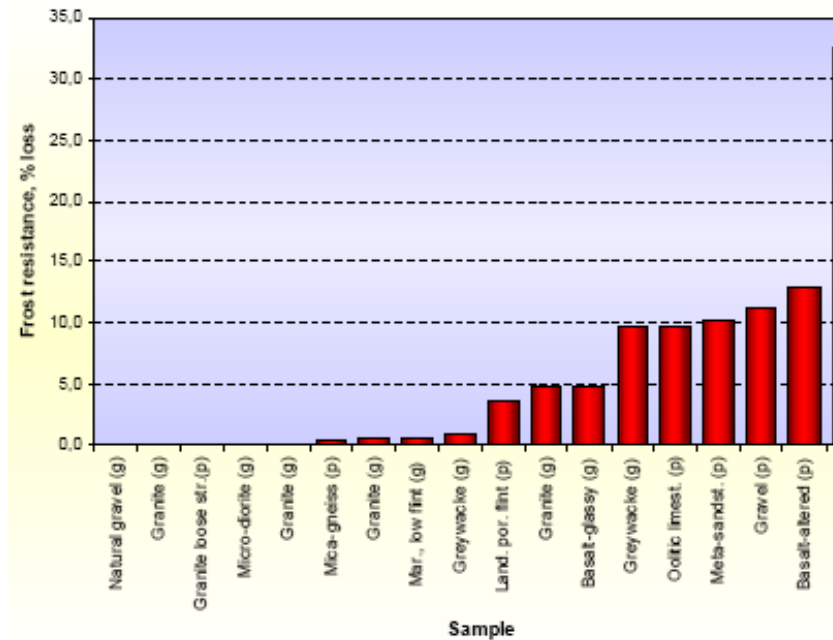
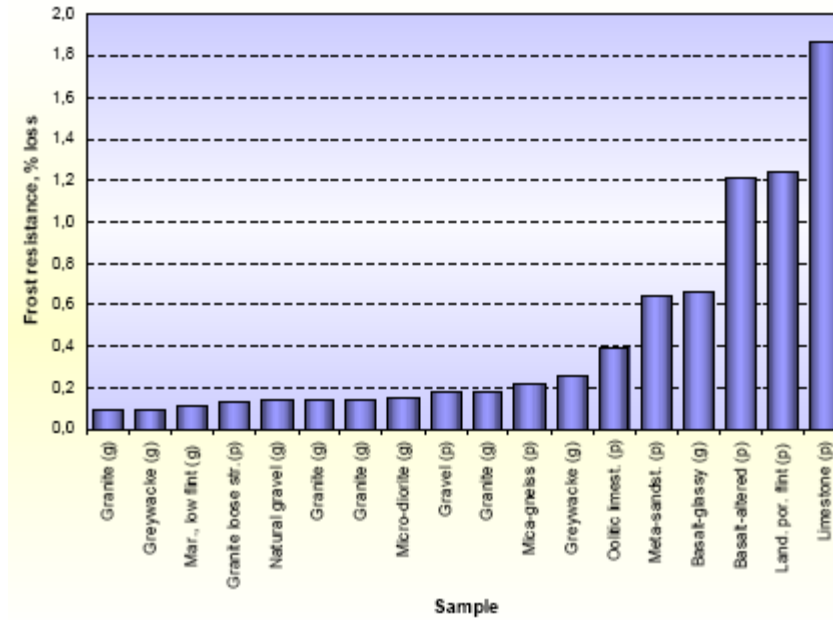
FINAL REPORT, SEPTEMBER 2004:

NORDTEST PROJECT No. 1624-03

Frost Resistance Test on Aggregates With and Without Salt (FRAS)



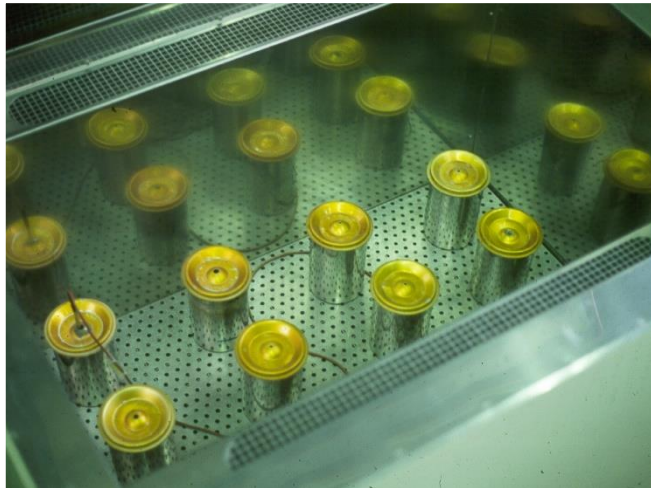
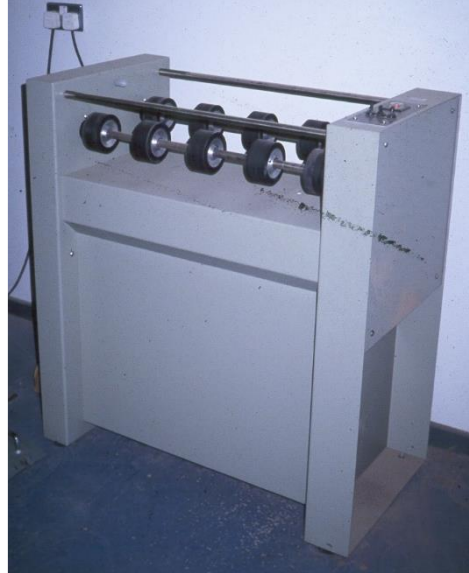
Pétur Pétursson, IBRI, Icelandic Building Research Institute
Björn Schouenborg, SP, Swedish National Testing and Research Institute



Some different aggregates – can we predict their in-situ performance evolution in the lab?



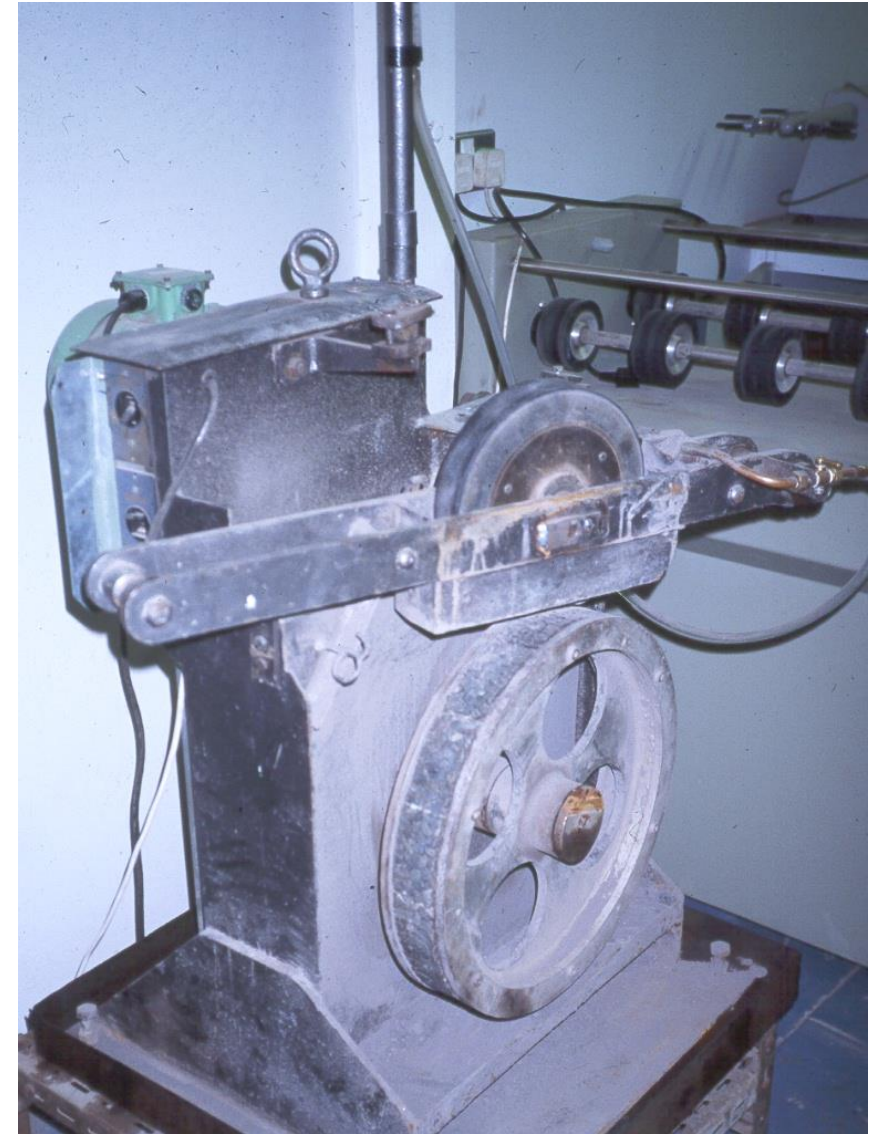
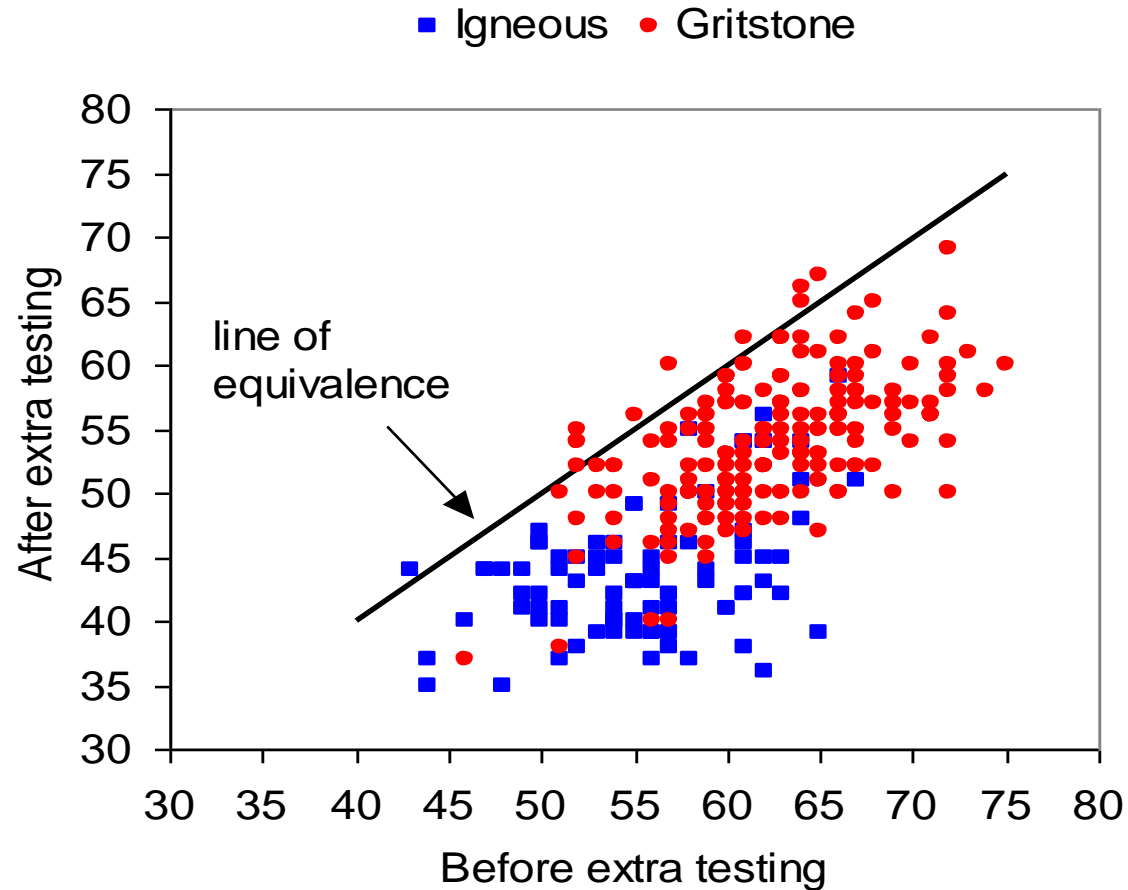
Some standard aggregate test methods



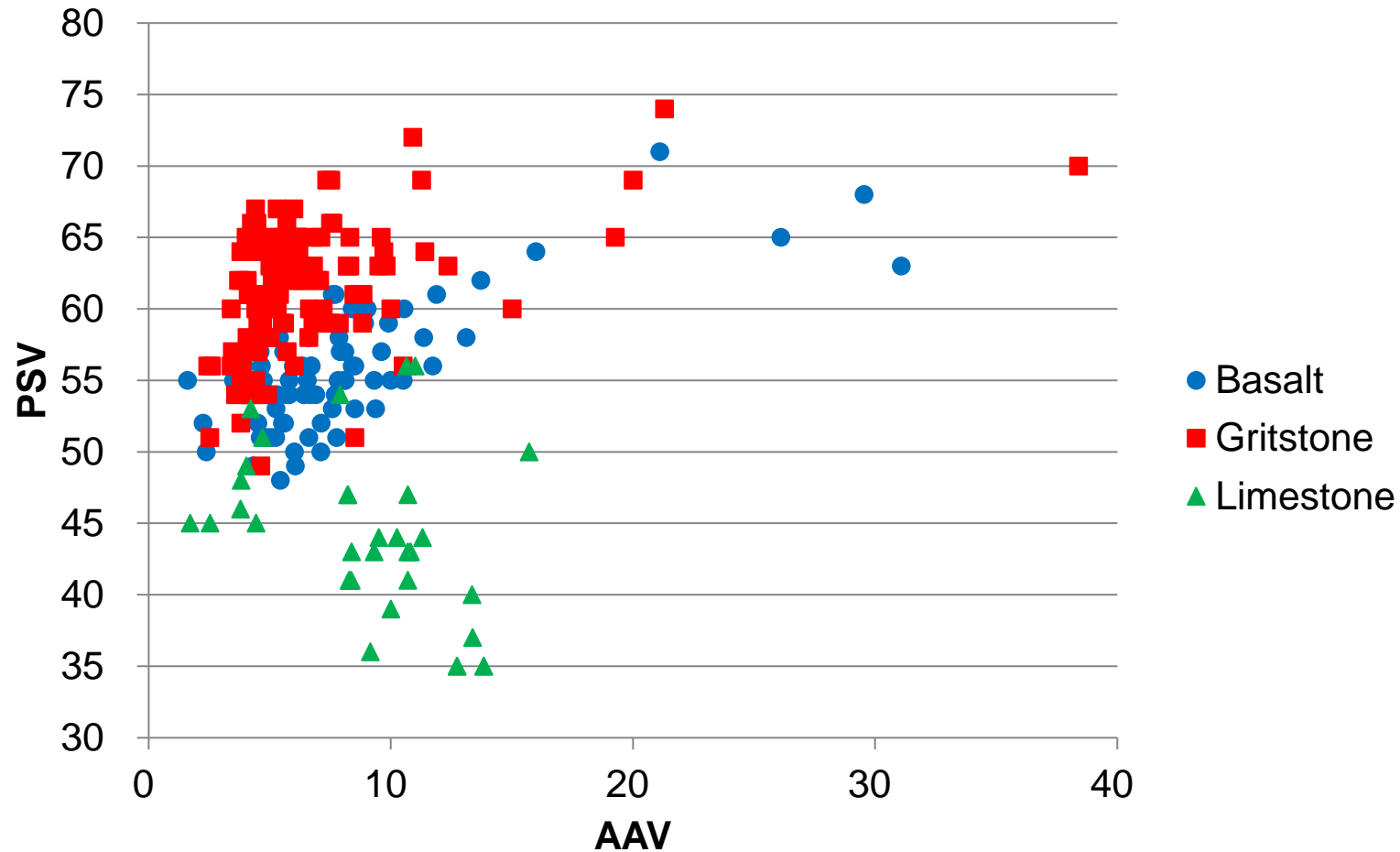
Different aggregates behave differently in different types of asphalt mix under different conditions of trafficking, climate etc



3 hours additional angled polishing
more stress = different ranking
(up to 26 points further reduction)



PSV v. AAV for 3 rock types (wet skid resistance v. dry wear resistance)



PSV and FAP – do they predict performance?



Examples of HAPAS asphalt mixes developed to offer different types of performance

In a recent survey
9 out of 10 hedgehogs preferred the stopping power of Hitex

As used on the A38 at Ashburton, Devon

Hitex - the first Highways Agency approved thin layer wearing course developed in the UK

- Outstanding skid resistance
- Excellent traffic noise reduction in excess of 3dB(A)
- Significantly reduced spray hazard in wet weather conditions
- Rut resistant and durable
- Whole life performance offers considerable cost saving benefits

BARDON AGGREGATES
INQUIRY NO: 742

Scotland Region Tel: 01698 870811	Northern Region Tel: 01524 732261	Midlands Region Tel: 01455 285200	South East Region Tel: 01895 442852	South West Region Tel: 01934 742621	Bardon Surfacing Division Tel: 01530 510066
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Bardon Aggregates, A Division of Aggregate Industries UK Limited. An Aggregate Industries Plc Company.

HARD AS NAILS

...anyone arguing?

Smatex - A range of Stone Mastic Asphalt products specially tailored for heavily trafficked and industrial areas.

- Hard-wearing and resistant to rut development

BARDON AGGREGATES
Bardon Surfacing Division
Tel: 01530 510066
INQUIRY NO: 742

Bardon Superstructure
Hidden strength

Bardon Superstructure
Maximum value engineering opportunities

- Long life asphalt base layer
- Developed with Shell Bitumen
- Allows thinner pavement design
- Suitable for trunk roads
- Strong, durable and dependable

Developed in collaboration with **Shell Bitumen**

AGGREGATE INDUSTRIES
FOR MORE INFORMATION CONTACT THE BRANDED PRODUCTS HELPLINE
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INQUIRY NO: 742

Bardon Thinpave
- as quiet as a mouse

SLEEPY HOLLOW

Bardon Thinpave is Highways Agency approved

Bardon Thinpave
The silence is deafening

- High textured ultra-thin surfacing
- Excellent noise reduction properties
- Reduced traffic spray hazard
- Cost effective overlay solution

AGGREGATE INDUSTRIES
FOR MORE INFORMATION CONTACT THE BRANDED PRODUCTS HELPLINE
0845 600 0860
INQUIRY NO: 742

Aggregate Industries UK Limited. An Aggregate Industries Plc Company.

Laying a HAPAS trial





Thin surfacing on all 5 lanes
of this part of the M25

Daily Mirror
23rd February 2005

FAULTY ASPHALT

Safety fears over new surface material used on our fastest roads

MOTORWAYS and main roads are being surfaced with a material which may cost lives, was claimed last night.

Police crash investigators are worried because, in certain conditions, stone mastic asphalt (SMA) offers little grip for two years until bedded in.

Sergeant Jim Allen said of a test he carried out on newly laid SMA: "It was a sunny day in August. I jumped on the brakes and the car just kept going and going."

"Instead of the scream of tyre on road and a cloud of smoke there was just a gentle hiss and I skidded far further than I ever expected to."

Fears were raised by BBC Radio's file On 4 show which said resistance tests were carried out in the wet and on worn surfaces but dry conditions were overlooked. SMA's critics say slipperiness occurs on new, dry roads.

SMA now been banned from streets

By TOM PARRY

with speed limits above 30mph in Ireland and faster roads on which it had been put down have been resurfaced.

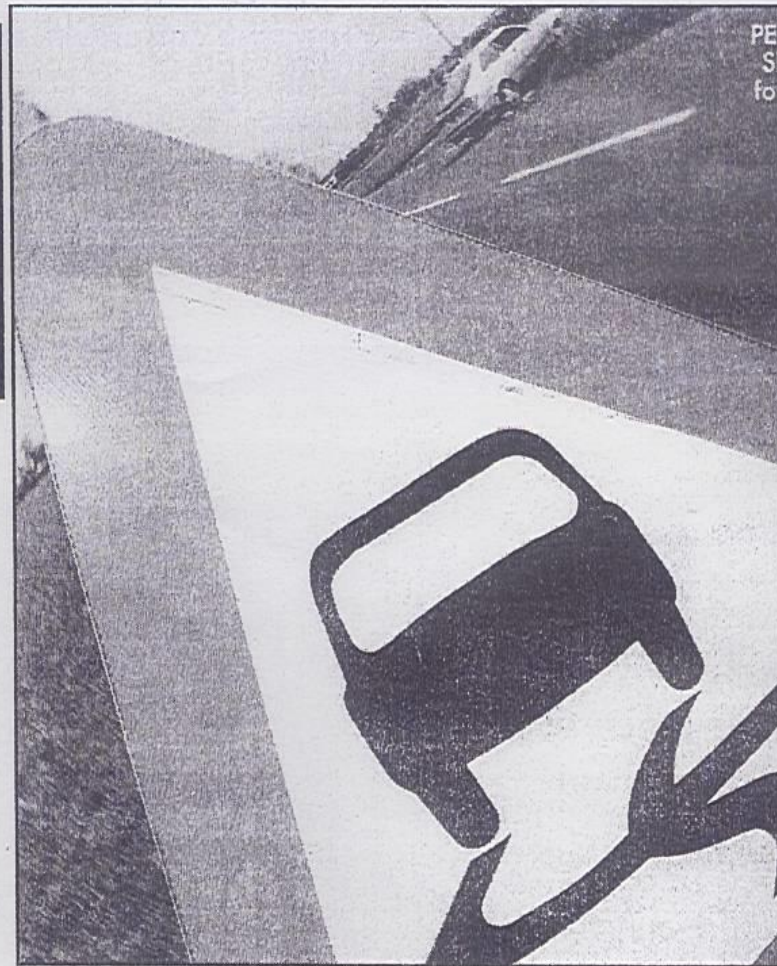
Concerns about grip have also been raised in Germany, where SMA was pioneered in the 60s, and in Holland.

But a Highways Agency source said: "There are differences between the material which we've tested and SMA banned in Ireland. The SMA in Britain has a different consistency. We're talking about materials that have been thoroughly inspected."

The AA Motoring Trust warns the road network is in its worst condition since the 70s and said: "Surfaces are a hidden menace. In London as many as a third of main roads need looking at. There could be lives at risk."

The Government says it is spending more than £31 billion over 10 years on highway repairs.

tom.parry@mirror.co.uk



Slippery road signs



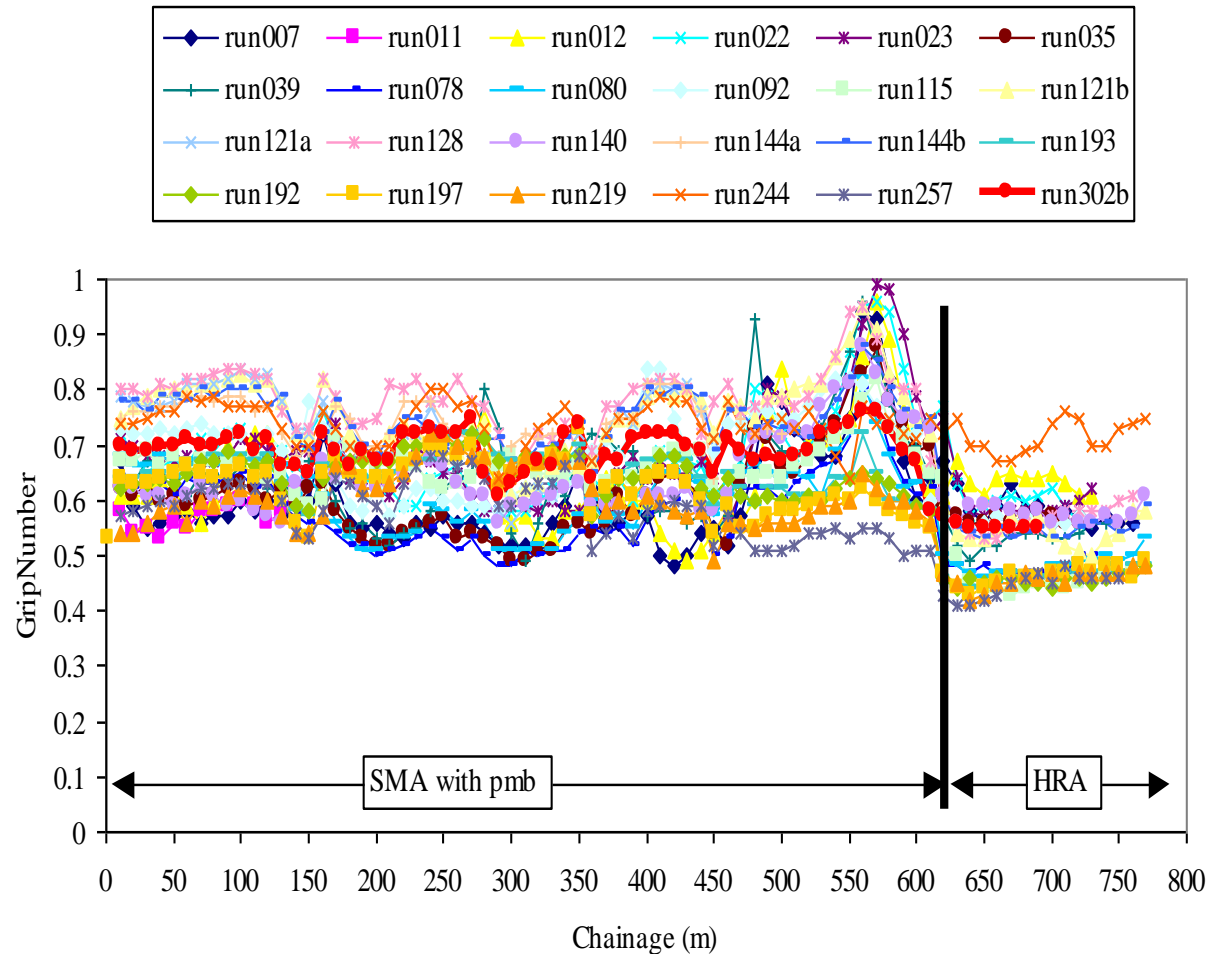
Looking
the
other
direction



Is this
bitumen
or rubber?

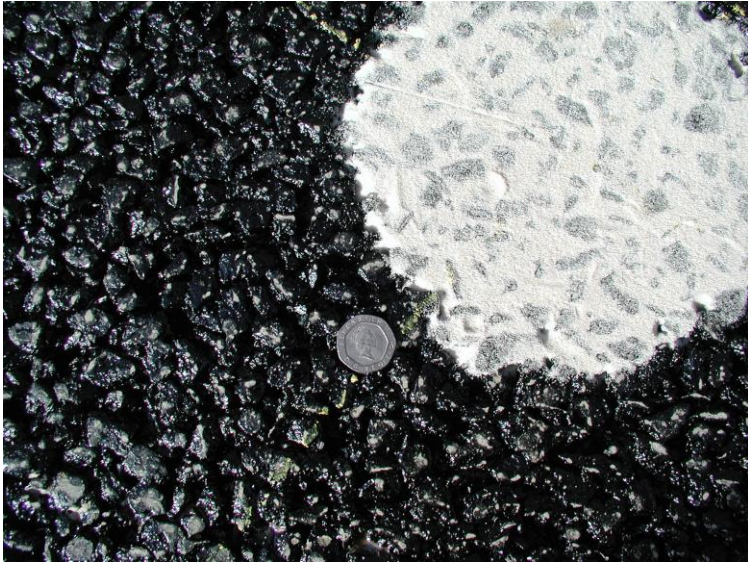


Evolution in wet grip for a SMA with pmb



- Roundabout.
- Variation in GripNumber over a 2 year period
- Different stressing locations
 - cornering
 - braking
 - accelerating
 - slow moving slewing traffic

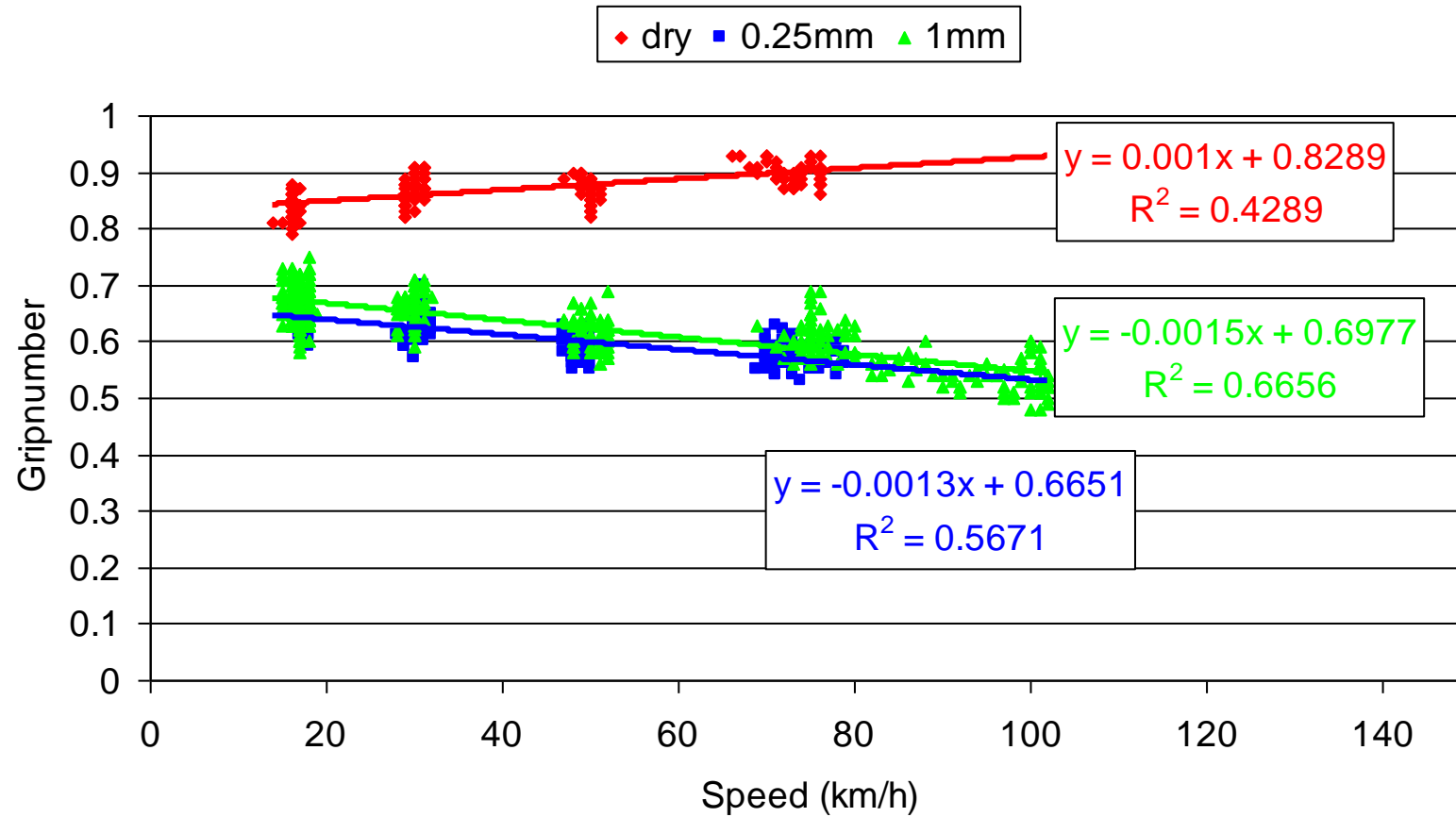
Evolution of an SMA



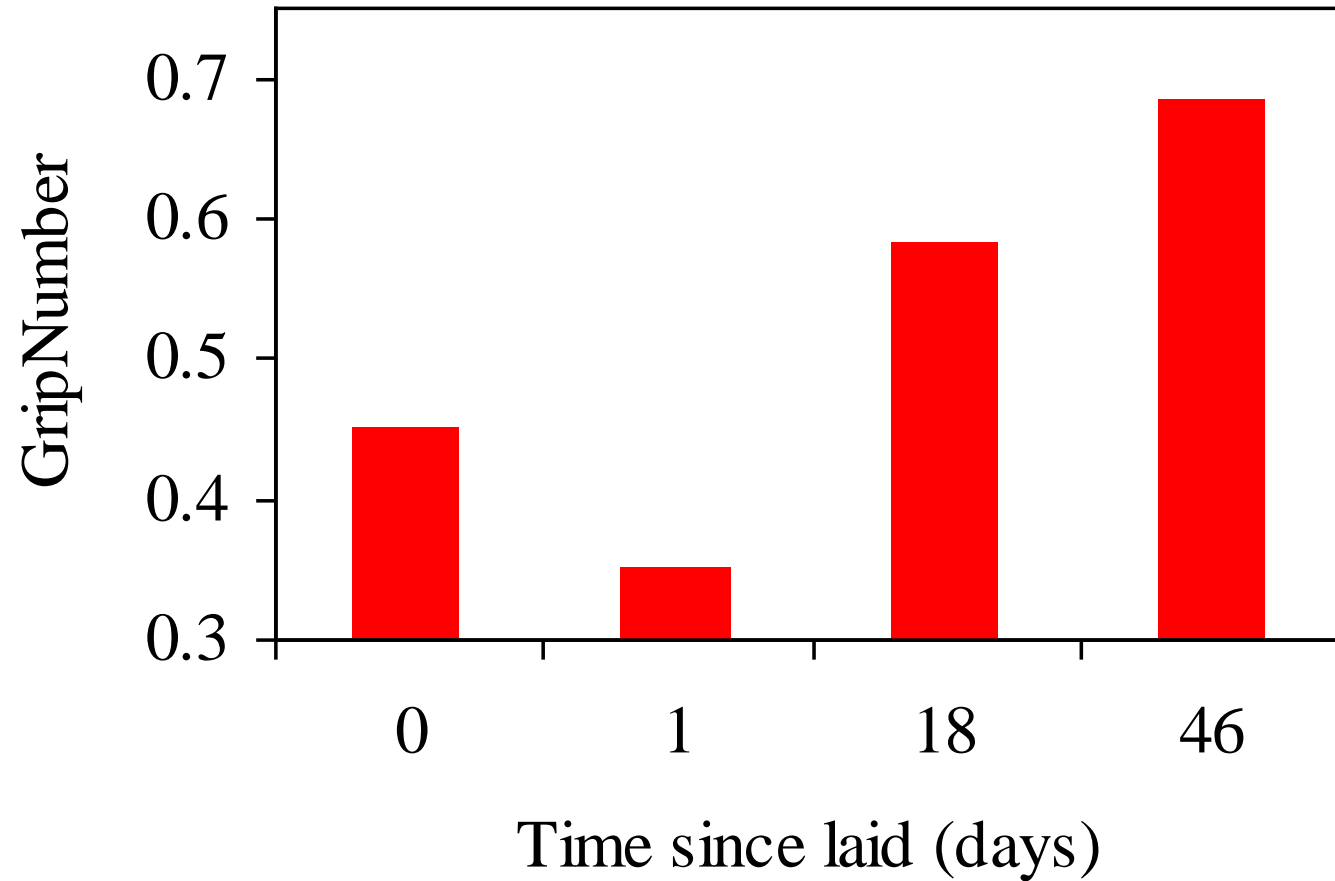
14mm thin surface – skid resistance for day 1



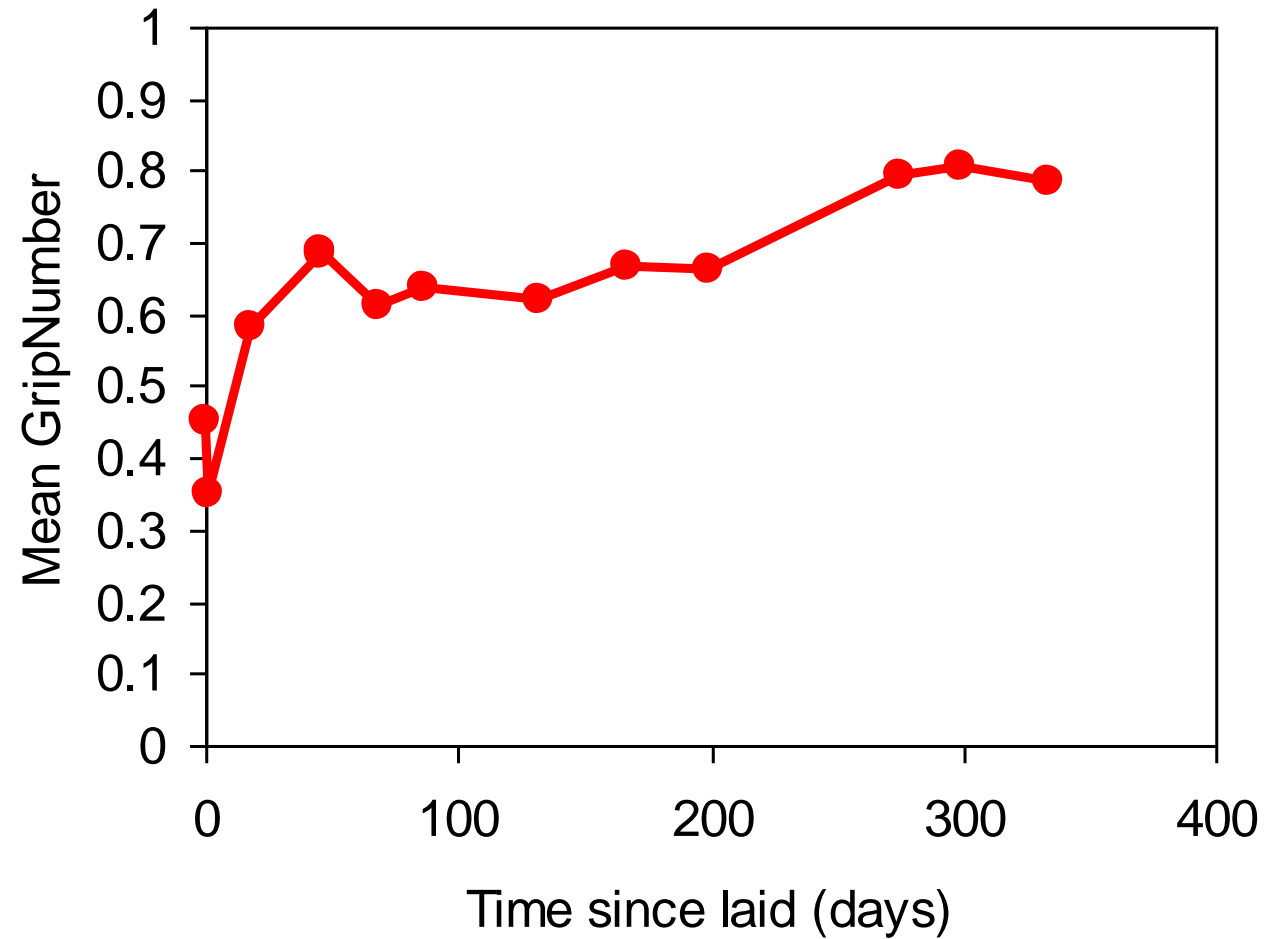
1 day old 14mm thin surfacing – dry / wet / different speeds



Initial drop followed by rise



First year for a 14mm thin surfacing





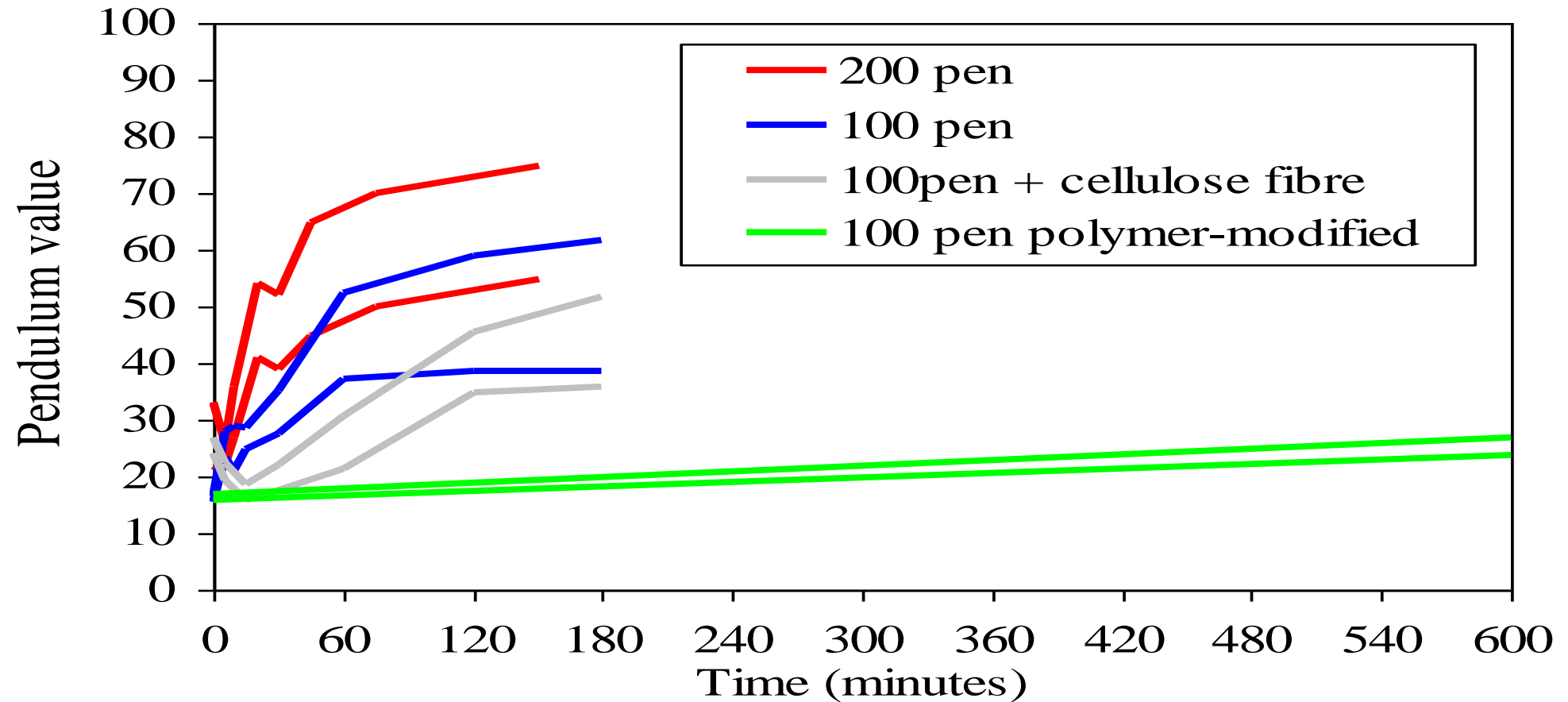
Predicting early life skid resistance using modified PSV testing

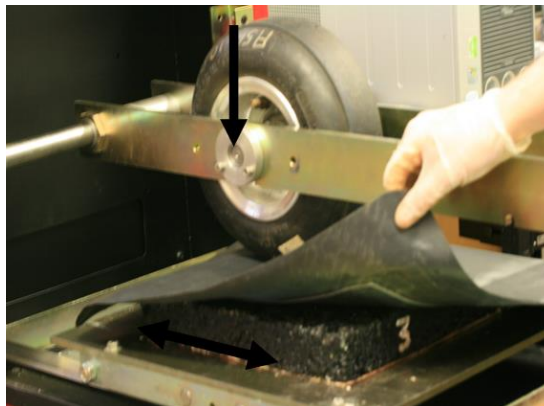
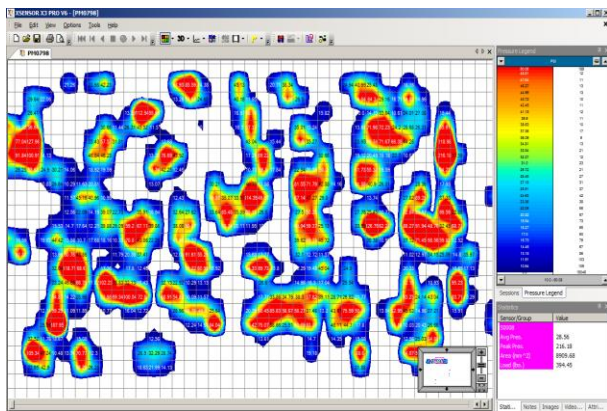
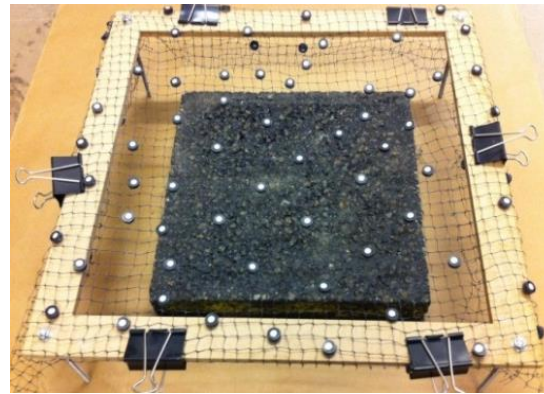
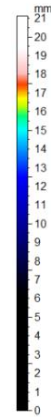
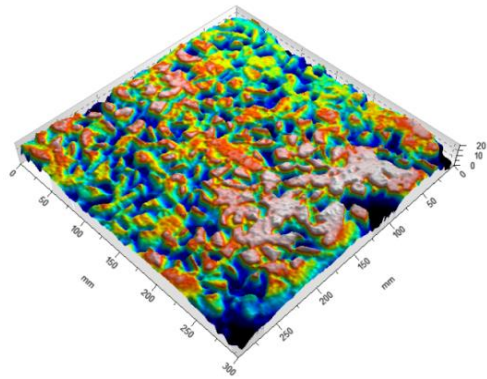
- New mixes:
 - polymer modified
 - thicker asphalt coatings with fibres
- How long to expose the aggregate?



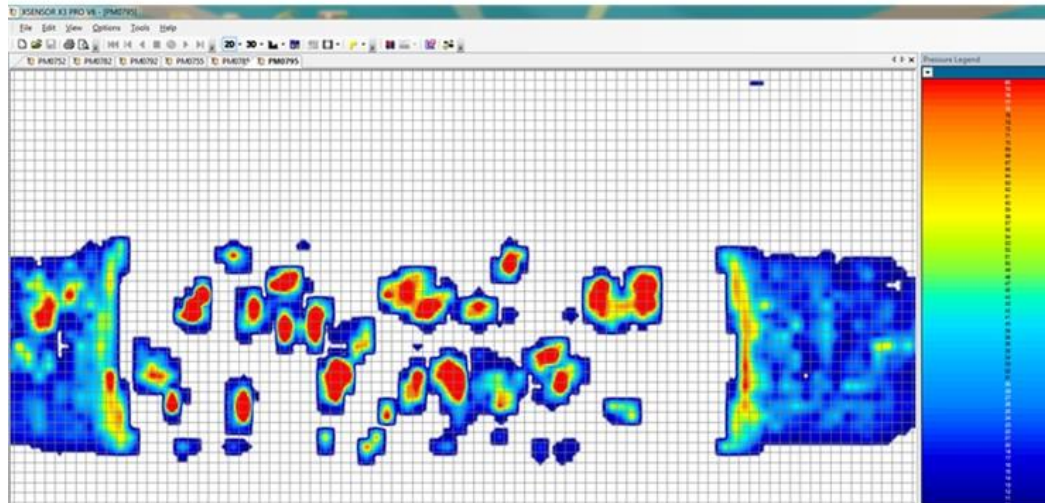
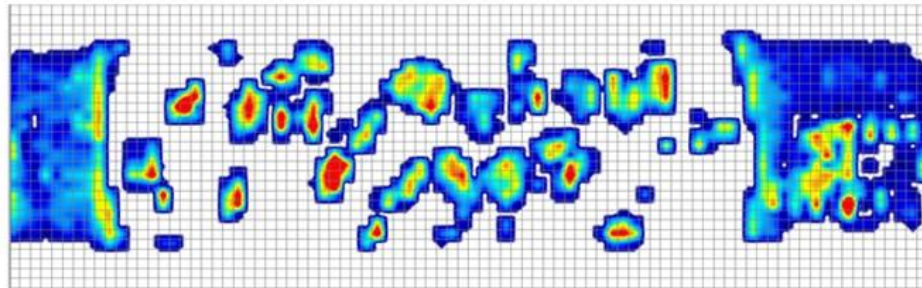
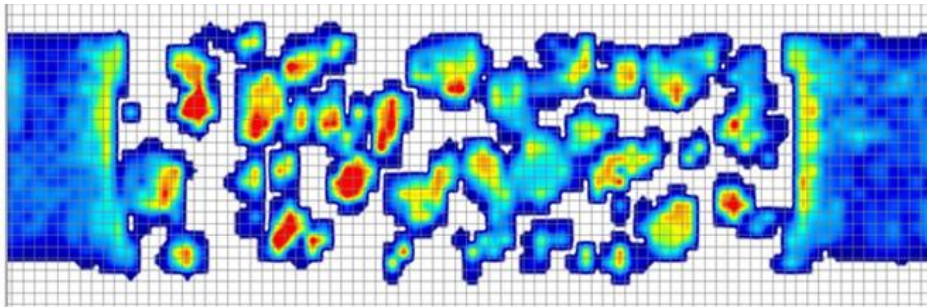
Comparison of different bitumen types

- note the initial drop followed by an increase dependant on binder type





Change in vertical contact pressure for a SMA 10 core extracted from a road and subjected to simulated trafficking (with University of Bologna)



Simulated trafficking of runway grind / grooves

