Road surface properties and high speed friction

Peter Sanders – Senior Researcher, TRL
pdsanders@trl.co.uk
May 2017

SaferRoads2017
5th International Conference

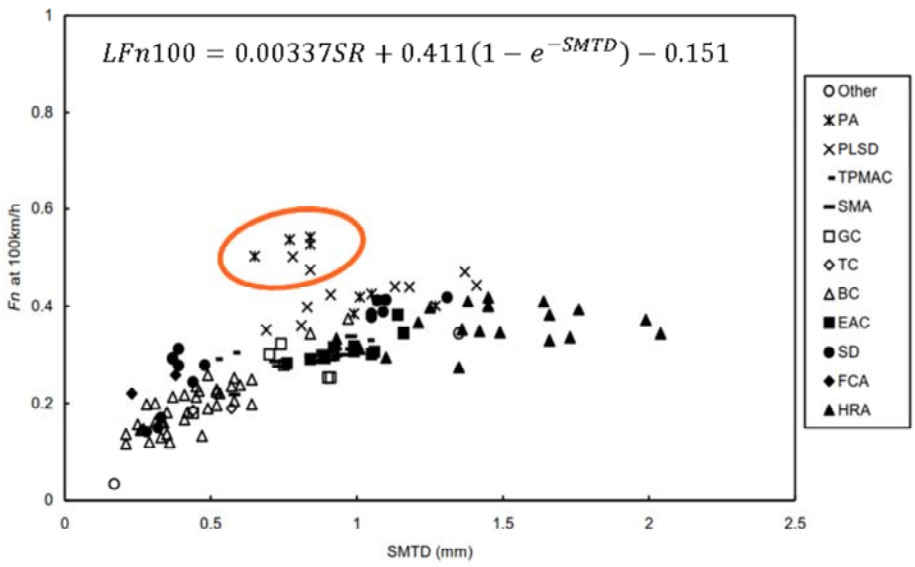
TRL THE FUTURE OF TRANSPORT

Contents

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Introduction and background – the TRL 367 model



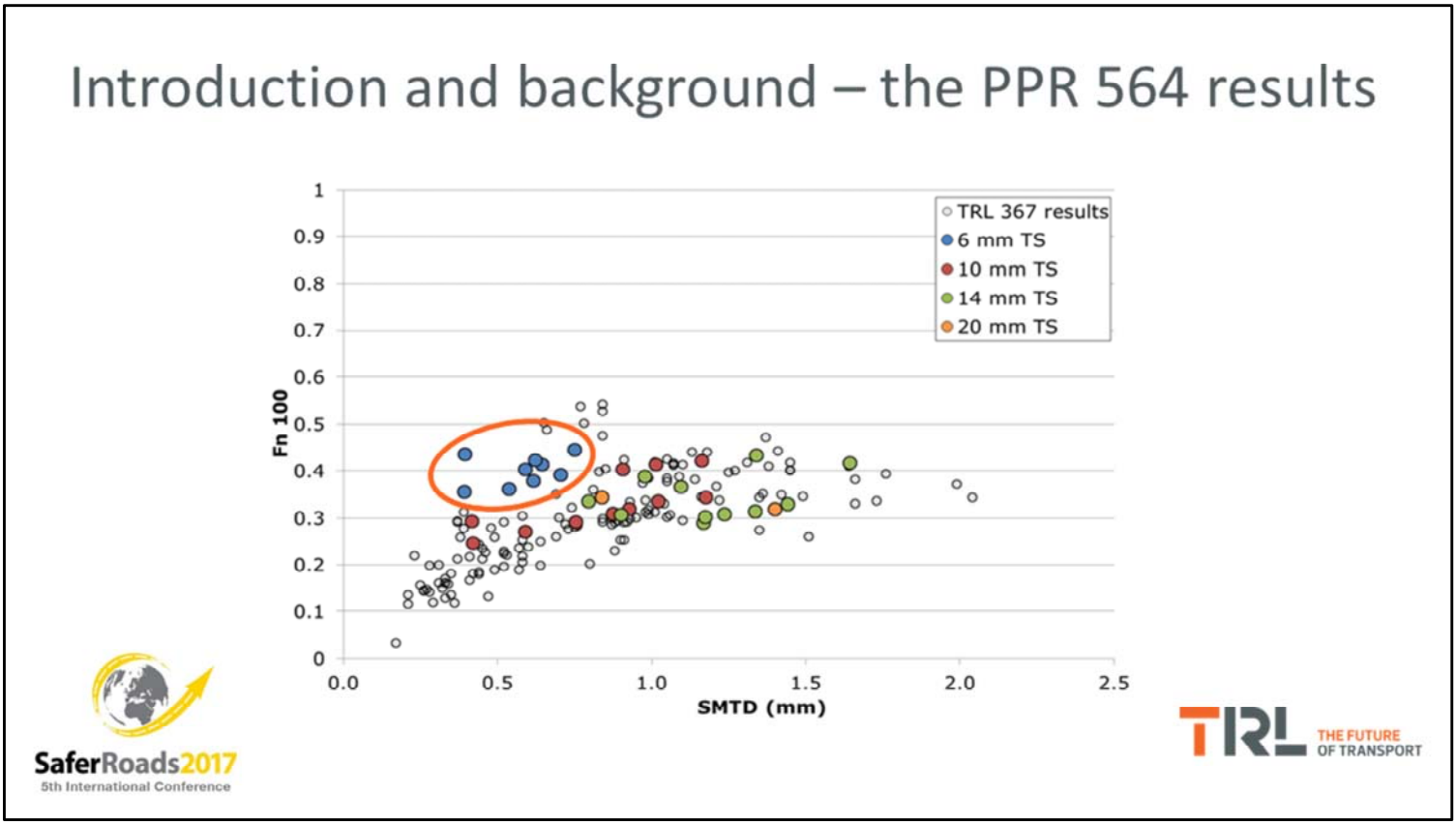
SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

The risk posed to motorists by the skid resistance condition of the road surface is managed in the UK through the specification of low speed skid resistance, which is monitored annually. And through a high-speed friction proxy; texture depth.

The relationship between texture depth and high speed friction was investigated as part of work reported in TRL367. As part of this work texture depth, low speed skid resistance and high speed friction measurements were made on a number of different surface types. The measurements were used to create this formula and were also used as the basis for setting the texture depth requirements for the UK SRN.

However, even this early work showed some anomalous results, highlighted here in the circle. These measurements demonstrate a performance which is low texture but high friction, contrary to the model.



A similar behavior was also observed as part of work reported in PPR 564. This work was assessing the friction and texture performance of a number of different thin surfacing materials.

Here the effect is more pronounced as the materials affected can have markedly low texture depths but very good high speed friction performance. The implications of this are that materials that demonstrate good high speed friction performance were not permitted for use on the UK network because their proxy measure was not consistent with the model.

HE sought to address this in the short term by amending the acceptable texture depth limits for these materials under the caveat that they demonstrate acceptable high speed friction performance.

However in the longer term a more universal solution is required and so HE (Then HA) commissioned some research to look into this issue.

Introduction and background – research aims

- Develop a system capable of measuring texture depth in a way which includes the outlying materials in a correlation with high speed friction.
- Understand the cause of the effects observed in TRL367 and PPR564.
- Produce a specification for a new device that could be used on the current fleet of traffic speed assessment vehicles.

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Collection of reference data and laboratory specimens

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

The work proposed was primarily a laboratory based study using the information collected as part of PPR564 as a reference data set.

Collection of reference data and laboratory specimens

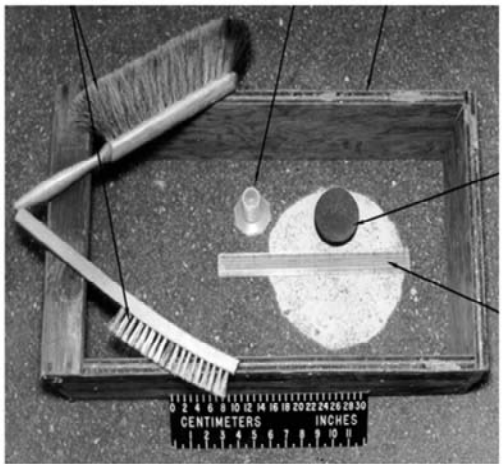
SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

225mm diameter and surface layer only

Traditional texture depth measurements and characterizations

MPD and RMS



MTD

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

In order to rule out the possibility that an existing methodology exists, the following other standard texture depth methodologies were used to measure the cores.

The CTM was used to measure Mean profile depth and Route mean squared texture depth

The volumetric technique was used to measure Mean Texture Depth

Recap of measurements made

- Fn100
- SC(50)

- SMTD
- MPD
- RMS
- MTD

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

The work proposed was primarily a laboratory based study using the information collected as part of PPR564 as a reference data set.

Results of measurements made

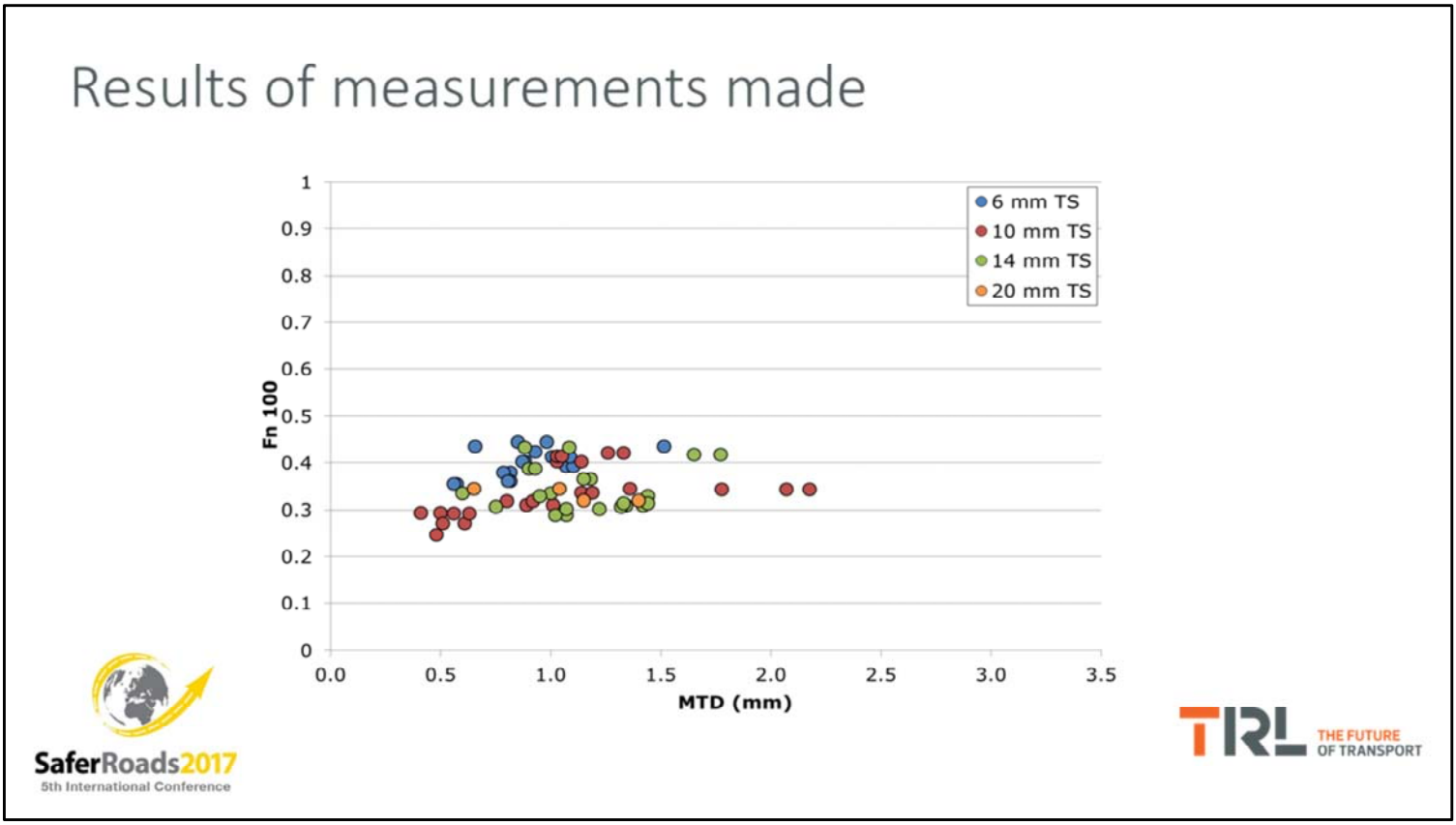
- Fn100
- SC(50)

- ~~SMTD~~
- ~~MPD~~
- ~~RMS~~
- MTD

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

The work proposed was primarily a laboratory based study using the information collected as part of PPR564 as a reference data set.



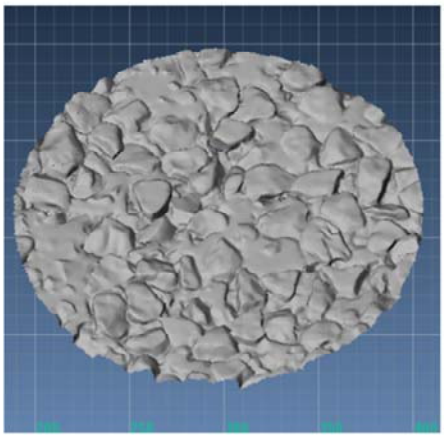
A similar behavior was also observed as part of work reported in PPR 564. This work was assessing the friction and texture performance of a number of different thin surfacing materials.

Here the effect is more pronounced as the materials affected can have markedly low texture depths but very good high speed friction performance. The implications of this are that materials that demonstrate good high speed friction performance were not permitted for use on the UK network because their proxy measure was not consistent with the model.

HE sought to address this in the short term by amending the acceptable texture depth limits for these materials under the caveat that they demonstrate acceptable high speed friction performance.

However in the longer term a more universal solution is required and so HE (Then HA) commissioned some research to look into this issue.

Alternative assessment of surface properties – 3D surface profile



SaferRoads2017
5th International Conference

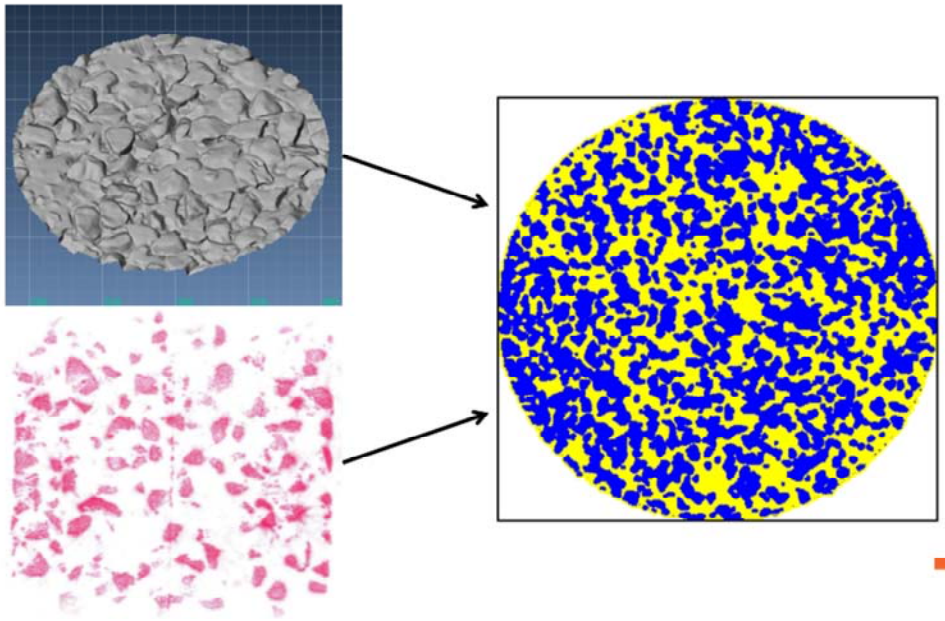
TRL THE FUTURE OF TRANSPORT

Alternative assessment of surface properties – tyre / surface pressure

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Alternative assessment of surface properties – characterizations developed

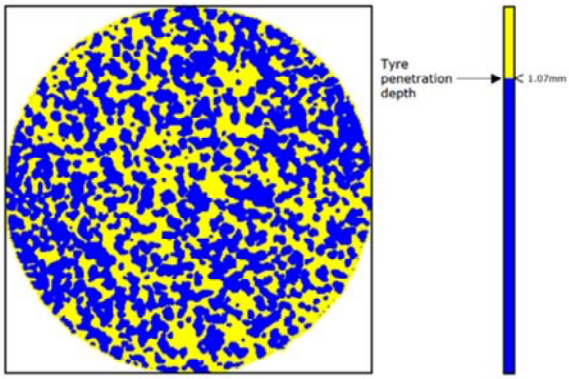


SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Alternative assessment of surface properties – characterizations developed

- Tyre penetration depth
- Percentage pressed area
- Volume of void below tyre
- Volume of void occupied by tyre



Projected Area (%)	33.9	60.1
Volume of void (%)	5.61	77.0
Volume of material (%)	94.4	23.0
Volume of void (mm^3/mm^2)	0.244	0.824
Volume of material (mm^3/mm^2)	4.11	0.247
Mean thickness of void (mm)	0.244	0.824
Mean thickness of material (mm)	4.11	0.247

Volume of void below tyre

Percentage pressed area

Volume of void occupied by tyre

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Alternative assessment of surface properties – Glass spheres texture depth

- Same as the volumetric technique but using 0.025 mm to 0.105 mm diameter spheres.
- Volumetric uses 0.18 mm to 0.25 mm diameter spheres.

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Recap of measurements made

- Fn100
- SC(50)
- ~~SMTD~~
- ~~MPD~~
- ~~RMS~~
- MTD

- Tyre penetration depth
- Percentage pressed area
- Volume of void below tyre
- Volume of void occupied by tyre
- Glass spheres texture depth

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

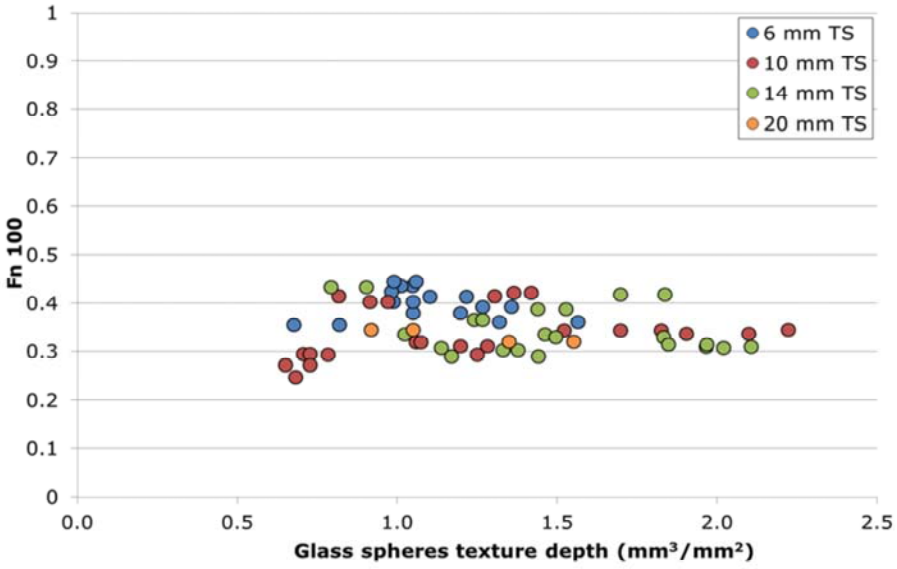
Recap of measurements made

- Fn100
- SC(50)
- ~~SMTD~~
- ~~MPD~~
- ~~RMS~~
- MTD
- ~~Tyre penetration depth~~
- ~~Percentage pressed area~~
- ~~Volume of void below tyre~~
- ~~Volume of void occupied by tyre~~
- Glass spheres texture depth

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

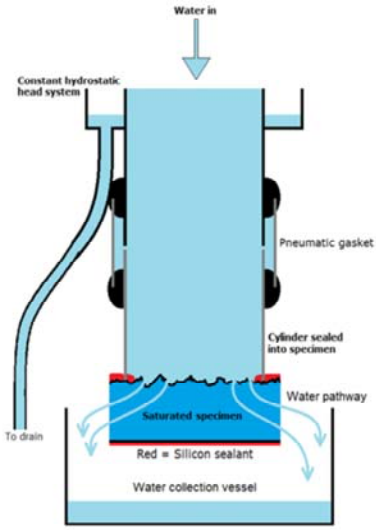
Results of alternative texture depth characterizations



SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

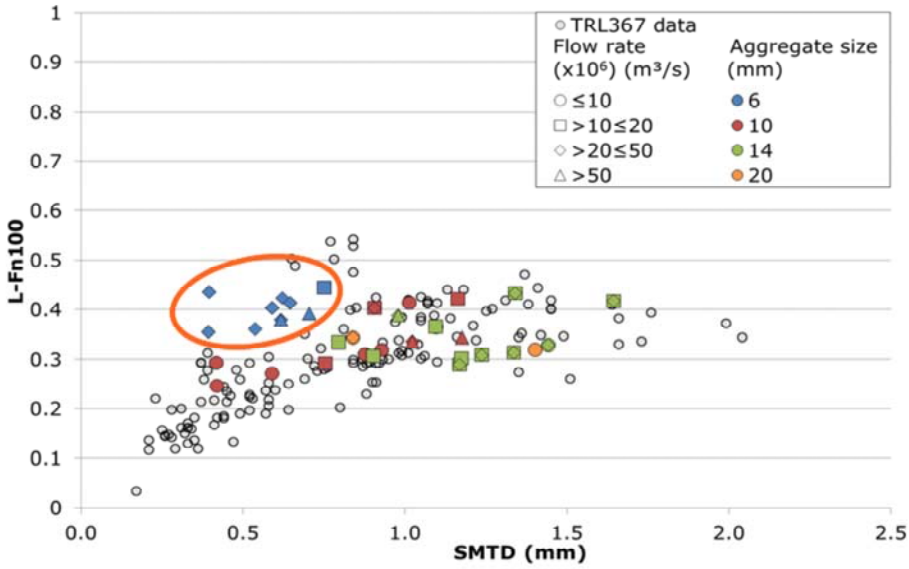
Assessment of permeability – methodology



SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

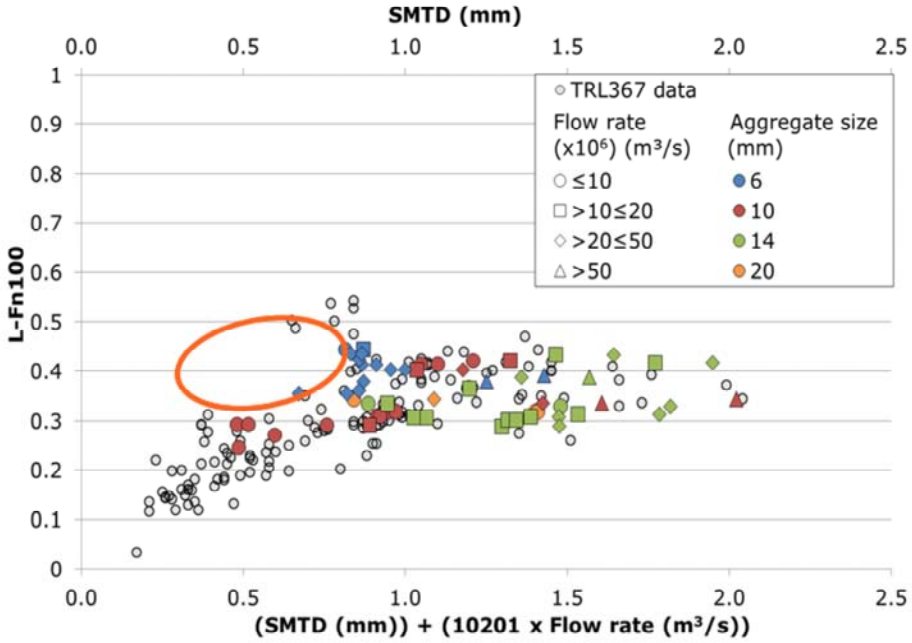
Assessment of permeability - results



SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Assessment of permeability - results



SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Conclusions

- It is not possible to use optical methods to measure texture in a way which takes into account the outlying behavior.
- This behavior is based on the inter-connected void network of the road surface.
- The effect of texture and porosity can be considered additive.

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT

Road surface properties and high speed friction

Peter Sanders – Senior Researcher, TRL
pdsanders@trl.co.uk
May 2017

SaferRoads2017
5th International Conference

TRL THE FUTURE OF TRANSPORT