WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE
Norfolk, Virginia / September 19-22, 2012
7th symposium on pavement surface characteristics
SURF 2012

THE DEVELOPMENT OF ASPHALT SURFACING PROPERTIES

David Woodward, Phillip Millar, Shaun Friel and Ruth Mitchell

University of Ulster

Predicting changing asphalt properties

- **Sustainability**

  …how properties change with time

- **Every surfacing:**
  - **Laid and then strives towards equilibrium until its done and needs replaced**
- **How can we predict what's going to happen during this period?**

Ireland – setting the scene

- **From Celtic Tiger to austerity**
  - **8 billion Euro over 10 years spent on infrastucture**
  - **We now have almost a decent highway infrastructure that needs maintained**
- **Known for its 40 shades of green**
  - **Typically it rains (hence the green)**
  - **Now getting more extreme weather events e.g. -20C for 1 month in 2009/10**

Ireland – what do we do

- Abundant sources of high quality aggregate
- Main local rock type is low PSV limestone
- Specification requirements for high PSV
- Issues with:
  - transport costs
  - carbon foot-print / energy etc
  - loss of other aggregate properties related to high PSV

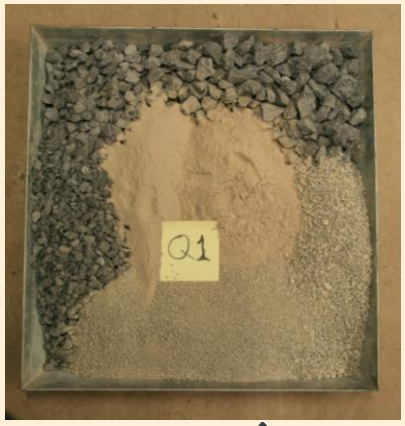
Ireland – where are we going

- Wet / colder changing climate
- Reduced trafficking due to our sick Celtic Tiger
- Changes coming from Europe and UK
  - Specifications
  - Asphalt mixes
- Hug a tree philosophies v. real life
  - 1st warm mix surfacing trial this week in Dublin

Different examples

- **Simulating traffic under controlled conditions**
- **Change in grip**
- **Textures at different scales**
- **Aggregate exposure**
- **Tire / asphalt contact**
- **Tire / asphalt pressure distributions**

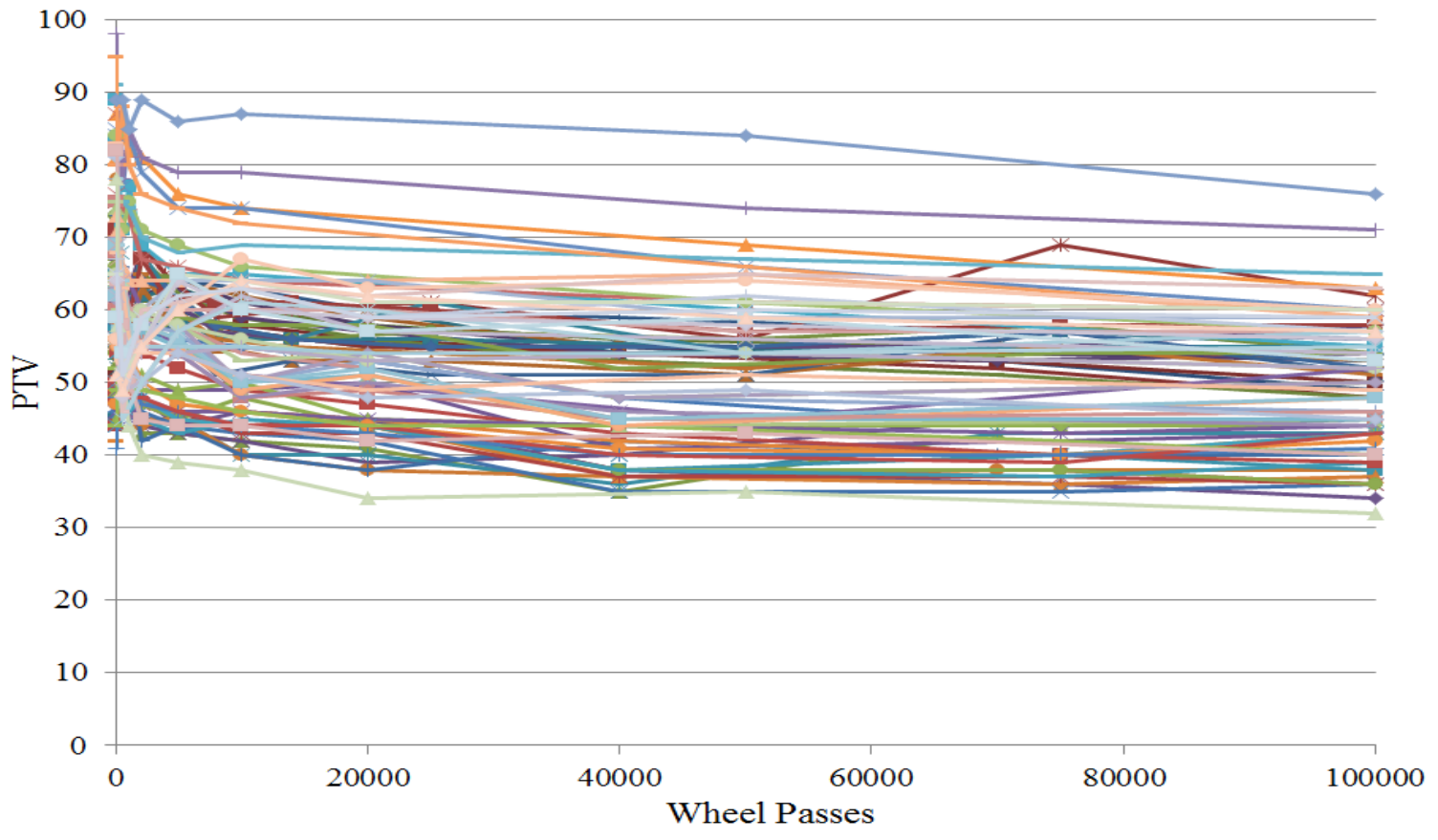
From raw materials to 3d modelling



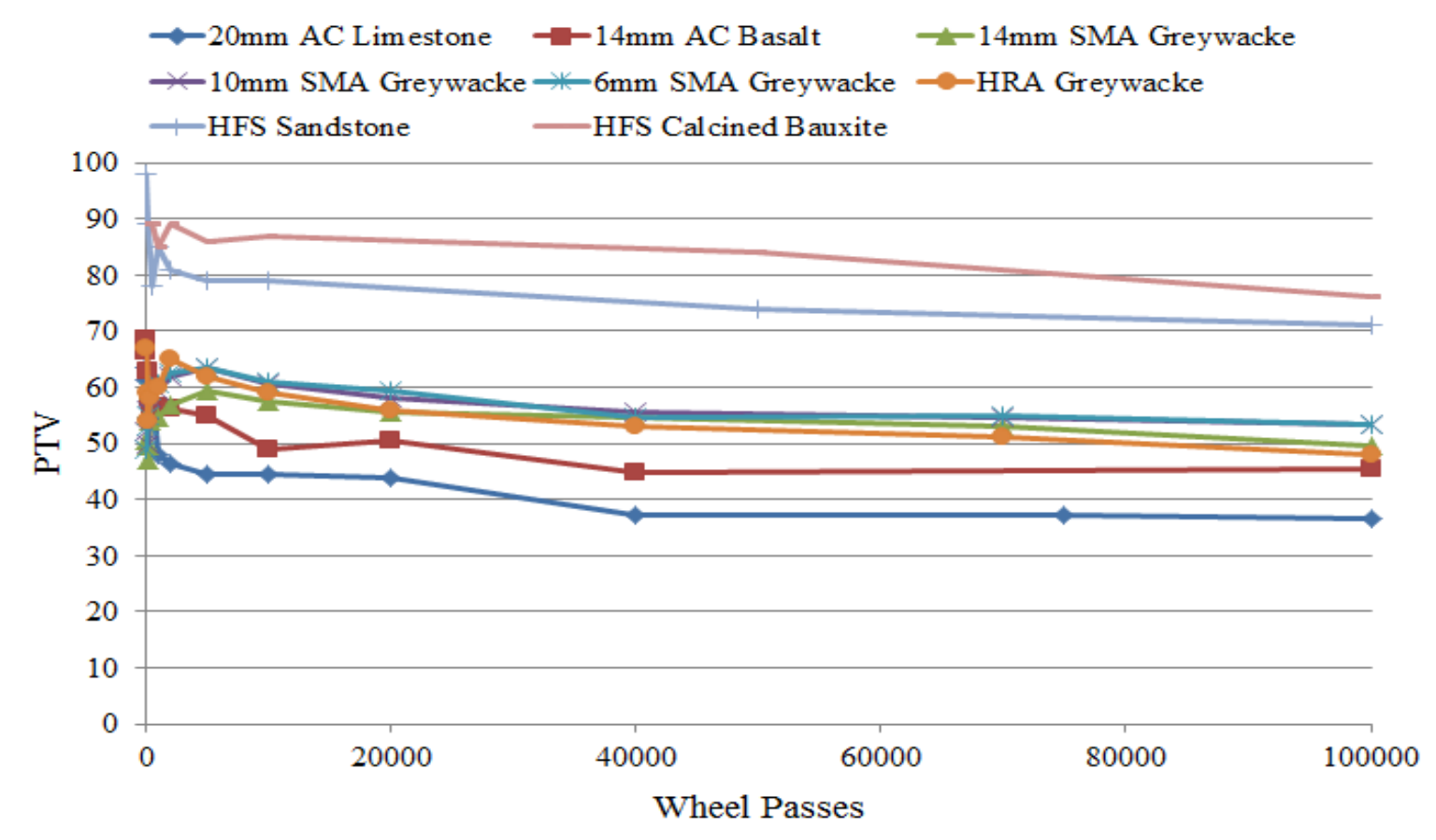
Road Test Machine

- How we simulate trafficking
- 10 asphalt slabs
- 2 full-scale tyres
- 100,000 wheel passes
  - 5 to 8 years trafficking
- Measure change in properties as they develop

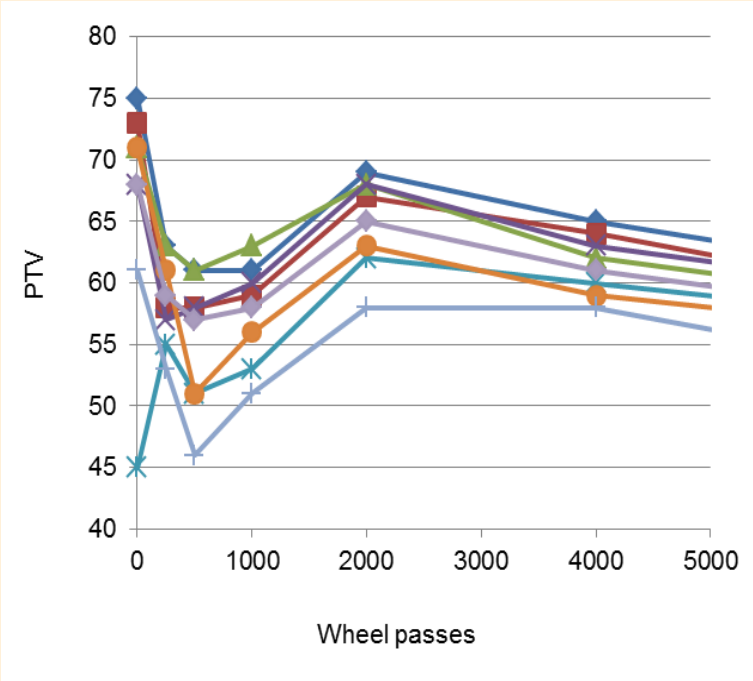
Part of our data set of skid resistance development

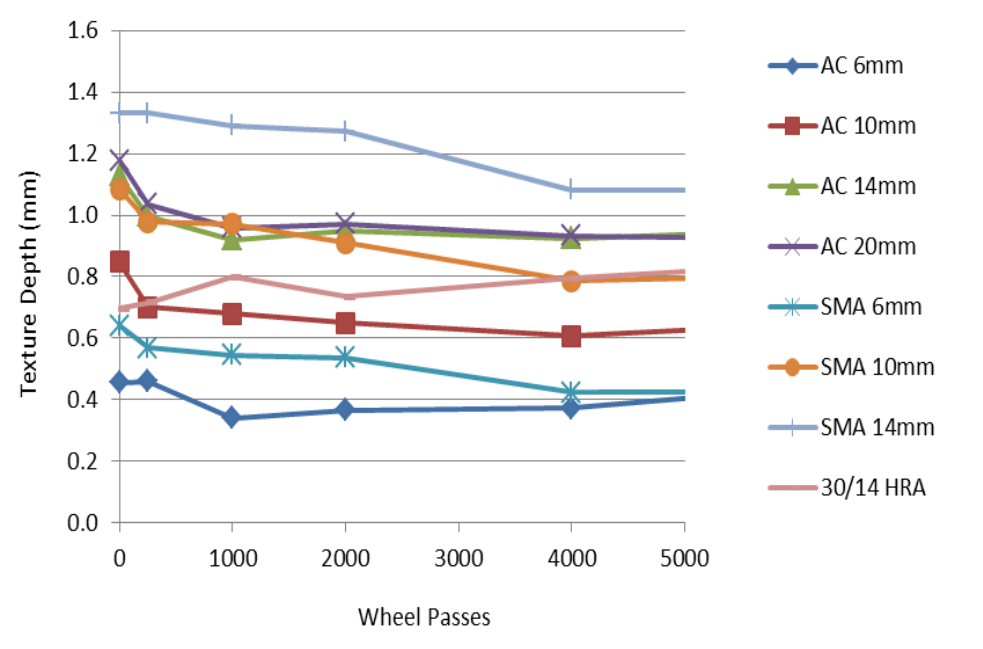


Breakdown relating to surfacing and rock type

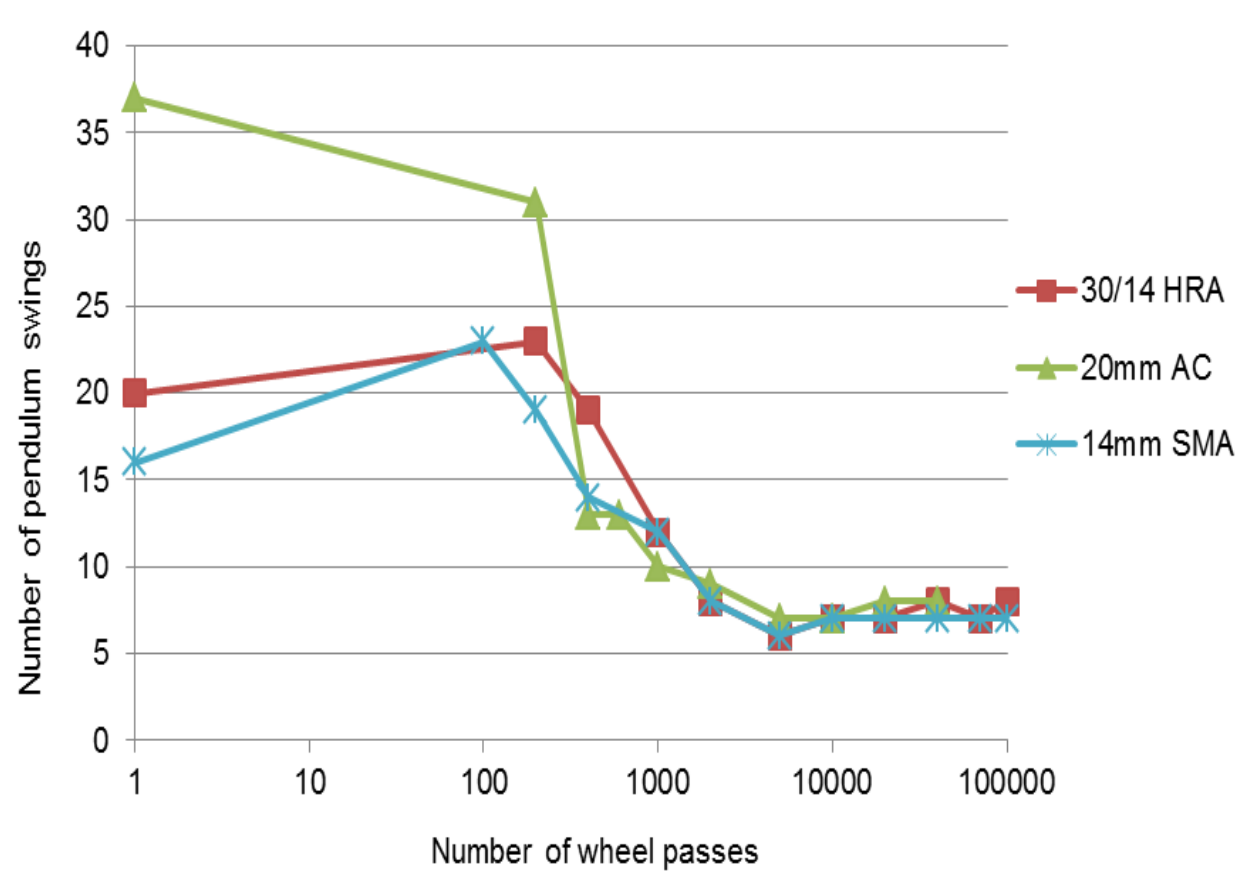


Same high PSV (63) aggregate used in different mixes – early life changes in grip and texture

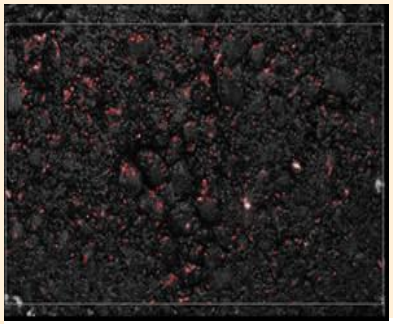


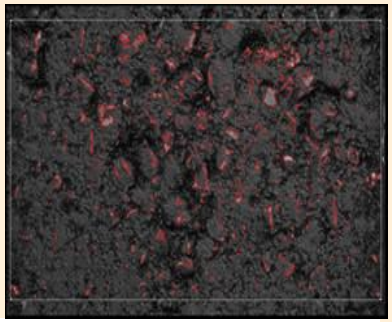


Role of bitumen coatings during early life – the risk of early life bituplanning?

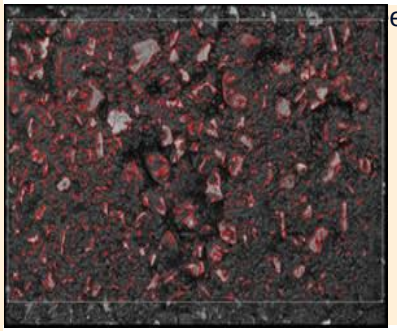


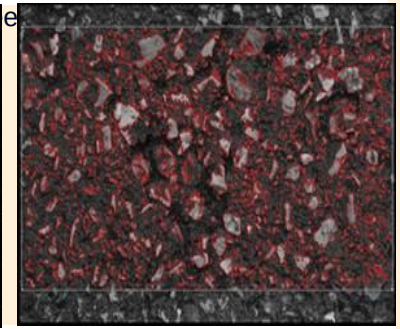
Aggregate exposure





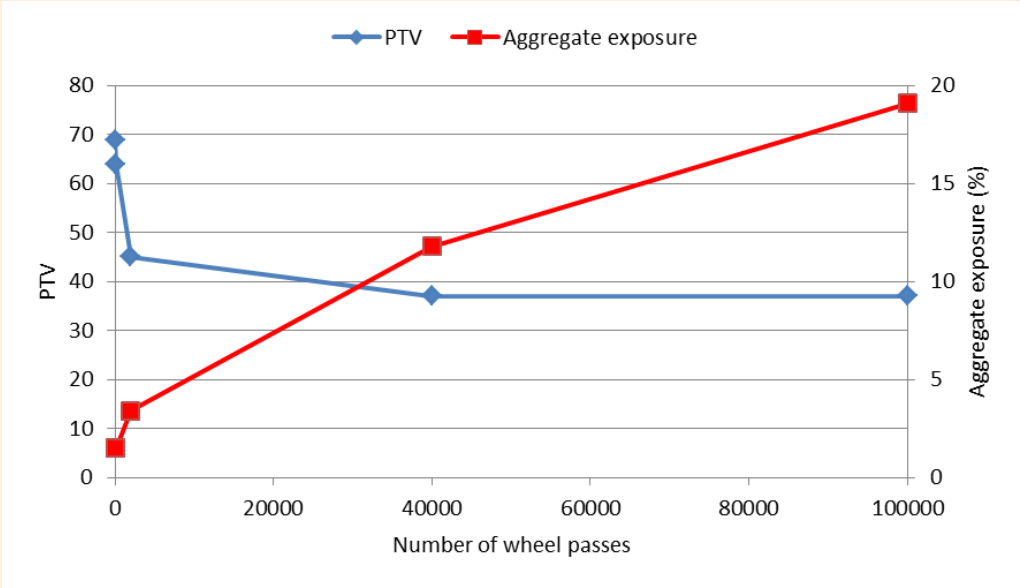
Aggregate exposure 0 wheel passes





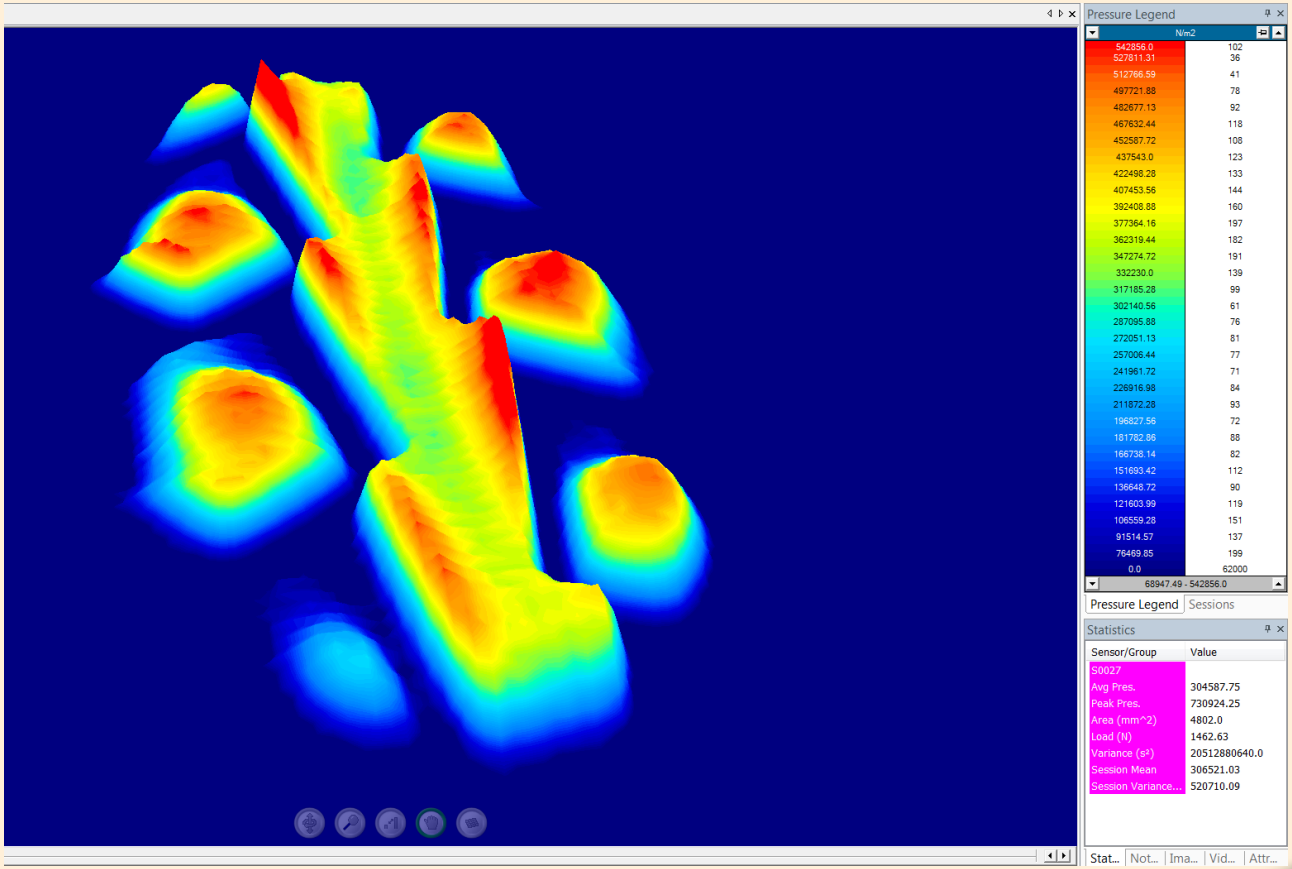
Aggregate exposure 40,000 wheel passes

Aggregate exposure 100,000 wheel passes



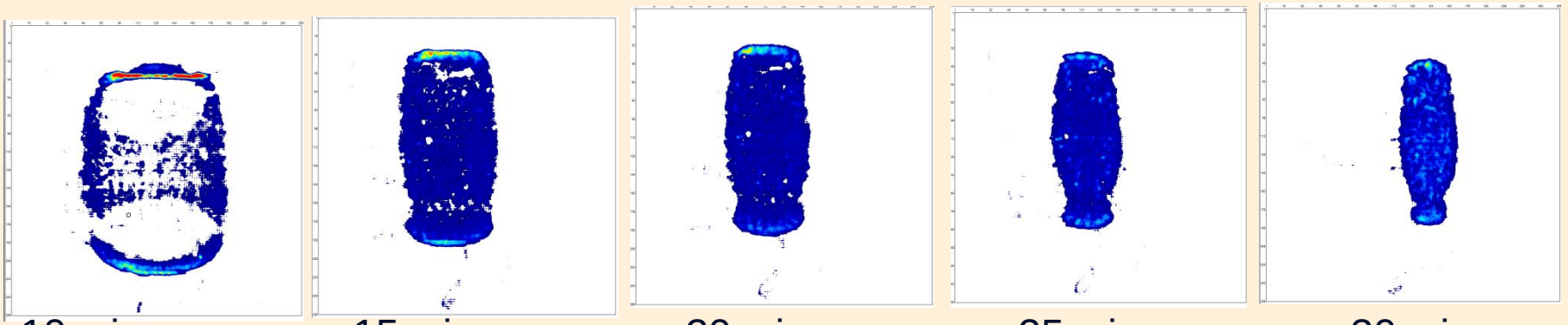
Tire pressure mapping

From paint to pressure mapping

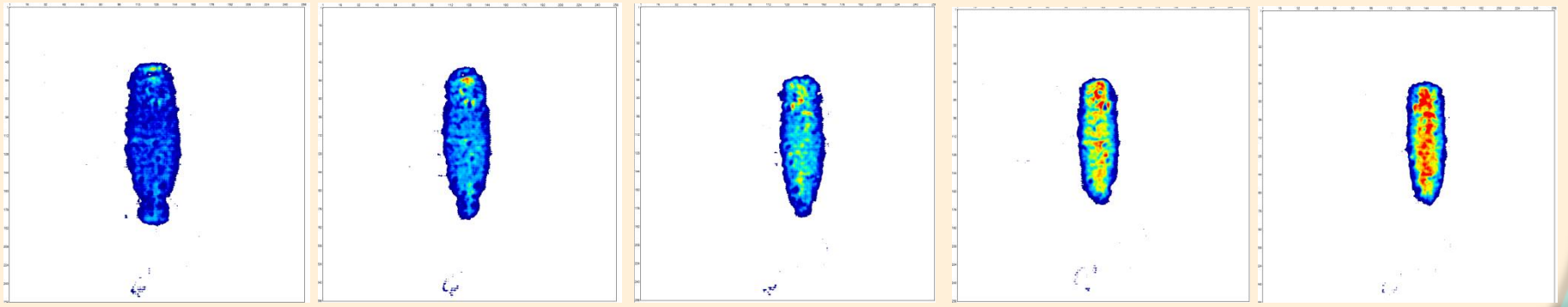


Formula Student rear slick

flat 1psi 3psi 5psi 8psi

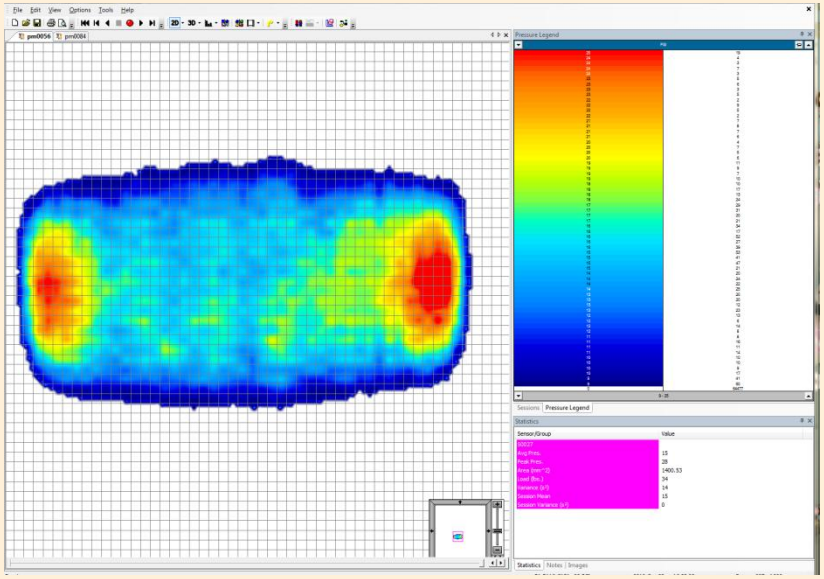


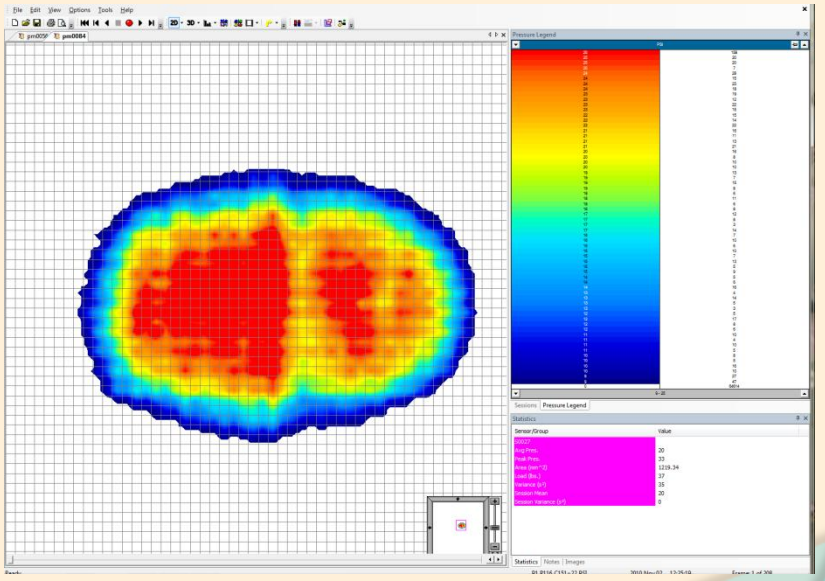
10psi 15psi 20psi 25psi 30psi



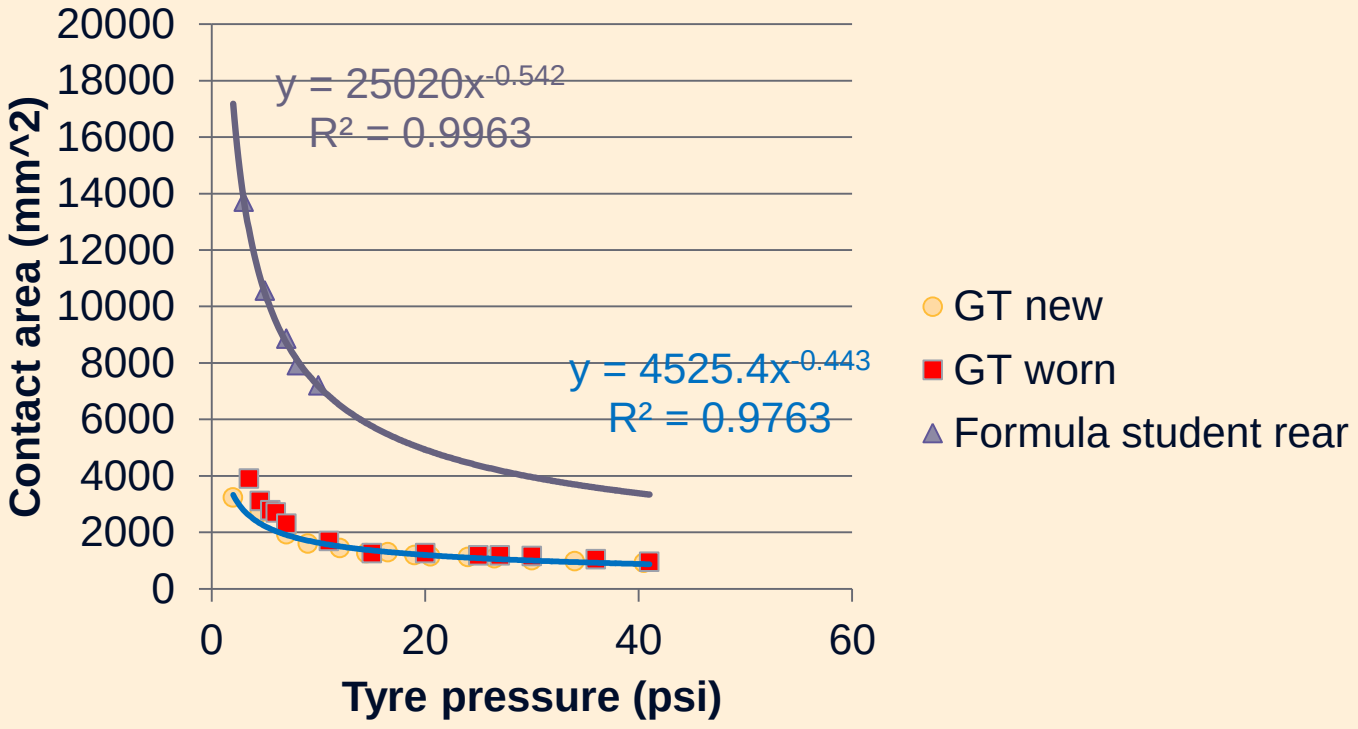
GT and µGT on high resolution XSensor pressure pad

GripTester tyres @ 20psi worn (left) and new (right)

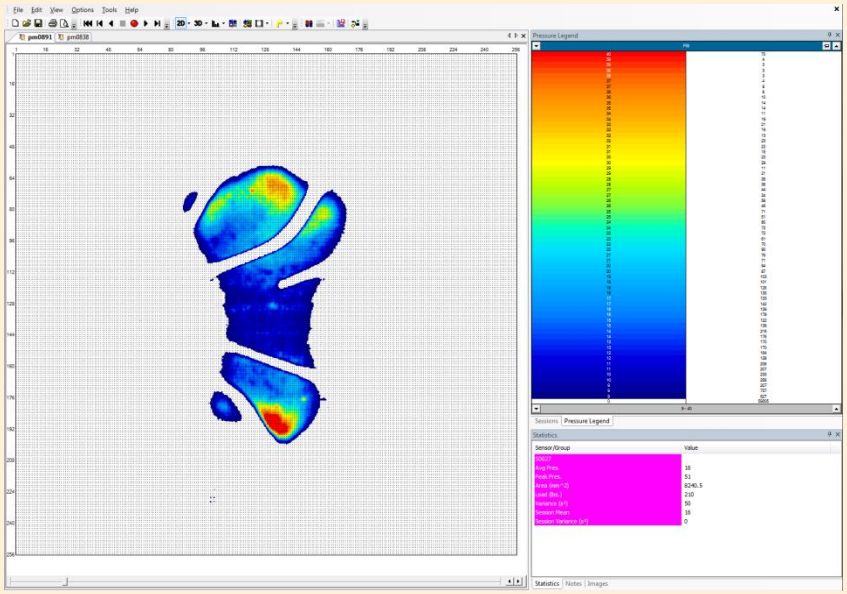


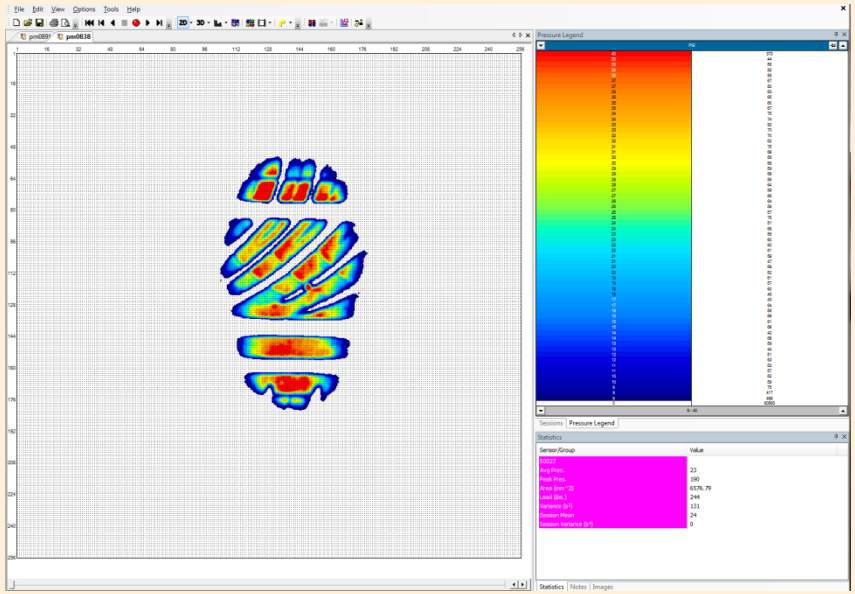


Comparison of 2 different types of slick tyre – GripTester and rear Formula Student

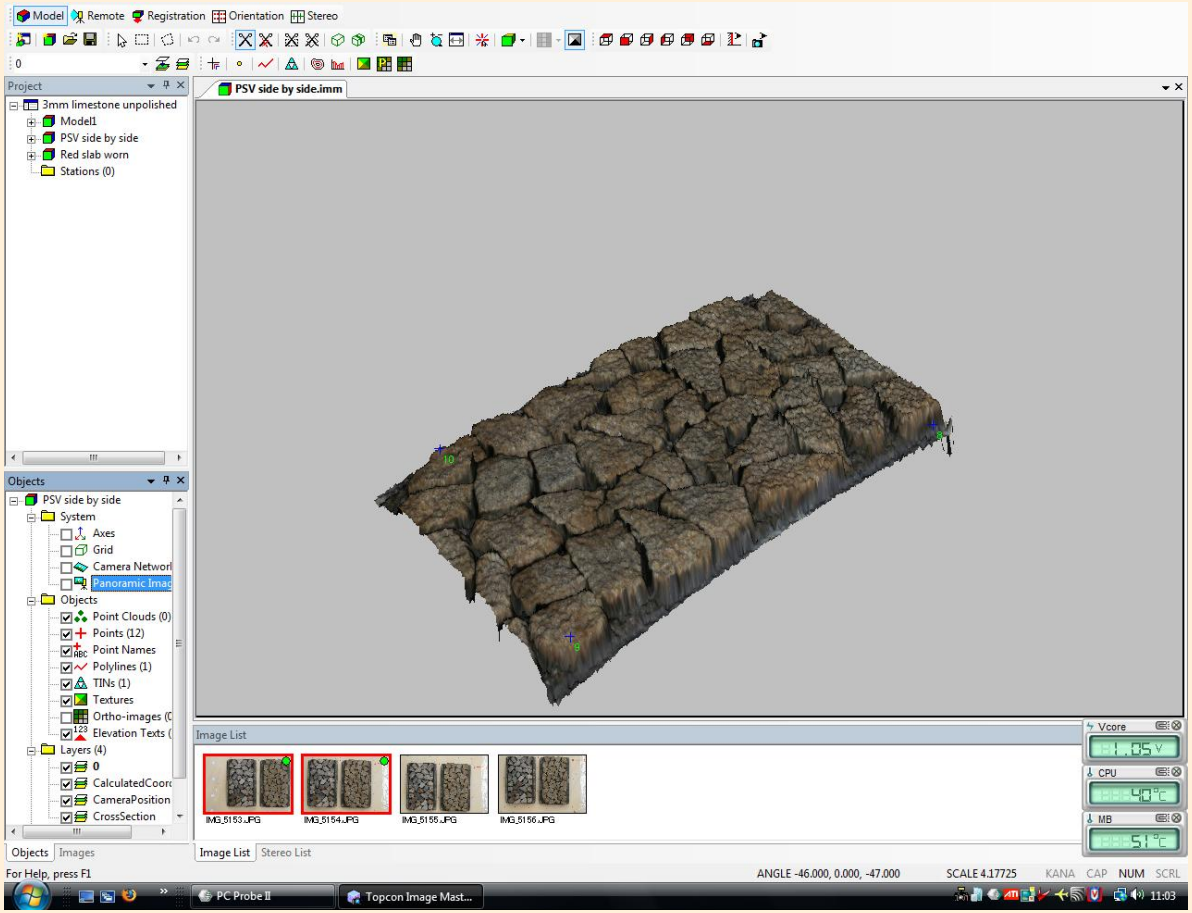


Toyo 888 v. Avon – rear right @ 20psi

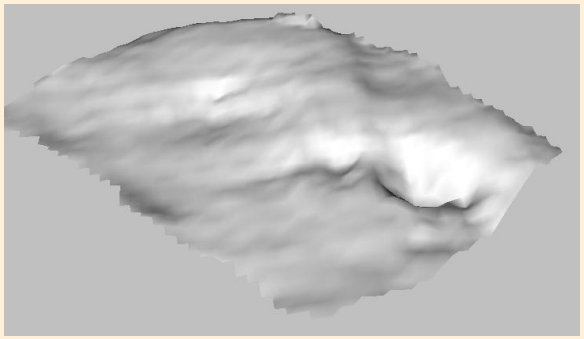


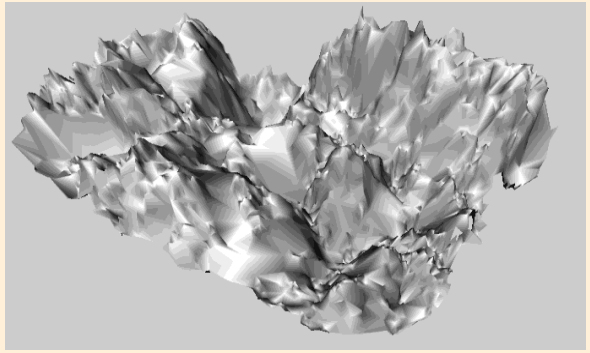


3-d model of a PSV mould pre-test (Image draped over a TIN)

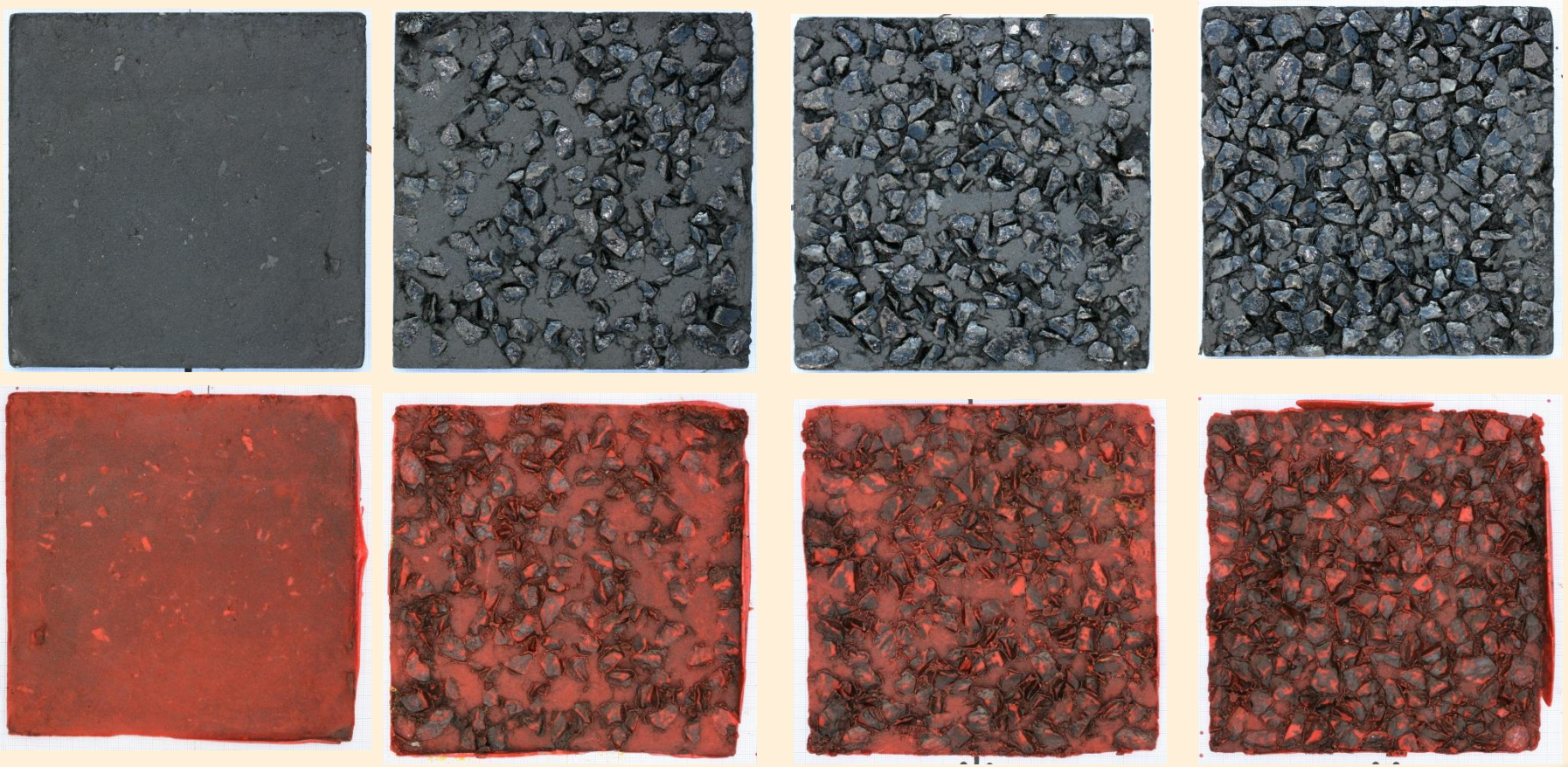


Polished limestone and sandstone chippings with 3-d model images

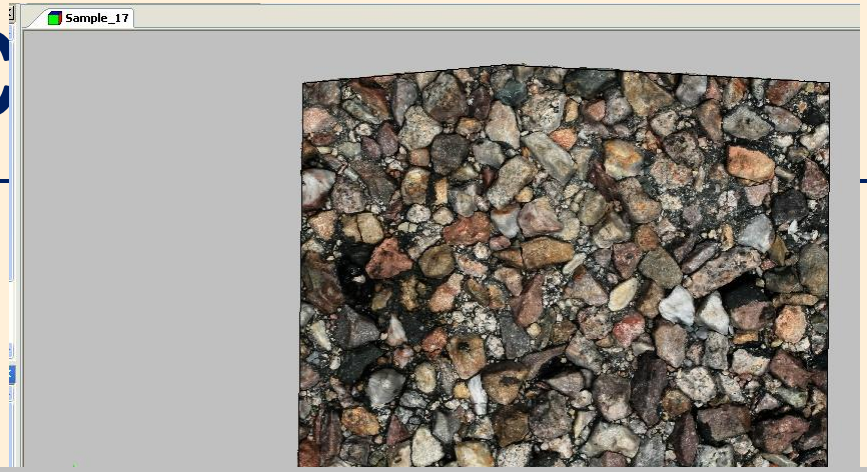


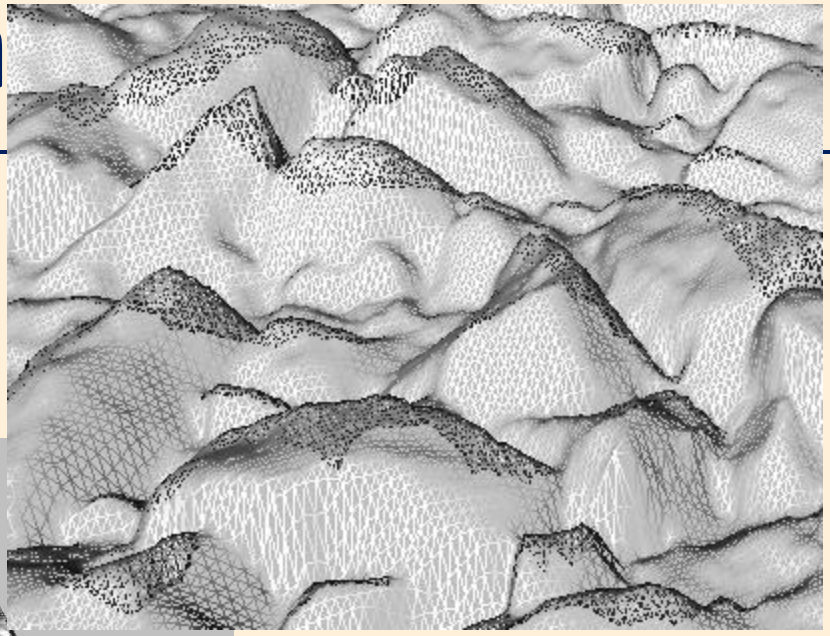


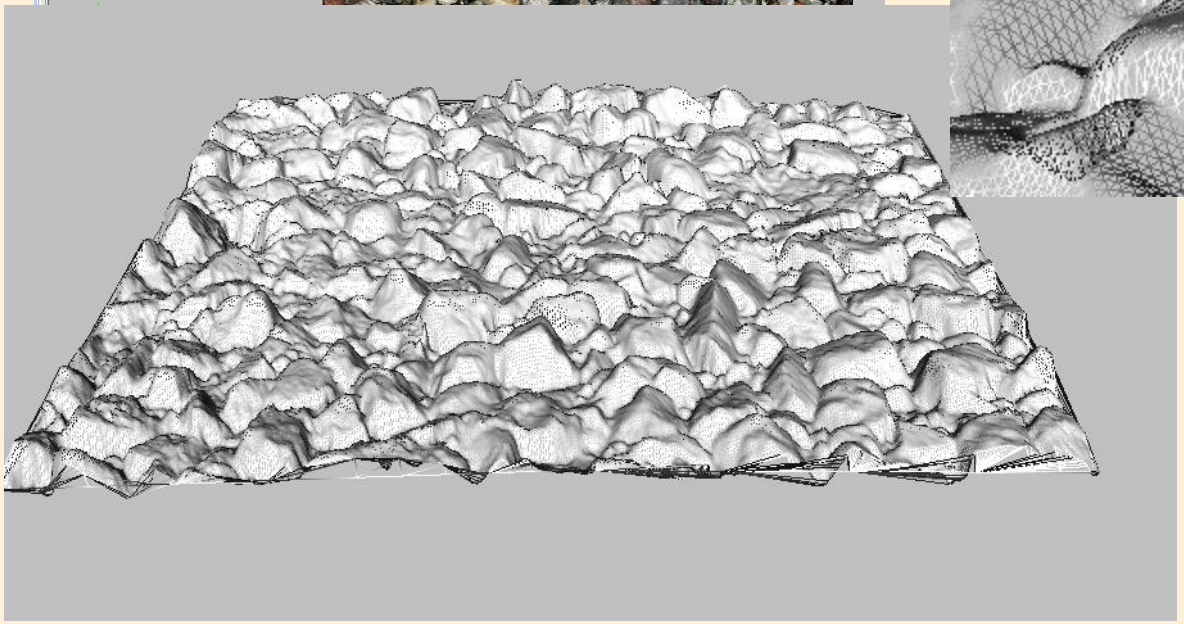
Asphalt slabs or latex peels



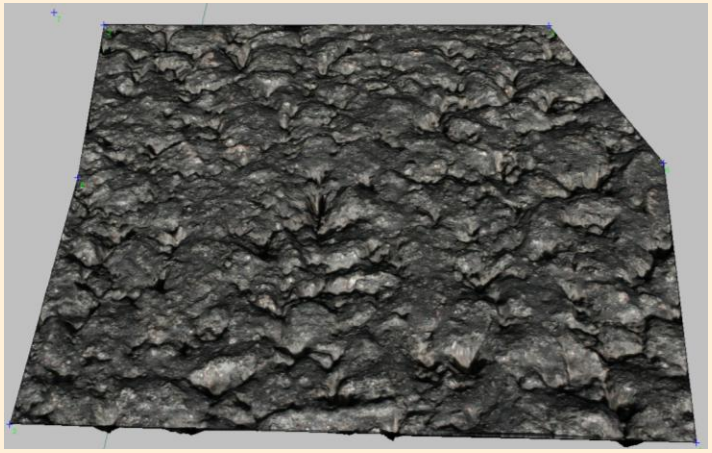
C h



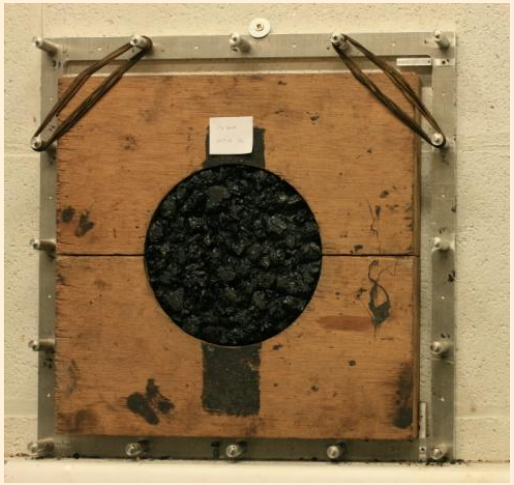


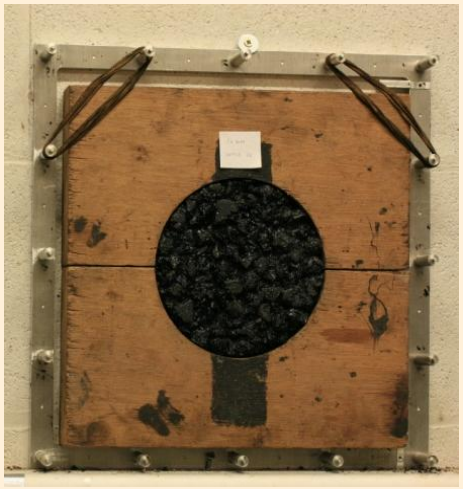


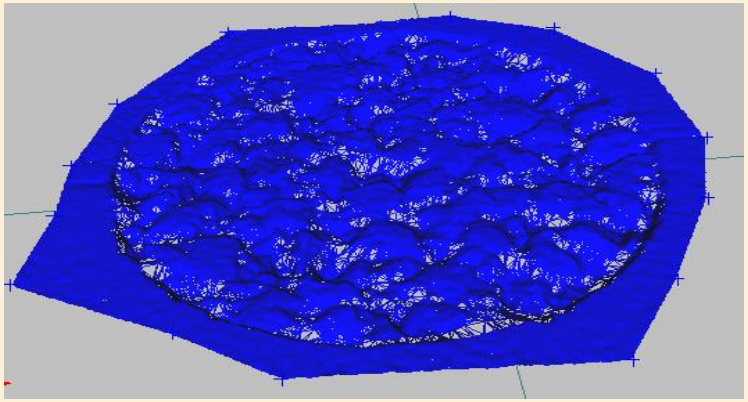
Close range photogrammetry 2 ½ modelling – trafficked slabs



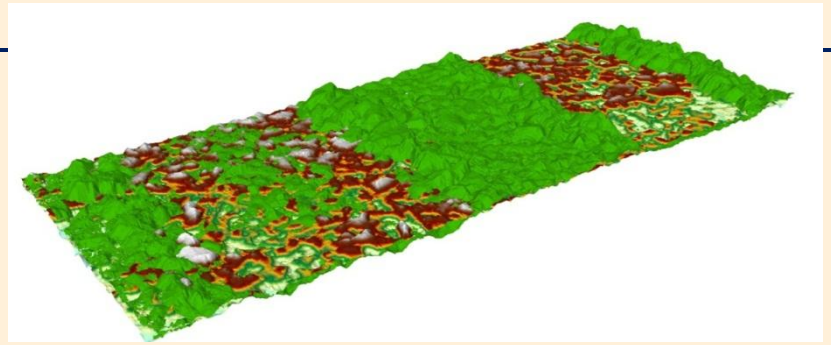
Trafficked gyratory specimens

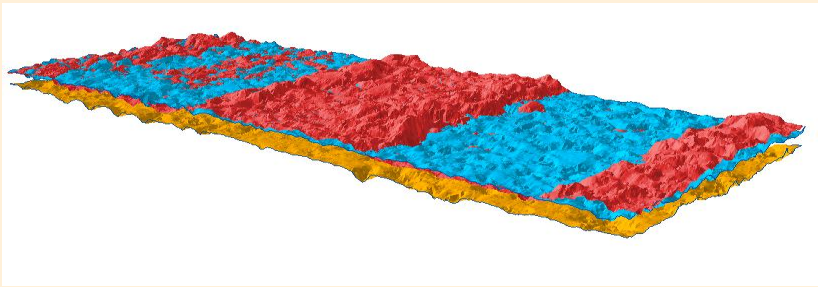


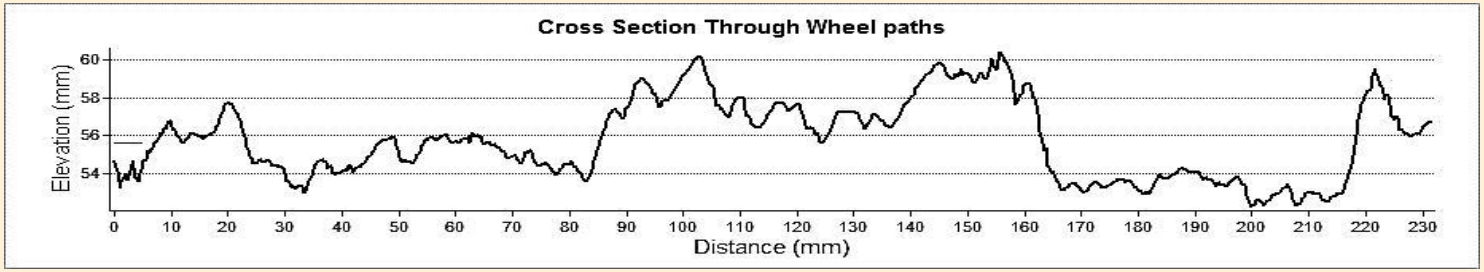


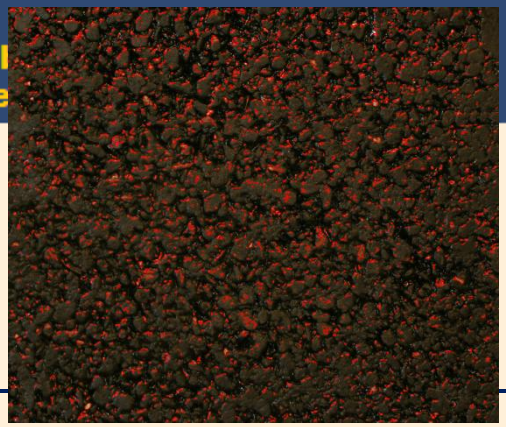
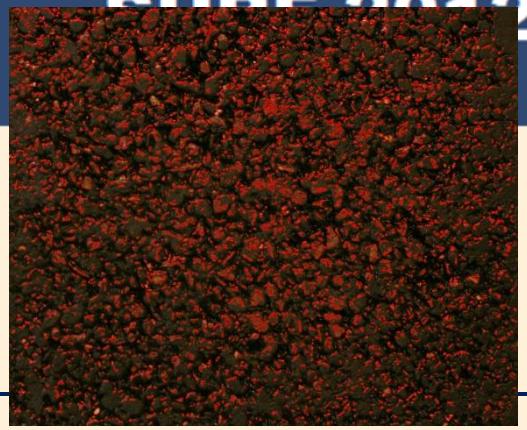
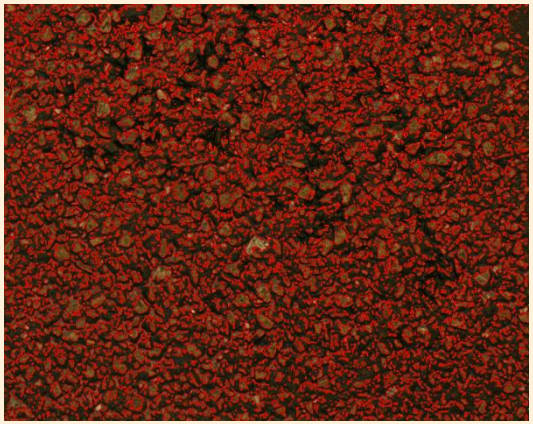


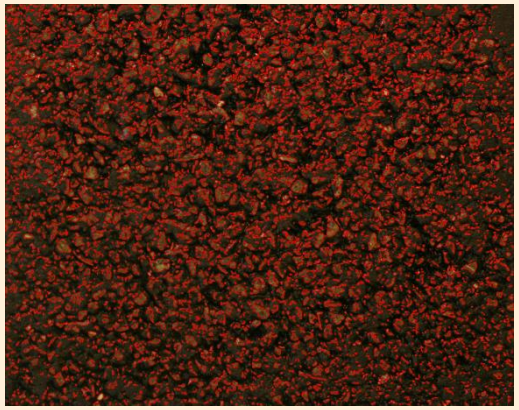
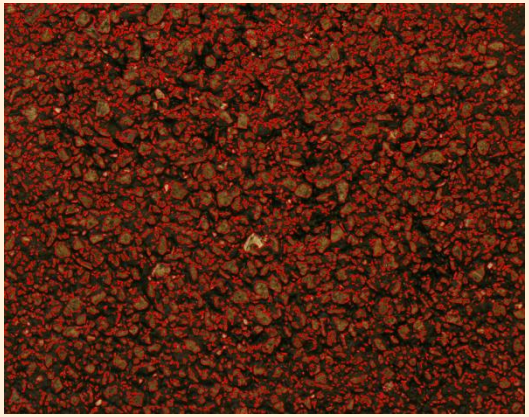
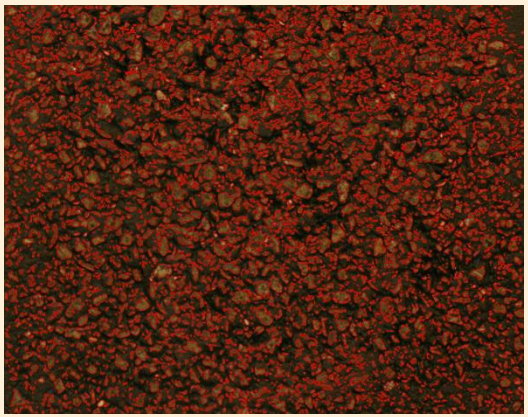
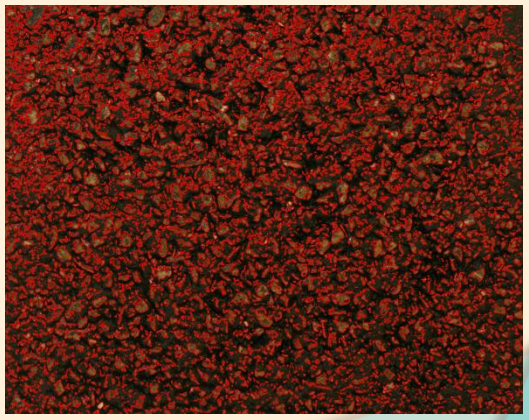
Tracked 3mm HFS 3d surfaces modelled in GIS



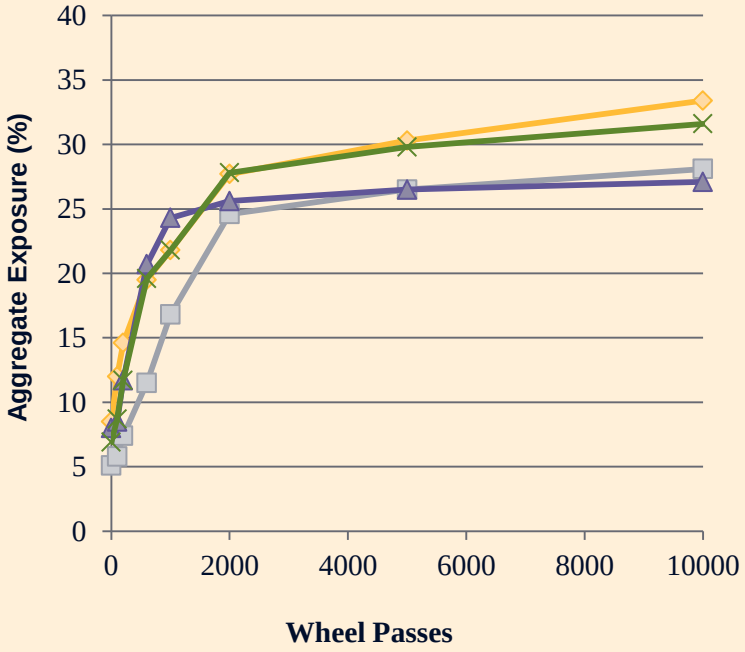


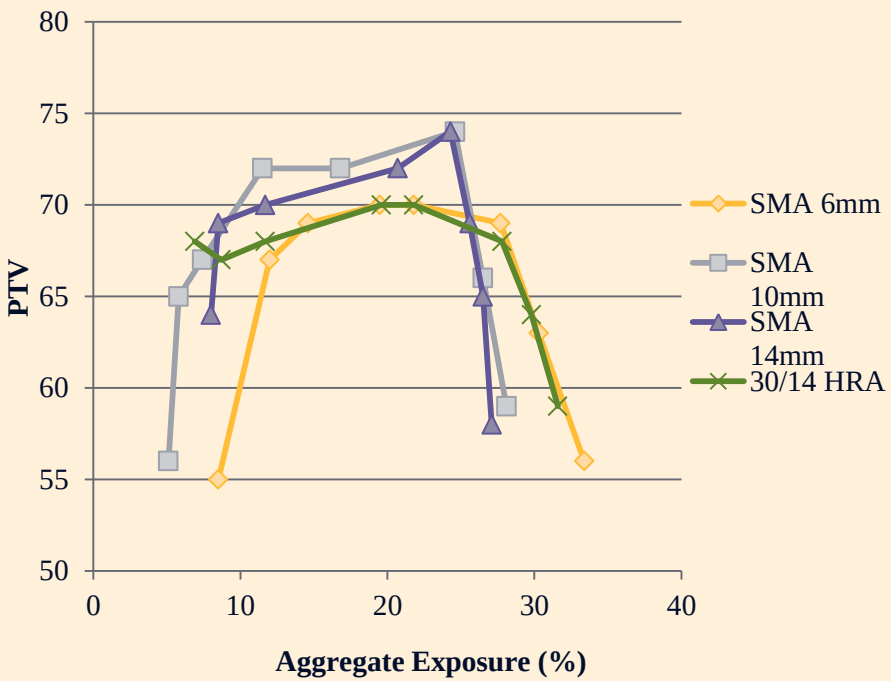


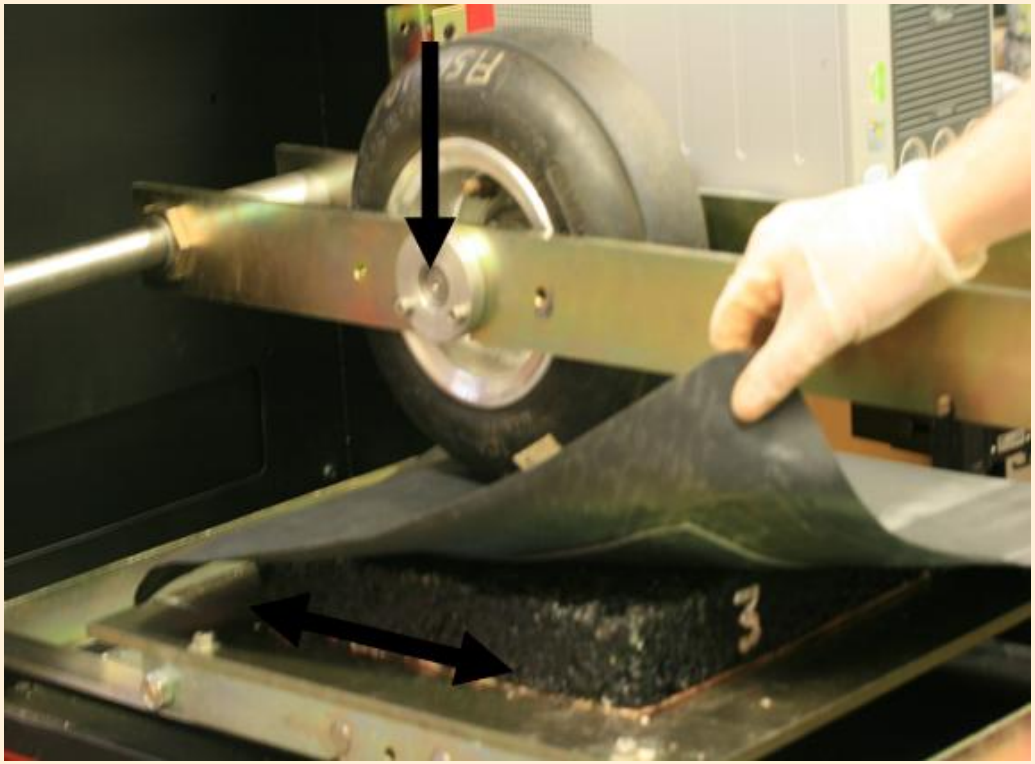





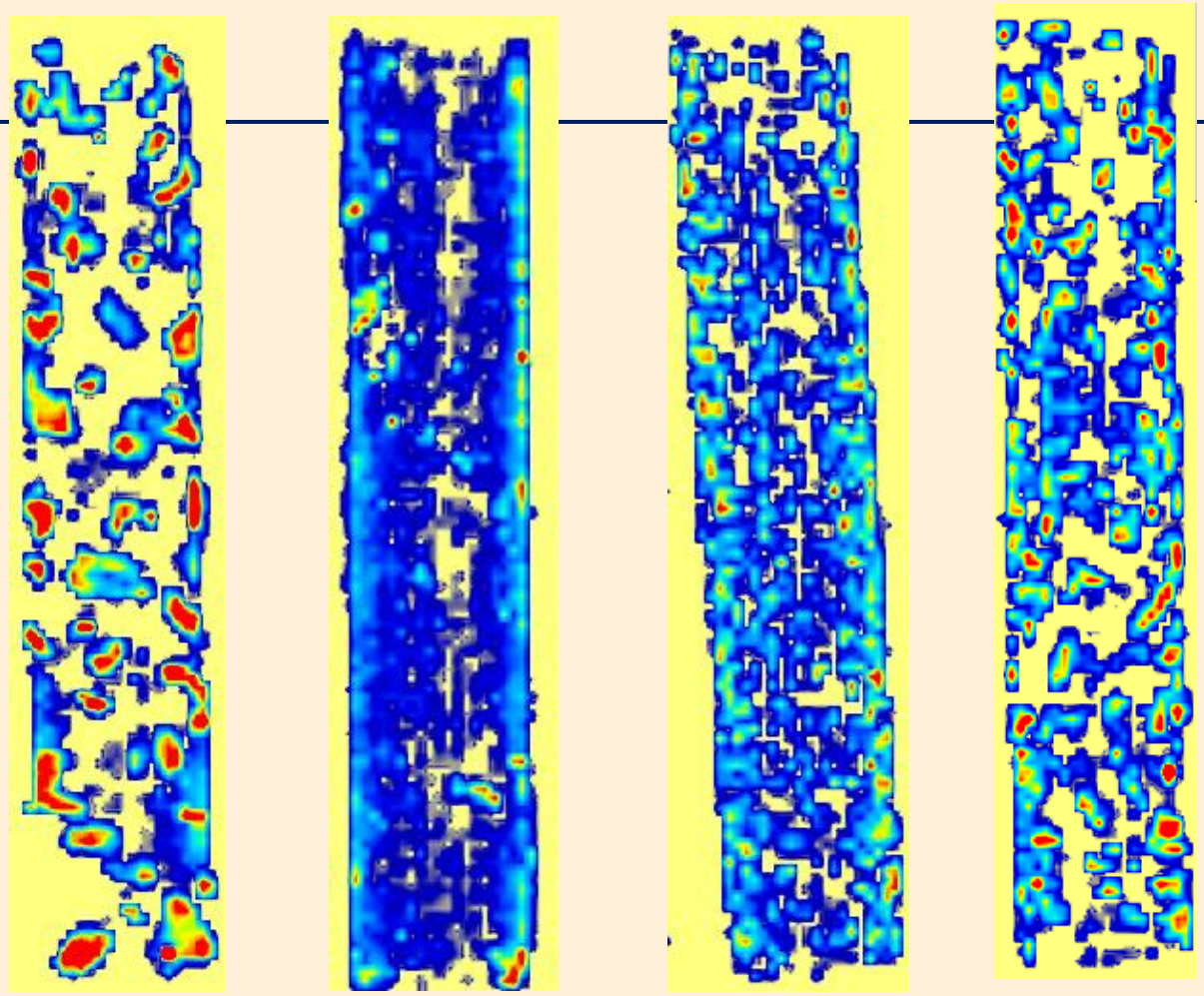
Trafficking / exposure / PTV



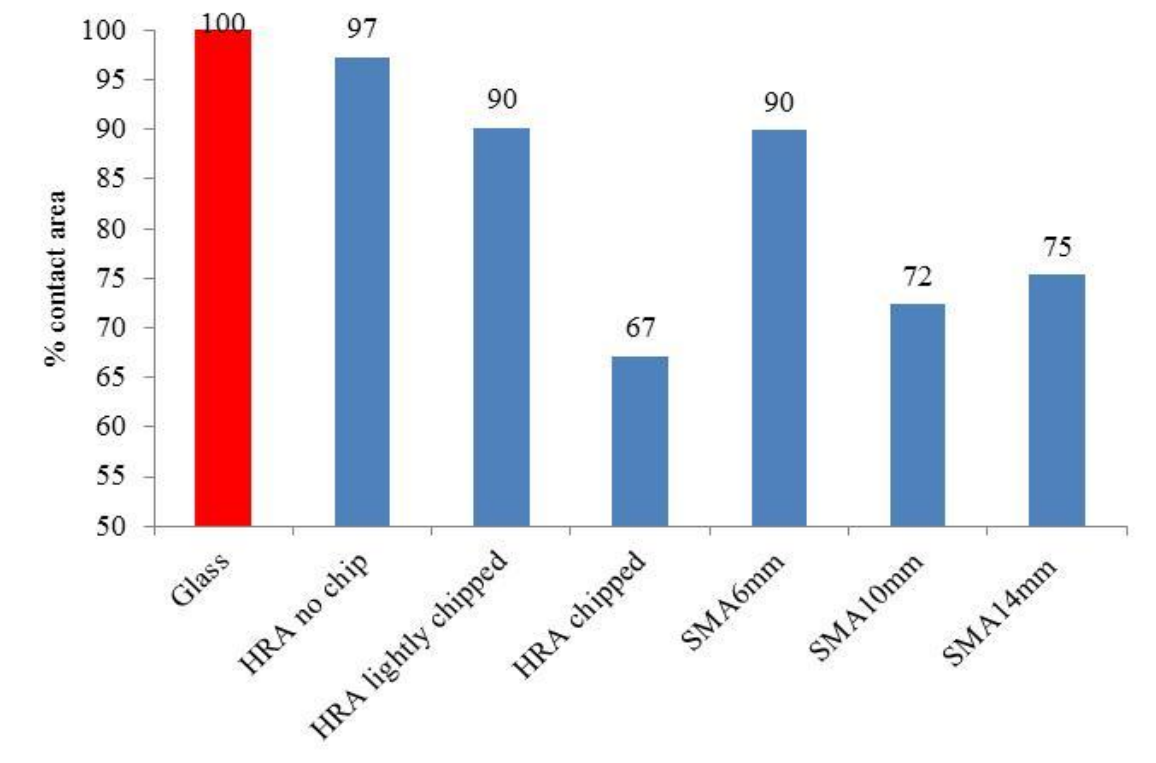


Development of interface contact with time

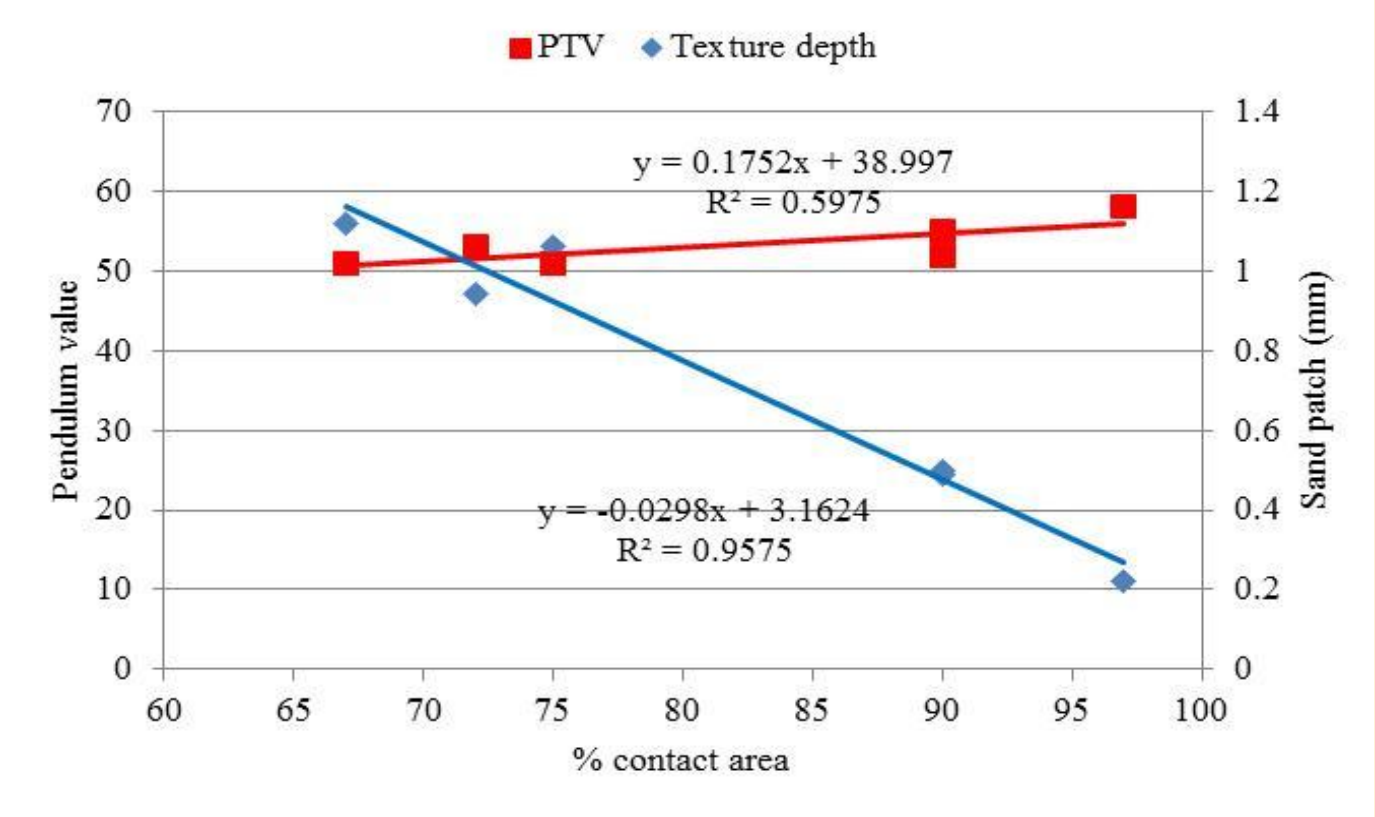




Different contact areas

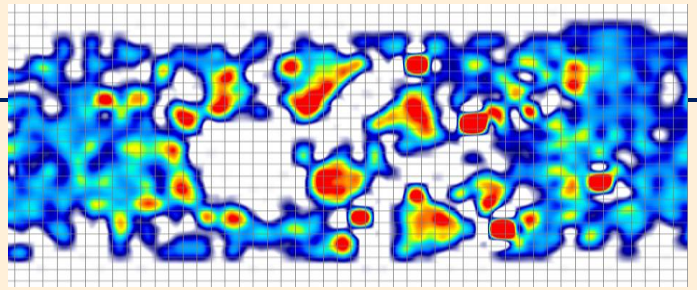


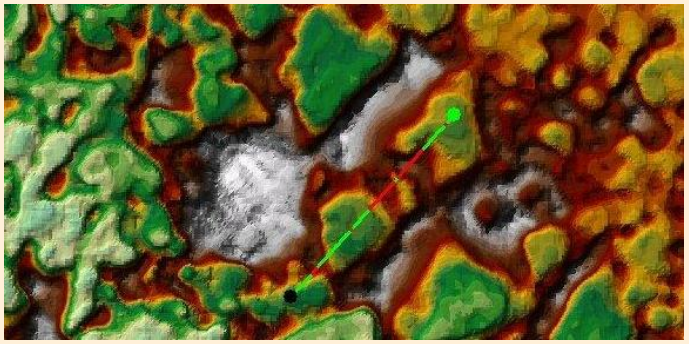
Contact area / PTV / sand patch

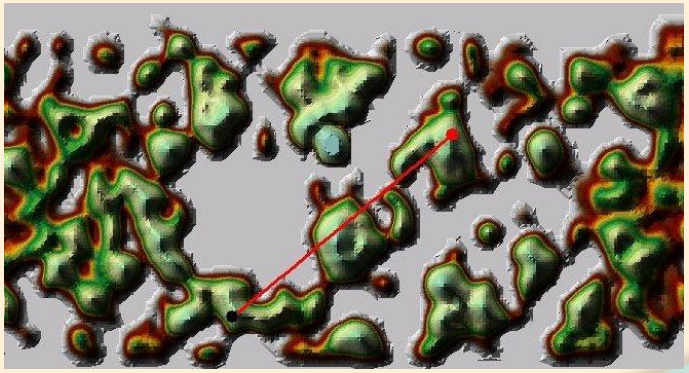


Using these technologies

- XSensor 2D pressure map showing concentrated contact around a missing piece of coarse aggregate in the centre of the image i.e. (1mm grid)
- Topographic map processed in ArcGis and depth-banded at 0.25mm increments
- Contact pressure map processed in ArcGis derived from a raster digital elevation model (DEM) showing stress peaks





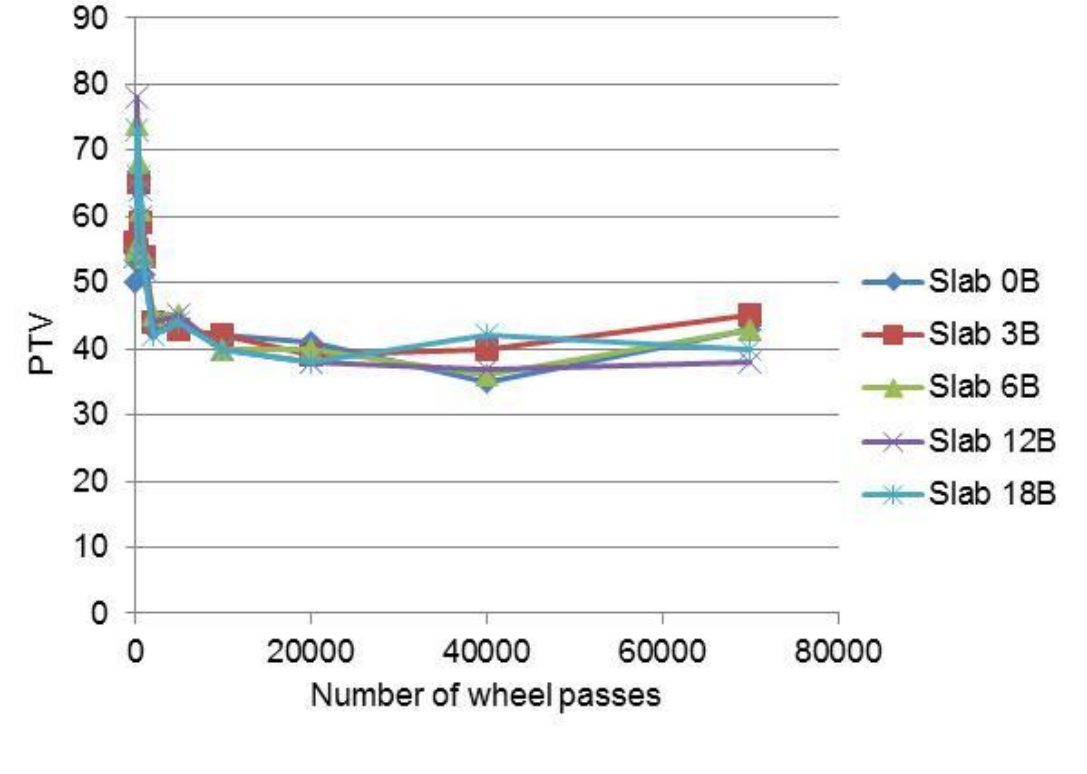


Different durability depending on how the same poor quality aggregate is used

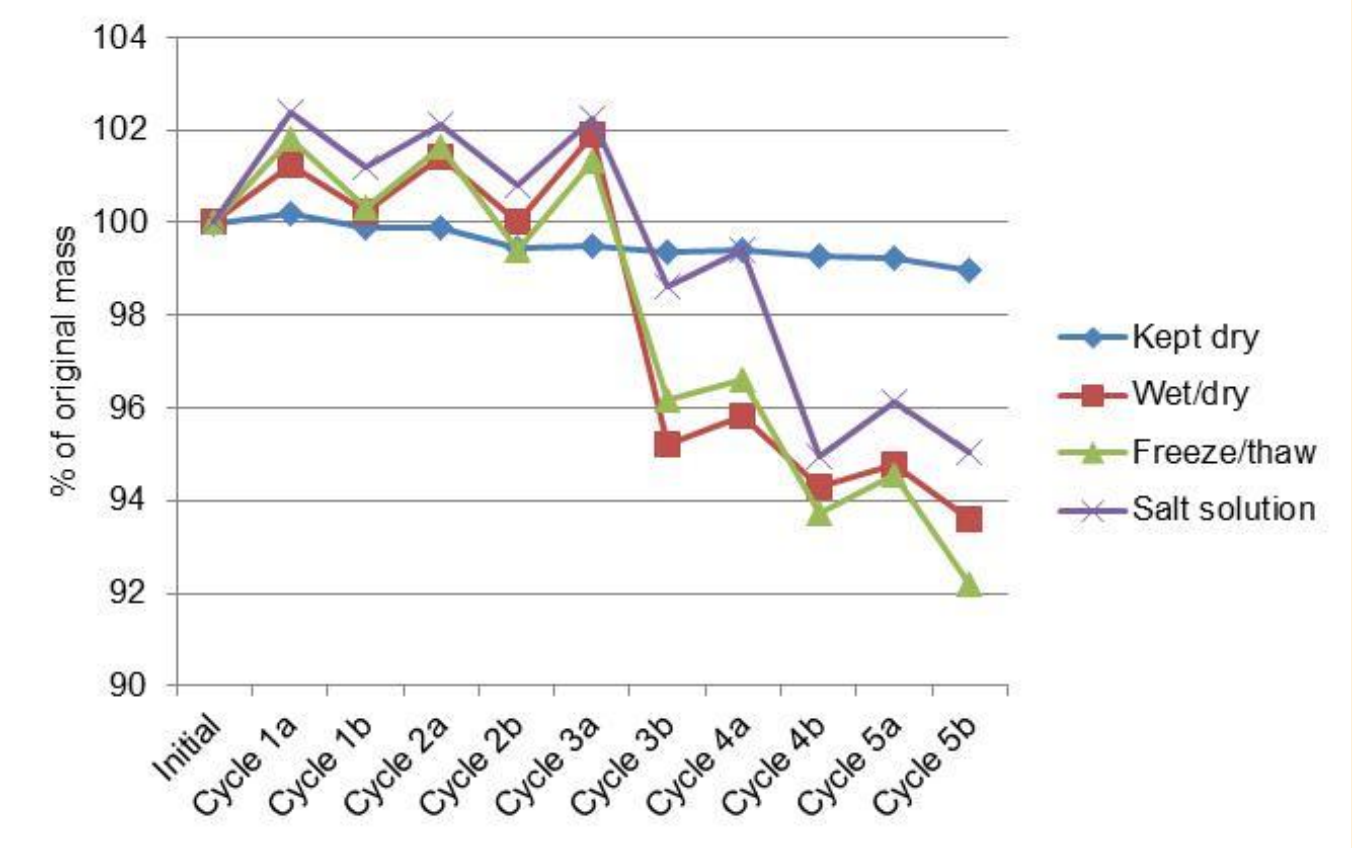
As coarse aggregate

As fine aggregate

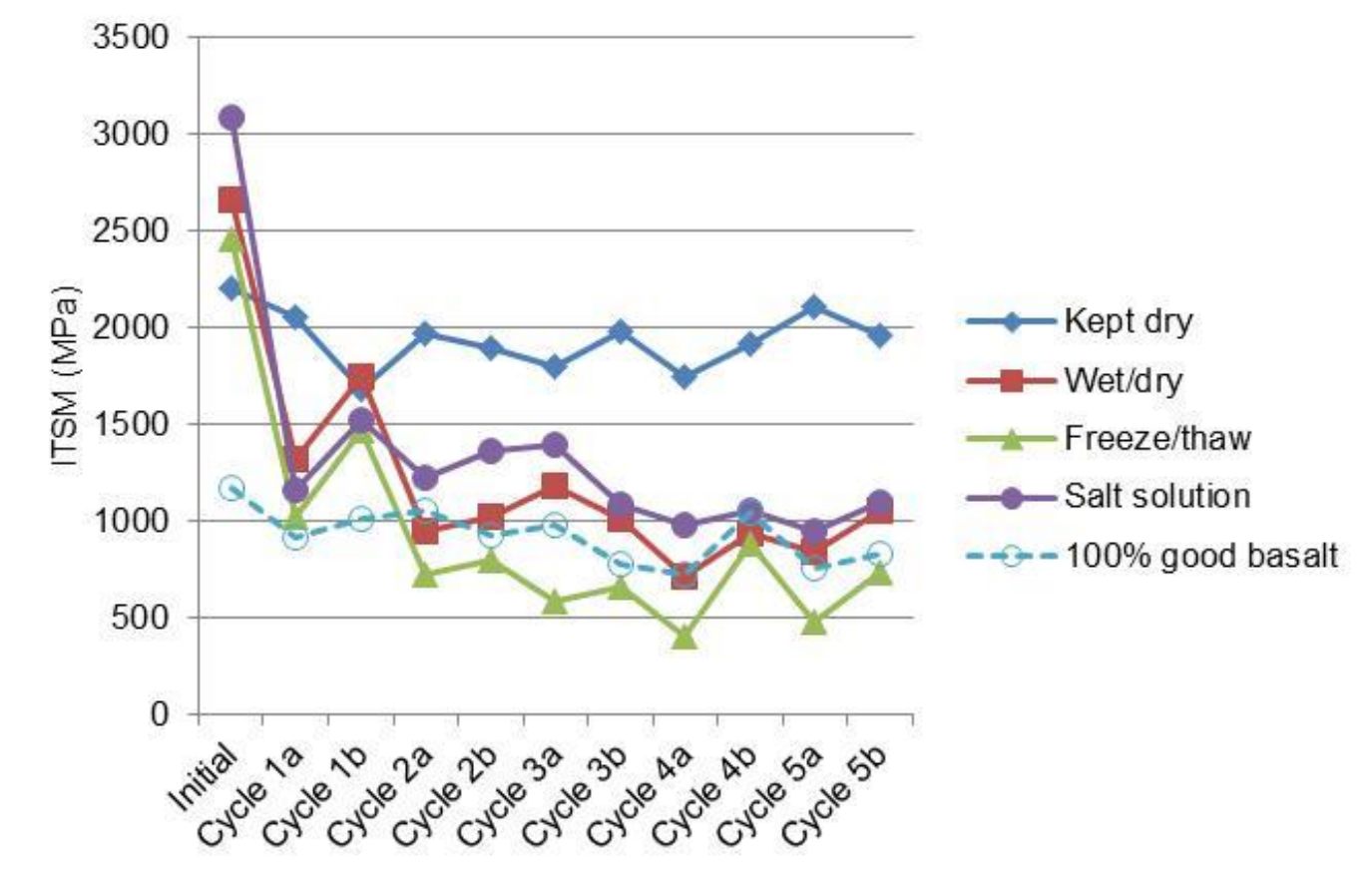
Increasing % of poor quality coarse aggregate had little effect on long term skid resistance



Effect of poor quality fine aggregate on stone loss due to asphalt conditioning



Effect of poor quality fine aggregate on NAT stiffness loss due to asphalt conditioning



Conclusions

- **Hot Mix Asphalt surfacing properties change with time.**
- **Combination of many factors.**
- **Simulated trafficking using full-scale tyres allows better insight what happening.**
- **Different things happening to bitumen coatings**
- **Different things happening at different scales of texture.**

Areas of developing interesting

- Contact area.
- Distribution of tire / asphalt stress.
- Significance / importance of different properties with time.
- Differing role of aggregate when used as different sizes.
- Importance of test specimen conditioning.

- Need to find methods and techniques to better understand performance and how these may be predicted in the laboratory.

Acknowledgement:

The research presented in this paper is being funded by the National Roads Authority of Ireland through the NRA Research Fellowship Programme. The views expressed are not necessarily those of the National Roads Authority.