Predicting the potential of local aggregate in surfacing mixes without the risk of road trials

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Background

- The UK selection of aggregate used in surfacing mixtures is typically based on PSV.
- Many years of product development and road testing has identified those aggregates that are considered safe and those that are not so good.
- The implementation of the Construction Products Regulation (CPR) in 1st July 2013 has resulted in revisions to standards and specifications to make them CPR compliant.
- Construction products are expected to perform during their entire life and then be recycled.
- Road trials typically used in the later stages of BBA HAPAS or TS2010 product accreditation to prove performance of the system.

This paper

- Considers how the potential performance and durability of surfacing systems can be quickly assessed without the risk of something going wrong in full-scale trials.
- Investigations are based on test slabs subjected to accelerated simulated trafficking.
- The development of properties such as skid resistance and texture depth are determined through the early, equilibrium and later stages of life.
- This allows combinations of good and what may be traditionally regarded as unlikely local aggregates and mix types to be quickly assessed under the same conditions.
- Examples of local aggregate use that would typically not be considered suitable as a surfacing are given in this paper.

The CPR

- Full implementation of the Construction Products Regulation (CPR) took place on 1st July 2013.
- This European Regulation aims to break down technical barriers to trade in construction products within the European Economic Area.
- The CPR has four main elements:
  - a system of harmonised technical specifications
  - an agreed system of conformity assessment for each product family
  - a framework of notified bodies
  - CE marking of products
- Key to CE marking is a product that is consistent to its Declaration of Performance (DoP).
- **How can we predict performance?**

7 basic CPR requirements

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

CPR and friction

- Two of the 35 products areas in the CPR are:
  - Road construction products
  - Aggregates
- European Specifications for asphalt are currently being revised to be compliant with the CPR.
- The seven basic requirements of the CPR pose challenges if reliance is placed on current harmonised European Standards to predict the long term frictional performance and durability of surfacing materials.

Harmonised European standard test methods for friction

- Two methods:
  - PSV test method for aggregate
  - Friction after Polishing test (FAP) also known as the Wehner Schulze (WS) test for asphalt mixes and aggregate

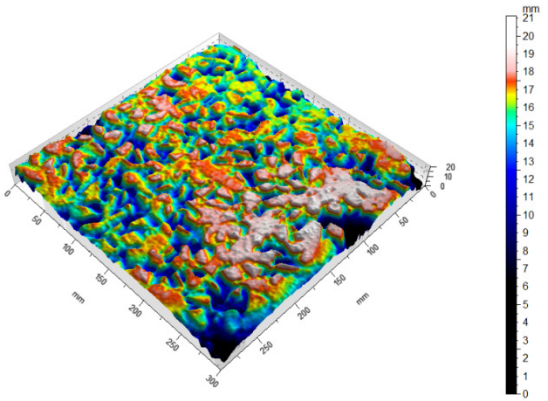
CPR and the PSV test

- Research has shown that the PSV test:
  - Offers limited prediction of performance.
  - It is a ranking test and gives a single value of friction for a single size 10mm aggregate that relates to the testing conditions
  - Change the test conditions e.g. increase the load, test duration or polishing media and a different value of friction will result.
- With regard to a Declaration of Performance and CE marking an aggregate test method being used to predict all in-service conditions will inevitably lead to problems.

CPR and the FAP test

- Seen as an improvement to PSV:
  - it can assess both single size aggregates and surfacing mixtures.
- A source of aggregate can be used to:
  - prepare a range of surfacing mixtures based on mixture type or nominal size and their friction determined.
- Can be used to better optimise:
  - address the CPR requirement of making better use of local materials that may not have the higher values of PSV required to meet current specifications.
- Limited number of apparatus currently available.
  - only 1 FAP test apparatus in the British Isles
- Although the FAP offers better possibility of addressing the CPR requirements its current limited availability and cost will restrict this method of test for some foreseeable time.


Q1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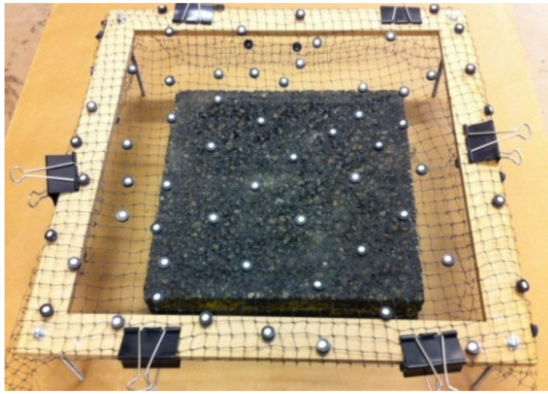
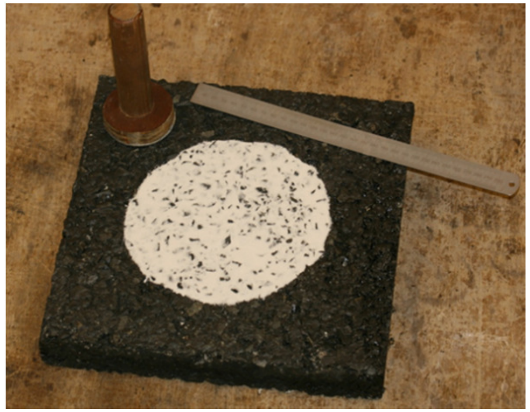
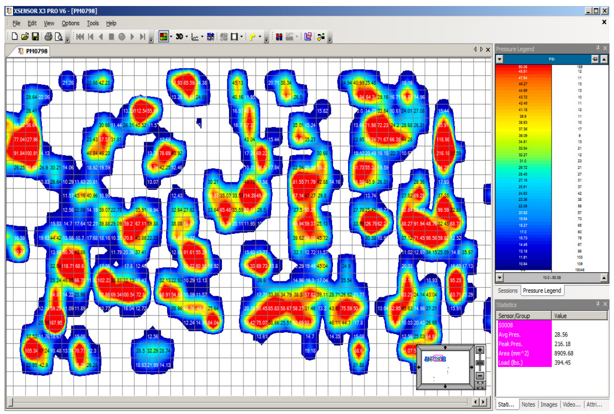
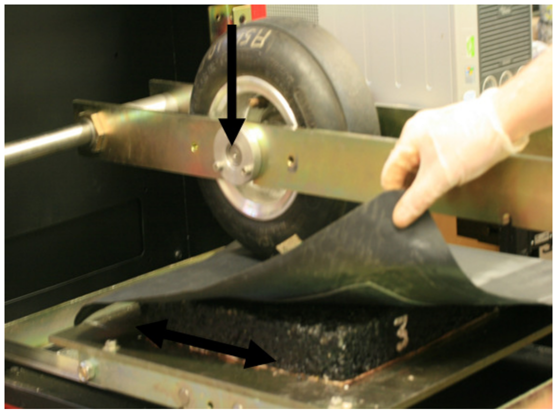




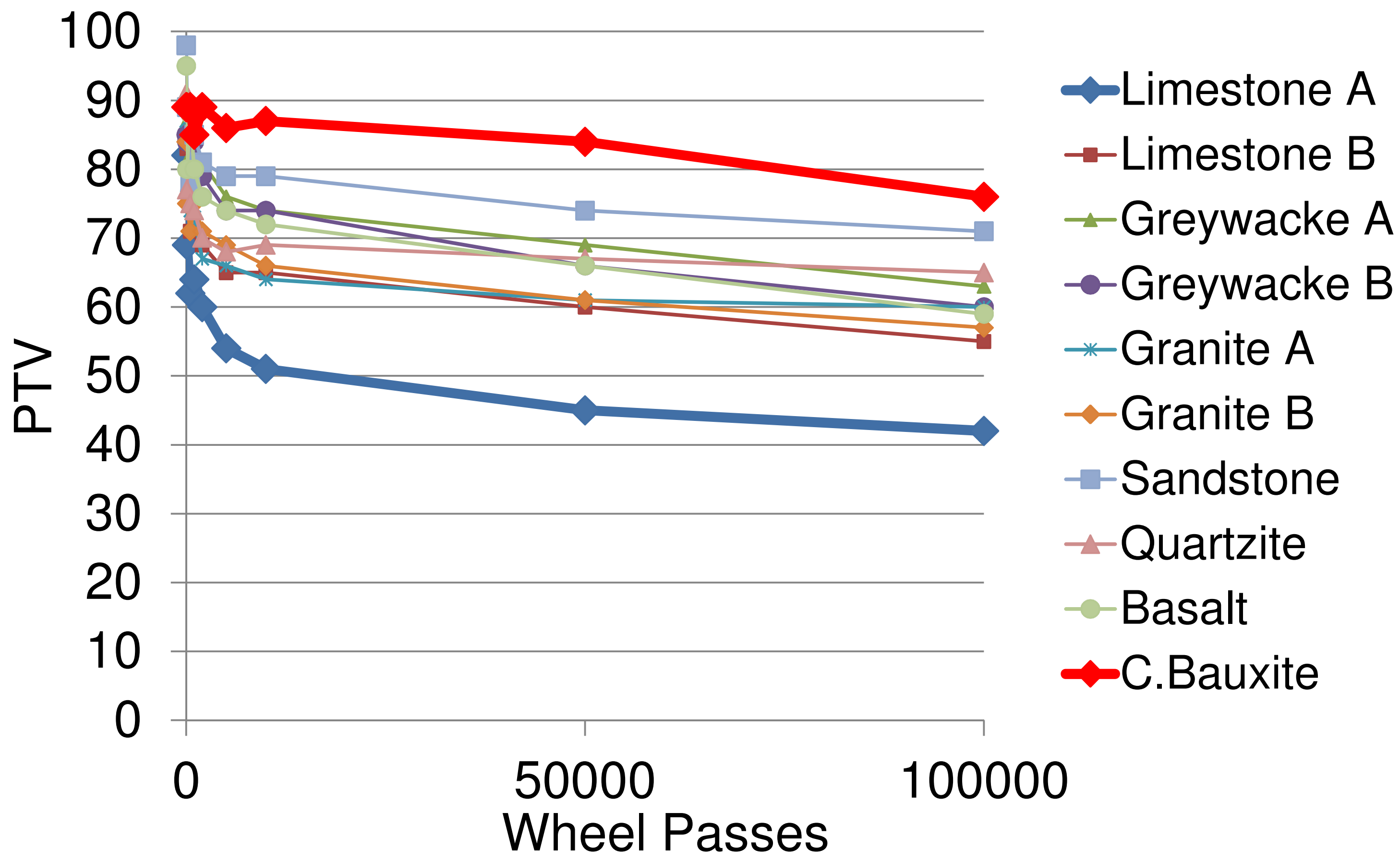




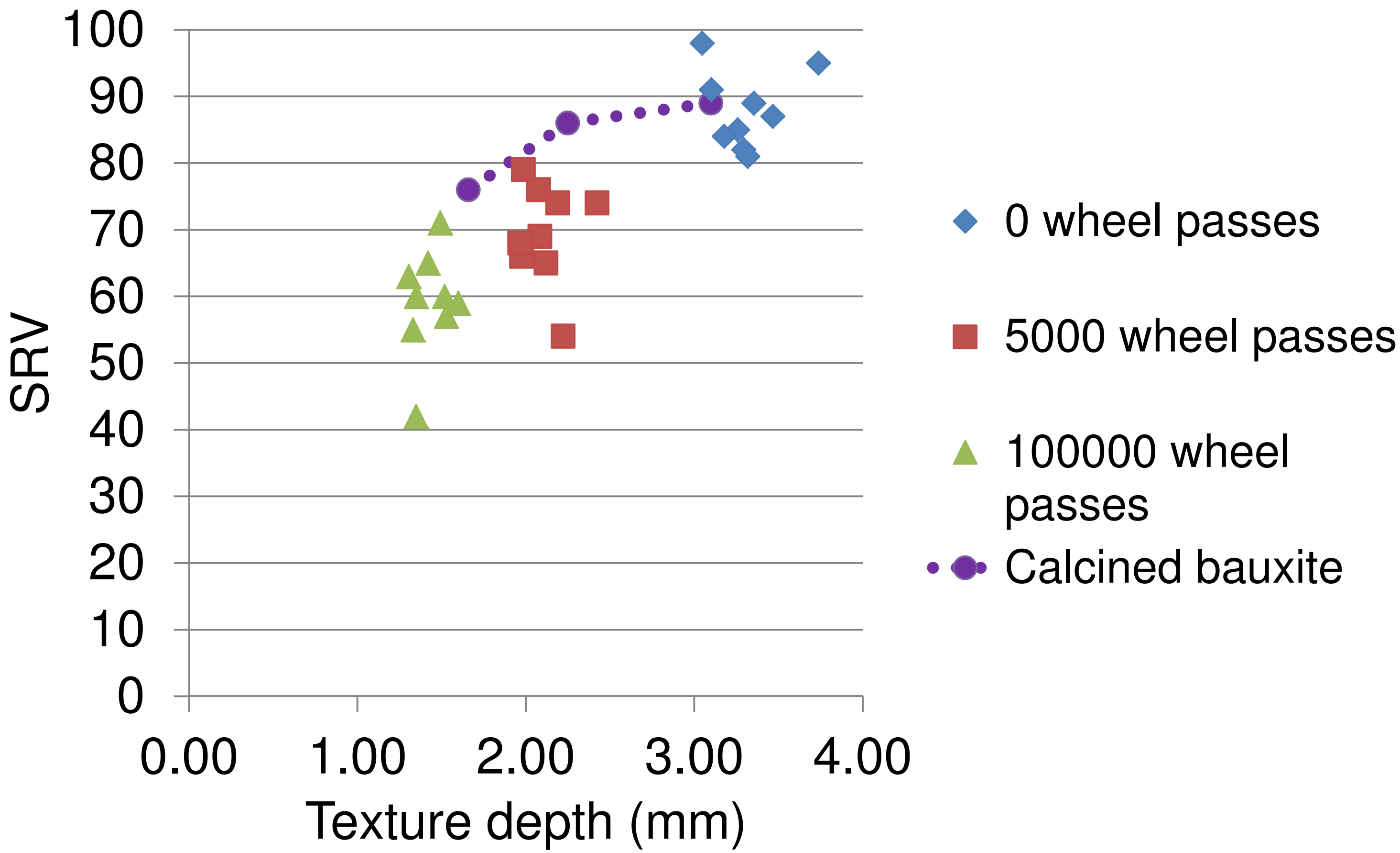
Two studies considered in this paper

- The use of natural aggregates in high friction surfacing systems.
- Blends of aggregates in thin surfacing systems.

Development of HFS wet friction



Development of wet friction and texture depth at three stages during testing



Declared PSV, texture depth, PTV and HFS specification requirements

<table>
<tr><th rowspan="2">HFS Slab</th><th rowspan="2">Declared PSV</th><th colspan="2">After 100,000 wheel passes</th><th colspan="3">HFS specification requirements after 100,000 wheel passes</th></tr>
<tr><th>Texture depth (mm)</th><th>PTV</th><th>Type 1</th><th>Type 2</th><th>Type 3</th></tr>
<tr><td>Calcined bauxite</td><td>70+</td><td>1.7</td><td>76</td><td rowspan="5">PTV ≥ 70</td><td rowspan="5">PTV ≥ 65</td><td rowspan="5">PTV ≥ 65</td></tr>
<tr><td>Sandstone</td><td>70</td><td>1.5</td><td>71</td></tr>
<tr><td>Quartzite</td><td>58</td><td>1.4</td><td>65</td></tr>
<tr><td>Greywacke A</td><td>65</td><td>1.3</td><td>63</td></tr>
<tr><td>Greywacke B</td><td>68</td><td>1.4</td><td>60</td></tr>
<tr><td>Granite A</td><td>55</td><td>1.5</td><td>60</td><td rowspan="5">Texture depth ≥ 1.1</td><td rowspan="5">Texture depth ≥ 0.9</td><td rowspan="5">Texture depth ≥ 0.8</td></tr>
<tr><td>Basalt</td><td>53</td><td>1.6</td><td>59</td></tr>
<tr><td>Granite B</td><td>55</td><td>1.5</td><td>57</td></tr>
<tr><td>Limestone B</td><td>54</td><td>1.3</td><td>55</td></tr>
<tr><td>Limestone A</td><td>40</td><td>1.3</td><td>42</td></tr>
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Thin surfacing blends

- Blending of >10 mm limestone aggregate with higher PSV aggregate.
- 14 mm Clause 942 thin layer surface course.
- Simulates an imported higher PSV aggregate blended with a local Carboniferous limestone aggregate with lower PSV.
- This study addresses the CPR requirement of using local materials and the sustainable sourcing of aggregates.

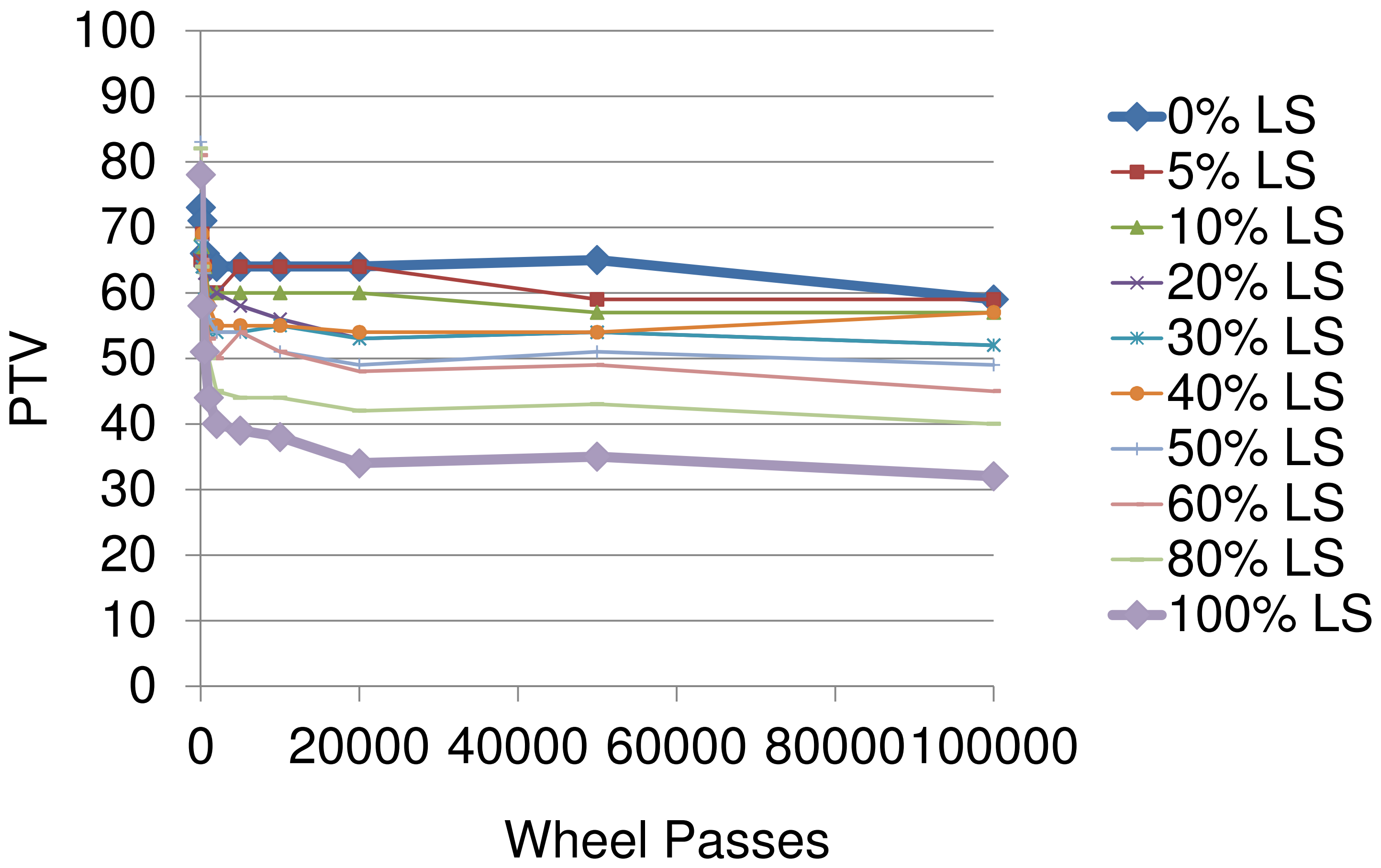
Three higher PSV / lower PSV combinations

- Combination 1
  - declared PSV 72 Carboniferous sandstone blended with declared PSV 52 Carboniferous limestone.
- Combination 2
  - declared PSV 62 Silurian greywacke blended with found PSV 54 Carboniferous limestone.
- Combination 3
  - declared PSV 62 Silurian Greywacke blended with found PSV 36 Carboniferous limestone aggregate.

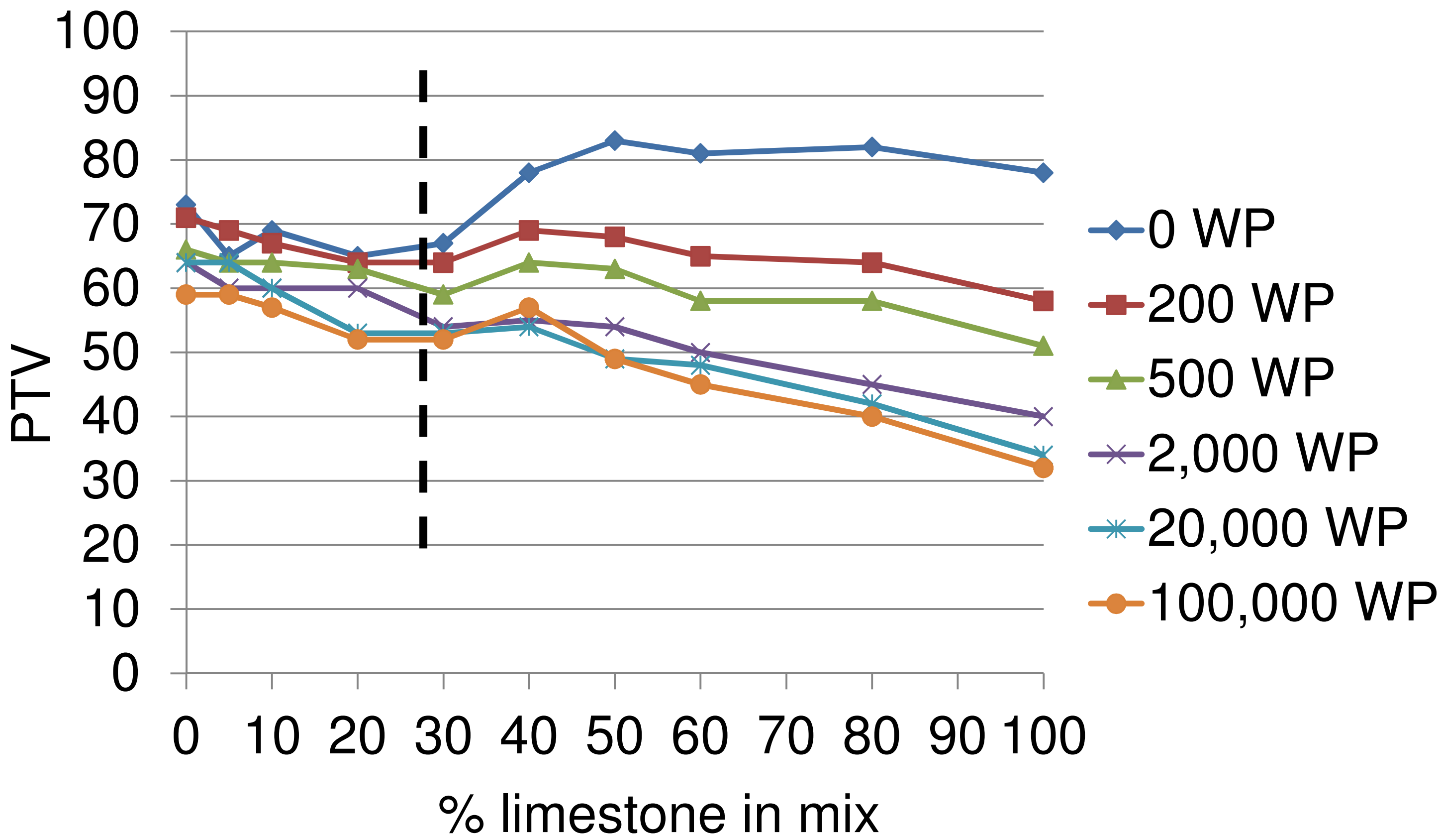
Combination 1

- 14 mm and 10 mm declared PSV 72 Carboniferous sandstone and declared PSV 52 Carboniferous limestone
- < 10 mm kept constant.
- Polymer modified bitumen.
- Ten slab specimens 305 x 305 x 50 mm made using a Cooper Roller compacter.
- The 14 mm and 10 mm size fractions of each test specimen adjusted to create limestone blends ranging from 0 to 100 %.

Combination 1 - development of wet friction



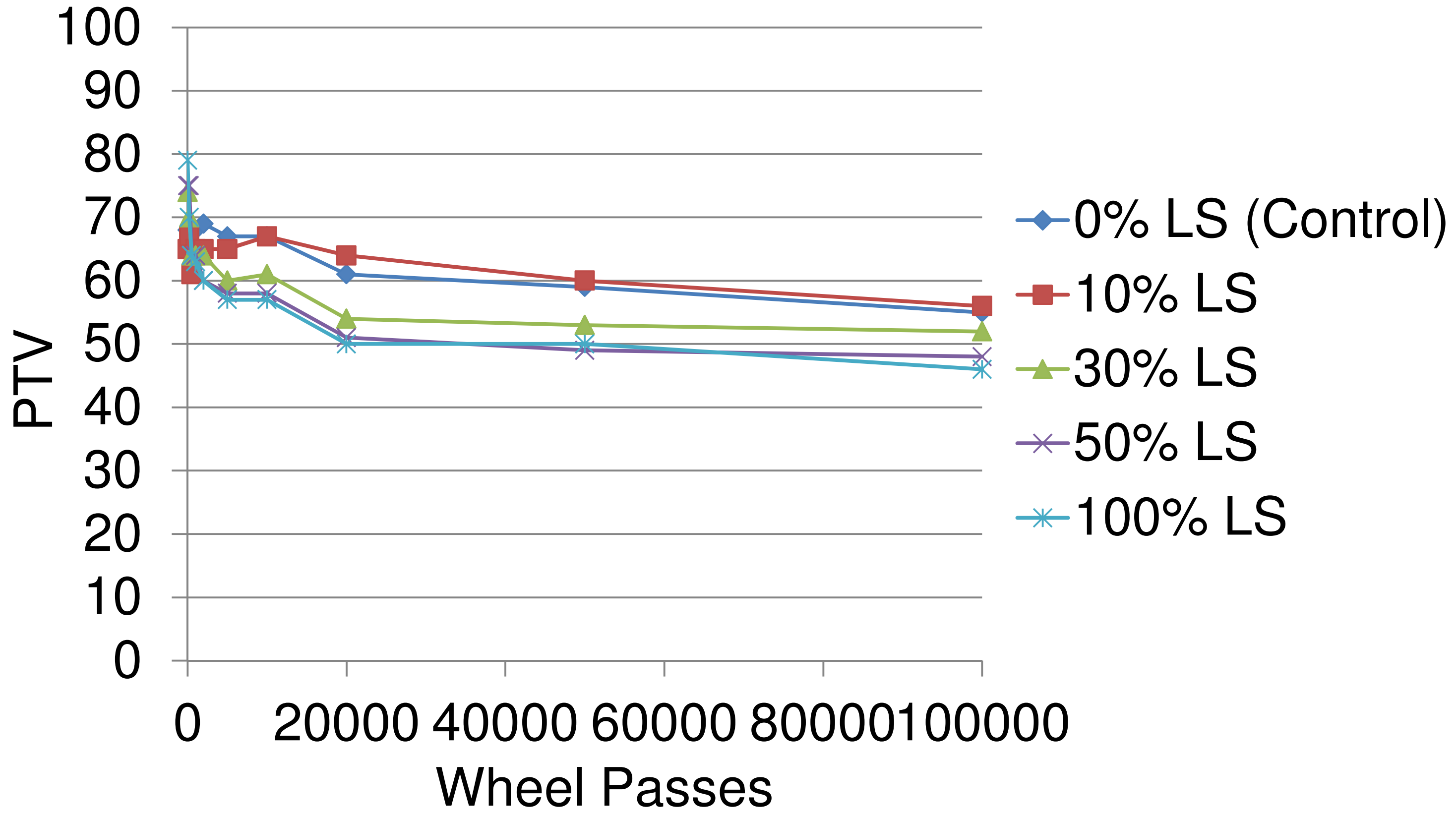
Combination 1 - plot of PTV and limestone content



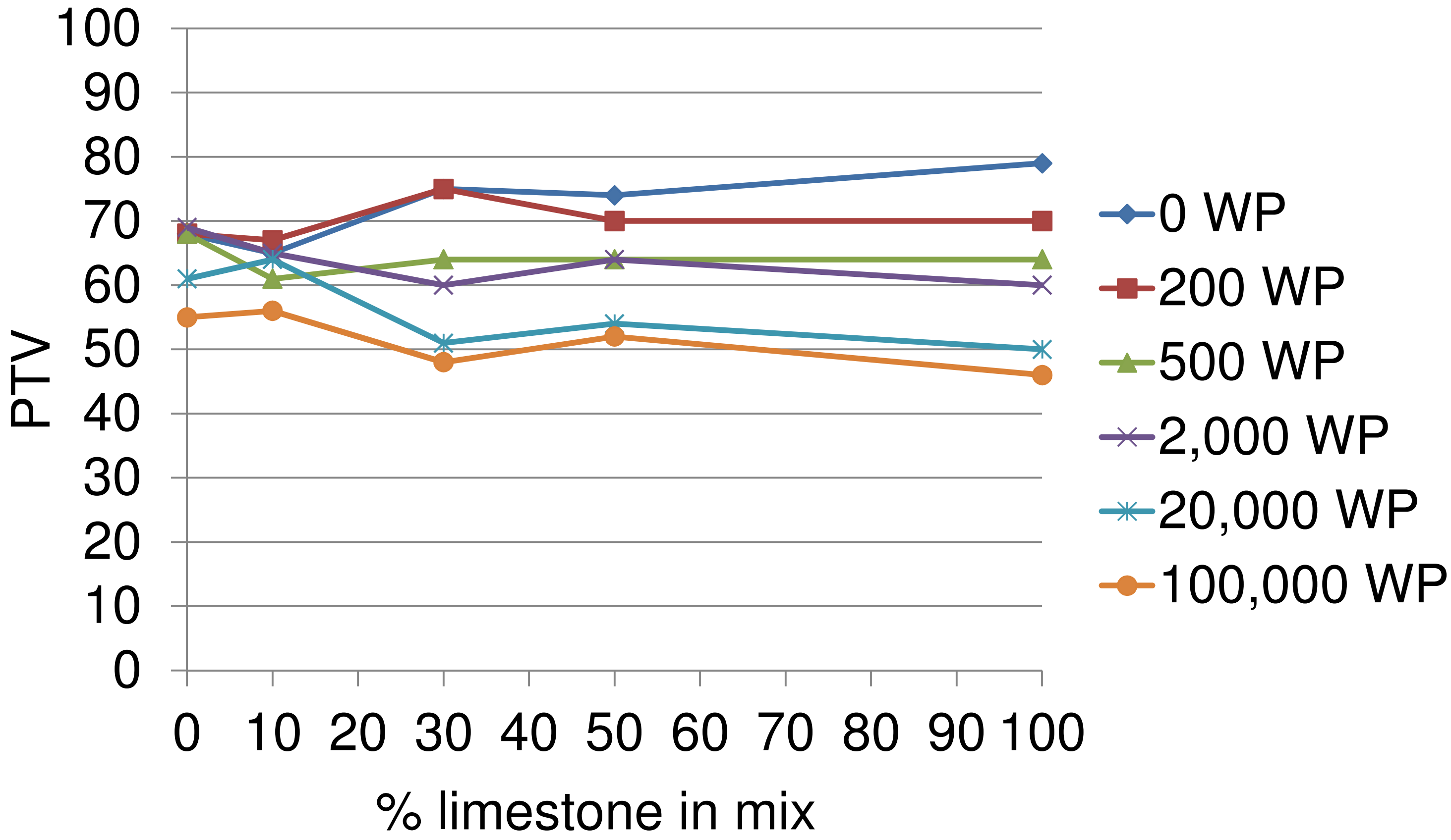
Combinations 2 and 3

- Combination 2:
  - 14 mm and 10 mm declared PSV 62 Silurian greywacke and found PSV 54 Carboniferous limestone
  - < 10 mm kept constant.
  - Polymer modified bitumen.
- Combination 3:
  - Same Silurian greywacke blended with a found PSV 36 Carboniferous limestone.
- Chemical analysis of the limestones:
  - Found PSV 54 - 28% SiO_2, 32% CaO and 27% organic content.
  - Found PSV 36 - 1% SiO_2, 55% CaO and 44% organic content.

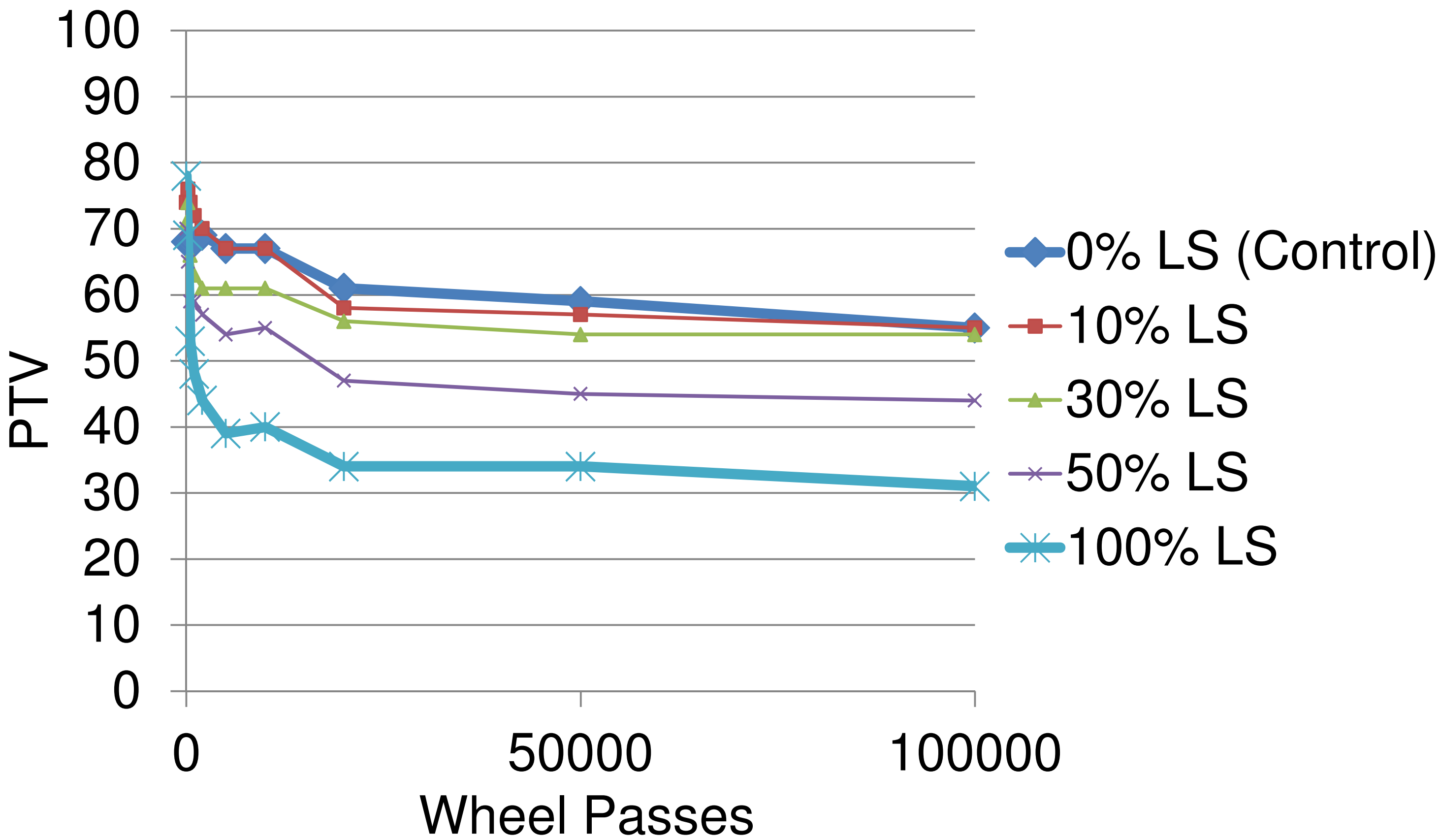
Combination 2 – development of wet friction



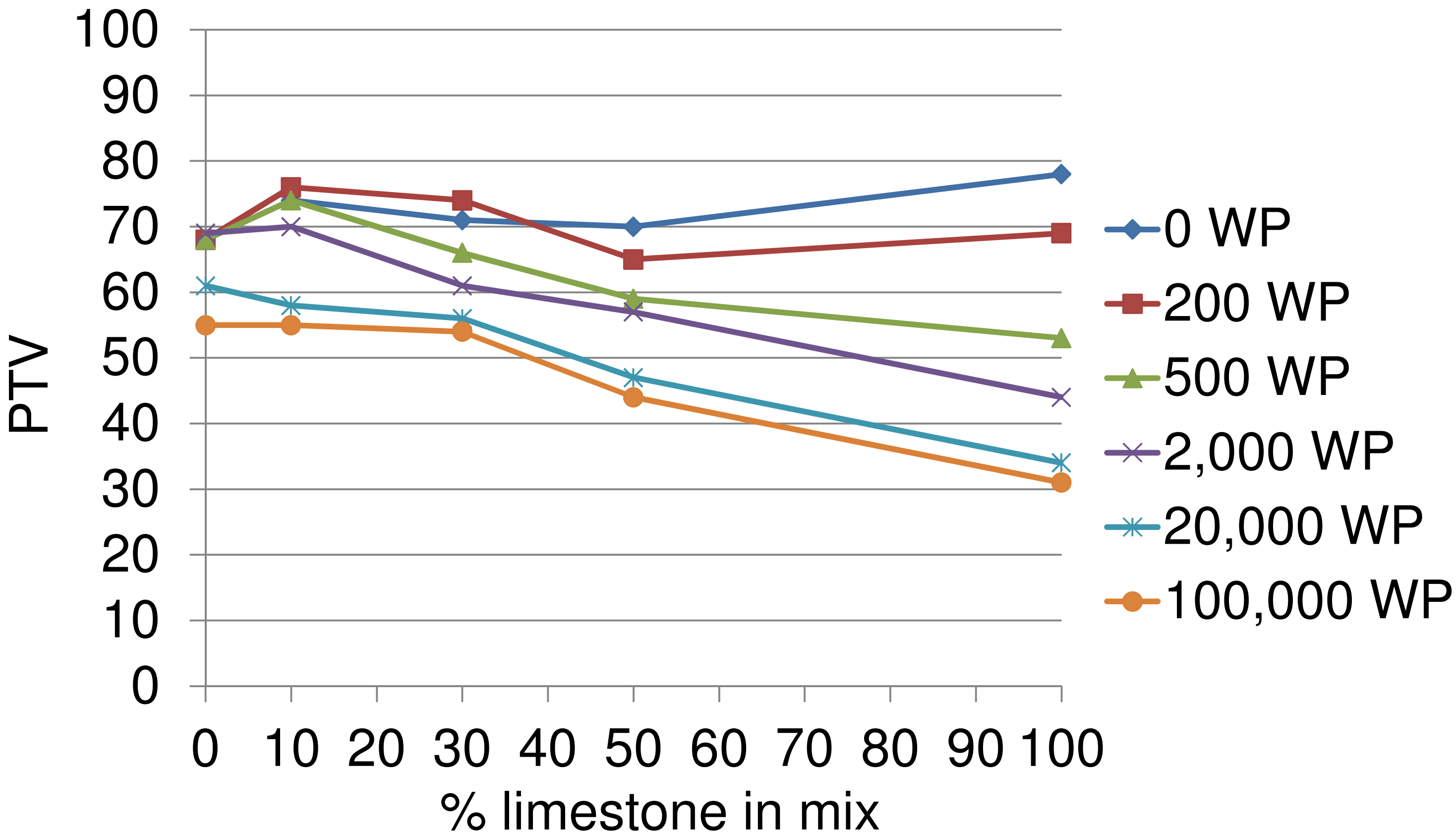
Combination 2 - plot of PTV and limestone content



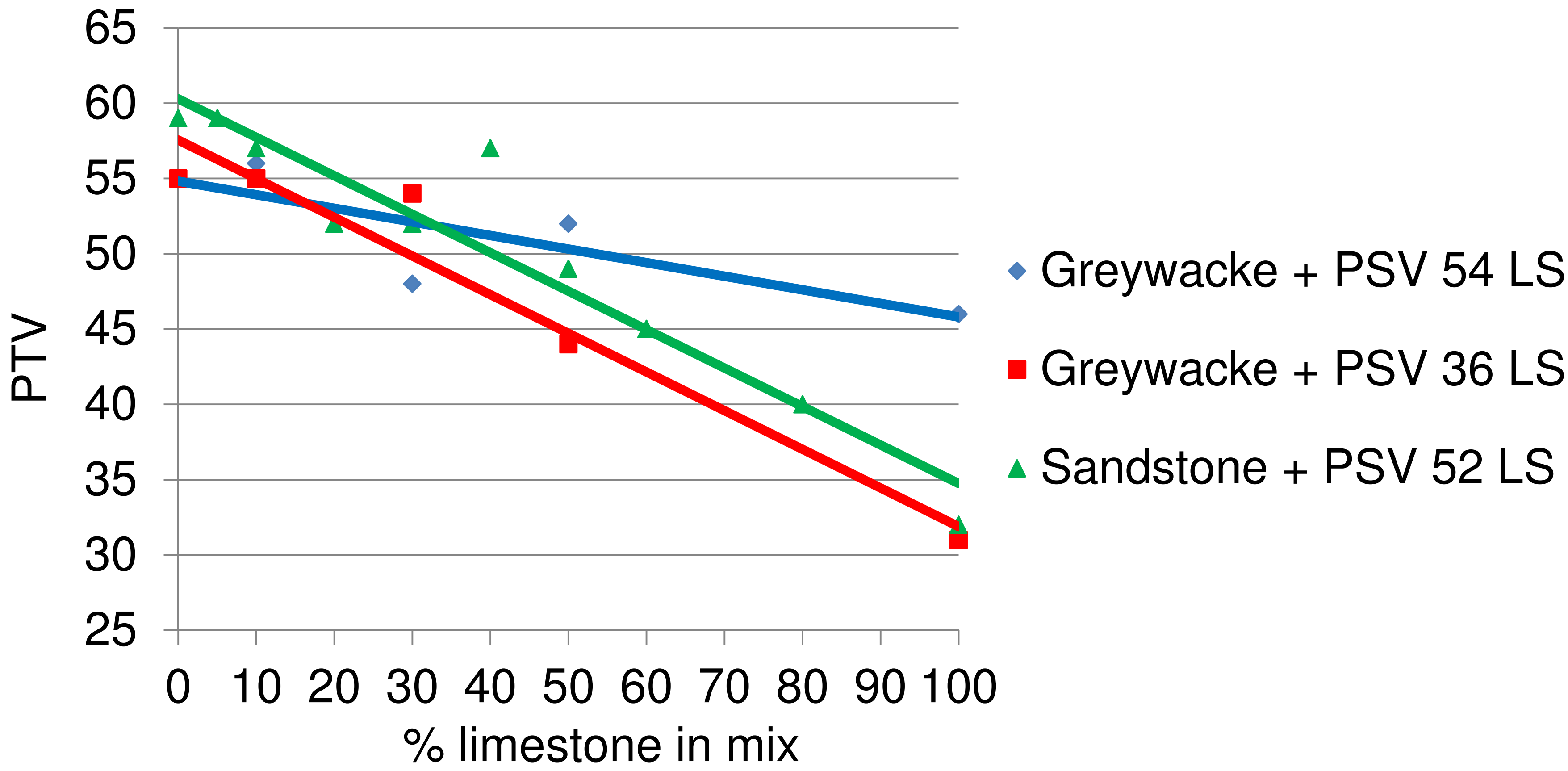
Combination 3 - plot of PTV and limestone aggregate content



Combination 3 - plot of PTV and limestone content



Comparison of the three Combination blends after 100,000 wheel passes



Conclusions

- This paper has considered the assessment of 2 surfacing systems in the laboratory without the need for full scale road trials.
- Both studies have shown the improved prediction of performance achievable by considering the asphalt mixture.
- Each study has shown that it is possible to make better use of local materials that existing specifications may not allow.
- The basic expectations of the CPR require improved methods / understanding to better predict performance.

Friction v. noise, rolling resistance and mix durability?