Flushing Chip Seals

The Aggregate Contribution

WAKA KOTAHI
NZ TRANSPORT AGENCY

New Zealand Government

Road Safety

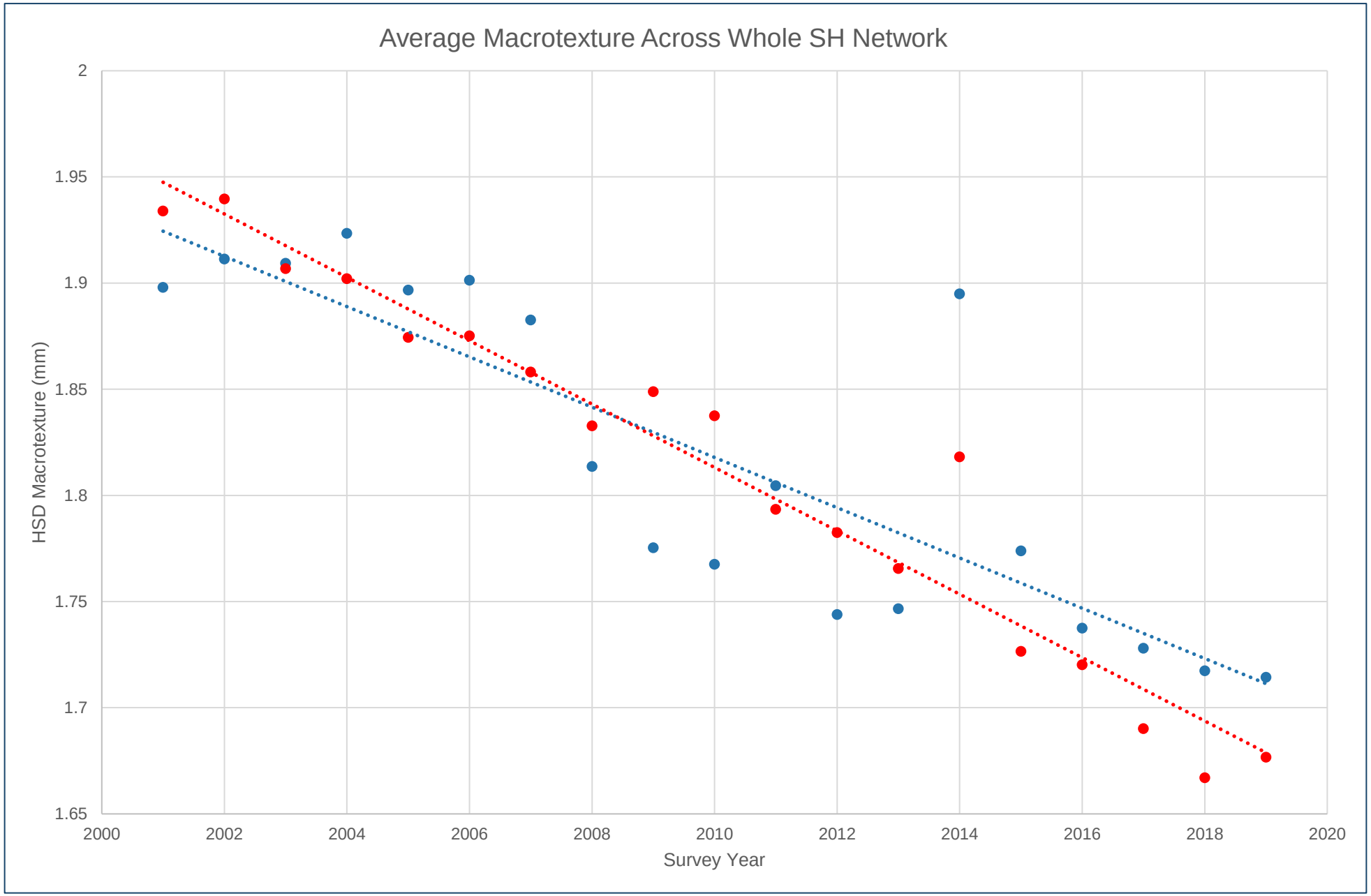
- The development of a transport system where no-one is killed or seriously injured is a strategic priority
- Waka Kotahi is committed to road safety

The Issue with Flushed Road Surfacings

- Pavement skid resistance is an essential contributor to safety.
- Skid resistance is a function of:
  - The aggregate state of polish (microtexture), and
  - The texture (macrotexture) of the surfacing
- Minimum texture specified by NZTA T10
- Average texture across the State Highway network is declining

Table 3 Minimum macrotexture requirements

Minimum macrotexture – mean profile depth (MPD mm)						
Permanent speed limit	Chipseal		Asphaltic concrete, ESC ≥ 0.4		Asphaltic concrete, ESC < 0.4	
	ILM	TLM	ILM	TLM	ILM	TLM
50km/h and less	1.0	0.7	0.4	0.3	0.5	0.5
Less than or equal to 70km/h but >50km/h	1.0	0.7	0.4	0.3	0.7	0.5
Greater than 70km/h	1.0	0.7	0.9	0.7	0.9	0.7


Average Macrotexture Across Whole SH Network
HSD Macrotexture (mm)
2
1.95
1.9
1.85
1.8
1.75
1.7
1.65
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Survey Year

The Issue with Flushed Road Surfacings

- Pavement skid resistance is an essential contributor to safety
- Skid resistance is a function of:
  - The aggregate state of polish (microtexture), and
  - The texture (macrotexture) of the surfacing
- Minimum texture specified by NZTA T10:
  - The texture minimises the progressive loss of skid resistance with increasing speed on wet roads, and;
  - Texture prevents or minimises the loss of skid resistance due to contact between vehicle tyres and bitumen – primarily for chip seal surfacings.
- Flushing can be difficult and expensive to remedy. Prevention is better than cure in this instance.

Mechanisms that Cause Flushing

- Excess binder application
- Embedment of the sealing chip into the basecourse or substrate
- Low binder viscosity
- Chip reorientation and compaction of the seal layers
- Water induced migration of the bitumen to the surface
- Thermal expansion of the binder, and finally
- Abrasion of the seal aggregate to produce fines that increase the volume of the bitumen mastic and reduce the size of the sealing chip.

Aggregate Abrasion

- Traffic-induced stresses can cause aggregate breakdown, especially in the presence of water
- Aggregate durability specified in M06 specification, using:
  - The Crushing Resistance test;
  - The Weathering Quality Index test, and
  - The Weak Particles test.

NZTA M06

Table 1: Source Property Sample Size Testing Requirements

Source Property Test	Fraction Size Range (mm)	Mass of Aggregate Required (kg)
Polished Stone Value	10.0 – 7.2 Flake Sorting Sieve	20
Crushing Resistance	13.2 – 9.5	10
Weathering Quality Index	19.0 – 9.5	5
	9.5 – 4.75	6

4.2 Crushing Resistance

When naturally occurring aggregates are tested in accordance with *NZS 4407 Test 3.10 – The Crushing Resistance of Coarse Aggregate Under a Specified Load*, a maximum of 10% fines shall be produced under a load of 230kN.

When GMA is tested in accordance with *NZS 4407 Test 3.10 – The Crushing Resistance of Coarse Aggregate Under a Specified Load*, a maximum of 13% fines shall be produced under a load of 230kN.

4.3 Weathering Resistance

Sealing chip shall have a quality index of AA or BA when tested in accordance with *NZS 4407 Test 3.11 – The Weathering Quality Index of Coarse Aggregate.*

4.4 Weak Particles Test

The Weak Particles test is only required if source properties are disputed. When testing is required and carried out, sealing chip shall have a maximum of 1% of unsound materials when tested in accordance with *AS 1141.32 – The Weak Particles Test.*

Aggregate Abrasion

- Traffic-induced stresses can cause aggregate breakdown, especially in the presence of water
- Aggregate durability specified in M06 specification, using:
  - The Crushing Resistance test;
  - The Weathering Quality Index test, and
  - The Weak Particles test.
- None of these tests fully examine the effect of abrasion on the aggregate.

Research

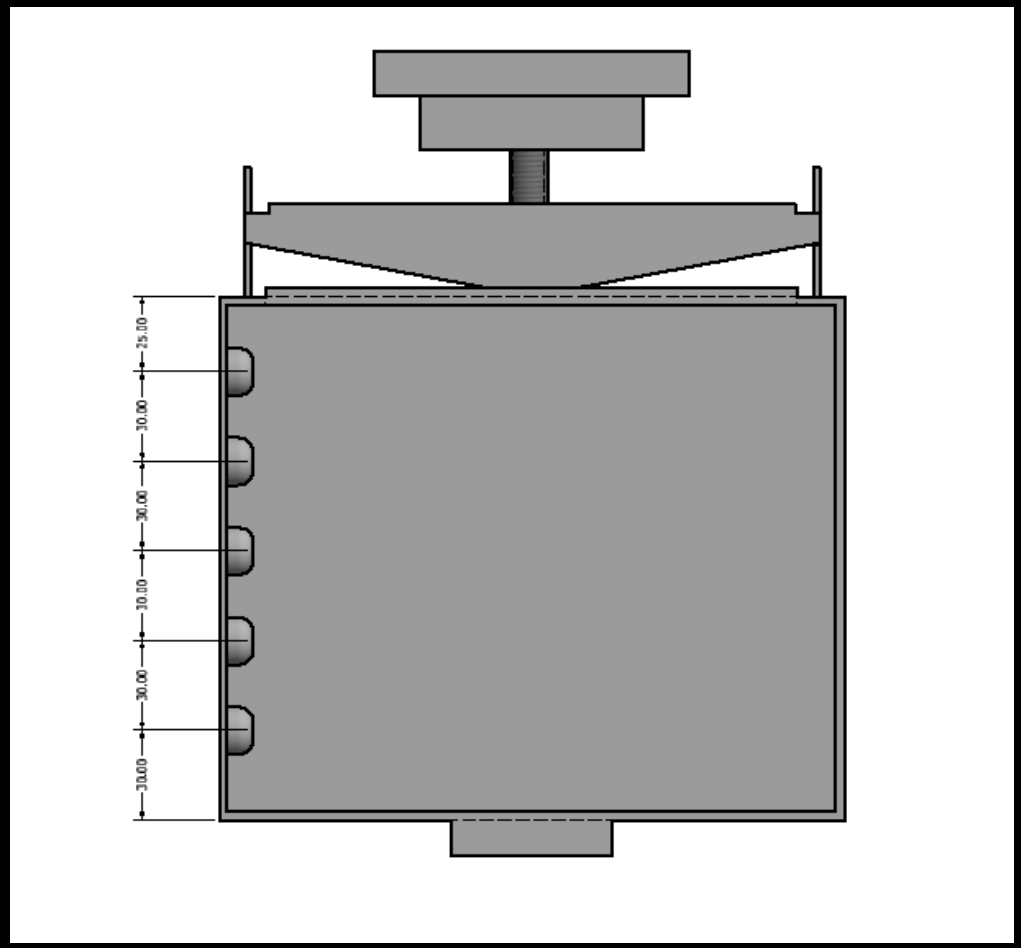
- Waka Kotahi has undertaken research into aggregate abrasion and determined that:
  - Aggregate breakdown contributes to flushing by reducing the size of the sealing chip, and;
  - Fines derived from aggregate breakdown fill the available void volume by bulking up the bitumen mastic, leading to flushing.
- This research documented in Research report 576, located at https://www.nzta.govt.nz/resources/research/reports/576/
- Petrographic examination of the fines in the flushed binder showed they were derived from the sealing chip aggregate.

Aggregate Breakdown in Service: Before

Aggregate Breakdown in Service: After

Quantifying Aggregate Abrasion Resistance

- Test methods used to assess abrasion resistance include:
  - Los Angeles Abrasion test
  - Micro-Deval test
  - Nordic Mill test
  - ORMD “modified micro-Deval” test.
- Of all of these, the ORMD test differentiates between different aggregates
- The ORMD test reproduces the fines grading curves found in flushed field sites
- ORMD may provide a tool to quantify aggregate abrasion resistance.


25.00
30.00
30.00
10.00
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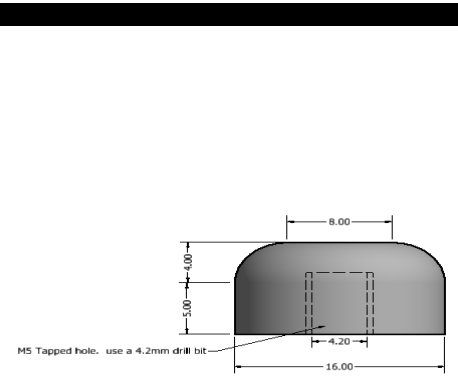
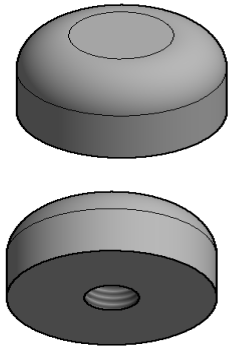
10.00


8.00
4.00
5.00
4.20
M5 Tapped hole. use a 4.2mm drill bit
16.00



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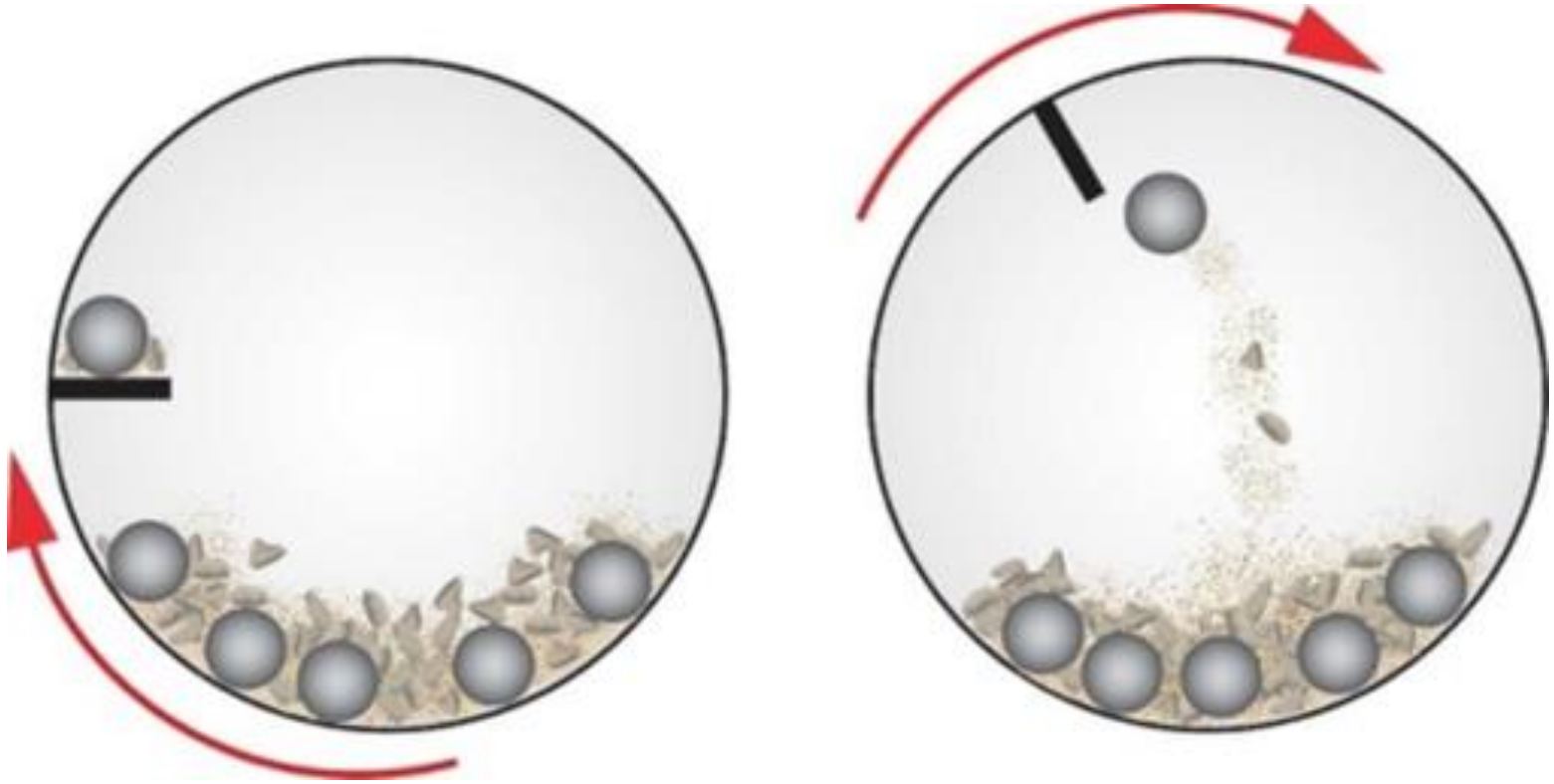

Where to from here?

- Finalise and publish the ORMD test
- Collect more data on NZ chip aggregates
- Construct trial sections at CAPTIF and calibrate the test
- Engage with industry to agree on implementation, as a “report only” criterion
- Work towards setting abrasion limits in M06 Specification for Sealing Chip.

Thank you