Tuesday, 11 June 2019

Skid Resistance Measurement, Evolution and Predictive Laboratory Methods

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Overview

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- The New Zealand Transport Context
- NZ’s Road Safety performance & Skid Resistance
- Surface Friction Measurement in NZ
- Aggregates, Polishing and Resource Efficiency
- Accelerated Pavement Polishing in Laboratories
- Microtextural analysis & quantifying polishing
- Rubber and Temperature Effects
- The Future of Skid resistance measurement

NZ and the World

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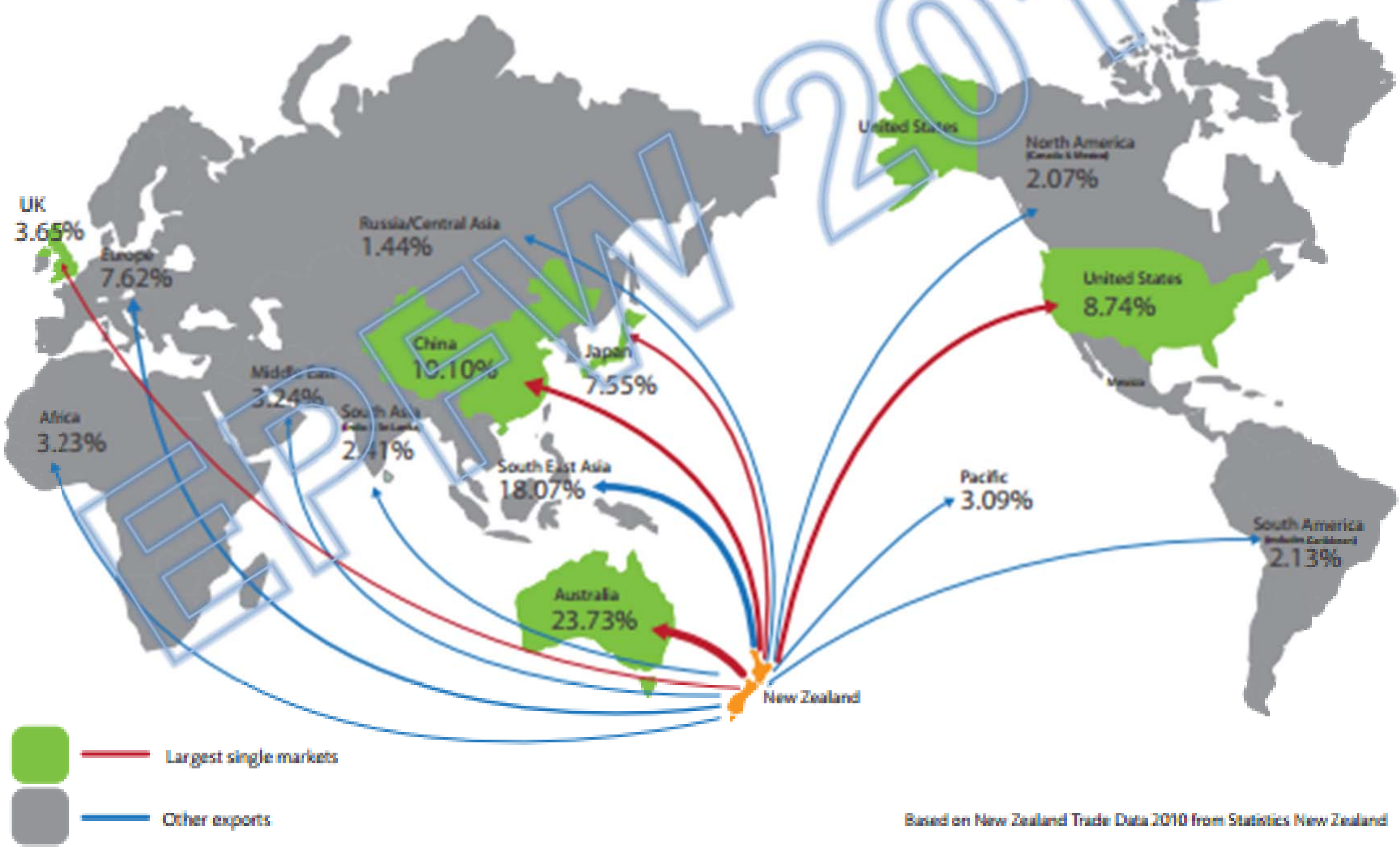
Figure 1 – Where our exports go



Based on New Zealand Trade Data 2010 from Statistics New Zealand

NZ Roads vs France

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NZ vs France Context

- Land Area, 268,000 sq km vs 545,630sq km
- Population – 5.0M vs 65M
- Pop Density – 16 vs 117 ppl per sq km

Road Length
~93,000kms vs ~956,000 kms

Rail Length
NZ – 4138 vs 29085

Unpaved Roads
NZ – 33,000 (1/3rd) vs 0? in France

GDP $ per km of Road + Rail - NZ – $1.2M per km vs $2.1M per km – NZ ½ of France

NZ Surfacings

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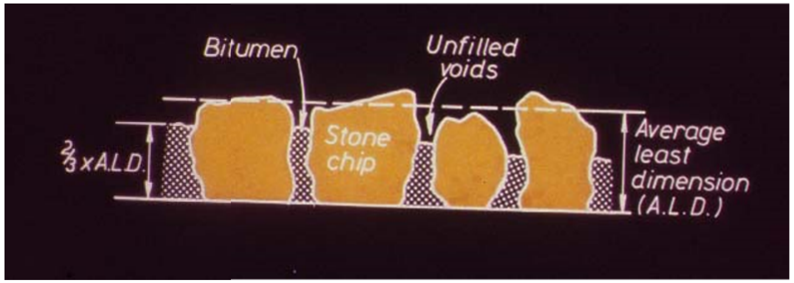

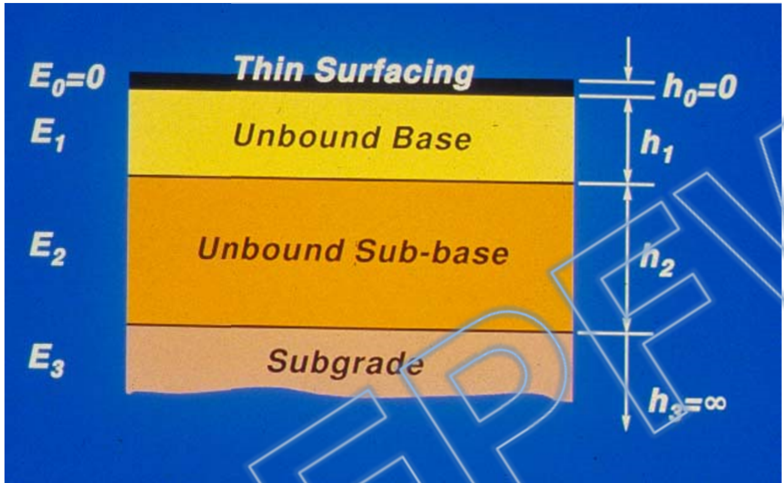

Auckland Total Road Length ~8,075 kms
8.6% of National network but carries > 20% of VKT

NZ Total Road Length ~93,000 kms
France - ~956,000kms

NZ Chip Sealed Surfaces









NZ Road Safety – The Why?

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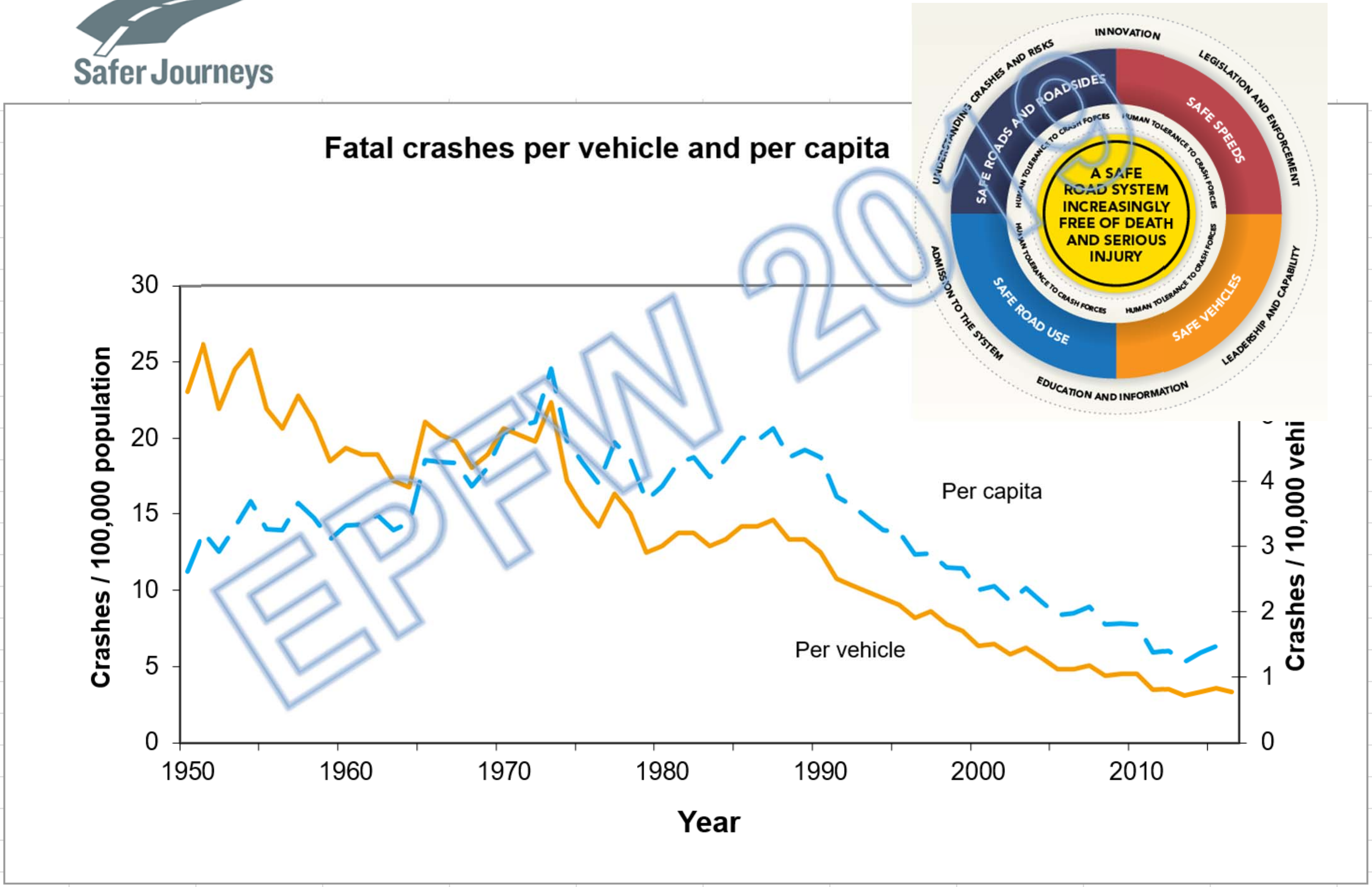
Safer Journeys



NZ Road Safety – The Why?

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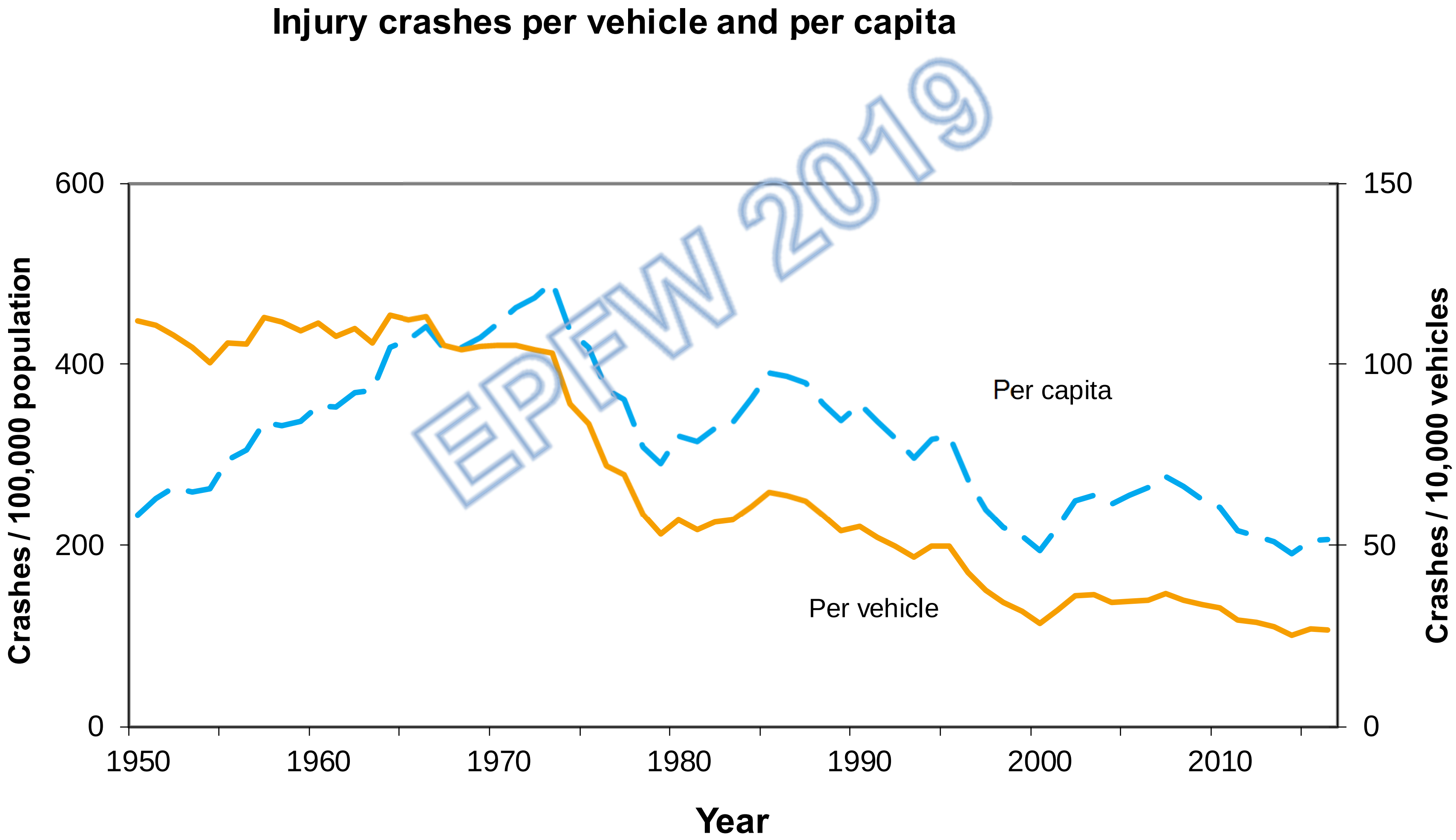
Safer Journeys



NZ Road Safety – The Why?

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Figure 1a: International comparison of deaths per 100,000 population (2015)

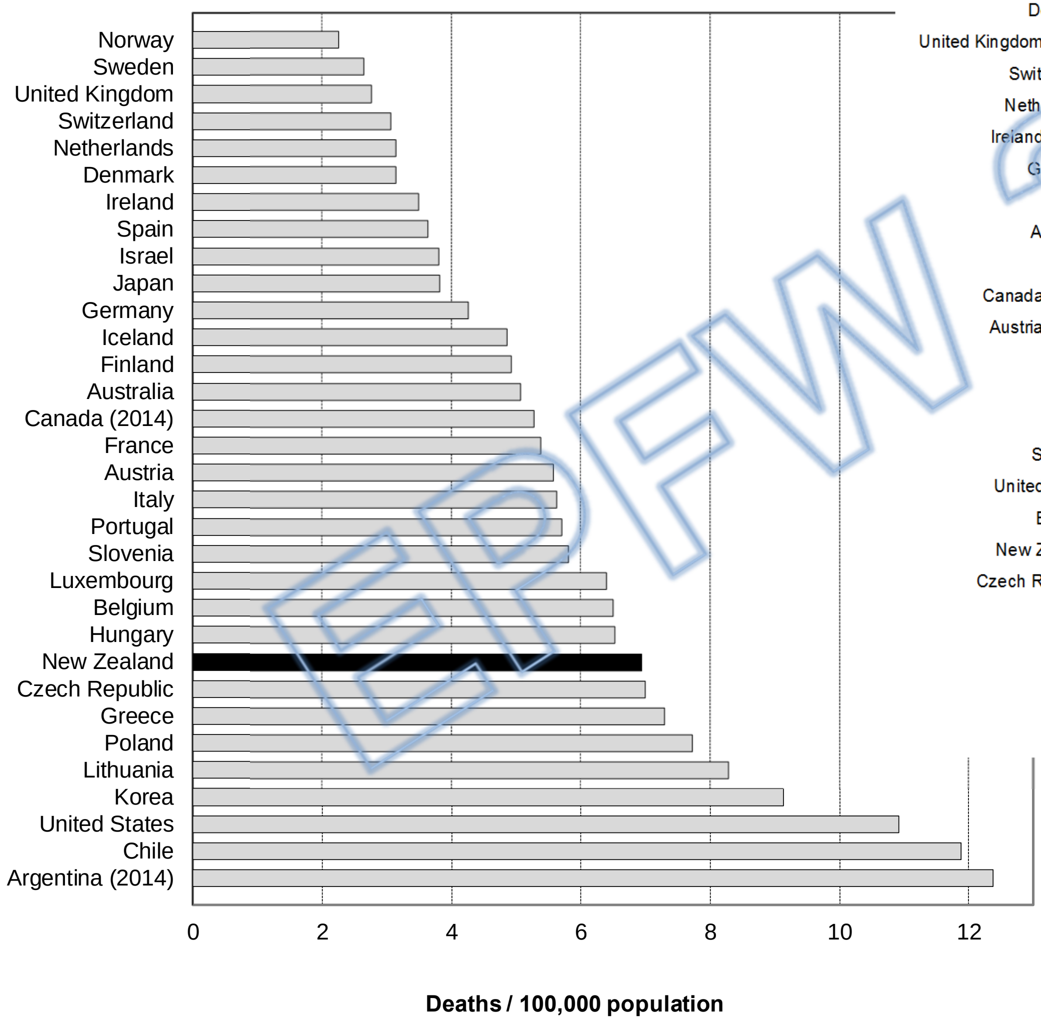
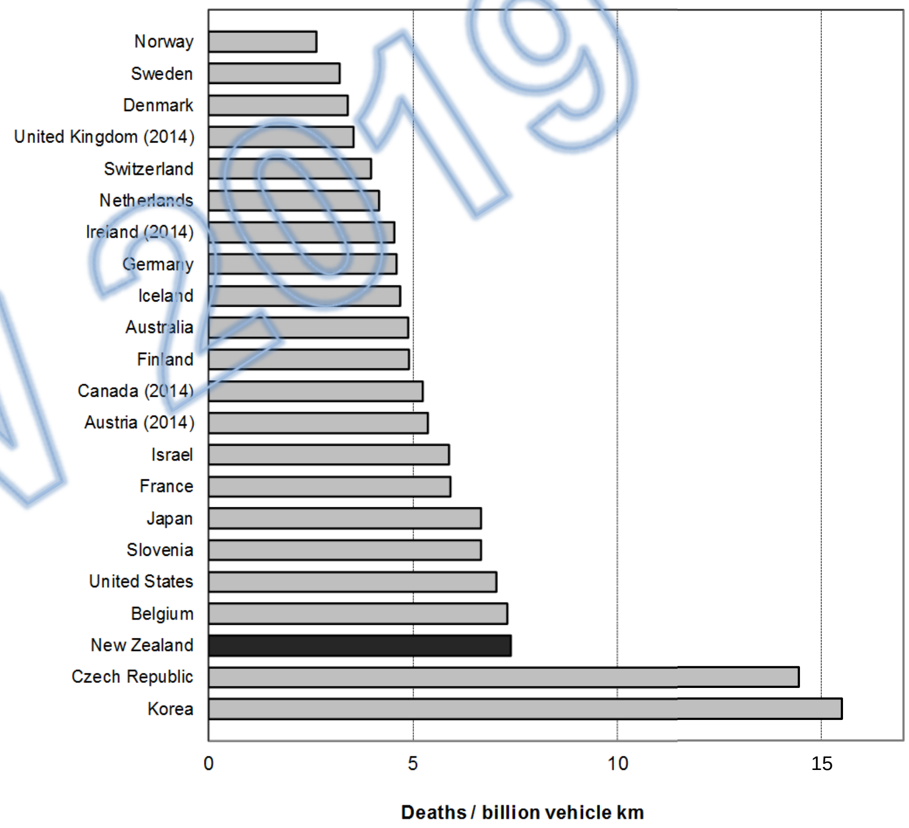


Figure 1c: International comparison of deaths per billion vehicle km (2015)



Crash Movement Classifications

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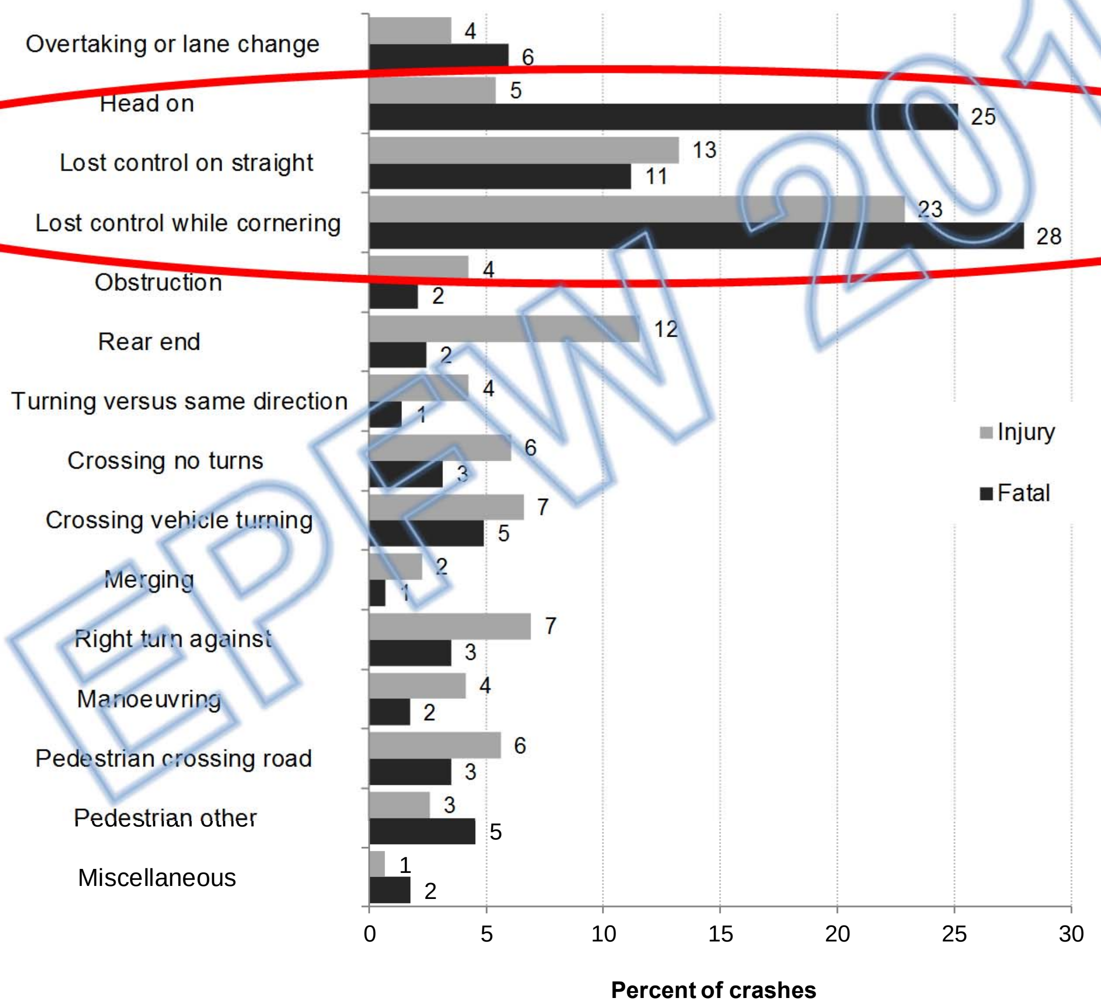
Figure 12
Crash movements by crash severity



Wet Road Crashes by Local Road Region in NZ (not incl SH's)

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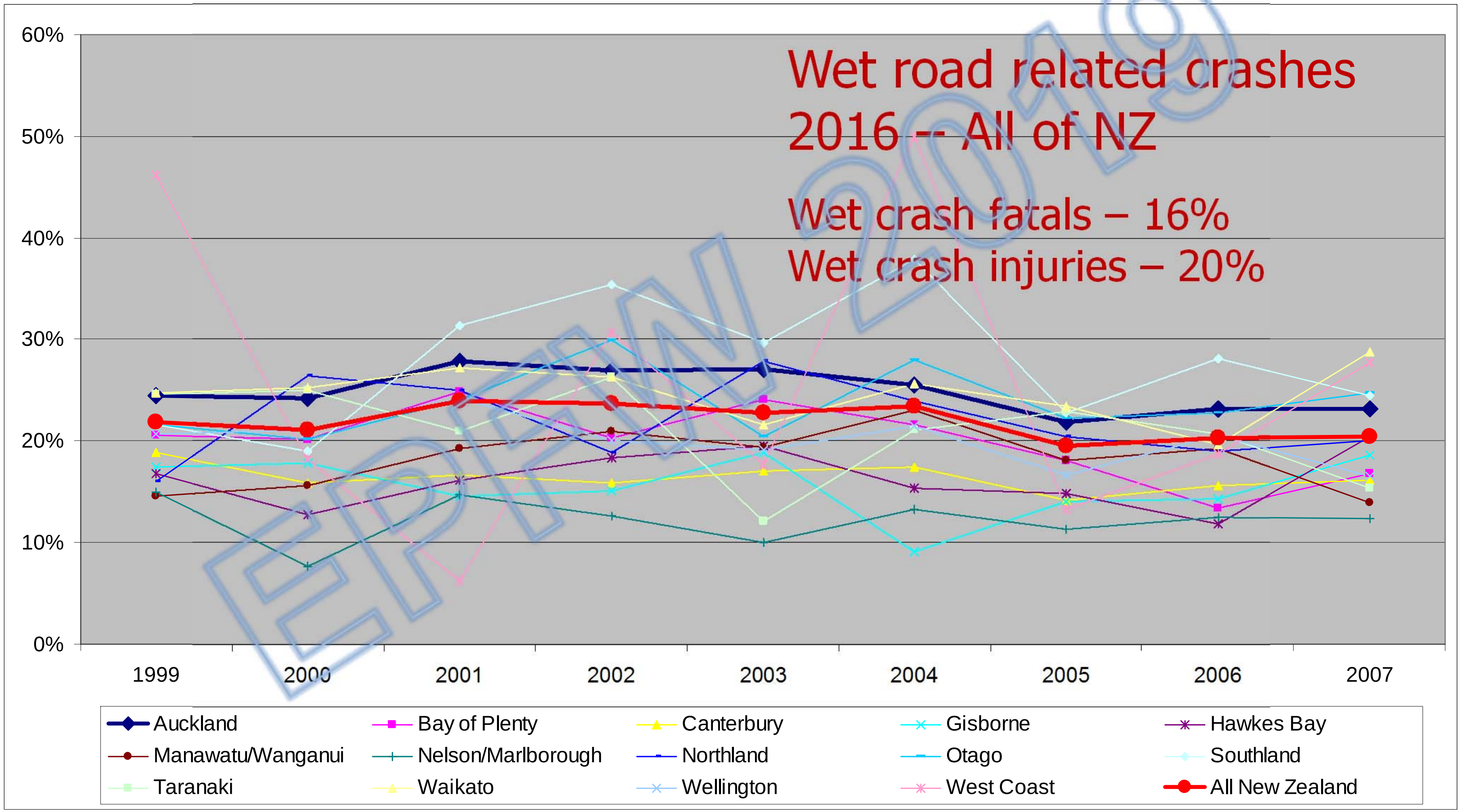

Crash Contributing factors

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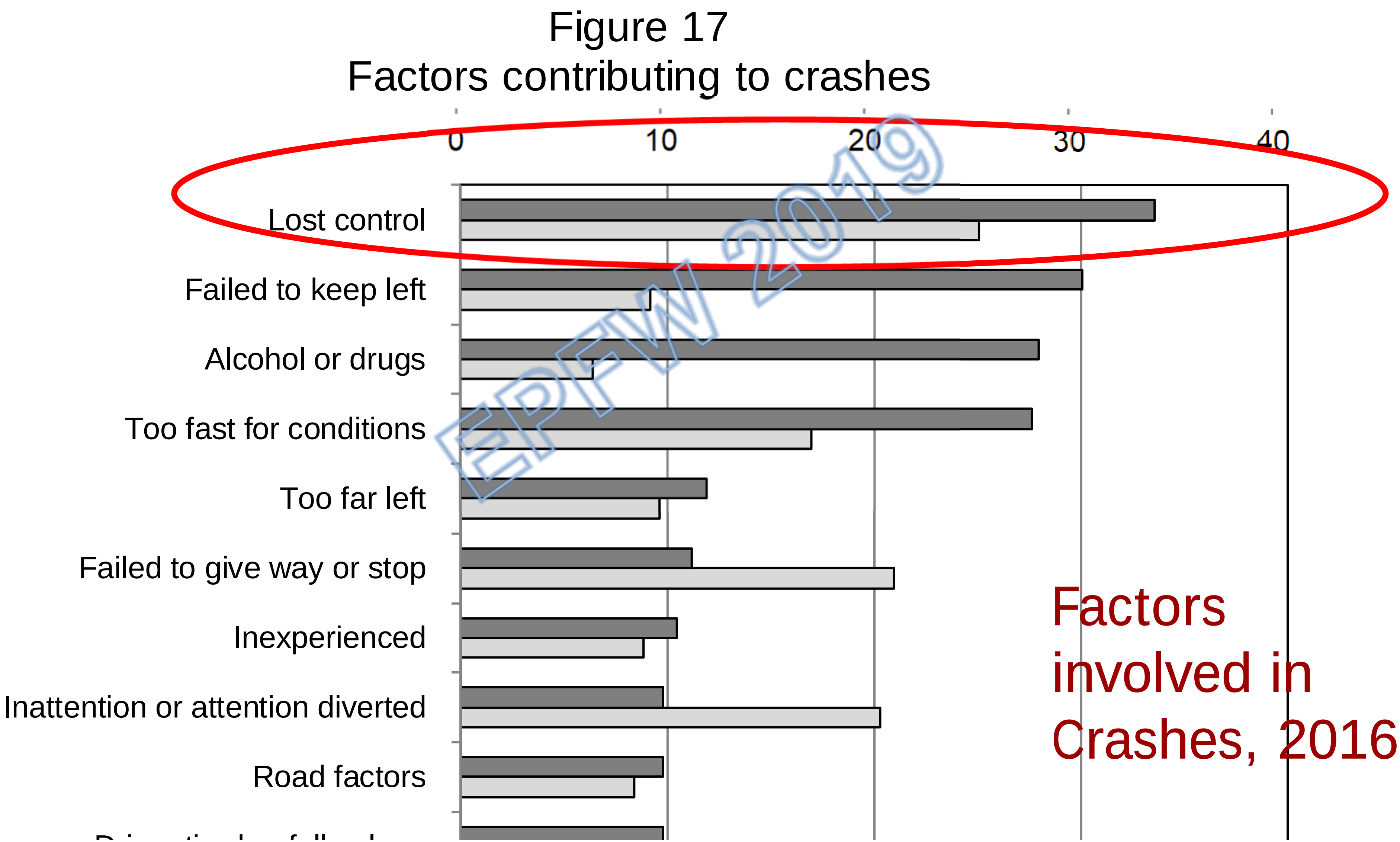

Factors involved in Crashes, 2016

Road crashes are now not as clustered together

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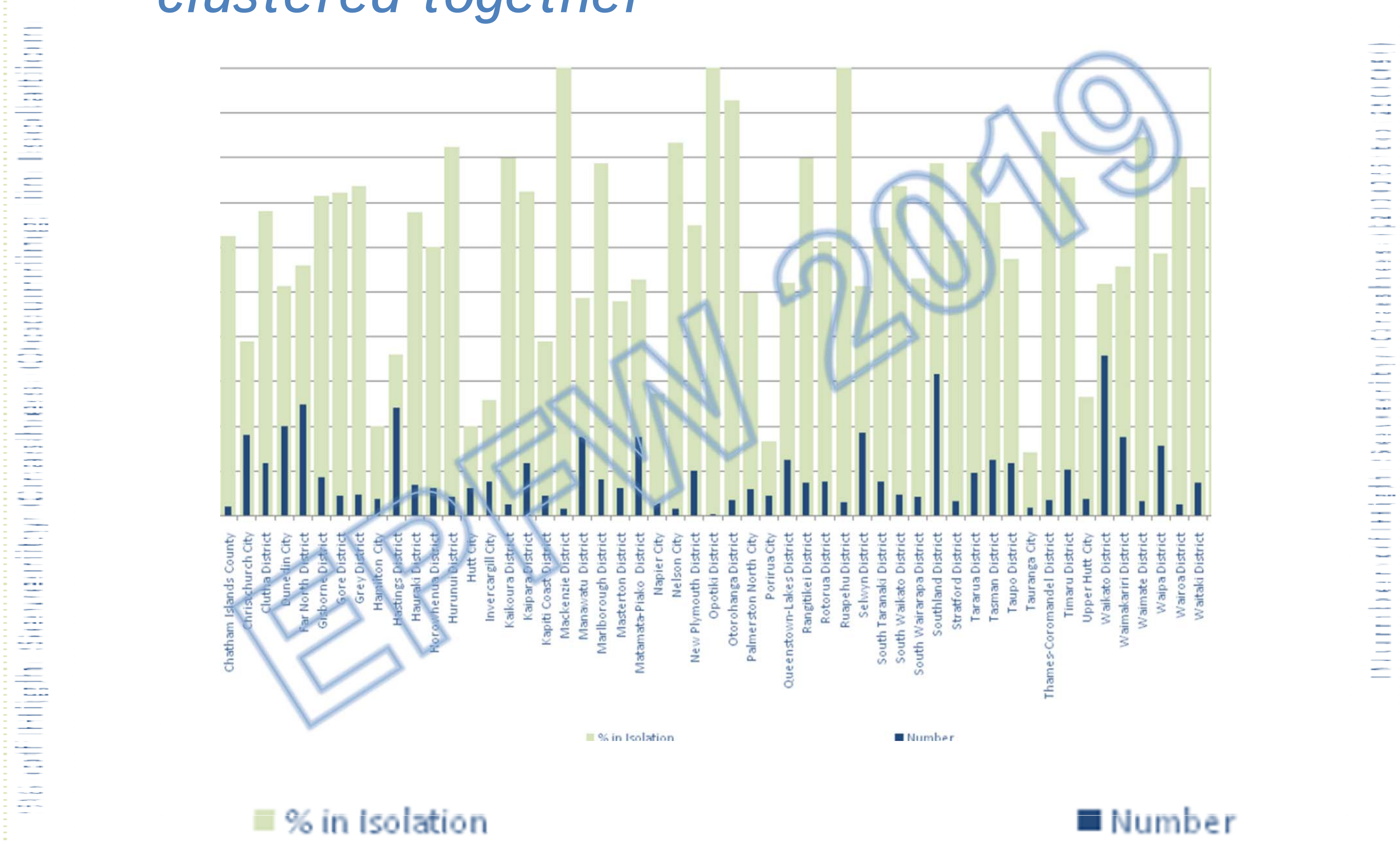
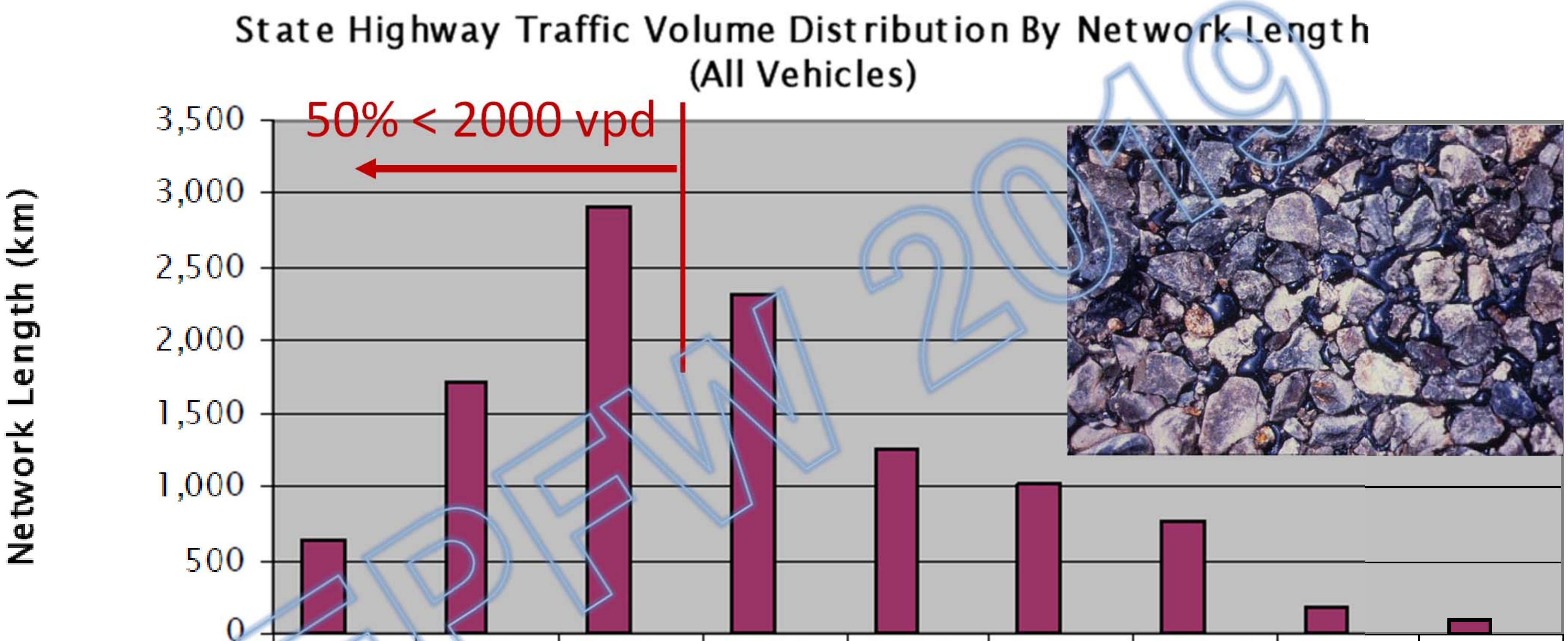


MBIE, University of Auckland, Leveraging Aggregate Resources Project 18.03.2019.

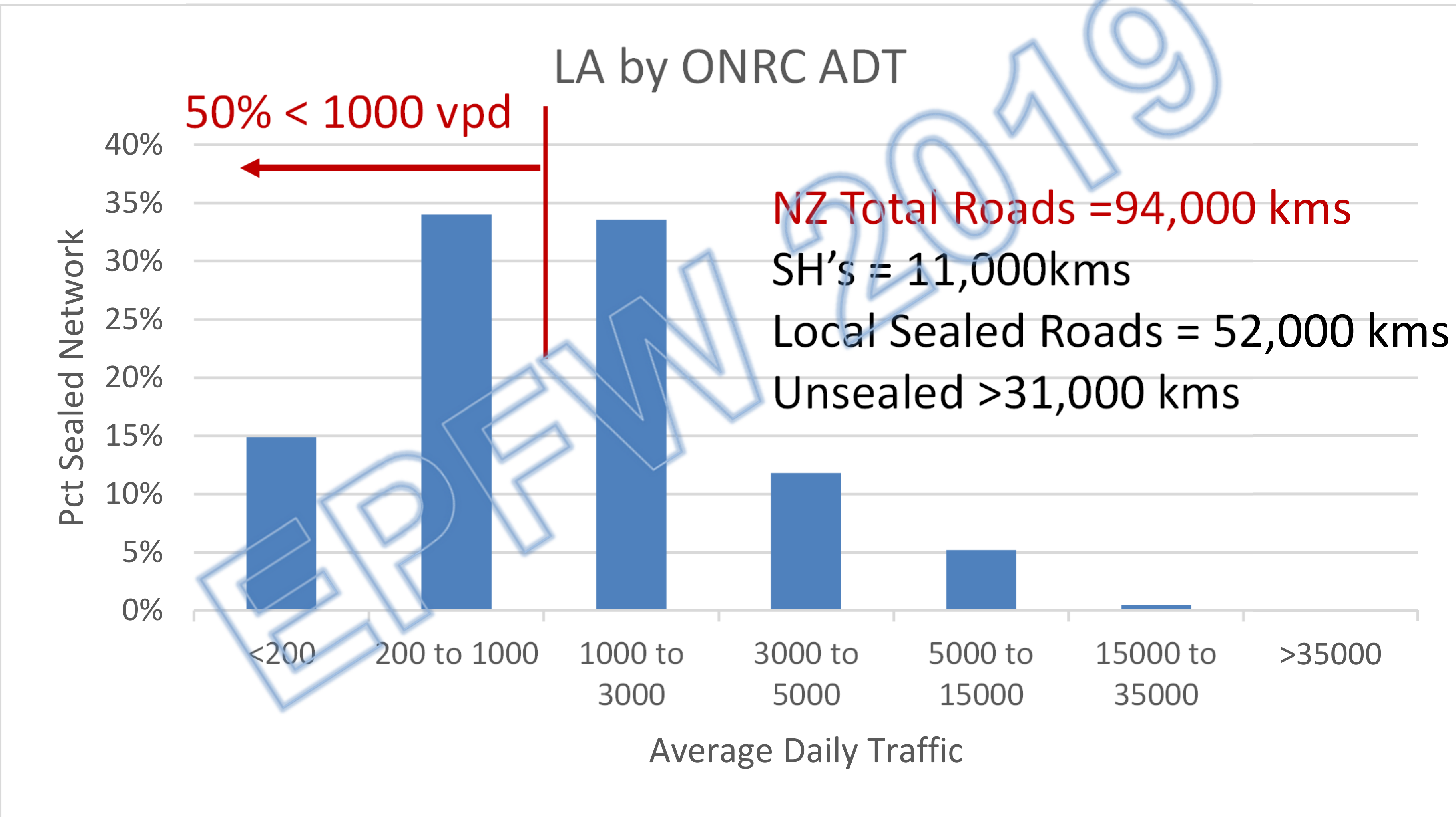
NZ -Relatively low traffic vols



	0-500	500-1000	1000-2000	2000-4000	4000-6000	6000-10000	10000-20000	20000-30000	>30000
Length(km)	635	1,709	2,925	2,315	1,251	1,026	774	182	91
% of Network	5.8%	15.7%	26.8%	21.2%	11.5%	9.4%	7.1%	1.7%	0.8%

Traffic Volume

NZ Local Roads (Urban & Rural)



Aggregates, quality, cost, Resource Efficiency & Durability

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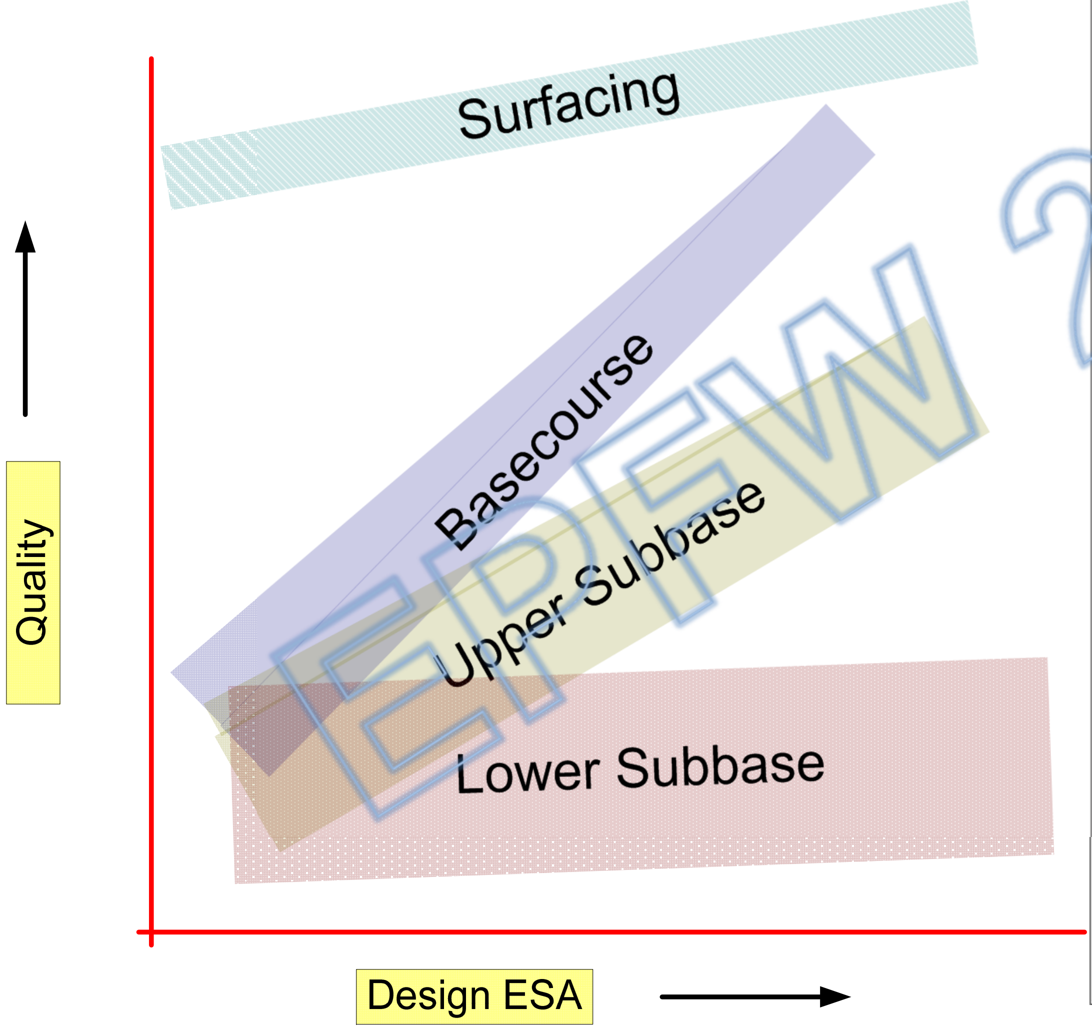

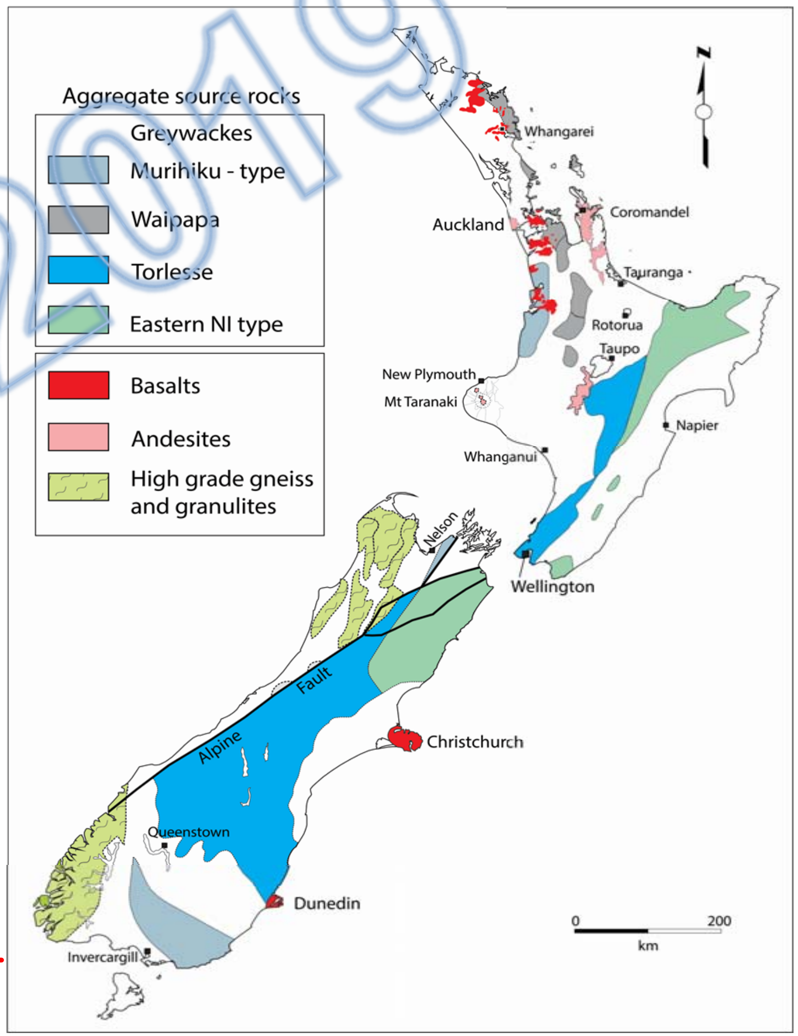

Factors Influencing Skid Resistance

Pavement Surface Aggregate Factors	Load Factors	Environment Factors	Vehicle Factors
Geological properties of the surfacing aggregate	Age of the surface	Water film thickness and drainage conditions	Vehicle speed
Surface texture (microtexture and macrotexture)	Traffic intensity and composition – equivalent vehicle loadings	Surface contamination	Angle of the tyre to the direction of the moving vehicle
Chip size and shape	Road geometry	Temperature	The wheel slip ratio
Type of surfacing (concrete, asphalt mix and mix design, chip seal surface and design method	Traffic flow conditions	The combined 'seasonal effects' and short-term variations	Tyre characteristics (structural type, hardness and wear)
		Rainfall	Tyre tread depth and pattern

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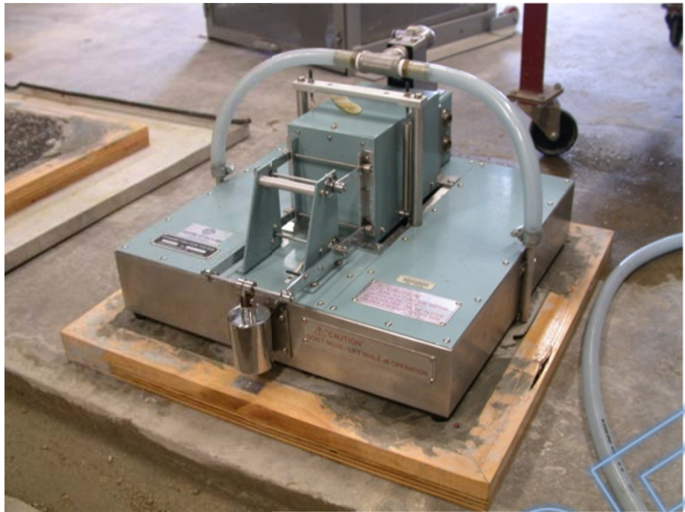
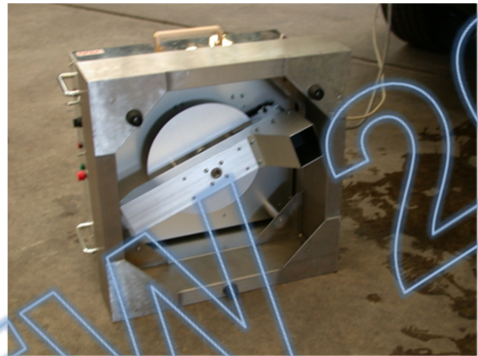
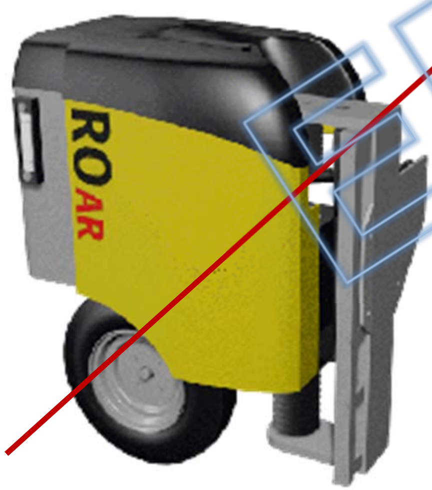
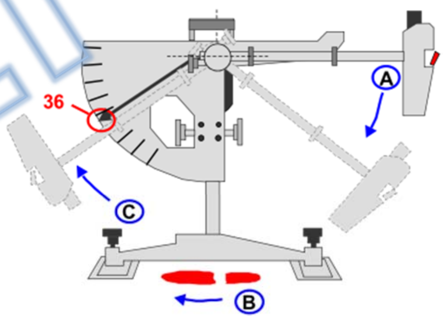
Skid Resistance Testing Devices in NZ









Standardisation of APPD as a laboratory simulated accelerated polishing method

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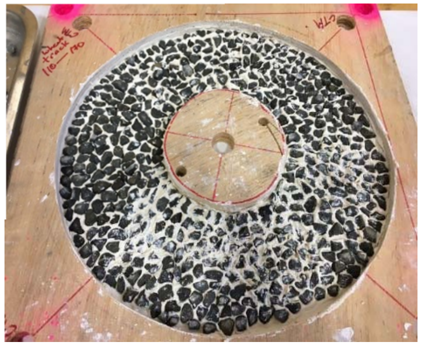
Adelia Nataadmadja & Ashkan Tatari

- Skid Resistance Prediction is complex
- Current PSV methods have been shown to be inadequate
- Research with IFSTTAR demonstrates APPD and WS method reflects in-field SR performance well
- Cost for industry for new method much lower than WS.


Auckland Pavement Polishing Device (APPD)

APPD's specimens



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APPD – DFT process

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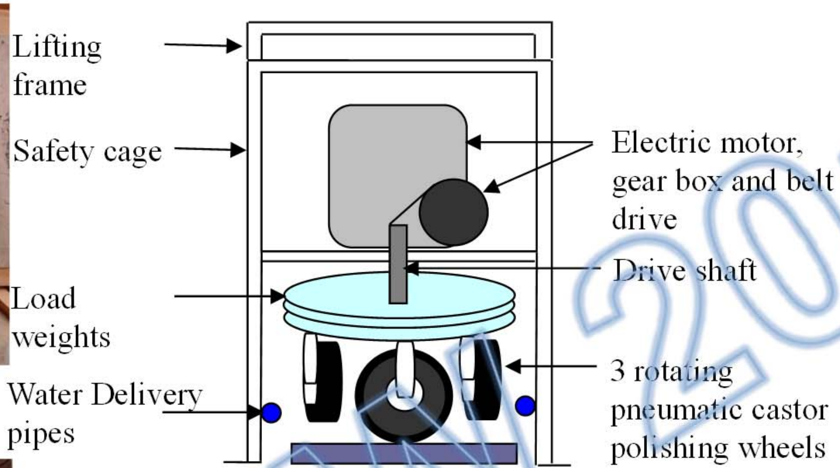
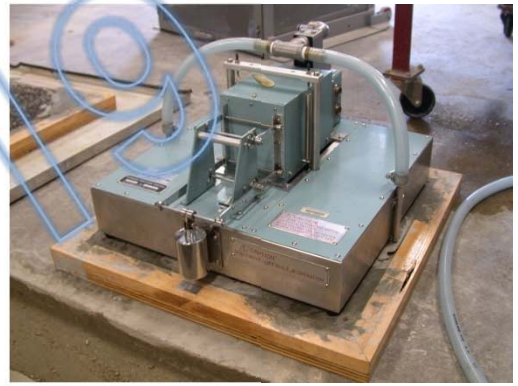
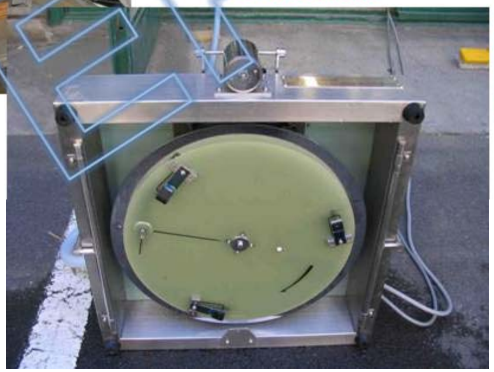
A prepared Lab Sample



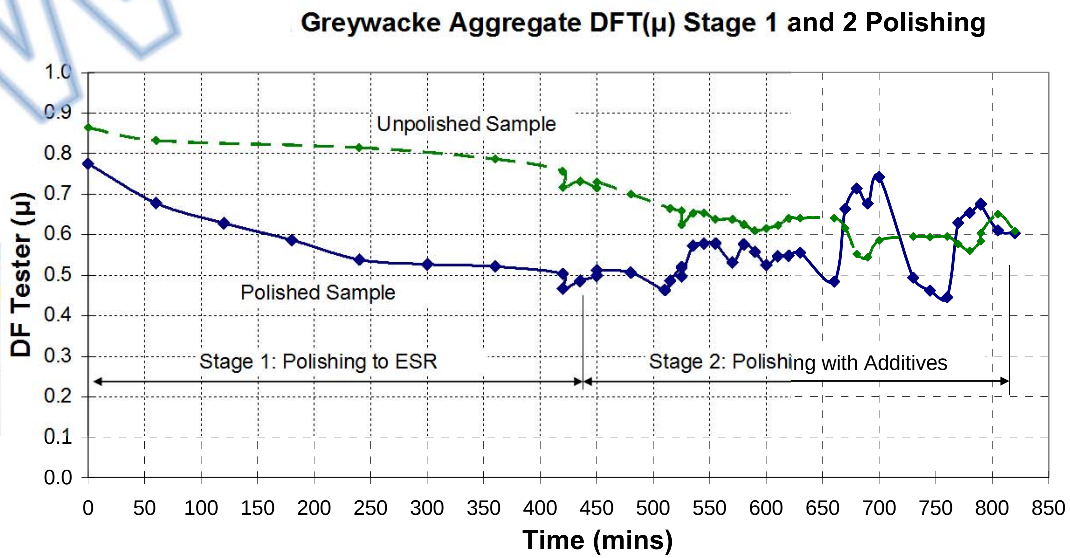


The Dynamic Friction Tester

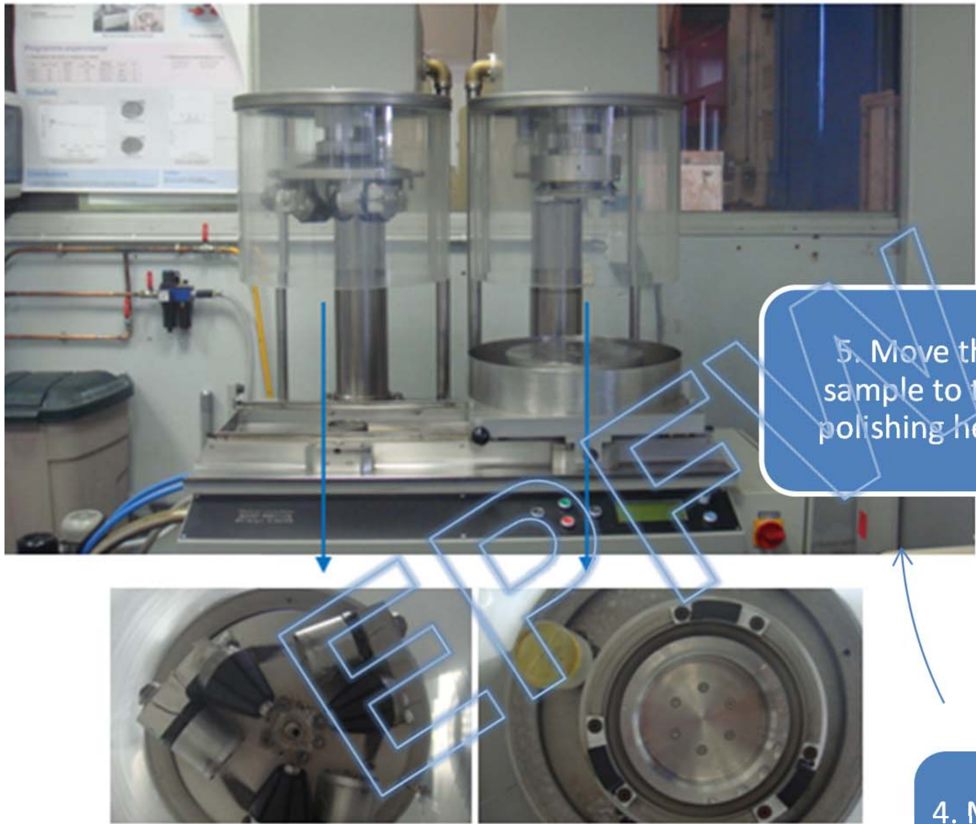
The Dynamic Friction Tester



The Accelerated Polishing Machine



Wehner/Schulze



Polishing Head

Friction Measuring Head

1. Polish the sample for the required time
2. Water is sprayed for two minutes to clean the fine silica from the sample
3. Move the sample to the friction measuring head
4. Measure the skid resistance and record the value
5. Move the sample to the polishing head

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Microtextural surface wavelength analysis methods

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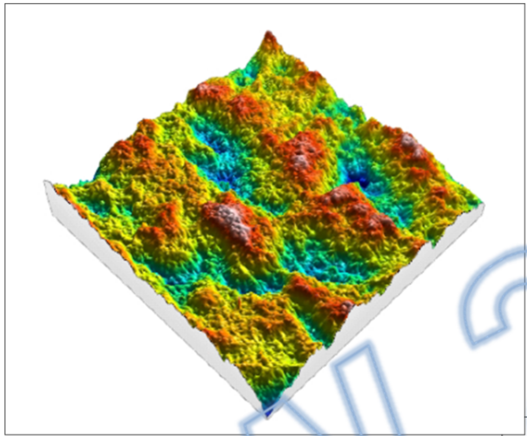
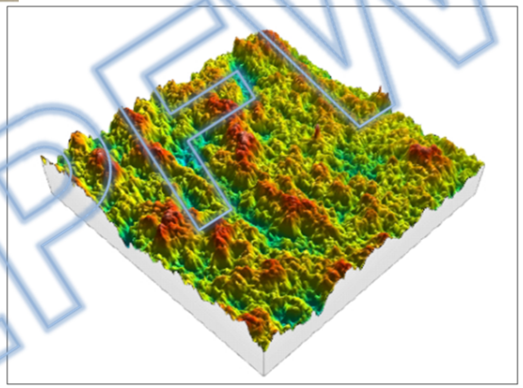
PhD Student – Ashkan Tatari

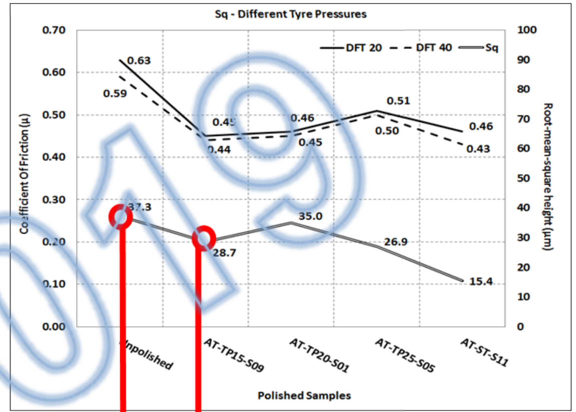
Alicona, IFSTTAR Nantes

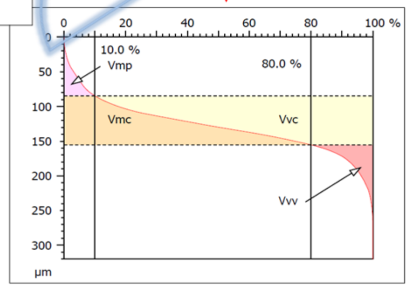


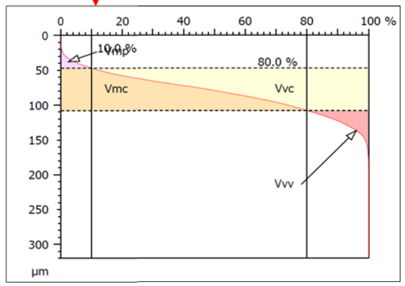
Unpolished chip



Chip polished 8 hours with tyre pressure 15, applied load 58 kg







Volume parameters related to surface roughness

- Peak Material Volume - Vmp
- Core Material Volume - Vmc
- Core Void Volume – Vvc
- Dales Void Volume - Vvv

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WS – Polishing Microtexture

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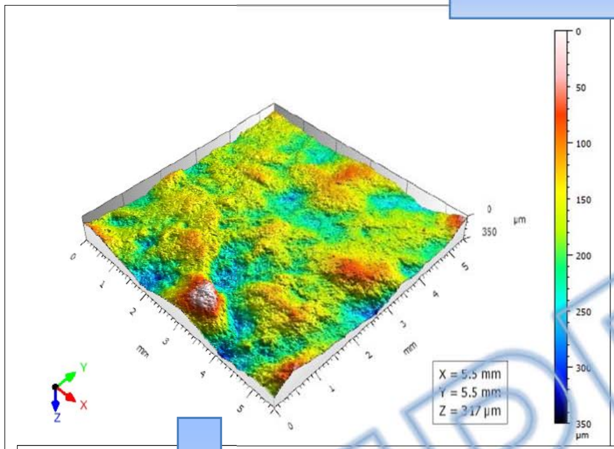
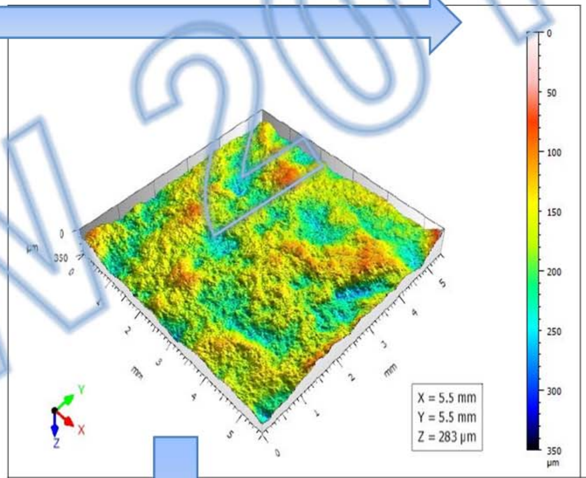
WS

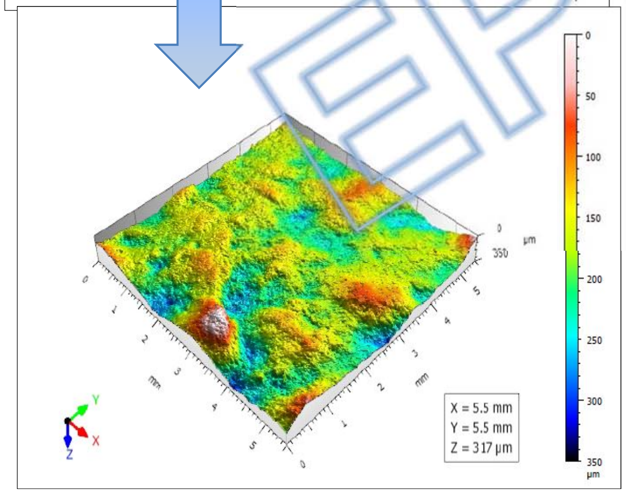
Polishing Passes	0	1000	2000	3000	4000	5000	10000	20000	50000	90000	180000
CoF	0.474	0.414	0.395	0.386	0.380	0.371	0.363	0.349	0.317	0.298	0.274
	1.00	0.87	0.83	0.81	0.80	0.78	0.77	0.74	0.67	0.63	0.58



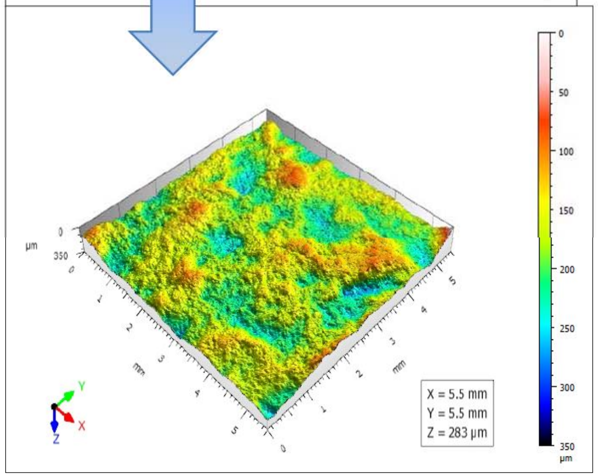
Initial Unpolished Zone 1



Initial Unpolished Zone 2

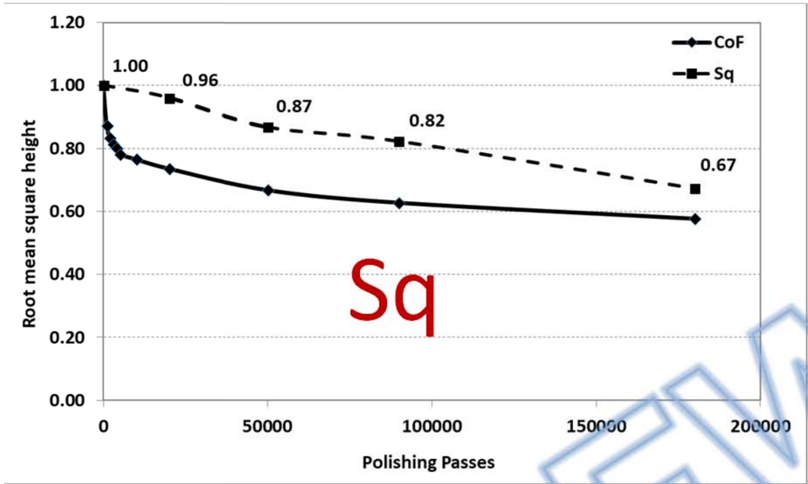


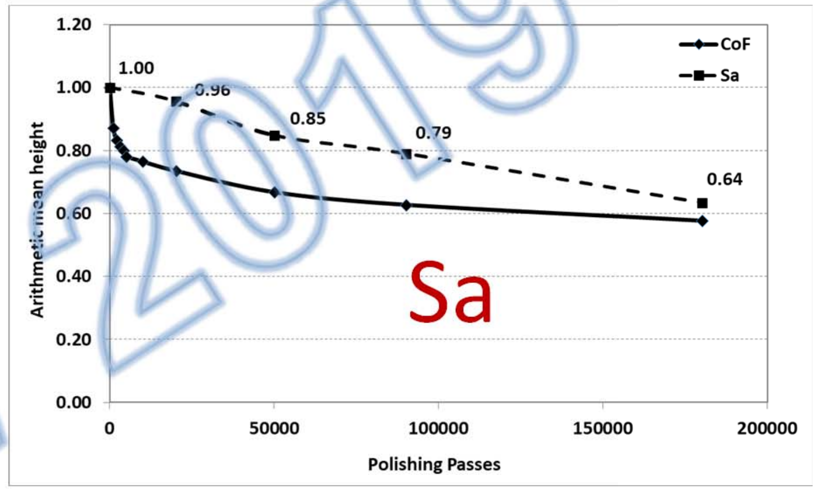
WS After Polishing 180,000 cycles - ESR Zone 1

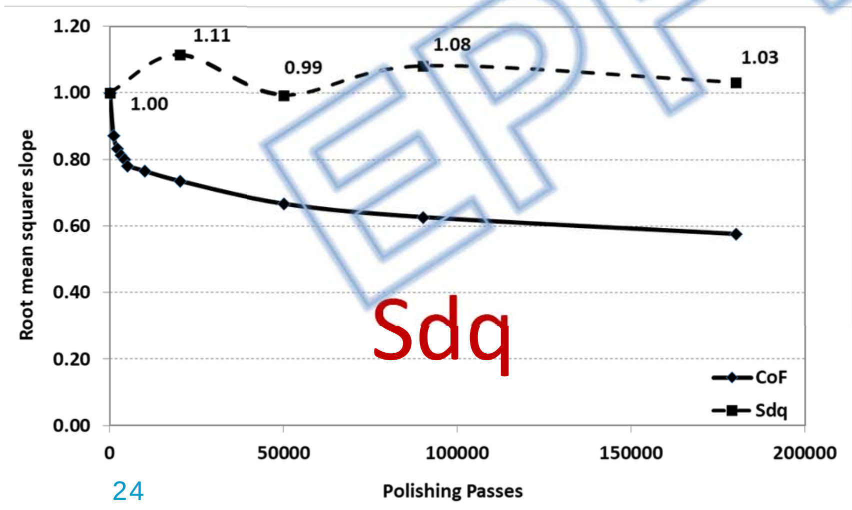


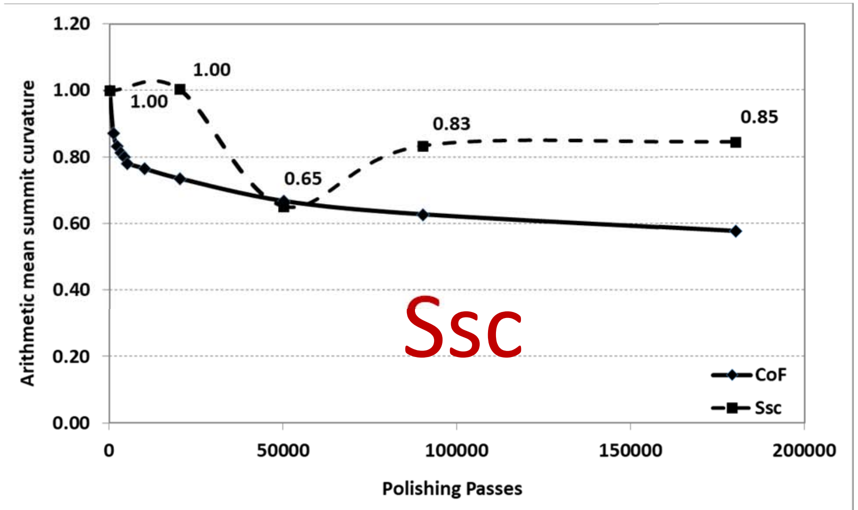
WS After Polishing 180,000 cycles - ESR Zone 2

Microtextural analysis parameters at various stages of polishing









SCRIM tyre rubber and temperature effects

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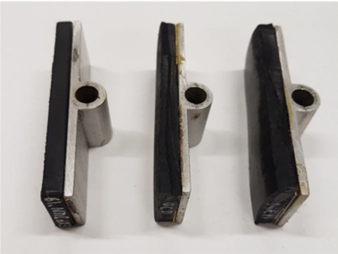
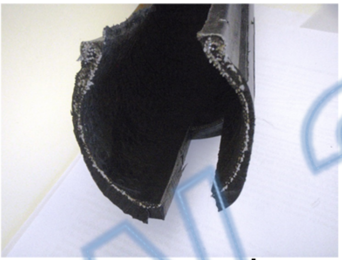
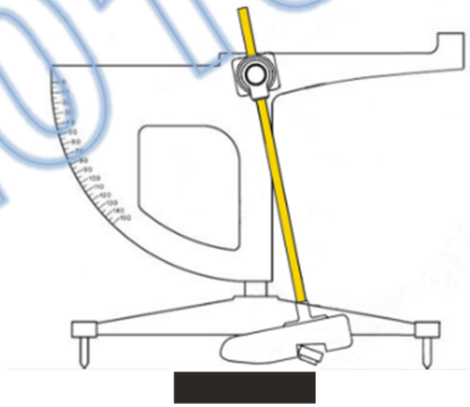
- An experiment measured skid resistance with a pendulum tester
- Three rubber sliders were used



- Two test surfaces were used


- Two temperature conditions were used
  - Rubber slider temperature changing from 5 to 50 °C
  - Test surface temperature changing from 5 to 50 °C

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Skid resistance measurement and temperature effects

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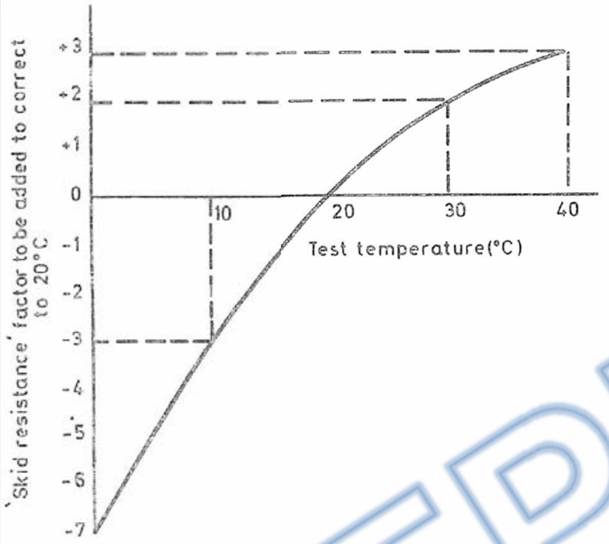
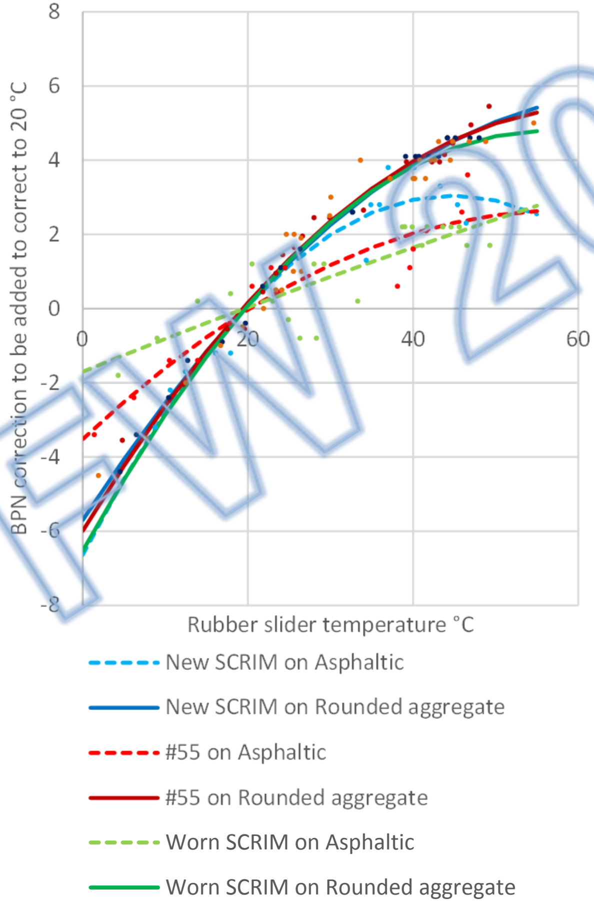
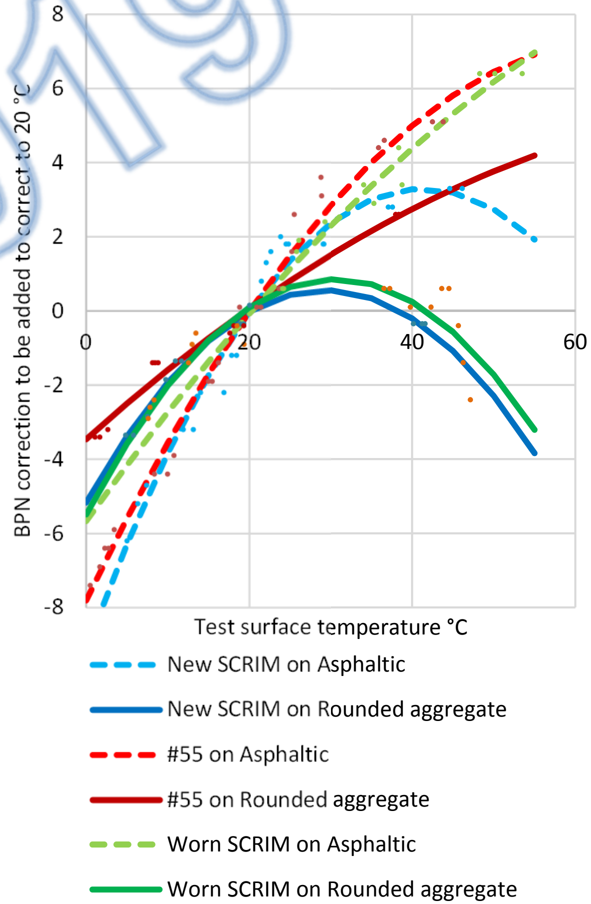


FIG. 1. Suggested temperature corrections for 'skid-resistance' values to allow for changes in resilience of the slider rubber





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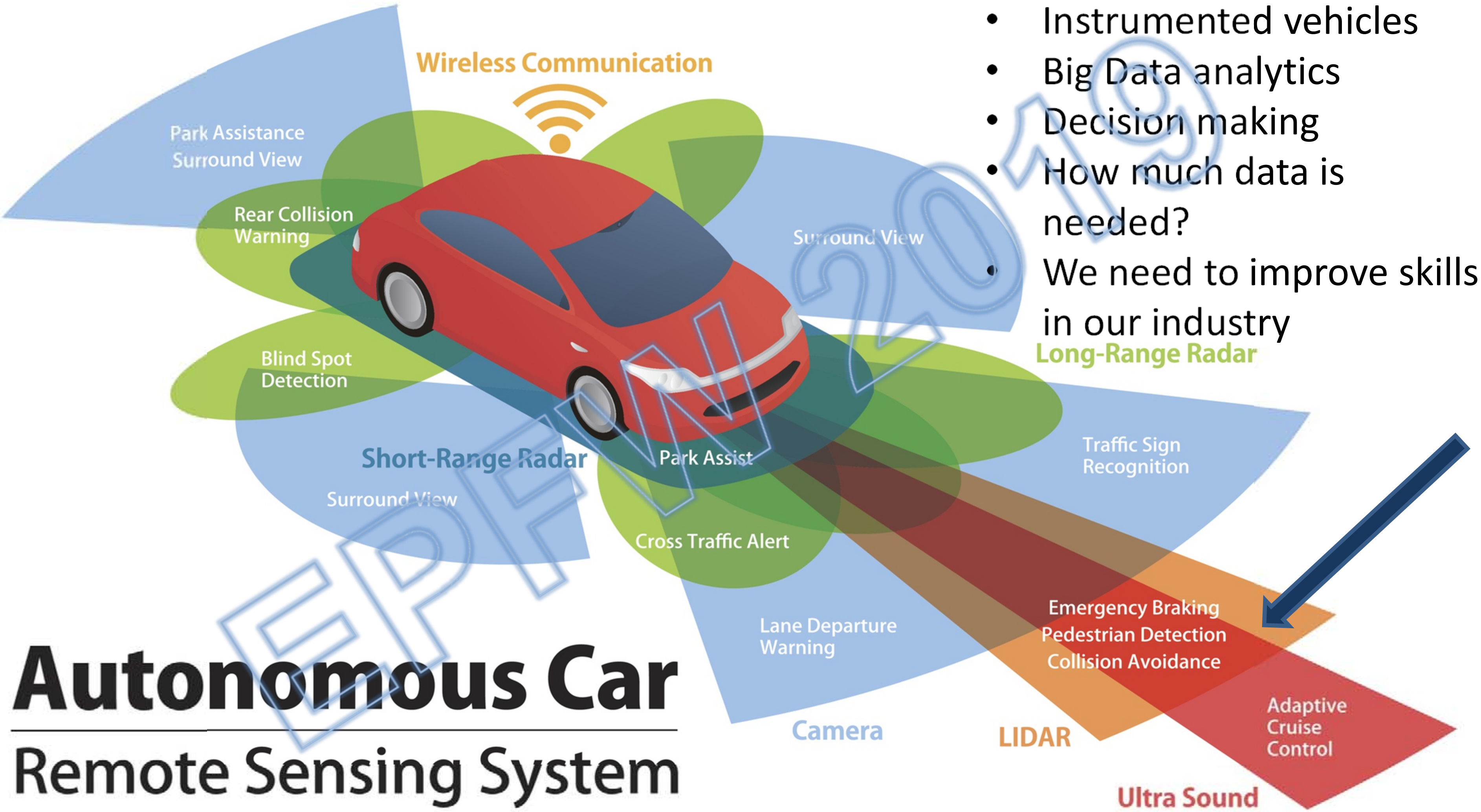
- Instrumented vehicles
- Big Data analytics
- Decision making
- How much data is needed?
- We need to improve skills in our industry



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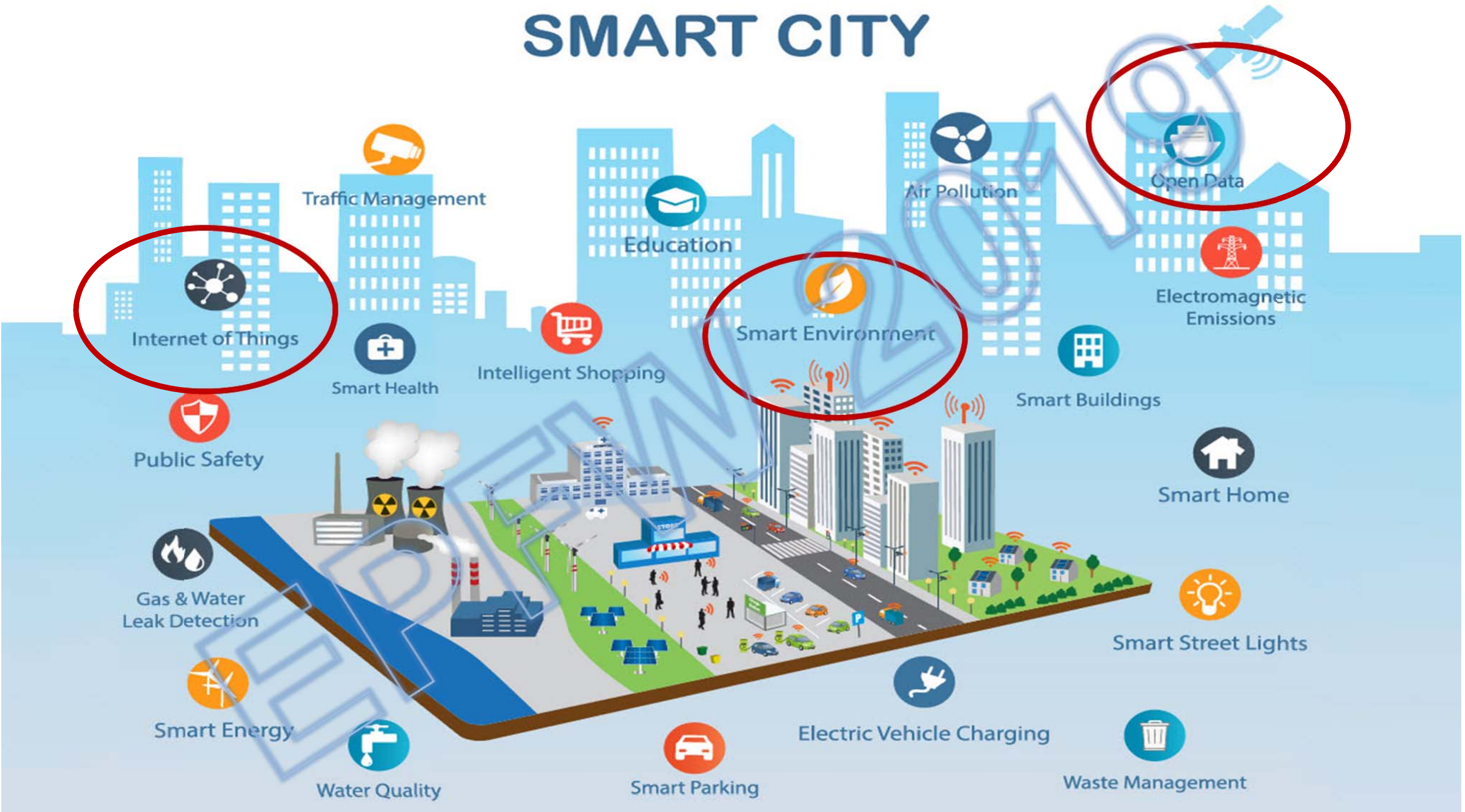

- New vehicle & connected infrastructure technologies, AI data analytics can help in being able to get almost real time information on surface condition but how we make good decisions from this data is still in its infancy.

Summary

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- Sparsely populated country's (like NZ) have a significant challenge ahead in improving historical infrastructure that was not designed for today's demands
- Road crashes are now increasing, complex and do not necessarily cluster together – more unpredictability and multi factored crashes are occurring – more difficult to target $
- Natural raw materials (aggregates) are not consistent in quality, nor evenly spread in supply / demand – need more sustainable use & reuse of resources with improved methods
- Laboratory methods of prediction of aggregate performance is complex but is possible with lower cost devices c.f. eg. APPD vs Wehner Schulze
- Microtextural analysis by non contact methods are showing promise yet understanding of how and where to use these methods is not clear
- What skills will our future engineers need?

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Merci… des questions

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Au revoir

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