NZ Guide to Pavement Evaluation and Treatment Design

Rehabilitation guide

NZ TRANSPORT AGENCY
WAKA KOTAHI

New Zealand Government

Detailed pavement design

Documented design story

"The report should contain sufficient investigation information and a clearly documented decision making process supported by modelling for a reader to be confident the correct risk-based design process has been adopted."

Construction quality assurance

Chapter included on construction quality assurance

Supports the Renewal Quality Plans required by the Network Outcomes Contracts

Design reports

- Provides specific design and documents assumptions and anticipated construction materials
- Either within the design report or separate should be an Inspection and Test Plan
  - The ITP will identify the tests, frequency of testing, compliance criteria and inspection and testing resources

Renewal quality plans

- Documents methodology used to demonstrate that the design assumptions have been met
- Documents how construction risks are managed
- Documents work procedures used to ensure an appropriate level of quality is obtained
- Inspection and Test Plans that identify critical inspection points and the test program that is best able to ensure the assumed construction quality is achieved.

Construction risk register

A risk register will detail how construction risks such as

- Construction timetable, particularly in relation to periods of high traffic levels and weather
- Material supply and quality
- Subbase material specification
- Construction tolerances and quality

Construction risk register

As well as

- Construction plant
- Material testing
- Material handling (for example aggregate segregation)
- Asphalt compaction temperatures
- Underground services, and
- Any other construction risks

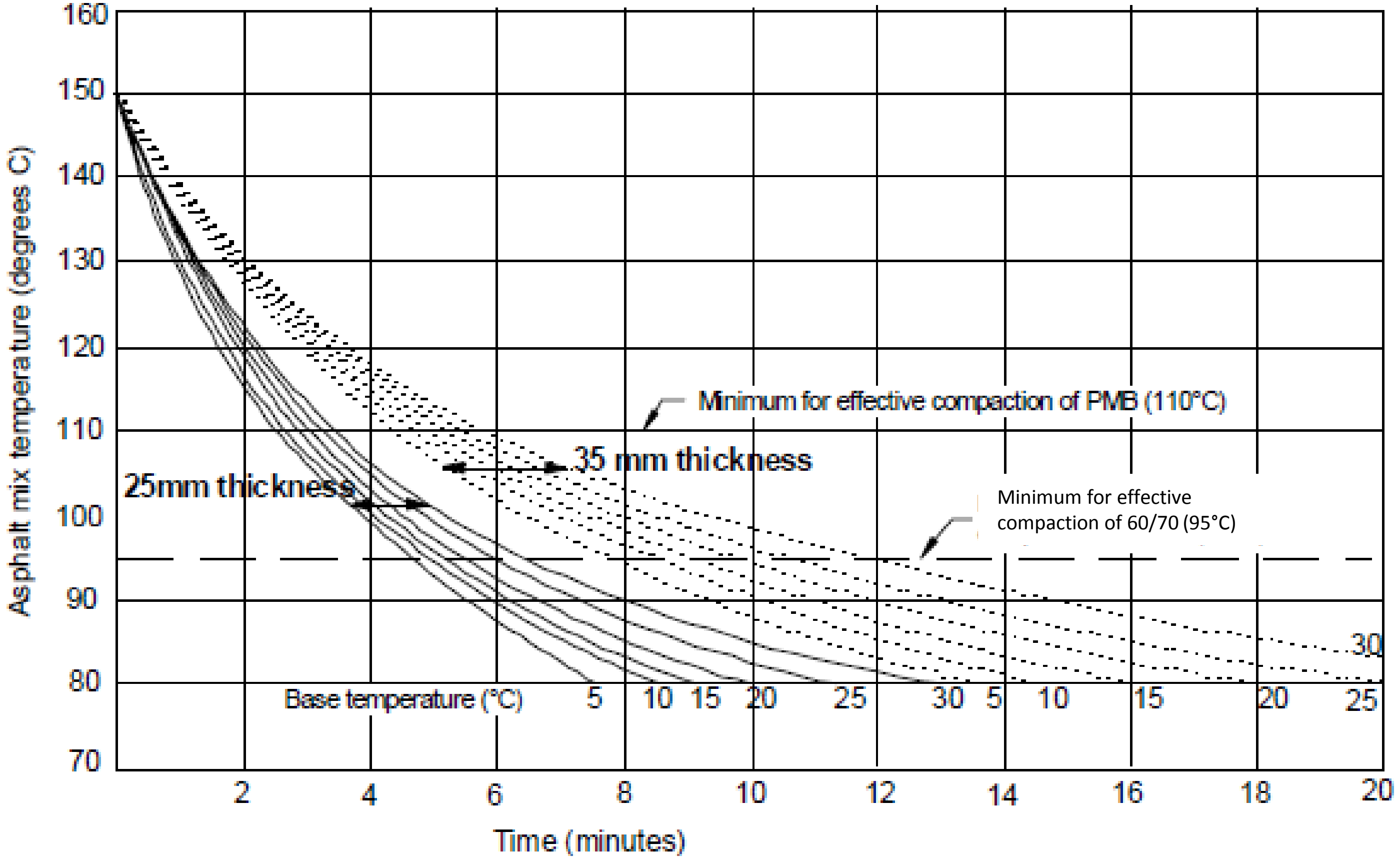
Inspection and test plan

- Designed to eliminate or mitigate identified construction risks
- Demonstrate design assumptions are met
- Identify actions should any requirements not be met

Compaction temperatures

Binder	Minimum for final rolling (100 Pa.s)	Minimum for effective compaction (10 Pa.s)	Maximum for compaction (cohesion) (0.25 Pa.s)
80/100	65°C	90°C	140°C
40/50 and 60/70	70°C	95°C	150°C

Asphalt rolling time



Construction risk management

Identified risk

- Weather
- Materials
- Resources
- Site specific constraints

Construction methods

Program slip

Other requirements

- Post construction testing and monitoring

NZ Guide to Pavement Structural Design

NZ Supplement

NZ Guide to Pavement Structural Design

- Update to the New Zealand supplement to Austroads published by Transit in 2007
- Changes are mostly to update references and align the document with the Guide to Evaluation and Treatment Design

This is the new NZ supplement

NZ Guide to Pavement Structural Design

- Project reliability changed
- Risk tables updated
- Sensitive subgrades discussed
- Foamed bitumen design consistent between documents

Aligns with other guide

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What is missing?

- The response of asphalt layers to traffic loading is dependent on the rate of loading, Pavement Design Speeds.

Designated Speed Limit V (km/hr)	Pavement Design Speed (km/hr)
$V \geq 100$	80
$60 \leq V < 100$	60
$40 \leq V < 60$	40
Signalised Intersections or Roundabouts	10

Risk of pavement design against traffic volume

25 year design traffic volume (ESAs)	Less than 5×10^6	Between 5×10^6 and 1×10^7	Between 1×10^7 to 5×10^7	Greater than 5×10^7
Continuously Reinforced Concrete Pavement	**Unlikely to be economic**	**Unlikely to be economic**	**Unlikely to be economic**	**Low risk**
Structural Asphalt	**Unlikely to be economic**	**Unlikely to be economic**	**Low risk**	**Low risk**
Modified aggregate overlay basecourse and bound subbase	**Unlikely to be economic**	**Low risk**	**Low risk**	**Medium risk**
Foamed bitumen basecourse	**Low risk**	**Low risk**	**Low risk**	**Medium risk**
Modified aggregate base only	**Low risk**	**Low risk**	**Medium risk**	**High risk**
Unbound aggregate	**Low risk**	**Medium risk**	**High risk**	**High risk**

Foamed bitumen design

- Design process is the same as that described in NZ Guide to Pavement Evaluation and Treatment Design
- Modular limits for foamed bitumen placed under asphaltic cement with thicknesses greater than 60 mm.

Technical Advice Note 17-01

- Asphalt depths at high stress locations for new pavements and renewals.
- Where high shear stress then the **minimum** asphalt depth is 125 mm.
- Roundabouts with greater than 100 heavy vehicle movements per lane per day
- Intersections with greater than 500 heavy vehicle movements per lane per day
- Requires pavement design

EMOGPA update

Outline

- Customer Focus
- Implementation
- Safety
- Sustainability
- Noise
- Where are we at?
- What is in it for the Customer

The Customer focus

Customers want safe, sustainable and quiet roads

OGPA

- 6.4% of network, but will likely double in 5 years.
- 7.2 year life / $\$20/m^2$- $\$30/m^2$ to replace?
- Safe and Quiet but not Sustainable

EMOGPA

- 40 year life? / $\$6/m^2$ + incremental material cost
- Safe and Quiet and Sustainable

Implementation

- First "normal production" - 11 Feb 2016
- First site SH16 Lincoln Road by Fulton Hogan.
- NZ Transport Agency laid 570,000 m^2 of EMOPGA.
- 8% of the NZ Transport Agency 7M m^2 OGPA
- AMA - 2 sites on SH1 / 160,000 AADT.
- First new Epoxy approved and almost laid.
- Largest Projects - Cambridge BP (290,000 m^2)
  - Te Atatu (63,000m2)
  - St Luke at (60,000m2)
  - N2AQ at (48,000m2).

Why does OGPA fail?

Herrington, P.R., Reilly, S., Cook S. 2005. Porous Asphalt Durability Test. Transfund New Zealand Research Report 265.

- Most common form of distress is loss of chip from the surface (fretting and ravelling)
- Caused by embrittlement through reaction with atmospheric oxygen.
- Durability depends on
  - oxidation resistance of the binder
  - binder film thickness
  - aggregate grading
  - and percentage of air voids.

OECD long life surfacings study

Epoxy Modified Bitumen - the only existing product with the potential to extend surface lives.

- Stiffer (higher modulus) at service temperatures, with greater load spreading ability
- More resistant to rutting, low temperature crack initiation, and surface abrasion from tyre action, even after oxidation
- More resistant to fatigue cracking (although the benefits are less marked at higher strain levels)
- Less susceptible to water induced damage
- **More resistant to oxidative degradation**.

Epoxy bitumen – where does it come from?

Developed by Shell in 1960s for airfields

Main use is on very large difficult orthotropic steel bridge decks

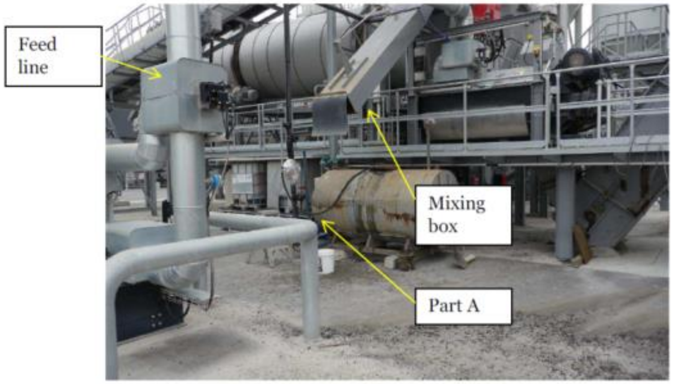
First application, on the San Francisco Mateo Bridge (California, United States), met performance requirements for over 40 years.

Two part system:

- Part A - epoxy resin formed from epichlorhydrin and bisphenol.
- Part B - fatty acid curing agent in approximately 70 penetration grade bitumen

Part A Part B

NZ Input to OECD Study

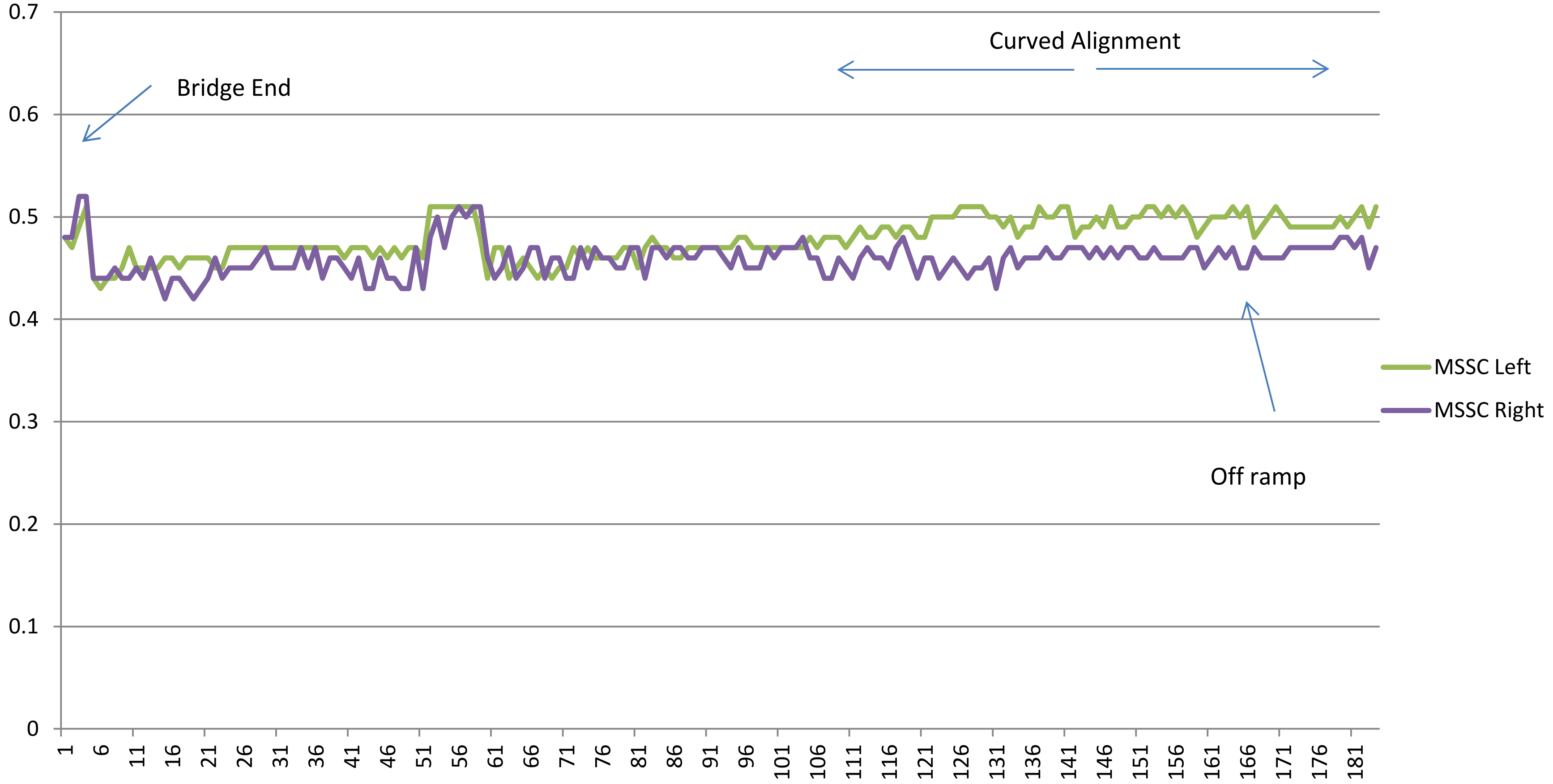


NZ implementation

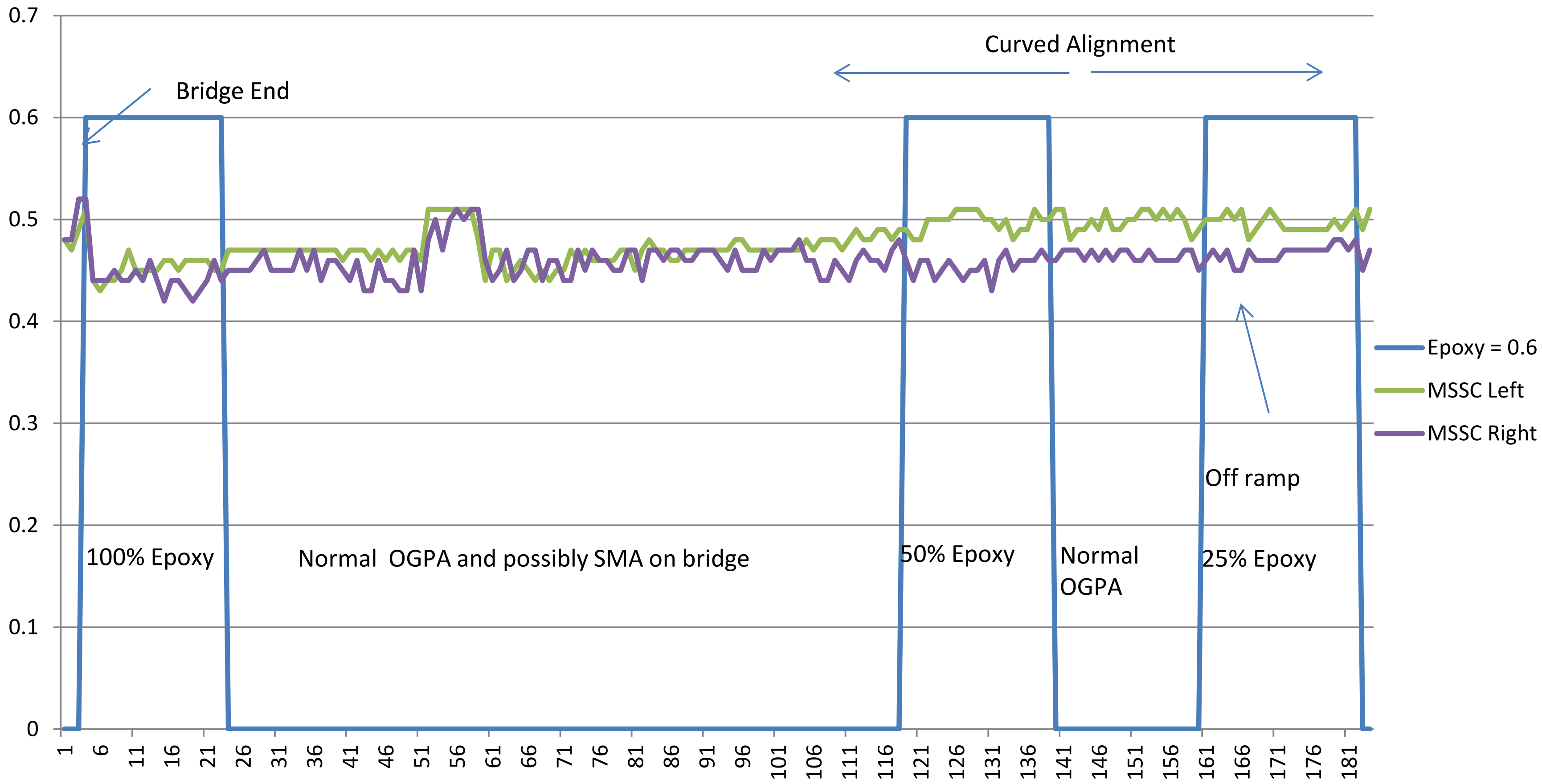
- Reducing costs by diluting the Epoxy Binder
- 25% EMOGPA lost all the rheological properties
- But maintained bulk of the oxidation properties
- Estimated life – 40+ years
- Costs of $6/m^2$ extra for 25% epoxy bitumen
- Break-even is 11 years.

- But room to improve as designs based on conventional OGPA thinking!

Skid resistance



Skid resistance



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Safety considerations

- OGPA used in T/10, Cat 3, 4, and 5 sites
  - Cat 4 & 5 sites rarely require intervention
- EMOGPA to be used on lower stress sites
  - i.e. only in T/10 Site Cat 4 and 5.
- Using current T/10 aggregate performance requirements
  - Should not need change in aggregate from OGPA

Optimising sustainability

- Looked at optimizing sustainability with
  - less binder and
  - less aggregate (i.e. more air voids).

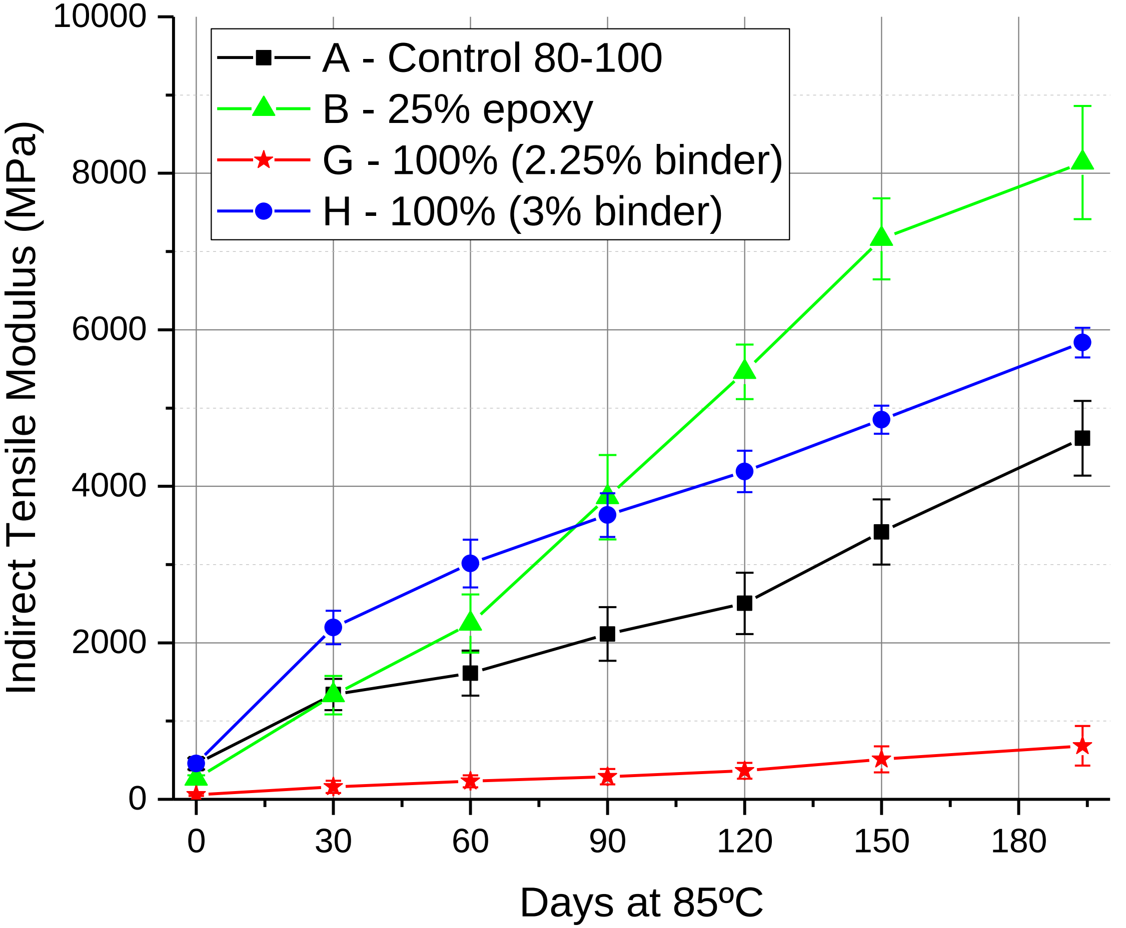
- Cost wise - 5.5% binder content, 25% epoxy bitumen mix (20% air void) = 100% epoxy bitumen with a 1.75% binder

- Unfortunately, 1.75% mix is dry and friable by hand
- Satisfactory 20% air void mixes need 2.25% binder
- High air void (~30%), low binder content mixes showed the coating of the aggregate at 2.25% binder was better

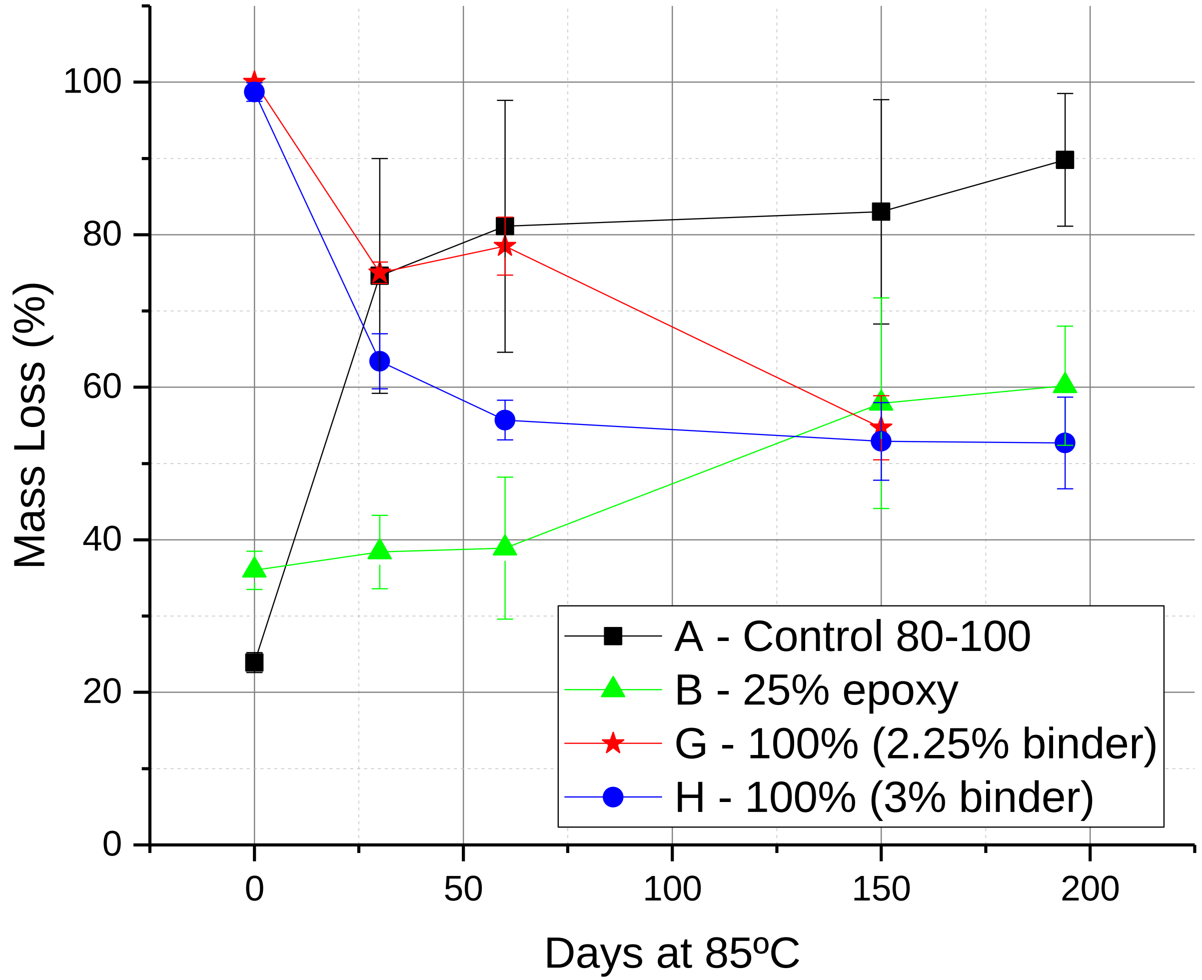
Sustainability Options

Name	% Air void	Binder % Mass	Binder Type (% by wt)
Control	~20%	5.5%	100% 80-100 bitumen
25% epoxy	~20%	5.5%	25% Type V, 75% 80-100
100% epoxy	~30%	2.25%	100% Type V
100% epoxy	~30%	3%	100% Type V

Low Binder Modulus Results



Low binder oxidation results



Sustainability Conclusions

To be practical rapid curing of the high void mixes needed. i.e.

- use of higher mixing temperatures
- *in situ* infrared heating or
- changes to the epoxy binder formulation
- use of curing accelerators

Noise - CSM1 Sites

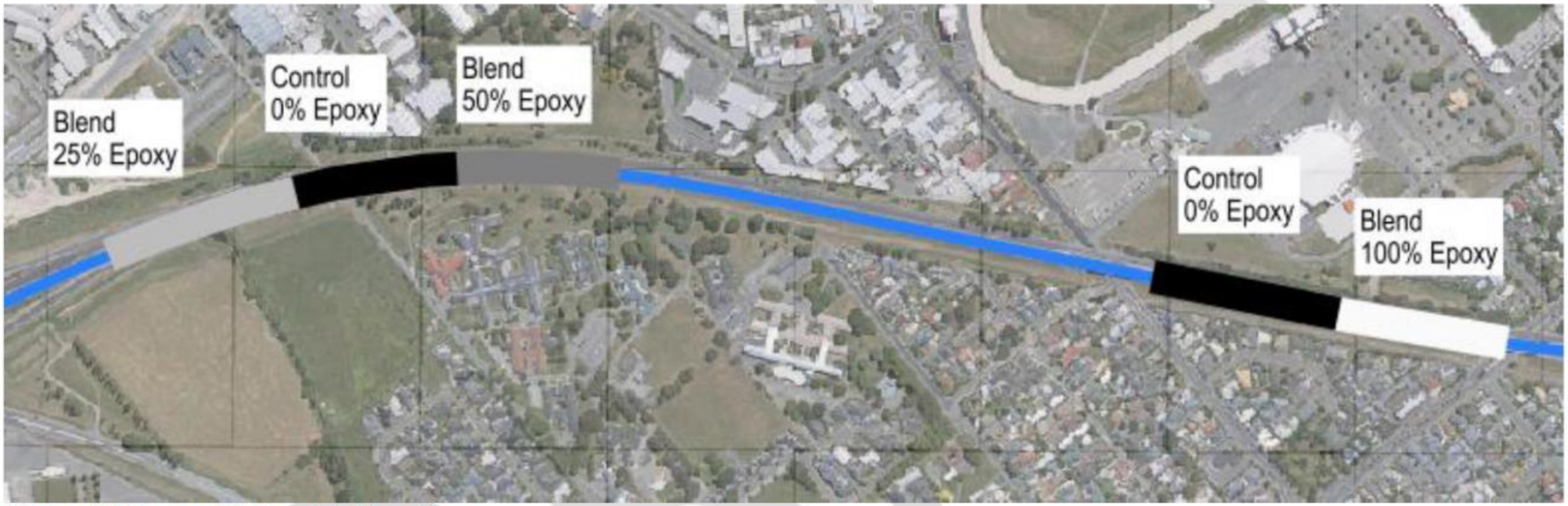
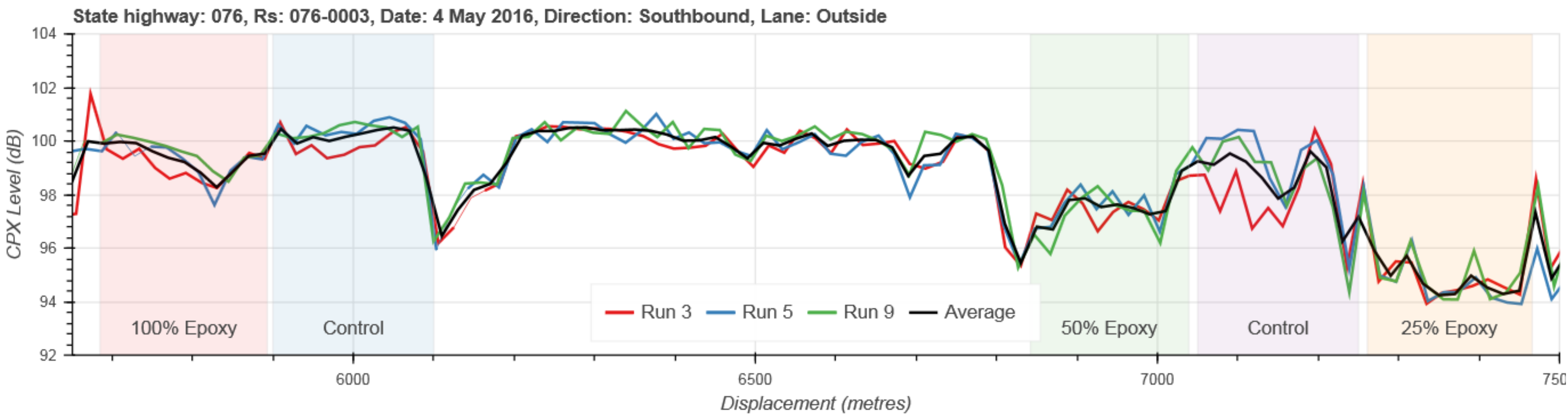
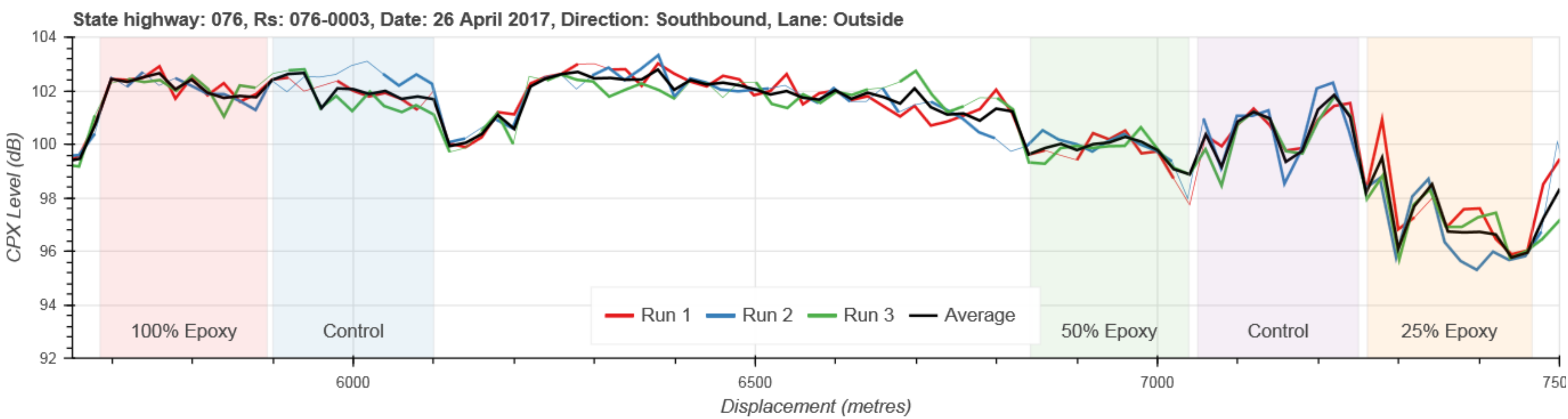


Figure 20 Epoxy dilution trial locations

Noise - CPX Trailer

Noise from CPX – CSM1





CSM1 – Systems & Operators

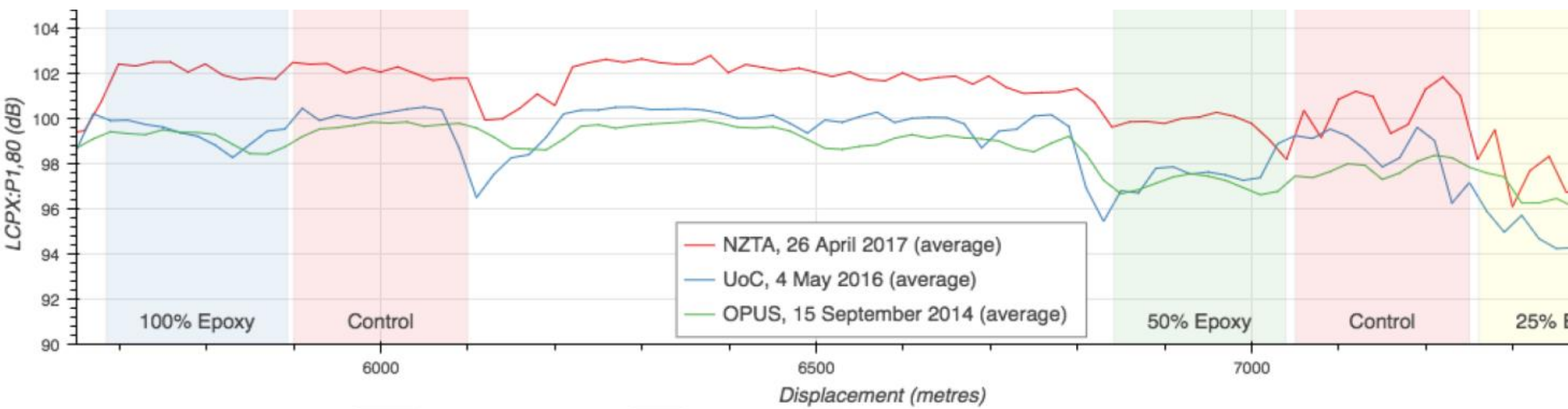


Figure 22 Comparison of measurement systems

HV Trials – S2G

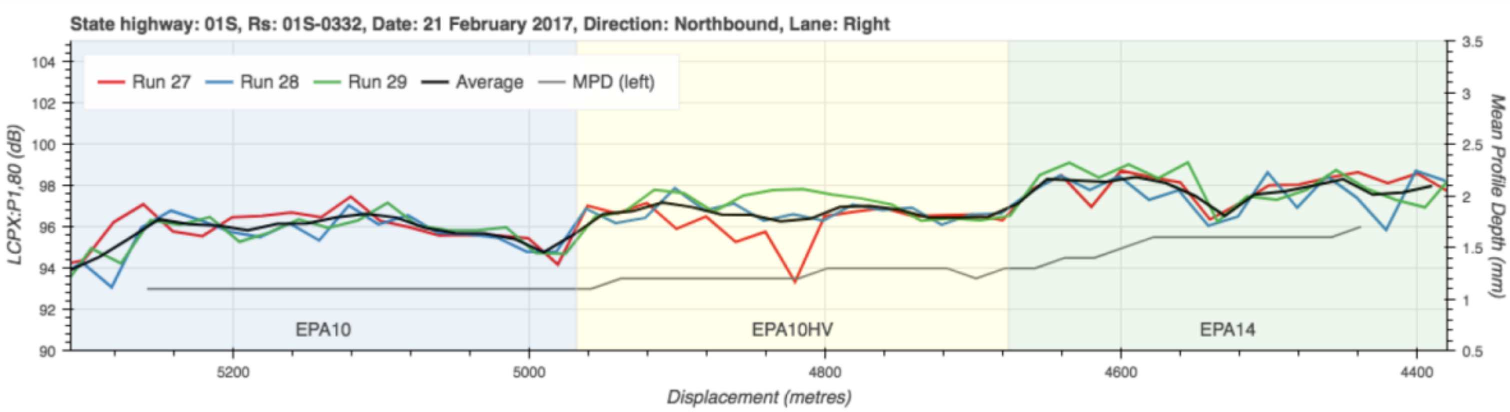


Figure 17 High void trial sections - Right lane, 21 February

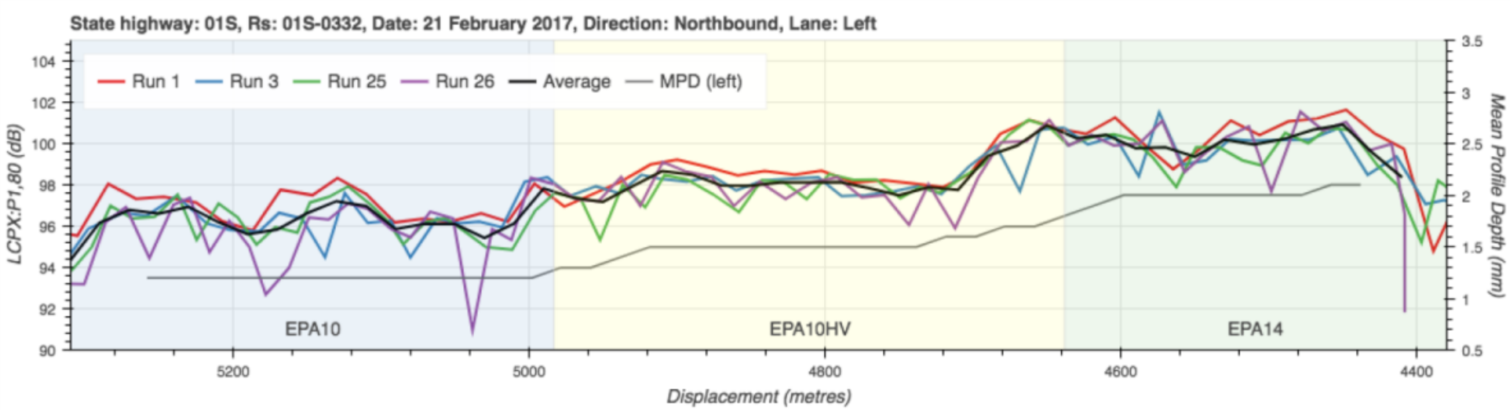


Figure 18 High void trial sections - Left lane, 21 February

Texture vs Noise – S2G

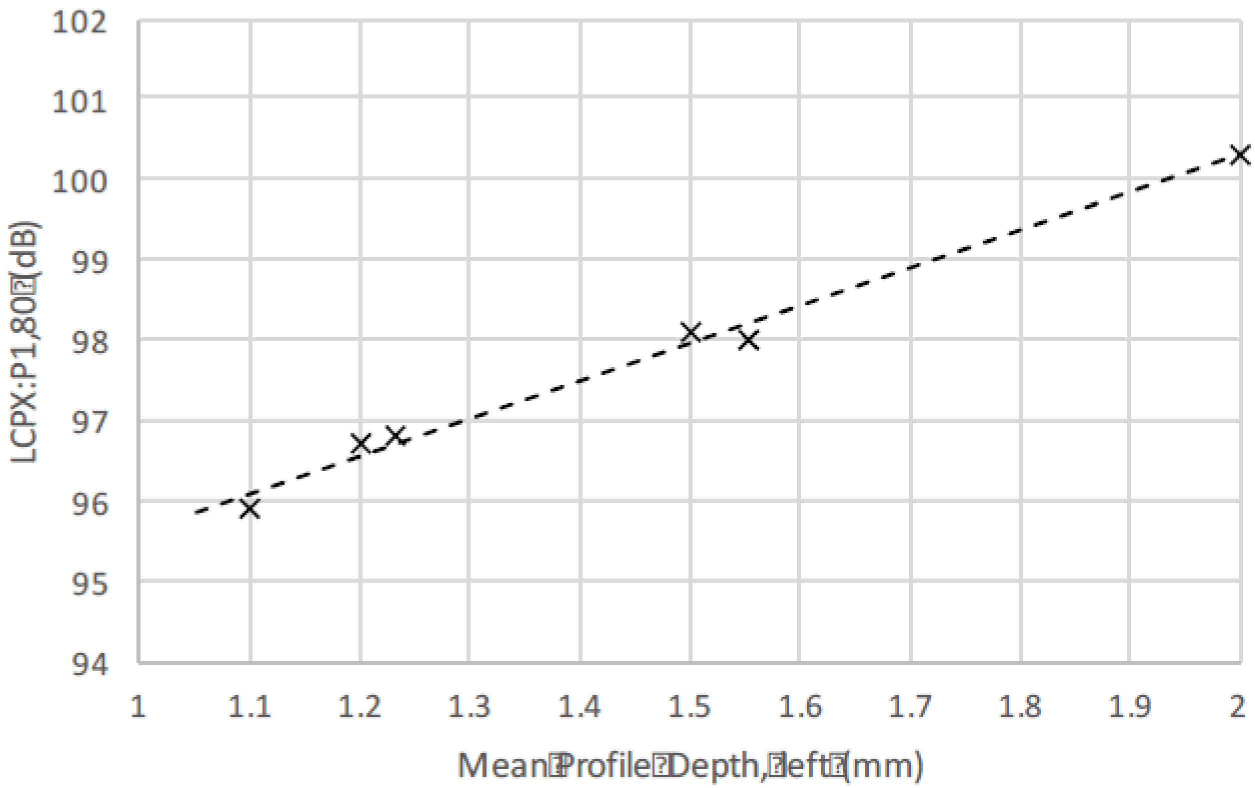
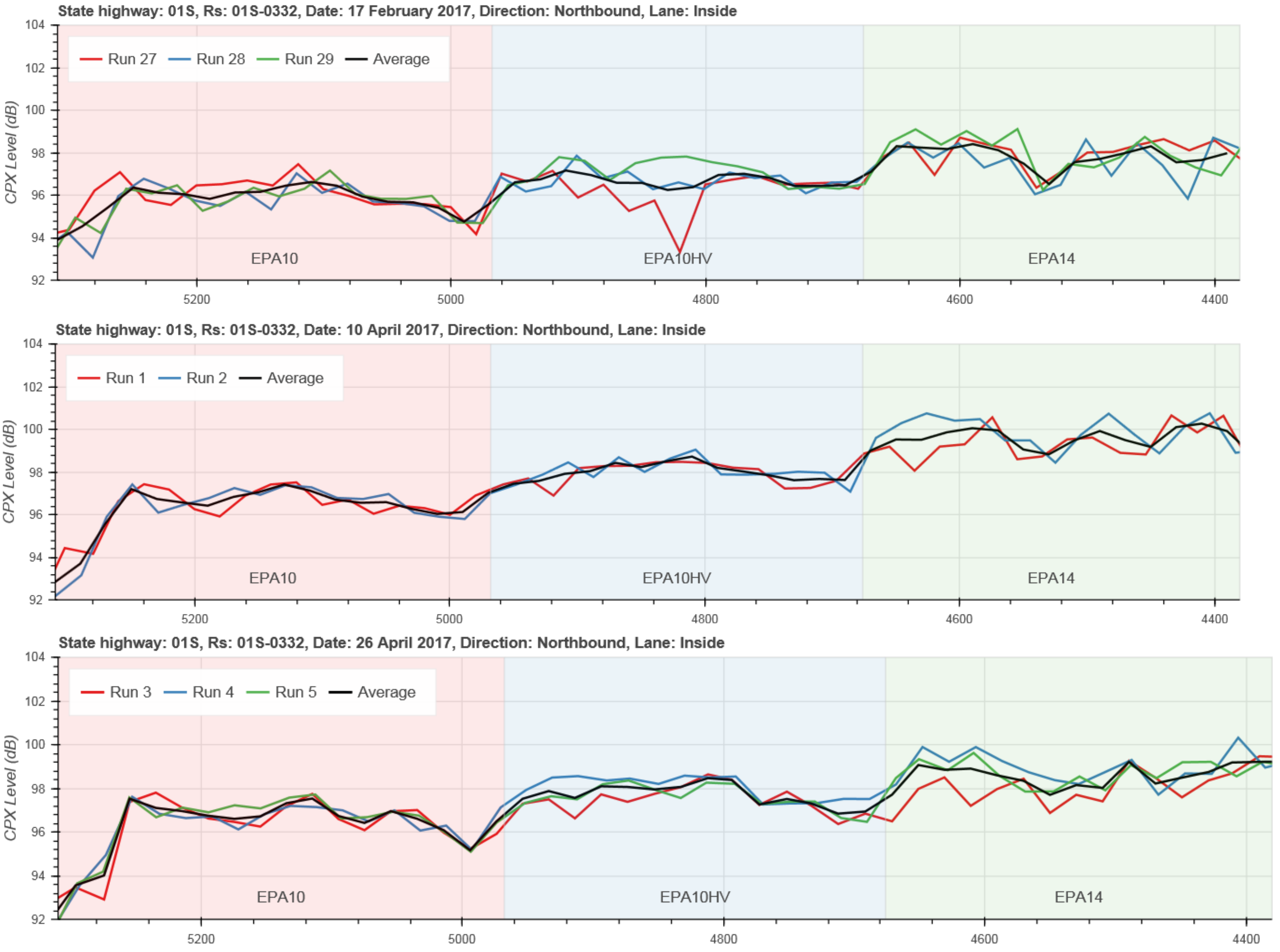


Figure 19 High void trial sections - relationship between Mean Profile Depth and LCPX:P1,80


State highway: 01S, Rs: 01S-0332, Date: 17 February 2017, Direction: Northbound, Lane: Inside
Run 27
Run 28
Run 29
Average
CPX Level (dB)
EPA10
EPA10HV
EPA14
State highway: 01S, Rs: 01S-0332, Date: 10 April 2017, Direction: Northbound, Lane: Inside
Run 1
Run 2
Average
CPX Level (dB)
EPA10
EPA10HV
EPA14
State highway: 01S, Rs: 01S-0332, Date: 26 April 2017, Direction: Northbound, Lane: Inside
Run 3
Run 4
Run 5
Average
CPX Level (dB)
EPA10
EPA10HV
EPA14

Where are we going?

- New IR QA test working well.
- Working with Environmental Team to optimise acoustics (of all OGPA).
  - Smaller chip better under CPX?
  - Positive traffic control for a day after opening?
- New Epoxy Binders being approved.
- Developing lower binder/ higher void solutions?
- Working on Epoxy Binder Chipseals
- Need check on old pavements before use

What's in it for the Customer

Customer Focussed, Collaborative and Curious work delivering a surface that is:

- Safe
- Sustainable
- Low Noise
- Long Life

- A future OGPA budget 1/6 of current level

For more information contact: David.Alabaster@nzta.govt.nz

HiLab

- The High strength Low fines Aggregate Base, (Hi-Lab), has been in use by the agency in maintenance rehabilitation work and trial sections over the past eight years.
- Is very stiff, offers a high degree of rut resistance and low deflection under loading.
- To achieve good long term performance it requires a sound construction platform.
- Contact Gerhard van Blerk, Principal Technical Advisor (Pavement), New Zealand Transport Agency

First coat seal designs

- The first coat seal design should be suitable for the stress environment

Chipseals

- Use single coats in preference to two coats
- Analysis shows that single coats are achieving higher lives than two coats
- This is when sites with similar stress conditions are compared.

Second coat seals

- The second coat seal should be placed in the following construction season

Guide to Pavement Structural Design and Guide to Pavement Evaluation and Treatment Design

- Some errors in initial documents, new versions to be issued soon
- Monitoring use and, if necessary, intent is to issue a new edition in late 2018

Use of the guides

- Pavements are a high risk item
- Probability of failure is low particularly when good construction techniques and materials are used to construct an appropriate design
- But the consequence of failure is high given cost of materials, construction and traffic disruptions

Any questions?

Transport Agency Pavement Engineers can assist

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