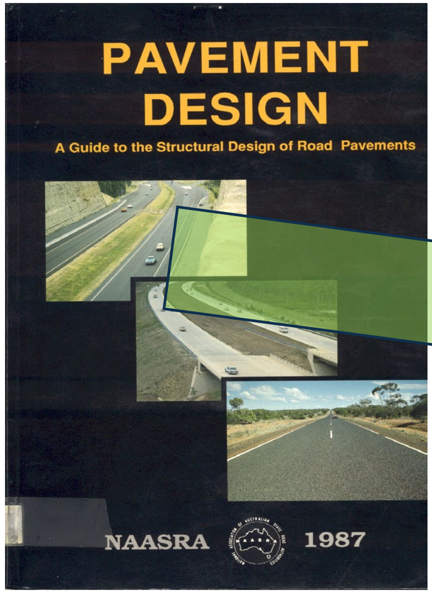
Waka Kotahi Pavement Design Standard Volume 6 Field Testing and Investigation and Volume 7 Laboratory Testing Requirements

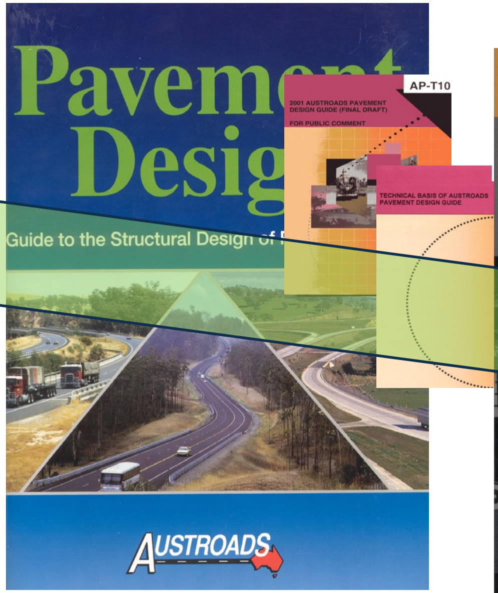
Greg Arnold – Asco/Colas

Rob Damhuis – Waka Kotahi NZTA

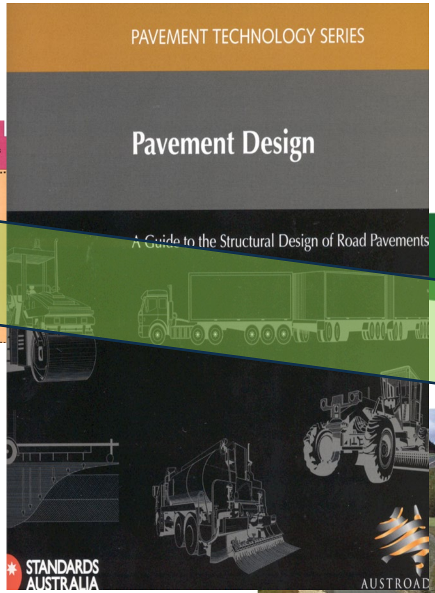
Austroads & NZ guidelines – progression



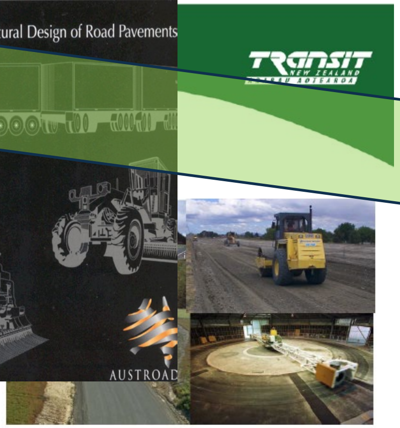
1987 Guide



1992 Guide included revised design procedures for rigid pavements



2004 Design procedures for: flexible pavements consisting of unbound granular materials, sprayed seal surface flexible that contain one or more bound layers rigid pavement (concrete)



NEW ZEALAND SUPPLEMENT TO THE DOCUMENT,
Pavement Design – A Guide to the Structural Design of Road Pavements (AUSTROADS, 2004)
2007

2007 NEW ZEALAND SUPPLEMENT TO THE DOCUMENT, Pavement Design – A Guide to the Structural Design of Road Pavements (AUSTROADS, 2004)

2017 Guide to Pavement Technology Part 2: Pavement Structural Design (AUSTROADS, 2017)
Inclusion of some changes including TDS

2017 NZ Supplement: includes additional guidelines for the Engineer in applying the Austroads design procedures resulting from research results and experience gained in New Zealand.)

2020
Some issues / anomalies / gaps identified in 2017 NZ supplement

Review of State Highway Pavement Delivery

January 2020

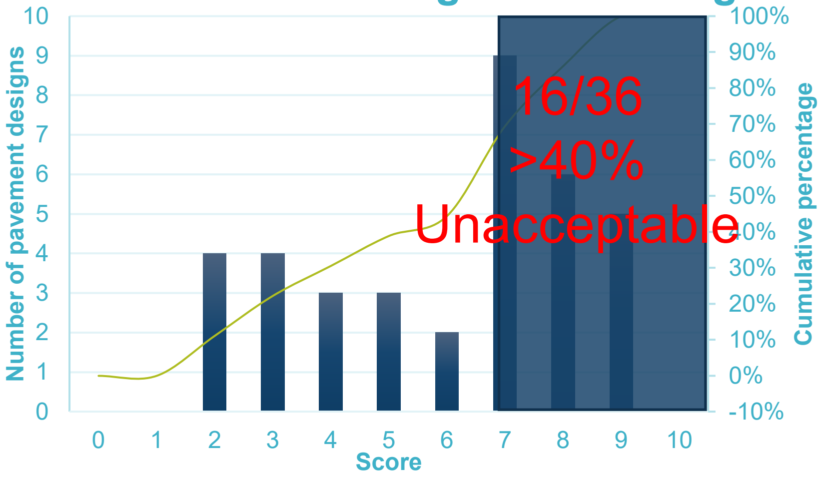
- Highlighted pavement design as risk-based process

Closing remark

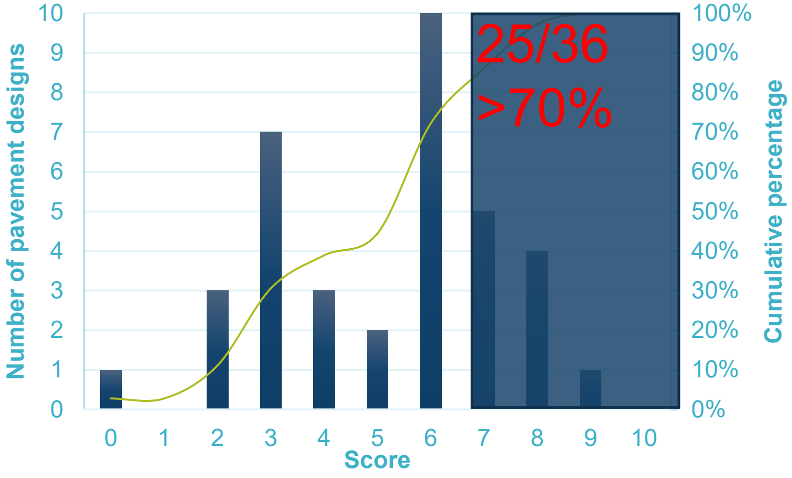
- "Risk could only be managed by reducing the probability of failure by *achieving accurate characterisation of material properties*, adopting *lower risk pavement designs*, and a focused attention on the *quality of the construction process*"

2021 Analysis of NOC pvt designs across NZ

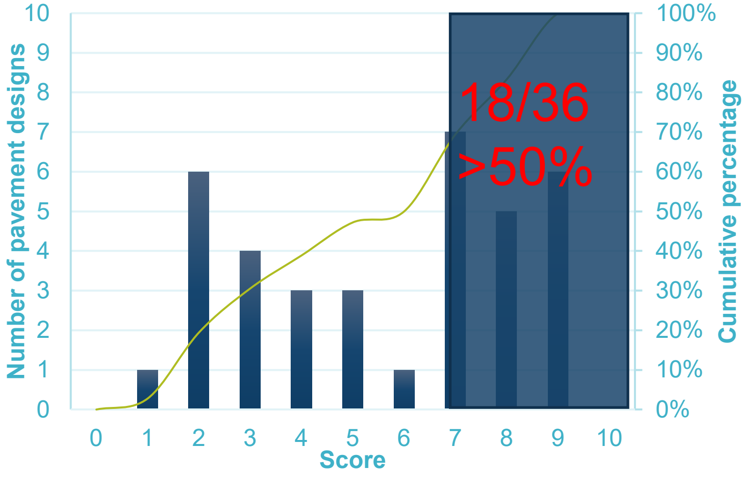
Document Editing & Formatting



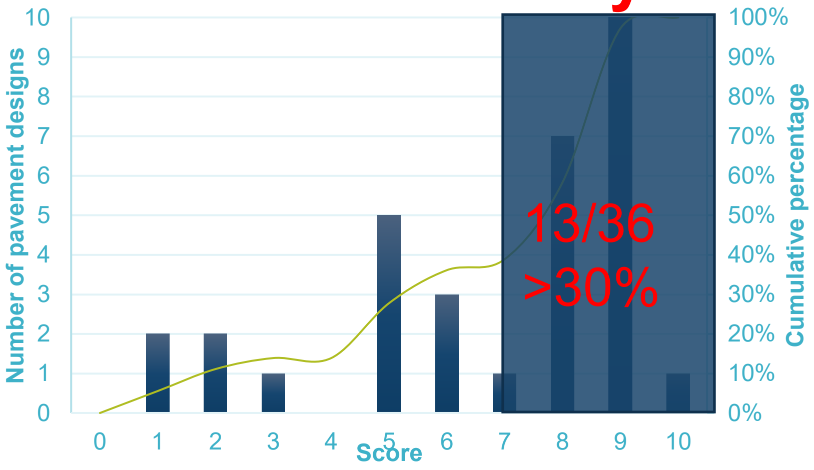
Document Detail



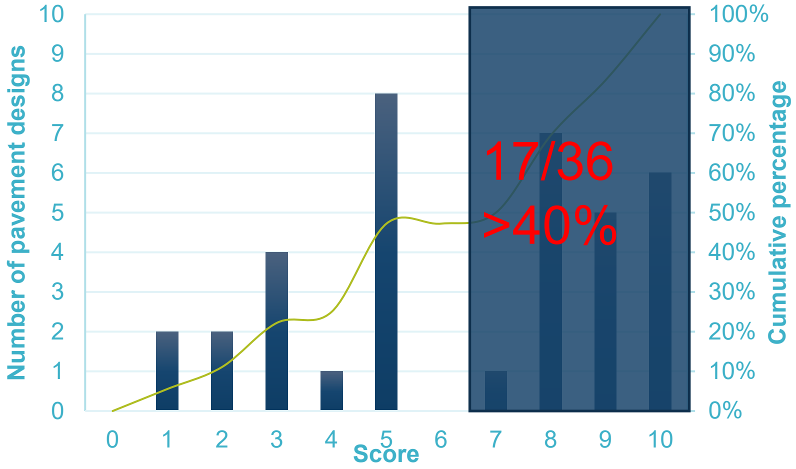
Austroads Best practice



Failure Mode Analysis



Pavement Model



Study Representation

- Small sample size (36 PDRs)
- Most NOCs but all NOC contractors.
- Most Consultants
- Unbound, FBS, Cement and SAC

Reviews

- 36 x PDRs reviewed by Reviewer
- 10 x PDR reviewed by Moderator
- 5 x PDRs compared by 3 Principle Pavement Engineers

2021 Analysis of NOC pvt designs across NZ

Areas of concern noted

i. **Test pits and Testing**
- Highly variable scopes of TPs and testing, with very different outcomes.
  - TPs small, not to SG, sometimes only 400mm deep.
  - RLT tests done but not used, decision to do RLT is based on no technical decision. Eg poor grading, poor broken faces, etc.
  - Quality of material in reports don't align with test results at a materials engineering level.
  - Poor representativity of samples, sample sizes, not taken, combined.
- SG Scala DCP only done sometimes, and often well below top of subgrade.
- Vane shears rare.

ii. **Distress plans**
- Distress plans rare and don't show extent, degree and severity.

iii. **High Speed Data analysis**
- Analysis and integration of data into design.
- Presented year on year –shows deterioration but little value to pvt design, no link FMA.
- Little correlation between data sets and visual to identify uniform areas.

iv. **Failure Mode Analysis**
- Often come to incorrect conclusions.

v. **Mix design**
- Cement designs not consistent. Some designs at 1.5, 2 and 2.5% with high ITS, but choose 2% anyway.
- Cement use?? To achieve construction quality rather material engineering.
- Others just state the outcomes ie 2% cement withiout backup.
- Often lab testing on base material or quarry material only, but overlay and recycle recommended.

vi. **Traffic**
- Few using TLD. 2017 requires TLD on bound but need to calc for ESA/HCV.
- Clarification needed around process.

vii. **Catalogue designs**
- Few designs done using catalogue & generally not well referenced.
- Many designs don't always make sense, and then go back to 100mm Overlay with client taking risk ownership. Needs guidance around this.
- Catalogue design method still only a draft and not ratified for use outside of Waikato, but used extensively across the country.

viii. **Subgrade characterisation**
- Lab tests and Scala DCP not interpreted well, optimistic, no seasonality.
- No clear methodology used.

ix. **Pavement model**
- Designer has rehab design in head and works to achieve that, rather than engineering to determine outcome.
- Guidelines not followed.
- Moduli often inappropriate for material type and/or layer position.

x. **Construction methodology**
- Repairs – "*repair worst areas*" – no guidance given to constructor as WHAT to do. No contingency in construction methodologies.
- Overlays or widening – no guidance on checking of SG materials ie scalas.
- Tie in detail lacking - design must take continuity of design into account.
- Certain organizations not following procedure. Needs to be right reasoning and logic. Maybe ok for areas with marginal materials. Need to get some process to determine how to choose if this is the correct way.

xi. **Reviews**
- A few internal but very few external reviews (but no expectation for external review).

NPTG 2018 rehab guide updates V3

NPTG
National Pavements Technical Group

7/09/2018

- 36 comments submitted by NPTG.
- Promises of more to come
- Areas covered by comments similar to analysis of NOC designs:

  i. Test pits and Testing (insitu & lab)
  iv. Subgrade characterisation
  vi. Traffic
  vii. Catalogue designs
  ix. Pavement model – layer moduli

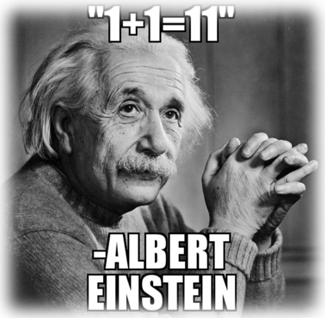
Other areas covered

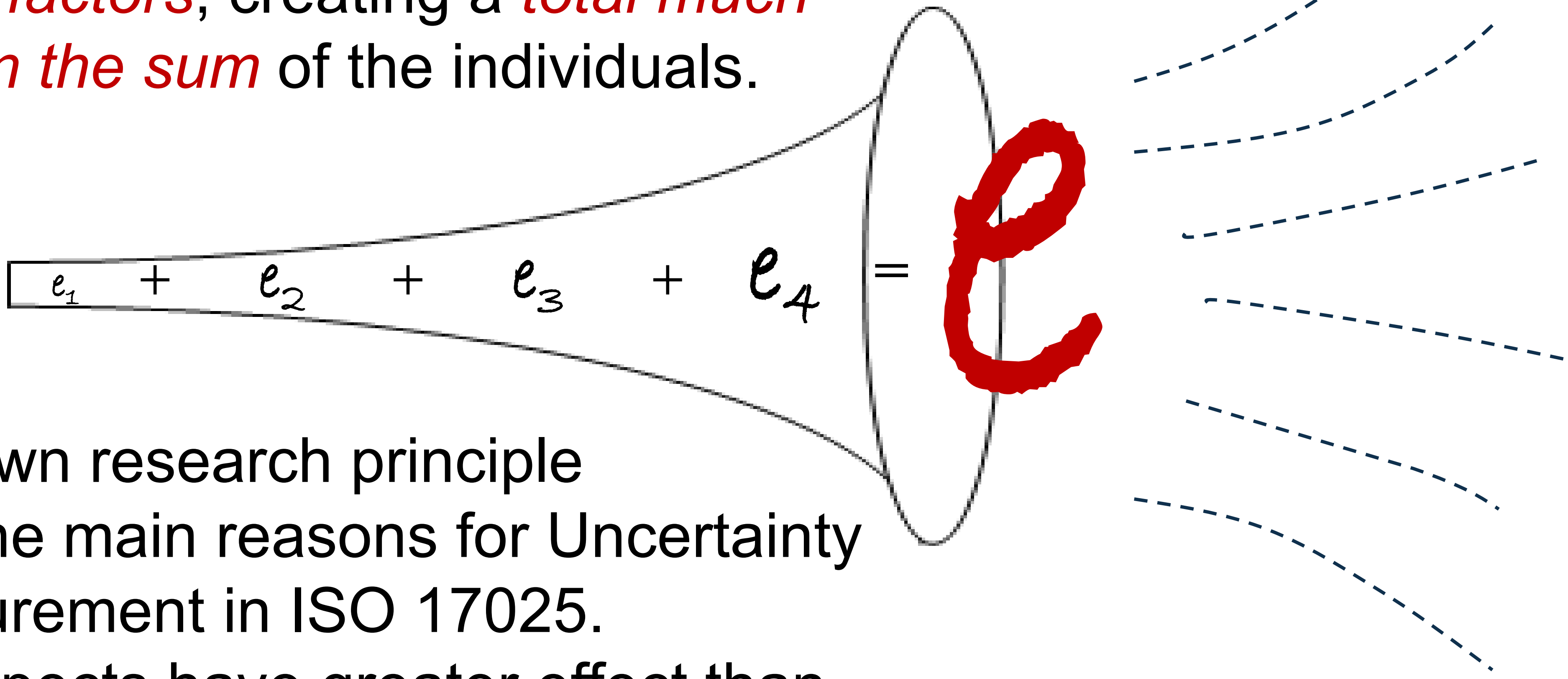
- Reliability / risk
- Modified / bound materials

A number of these issues were not covered adequately in last review

“Compound Error” Effect

The *ability of one factor to influence a whole number of factors*, creating a *total much bigger than the sum* of the individuals.





- Well known research principle
- One of the main reasons for Uncertainty of Measurement in ISO 17025.
- Some aspects have greater effect than others.

Technical Standards for Pavement Design 06 Field Investigation and Testing

3.1 Austroads

- Austroads AGPT02-17 Part +G:N2 Pavement Structural Design (Edition 4.3 published November 2019) (P2Chxx)
- P2:Ch4.2; P2:Ch2.3.1 ; P5:Ch4

3.2 Test methods

- Guideline for Shear Vane Testing. NZ Geotechnical Society (2001).
- NZS 4402.6.5.2:1988 Methods of testing soils for civil engineering purposes - Soil strength tests - Determination of the penetration resistance of a soil - Test 6.5.2 Hand method using a Dynamic Cone Penetrometer.
- TNZ T/1: 1977 Standard Test Procedure For Benkelman Beam Deflection Measurements.

3.3 Appendices

Appendix 5A – Uniform Sections

Appendix 6A – Specification for Test Pitting

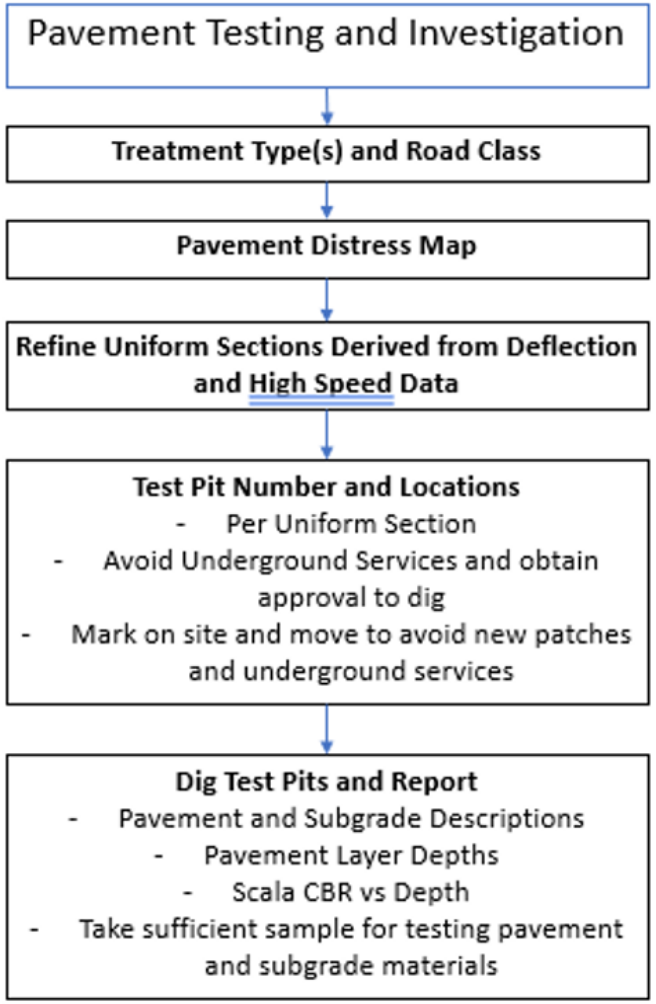


Figure 2: Scope of this Technical Specification in the pavement design process

Technical Standards for Pavement Design 06 Field Investigation and Testing

Table 7-1 – Road Class

Class	25 Year DESA[1]	ONF
1	> 5 MESA[2]: motorway / strategic transport route	M2 and M1
2	1 to 5 MESA[2]: arterial route	M3
3	0.1 to 1 MESA[2]	M4
4	< 0.1 MESA[2]	M5

[1] DESA – Design Equivalent Standard Axles (Vol 13 Traffic Analysis)

Technical Standards for Pavement Design 06 Field Investigation and Testing

7.2.1 All Granular and Stabilised/Modified Granular type Treatments

Table 7-1 -Test Pit Number for Granular Treatment Types.

Class	Number of Test Pits (TPs) – Per Uniform Section (maximum size of Uniform Section is 1000m)
1	1 TP per 100m with maximum of 3 TPs
2	1 TP per 200m with maximum of 3 TPs
3	1 TP per 400m with maximum of 3 TPs
4	1 TP per 800m with maximum of 3 TPs

Table 7-2 -Test Pit Number for Asphalt Treatment Types.

Class	Number of Test Pits (TPs) – Per Uniform Section
1	1 TP per 200m with maximum of 3 TPs
2	1 TP per 400m with maximum of 3 TPs
3	1 TP per 800m with maximum of 3 TPs
4	1 TP per 1600m with maximum of 3 TPs

Technical Standards for Pavement Design 06 Field Investigation and Testing

7.2.1 All Granular and Stabilised/Modified Granular type Treatments

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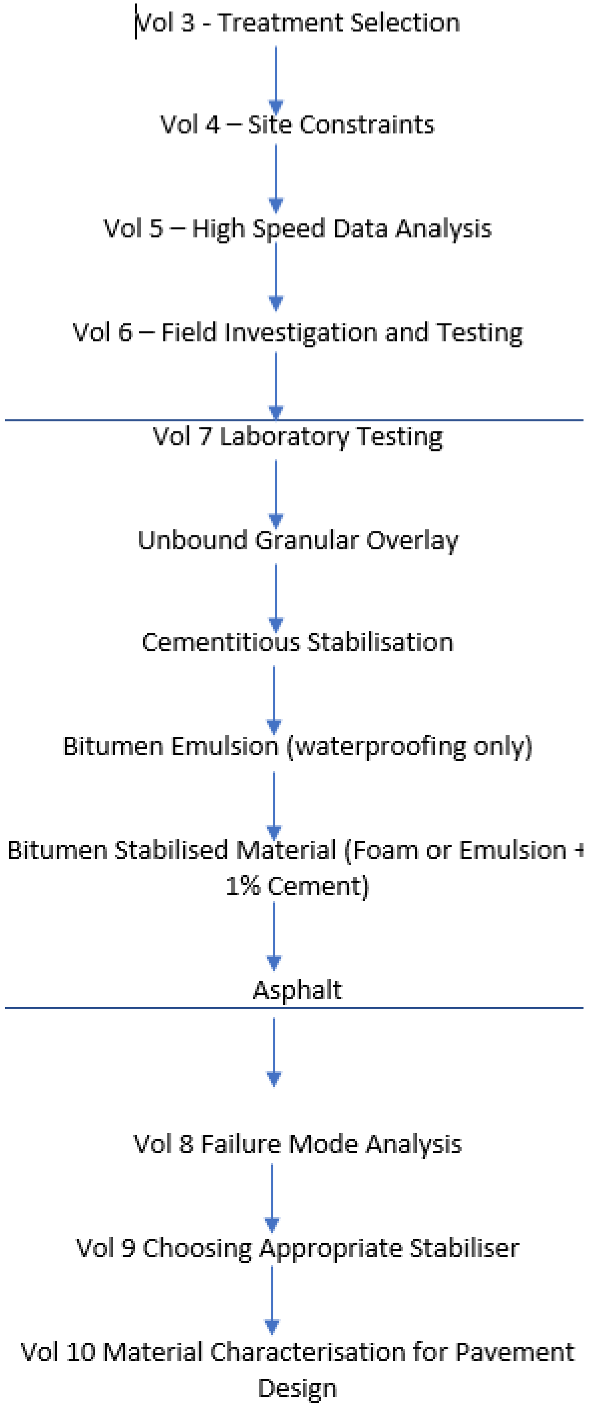
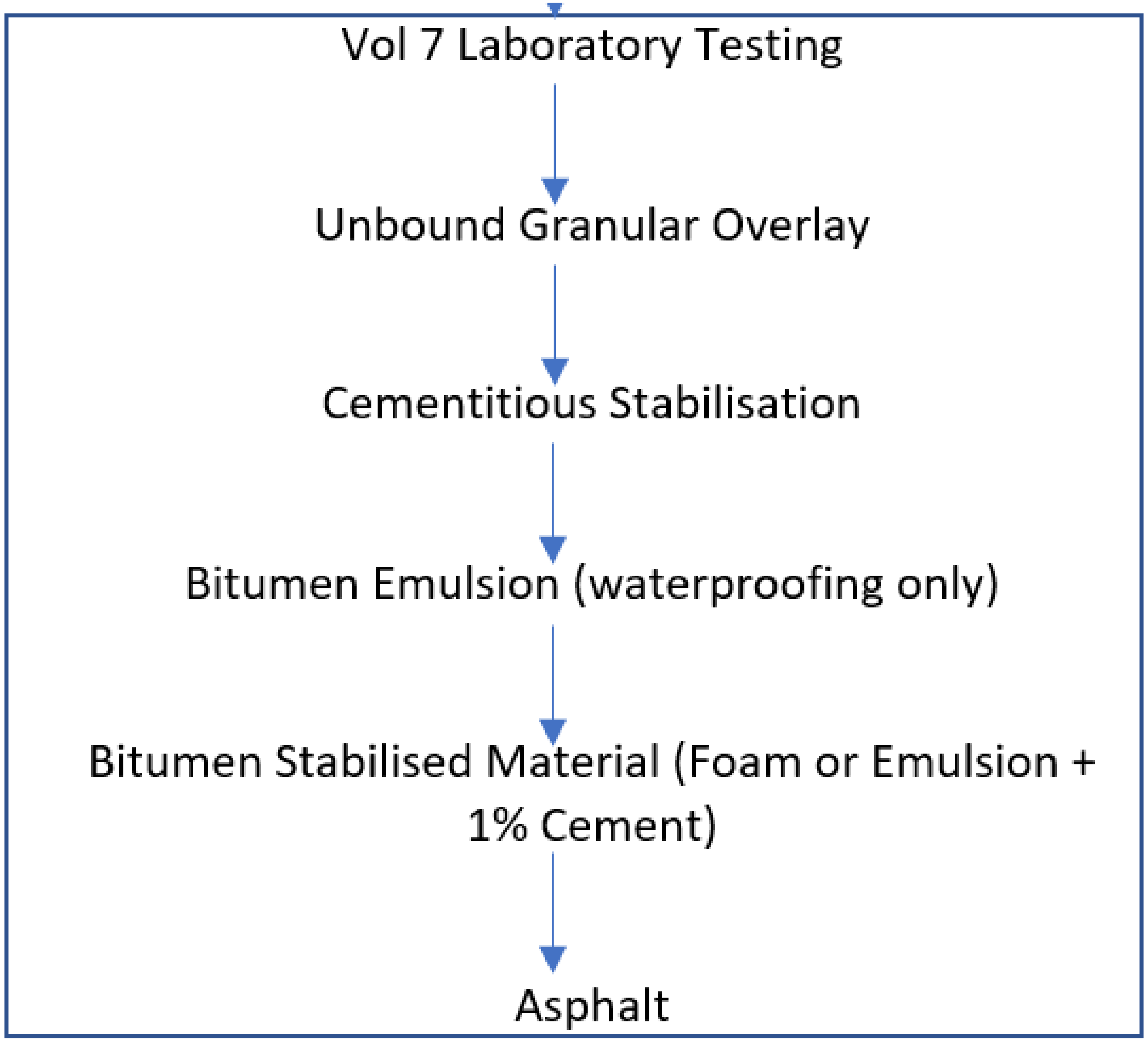
4	1 TP per 1600m with maximum of 3 TPs

Technical Standards for Pavement Design 07 Laboratory Testing





07 Laboratory Testing

14.1 Unbound Granular Overlay and Granular Digouts

Table 7-1 -Testing Requirements (blank=optional).

		Road Class			
Material	**Test**	**4**	**3**	**2**	**1**
Imported Granular	NZTA M4	Y	Y	Y	Y
	NZTA T15 RLT			Y	Y
	MDD & OMC	Y	Y	Y	Y
Insitu Granular Base (top 200mm) – Proportion of TPs tested (with minimum of 1 test)	Soaked CBR		.2	.5	1.
	PSD		.2	.5	1.
	MC		.2	.5	1.
	SE		.2	.5	1.
	PI, CI, LL and CPL < 75µm		.2	.5	1.
Insitu Subgrade	Geological	1.	1.	1.	1.

		Road Class			
Material	**Test**	**4**	**3**	**2**	**1**
Proportion of TPs tested (with minimum of 1 test) – 1= all TPs – .5 = half of TPs **See note below**	Description				
	DCP (Scala)	1.	1.	1.	1.
	Shear Vane		.2	.5	1.
	Lab CBR as received and 4 day soaked		.2	.5	1.
	MC		.2	.5	1.
	RLT Resilient Modulus			.2	.2

07 Laboratory Testing

14.2 Cementitious Stabilisation

Table 7-1 -Testing Requirements for each material being stabilised which could be 100% insitu or imported or a mixture of materials including seal layers (blank=optional).

1 Test per Uniform Section (in terms of materials to be stabilised)	Road Class			
	4	3	2	1
Lime or Cement Demand Test ICL	N	Y	Y	Y
NZTA T19 ITS at 2 binder contents (e.g. 1.5 & 3%)	Y	Y	Y	Y
NZTA T15 RLT dry/drained on material with nil binder	N	N	Y	Y
NZTA T15 RLT soaked/undrained on material with chosen binder of 1% or less	N	N	Y	Y

14.3 Bitumen Emulsion (Waterproofing)

Table 7-1 -Testing Requirements for each material being waterproofed which could be 100% insitu or imported or a mixture of materials including seal layers (blank=optional).

1 Test per Uniform Section (in terms of materials to be stabilised)	Road Class			
	4	3	2	1
NZTA T15 RLT dry/drained on material with nil binder	N	N	Y	Y
PSD with nil binder	Y	Y	Y	Y
NZTA T15 RLT soaked/undrained on material with chosen bitumen emulsion binder content based on PSD	N	N	Y	Y

07 Laboratory Testing

14.4 Bitumen Stabilisation (Foam or Emulsion with 1% cement)

Table 7-1 -Testing Requirements for each material being waterproofed which could be 100% insitu or imported or a mixture of materials including seal layers (blank=optional).

1 Test per Uniform Section (in terms of materials to be stabilised)	Road Class			
	4	3	2	1
NZTA T15 RLT dry/drained on material with nil binder			Y	Y
PSD with nil binder	Y	Y	Y	Y
PI of insitu material to be stabilised	Y	Y	Y	Y
NZTA T19 ITS with 1 or 2 or 3 trial binder contents	Y	Y	Y	Y

14.5 Treatments Requiring Asphalt

Table 7-1 -Testing Requirements for each asphalt material used on site structural and surfacing (blank=optional).

Test per Site	Road Class			
	4	3	2	1
WK NZTA AC Mix Design, production trial and QA as per M/10, M32, M27, P11, M1A specs	Y	Y	Y	Y
AGPT274 Flexural Beam Modulus and Fatigue Test Data			Y	Y

07 Lab Testing – Appendix Test Pit Specification

1 INTRODUCTION

2 REQUIREMENTS, ROLES AND RESPONSIBILITIES

2 TEST PIT, TRENCHES AND AUGER HOLE REQUIREMENTS

3 AUGER HOLES IN PAVEMENT LAYERS

4 DRY-CORING OF STABILISED LAYERS

5 LOGGING OF TEST PITS AND AUGER HOLES

6 IN-SITU TESTING IN TEST PITS, AUGER HOLES AND CORE HOLES

7 SAMPLING FOR TESTING FROM TEST PITS

8 LABORATORY TESTING

07 Lab Testing – Appendix Test Pit Specification

APPENDICES

1. Description of the site
2. Purpose of the investigation
3. Expected ground conditions
4. Existing utility services
5. Investigation Locations
6. Permit and consent requirements
7. Hole reinstatement requirements
8. Sample and core management

Acknowledgement

Lead Working Group

Rob Damhuis - Waka Kotahi

Ross Peploe – Bartleys

Mark Cruden – Meyer Cruden

Thorsten Frobel – Higgins

Adam Leslie – Waka Kotahi

Greg Arnold – Asco/Colas

Bryan Pidwerbesky – Fulton Hogan

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Grant Bosma – Waka Kotahi

Danny Wyatt - Geotechnics

William Gray – WSP/Retired

Thorsten Frobel - Higgins

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