Hiway Group

FOAMED BITUMEN STABILISATION IN NEW ZEALAND

– A Performance Review and Comparison with Australian and South African Design Philosophy

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Hiway Stabilizers New Zealand Limited

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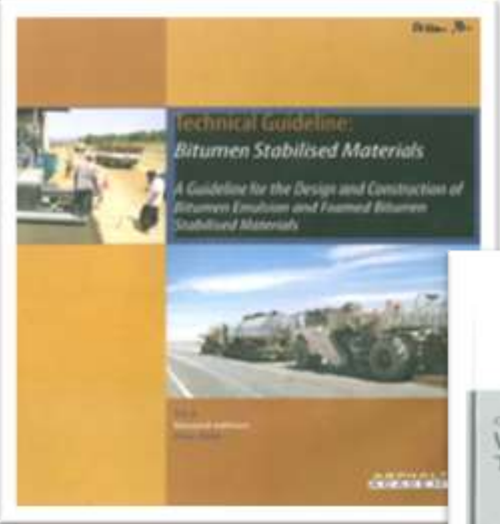
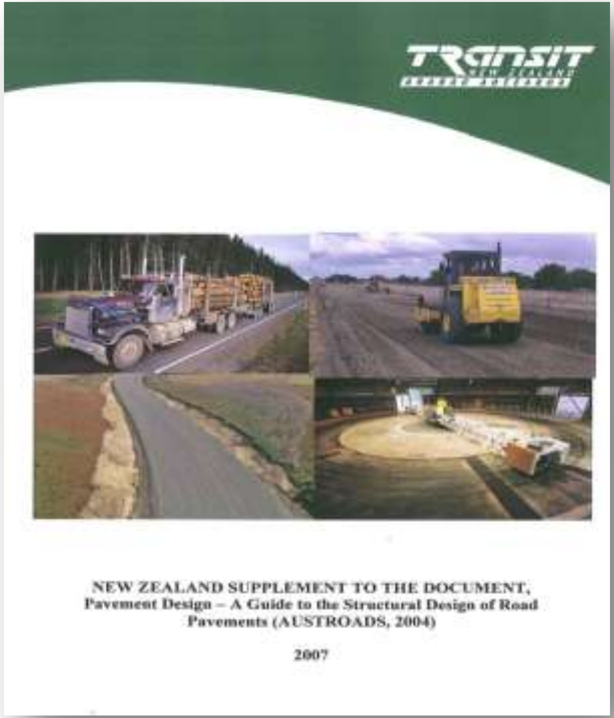
Foamed Bitumen in New Zealand Since 2004

Multitude of FBS Design Methodologies / Guides



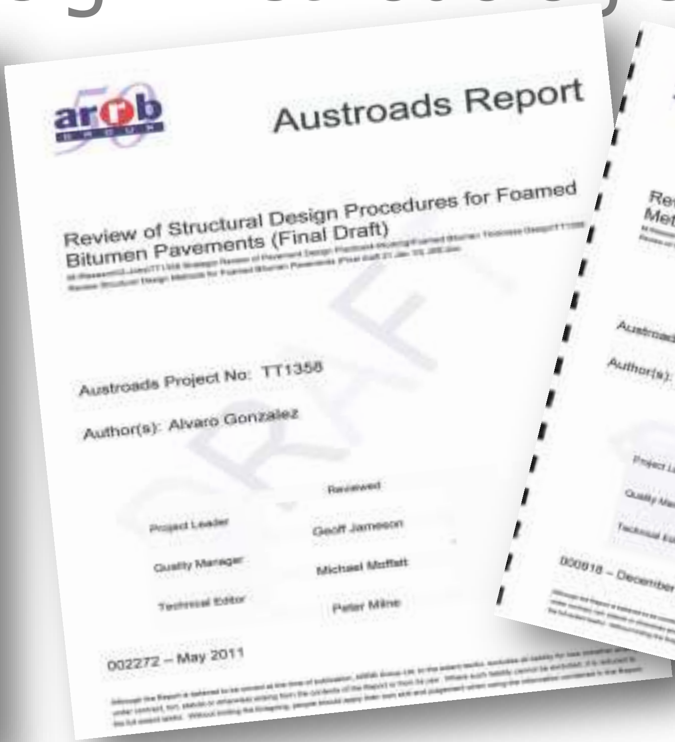
Multitude of Design Methodologies / Guides



TRANSIT NEW ZEALAND

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

2007



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Austroads Report

Review of Structural Design Procedures for Foamed Bitumen Pavements (Final Draft)

Austroads Project No: TT1358

Author(s): Alvaro Gonzalez

	Reviewed
Project Leader	Geoff Jameson
Quality Manager	Michael Moffatt
Technical Editor	Peter Milne

002272 – May 2011

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Austroads Report

Review of Foamed Bitumen Stabilisation Mix Design Methods

Austroads Project No: TT1358

Author(s): Colin Leek and Geoff Jameson

	Reviewed
Project Leader	
Quality Manager	Geoff Jameson
Technical Editor	Michael Moffatt
	Peter Milne

000818 – December 2010

Plenty of Research Reports

Modelling FBS in New Zealand

NZ Supplement to Austroads Pavement Design Guide recommends foamed bitumen parameters of:

Phase 2 Resilient Modulus 800 MPa

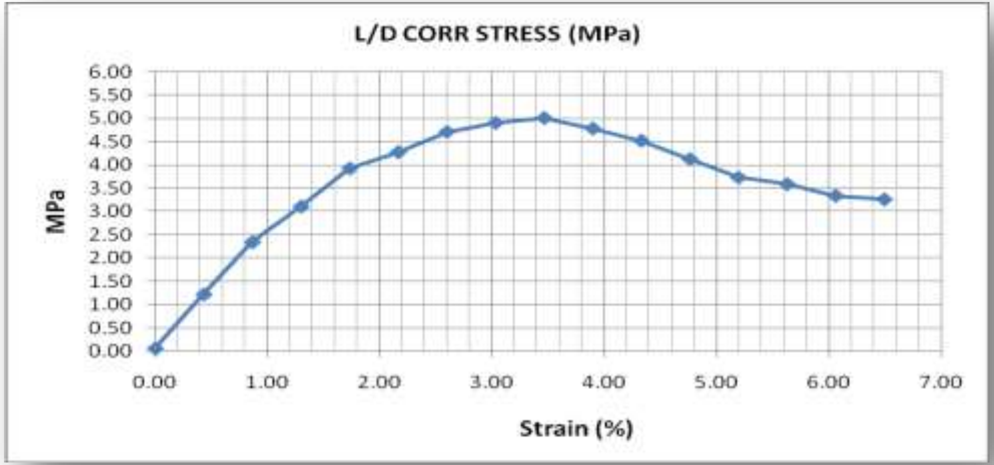
- Anisotropic (conservative?)
- No Sublayering (unconservative?)
- Poissons Ratio = 0.3

"Care should be taken to ensure that cracking is not a primary mode of failure by limiting the application of cementitious additives".

Modelling FBS in New Zealand

- Typically active filler used is 1.0 to 1.5% cement (2.7 to 3.0% bit)
- Nominal ITS targeted is 200 kPa (dry) and 150 kPa (wet)
- Strong yet flexible! Most importantly – ductile failure.

FBS Cement only



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Active Filler in Foamed Bitumen

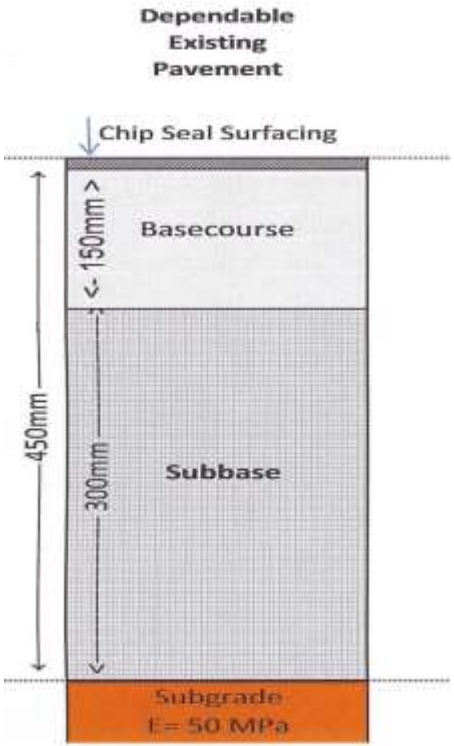
- Australia ≤2% Hydrated Lime (also pretreat)
- South Africa ≤1% Cement or Lime or no active filler
- New Zealand ≤ 1.5% cement primarily early strength.

Time for compaction <2 hours primary, same day finishing

Note: China (Xu et al) 1.5% Cement optimum active filler

Element	New Zealand	Australia	South Africa
Design Philosophy	Equiv Granular Mechanistic	Effective Fatigue Asphalt Criteria	Knowledge Based Empirical
Expansion / Half Life	Minimum of 10x and 6 seconds	Minimum of 15x and 30 seconds	Minimum of 10x and 6 seconds
Foaming Agent	Not Typically	Yes (Teric 311)	Not Typically
Tensile Test Loading Rate	1mm/min (debatable)	3000ms pulse with 40ms rise	50.8mm/min
Characteristic Design Modulus	800 MPa (phase 2)	3 - 4000 MPa Dry 1.8 - 2000 Soaked	BSM1 600 MPa BSM2 450 MPa
Early Life / Initial Modulus	Unstated - Traffic without rut/shove.	700 MPa (3 hours curing)	As per char. design modulus.
Characteristic Bitumen Content (%age by mass)	2.5% to 3.5% Typically 2.7 to 3.0%	Typically 3.0 to 4.0%	Typically 1.7% to 2.5%. Lower if High RAP mixes

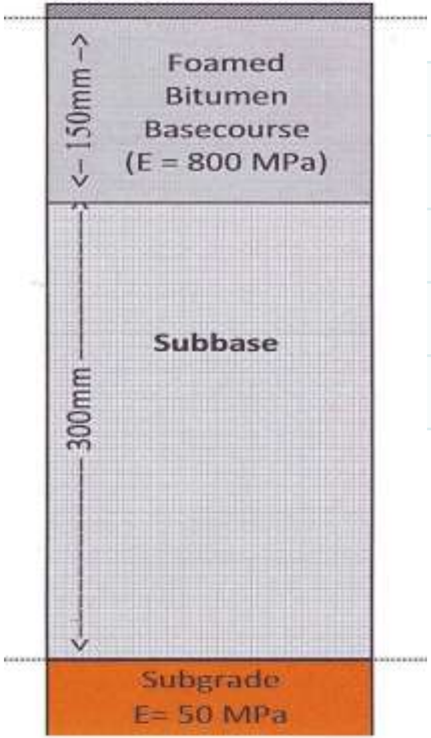
FBS Design Comparison Study – Existing Pavement



Layer	Thickness (mm)	Existing Vertical Modulus (MPa)	Comments
Seal Surfacing	10	N/A	Grade 4 Chipseal
Basecourse	150	300 MPa (Top Sub-layer)	Aged 40mm all-in basecourse
Subbase	290	210 MPa (Top Sub-layer)	Aged 65mm all-in basecourse
Subgrade	Semi-infinite	50 MPa	Cohesive sandy clayey silt soils

This existing pavement will be evaluated to NZ / AU / SA convention for a design traffic of 5 million ESA

New Zealand Design Configuration



New Zealand (NZTA Supplement to Austroads)

Layer	***Material***	***Thickness (mm)***	***Modulus (MPa)***	***Sub-layering?***
Surfacing	2-coat chip seal	10	0	N/A
Basecourse	Foamed Bitumen	150	800	No
Subbase	Existing Subbase	300	210	Yes
Subgrade	Sandy clayey Silt	Semi-infinite	50	N/A

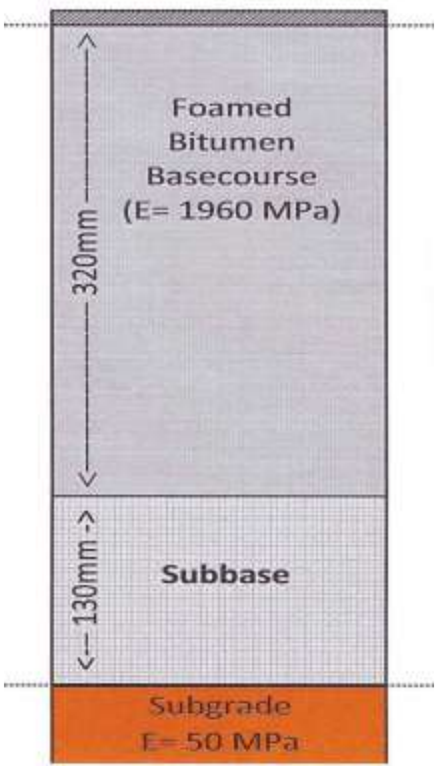
Critical damage factor (CDF) = 0.65 for the subgrade. Basecourse / subbase not modeled for fatigue.

Provide "stress spreading mechanism" for subgrade (unlike bound layers that have a fatigue criteria).

Rely on materials / const specifications for properties / durability

Australia Design Configuration

Interim Design Procedure ARRB & Austroads



Layer	***Material***	***Thickness (mm)***	***Modulus (MPa)***	***Sub-layering?***
Surfacing	2-coat chip seal	10	0	N/A
Basecourse	Foamed Bitumen	320	1960	No
Subbase	Existing Subbase	130	103 (top sublayer)	Yes (5 x 26mm)
Subgrade	Sandy clayey Silt	Semi-infinite	50	N/A

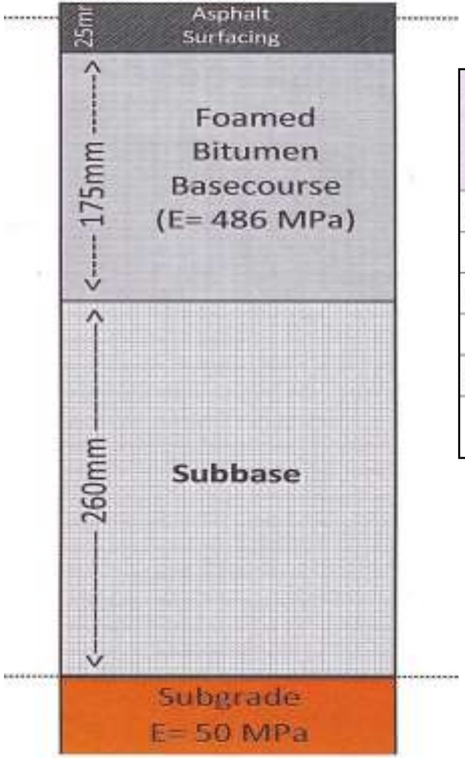
Critical damage factor (CDF) = 0.92 for the FBS basecourse & CDF = 0.0003 for the subgrade.

Large difference modulus FBS Basecourse to subbase

Note – FBS likely to be constructed in 2 layers

A 50mm AC surfacing reduces FBS base to 240mm

South Africa Design Configuration



TG2 (2009) Pavement Number Structural

Layer	Thickness (mm)	Material class	Modular Ratio	Max Stiffness (MPa)	min (Max,Lwr MR Permissible)	ELTS (MPa)	Thickness Adjustment	BCF (Base only)	Layer Contribution
Surfacing	25	Thin AC	5	3500	2430	2430	1	N/A	6.1
Base	175	BSM1	3	600	486	486	1	1	8.5
Subbase	130	G3	1.8	400	162	162	1	N/A	2.1
Select	130	G6	1.8	180	90	90	1	N/A	1.2
Subgrade	N/A	G9	N/A	90	50	50	Pavement Number =		17.9
							Pavement Capacity Cat B =		5.0 MESA

- A sprayed seal surfacing required 300mm of BSM1 basecourse. Empirical PN method is conservative.
- Mechanistic modelling provides a “leaner” structure
- Methodology is extremely sensitive to the subgrade ELTS which constrains all overlying pavement layer properties

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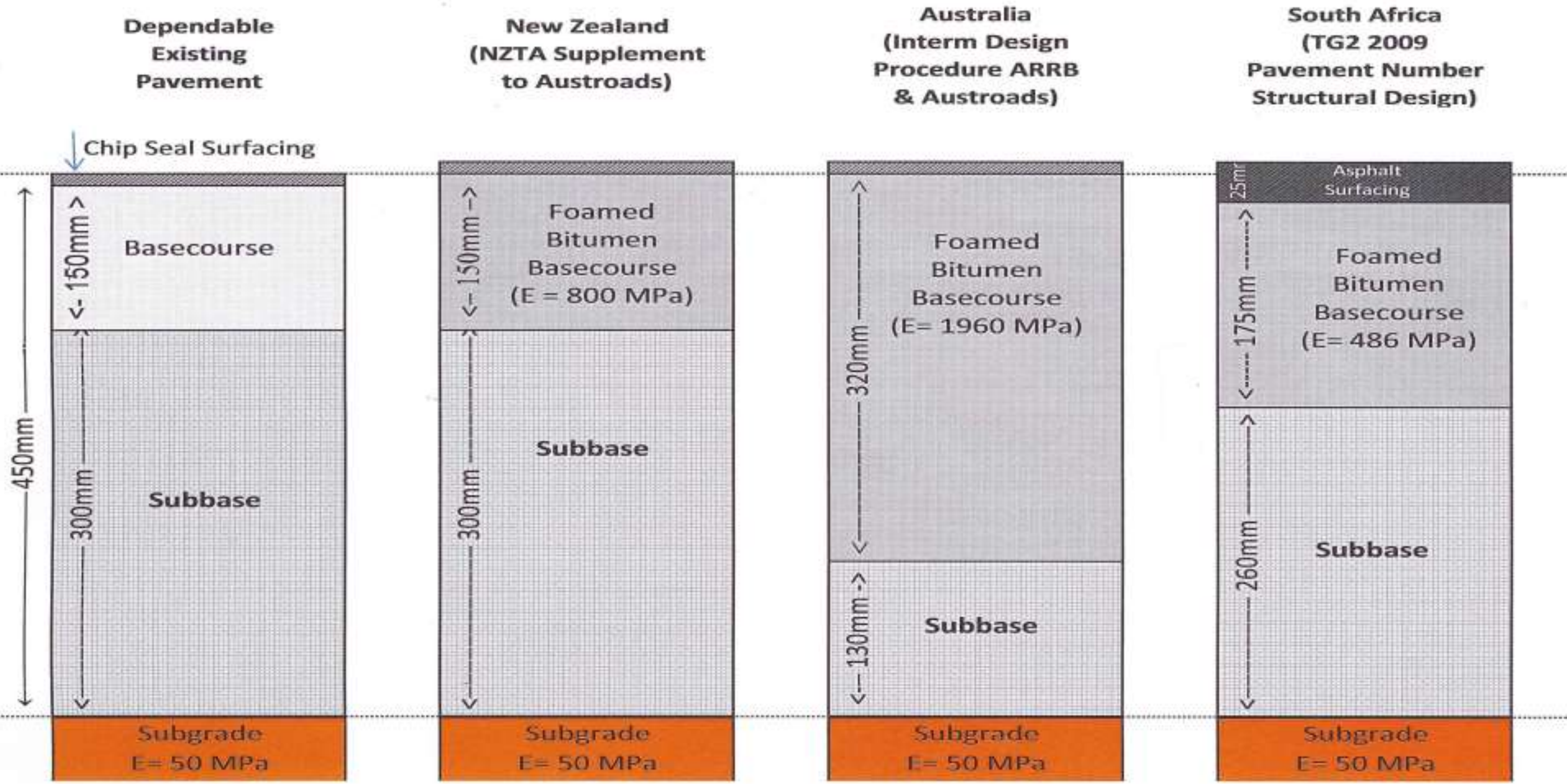
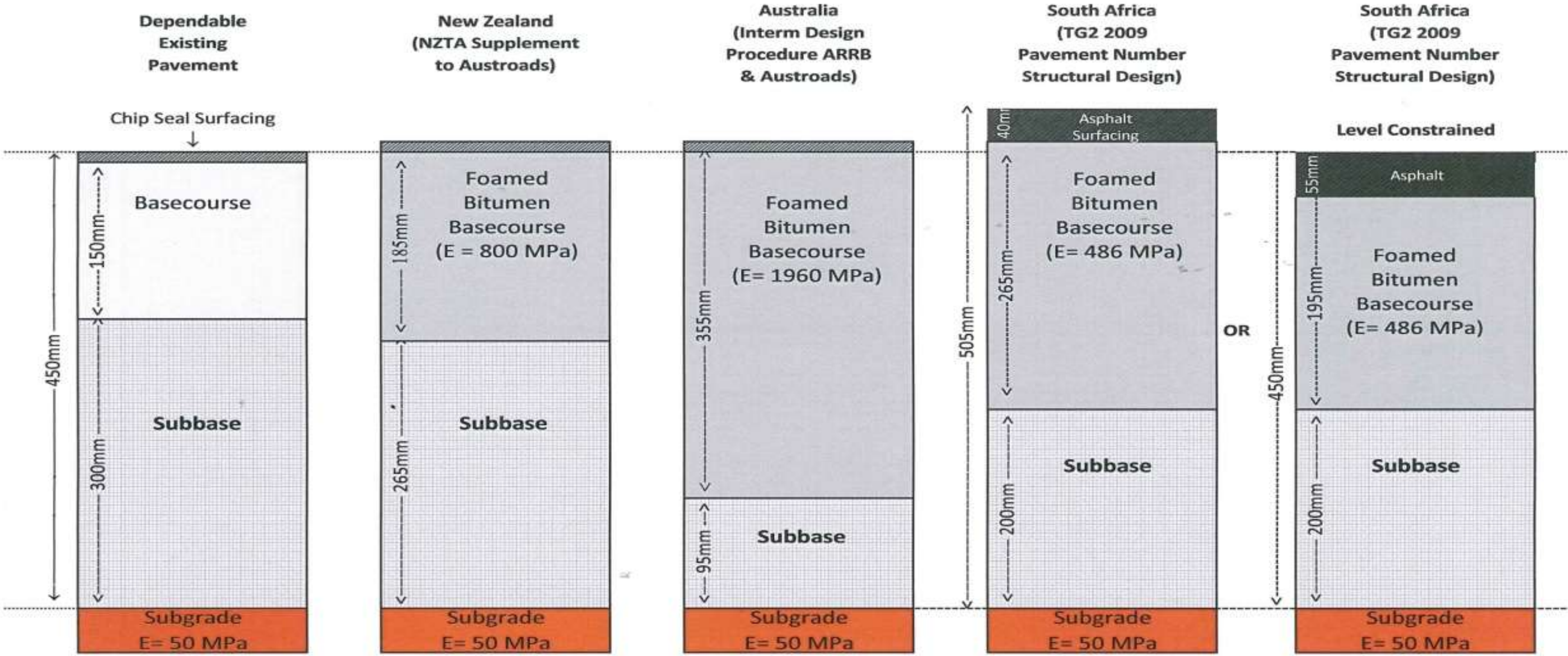
Summary of Relative Pavement Configurations



Summary of Relative Pavement Configurations - 10MESA



Comparison of Different Model Configurations

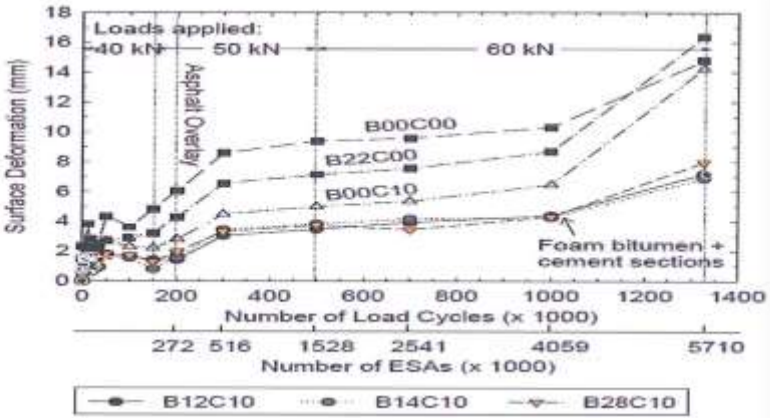
- The New Zealand approach provides a reduced thickness of foamed bitumen.
- Interesting to note that doubling the design traffic provides a similar change in thickness of FBS basecourse for *all design approaches.*
- Some practitioners may suggest NZ Approach is unconservative.
- Necessary to review the performance of FBS in New Zealand – particularly ‘older’ pavements.
- *However, Oldest NZ FBS pavements are 2004*





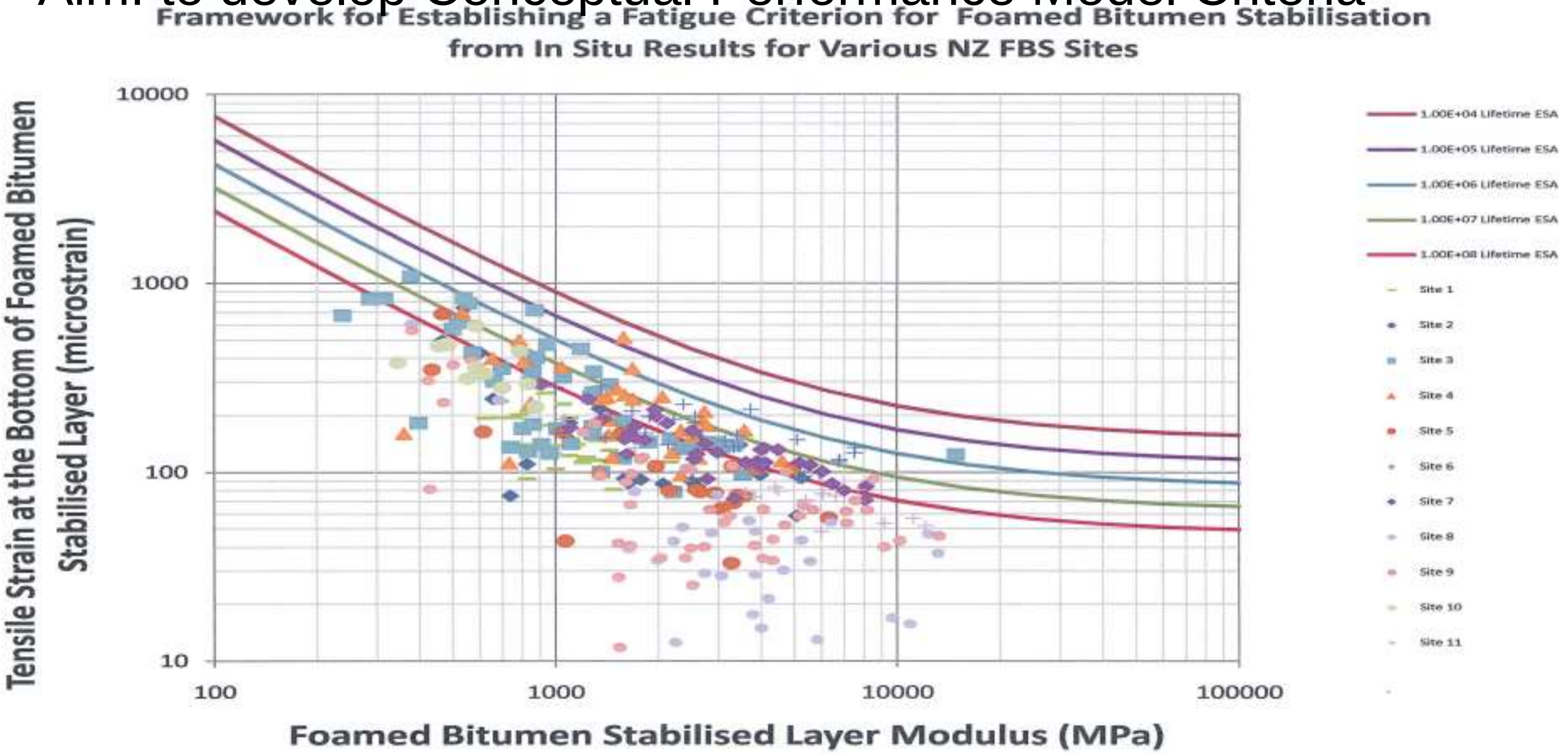
Validating the NZ FBS Approach – CAPTIF 2009

- Full scale - Canterbury Accelerated Pavement Testing Indoor Facility
- Six Sections – 3 x bitumen (1.2% / 1.4% & 2.8% & cement (1.0%),
  1 x cement only, 1 x foamed bitumen only & 1 control unbound aggregate
- Layer thickness 200mm aggregate batched and placed directly over subgrade comprising clay soils of CBR 9
- Not compliant with recent design desired modular ratio (failure sought)



Validating the NZ FBS Approach – Gray 2011

Aim: to develop Conceptual Performance Model Criteria



2011-2012 Austroads TT1663 FBS Study

- FBS Pavement sections in Australia and NZ
- ARRB to collate data and write report on the 6 x selected LTPP trial sections – comprising 3 x Australia and 3 x New Zealand
- To be supplemented with several intentionally “designed for failure” trial sections.
  - Thin AC surfacing to recognise cracking
  - Criteria is more than 50% chance of cracking failure inside two years

Conclusions for FBS Modelling in NZ

- May not correctly represent mechanistic properties – but does not overstate fatigue capacity of FBS materials
- Lower resilient modulus is favourable for accom. strain
- Provided stiffness adequate to resist rutting, little chance of developing fatigue cracking
- Control modular ratio to no more than 5
- Want to improve correlation laboratory performance to as-built field performance.
- Copious research and post construction performance testing underway. Will continue to refine FBS design and modelling.





Thank You.