Performance-Based Pavements:

Unlocking Local Materials

Accelerated Load Testing (ALT) and material innovation in Local Government

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Western Victoria Rock Types

Characteristic	Material			
	DTP Compliant Newer Volcanics	**Scoria**	**Tuff**	**Limestone**
Rock Type	Volcanic			Sedimentary
	Basic Igneous	Pyroclastic	Pyroclastic	
Origin	Stable eruption, lava flow	Explosive, fountain-like eruptions	Consolidation of volcanic ash and ejecta	Accumulation of calcium carbonate from shells, corals etc.
Main Composition	Basalt, olivine basalt, some trachyte	Similar to basalt but highly vesicular	Volcanic ash	Mostly calcium carbonate ($CaCO_3$)
Typical Colour	Dark grey to black	Mostly red, some black/yellow	Light grey	White to orange
Raise	Blast	Rip	Rip	Rip
Crushing	Hard	Moderate	Easy	Moderate

DTP Accreditation

- Stage 1 - Code of Practice RC500.00 – Source Rock Investigations
- Stage 2 - Code of Practice RC500.02 – Registration of Crushed Rock Mix Designs, compliance with many DTP Specifications
- LAV is the killer of DTP soft rock accreditation
- Marginal and unsound stone can be also be a killer – but you still need LAV first

DTP Accreditation

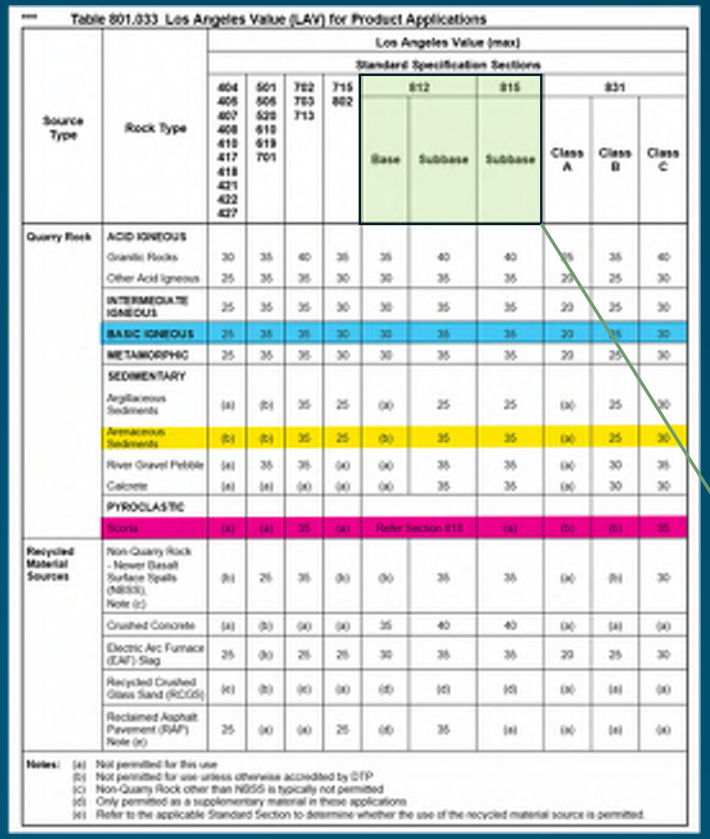

Table 801.033 Los Angeles Value (LAV) for Product Applications

Source Type	Rock Type	Los Angeles Value (max)									
		Standard Specification Sections									
		404 405 407 408 410 417 418 421 422 427	501 505 520 610 619 701	702 703 713	715 802	812		815	831		
						Base	Subbase	Subbase	Class A	Class B	Class C
Quarry Rock	ACID IGNEOUS										
	Granitic Rocks	30	35	40	35	35	40	40	25	35	40
	Other Acid Igneous	25	35	35	30	30	35	35	20	25	30
	INTERMEDIATE IGNEOUS	25	35	35	30	30	35	35	20	25	30
	BASIC IGNEOUS	25	35	35	30	30	35	35	20	25	30
	METAMORPHIC	25	35	35	30	30	35	35	20	25	30
	SEDIMENTARY										
	Argillaceous Sediments	(a)	(b)	35	25	(a)	25	25	(a)	25	30
	Arenaceous Sediments	(b)	(b)	35	25	(b)	35	35	(a)	25	30
	River Gravel Pebble	(a)	35	35	(a)	(a)	35	35	(a)	30	35
	Calcrete	(a)	(a)	(a)	(a)	(a)	35	35	(a)	30	30
	PYROCLASTIC										
	Scoria	(a)	(a)	35	(a)	Refer Section 812		(a)	(b)	(b)	35
Recycled Material Sources	Non-Quarry Rock - Newer Basalt Surface Spalls (NBSS), Note (c)	(b)	25	35	(b)	(b)	35	35	(a)	(b)	30
	Crushed Concrete	(a)	(b)	(a)	(a)	35	40	40	(a)	(a)	(a)
	Electric Arc Furnace (EAF) Slag	25	(b)	25	25	30	35	35	20	25	30
	Recycled Crushed Glass Sand (RCGS)	(c)	(b)	(c)	(c)	(d)	(d)	(d)	(a)	(a)	(a)
	Reclaimed Asphalt Pavement (RAP) Note (e)	25	(a)	(a)	25	(d)	35	(a)	(a)	(a)	(a)

Notes: (a) Not permitted for this use
(b) Not permitted for use unless otherwise accredited by DTP
(c) Non-Quarry Rock other than NBSS is typically not permitted
(d) Only permitted as a supplementary material in these applications
(e) Refer to the applicable Standard Section to determine whether the use of the recycled material source is permitted.

Type	Specification No.	Specification Name
Asphalt/ Surfacing Aggregates	404	Stone Mastic Asphalt
	405	Regulation Gap Graded Asphalt
	407	Dense Graded Asphalt
	408	Open Graded Asphalt Mixes for Cold Weathering Applications
	410	Asphalt Surface Regulating and Levelling Course
	417	Open Graded Asphalt
	418	Stone Mastic Asphalt for Airports
	421	High Binder Crumb Rubber Asphalt
	422	Fine Gap Graded Asphalt
	427	Microsurfacing
Concrete Aggregates	501	Pavement Surfacing and Associated Works
	505	Concrete Pavement Base and Subbase
	520	Concrete for Structures
	610	Cast In Situ Concrete
	619	Steel Fibre Reinforced Concrete Pavement
Drainage and Filter Aggregates	701	Underground Drainage
	702	Geotextiles for Pavements and Subsurface Drainage
	703	Filter Material
Environmental	713	Environmental Management of Road Construction Materials
Rock Protection Materials	715	Gabions and Rock Mattresses
Source Rock	801	Material Sources for the Production of Crushed Rock and Aggregates
	802	Source Rock for the Production of Armourstone
Pavement Materials	812	Crushed Rock for Pavement Base and Subbase
	815	Cement Treated Crushed Rock for Pavements
Sealing Aggregates	831	Aggregate for Sprayed Bituminous Surfacing
What About?	811	Gravel, Sand and Soft or Ripped Rock for Pavement Base and Subbase

DTP Accreditation

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	Arenaceous Sediments	(b)	(b)	35	25	(b)	35	35	(a)	25	30
	River Gravel Pebble	(a)	35	35	(a)	(a)	35	35	(a)	30	35
	Calcrete	(a)	(a)	(a)	(a)	(a)	35	35	(a)	30	30
	PYROCLASTIC										
	Scoria	(a)	(a)	35	(a)	Refer Section 818		(a)	(b)	(b)	35

Sources which do not comply with the specified durability and hardness requirements for crushed rock and aggregates but have proven satisfactory performance may be accepted for use subject to the written approval of DTP.

818.03 SOURCE ROCK

Prior to the commencement of work, the Contractor shall confirm the source from which the material will be obtained.

VicRoads will investigate quarries in accordance with Code of Practice 500.00 (Quarry Investigations).

The scoria quarry shall have an assigned Los Angeles Abrasion test value not exceeding that specified in Table 818.031.

Table 818.031 Assigned Los Angeles Abrasion Loss of Scoria

Pavement Course/Layer	Assigned Los Angeles Abrasion Loss Value (maximum)
Base	30
Upper Subbase	35
Lower Subbase	-

If the Contractor proposes to use scoria or scoria blends, the source of the scoria shall have an assigned Los Angeles Value not exceeding that specified in Table 811.044.

Table 811.044 – Scoria Source Rocks, Hardness Requirements

Pavement Course/Layer	Assigned Los Angeles Value (maximum)
Base	40
Upper Subbase	45
Lower Subbase	50

Los Angeles Abrasion (LAV)

- Local limestones often have LAV of over 50%
- South Australian requirements covered by Master Specification RD-PV-S1 – Supply of Pavement Materials
  - PM1 (Class 2 equivalent) LAV maximum 30%
  - PM2 (Class 3 equivalent) LAV maximum 45%
  - PM3 (Class 4 equivalent) LAV maximum 45%
- Where are the limestones with LAV < 35%
- Where are scoria sources with LAV < 30%

Limestone Performance – Princes Hwy

- Princes Highway between Heywood and Portland
- 2021 AADT = 6,664 vpd, 27% HV's
- Southbound lane carrying full trucks to Port of Portland
- Limestone road pavement in Heywood estimated 40 + years old, still in good condition
- DTP compliant crushed rock road pavement in Heathmere reconstructed in 2007/2008, estimate 30% + of southbound reconstruction replaced with deep lift asphalt


STANLEY

Are we selecting the wrong materials?

- Good studies undertaken on marginal materials, including full scale ALF testing.
- Real world full scale trials throughout the road network.
- Why are we choosing alternates when the existing has lasted 30+ years?
- A road authority (non-DTP) can utilise any suitable material – it does not need to be DTP accredited.

Who is ALF?

Glenelg Shire Council Limestone Spec

- Based on tables from DTP S811 - Gravel, Sand and Soft or Ripped Rock for Pavement Base and Subbase
- Specification based on performance and availability
- No LAV requirement
- Minimum testing requirements – not a faxed copy of a faxed copy unicorn test from 1993.....
- Subbase only – based on ALT testing this can be amended to include base pavement

Glenelg Shire Council Limestone Spec

Table A – Physical Properties

Type of Material and Use Subbase	All Passing Sieve Size AS (mm)	Liquid Limit (%/max)	Plasticity Index		California Bearing Ratio (%/min)
			(min)	(max)	
Class 3 Subbase	40mm	25	0	6	70 (1)
Class 4 Subbase	40mm	30	0	10	50 (1)

(1) CBR value applicable to material passing 19mm sieve: initially at Optimum Moisture Content (OMC) and 98% of Maximum Dry Density (MDD) as determined by test using modified compactive effort, but then soaked for 4 days prior to the CBR test. Samples shall be pre-treated in accordance with the requirements of Code of Practice 500.20 (Section 5.2) prior to testing.

Table B – Grading Requirements (percentage passing by mass)

Type of Material and Use Subbase	Sieve Size - AS Sieve (mm)										
	150	75	37.5	26.5	19	13.2	9.5	4.75	2.36	0.425	0.075
Class 3	100	100	95-100	80-100	70-90	55-80	45-75	40-65	35-60	25-50	5-15
Class 4	100	100	95-100	75-100	65-90		40-80		30-65		5-20

Table C – Testing Frequency

Test	Minimum Frequency of Testing
Grading	One test per 2500 tonne for first 5000 tonne of a production/crushing campaign One test per 5000 tonne of produced product thereafter
Liquid Limit	One test per 5000 tonne of produced product
Plasticity Index	One test per 5000 tonne of produced product
California Bearing Ratio	One test per 5000 tonne of produced product

Note: When in the opinion of GSC, the nature and/or physical properties of the material have changed, GSC reserves the right for additional testing to be undertaken and submitted for approval.

The Local Government Road Challenge

- **The Issue:** Increasing construction costs and sustainability targets.
- **Why:** Council is being expected to do more with less.
- **What We Did:** Tested alternatives to Class 2 crushed rock

Benchmarking the Alternative Materials

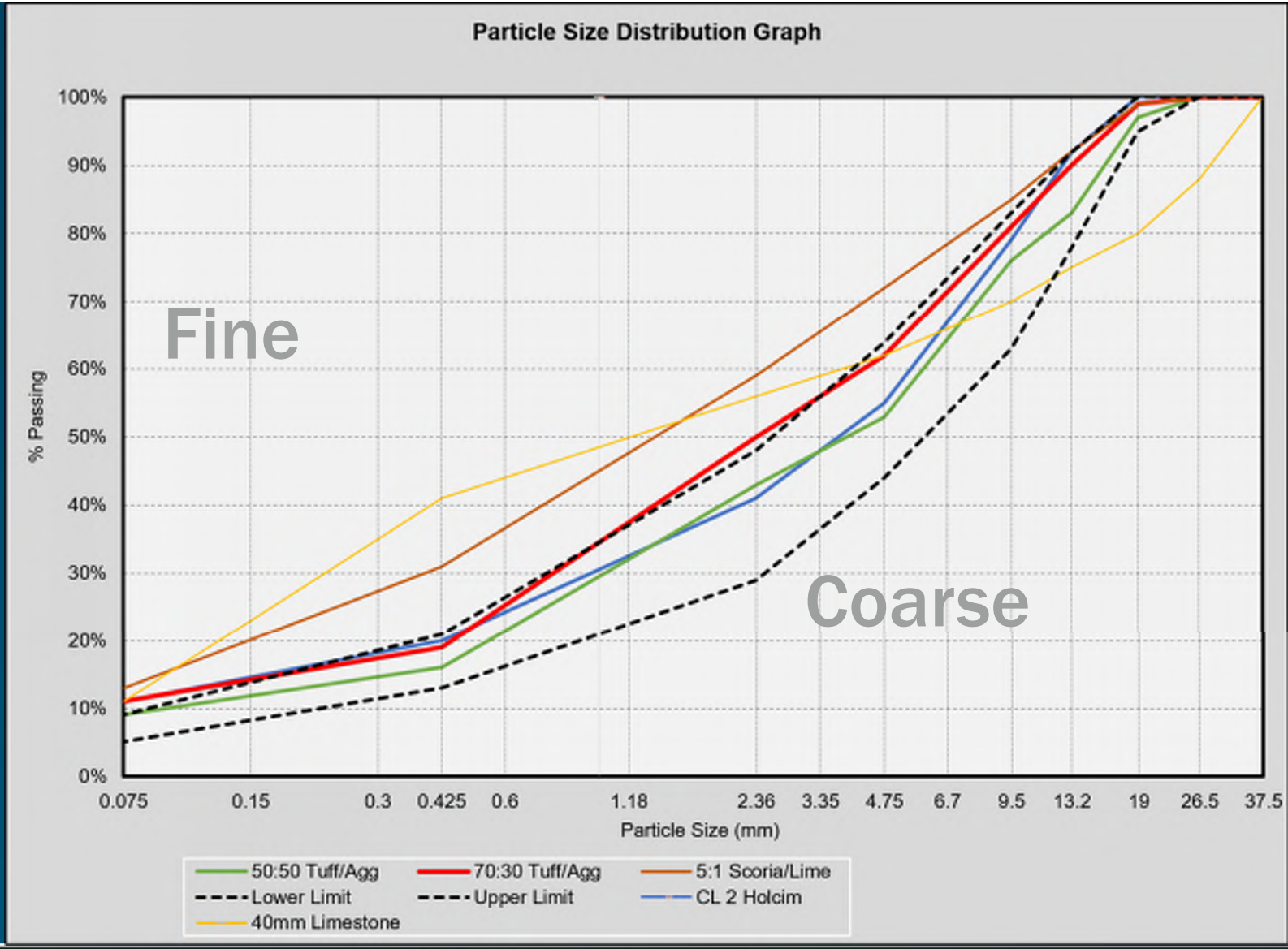
- **Control:** Holcim Class 2 crushed rock
- **Local Alternatives:** McInnes limestone
- **Engineered Blends:** 50:50 tuff/basalt aggregate & Mt Shadwell scoria/lime
- **Advanced Treatments:** Foam Bitumen Stabilised 50:50 tuff/basalt blend
- **Hybrids:** Combined limestone/Class 2 pavement section

Material Grading Analysis

- Particle Size Distribution (PSD) serves as the primary consideration of material suitability.
- Which is the right one? RC500.02, VR812 / 813 / 818, AGPT4A? The limits vary significantly.
- Tolerances get tighter as materials get finer - 0.075mm to 0.425mm in particular.
- Strict compliance with fine particle limits at the 0.075mm and 0.425mm levels presents challenges.

Comparison of Gradings

Outside the Black Lines = Spec says “no”



Spotlight on Scoria / Lime Blend

- **The Challenge:** Scoria alone reported as less durable (LA = 57) and workable
- **The Moyne Solution:** 5:1 blend with limestone
- **The Outcome:** CBR uplift, better PSD

Spotlight on Limestone

- **The Challenge:** More fines than specifications allow
- **The Innovation:** Development of a DTP approved bespoke specification for subbase.

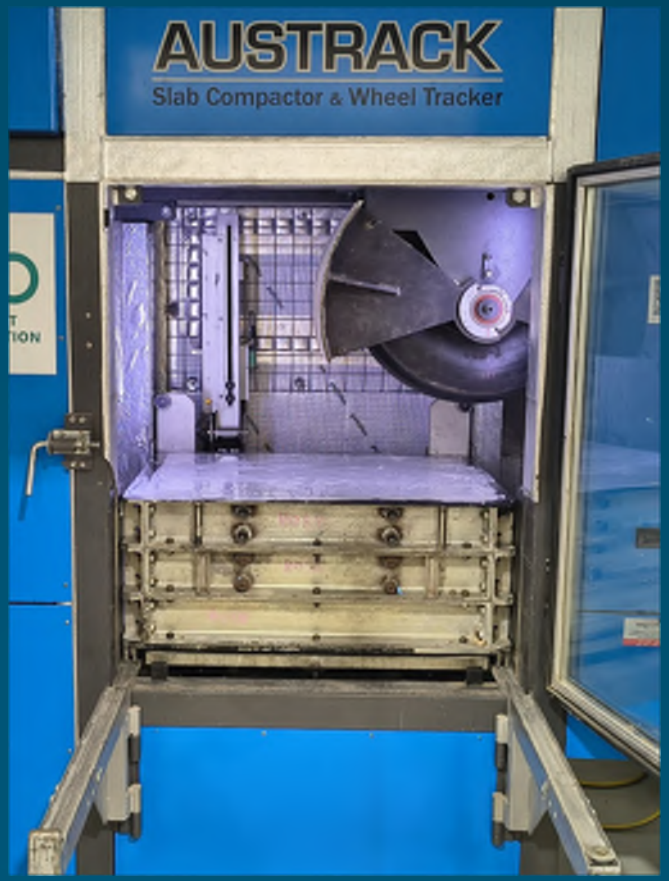
Spotlight on the Tuff/Basalt Blend

- **The Challenge:** PSD too fine, concerns over durability, harder to work.
- **The Innovation:** Development of an engineered 50:50 blend of tuff and basalt aggregate.
- **Sustainability:** 50% recycled material.

Material Characteristics

	Min	Max	Characteristic	Holcim CL2	50:50 Tuff/Agg	70:30 Tuff/Agg	40mm Limestone	5:1 Scoria/Lime
Liquid Limit	0	30	Liquid Limit (LL)	15%	19%	20%	0%	0%
Plastic Index	0	6	Plastic Index (PI)	2%	5%	3%	0%	0%
CBR	100		California Bearing Ratio (CBR)	390%	280%	230%	150%	180%
Flakiness Index	0	35	Flakiness Index (FI)	18	11	13	18	4
LA Value	0	Varies	LA Value (LA)	23	27	27	47	56
Unsound Rock	0	7	Unsound Rock	0	0	0	0	0
Meets CL2 PSD				Yes	Yes	Yes	No	No
Meets CL3 PSD				Yes	Yes	Yes	No	No
Denotes Conformance								
Denotes Non Conformance								

Evaluating Real-World Pavement Behaviour

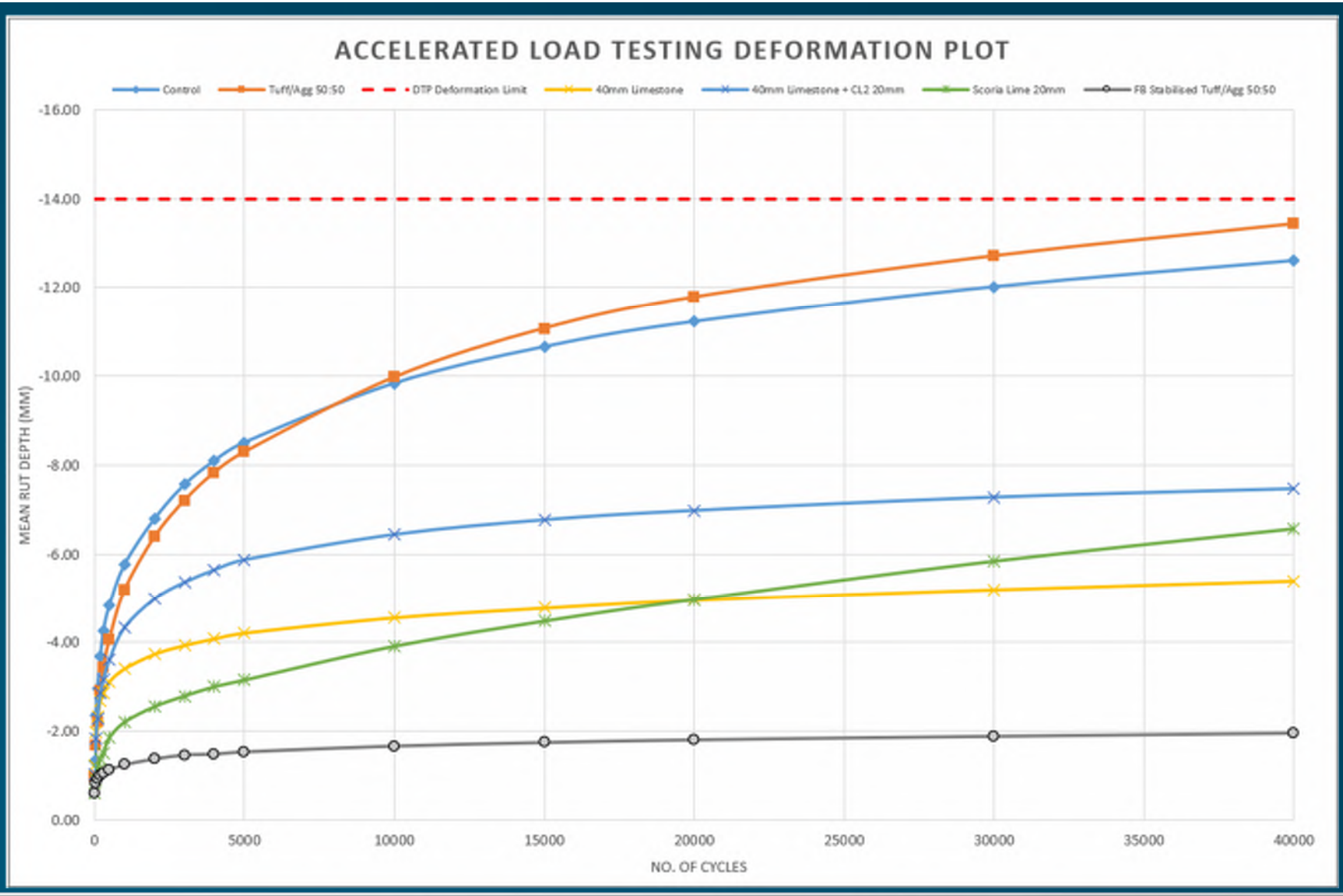


- **Methodology:** NTRO Austrack testing regime simulating heavy traffic wear.
- **Test Parameters:** 8 kN wheel load applied over 40,000 cycles.
- **The Benchmark:** Rutting evaluated against the DTP reference limit of 14mm deformation.
- **Value:** Provides a rapid, reliable indicator of long-term field performance.

ALT in Action

The Surprise

The nonconforming products far exceeded expectations.


ACCELERATED LOAD TESTING DEFORMATION PLOT
Control
Tuff/Agg 50:50
DTP Deformation Limit
40mm Limestone
40mm Limestone + CL2 20mm
Scoria Lime 20mm
FB Stabilised Tuff/Agg 50:50
MEAN RUT DEPTH (MM)
-16.00
-14.00
-12.00
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
0
5000
10000
15000
20000
25000
30000
35000
40000
NO. OF CYCLES

Performance Outcomes

- **The Winners:** Limestone and scoria/lime both outperformed the traditional Class 2 control.
- **Compliance:** All tested materials successfully remained within the 14mm DTP limit.
- **Top Performer:** Foam Bitumen Stabilised tuff/basalt blend showed the least deformation.
- **The Insight:** A conforming product is no guarantee of success; non-conformance does not guarantee failure.

Stabilising EcoTUFF 50:50

- **The Mix:** 3.5% C170 foamed bitumen combined with 1% hydrated lime.
- **The Impact:** Drastically slashed material deformation from 13.3mm down to just 1.9mm.
- **Future Potential:** Economically viable especially on low CBR subgrade.
- **Life Cycle:** Lowers the carbon footprint compared to unbound or cement stabilised pavements.

Are We Specifying the Wrong Thing?

- **The Paradox:** Limestone and scoria/lime failed specific material characteristics.
- **The Reality:** Both materials outperformed the fully conforming Class 2 with regard to rutting.
- **Validation:** Laboratory ALT results match years of local, practical field experience.
- **The Case:** A strong argument for councils to adopt performance-based material acceptance irrespective of material characterisation.

The Power of the MDD

- **Core Message:** The lower the MDD the greater the value for money (cartage is king).
- **Cost Driver:** Transport haulage costs often offset material price differences.
- **Weight Benefit:** Lower density materials mean fewer total tonnes need hauling.
- **Eco-Impact:** Reduced truck movements, lower emissions and less binder.

Key Takeaways for Council Networks

1. **Look Beyond Specification:** Local non-registered materials can outperform traditional products.
2. **Innovate with Blends & Recycling:** The tuff/basalt success shows how to engineer local resources.
3. **Prioritise Logistics:** Proximity, haulage and MDD impact total project budgets.
4. **Embrace Stabilisation:** Foam bitumen delivers a robust technical and structural outcome.
5. **Next Steps:** Real world implementation.