REAAA 2011 Workshops

NZTA Research Project TAR 09/10: Characterisation and Use of Stabilised Basecourse Materials in Transportation Projects in New Zealand

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Introduction

• This research project has been undertaken by members of the Roading New Zealand initiated National Pavement Technical Group

• Our objective is to provide guidance to industry on the characterisation and effective use of stabilised granular materials on transportation projects in New Zealand

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• Stabilisation is a recognised pavement construction technique in NZ
• Stabilisation of near surface granular materials uses cementitious and foamed bitumen binders
• Modern plant & technology enables process control of key inputs in a “road train”
• Outcomes are increasingly effective and utilised around NZ
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- Stabilisation of granular materials (with or without seal inclusion) with <3% binder by dry weight considered previously to deliver a modified material
- Designed as an unbound pavement
- Our research suggests stabilised material more likely to be “lightly bound” initially
- Cracking/rutting can occur in unfavourable circumstances
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- Implications of “lightly bound” behaviour
- Can be air “cored”...good sign
- Cracking/rutting risk needs to be evaluated?
Our research involved:

- Pavement performance data retrieved from around NZ
- For a range of cement stabilised sites
- With different ages and from different locations
- Including “failure sites”
- Back analysis of test data: FWD and lab tests
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- and from more recent foamed bitumen and cement stabilised sites
- again back analysis of test data: FWD and lab tests
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- Results from laboratory tests reviewed
- Currently Austroads design guidelines says for samples compacted to “standard compaction”
Research team considered several conceptual models for cement stabilised pavements with “lightly bound” layers.

**Model 1**: Could we relate pavement life to measurements of central deflection and curvature? .....so data collection easy!! .... too many variables....
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- The results of long-term monitoring of two sites on SH 2 north of Napier showed how a cement stabilised “lightly bound” upper pavement layer changes with time.
Model 2: Relating observed and back calculated pavement performance to Austroads “fatigue equation”?

\[ N = \left( \frac{a}{\mu \varepsilon} \right)^b \]

where:
- \( N \) = allowable number of repetitions of the load
- \( \mu \varepsilon \) = tensile strain produced by the load (microstrain)
- \( E \) = cemented material modulus (MPa)
- \( RF \) = reliability factor for cemented materials fatigue (Table 6.8)

Table 6.8: Suggested reliability factors (RF) for cemented materials fatigue

<table>
<thead>
<tr>
<th>Desired project reliability</th>
<th>80%</th>
<th>85%</th>
<th>90%</th>
<th>95%</th>
<th>97.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>4.7</td>
<td>3.3</td>
<td>2.0</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

This fatigue criterion is valid for cemented materials with moduli within the range 2000 to 10,000 MPa.
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- **Model 2**: Outcomes were encouraging
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**Model 3**: Incorporate refinements including:
- Post-construction layer modulus ……standardised for end of Year 1 - called $E_c$
- Trends shown below are for the median moduli

New conceptual equation is:

$$\mu \varepsilon = \frac{113,000}{E_c^{0.6}} + A$$

Where:
- $A$ is a coefficient to maintain compatibility with Austroads
- $N_f$ is the number of ESAs inducing fatigue (since the time when curing was essentially complete) – this includes the SAR12/ESA factor of 3.6
- $RF$ is the Project Reliability Factor (for 90% this is 2, for 95% this is 1)
- $PF$ is the Power Law Factor, $9 - 1.5 \ast (\log_{10}(N_f) - 4)$

![Graph showing trends in $E/E_c$ over time for different ESA rates.](image)
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- **Model 3**: Outcomes more encouraging
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- For the foamed bitumen stabilised sites we did not have any observed “failure conditions”
- Hence data to date shows relative location on modulus/strain curve only........
- More opportunity here for future work!
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Figure 27 from project report
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Project Example: Awaho SH 2

- Historic seal depth 50mm
- Underlying pavement 350mm
- Subgrade CBR 5%
- Design traffic 1MESA (10^6ESA)

- **design concept:** Overlay 100mm (giving a total depth of 500mm) stabilise the upper 200mm layers with 3% cement ..... Expected Layer 1 modulus 2000 MPa... has performed for 14 years and carried around 1MESA

- CIRCLY: expected tensile strain 180 µε ...OK ✔
- Design life from Fig 27 ≈ 0.8MESA
- CIRCLY: expected tensile stress 400kPa ...approx 50% tensile strength ...OK ✔

[Diagram showing Awaho Project SH 2]
Where does this leave us:

• This research improves our understanding of lightly bound stabilised granular pavement materials
• This is NOT YET a complete design method….but has potential
• Enables a reality check for our pavement design – based on actual pavement performance
• NOT to be used to replace the Austroads PDG and NZ Supplement……yet?
• Thank you....................QUESTIONS?