Material Characterisation of Australian Asphalts

Progress Summary Report – April 2013

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Australia designs some of, if not, the thickest asphalt pavements in the world

Fatigue Endurance Limit valid and accepted

Poor correlation between how and when damage occurs and design models
APS-fL Project Elements

• Project Management
• National Asphalt Materials Characterisation
• International Validation – NCAT
• Calibrate model against NCAT track data
• Information Dissemination & Training
• LLAP Design Software and Manual
• Environment & Sustainability Study & Report
Material Characterisation

• Why Dynamic Modulus
  – Characterises material properties over a full range of loading times and temperatures
  – Ability to develop “mater curves”
  – Established researched test method internationally used
  – Link to overseas performance studies
Dynamic Modulus Test
Temperature Shifting
Temperature Shifting

![Graph showing the dynamic modulus (MPa) vs. frequency (Hz) for different temperatures. The graph includes data points for 5, 20, 35, and 50°C.](image)
Comparison with NCAT Data
Comparison with NCAT Shifted
Materials tested

- Commercial project mixes ex production plant (from all states)
  - 28 mixes in total: 14 x AC14: 14 x AC20
  - Binders: C320; C450; C600; A15E; Multigrade
Mix Gradations-AC14
Mix Gradations – AC20

APS-FL PROJECT: AC20 MIX - GRADATION COMPARISONS

PERCENT PASSING

SIEVE SIZE mm
Material Characterisation

• Dynamic Modulus characterisation
  – 28 standard production mixtures tested
  – The ability now exists to characterise Australian mixtures for any load time or temperature

• Link established link between Australian test results and NCAT
Level 1 Design Recommendations

• Pavement designer will not have access to mix design characteristics
  – Use confidence based Master Curves with field shift factors (as being developed)
  – Frequency related to depth in the pavement (the relationship is to be calibrated)
Level 1 Master Curves

- Based on grouping common Australian production mixtures
- Confidence based on t-distribution around common mixtures
- No difference between Australian Mixtures
Temperature Shift

\[ a(T) = 10^{0.0003(7-T) - 0.1042(7-T)^2} \]

\[ t_r = \frac{t}{a(T)} \]
Master Curve C320 Binder

\[ \log|E^*| = \alpha + \frac{3.348}{1 + e^{-0.782 + 0.657 \log(t_r)}} \]

Where, \( \alpha \):
- 1.098 at 50%
- 1.049 at 75%
- 0.972 at 95%
Master Curve C450 Binder

\[ \log|E'| = \alpha + \frac{3.323}{1 + e^{-0.885 + 0.648 (\log(t_r))}} \]

Where, \( \alpha \):
- 1.204 at 50%
- 1.168 at 75%
- 1.107 at 95%
Master Curve C600 Binder

\[ \log|E| = \alpha + \frac{3.215}{1 + e^{-0.874 + 0.611 \log(t_1)}} \]

Where, \( \alpha \):
- 1.261 at 50%
- 1.226 at 75%
- 1.165 at 95%
Master Curve A15E Binder

\[ \log[|E^*|] = \alpha + \frac{3.141}{1 + e^{-0.292 + 0.550(\log(t_r))}} \]

Where, \( a; \)
- 1.253 at 50%
- 1.200 at 75%
- 1.125 at 95%
Dynamic Modulus vs. Field

![Graph showing Dynamic Modulus vs. Average Modulus (FWD) MPa]
Results are logical
Results are higher than design modulus used in Australia
We are undervaluing the performance of asphalt in pavement design
Outcomes of this work can immediately deliver significant benefits for Australian road communities
Immediate (interim) changes can be made to achieve first step benefits
Next Step Empirical Calibration - NCAT
Thank you