Australian Asphalt Pavement Association

Brisbane
22–25 September 2013

AAPA Pavement Research & Technology State of Play & Future Directions - in liaison with Client Organisations

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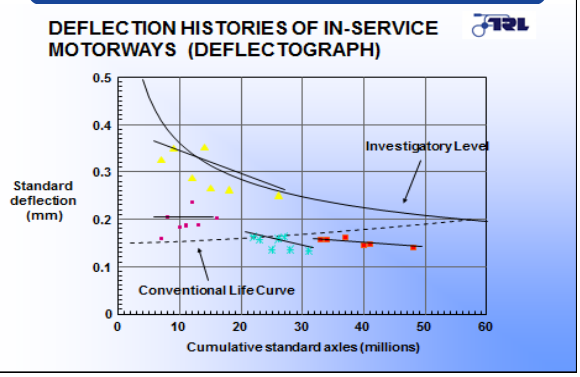
Asphalt Pavement Solutions – for Life Project

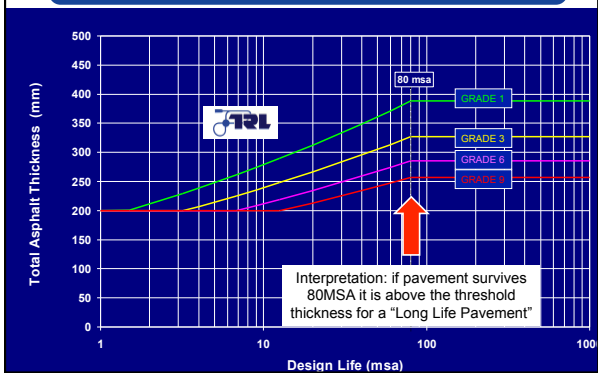
Development of a validated Mechanistic Design Procedure for Long Life Asphalt Pavements in Australia

An overview of status and foreseen outcomes

APS-fL Project : Genesis in UK



UK Highways Agency Design Chart



APS–fL : Local Background

- LTPP Projects AAPA and SRA's since 1980's
- Regular positive reports on the studies
- Sharp & Tepper 2001
- Youdale 2004
- Foley 2008
- Rickards 2009
- Armstrong & Rickards 2010
- AAPA Study Tour 2010

APS-fL Project Elements

- Literature Review
- Project Management Team
- National Asphalt Materials Characterisation
- International Validation – NCAT and others
- Calibrate model against LTPP data
- Information Dissemination
- LLAP Design Software and Manual
- LLAP Construction Guidelines
- Environment & Sustainability Factors
- Education and promotion

2011 MASTER CLASS IN FLEXIBLE PAVEMENTS

Outcomes

LONG LIFE ASPHALT PAVEMENT PRINCIPLES

- **Do LLAPs exist?**
- **Is there a threshold design thickness?**
- **Are stable/decreasing deflection and curvatures characteristic of LLAPs?**

2011 MASTER CLASS IN FLEXIBLE PAVEMENTS

Enabling Features

- **Is the cumulative strain distribution suitable as a transfer function?** (validate for high temp)
- **Is the dynamic modulus (E*) a suitable means of materials characterisation?** (correlate with overseas materials)
- **Do not include asphalt curing as part of the design method.** (too hard, but impact is conservative)

2011 Master Class - Summary of Outcomes

- **The principles of Long Life Asphalt Pavements are firmly established globally.**
- **The means of structural design, including materials characterisation and transfer functions are available but require harmonisation to suit local conditions.**
- **Software can be readily developed to align with currently used Austroads methodology.**
- **Strong links were forged with overseas experts in this field.**

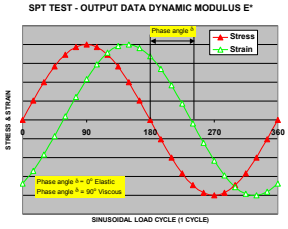
Australian Materials Characterisation

Tests

- Dynamic modulus E* using AMPT
- Binder complex shear modulus G* using DSR

National asphalt characterisation study Dynamic modulus E*

ASPHALT MATERIALS PERFORMANCE TESTER (AMPT)

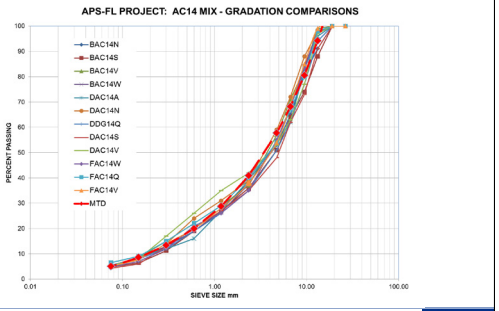


Australian Materials Characterisation

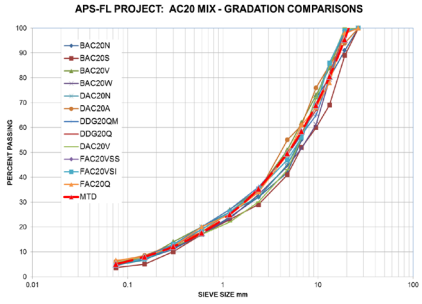
Materials tested

- Commercial project mixes ex production plant (from all states)
- 28 mixes in total: 14 x AC14: 14 x AC20
- Binders: C 320; C 450; C 600; A15E; Multigrade

Gradation range – AC14 mixes

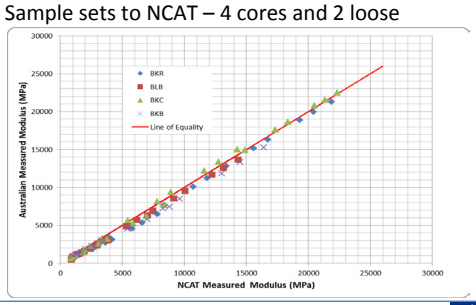


Gradation range – AC20 mixes



NCAT Parallel Test Validation

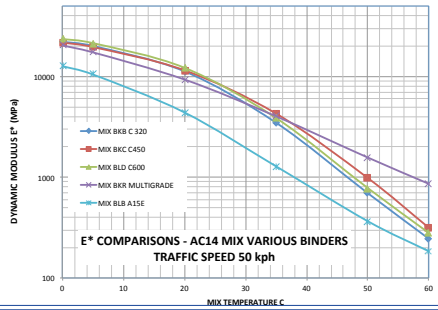
- 6 Sample sets to NCAT – 4 cores and 2 loose



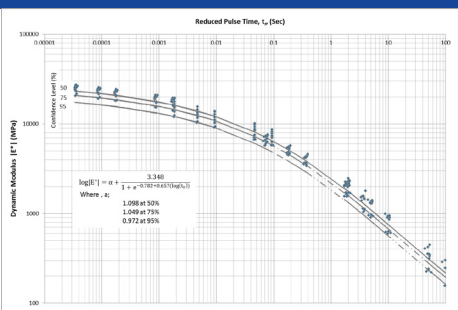
Materials Characterisation Summary

- 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
- Characterising materials using dynamic modulus
  - Repeatability
  - Captures time/temperature measurements
  - International test methods
  - Links to international research and field performance data

E* Comparisons AAPA study



Master Curve Confidence Limit

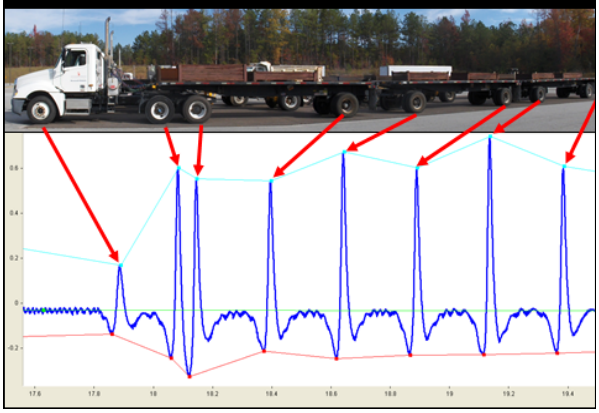


Master Curves Confidence Limits

- Based on grouping common Australian production mixtures
- Confidence based on t-distribution around common mixtures
- No statistically significant difference between Australian mixtures with same binder class

Empirical calibration - NCAT

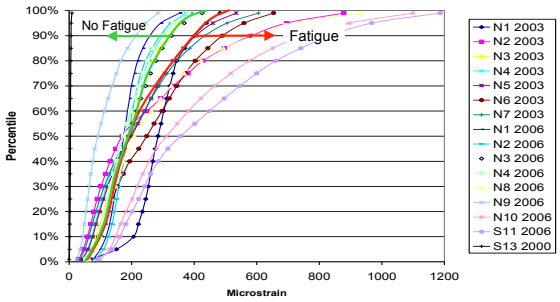
Strain Measurements



Lab to Field Modulus

- No laboratory test (E* or fatigue) can fully capture the effects of:
  - Loading Time
  - Temperature distributions
  - State of stress / confinement etc
- A tentative relationship has been established between the dynamic modulus in the lab and the field

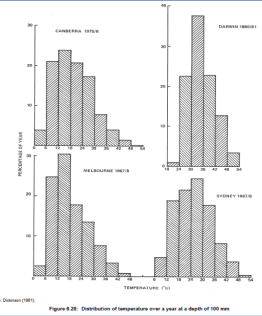
NCAT findings: field performance v cumulative distribution of strain



Pavement Temperature Spectrum

- Pavement temperature spectrum is a critical design element
- E* can be determined over the spectrum to enable the calculation of the strain distribution
- Austroads commissioned ARRB TR report "Pavement Temperature and Load Frequency Estimation" (Denneman)

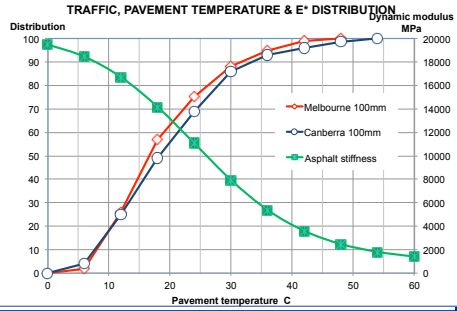
Australian Pavement Temperature Spectra – Dickinson studies 1970's



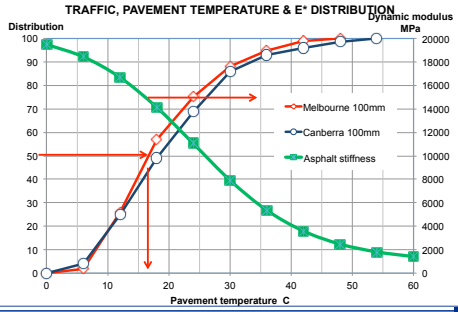
The Calculation of the Cumulative Distribution of Strain

- Select candidate pavement profile and materials
- Determine the cumulative distribution of pavement temperature
- Determine the E* values over the temperature spectrum specific to the mix used and traffic speed
- Use CIRCLY to calculate asphalt strain over the temperature spectrum and plot cumulative distribution
- Adopt design if to the left of the limiting criterion

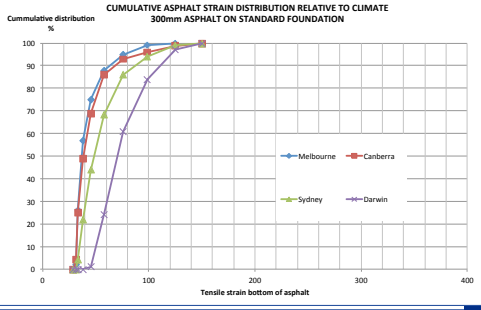
E* v Temperature spectra



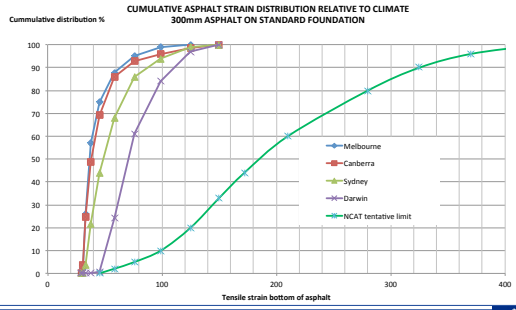
E* v Temperature spectra



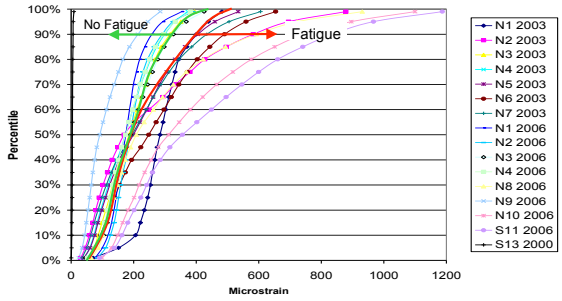
E* v Asphalt Strain Distribution



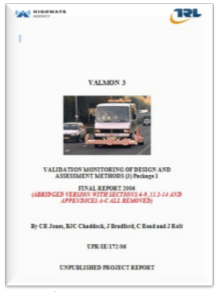
E* v Asphalt strain distribution compared with NCAT tentative limit



NCAT findings: field performance v cumulative distribution of strain



APS-fL validation study VALMON Data



28 Fully flexible sites monitored

APS-fL validation study VALMON Data

- Outline of validation procedure
  - Assemble and review data to ensure adequate deflection data and details of pavement structure
  - Estimate pavement temperature gradient relative to surface temperature data using local model
  - Conduct back analyses of raw deflection data to estimate asphalt modulus at temperature at time of test
  - Develop master curves extrapolating from back analysed data (generally limited range) at a frequency appropriate to traffic speed
  - Estimate pavement temperature spectrum from local climatic records
  - Determine modulus values over the temperature spectrum
  - Calculate cumulative distribution of strain under legal axle limit 11.5t
  - Compare with NCAT and modify as appropriate

Flexible Framework of APS-fL

Framework Goal is to be flexible to adopt changes and developments as they appear along the path of the project elements:

- Literature Review
- Material Characterisation
- Validation of modulus with field measurements
- Temperature with depth profile
- Frequency with depth
- Strain calibration
- Fatigue Damage Equation
- Seasonal analysis
- Damage Threshold
  - Cumulative distribution of strain
  - Healing
  - Threshold Strain
- Calibration and Validation

Summary

- Work on the development of a validated LLAP design process is well underway
- The technical elements of the process have been and will continue to be subjected to peer review
- The active involvement and contributions from Austroads and ARRB TR experts is welcome and constructive
- The asphalt characterisation study is complete and provides a basis for comparison with international R&T

Summary

- The properties of Australian asphalt materials have been established and are available for design purposes.
- The cumulative distribution of strain is considered to be an improved limiting design criterion avoiding the uncertainty of endurance limit and healing models
- Work aimed at calibrating the limiting cumulative distribution is advancing based on NCAT and UK data
- This work is unique in Australian history

Summary

- The framework of the project is flexible – we are committed to the implementation of a LLAP design process – and if there is good evidence for us change direction then so be it
- The project team is confident we can soon make recommendations to deliver change based on the work to date and the considerations of the Master Class

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