AAPA 2012 Study Tour to Europe
Introduction to tour objectives

• 2nd to 21st June 2012
• Tour group 9 Australian roads people
• Six countries & 5th E&E
  France / Belgium / Netherlands / UK / Turkey / Germany
• Five key topics
  1. Long life pavements
  2. High performance asphalt & binders
  3. Sustainability
  4. Health & Safety
  5. Procurement Systems

Introduction & Tour objectives

 AAPA

Itinerary

Travel route

Australia & its roads

BIG, FLAT, DRY/FLOODS, MINERAL RICH, FOOD BASKET, LUCKY COUNTRY

“Icon” & loads

Seals vs. heavy pavements

Poor materials

Page 1
AAPA 2012 Study Tour to Europe
Introduction to tour objectives

Statistics

<table>
<thead>
<tr>
<th></th>
<th>Europe/EEC</th>
<th>Australia</th>
<th>ratio</th>
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<tbody>
<tr>
<td>Land area (km²)</td>
<td>4,324,782</td>
<td>7,741,220</td>
<td>X 0.6</td>
</tr>
<tr>
<td>Population (June 2010 est)</td>
<td>502,486,499</td>
<td>21,766,711</td>
<td>X 23</td>
</tr>
<tr>
<td>Unemployment (%)</td>
<td>10%</td>
<td>5.0%</td>
<td>X 2</td>
</tr>
<tr>
<td>GDP US$ purchasing power (b)</td>
<td>$15,821</td>
<td>$911</td>
<td>X 17</td>
</tr>
<tr>
<td>GDP / person</td>
<td>$35,116</td>
<td>$40,800</td>
<td>X 0.9</td>
</tr>
<tr>
<td>GDP growth rate (2011)</td>
<td>+0.7%</td>
<td>+1.8%</td>
<td>X 0.4</td>
</tr>
<tr>
<td>Roads total length (km)</td>
<td>818,356</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roads paved (km)</td>
<td>341,448</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Asphalt (million tonnes/annum)</td>
<td>309,2 (Europe)</td>
<td>7.5 (Australia)</td>
<td>X 42</td>
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<tr>
<td>Bitumen (tonnes/annum)</td>
<td>14,492,000</td>
<td>750,000</td>
<td>X 19</td>
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</tbody>
</table>

Key topics 2010, 2011, 2012

1. Perpetual Pavements / Long life pavements
2. Warm Mix Asphalt
3. Recycled Asphalt Pavements
4. Accelerated Pavement Testing

1. Surface Treatments
2. Binders
3. Improving Pavement Performance
4. Sustainability

1. Long life pavements
2. High performance asphalt & binders
3. Sustainability
4. Health & Safety
5. Procurement Systems

2012 Study Tour Key Topics

1. Long life pavements
   - Experience, design systems, use, durability & performance
2. High performance asphalt & binders
   - High modulus asphalt (EME, HIMA), modifiers
3. Sustainability
   - RAP/WMA, bitumen substitutes, carbon calculators & energy analysis climate change impacts, societal concerns
4. Health & Safety
   - Construction of road works, health considerations for bitumen and asphalt products
5. Procurement Systems
   - Proprietary products (Avis Technique, HAPAS, etc.), “green” procurement, REACH, responsible sourcing, PPP and contract models

Topic 1: Long life pavements

Overview of reasons

• A revision to the Austroads pavement design guide is required to keep flexible pavements competitive against rigid pavements
• The proposed revision will take into account the ‘perpetual pavement concept’ underpinned by the asphalt fatigue endurance limit and healing which is widely accepted in the literature (mainly NCHT test track findings)

• A number of issues hinder implementation in Australia, e.g.
  • evidence of successful implementation by Road Authorities
  • proven structural and material design procedures
  • appropriate laboratory testing and criteria (moduli and fatigue properties)
  • specification, construction and quality control requirements.
• European performance data will facilitate the validation and calibration of the limiting cumulative distribution of asphalt strain for long life pavements.

Questions

• Usage and performance records
  • Examples and case studies
  • Composition, traffic, deflection history
  • Typical maintenance
• Design aspects
  • Design procedures
  • Most appropriate approach - mechanistic or catalogue
  • Prioritisation of focus – design models or construction
• Material properties
  • Types of materials typically used
  • Relevant material properties
  • Measurement of material properties
  • Laboratory curing and testing
  • Incorporation of “non standard” materials, e.g. PMB, EME, RAP
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Introduction to tour objectives

**Topic 1: Long life pavements**

Questions
- Fatigue & healing
  - Definition of fatigue/failure
  - Fatigue testing and the determination of endurance limit
  - Correlation between laboratory test results and field performance
  - Effect of binder type on fatigue/endurance
  - Healing of asphalt mix — testing, effect of traffic loading frequencies

- Contract and construction
  - Initial construction cost – flexible
  - Specification requirements in D&C contract

**Overview of reasons**
- Climate Change – Green House Gases
- Future Carbon Tax
- Increasing Demand - Limited Resources
- Ageing Infrastructure - Rehabilitation
- Waste Reduction - Focus on Recycling
- Reduced Construction Periods – Minimise Delays
- Society’s Perceptions & Funding Constraints

**Topic 2: High performance asphalt & binders**

Questions
- Asphalt
  - EME/ HMA - specification, testing, field links, pavement & subgrade requirement, binder selection & processing
  - Performance & Construction
  - Reinforced, Modified Binders & SMA – design & composition, service life, pros & cons
  - Moisture Susceptibility: measures, tests & approaches
  - PMA/PA: maintenance & performance

- Specifications and Test Methods
  - Approaches to proprietary mix design, types of modifiers used, low temperature test methods, control of segregation & degradation, etc

**Overview of reasons**
- Bituminous binders – key component in the performance and service life of bituminous surfacings & asphalt pavements
- About 90% of the Australian all weather road network length is surfaced with sprayed seals – about 50% of binder usage
- Need to ensure optimum asphalt and seals performance in the field, and to promote best practices suitable to be adapted and adopted in Australia. Seeking details on:
  - New developments and test methods in high performance asphalt and bituminous materials (e.g. HMA / EME, PMB, Emulsion)
  - Actions taken by European and others (e.g. binder manufacturers, asphalt producers and researchers) to overcome field problems (e.g. climate change)

**Questions**
- Binders
  - Concerns: climate change, quality & characteristic of imported material
  - Testing level, lab-field correlation, stabilisation of unbound material

- Emulsions
  - Test methods
  - Types used in sprayed chip sealing
  - Performance based specifications

- Surfacing
  - Cost benefit of thin surfacings, reasons of application & modelling

**Topic 3: Sustainability**

Overview of reasons - Challenges
- Recycled Asphalt Pavement (RAP)
  - How Extensively Used / Percentage Added
  - RAP Materials – QA, Binder Types, Ownership
  - Mix Design Changes – Binder Type & Quantity
  - Production Issues – Blending, Mixing, “wet” RAP
  - Placement Issues

- Warm Mix Asphalt (WMA)
  - How Extensively Used
  - What Technologies – Most common
  - Design & Testing Changes
  - Problems / Performance Issues

**Questions**
- RAP in WMA
- Other Low Temperature Technologies
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Introduction to tour objectives

**Topic 3: Sustainability**

*Questions*

- Bitumen Alternatives
  - Long Term Binder Availability
  - Reliance on Oil
- Carbon & Energy Calculators
  - What, When, Where & Why are they used?
- Climate Change
  - Is it being considered?
  - What Material / Specification changes?
- Societal Concerns
  - Perceptions of Asphalt Industry
  - Other Recycling Opportunities

**Topic 4: Health & Safety**

*Overview of reasons*

- Australia has high expectations & legal requirements for a healthy & safe operating environment – key operating focus
- Europe is considered to be aware and sensitive to this requirement
- Recent changes to the European operating environment (REACH, IARC, austerity) may have impacted and lessons learnt could be shared

- Specific issues and implications for Australia
  - Improving road work site safety
  - Full closure / contraflow / automatic aids / speed
  - Increased environmental awareness & society friendly treatments
  - New developments & emerging concerns
  - Impact of REACH on products and operations
  - IARC classification of bitumen

*Questions*

- Health
  - Impacts of IARC classification of bitumen on industry?
  - Has REACH impacted on the supply and use of products?
  - Drive for healthier products? What products?
  - Noise – measured, surfacing options, maintenance?
- Safety
  - Statistics – injuries & fatalities? How measured & collected?
  - What are the greatest road worker risks?
  - What training is available?
  - What techniques / methods for safer maintenance?
  - Communicating road worker safety needs to the public – how?
  - Urban & multi accessed sites – any special safety approaches?
  - Are higher safety road surfacing products preferred?

**Topic 5: Procurement Systems**

*Overview of reasons*

- Australia has tried to set up systems like Avis Technique & HAPAS but have been unsuccessful
- The benefits of innovation and declining skills in the road authorities point to its greater use.
- Lessons learnt, benefits of the systems used, changes to purchasing to accommodate and implications for road authority expertise is sought.
- Use of the systems to promote innovation and product development in new areas such as CO2 reduction, energy efficiency, noise reduction etc.
- The use of procurement systems from PPP, Alliancing, DBOM, EOI including normal contracts, long & short term contract maintenance systems.
  - What key performance characteristics over time?
  - How to retain the culture of stewardship in the contracting agency?
  - How to retain expertise on the road authority to manage / ensure value for money?

*Questions*

- Systems
  - Avis Technique systems – are they working / cost effective?
  - Lessons learnt, still promoting innovation?
  - How are underperforming products addressed?
- Functional and performance requirements
  - Are performance based specifications used?
  - What test methods used to measure performance / proprietary?
  - Functional specifications and fitness-for-purpose assessed over time – how is this done?
  - How are environmental / traffic loading changes included in the assessment?
  - Define what a “warrantee” means, for how long, end state?
  - Can proprietary product systems replace performance-based specs?
  - Can “green procurement requirements fit into the system (CO2, energy)
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Introduction to tour objectives

**Now for the discussion & finding the answers**

**Current Australian Research & Development in Pavements**
**Asphalt & Binders**

**Australian Research & Developments**

- Binders & Seals
- PMB Trials
- WMA Trials & introduction
- Long Life Pavements
- Innovation – BTB using foam technology
- Innovation – In-situ foamed Innovation
- Anything else?? – ARRB Conference in Perth

**R&D – Austroads Projects**

- TT 1353: Asphalt Properties and Mix Design
  SMA issues and performance. EME (HiMa) studies
- TT 1454: Performance of WMA
  Trials and introduction of State based WMA specifications
- TT1608: Aggregate Polishing Test
  Possible adoption of UK PSV test
- TT 1659: Revision of Austroads Guide pt 4B
  General advice document

**R&D – Austroads Projects**

- TT 1352: Scarce and Quality Resources
  Characterisation of bitumen from supply points in Australia
- TT 1354: Optimising PMB performance
  Segregation studies, PAV vs Durability
- TT 1357: Maintaining the rural road network
  Sprayed seal performance, adhesion etc
- TT 1665: Current generation PMB sprayed seal trials
- TT 1612: Future availability of bitumen
  Extended bitumen (tall oil) sprayed seal trial

**R&D – Binders**

- Australia is aware of the potential for sustainability issues with bituminous surfacings
  - conserve existing
    - seals: extra life available
    - asphalt: strict compaction control, etc.
  - recycle – asphalt in particular
  - extend – add suitable extenders to bitumen
  - replace – difficult to manufacture any renewable binder in sufficient quantities to meet current usage
**R&D – Binders**

- Conventional bitumen specified by viscosity at 60°C
  - Class 600 (500 – 700 Pa.s. Pen at 25°C > 20 dmm)
  - Class 320 (260 – 380 Pa.s. Pen at 25°C > 40 dmm)
  - Class 170 (140 – 200 Pa.s. Pen at 25°C > 62 dmm)
- PMBs specified by softening point, torsional recovery, viscosity and ‘consistency’. Related to asphalt applications and sealing applications
  - A10E – highly elastomerically modified asphalt grade
  - A15E – highly elastomerically modified asphalt grade
  - A20E – mid elastomerically modified asphalt grade
  - A35P – highly plastomerically modified asphalt grade

**R&D Binders**

- TT 1352: Scarce and Quality Resources
  - Key activities – characterisation of bitumen from supply points in Australia (including imported bitumen)
  - Viscosity (25°C – 135°C), durability, softening point, penetration, chemical fractionation (SARA, Gaestel Index)
  - Comparing the above data with historical results going as far back as 1950s
  - Enabling to see whether any trends in bitumen properties are occurring.

- TT 1354: Optimising PMB Performance
  - Key activities:
    - Development of a long term ageing test method (PAV vs. Durability)
    - PMB segregation study

- TT 1357: Maintaining the rural road network
  - Key activities:
    - Sprayed seal performance: adhesion mechanisms - aggregate wetting, cutting practice, precoat effectiveness
    - Double/Double seal design
    - Primerseal design
    - Guide to the selection and use of PMBs
    - Sprayer Calibration
    - Improving seal design for heavy vehicle

- AT 1612: Future availability and increasing cost of bitumen
  - Key activities: extended binder trial was established near Ballarat (Victoria) in March 2012.
  - To date the extended bitumen is behaving identically to the C170 control, although both are showing some slight stripping.

- TT 1665: Current generation PMB sprayed seal trials
  - Performance of current generation sprayed seal PMBs through full scale road trials
R&D – PMB Trials
TT 1665 - Road trials of strain alleviating membrane seals (SAMs) sprayed at 2 sites in Australia in 2011/12. A hot, dry climate site (Coober Pedy) and a cold, wet climate site (Cooma)

Coober Pedy (hot, dry climate) layout

Cooma (cold, wet climate) layout

Some measurements...

R&D – WMA Trials & Implementation
- AAPA members have dabbled with WMA since 2000
- Field validation trial – initiative of AAPA and Austroads
- Dissemination and acceptance of data
- Aim: Does WMA perform equal, better or worse than HMA? – not an evaluation of individual WMA technologies
- Development of a laboratory evaluation protocol for WMA technologies

Field Validation Project
- Comparison of field performance of HMA and WMA
- Includes 2 additives and 2 foamed WMA mixes
- 3 HMA, 4 WMA (0% RAP), 3 WMA (with RAP of 10% to 50%)
- 3 major asphalt suppliers providing mix
- HMA is VicRoads standard mix, Dense Graded Asphalt Type H
- Field trial constructed April 2010
**Pavement Before WMA Resheet**

**Field Validation Project**

**Laboratory testing**
- 28 tests for WMA, 28 tests for HMA
- Each asphalt company completed testing
- Preparation of samples and testing by asphalt companies and ARRB – established protocol
- Laboratory observers (from VicRoads, RMS NSW, QTMR and SA DPTI) during asphalt placement, preparation of samples and testing

**Hydro Technologies**

- Water-bearing Additives
- Water-based Processes
- Foam Technologies
- Emulsified Technologies

<table>
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<tr>
<th>Generic Definition</th>
<th>WMA FHWA Definition</th>
<th>Process Definition</th>
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<tr>
<td>Organic Additives</td>
<td>Sasobit</td>
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<tr>
<td>Chemical Additives</td>
<td>Surfactant Additives &amp; Other Chemicals</td>
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</tr>
<tr>
<td>Hydro Technologies</td>
<td>Zeolite</td>
<td></td>
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<tr>
<td></td>
<td>Astec Double Barrel Green</td>
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</table>

**Field Validation Project**

Field Testing:
- roughness,
- rutting,
- texture
- strength/deflection (FWD and Deflectograph)
- cracking (multi-laser NSV and visual)
- traffic volumes
- initial compaction

Austroads reporting at 0, 12 and 24 months
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Introduction to tour objectives

Field Trial (Foamed)

<table>
<thead>
<tr>
<th>Property</th>
<th>WMA</th>
<th>HMA</th>
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<tr>
<td>Modulus (GPa)</td>
<td>4.0</td>
<td>4.6</td>
</tr>
<tr>
<td>Rec Visc 25ºC (Pa.s)</td>
<td>1,520</td>
<td>4,340</td>
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<tr>
<td>Moisture (%)</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>Moisture Sensitivity (%)</td>
<td>78</td>
<td>97</td>
</tr>
<tr>
<td>Wet Tensile Strength (kPa)</td>
<td>691</td>
<td>950</td>
</tr>
<tr>
<td>W/Tracking (mm)</td>
<td>5.5</td>
<td>4.5</td>
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</table>

WMA Project Conclusions

- Performance after two years of trafficking was excellent and also independent of asphalt mix type, type of warm mix asphalt, and the percentage of RAP (0-50%) incorporated into the mix.
- Extent of cracking after almost two years of trafficking, compared to the extent of cracking prior to patching and overlay, was small and also that almost all of the cracking that was observed appeared to be reflection cracking.
R&D – Long Life Pavements

• Adopting best international practice is a key requirement for Australia.
• A revision to the Austroads pavement design guide is required to keep flexible pavements competitive against rigid pavements.
• AAPA is conducting an R&D project to prove the perpetual pavement concept through material characterisation and field performance. Asphalt Pavement Solutions – For Life (APS-FL)

APS-fl Project: Cracking Top Down

APS-fl: Cumulative Distribution of Strain

CORRELATION OF STRAIN DISTRIBUTION AND PERFORMANCE

Fig 3.2 Asphalt thickness design for 100 MSA_80 design traffic

R&D – Long Life Pavements - Project

• Materials characterisation in APS-FL will generate dynamic modulus master curves (using AMPT).
• Complex shear modulus master curves for bitumen and bitumen mastic
• Material properties to be used in CIRCLY layered elastic design analyses to determine the asphalt strain distribution over pavement temperature and loading spectrum
• Material properties to be compared with US and European data to validate the approach adopted.
• Confirmation of test results will mean that data from US and European LTPP studies can be transferred to Australia for similar climate and loading regimes

Resilient options for floods in Queensland

Damage across the whole state, 85% of roads with pavement damage, road users aware of the inconvenience and economic impact.

Opportunity for innovative more resilient pavement options: BTB & foam
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Introduction to tour objectives

**R&D – Innovation – BTB & foam**

- Industry supported project trial in Queensland (220 000 = 80 000 tonnes)
  - Remote regional centre, limited asphalt production, aggregates marginal
- Run of crusher aggregate < 20mm to base course standards
- Binder (foamed) at 4% with CL 170 (35/50 pen)
- Layer thickness of 300mm with waterproofing 7mm seal
- Properties:
  - Hamburg rutting < 8mm 20 000 passes, stripping > 16 000 pass
  - Coopers WT < 3mm, TSR > 85%
  - Density 93% CV on max theoretical density
  - Air voids target 4.5% (getting 4.5 to 6%)

**R&D – In-situ foamed bitumen**

- In-situ foamed bitumen
  - Has successfully been used in Australian and NZ for a number of years
  - Design
  - Different approaches by Road Agencies
    - Material/mix
    - Structural design

**R&D – Any thing else??**

25th ARRB Conference, 23 - 26 September 2012, Perth
- Theme: Shaping the Future: Linking research, policy and outcomes
- "International best practice workshop", Sprayed Sealing Alliance’s – brainstorming ideas: aggregate rolling and aggregate precoating
- http://wired.ivvy.com/event/6NRYPB/