The Development of an Evaluation Protocol for Warm Mix Asphalt Pavements

Prepared by: Kieran Sharp
Presented by: Erik Denneman
ARRB Group

Warm mix asphalt: background

- Increasing emphasis on need to reduce emissions and energy usage which contribute to global warming
  - WMA a good option
- However, acceptance of WMA depends on:
  - Confirmation of environmental benefits
  - Evidence that field performance is at least equal to that of HMA
  - Assurance regarding possible impact of use of WMA on current specifications
- Independent review sought by road agencies

Austroads research project: tasks

- Develop draft WMA evaluation protocol:
  - Guidance on the evaluation of WMA technologies and processes
- Assemble information on current field validation projects
  - Review overseas and Australian studies
  - Determine need for APT trial
- Conduct field validation of WMA and HMA pavements
- Literature review of existing carbon emission calculators
  - Recommend a system for inclusion in WMA evaluation protocol
- Finalise WMA evaluation protocol

WMA evaluation protocol

- Purpose of WMA Evaluation Protocol:
  - Provide a guide to the evaluation of specific WMA technologies and processes such as additives and foamed bitumen
- Protocol sets out the conduct of appropriate laboratory tests and field validation projects in order that the performance of WMA and conventional HMA can be compared
- Protocol an evaluation tool only; not a specification
- Environmental assessment of the impact of WMA not addressed owing to lack of sufficient quality data under local conditions

Review of field/validation trials

- About 120 references identified addressing field testing of WMA in USA, Canada, Europe, Asia and Australasia
- When criteria applied, only about 20% provided sufficient information to allow detailed review
- General trend suggested that performance of WMA was at least equivalent to HMA
- APT conducted in USA
- Limited information re usage in Australia (SRAs or industry)

WMA technologies

- About 50 registered WMA technologies in the USA (only three in 2005) and almost all States are conducting demonstration trials (only 15 States in 2007)
  - WMA technologies associated with water-bearing, chemical and organic additives have received more attention than technologies using water-based mechanical systems
- Commercially-available WMA technologies identified and grouped into six categories depending on:
  - Additive content
  - Aggregate drying temperature
  - Maximum bitumen temperature
  - Requirements in terms of plant modifications
WMA technologies

- Sequential aggregate coating and binder foaming
  - low energy asphalt (LEA1)
  - low emission asphalt (LEA2)
  - WAM-Foam®
- Water-based binder foaming
  - AQUABlack®
  - Double Barrel® Green
  - Terex®
  - Ultrafoam GX®
- Binder foaming with water-bearing additive
  - Advera®
  - Aspha-Min®

WMA technologies

- Chemical additive (surfactants / emulsions)
  - CECABASE RT®
  - Evotherm® / Evotherm 3G
  - Rediset® WMX
- Organic additives
  - Asphaltan B
  - Sasobit®
  - LEADCAP®
- Combined binder modifier and organic additives
  - Thiopave®
  - TLA-X®

WMA field evaluations

- Three types of field trials of WMA technology identified:
  - development (least detailed)
  - demonstration
  - validation/implementation (most detailed)
- Each has a different framework depending on:
  - technology developed
  - asphalt producer’s marketing strategy
  - road agency’s implementation strategy
  - available funding

WMA field evaluations

- Several asphalt producers and road agencies have collaboratively conducted APT trials of WMA and HMA
  - National Center for Asphalt Technology (NCAT) & University of California Pavement Research Center (UCPRC)
  - work to date has suggested that the performance of WMA is at least equivalent to that of HMA; more work planned
  - no immediate need for an accelerated pavement test in Australia
- Published material relating to demonstration or validation trials in Australia limited
  - QTMR, RMS NSW, Brisbane City Council
  - NZTA and one industry member in NZ
  - many industry trials (mainly LG) but details sketchy

Validation project (Melbourne)

- Purpose: to compare performance of HMA and WMA pavements under real traffic conditions
  - 2 additives and 2 foamed WMA
  - 3 HMA, 4 WMA (0% RAP), 3 WMA (with up to 50% RAP)
  - 3 major asphalt suppliers (3 aggregate sources)
  - HMA: standard VicRoads mix
  - VicRoads Metro North-West provided field site
    - Old Hume Highway, Campbellfield
  - Major effort by AAPA members and Austroads

Concerns regarding the use of WMA

- incomplete drying of aggregate (especially with absorptive limestones)
- potential for increased moisture susceptibility when using WMA processes that involve the use of water
- effects of chemical additives on long term performance of the binder
- ability of WMA to provide enough radiant energy to heat the reclaimed asphalt component in mixes containing RAP
- general lack of information regarding long term performance of new asphalt mix designs (e.g. high RAP content or rubber asphalt)
- Laboratory trials focusing on moisture susceptibility, rut resistance and durability
View and layout of validation site

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<th>Lane 3</th>
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sites constructed over three nights in April 2010

Site conditions
- site approximately 1.3 km long
- constructed along three lanes, each 3.5 m wide
- length of sites varied from 160 m to 215 m
- thin (40 mm thick) layer placed over existing pavement
  - existing site milled and patched prior to placement of mixes
- sites laid out so WMA and HMA mixes subject to same testing conditions, including traffic levels
  - AADT = 23,000, incl. ~ 11% CVs (2010)
  - posted speed limit = 80 km/h

Validation project: data collection
- Cracking/patching data collected before construction
- Temperature data (ex auger, field) collected during construction
- Condition surveys (FWD, MLP) before/after construction and about every 6 months
  - roughness, rutting, texture, strength
- Cracking surveys (cameras on MLP, manual surveys)
- Laboratory testing of samples manufactured during construction (industry)

Condition data (roughness, rutting)

Validation project: laboratory testing
- Industry participants conducted own laboratory testing in line with draft Protocol
  - observers from SRAs and ARRB present during testing

Sampling from bulk sample (time of asphalt production, asphalt temperature, etc.)
- Deformation resistance (wheel-tracking)
- Mixing, compaction and conditioning – Gyropac, Marshall
- Bulk density – 1 hour conditioning
- Modulus (indirect tensile) – AS2891.13.3-1995
- Air voids and bulk density at design binder content – AS2891.13.2005
- Mix density / voids free bulk density
- Moisture content – VicRoads RC211.01
- Moisture sensitivity / stripping potential – Tensile Strength Ratio / RTA T649
- Viscosity of recovered bitumen – ARRB Test Method No. 7 & AS2341.5
  - Field density of cores

Crack survey - September 2011

- Almost all cracking identified developed over existing cracks, regardless of asphalt type
- Slightly more cracking in HMA than WMA

Crack survey - September 2011
- Bus bay south of intersection (Type V asphalt)
Validation project: laboratory testing

- Protocol too demanding in terms of what can be practically achieved
- Need hierarchy of testing depending on type of trial, e.g.
  - development (least detailed)
  - demonstration
  - validation/implementation (most detailed)
- Need to set minimum requirements and then ‘desirable’ requirements

Summary

- Performance of WMA and HMA pavements at validation site in Melbourne excellent after 18 months
  - almost all observed cracking reflective from original surface
  - draft protocol in line with requirements for a ‘validation’ trial
- Laboratory testing conducted in line with draft Protocol
  - Protocol too demanding in terms of what can be practically achieved
    - need to set minimum requirements and ‘desirable’ requirements
- Monitor overseas projects (e.g. NCHRP, NCAT, UCPRC) and examine outputs in terms of possible application to Australia
- Premature to recommend a carbon calculation system for inclusion in Protocol
  - need to develop data sets to allow local carbon dioxide emissions factors for the main components of road construction