Cold Mix Asphalt Research in Kenya

Low Volume Roads Symposium

Cairns

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Presented by:

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Presentation outline

1. Background
2. Advantages of Cold Mix Asphalt
3. Cold Mix Asphalt in Kenya
4. Construction
5. Quality control
6. Material properties
7. Typical examples
8. Discussion
9. Conclusions
10. Ongoing activities
Background

• CMA developed under Expanded Public Works Programme, Limpopo Province, South Africa 2007/08

• LVSR surfacing options explored:
  — Graded gravel seal (Otta Seal), Cape Seal using hot bitumen
  — Modified Otta Seal using emulsion

• Attainment of consistent, good quality difficult for inexperienced contractors

• Emulsion based alternatives more suited to labour based construction
Background

• Graded aggregates
  – Potential for cost savings (locally available, crushed or natural, lower quality stone)

• Cold Mix Asphalt preferred LVSR surfacing option

• Thin CMA (+/- 15 mm) since successfully constructed in different locations (Pemba Island - Tanzania, Sumatra and Nias – Indonesia and Central Province, Kenya)
Advantages of Cold Mix Asphalt

• Contractor and labour friendly
  — Removes hazards of working with hot bitumen
  — Technique easy to learn
  — Quality control simplified

• Simple tools and equipment

• Creates community employment

• Durable

• Good riding quality

• Ideally suited to maintenance operations
Cold Mix Asphalt in Kenya

• Roads 2000 programme in Central Province
  — 1100 km of gravel roads
  — 100 km of LVSR

• Aims to provide sustainable rural access

• Cold Mix Asphalt adopted as preferred surfacing for LVSR

• LVSR component to be increased due to success of first trials
  — 400 km gravel changing to 80 km of LVSR)
Construction

Basic mix recipe applied and adapted through limited “hands-on” trial mixes before full scale application

Construction by labour

• Max. batch volume – 40 ltr

Aggregates

• 6/10mm – 12 ltr
• 0/6mm – 28 ltr

Water

• ≈1 ltr (if dry aggregates)

Binder

• CSS-65 cationic emulsion – 6 ltr
• Residual bitumen content 5 – 6 %

Tools and equipment

• Mixing trays
• Spades
• Steel guide rails
• Spreaders and screeds
• Pedestrian roller
• Brooms
• Watering cans
• Batching boxes
• Measuring containers
Construction

Tack coat

• Thin layer of diluted SS-60 applied by buckets or watering cans and brooms
Construction

Mixing trays preferred over concrete mixers

• Can be made locally
• Easy to clean, stack and transport
• Concrete mixers difficult to clean out
Ready mix tipped in between guide rails

- Use of wheel barrows (double handling) not needed when tray placed adjacent to strip to be surfaced
Construction

Mix spread and screeded level with top of guide rails

- Guide rails 20 x 20 mm gives approx. 15 mm compacted CMA
- Thickness can be varied by using larger guide rails, e.g. 25 x 25 mm gives approx. 20 mm compacted CMA
Compaction and traffic control

• Normally within ½ hour
• Pedestrian roller only required (e.g. Bomag 75)
• First pass in static mode
• Careful not to over-compact before emulsion has set
• Fresh CMA susceptible to damage by turning vehicles
• Traffic normally allowed next day
Quality control

Control of CMA thickness
• Base corrections if required
• Placement of guide rails to prevent thin spots over high points in base

Batching
• Control of accurate mix proportions and mixing process

Spreading and screeding
• Use of correct tools (no rakes) and technique to prevent segregation of coarse aggregates

Compaction
• Timing and correct compaction technique

Joints
• Open longitudinal and transverse construction joints sealed with emulsion and crusher dust
Material properties

Grading

- Continuous grading recommended for dense mix and impermeability
- High fines content may result in balling

<table>
<thead>
<tr>
<th>Sieve size mm</th>
<th>Percentage passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>14</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>85</td>
</tr>
<tr>
<td>6.3</td>
<td>62</td>
</tr>
<tr>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>0.425</td>
<td>7</td>
</tr>
<tr>
<td>0.3</td>
<td>5</td>
</tr>
<tr>
<td>0.15</td>
<td>2</td>
</tr>
<tr>
<td>0.075</td>
<td>1</td>
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</table>
Material properties

Strength and shape

• Specifications basically adapted from Otta Seal (graded gravel/crushed aggregates)
• Lower quality stone than for Surface Dressing due to different performance characteristics.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Spec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. 10% FACT (dry)</td>
<td>90 kN</td>
</tr>
<tr>
<td>Wet/Dry strength ratio</td>
<td>0.60</td>
</tr>
<tr>
<td>FI (for 6/10 mm fraction (%))</td>
<td>Max 30</td>
</tr>
<tr>
<td>SSS</td>
<td>Max 12</td>
</tr>
<tr>
<td>PI on material passing 0.425 sieve</td>
<td>Non plastic</td>
</tr>
</tbody>
</table>

Specifications basically adapted from Otta Seal (graded gravel/crushed aggregates).

Lower quality stone than for Surface Dressing due to different performance characteristics.
Typical examples

D379 Wamwangi – Karatu

• 400m test section in Kiambu County
• Completed June 2012
• Design Traffic Loading : 0.07 MESA for 15 year design period
• Pavement Design: DCP Design Method / LVR DCP Design catalogue
Typical examples

**D379 Wamwangi – Karatu (cont.)**

- Grading towards lower side of envelope
- Appeared fairly open when fresh
## Typical examples

### D379 Wamwangi – Karatu (cont.)

<table>
<thead>
<tr>
<th>Position</th>
<th>IRI (m/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHS - OWP</td>
<td>3.4</td>
</tr>
<tr>
<td>RHS - IWP</td>
<td>3.1</td>
</tr>
<tr>
<td>LHS - OWP</td>
<td>3.0</td>
</tr>
<tr>
<td>LHS – IWP</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.2</strong></td>
</tr>
</tbody>
</table>
Typical examples

D415 Mackenzie – Kandara

• 6.7km test section in Murang’a County
• Used as training and demonstration project
• Completed section wise 2011 - 2012
• Design traffic loading: 0.5 MESA for 10 year design period

<table>
<thead>
<tr>
<th>Pavement Material</th>
<th>Base Layer Thickness (mm)</th>
<th>Length of Section (Km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gravel</td>
<td>200</td>
<td>2.0</td>
</tr>
<tr>
<td>Cement Improved Gravel</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td>Composite Bitumen Emulsion Treated Gravel</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td>Consolid System Treated In situ Material</td>
<td>100</td>
<td>1.7</td>
</tr>
<tr>
<td>Hand Packed Stones</td>
<td>150</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Surfacing:** 15mm Cold Mix Asphalt surfacing on the entire length of the road.
Typical CMA examples

D415 Mackenzie – Kandara (cont.)
Discussion

- Pavements structurally sound based on DCP and FWD tests
- Both roads well drained, routine maintenance done
- Road sections generally performs well
- Some development of hairline cracks (shrinkage in base) and some minor potholes (construction deficiencies) observed
- Initially CMA appears to be fairly open and porous, but beds down and densifies quickly under traffic
- No aggregate loss or bleeding observed
Discussion

- CMA would probably benefit from compaction by PTR, but this is hardly realistic for labour-based projects.
- CMA is vulnerable to turning traffic action during the first hours. Sections should be kept closed until the next day.
- Increased thickness, +/- 20mm, considered to counteract spots with uneven surface of base.
Conclusions

• CMA excellent surfacing option for LVR
  — Anticipated life similar to Double Surface Dressing
  — Reduces emission of greenhouse gases and energy consumption
  — Reduces dependency on heavy construction plant and sophisticated equipment

• CMA particularly suited to labour based projects
  — Improves OH&S (removes toxic fumes and hot bitumen hazards)
  — Permits sealing to progress closely behind base construction

• Provides satisfactory skid resistance

• CMA well suited for maintenance operations
Ongoing activities

• Continued monitoring for long term performance
• Further development of specifications, mix design procedures
• Develop mixing techniques to broaden the scope for using local materials
• Perform Marshall tests on samples for stability, density and void content
• Trials with different binders (modifiers, additives) for improved adhesion, elastic properties and accommodation of fines
Question to the audience

• What is the experience, if any, with CMA in Australia and the Australasian region to date?
  — Performance
  — Design
  — Mixing and laying techniques
Thank you