Appropriate Surface Sealing for Sustainable Low Volume Rural Roads in Vietnam

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Presented by Dr J Cook
Presentation Focus

**Context:** Rural Road Surfacing Research (RRSR) programmes for basic rural access

**Research:** Vietnam Rural Road Surfacing Trials

**Practical application:** Environmentally Optimised Design – Spot Improvements
SEACAP: Improved Sustainable Access to Rural Communities.
Available Materials

Road

Environment

Road Task

SUSTAINABLE RURAL ROADS

South East Asia Community Access Programme
SEACAP research highlighted a serious mismatch between the design options currently being used; the road environment; road tasks and the materials being used to construct them.

A particularly challenging environment for unpaved roads

Poor Materials
South East Asia Community Access Programme

- Erosive high rainfall
- Poor maintenance
- Variable terrain
- Coastal floods
Control Section

As Built

After 6 Months

South East Asia Community Access Programme
The UK Department for International Development (DfID) and World Bank has co-fund research into appropriate alternatives to the use of unsealed gravel surfacing.
In Vietnam two Rural Road Surfacing Research trial programmes carried under the guidance of the MoT Steering Committee and SEACAP.
41 trial roads in 12 provinces completed between May 2005 and June 2006.

- Appropriate to the road environments.
- Local construction materials
- Sensible Maintenance requirements
<table>
<thead>
<tr>
<th>Vehicles Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Motor Vehicles</strong></td>
</tr>
<tr>
<td>Mekong Delta</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Central Highlands</td>
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<td></td>
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<td></td>
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<tr>
<td>Northern Highlands</td>
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</tbody>
</table>
Bitumen emulsion sealed surface trialled in comparison with hot bitumen

- Better suited to labour oriented construction
- Suitable for village based maintenance operations
- Better site control on small rural contracts
Range of Sealed Pavement Options

- Armoured gravel
- Waterbound macadam
- Drybound macadam
- Graded crushed stone
- Lime stabilised soil
- Cement stabilised sand
- Clay bricks
- Concrete bricks
A total of 66 sealed trial sections (100-200m) are being monitored:

Emulsion seals:
- Double stone chip seals (DBEST); - 23
- Single stone chip + sand seal (SBEST+ESS); - 8
- Single sand seal (ESS); - 8

Standard Vietnamese options:
- Hot bitumen double stone chip seal (DBST), - 18
- Hot bitumen penetration macadam (PenMac), - 7
- Hot bitumen triple stone chip seal - 2
Emulsion seals have performed as well as hot bitumen and penetration macadam surfacing. Some cracking in seals on lime stabilised bases associated with the roadbase problems rather than the seals themselves.
- Single ESS on clay and concrete bricks is showing signs of wear and cracking
- Some road deterioration due to gross traffic overloading in one province
## Typical Costs: Vietnam

<table>
<thead>
<tr>
<th></th>
<th>DBEST Cost/m²</th>
<th>DBST Cost/m²</th>
<th>DBEST over Waterbound Macadam Cost/km</th>
<th>Gravel Cost/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northen Highlands</td>
<td>$2.18</td>
<td>$2.50</td>
<td>$18,590</td>
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<td>Central Coast</td>
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<td>$2,800</td>
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<td>Red River Delta</td>
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<td>$4.06</td>
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<td>Mekong Delta</td>
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<tr>
<td>Central Highlands</td>
<td>$2.57</td>
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<td>$29,400</td>
<td>$3,200</td>
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</tbody>
</table>

Costs in US$

Cost/km calculated on a 3.5m wide carriageway
Whole-life Asset Costs

Typical Example - Hill region of N Lao with:
- 4% gradient; 2000mm rain/yr; 50-100 VPD
- sub-grade CBR 7%; 6T axle load

Costs US$/kilometre of pavement (3.5m)

<table>
<thead>
<tr>
<th></th>
<th>Construction</th>
<th>Construction + Maintenance</th>
<th>NPV Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsealed Gravel</td>
<td>$5,000.00</td>
<td>$52,869.00</td>
<td>$31,632.00</td>
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<tr>
<td>Sealed Dry-bound</td>
<td>$18,000.00</td>
<td>$30,826.00</td>
<td>$23,751.00</td>
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</tbody>
</table>
Practical application; Whole-Life Costed & Environmentally Optimised Design (EOD)

Utilising the available resources of budget and materials in the most cost-effective manner.
EOD a spectrum of solutions for improving volume rural access – Spot Improvement to Variable Longitudinal Design
Sealed surfaces: a cost-effective alternative within the EOD framework.

Bitumen emulsion options, are particularly attractive in this regard.

*South East Asia Community Access Programme*
## Low Volume Rural road

### Construction Costs

<table>
<thead>
<tr>
<th>Option</th>
<th>Km</th>
<th>Design</th>
<th>Construction Cost only US$/km</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>Gravel</td>
<td>$5,000</td>
<td>$35,000</td>
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<tr>
<td>2</td>
<td>7</td>
<td>Sealed Macadam</td>
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<tr>
<td>3</td>
<td>5</td>
<td>Gravel</td>
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<td>$25,000</td>
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<tr>
<td></td>
<td>2</td>
<td>Sealed Macadam</td>
<td>$18,000</td>
<td>$36,000</td>
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<tr>
<td></td>
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<td><strong>Total EOD</strong></td>
<td></td>
<td><strong>$61,000</strong></td>
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</table>
Two key outcomes within the Low Volume Rural Road sector in S E Asia

The use of natural gravel as an unsealed road surface has been shown to be unsustainable in many circumstances.

The appropriate use bituminous surface seals, has been demonstrated as being cost-effective and sustainable.