AustStab & GRC
Unsealed road black soil stabilisation trial
Goondiwindi Regional Council LGA
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• Total land area of 19,300 square km
• 2,471km of local government roads
• Approximately 1,720km unsealed
• Various landforms and soil types including black soil plains, sand ridges, jump ups, red soil and trap rock.
Unsealed Roads

• Significant maintenance expenditure, ~50/50% split between sealed & unsealed
• Significant renewal expenditure
• Finite resources to continue renewals
• All weather access critical for agriculture
• Dust can be a safety issue
The Project

- 2007 DOTARS funded project by AustStab in NSW Riverina showed success.
- IPWEA NSW – Roads Directorate & AustStab desire to expand on previous success to investigate black soils. Initial funds allocated in 2014/15.
- NW NSW & SW QLD LGA’s with black soils invited to participate.
The Project (Cont.)

Lime adds strength

Lime stabilised of unsealed road after rain

The same (non-stabilised) unsealed road adjacent to the stabilised section after rain
The Project (Cont.)

- GRC attended a workshop in Moree with a view to investigating long term sustainable alternatives to gravel re-sheeting and reducing ongoing maintenance costs.
- Works to be jointly funded by AustStab & GRC.
- GRC selected proposed sites on black soil subgrades due for re-sheeting.
AustStab brief determined that trial sites have the following characteristics:

- Nominally 2km in length & 6m wide
- Scheduled for rehabilitation with 50mm of existing granular overlay retained on site
- Expansive clay (black soil) subgrades
- Have proper shape and drainage maintenance completed
- Have a granular overlay scheduled
- Be subject to flooding
The name ‘black soil’ is used to describe fine grained, uniform soils of moderate to high Plasticity, which are typically characterized by grey to black colourisation. The black colour mainly comes mainly from iron and to a lesser extent from manganese and organic matter. These soils are highly expansive with their properties varying from one locality to another. Typical black soil properties are shown below.

### Typical properties of black soil

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical range of values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasticity Index (PI)</td>
<td>21 – 47</td>
</tr>
<tr>
<td>Swell CBR</td>
<td>2.5 – 14</td>
</tr>
<tr>
<td>CBR unsoaked</td>
<td>10 – 40</td>
</tr>
<tr>
<td>CBR 4 day soaked</td>
<td>1. – 7%</td>
</tr>
<tr>
<td>Optimum Moisture Content (OMC)</td>
<td>20 - 30% (Approximately)</td>
</tr>
<tr>
<td>Linear Shrinkage</td>
<td>13 - 17%</td>
</tr>
</tbody>
</table>

Source: Walter, P. Anwar, S. Sutherland, M. PERFORMANCE OF PAVEMENTS CONSTRUCTED WITH EXPANSIVE CLAY, ARRB Conference, Perth 2012

Blue & Yellow areas of the following map of the former Waggamba Shire show typical black soil areas.
Black Soil areas (GRC)
Burumbah Road
Burumbah Road (Cont.)

- 500m long section, 6m wide
- Scheduled for rehabilitation with nominally 50mm of existing granular overlay retained on site
- Expansive clay (black soil) subgrades
- Has proper shape and drainage maintenance completed
- Had a granular overlay scheduled
- Subject to occasional flooding from the Weir River
Burumbah Road – Before stabilisation
Testing

- 2 test pits
- Atterberg Test (Liquid limit & plastic limit)
- Grading
- Lime demand
- Unconfined Compressive Strength (UCS)
- Maximum dry density (MDD) & Optimum Moisture Content (OMC)
- California Bearing Ratio (CBR) after mixing
- Capillary Rise
Testing photos
<table>
<thead>
<tr>
<th>Material Blends</th>
<th>Binder</th>
<th>MDD (t/m³) OMC (%)</th>
<th>Resultant PI (%)</th>
<th>CBR (%) (Q113C)</th>
<th>UCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>66% Black Soil 33% granular</td>
<td>4% lime</td>
<td>1.730 15.5</td>
<td>7</td>
<td>58</td>
<td>0.3</td>
</tr>
<tr>
<td>66% Black Soil 33% granular</td>
<td>2% lime</td>
<td>1.756 15.4</td>
<td>9.8</td>
<td>22</td>
<td>0.2</td>
</tr>
<tr>
<td>66% Black Soil 33% granular</td>
<td>1% lime</td>
<td>1.656 17.4</td>
<td>Not tested</td>
<td>Not tested</td>
<td>0.1</td>
</tr>
<tr>
<td>66% Black Soil 33% granular</td>
<td>3% PR12L</td>
<td>Capillary Rise 48% 72 hours</td>
<td>Not tested</td>
<td>Not tested</td>
<td>Not tested</td>
</tr>
</tbody>
</table>
Binder selection

- Lime demand showed 4% required. 2% was trialled due to relative short life of unsealed wearing surface & high cost of binder.
- Addition of lime at 2% & 4% showed varying increase in CBR & reduction in PI.
- Capillary rise results indicated potential for Polyroad. Excluded from trial due to high cost of binder supply.
Lime Stabilisation

Hydrated lime in the presence of water creates an alkaline environment (pH > 12.4) in which the lime will react with any Pozzolans (materials containing reactive silica and alumina). Clays are usually made up of silica and alumina components which react with the lime.

The lime’s reaction is twofold. It firstly agglomerates fine clay particles into coarse friable particles resulting in a dewatering effect. Second, the increased pH encourages chemical reactions that lead to the formation of calcium silicates and aluminates similar to cement reactions. As a result the Plasticity Index decreases due to the liquid limit decreasing and the plastic limit increasing, it creates a permanent change in the detrimental clay characteristics.
Lime Stabilisation

Realignment of clay particles to produce coarse, friable particles.
Trial site layout

- Total site length 500m constructed in 5 x 100m sections
- Section 1 – Control section, existing recently placed 150mm depth of white rock, wet mixed & compacted with stabiliser & rollers
- Section 2 – 2% Lime, 150mm deep
- Section 3 – 2% Lime, 300mm deep
- Section 4 – 4% Lime, 150mm deep
- Section 5 – 4% Lime, 300mm deep
Trial site layout (Cont.)
Construction – October 2016

- Testing provided by AustStab contractor, payment by AustStab
- Binder supplied by AustStab contractor, payment by Council
- Binder placed by AustStab contractor, payment by AustStab
- Stabiliser supplied & operated by AustStab contractor, payment by AustStab
- Grader, rollers & water truck supplied by Council, payment by Council
Construction photos – 1st pulverisation run
Construction photos – Wet mixing
Construction photos – Watering from the top (incompatible connections)
Construction photos – Wet mixing
Construction photos – spreading quicklime
Construction photos – spreading quicklime
Construction photos – spreading quicklime
Construction photos – slaking quicklime
Construction photos – slaking quicklime
Construction photos – slaking quicklime/compaction
Construction photos - compaction
Construction photos - compaction
Construction photos - trimming
Costs $$

- Traditional gravel re-sheeting 150mm depth costs $25K-$30K/km depending on haul distance
- Re-sheet lasts approximately 15yrs
- Based on productivity of 1km/day, stabilisation costs approximately $25K/km
- Life of stabilised pavement yet to be determined
- Very similar capital investment
Maintenance

- Typically grade this road 2-3 times/year
- Maintenance grading (dry) costs ~$255/km
- No maintenance done since October 2016, still in good condition, some corrugations on the bend
- Potential for significant savings in maintenance expenditure
Condition March 2017
Condition March 2017
Condition March 2017
Condition March 2017
Condition April 2017
Condition April 2017
Condition April 2017
Recent video – wet weather 6 March 2018
Observations so far

- Comparable capital cost subject to lime demand
- Improved productivity
- Potential for maintenance savings
- No noticeable loss of traction wet or dry
- No noticeable reduction in dust (no testing to confirm this)
- Encouraging enough to warrant further trials
Questions?