NEW PERSPECTIVES ON UNSEALED ROADS IN SOUTH AFRICA

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Nelson, 20 July 2007
THANK YOU:

Organisers
Sponsors
Summary

- Background
- Implementation
- Problems
- Conservation
- Chemical stabilization
Background

- Unsealed roads still comprise about 75% of all roads in SA (and elsewhere)
- Today, even more burdened with the baggage accompanying them
  - Continual maintenance
  - High environmental impacts
Maintenance

• Ongoing and costly
Environmental impacts

- “Borrow” pits
- Erosion
- Dust
- (Safety)
Problems

- Often poor performance
- Frequent and costly maintenance
- Continual gravel loss

- HOW DO WE ADDRESS THESE ??
## Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size</td>
<td>37.5 mm</td>
</tr>
<tr>
<td>Max oversize index</td>
<td>5 %</td>
</tr>
<tr>
<td>Shrinkage product ( (S_p) )</td>
<td>100 – 365 (240)</td>
</tr>
<tr>
<td>Grading coefficient ( (G_c) )</td>
<td>16 – 34</td>
</tr>
<tr>
<td>Min CBR (%)</td>
<td>15 at 95% Mod AASHTO</td>
</tr>
<tr>
<td>Treton Impact value (%)</td>
<td>20 - 65</td>
</tr>
</tbody>
</table>

\( S_p \) – Weighted bar linear shrinkage

\( G_c \) – \((P26.5 – P2)*P4.75/100\)
Derivation

- Monitoring of 110 sections of *existing* roads
- Factorial design
Test methods

- **A**: Erodible
- **B**: Corrugates and ravels
- **C**: Ravels
- **D**: Slippery

**Chart Details**
- **Y-axis**: Shrinkage Product
  - 550
  - 500
  - 450
  - 400
  - 350
  - 300
  - 250
  - 200
  - 150
  - 100
  - 50
  - 0
- **X-axis**: Grading Coefficient
  - 0
  - 2
  - 4
  - 6
  - 8
  - 10
  - 12
  - 14
  - 16
  - 18
  - 20
  - 22
  - 24
  - 26
  - 28
  - 30
  - 32
  - 34
  - 36
  - 38
  - 40
  - 42
  - 44
Deterioration prediction

Gravel loss

AGL = 3.65[ADT(0.059 + 0.0027N - 0.0006P26) – 0.367N - 0.0014PF + 0.0474P26]

Roughness

LnR = D[13.8 + 0.00022PF + 0.064S1 + 0.137P26 + 0.0003.N.ADT + GM(6.42 - 0.063P26)]

LRA = 1.07 + 0.699LRB + 0.0004ADT - 0.13DR + 0.0019LABMAX
Implementation

- Requires a paradigm shift!!
- Specifications were only implemented properly in early 2000s
- (W Cape, G van Zyl)
- Material and construction strictly controlled
  - Oversize
  - Properties (E zone only)
  - Compaction (wet and to refusal)
Implications

• Costs increased 30%
  – 10% material selection, design & QA
  – 20% Construction
    • Initial slower progress
    • Drainage and road bed preparation
    • Trial sections
    • Extra grid rolling or crushing
    • Higher compaction (97% or refusal)

• Consequence?
Drainage

Existing Road Profile
Roughness Deterioration
(No Maintenance section)

MR270: km32 - 32.5: Roughness Deterioration (Model vs. Actual)

AADT = 66, 17% heavy
Roughness Deterioration (Bladed section)

MR276: km1.8 - 2.3: Roughness Deterioration (Model vs. Actual)

AADT = 323, 19% heavy
Roughness Deterioration
(Bladed section)

MR276: km1.8 - 2.3: Roughness Deterioration (Model vs. Actual)
Gravel loss

MR 276 Gravel Loss

Gravel loss

Years

Gravel Loss Predicted  Gravel loss measured
Suggested approach

• Outcome not surprising
• 20 sections being monitored
• Constructed carefully
• More light maintenance
  – Spread loose gravel
  – Repair spots
• Rip and recompact when IRI > ± 7.7
  (after 2 – 3 years)
Recent problems

• Couple of roads recently
• Loose within 4 weeks after construction
  – Poor construction
  – Crystallization of soluble salts
Recent problems

- Quartzite and calcrete
- Construction records (OK)
- Suggested solution
  - Rip
  - Grid roll
  - Water & Compact
- Solved problems
  - Poor compaction
  - Beware construction records
Recent problems

- Shale/mudrock
- Construction records (OK)
- Ravelling/crumbling of surface
- Cause
  - Material variability in BP (hard and soft)
  - Slushed followed by very dry
  - Attracted traffic (trucks saved 30 km)
- Solution
  - Grading
  - Localised rip and recompact
Gravel Conservation

- Major problem
- 27 Acts
- Case study of Kruger National Park

Area = 19 000 km²
Nearly the same size as Israel
1.25 Million visitors/year
1746 km unsealed roads
Gravel loss in KNP

- ± 13 mm/y (120 000 m³/y)
- Erosion (12 mm) & traffic (1 mm)
- Replacement required
- Disagreement between Nature Conservation Dept and Roads Dept
Solutions

- Seal
- Narrower roads
- Better construction
- Treat
Treatment

- Various experiments
- Sceptical but open-minded
ACTION OF SULFONATED OILS ON CLAYS

• Theoretically:

- Attach to clay particles (ionic exchange)
- Water expulsion
- “Water proofing” through hydrophobic action
- Better compaction (lubrication and less water to compress)
Testing for suitability

- Need plasticity and correct clay mineralogy
- Grading (% < 0.075 mm)
- Do they improve the soaked CBR?
- Normal CBR test with different products and application rates
- If the required CBR is produced, go ahead.
FIGURE 4: THE EFFECT OF TREATMENT OF SOILS WITH LIME AND DIFFERENT SPP's AT 0.03 l/m²

FIGURE 5: THE EFFECT OF TREATMENT OF SOILS WITH DIFFERENT SPP CONCENTRATIONS
# EFFECT OF CHEMICALS

<table>
<thead>
<tr>
<th>Material</th>
<th>Diabase</th>
<th>Black clay</th>
<th>Ferricrete</th>
<th>Chert</th>
<th>Shale</th>
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</thead>
<tbody>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>32</td>
<td>2</td>
<td>181</td>
<td>51</td>
<td>33</td>
</tr>
<tr>
<td>Product B</td>
<td>76</td>
<td>2</td>
<td>137</td>
<td>39</td>
<td>42</td>
</tr>
<tr>
<td>Product G</td>
<td>65</td>
<td>2</td>
<td>144</td>
<td>41</td>
<td>37</td>
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<tr>
<td>Product C</td>
<td>72</td>
<td>-</td>
<td>-</td>
<td>85</td>
<td>45</td>
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<tr>
<td>Product D</td>
<td>69</td>
<td>-</td>
<td>-</td>
<td>46</td>
<td>38</td>
</tr>
</tbody>
</table>
Conclusions

• Unsealed roads still very important
• Can’t get away from them
• Can improve their performance
  – Better construction
  – Treatment – jury is still out?
• Sustainability is questionable
Final thought

When you talk to the half-wise, twaddle;
when you talk to the ignorant, brag;
when you talk to the sagacious, look very humble and ask their opinion

(Edward G. Bulwer-Lytton 1803-1873)

THANK YOU