Optimising Gravel Road Maintenance Strategies

Presenter:
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Scope

• Introduction
• Road management systems
• Utilising information to improve maintenance strategies
• Blading optimisation process
• Conclusion
Integrated Road Management Systems

- Road Referencing System
- Road Proclamation System
- Traffic Surveillance System
- Pavement Management System
- Unsealed Road Management System
- Bridge Management System
- Network Integration Module
ACTIVITY FLOW IN ROAD MANAGEMENT

DATA MANAGEMENT

Location referencing

Inventory

Condition monitoring

Condition description

Analyses

Deterioration

Measure selection

Prioritisation & Optimisation

Presentation to Management

Final prioritisation

Fund allocation

Project Planning

Detailed investigation and design

Maintenance/ rehabilitation or upgrading

Condition

Prioritisation & Optimisation
Location Referencing and Inventory

- Road No
- Start & End
  - Description
  - Km
  - GPS
- Attributes
  - Category
  - Surface type
  - Geometry
  - Features
  - Etc.
ACTIVITY FLOW IN ROAD MANAGEMENT

- Inventory
- Condition survey
  - Condition description
  - Deterioration modelling
  - Prioritisation & Optimisation
- Final prioritisation
- Presentation to Management
- Project Planning
- Detailed investigation and design
- Maintenance/rehabilitation or upgrading
- Location referencing
- Fund allocation

DATA MANAGEMENT
Condition Assessment

- Formalised visual assessment (TMH12)
- Roughness
- Material thickness and properties
- Insitu strength (DCP)

- Additional information
  - Traffic
  - Climate
  - Topography
Condition assessment

- Visual assessment
- Roughness
- Layer thickness
- Material properties
- DCP
- Unit costs
DCP testing

Inadequate strength
Condition description

- Condition description (Network)
• Condition trends
Project Activity Cost Analysis

- 34.4% Transport & Tipping
- 12.8% Breaking Down Material
Gravel Loss

• Function of:
  – Material properties
  – Climate
  – Traffic
  – Construction
  – Blading frequency

• Calculate remaining life
  – Minimum thickness
PERFORMANCE MONITORING

- Visual assessment of distress type
- Roughness measurement
- Gravel loss and shape change
- Structural capacity
- Change in material properties
Material information availability

Shrinkage product (Sp) = % linear shrinkage x % passing 0,425 mm sieve

Grading coefficient (Gc) = ([% passing 26,5 mm – % passing 2,0 mm]x % passing 4,75 mm) / 100
Roughness deterioration

- Impact of different strategies
Light blading

- Remove cohesionless material

- Spread fine material (moist & slightly plastic)
OBSERVATIONS AND IMPLICATIONS

- No deterioration after blading at low roughness levels

![Graph showing Riding Quality (IRI) over Years since construction for TR58/1: km 46.9 - 47.4: Roughness Deterioration (Model vs. Actual). The graph compares model prediction versus measured data, with a noticeable improvement in Riding Quality after blading.]
Effect of regular light blading

ROUGHNESS PROGRESSION
MR 584 km 2.7

Years

Normal Maintenance
Actual Roughness

AADT = 86, 14% heavy
CONCLUSIONS ON RESHAPING

- Reshaping more economic than continuous blading at high roughness levels

MR276: km 1.8 - 2.3: Roughness Deterioration (Model vs. Actual)

- Effect of reshaping (Adjusted model)

AADT = 323, 19% heavy (2001)

AADT > 500 (2007)
SIMPLIFIED DECISION TREE FOR REMEDIAL MEASURES

1st Level MEASURE

1-CONSTRUCT

1-CONSTRUCT

2-FORM & GRAVEL

3-GRavel

3-GRavel

4-SPOT GRAVEL

4-SPOT GRAVEL

5-SPOT GRAVEL

5-SPOT GRAVEL

6-SPOT GRAVEL

6-SPOT GRAVEL

7-REWORK/GRAVEL

7-REWORK/GRAVEL

8-SPOT GRAVEL

8-SPOT GRAVEL

9-FORMING

9-FORMING

10-RESHAPE

10-RESHAPE

11-SPOT GRAVEL/BLADING

11-SPOT GRAVEL/BLADING

12-NOR BLADING

12-NOR BLADING
Measure Selection

- Routine maintenance
- Scheduled maintenance
- Upgrading to surfaced/seal
Routine maintenance

- Light and heavy blading
- Maintain drainage systems
- Vegetation control
- Fence repair
- Signage maintenance
- Patching
Periodic/ Scheduled Maintenance

- Forming
- Gravelling or spot gravelling
- Reshaping
- Reworking

- Panel Inspections
- Site verification
- Final prioritisation
- Fund availability - Work program

Network level

Project level
Blading optimisation

- Part of operational (day-to-day) Maintenance Management System
Balance between theory and practice?
Factors influencing blading program

• Funding
• Organisational policy (uitslaap), depots
• Effectiveness (Grader availability, working hours)
• Road condition, material and maintainability
• User requirements
• Methodology and operator abilities
• Emergencies
Define network
Define Uniform Maintenance sections
Define Minimum & Appropriate LOS
Determine minimum & appropriate blading frequency and adjust
Determine Min & Appr. Blading type, Blade passes, Blade km/ maint sect per annum
Determine/ Allocate Grader Productivity per road/ area
Combine maint sections to obtain balanced Distribution per Ward/ Maint Area
Distribute blading requirements to balance cycles: **Blading Schedules**
Verify monthly program on site & issue

- **Unit Costs**
- **Min Fund Required**
- **Funding Requirement**
- **Fund allocation**
- **Recalculate affordable blading frequency per maintenance section**

**Grader requirements Strategies**

**Feedback**
### Table 6  Productivity (Blade km per day)

<table>
<thead>
<tr>
<th>Maintenance measure</th>
<th>Easy Conditions</th>
<th>Moderate</th>
<th>Difficult conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light blading</td>
<td>65</td>
<td>45</td>
<td>25</td>
</tr>
<tr>
<td>Hard rain blading</td>
<td>30</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Hard blading with water bowser</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

**Note:**
- Difficult conditions could include
  - Only 4 working hours due to travel policy/ distance to depot
  - Steep grades
  - High traffic volumes resulting in shorter blading sections and additional time to accommodate traffic
  - Hard material
  - Poor condition
  - Long haulage for water bowser

Easy conditions include
- Moist fine material
- Flat areas
- Close to base (long potential working hours)
- Low traffic volumes
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost per hour (including operator)</th>
<th>Cost per day (15 blade km per day)</th>
<th>Cost per blade km (20 blade km per day)</th>
<th>Cost per blade km (25 blade km per day)</th>
<th>Cost per blade km (50 blade km per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production (km/day)</td>
<td></td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Maintenance grader</td>
<td>R 363.80</td>
<td>R 2,830.40</td>
<td>R 188.69</td>
<td>R 141.62</td>
<td>R 113.22</td>
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<tr>
<td>Vibration bowser</td>
<td>R 326.68</td>
<td>R 2,613.44</td>
<td>R 174.23</td>
<td>R 130.67</td>
<td>R 104.54</td>
</tr>
<tr>
<td>Vibratory roller (12 ton)</td>
<td>R 871.00</td>
<td>R 6,968.00</td>
<td>R 464.53</td>
<td>R 348.40</td>
<td>R 278.72</td>
</tr>
</tbody>
</table>
Results after implementation

- Well defined monthly programs
- Major reduction in complaints
- Positive feedback from communities/ RU
- Ability to adjust blading programs with reduced/ increased funding
- Ability to manage emergency work
CONCLUSIONS

• Formalised systems essential

• Integration of systems
  – Location referencing/ inventory
  – Traffic
  – Unsealed road management system
  – Maintenance Management System
  – Project Control System (Costs)
  – Materials Information System
  – Experimental data

• Strategic & tactical (Network)

• Operational level (Project)

• Blading optimisation (Process)
The way forward?
Any questions?