Pavement evaluation – an international perspective: Fit for purpose?

Richard Wix, ARRB Group
Roads – the arteries of a nation
‘All roads lead to Rome’

- Roads have always been important
- Romans built roads that lasted

http://www.crystalinks.com/romeroads.html
Appian Way today
Early pavement evaluation
This Instrument is capable of being applied to several very important purposes in road engineering, amongst which are the following.

First, It affords the means of ascertaining the exact power required to draw a carriage over any line of road.

Secondly, It can be applied to compare one line of road with another, so as to determine which of them is the best, and, the exact amount of the difference, as regards horse power, both for slow and fast coaches.

Thirdly, The comparative value of different road surfaces may be determined with great exactness,

Fourthly, It affords the means of keeping a registry, in a most accurate manner, from year to year, of the state of a road, showing its improvement or deterioration, and the exact parts in which such improvement or deterioration have taken place.
Theme:
• Right measures?
• Right quality?
• Right analysis?
• Right quantity?
• What is the benefit?
What’s going on in.....
### Kwazulu-Natal province

<table>
<thead>
<tr>
<th>Functional Class</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Paved</strong></td>
<td></td>
</tr>
<tr>
<td>Main Roads</td>
<td>7 090</td>
</tr>
<tr>
<td>District Roads</td>
<td>598</td>
</tr>
<tr>
<td>Local Roads</td>
<td>61</td>
</tr>
<tr>
<td><strong>Total Paved</strong></td>
<td><strong>7 749</strong></td>
</tr>
<tr>
<td><strong>Unpaved</strong></td>
<td></td>
</tr>
<tr>
<td>Main Roads</td>
<td>6 075</td>
</tr>
<tr>
<td>District Roads</td>
<td>11 065</td>
</tr>
<tr>
<td>Local Roads</td>
<td>6 278</td>
</tr>
<tr>
<td><strong>Total Unpaved</strong></td>
<td><strong>23 418</strong></td>
</tr>
<tr>
<td><strong>Total KZN Provincial Network</strong></td>
<td><strong>31 167</strong></td>
</tr>
</tbody>
</table>
### Estimation of ride quality

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Comfortable, Safe Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very Good</td>
<td>&gt; 100km/h</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>80 - 100km/h</td>
</tr>
<tr>
<td>3</td>
<td>Average</td>
<td>60 - 80km/h</td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>40 - 60km/h</td>
</tr>
<tr>
<td>5</td>
<td>Very Poor</td>
<td>&lt; 40km/h</td>
</tr>
</tbody>
</table>
Roughness

“The deviation of a surface from a true planar surface with characteristic dimensions that affect vehicle dynamics and ride quality” (ASTM E867)
Comparison – IRI versus visual
Use of satellite images for pavement evaluation

Transport Infrastructure Monitoring Project Phase II:

Funded by: Catapult Satellite Applications

Consultants:

- TRL Ltd
- Airbus Defence and Space

Cooperation with the Nigeria Infrastructure Advisory Facility – funded by DFID/UK
Pilot area – Kano State
Data actually used in project

SPOT6 satellite image 1.5m resolution for road **mapping**

Pleiades satellite image 0.5m resolution for road **condition**
Condition assessment system

0P – Paved, good to fair condition

0E – Earth, good to fair condition

1E – Earth, fair condition

2E – Earth, fair to poor condition

3E – Earth, poor condition

4E – Earth, very poor condition
Ground truthing using image collector
Forward facing images
Condition assessment rules
Results of assessment

- Road condition assessment based on rules
- 50cm resolution Pleiades satellite imagery
Change of condition
Bridge identification
Culvert identification
## Condition assessment accuracy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Length (km)</th>
<th>Positive Correlation with Image Collector</th>
<th>Negative Correlation with Image Collector</th>
<th>% Correlation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0P</td>
<td>1.9</td>
<td>1.9</td>
<td>0</td>
<td>100</td>
<td>Excellent correlation</td>
</tr>
<tr>
<td>0E</td>
<td>1.7</td>
<td>0.2</td>
<td>1.5</td>
<td>12</td>
<td>Condition for only one road - 0E looks like 0P on imagery</td>
</tr>
<tr>
<td>1E</td>
<td>8.5</td>
<td>6.7</td>
<td>1.8</td>
<td>79</td>
<td>Very good correlation</td>
</tr>
<tr>
<td>2E</td>
<td>19.4</td>
<td>11.5</td>
<td>7.9</td>
<td>59</td>
<td>Good correlation - tendency to condition as 3E</td>
</tr>
<tr>
<td>All</td>
<td>31.5</td>
<td>20.3</td>
<td>11.2</td>
<td>64</td>
<td>Good correlation for all scenarios</td>
</tr>
</tbody>
</table>
Horizontal curvature
Star Maps (preliminary results)
Caught on film
Caught on film
Drive by shopping
Road assessment programs

EuroRAP
European Road Assessment Programme

iRAP
International Road Assessment Programme

AusRAP
Australian Road Assessment Program

usRAP
United States Road Assessment Program

Together we can save millions of lives.

www.decadeofaction.org
A small island nation

Kiribati
Kiribati

- Remote Pacific Island nation
- Low population
- Small road network
Europe

• TRIMM (Tomorrow’s Road Infrastructure Monitoring & Management) advanced & specialised monitoring techniques, structural and surface condition

• ROSANNE main objective is the harmonisation and standardisation of the measurement of skid resistance, noise emission and rolling resistance of road pavements (predecessors were TYROSAFE, HERMES, SILVIA and MIRIAM)
Roughness statistics

- IRI

- WLP (weighted longitudinal profile)
Traffic speed condition surveys (TRACS)

- These largely cover the condition of the pavement surface
- TRACS surveys have been carried out on the English Strategic Road Network since 2000 (around 15,000km of main line lanes)
- The surveys are carried out by an independent contractor using a survey vehicle specifically constructed for the purpose
- TRACS surveys are subject to a detailed quality assurance regime, currently carried out by TRL Ltd
Detailed “end result” specification was issued in 1999 for the measurement of:

- location
- surface condition including surface cracking and rutting
- road geometry

TRACS 1&2

Traffic speed condition surveys

2000 - 2006

2006-2011
TRACS 3 from 2012 to present

The TRACS survey provides the following measures of the condition of the pavement surface over the main line of the HA’s strategic road network:

- Rut depth
- Ride quality
- Texture depth
- Cracking
- Surface Deterioration
- Fretting
- Lane fretting
- Surface type
- Noise
- Geometry
- Downward facing images
- Forward facing images
- Retro-reflectivity
Traffic speed structural surveys

**TRASS1**

- Network surveys using TSD already undertaken in TRASS1
- Two survey contracts let for a Winter survey and a Summer survey
  - Yotta (winter)
  - WDM (summer)
- Reports are available

<table>
<thead>
<tr>
<th>Survey period</th>
<th>Total surveyed [km]</th>
<th>Total valid [km]</th>
<th>% valid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer (WDM)</td>
<td>7057</td>
<td>6211</td>
<td>87.6%</td>
</tr>
<tr>
<td>Winter (Yotta)</td>
<td>7838</td>
<td>5775</td>
<td>73.7%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14895</td>
<td>11986</td>
<td>80.5%</td>
</tr>
</tbody>
</table>
Traffic speed structural surveys

TRASS2

- Network surveys with TSD undertaken by Fugro
- Survey Jan 2012 to End Mar 2012
- Data validity
  - Feb surveys: 67%
  - March surveys: 78%
  - Average: 75%
- Report is available
Traffic speed structural surveys (TRASS3)

- 3 year + 1 + 1 contract
- Started September 2014

TRASS3 Objectives
- Operate and Support the TSD to Collect
  - TRASS Raw Condition Data (RCD)
  - Base Condition Data (BCD)
  - Ground Penetrating Radar (GPR) data
- Deliverables:
  - The Surveys
  - Survey Data
  - Quality Assurance records and data
  - Progress reports
- Roles:
  - Highways Agency
  - Auditor TRL
  - Technical Advisor TRL
  - Survey Consultant
Australia

Common automated pavement condition parameters (meat & 3 veg)

- roughness
- rutting
- texture
- skid resistance
- strength

Moving to more sophisticated measures
Pavement strength testing

- Traditional methods such as FWD still in wide use
- Relatively slow technology
- Not safe for network testing; requires significant traffic control
2010 TSD trial

• 18,000 km in two states
Purchased a TSD

November 2013
Benchmarking

Source: Google Earth, “map title, scale” map data: CNES/Astrium, Sinclair Knight Merz & Fugro, Google, USA.
Even made the news.....

<table>
<thead>
<tr>
<th>TSD #</th>
<th>Country</th>
<th>Year</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Denmark</td>
<td>2004</td>
<td>The Danish Road Directorate</td>
</tr>
<tr>
<td>2</td>
<td>United Kingdom</td>
<td>2005</td>
<td>Highways Agency (TRL)</td>
</tr>
<tr>
<td>3</td>
<td>Italy</td>
<td>2010</td>
<td>ANAS S.p.A.</td>
</tr>
<tr>
<td>4</td>
<td>Poland</td>
<td>2011</td>
<td>IBDiM</td>
</tr>
<tr>
<td>5</td>
<td>South Africa</td>
<td>2012</td>
<td>SANRAL</td>
</tr>
<tr>
<td>6</td>
<td>China</td>
<td>2013</td>
<td>RIOH</td>
</tr>
<tr>
<td>7</td>
<td>USA</td>
<td>2013</td>
<td>Greenwood</td>
</tr>
<tr>
<td>8</td>
<td>Australia</td>
<td>2014</td>
<td>ARRB</td>
</tr>
</tbody>
</table>
Comparative measures

Illawarra 2 - Maximum deflection - DFG vs FWD vs TSD

<table>
<thead>
<tr>
<th>Distance [m]</th>
<th>Dmax [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>0.2</td>
</tr>
<tr>
<td>200</td>
<td>0.4</td>
</tr>
<tr>
<td>300</td>
<td>0.6</td>
</tr>
<tr>
<td>400</td>
<td>0.8</td>
</tr>
<tr>
<td>500</td>
<td>1.0</td>
</tr>
<tr>
<td>600</td>
<td>1.2</td>
</tr>
</tbody>
</table>

DFG
FWD
TSD

Threshold very strong/strong DFG
Threshold very strong/strong FWD
More than just deflection

- Roughness
- Rutting
- Texture
- Cracking
- Imaging
Big burger approach

- Cost benefits to road agencies
- Reduction in number of surveys
- Safer data collection methods
- More data
New technologies

• Original test methods developed in 2003
• ‘Since then, new road condition monitoring technologies..... have been developed’
• ‘The existing suite of Austroads documents do not provide specifications or test methods for these new technologies’
New Zealand (Aotearoa)

- Friction testing of entire road network
- ‘it is recommended that authorities in New Zealand should give strong consideration of using the automated crack detection’
- ‘the reality is .... that in the new performance based world of today, the repeatability and robustness of visual surveys are simply not good enough’
A pyramid

Bennett & Paterson
Another pyramid
Pavements – a valuable asset
Are we getting it right?

Right measures? Right quality? Right analysis? Right quantity? What is the benefit?
Kitami City, Japan (fit for purpose)
Thank you

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