Measuring and Monitoring Long Life Pavements -
(Progress on the Traffic Speed Deflectometer)

Presentation to AAPA Study Tour 2012
11 June 2012

Roger Fairclough
HA Netserv Pavements Team
## Contents

1. Background
2. TRASS1 and TRASS2
3. Use of TSD data
4. Future Plans
5. Other potential applications of the TSD
Maintaining the HA network

England’s Strategic Road Network

- 7000km of network,
- Carries 1/3 of nation’s traffic
- Carries 2/3 of LGVs.

Asset valued at being worth £62bn.
Annual maintenance spend of £750m

Maintenance management principles:

- Safety
- Serviceability
- Structure
Deflectograph

• UK standard structural assessment device
• Measures deflection of flexible pavements under a rolling wheel
• Surveys at 2.5 km/h, with measurements in both wheel paths every 3.5m
• Analysis method provides an estimate of residual life and an estimate of overlay thickness needed to achieve a required future life
• Up to 2000 used for routine network-level structural assessment on SRN
Long Life Pavements

- Mandatory requirement to assess structural condition using the deflectograph as scheme design (DMRB - HD29)
- Pavement Long Life Pavements (LLPs) identified
- Justification for shallow surface treatments (Top Down)
- Treatment to LLPs timing driven surfacing renewal (8 -15 years)
- Thickness of inlay linked to other conditions e.g. cracking depth
- No Network structural survey – No capability to monitor LLPs
- In 2005 the HA began programme to provide a Traffic speed Structural Surveys (TRASS)
From 2000: No network Deflectograph surveys

Network level

Identify potential schemes

Further surface investigations

Project level

Structural investigations

Deflectograph

TRACS

SCRIM

Coring, DCP etc

Visual surveys etc

FWD
What is the Traffic Speed Deflectometer?

- Procured as “HSD” 2005
- Articulated truck/trailer with 10T rear axle
- Launched as TSD by Roads Minister June 2006
- Commitment to start network surveys in 2009
How does the TSD work?

It doesn’t actually measure *deflection*

It measures *deflection velocity* using the Doppler principle
TSD Measurement System

- Measurement system
- Doppler lasers
- Stiff mounting beam
- Reference Doppler laser
- Measurement Doppler lasers

10 tonne rear axle load
TSD Development 2006-2009

Development of prototype into fully functional research tool

Development of relationship between TSD and Deflectograph

Ready for roll-out of network-level structural condition surveys as proxy for Deflectograph
Implementation Strategy Study

Study to identify preferred strategy for the implementation of network level TSD surveys from 2009. Process considered:

• Procurement options
• Costs and timescales
• User needs
• Industry capability and experience.
• Technical development

Key points of preferred strategy:
• Phased approach to increase industry knowledge
• Maximise use of research vehicle from 2009 – TRASS1 and TRASS2
• Develop industry experience before procuring fully-commercial surveys, potentially with new machine – TRASS3
• Parallel R&D stream to reduce reliance on scheme level Deflectograph
• Ultimate aim of removing Deflectograph surveys on the SRN by 2016
Rapid Hard Shoulder Condition Assessment

• April- June 2009

• Indicative maintenance options needed to be provided to MACs for delivery of schemes before April 2010

• TSD used to assess structural condition of 1000km of hard shoulder to inform strengthening requirements

## Contents

1. Background
2. TRASS1 and TRASS2
3. Use of TSD data
4. Future Plans
5. Other potential applications of the TSD
TRASS1 - objectives

• Make TSD suitable for routine surveys.
• Provide robust data on as much of SRN as possible
• Widen industry awareness
• Broaden industry experience
• Identify potential improvements
• Support parallel R&D stream
Implementation of TRASS1

Contract awarded to TRL:

• Stage 1:
  Make TSD suitable for network surveys
  Develop software for routine survey processing and network fitting
  Establish standard operating procedures (SOP)
  Provide survey database and reporting capability

• Stage 2:
  Surveys of minimum 5000 lane km by TRL
  Establish QA regime and new calibration site

• Stage 3:
  Commercial surveys of minimum of 9000 lane km by 2 sub-contractors
Stage 1

Make TSD suitable for network surveys

- Addition of climate control system
- New distance/velocity encoder
- Processing software
- Survey database.
- Standard operating procedures (SOP)
- Service contracts and technical support to survey contractor
Stage 2
Establishment of robust QA

- Accreditation/ re-accreditation procedures
- QA procedures
  - Primary checks (fortnightly)
  - Secondary checks (weekly)
  - Daily checks
- Software tools
- TRL survey
  - Establish reference data sets
  - Identify primary sites
Stage 3: TRASS 1 surveys

Divided into Summer and Winter Surveys
  • No more than 6000 lane km
  • Nominal duration of 4 months
  • Divided by agreement with HA and TRL on start of contract

Contractors tendered price for each survey, comprising:
  • A rate per km of delivered data
  • Monthly fixed charge for duration of survey
  • A preference for Summer or Winter
Stage 3 – Procurement of surveys

• OJEU sent out February 2010:
• Expressions of interest from ten potential survey contractors
• Five met pre-qualification.
  • Fugro Aperio, Jacobs, Scott Wilson, WDM and Yotta DCL.
• Potential bidders invited to hands-on demonstration in April 2010
• Tenders assessed on basis of cost and quality.
• Summer Survey won by WDM
• Winter Survey won by Yotta DCL
• TRASS1 start date of 6th June 2010.
Stage 3 – Summer Survey

• Undertaken by WDM
• Surveys targeted on North, West and South West
• 3-week processing break in surveys.
• Surveys completed 1 week ahead of schedule
• Total survey length 7087km
• Total valid data 6211km (88%)
Stage 3 – Winter Survey

- Undertaken by Yotta DCL
- Surveys targeted on East Midlands, East Anglia, South and South East,
- Survey contained programmed 1-month break in December
- Major mechanical breakdown of tractor unit – break extended to end January
- Surveys completed 3 weeks behind original schedule
- Total survey length 7870km
- Total valid data 5774km (74%)
TRASS1 – key findings

- Total length surveyed: 14958km
- Total valid length: 11986km (80%)
- Much higher efficiency in Summer Survey
- Issues with Winter Surveys:
  - Excessive warm-up times
  - Mechanical reliability of tractor unit
- TSD measurements consistent throughout survey
- Accreditation and QA procedures worked well
- Excellent feedback obtained from WDM and Yotta DCL for improvements for future surveys
TRASS2

• TRASS2: Smaller task but similar to TRASS1
• Full HA owned rig - inc. purchase of new tractor unit
• Main contractor: TRL awarded in September 2011
• TRL 2,500 lane kilometres.
• Market development – min 5,000 km via subcontract.
• Tendered previous five selected contractors.
• Fugro-Aperio successful commence January 2012.
• Completed around 6,000km by end of March 2012.
• Total of 8,500 km.
The use of TSD data

On the HA network, three types of scheme survey **must** be carried out on flexible pavements:
- Visual Condition Survey (HAPMS or equivalent);
- **Deflectograph**;
- Coring and Dynamic Cone Penetrometer (DCP);
Other types of survey and testing may also be required, depending on circumstances.

Aims:
- To help Service Providers to better identify and prioritise maintenance schemes and reduce the amount of unnecessary deflectograph surveys
- To enable the Highways Agency to consider deflection in Asset Valuation of the network to assist with the setting of maintenance budgets.
Process

- TSD data from P300 laser converted to equivalent Deflectograph deflections.
  - Not currently corrected for speed and temperature.
- Processed through modified deflectograph PANDEF algorithm in HAPMS. Other inputs:
  - Construction data
  - Estimates of past and future traffic
- Produces network-level estimates of residual life and predicted deflection level for 100m lengths.
- Residual life and deflection used to map each 100m length to one of four levels of **Network Structural Condition** (NSC) category.
# Network Structural Condition categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1        | **Sound flexible pavements**  
Should not require any further structural surveys. |
| 2        | **Flexible pavements with potentially some structural deterioration**  
May require further structural surveys. |
| 3        | **Flexible pavements with potentially moderate structural deterioration**  
Will require further structural surveys. |
| 4        | **Flexible pavements with potentially severe structural deterioration.**  
Will require further structural surveys. |
### NSCs - Things to consider

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sound flexible pavements</td>
</tr>
<tr>
<td>2</td>
<td>Flexible pavements with potentially some structural deterioration</td>
</tr>
<tr>
<td>3</td>
<td>Flexible pavements with potentially moderate structural deterioration</td>
</tr>
<tr>
<td>4</td>
<td>Flexible pavements with potentially severe structural deterioration</td>
</tr>
</tbody>
</table>

- NSCs **must** be used in conjunction with TRACS surface condition data
- Analysis relies on robust construction and traffic data.
- TSD data **not yet** to be used at project level for detailed design - Residual Life and strengthening requirements will not be provided to Service Providers
- Deflectograph surveys will still be required for schemes showing structural deterioration
- NSCs are calculated and stored within HAPMS and should be available to Service Providers from August 2011
- Interim Advice Note to be issued in support of release of NSCs
Illustration of Network Structural Condition categories

- TSD Slope [mm/m]
- DFG Deflection [microns]
Illustration of Network Structural Condition categories

![Graph showing network structural condition categories]
Benefits

• Scheme identification not based on surface condition alone.
• Earlier identification of structural deterioration
• Reduction in deflectograph survey costs
• Reduction in traffic management
• Better targeted and more timely maintenance
• Allows consideration of deflection in network-level asset valuation and budget planning
Asset valuation

- Included deflection from DfG up to 2000
- Currently uses only rutting as structural measure
- TSD allows reintroduction of deflection–related measure
- Agency to investigate potential impact of reintroduction in 2011/12
New assessment approach

From 2000: No network structural surveys

Network level

From 2000: No network structural surveys

Identify potential schemes

Further surface investigations

Project level

Structural investigations

Visual surveys etc

Deflectograph

Coring, DCP etc

TRACS

SCRIM

FWD
New assessment approach

From 2011: Network structural condition data available

**Network level**

Identify potential schemes

**Project level**

Further surface investigations

Structural investigations

Visual surveys etc

Coring, DCP etc

Deflectograph

FWD
Future assessment approach

From 2016: Network and Scheme level structural condition surveys with the TSD

Network level

Identify potential schemes

Further surface investigations

Visual surveys etc

Project level

Structural investigations

Coring, DCP etc

Deflectograph

FWD
<table>
<thead>
<tr>
<th></th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Background</td>
</tr>
<tr>
<td>2</td>
<td>TRASS1 and TRASS2</td>
</tr>
<tr>
<td>3</td>
<td>Use of TSD data</td>
</tr>
<tr>
<td>4</td>
<td>Future Plans</td>
</tr>
<tr>
<td>5</td>
<td>Other potential applications of the TSD</td>
</tr>
</tbody>
</table>
What is required 2011-2016

Develop TSD to provide robust scheme level data

Updated design methodology

Survey data!
- TRASS2
- TRASS3
Improved understanding of effect of external factors

Need to better understand the influence of the following:

• Pavement Temperature
• Survey Speed
• Texture
• Geometry
• Construction
• Profile
• Applied load (dynamic loading)

Progress made already.
Improved understanding of effect of external factors

Need to better understand the influence of the following:

- Pavement Temperature
- Survey Speed
- Texture
- Geometry
- Construction
- Profile
- Applied load (dynamic loading)

Progress made already.
Effect of **speed** and pavement **temperature**

For asphalt pavements, deflection:

- **decreases** as vehicle speed increases
- **increases** as pavement temperature increases

The same is found for deflection velocity

170mm EME2 + TSC

230mm JRC + TSC
Effect of speed and pavement temperature

Uncorrected network-level data
Effect of speed and pavement temperature

After simultaneous correction to standard velocity of 70km/h and temperature of 20°C

No obvious trends

\[ D_{70\text{km/h}, 20\degree C} = D_{\nu\text{km/h}, T\degree C} - 0.0035 \times (T - 20) + 0.0041 \times (\nu - 70) \]
Influence of longitudinal profile

No obvious relationship between deflection slope and 3m variance at network level
## Current understanding of correction needs

<table>
<thead>
<tr>
<th>Factor</th>
<th>Proposed corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal profile/</td>
<td>None required for network level – but likely to be required for scheme level</td>
</tr>
<tr>
<td>dynamic load</td>
<td></td>
</tr>
<tr>
<td>Gradient</td>
<td>None required for network level – influence at scheme level to be investigated</td>
</tr>
<tr>
<td>Cross fall</td>
<td>None required for network level – influence at scheme level to be investigated</td>
</tr>
<tr>
<td>Curvature</td>
<td>None at network level in addition to consideration of thickness and base type in NSC’s calculation – to be investigated further for scheme level</td>
</tr>
<tr>
<td>Construction</td>
<td>Correct to standard conditions of 70km/h vehicle speed and 20°C pavement surface temperature from V km/h and T°C by applying formula</td>
</tr>
</tbody>
</table>
Incorporation of GPR

Structural assessment and design relies on accurate construction information.

TRASS1 revealed issues with existing construction records.

Plan to add capability to collect simultaneous GPR data with TSD.

Assess reliability of construction data already held in HAPMS:
- Construction changes
- Significant differences.

Future direct collection of construction data?
TSD surveys from 2012

- Highways Agency wishes to continue annual network level structural condition surveys
- Desire to move to directly procured commercial surveys
- Make best use of ongoing advances in R&D
- Robust QA procedures.
- TRASS2: completed in 2011/12
- TRASS3: 2012-16
• Intend to have methodology and specification finalised in coming months
• Likely to use existing TSD
• Will be designed to accommodate further TSD development
• Surveys to be directly procured by the Highways Agency
  • Aim to start contract late 2012
  • 2 or 3 year duration
  • OJEU still to be issued
  • Parallel Accreditation and QA support contract to be awarded
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Background</td>
</tr>
<tr>
<td>2</td>
<td>TRASS1 and TRASS2</td>
</tr>
<tr>
<td>3</td>
<td>Use of TSD data</td>
</tr>
<tr>
<td>4</td>
<td>Future Plans</td>
</tr>
<tr>
<td>5</td>
<td>Other potential applications of the TSD</td>
</tr>
</tbody>
</table>
Joints in concrete pavements

TSD deflection response

Height laser response (5m transverse joint)
Joints in concrete pavements

Graph showing slope and setcom height measurements with chainage in meters. The graph includes a section marked with red and blue lines, indicating different measurement types or conditions. The legend labels P100, P300, P756, and Laser [mm].
TSD Progress Summary

- The TSD and its support systems has been successfully developed into a system capable of delivering routine network level surveys.
- Over 12000km of structural condition information was delivered in 2010/11 under TRASS1 and 7500km in 2011/12 under TRASS2.
- Service Providers will be able to identify and prioritise potential maintenance schemes on the basis of structural as well as surface condition.
- Reduced reliance on disruptive and expensive deflectograph surveys.
- The HA intends to continue annual network level condition assessment surveys under TRASS3.
- A programme is in place to develop the TSD into a tool capable of assisting in scheme-level by 2016.