How do 1st and 2nd generation TSD’s compare – results of a UK trial

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Background to network structural surveys in England

Until 2000 walking-speed Deflectograph surveys were needed to deliver this data

- Safety issues
- Disruptive to traffic
- Expensive per km

15 machines needed for whole network

Key Drivers for Traffic Speed Deflectometer Surveys

- TSD measures vertical deflection velocity
- Velocity highly correlated to maximum deflection
- Deflection can be used with construction and traffic to estimate structural condition

One TSD covers whole network
TSD – History in England

Worldwide review identified device

2nd prototype purchased for HA 2005

Developed into surveying tool 2006-2009

Routine surveys with HA TSD from 2010 under TRASS contracts

TRASS surveys provide:

- An efficient economical survey
- Without interfering with traffic flow
- Over the whole network, every one or two years

Programme of continuous improvement

2nd Generation machines now under assessment
First Generation TSD’s – DRD, Denmark and HA, England

Second generation TSD’s – ANAS, Italy, IBDiM, Poland, etc
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Purpose of comparative trial

To assess relative performance of first and second generation TSD’s in terms of:

- Measured deflection response
- Short-term repeatability of measurements
- Stability of measurements, i.e. long-term repeatability
- Methods of calibration

And therefore provide guidance to the English Highways Agency (HA) on the potential benefits of upgrading their TSD
Methodology

Controlled side-by-side tests of 1\textsuperscript{st} and 2\textsuperscript{nd} generation machines
- Calibration methods – on suitable sites
- On closed instrumented track - MIRA
- On well-characterised section of road network
- 1\textsuperscript{st} generation machines = HA TSD and DRD TSD
- 2\textsuperscript{nd} generation machine = ANAS TSD
- ANAS and DRI TSD measured right hand wheelpath
- HA’s TSD measured left hand wheelpath
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MIRA proving ground - Nuneaton, Warwickshire
Research Pavement thickness profile – nearside wheelpath

TT3  TT1  TT2  TT4
Deflection measurements on MIRA test sections

TT3  TT1  TT2  TT4

TSD slope
At 300mm offset

FWD Do

Deflectograph

Chainage [m]

Deflectograph

0  10  20  30  40  50  60  70  80  90  100  110  120  130  140  150  160  170  180  190  200  210  220  230  240  250  260  270  280

Slope (100) (10m averages) [mm/m]  d1 (0mm)  DFG N/S  Section changes
UK Comparative trials at MIRA

- October 2013
  - Closed instrumented site – MIRA HA test sections
  - Two 1st generation TSD’s
    - HA TSD with sensors at 100, 300 and 756mm
    - DRD TSD with sensors at 100, 200 and 300mm
  - One 2nd generation TSD
    - ANAS TSD with sensors at 100, 200, 300, 600, 900 and 1500mm

- However............
UK Comparative trials October 2013

- October 2013
  - Closed instrumented site – MIRA HA test sections
  - Two 1st generation TSD’s
    - HA TSD with sensors at 100, 300 and 756mm – LH WP
    - DRD TSD with sensors at 100, 200 and 300mm – RH WP
  - One 2nd generation TSD
    - ANAS TSD with sensors at 100, 200, 300, 600, 900 and 1500mm – RH WP
  - Poor weather
  - Slow height sensor failure on UK TSD
Methodology 1 for comparing right and left hand sensors

Methodology 2 for comparing right and left hand sensors
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MIRA Trials ANAS TSD P300 sensor 4 runs at 70 km/h

TT3 Strong

TT1 Weak

TT2 Intermediate

TT4 Existing

Distance (m)

TSD slope

Run 28
Run 29
Run 30
Run 37

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MIRA Trials DRD TSD P300 sensor 4 runs at 70 km/h
MIRA Trials HA TSD P300 sensor 3 runs at 70 km/h
MIRA trials Averages of all three TSD’s P300 sensor
Laser set-up – calibration

$P_{100}$ $P_{300}$ $P_{750}$ $P_{REF}$

$\beta$ $\alpha$

$v_{enc}$
ANAS TSD – variation in calibration of each sensor through trial period
Effect of variation in calibration angles on estimates of SCI300
MIRA site - ANAS TSD – all sensors

200mm offset

1500mm offset
MIRA site - ANAS TSD – all sensors

TT1

TT2

200mm offset

1500mm offset
Examples of simple modelling of deflection and deflection slope under load.
Examples of simple modelling of deflection and deflection slope under load.
ANAS vs DRI vs TRL slopes vs offset – Section TT1
ANAS vs DRI vs TRL slopes vs offset – Section TT2
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Summary and conclusions

Preliminary results from the 2013 TRL MIRA comparative trial have suggested that:

• First and second generation TSD’s can measure very similar longitudinal strength profiles to each other and to other deflection devices
• Short term repeatability is good
• Long term repeatability is not yet proven although some available calibration methods for second generation machines appear to offer promise.
• Robust methodology for calibrating and quality auditing surveys is essential if meaningful measurements are to be collected.
TRASS1&2 Summary

- The HA TSD was successfully developed into a system capable of delivering routine network level surveys.
- Over 18000km of structural condition information was collected by TRASS1 and TRASS2.
- Robust QA regime established.
- HA Managing Agents could be provided with indicator of network level structural condition.
- TRASS3 started last week.
Thank you

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