

SHRP2

International Symposium on Non-Destructive
Testing for Design Evaluation and Construction
Inspection

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Washington DC USA

Unfulfilled needs based on current and emerging technologies and techniques

By

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Presented by Brian Ferne

Transport Research Laboratory, UK

On behalf of FEHRL (the Forum of European Highways Research Laboratories)

Status of Technologies and Techniques



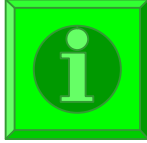
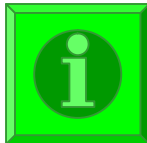
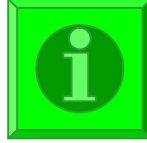


Existing and emerging technologies and techniques

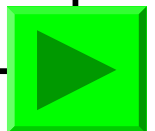
- Production models in routine use
- Pre-production models
- Several road prototypes

Unfulfilled needs based on current and emerging technologies and techniques

- Single road prototype
- Research version
- No known current solution

NDT needs in renewal projects

	Design	Construction	Performance
Pavements			
Bridges		—	
Earthworks		—	—
Tunnels	—	—	



Examples of unfulfilled needs

	Design	Construction	Performance
Pavements	Deflection Assessment	Material properties	Probe vehicles
Bridges	Visual defects		Remote Inspection
Earthworks	Topographic surveys	?	Moisture sensing
Tunnels	?	?	?

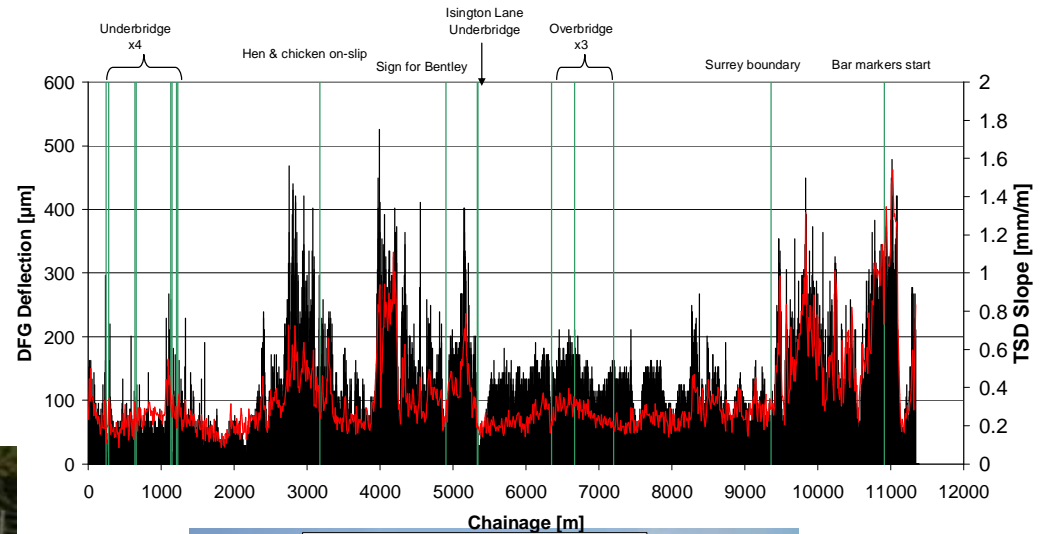
Pavement deflection assessment

Measurement of deflection response at traffic speed – European solutions

Both for design purposes and performance monitoring



TRL, UK



DRI, Denmark

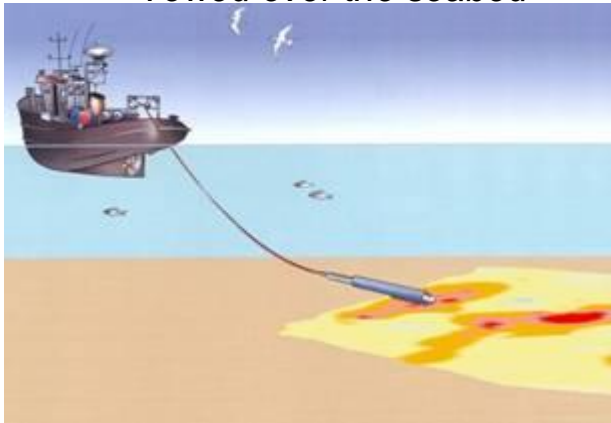


Pavement material properties

Material composition at traffic speed

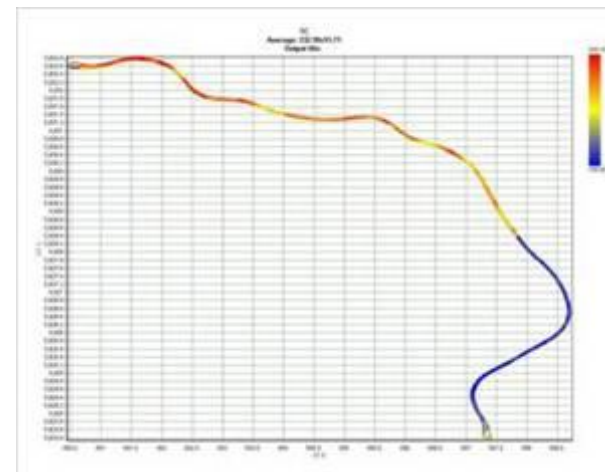
Both for design and construction quality control

Towed over the seabed



University of Gronigen, The Netherlands

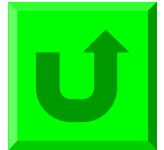
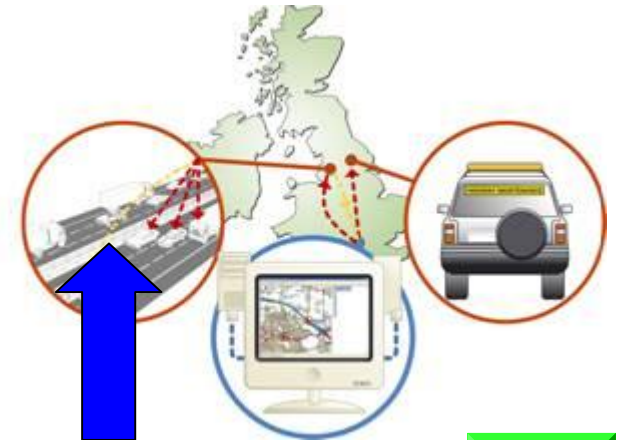
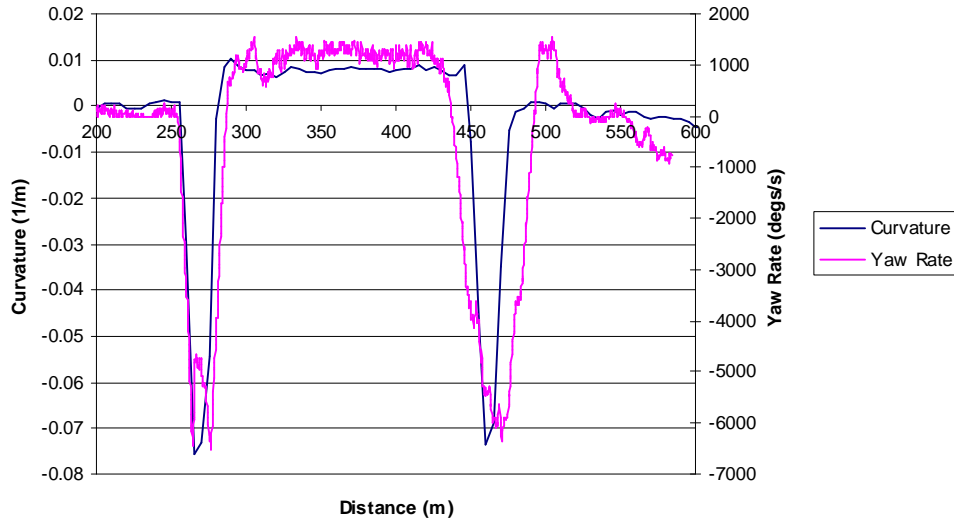
Behind a survey vehicle



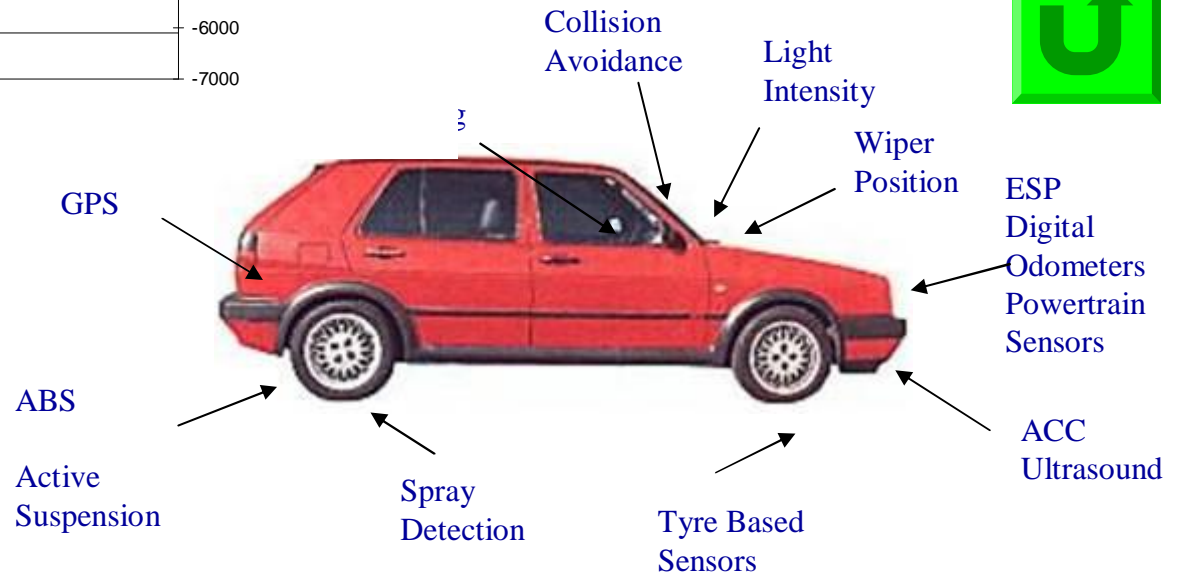
Probe vehicles or 24/7 monitoring

For pavement performance monitoring

Comparison of HARRIS curvature data with Jaguar Yaw rate data



- § Routine
- § Winter
- § Regulatory
- § Weather



VTI, Sweden and TRL, UK

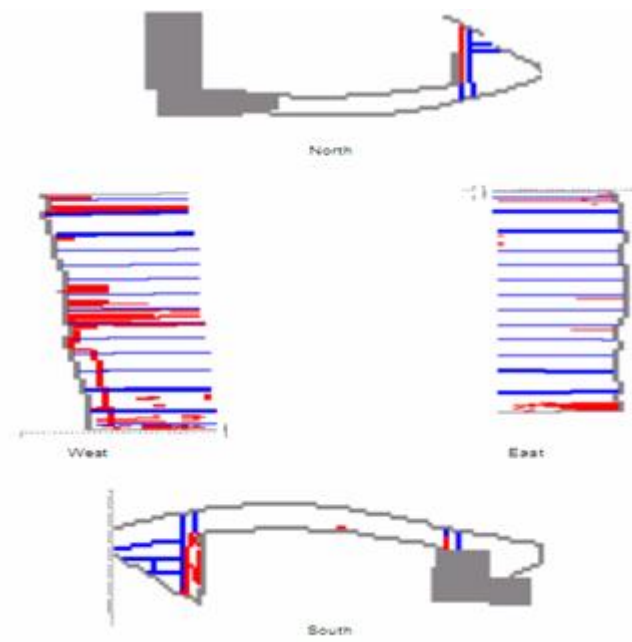
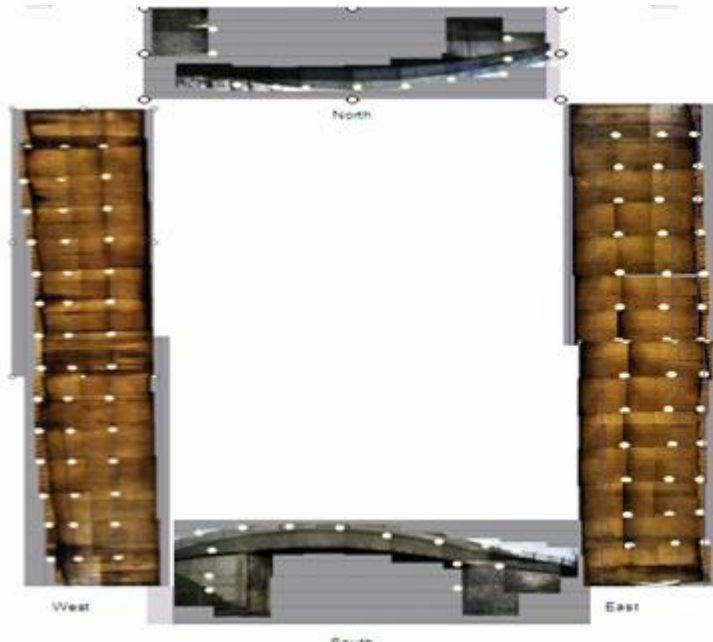
Assessing visual defects of bridges

Both for design purposes and performance monitoring



Images

Defect Map



TRL,UK

Intelligent Sensor Networks – To monitor performance of bridges

Autonomous, intelligent
sensor network

Wireless data transmission

Sensor as „embedded
System“

Monitoring of civil structures
(like bridges, buildings, ...)

Vibration protection

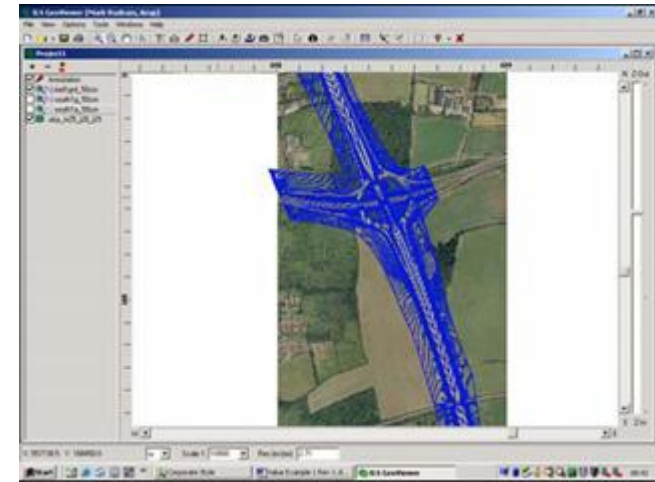


Arsenal, Austria

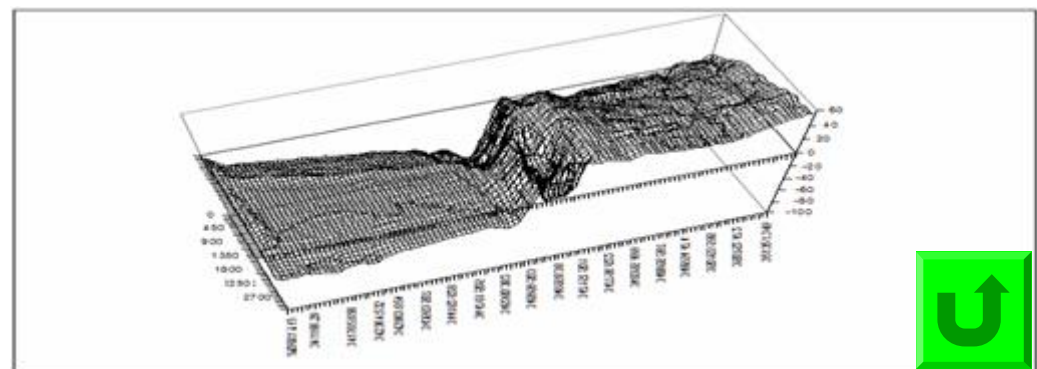
Topographic data for widening design

HA, UK

Alternatives to rod and level such as LiDAR, Clearcone and combining lane width profile with detailed GPS can reduce traffic disruption considerably for rehabilitation design and any trends might provide performance information



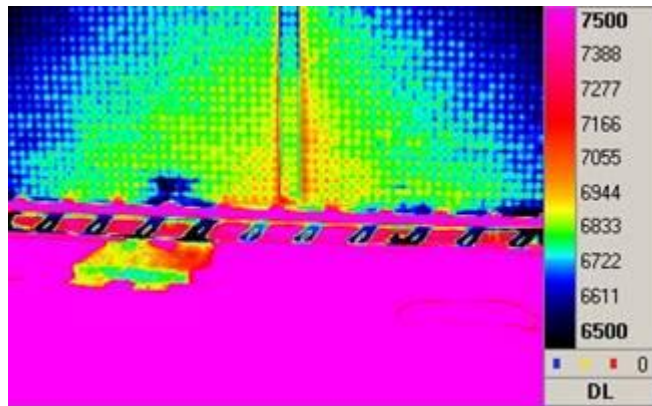
TRL, UK



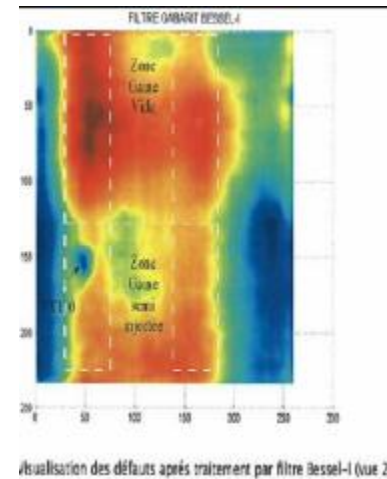
Design and performance monitoring of retaining walls

Thermal imaging to investigate water seepage through retaining wall

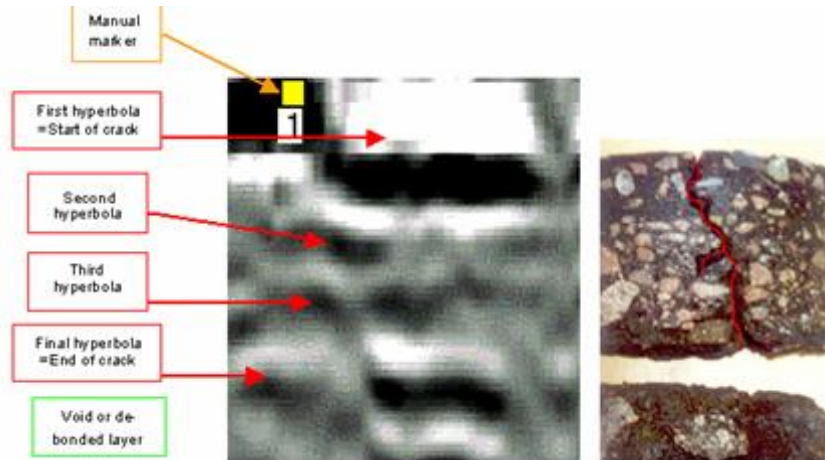
TRL, UK



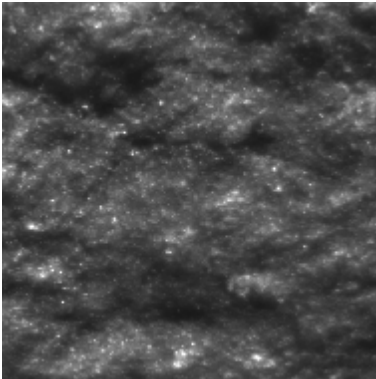
LCPC, France



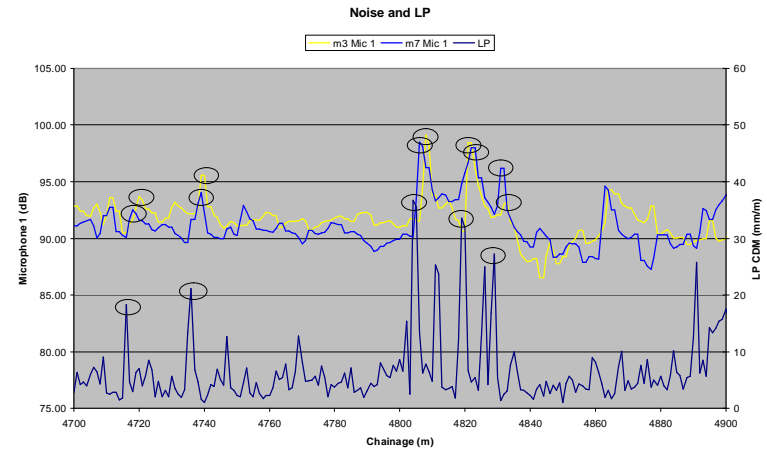
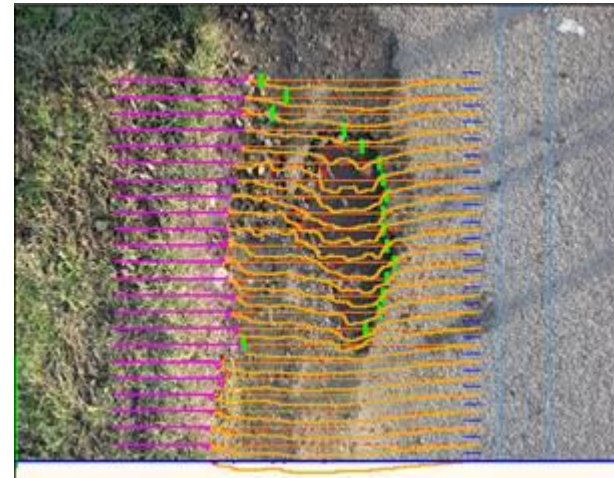
But also.....



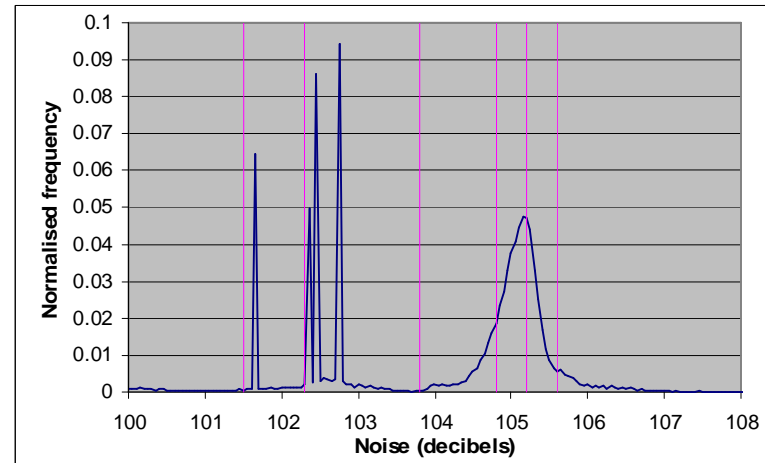
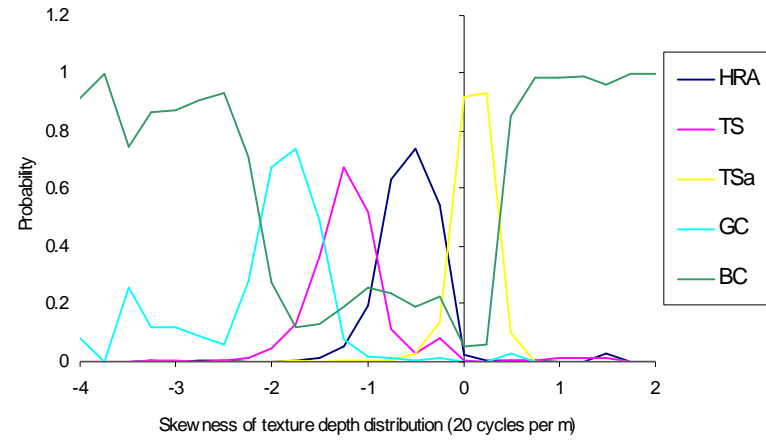
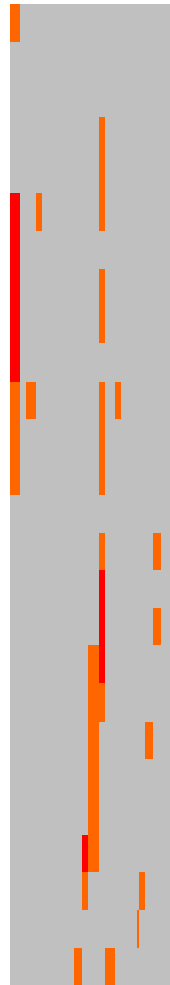
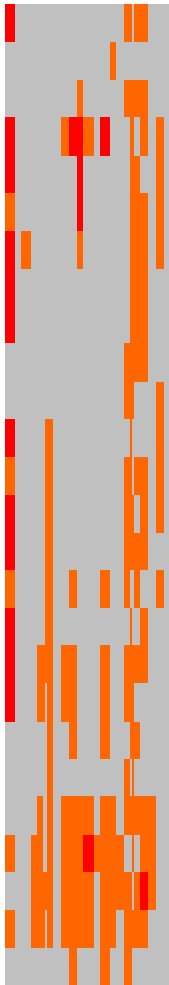
~ 3.5mm



~ 260,000 pixels



And also.....



In summary

Do these examples of emerging NDT solutions meet the main criteria of the project? i.e. minimise disruption.

	Design	Construction	Performance
Pavements	Deflection Assessment	Material properties	Probe vehicles
Bridges	Visual defects	—	Remote Inspection
Earthworks	Topographic surveys	—	—
Tunnels	—	—	Moisture sensing

In summary

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Other important issues re NDT

- Has technique been fully validated?
- How good is the coverage?
- Are there limitations to the operating conditions?
- How easy is it to robustly calibrate?
- Is the technique operator dependent?
- Is the technique safe?
- Etc.....

Some publications.....

Some examples of recent publications that summarise the latest NDT position in Europe:

1. European Project "FORMAT" including a review of pavement condition monitoring techniques published in 2005
2. A French review of NDT testing of concrete structures in France – 2005
3. The latest UK Government advice on NDT testing of Highway Structures and pavement assessment in their Design Manual for Roads and Bridges - 2006
4. The latest UK Government advice on Pavement Assessment in their Design Manual for Roads and Bridges -2004 and 2008
5. European Project "Sustainable Bridges" including review and development of bridge condition assessment and monitoring published in 2007

(1) FORMAT Report



Project funded by the European Community under the 'Competitive and Sustainable Growth' Programme (1998-2002)

Fully Optimised Road MAintenance (FORMAT)

Work Package 6 : Monitoring

Deliverable Reports

D6 – Optimised pavement condition data collection procedures

D12 - Assessment of high speed monitoring equipment

D17 – Application of high-speed equipment in pavement maintenance planning

Issued 2005, 250p in total

FORMAT Report D17 suggested priorities for pavement monitoring

Priority	Network level	Project level
Top Priority	<ul style="list-style-type: none"> ○ Longitudinal unevenness ○ Transverse unevenness ○ Crack information ○ Friction 	<ul style="list-style-type: none"> ○ Longitudinal unevenness ○ Transverse unevenness ○ Crack information ○ Friction ○ Bearing capacity ○ Pavement structure ○ Pothole
Medium Priority	<ul style="list-style-type: none"> ○ Macrotexture ○ Road marking condition ○ Megatexture ○ Other surface defects ○ Noise (outside vehicles) ○ Bearing capacity ○ Pavement structure ○ Pothole 	<ul style="list-style-type: none"> ○ Macrotexture ○ Road marking condition ○ Megatexture ○ Other surface defects ○ Noise (outside vehicles) ○ Cross fall ○ Curvature ○ Stepping, Faulting ○ Gradient or hilliness

(2) NDT of concrete structures

State of the art (2005, 555p)

- § mechanical waves (ultrasons-transmission mode-, impact écho, acoustic emission, tomography, surface waves)
- § electromagnetic methods (BF, radar, capacité),
- § Infrared thermography
- § electric methods (resistivity, corrosion rate, corrosion potentiel)
- § radiography (gamma, X)
- § optic methods (shearography, holography, fringe projection)

Method currently applied in France



(3) UK Advice on NDT of Highway Structures

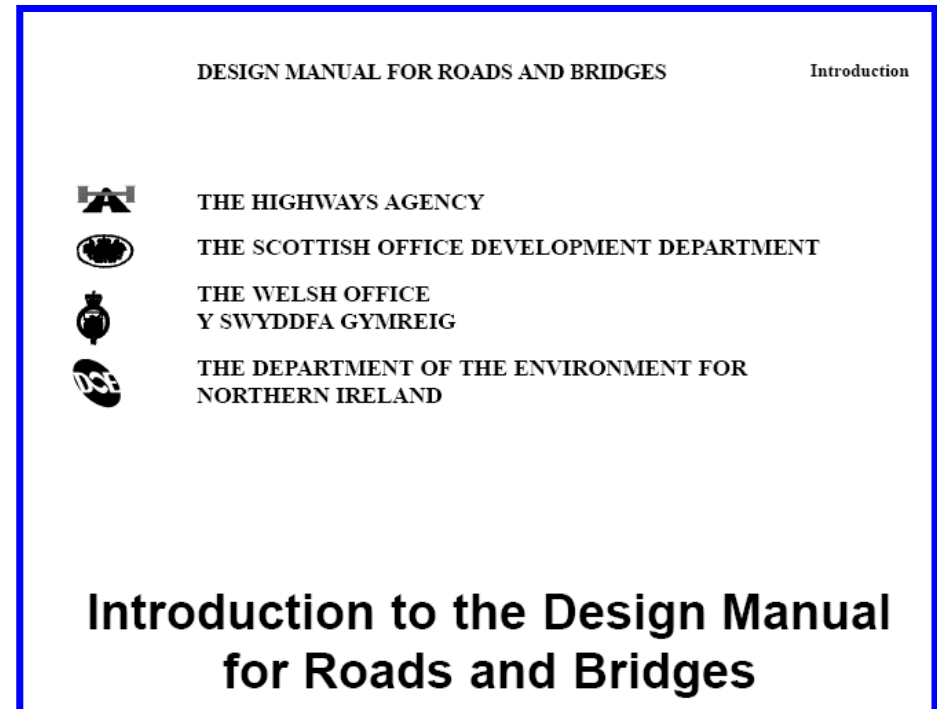
Design and
Maintenance of Roads
and Bridges

Volume 3

Highway Structures
Section 1 Inspection

Part 7 BA 86/06

Advice Notes on the Non-Destructive Testing of Highway Structures



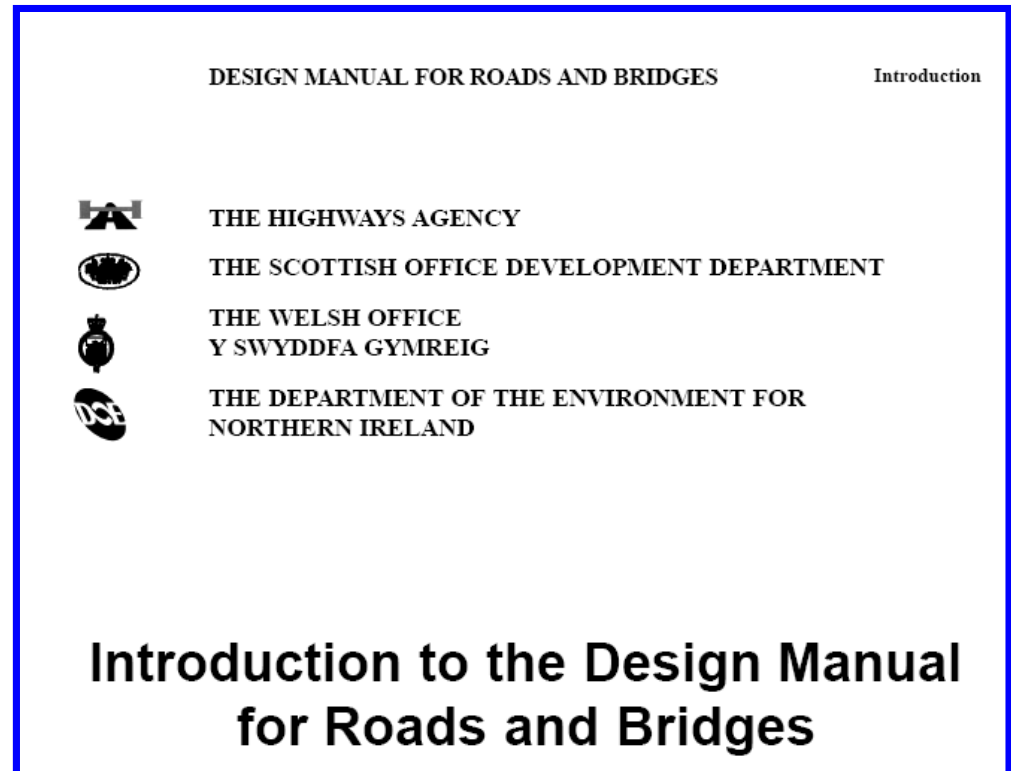
(4) UK Advice on Pavement Assessment

Design and Maintenance
of Roads and Bridges

Volume 7

Pavement Design and
Maintenance

Section 3 Pavement
Maintenance Assessment



Part 2 HD28/04 and HD29/08

Skidding resistance and Data for Pavement Assessment

(5) Sustainable bridges project



Sustainable Bridges



Project funded by the European Community under the
'PRIORITY 6 SUSTAINABLE DEVELOPMENT
GLOBAL CHANGE & ECOSYSTEMS' Programme (2003-2007)

Dedicated to railway bridges

Work Package 3: Condition Assessment and Inspections

Work Package 6: Monitoring

Deliverable Reports: guidelines

<http://www.sustainablebridges.net>

**Thank you for
listening!**

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