Creating the future of transport

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3. Current developments in automated crack systems

TRL experience in the UK

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TRL Ltd

International Workshop on
Automated monitoring of pavement surface cracking conditions - Quebec
13 August 2006

TRL – Transport Research Laboratory

- Established in 1933
- Privatised in 1996
- 550+ staff including many world recognised experts
- Head office in Crowthorne, Berkshire
  - Offices in Scotland, Wales and Australia
  - Project offices overseas

Our Work

Our Work

Customer Types

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Why measure cracking?

Cracking is a major pavement deterioration mechanism whether:

- Bottom up

Or

- Top down

Do we need it for

- Network use?

Or

- Project use?

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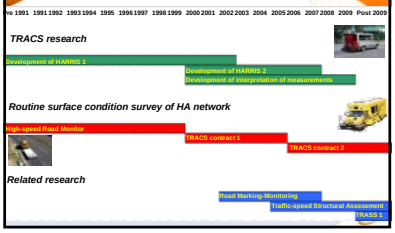
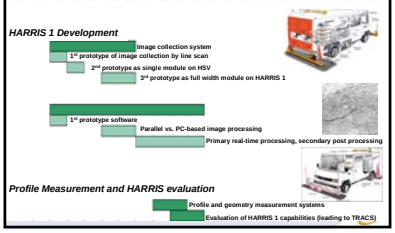
Research and Survey Timeline

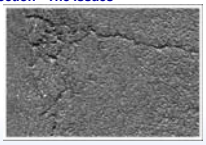


TRACS Research



HARRIS - Image Collection

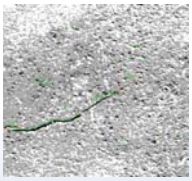
Crack Detection - The Issues



Systems have varying levels of performance, which may be

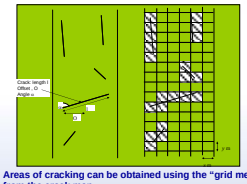
- Surface dependent
- Machine dependent
- Customer dependent

Crack Detection - The Data



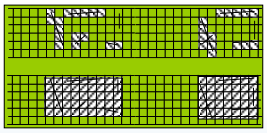
- Crack measurements are often available at a high level of detail, but require interpretation
- Hence cracking is typically reported as a "crack map"

Interpretation - Cracking



- Areas of cracking can be obtained using the "grid method" from the crack map

Interpretation - Cracking



Automatic survey with the grid

"Manual Survey"

However it must be noted that the grid method will give lower areas of cracking or cracking intensity than a manual survey:

- Sensitivity
- Grouping

- Areas of cracking or cracking intensity are assessed against specified thresholds

Challenges of implementation

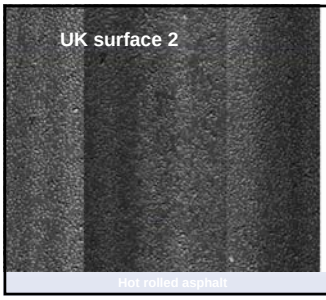
- **Surface type dependence**
- **Confusion with fretting**
- **Repeatability**
- **What is really required**
  - Overview

  or
  - Detailed view

North American surface?

UK surface 1

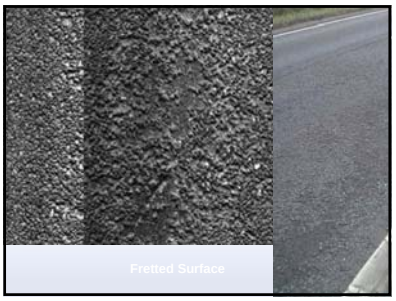
UK surface 2



Hot rolled asphalt

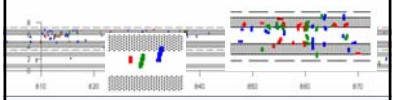
Crack intensities against surface type

Surface Type		Guidance levels Low	Med	High
Bits. – HRA	New	0.45		1.5
	Old	0.15		0.5
Bits. – other	New	0.15		0.5
	Old	0.15		0.5
Concrete		N/A		N/A



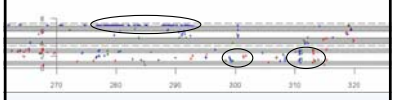
Fretted Surface

Crack maps (1)



Combining three survey years
Red = 2001/2 Green = 2002/3 Blue = 2003/4

Crack maps (2)



Combining three survey years
Red = 2001/2 Green = 2002/3 Blue = 2003/4

Cracking – what do Local Agencies want?

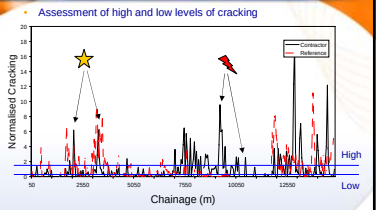
- What do we want from cracking?
  - Wheeltrack cracking most important – especially on urban roads
  - Edge cracking is also important – especially on rural roads
  - Cracking information of most value when considered with other defects (particularly rutting)
- However
  - LA's will accept a basic indication of good and bad areas
  - Do not need every individual crack to be detected and recorded
- Accuracy and consistency most important

What is the current status?

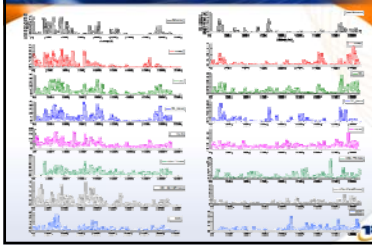
- The measure is by no means perfect!
- Research for LA's reviewed viable worldwide systems
  - Systems generally representative of commercial availability in UK
    - HARRIS (UK, TRL)
    - DCL (Roadware – Canada)
    - Jacobs Babtie (Ramboll – Sweden)
    - Waylink (USA)
    - WDM (UK)
- Undertook an assessment on local roads
  - Compared areas of cracking recorded
  - Targeted differences

Assessing Systems

- Assessment of high and low levels of cracking

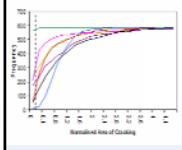


Assessing Systems

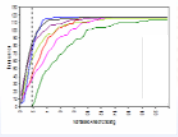


Assessing Systems

- Assessment of high and low levels of cracking



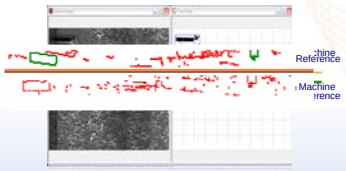
- Low



- High

Assessing Systems

- Differences?



What's the issue?

- Systems are able to identify cracks
  - Varying levels of accuracy
  - Network level assessment (e.g. longer lengths)
- Systems exhibit problems with common non-cracking features
  - Joints, Patches, Fretting, Ironwork, HFS, Road edges
- Systems are capable of correctly ignoring these features
  - Inconsistent
  - Affected by driving line and the image processing software
- So, "Accuracy and consistency most important" is not yet fully satisfied

What can be done?

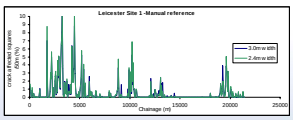
- Two approaches
  - Basic improvements in crack detection have to be achieved in image processing
  - Further improvements achievable in post-processing of the crack data
- Image processing
  - Improve crack detection by differentiating cracks from other features on the pavement surface
  - Through
    - Segmentation – Identification of objects
    - Feature Extraction – Measurement of object characteristics

Image Processing

- Target:
  - Edges of patches
  - Edges of ironwork
  - Road Markings
- Various methods available:
  - Brightness thresholding (histogram)
  - Texture analyses
    - Spatial Dependency Matrices
    - Fractal Dimension
    - Pulse coupled neural network
  - Statistical Filtering of pre-filtered images
    - Most promising method
- Aim to identify grid squares containing non-crack features
  - Use to clean crack maps

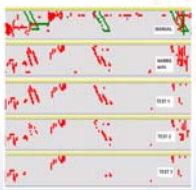
Post - processing

- Where are the false cracks?
  - Edge cracking
  - Could reduce the width of analysis without reducing performance, whilst reducing false positives
    - Appropriate to modify reported value of whole carriageway cracking?
  - Could apply rules to remove excessively high densities of cracks

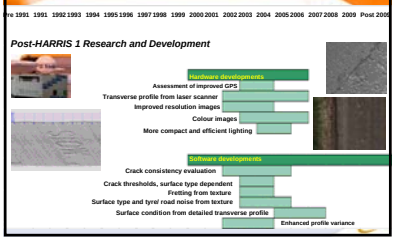


Post - processing

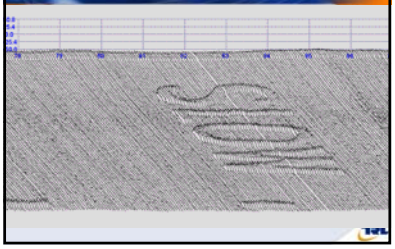
- Crack map algorithms for the removal of non crack features
  - Traffic Sensors



Continuing Research



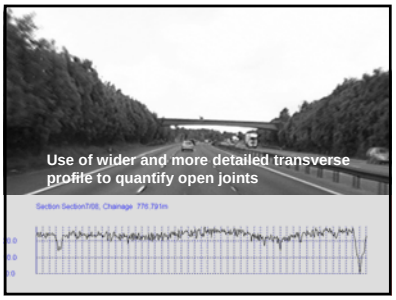
Laser 3D scans

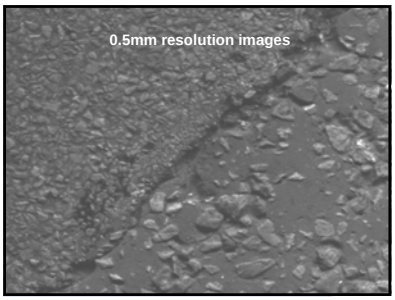


When is a crack not a crack?

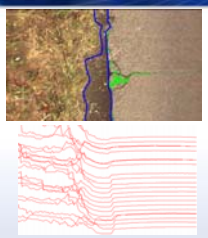
Answer:

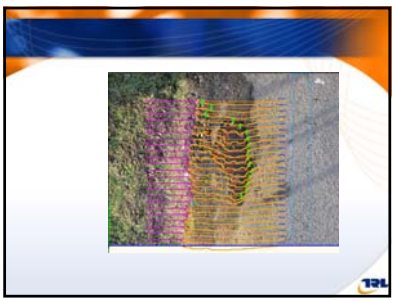
When it is an open joint?





Data fusion for detecting edge deterioration





Thank you for listening!

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