

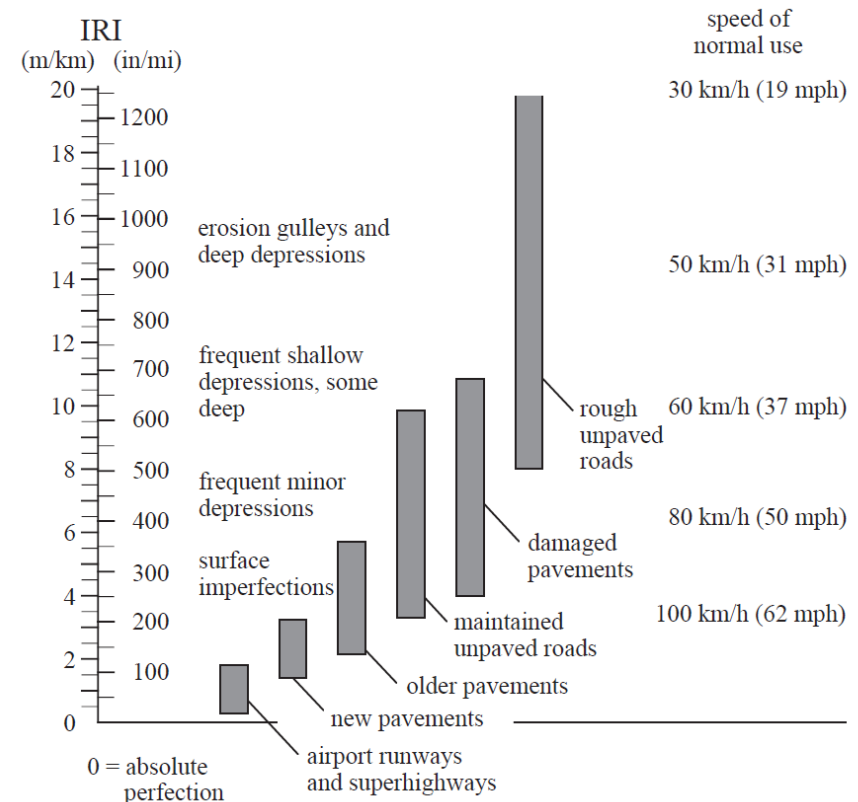
Why Do We Care About Roughness?

- Safety
- Enjoyable ride
- Transport of goods
- Vehicle damage
- Fuel economy



International Roughness Index

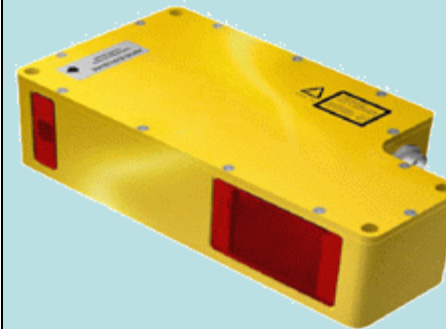
- Developed under NCHRP Report 228 and accepted by the World Bank in 1982
- Based on vertical profile in the wheel paths
 - Is independent of vehicle and speed
 - Can be collected by a range of equipment



Profiling Equipment (IRI)

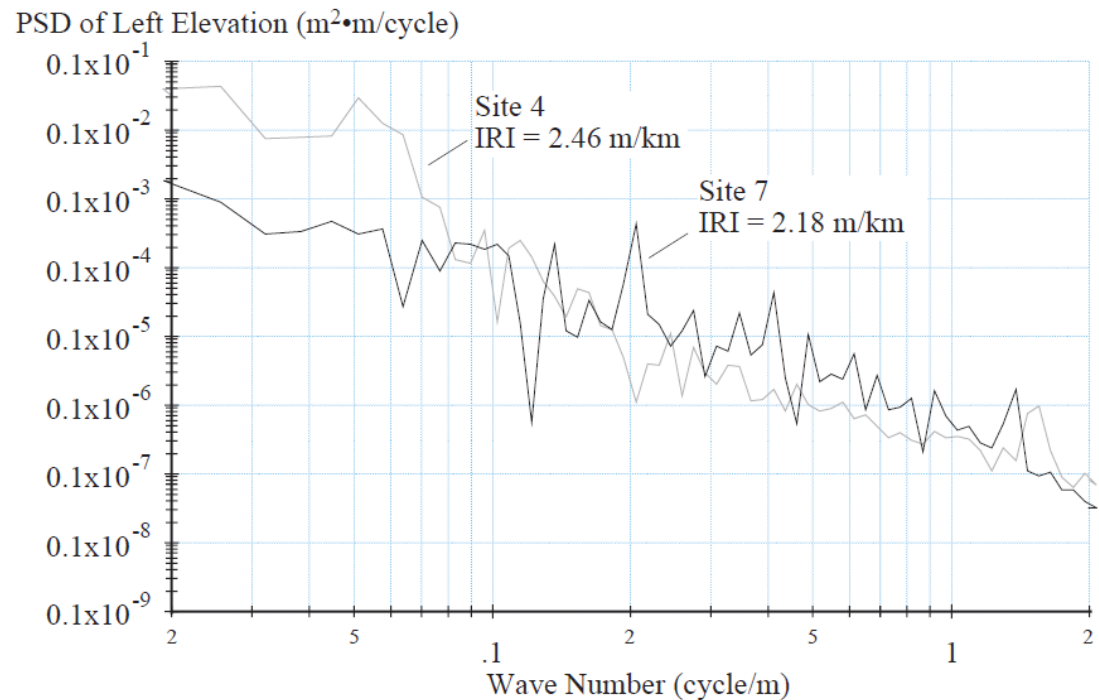


Other Sensor Types



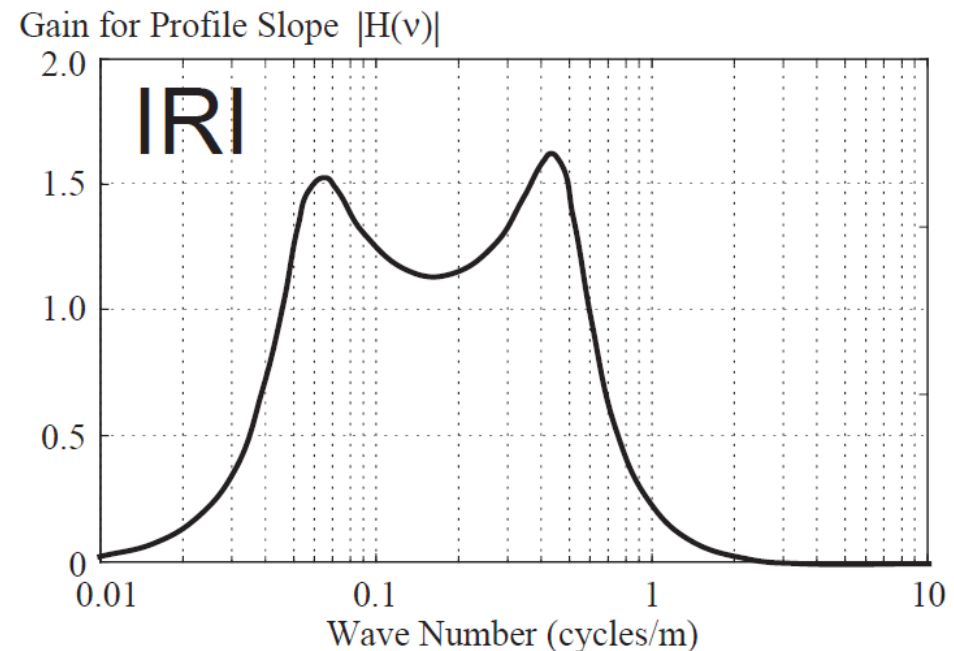
Profile gets converted into a series of waves

- Converted to a Power Spectrum Density (PSD)
- Profile is converted to a large series of sinusoidal waves
 - Frequency
 - Amplitude
 - Offset



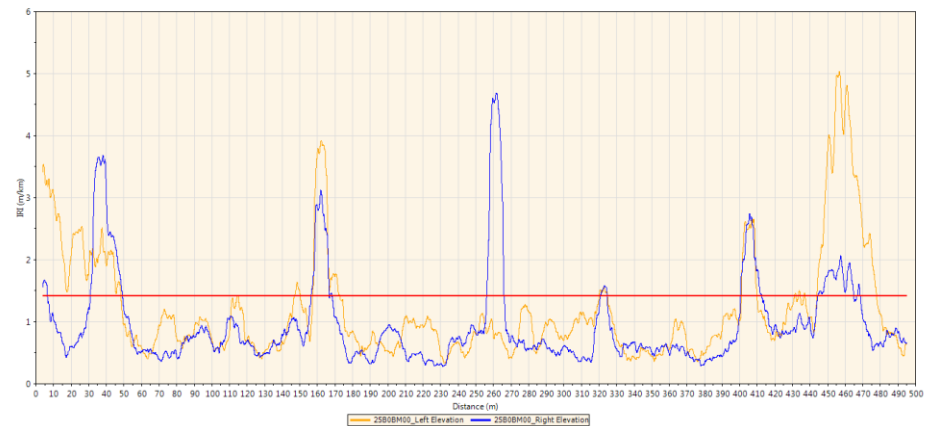
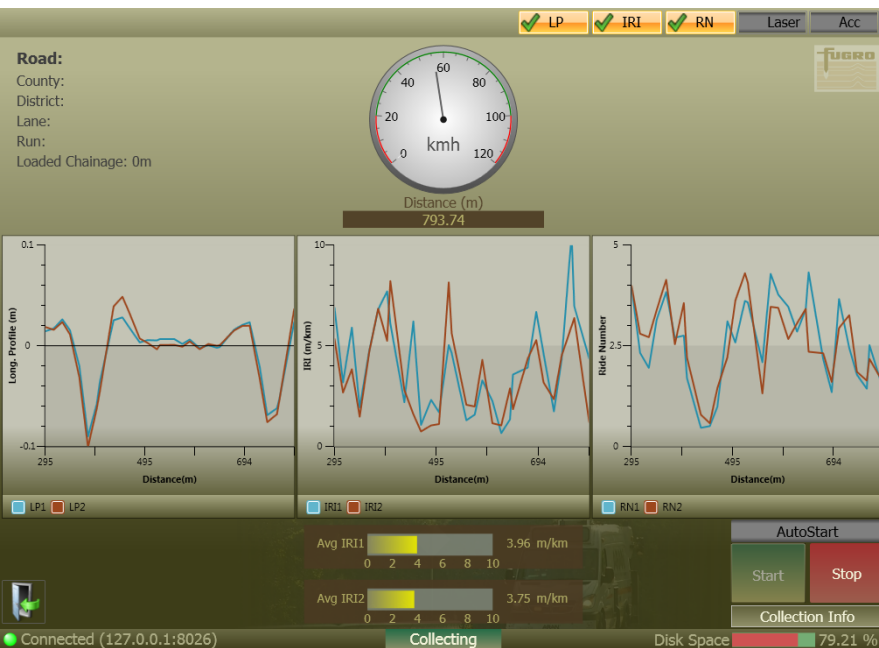
Important frequencies / wavelengths

- What frequencies are most important to drivers?
- IRI uses a standard set of values for priority
- Examples frequencies:
 - Rumble strips
 - Speed bump
 - Long hills
- ASTM E 1926



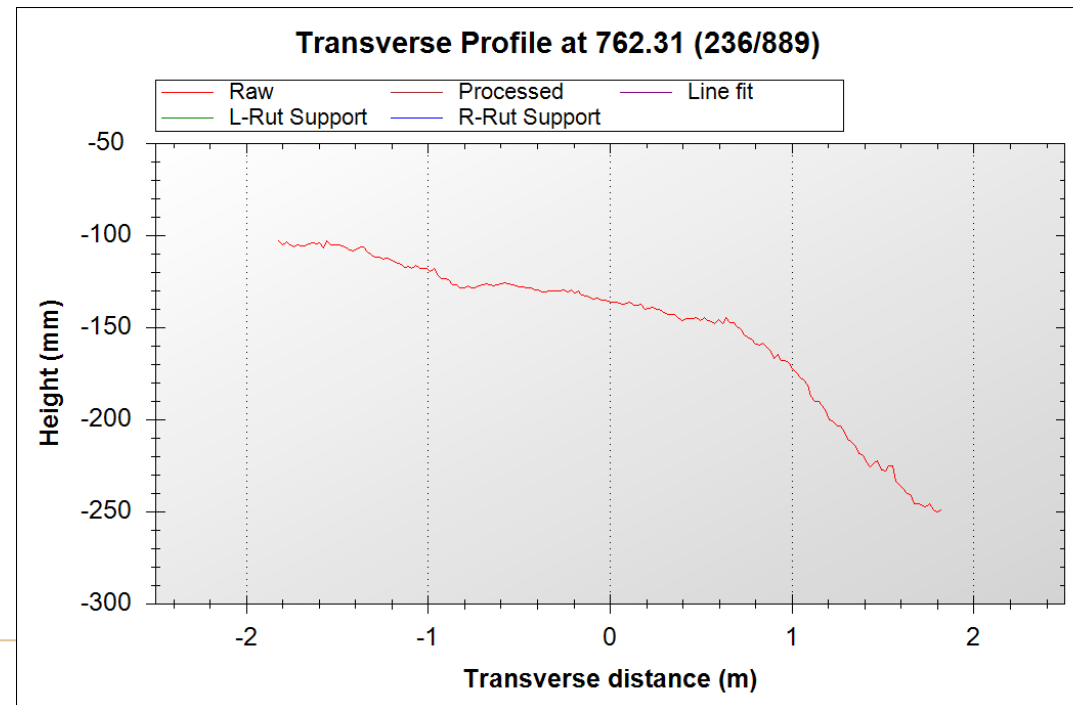
Analysis Tools

- Vehicle Specific Tools
- ProVAL – Free, publicly available software for analyzing roughness



Transverse Profiles & Rutting

- Systems can collect up to 4,000 points across at intervals as small as 0.2 inches (5 mm)
- Typically results are smoothed and reduced to approximately 200 points
- Lots of research with comparisons to field measurements



Rut Calculation

- Rutting is interpreted differently by different people
- Wire vs. Straight Edge Measurements
- Smoothing and removing crack depth
- Many other assumptions to match manual measurements



Automatic Road Analyzer

> TEXTURE (Option 2)

The LCMS sensors calculate full lane width texture measured in 5 AASHTO brands

> PAVE3D DISTRESS

With the ARAN's LCMS subsystem, 3D profile data is used for automated detection and full lane width image display.

> PAVE3D RUTTING

The 3D Laser Measurement System uses dual scanning lasers to accurately measure the transverse profile of the road with 4000 points over 4 meters.

> ROUGHNESS

The Laser SDP is a longitudinal profile measurement system that provides road profile data capture and real-time roughness index calculation using a combination of high-speed lasers and accelerometers.

> POSITIONING – POS LV 220

The POS LV tracks the position and orientation of the ARAN in real-time. This position and orientation solution and combines data from tactical-grade fiber optic gyros and accelerometers, a differential GPS, and a DMI.

> POSITIONING - GPS

Every ARAN is equipped with a GPS and is integrated with other subsystems so that if the receiver cannot lock on enough satellites to determine its position, the ARAN DMI and the ARAN Inertial Reference System will fill in the gaps.

> RIGHT-OF-WAY VIDEO

The ARAN can be outfitted with as many as six HDTV cameras which captures right-of-way images allowing you to virtually view the road from the comfort and safety of your office.

> GROUND PENETRATING RADAR

An electromagnetic device used to detect changes in road structure, including material thickness, changes in material and changes in material condition.

> POSITIONING - DMI

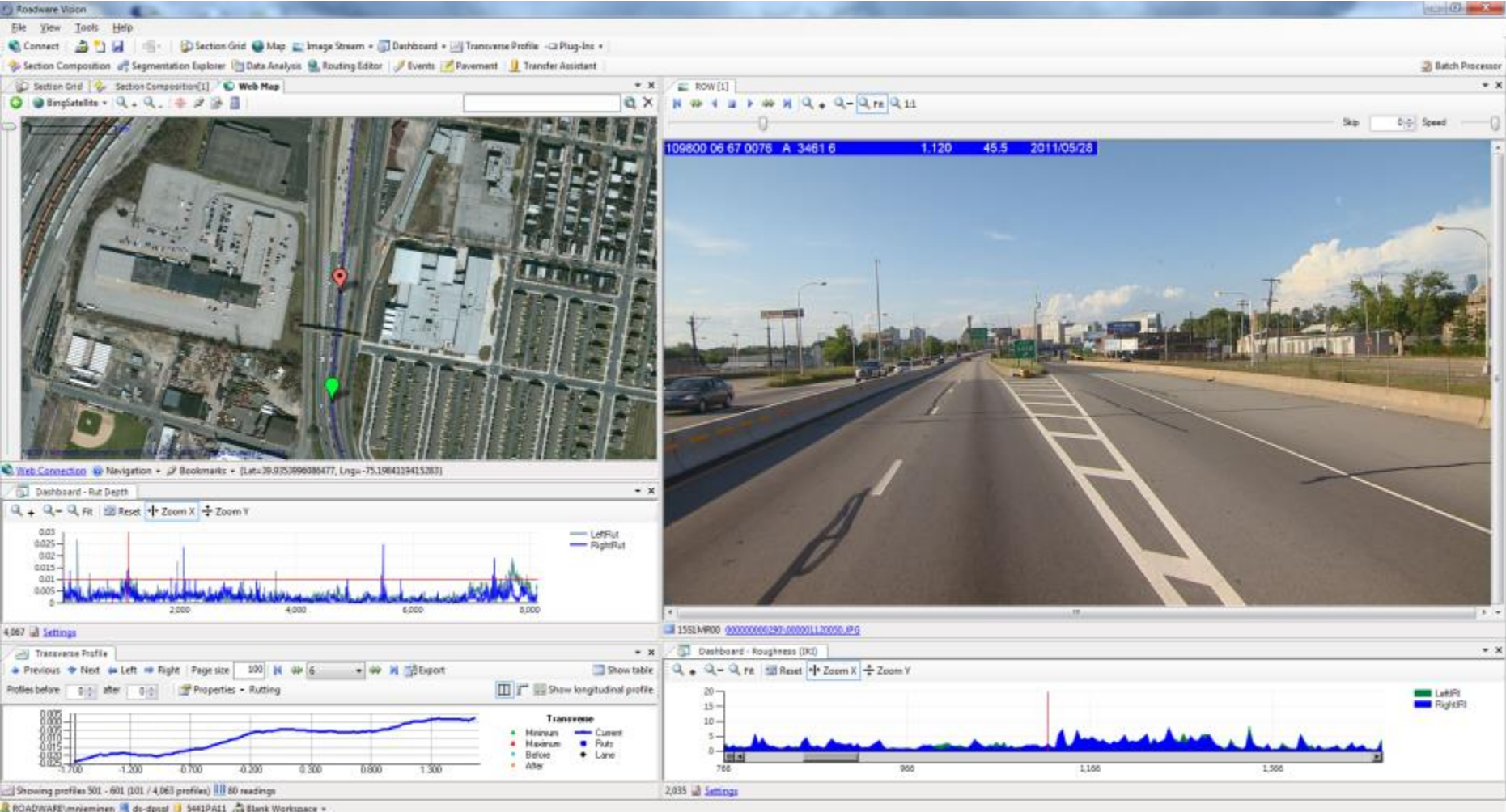
The Distance Measuring Instrument measures ARAN chainage and linear distance travelled. Every ARAN is equipped with a GPS and is integrated with other subsystems so that if the receiver cannot lock on enough satellites to determine its position, the ARAN DMI and the ARAN Inertial Reference System will fill in the gaps.

>TEXTURE (Option 1)

Smart Texture utilizes high frequency lasers to measure the mean profile depth of road surface macrotexture.



Analysis Tools



The screenshot displays the Roadware Vision software interface, which is used for road analysis. The main window is divided into several panels:

- Top Left:** Aerial satellite view of a road section with a red location pin and a green location pin.
- Top Right:** A street-level perspective view of a road with a blue data bar at the top showing coordinates and date: 109800 06 67 0076 A 3461 6 1.120 45.5 2011/05/28.
- Bottom Left:** A line graph titled "Dashboard - Rut Depth" showing rut depth measurements for LeftRut (red line) and RightRut (blue line) over a distance of 0 to 8,000 units.
- Bottom Center:** A "Transverse Profile" graph showing cross-sectional data for Current (blue line), Puts (red line), and Lane (green line) across a transverse range from -1,700 to 1,300.
- Bottom Right:** A line graph titled "Dashboard - Roughness (IRI)" showing roughness measurements for LeftIRI (green line) and RightIRI (blue line) over a distance of 700 to 1,500 units.

The interface includes a menu bar (File, View, Tools, Help) and a toolbar with various analysis and navigation tools. The status bar at the bottom indicates the current workspace and data source.

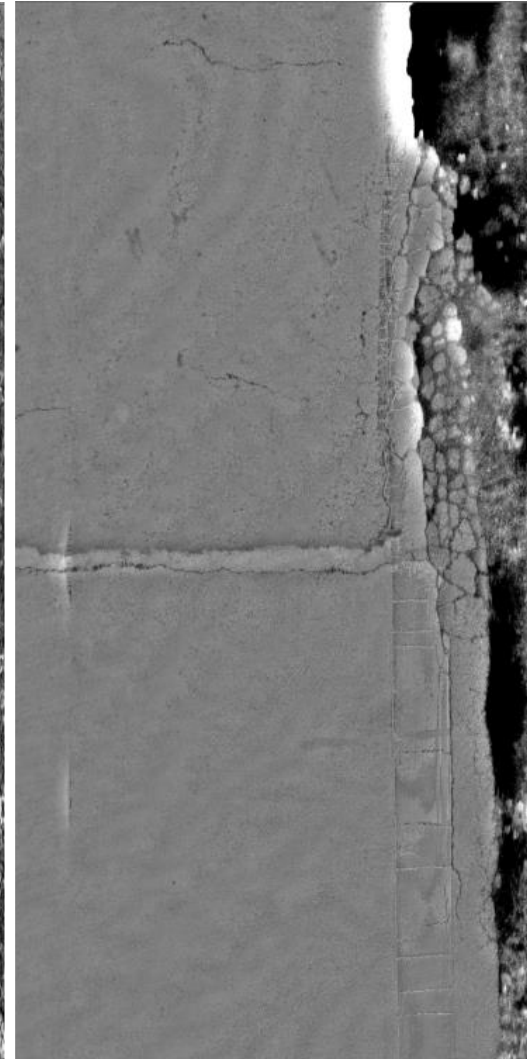
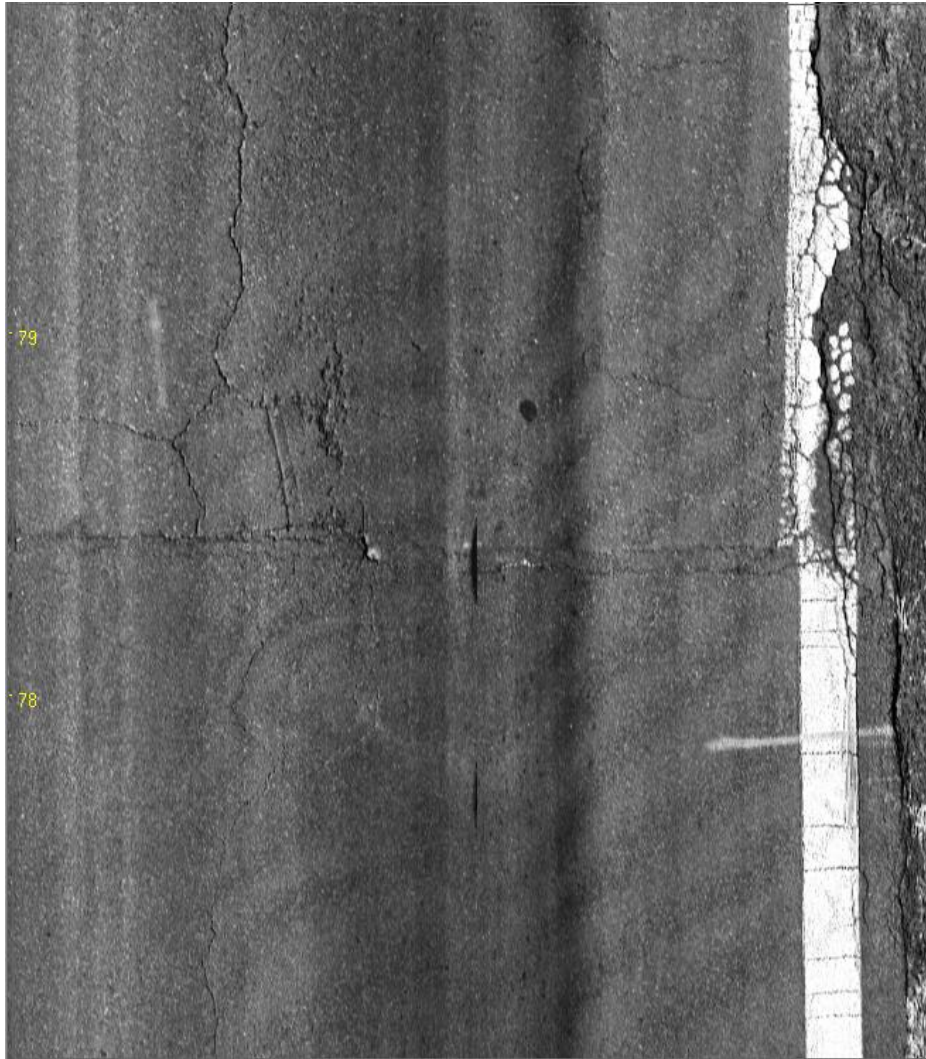
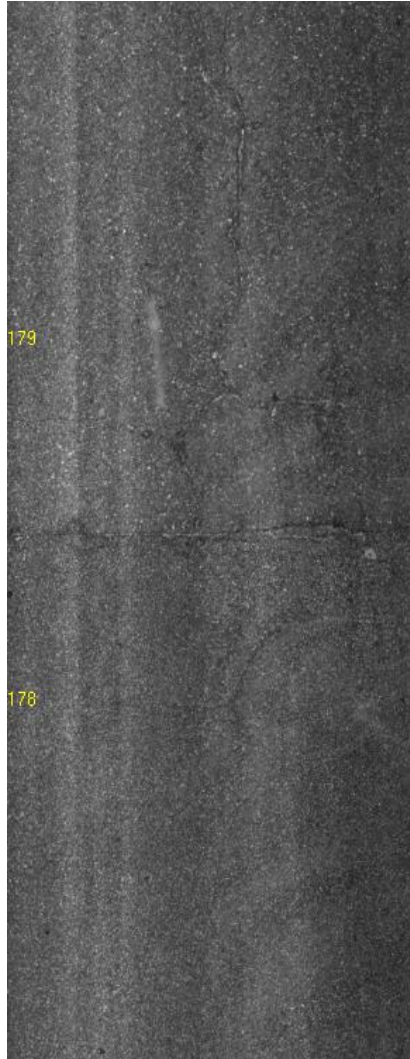
Right of Way Video

- High quality camera systems
 - Full HD image resolution
 - High frame rates and 3CCD sensors

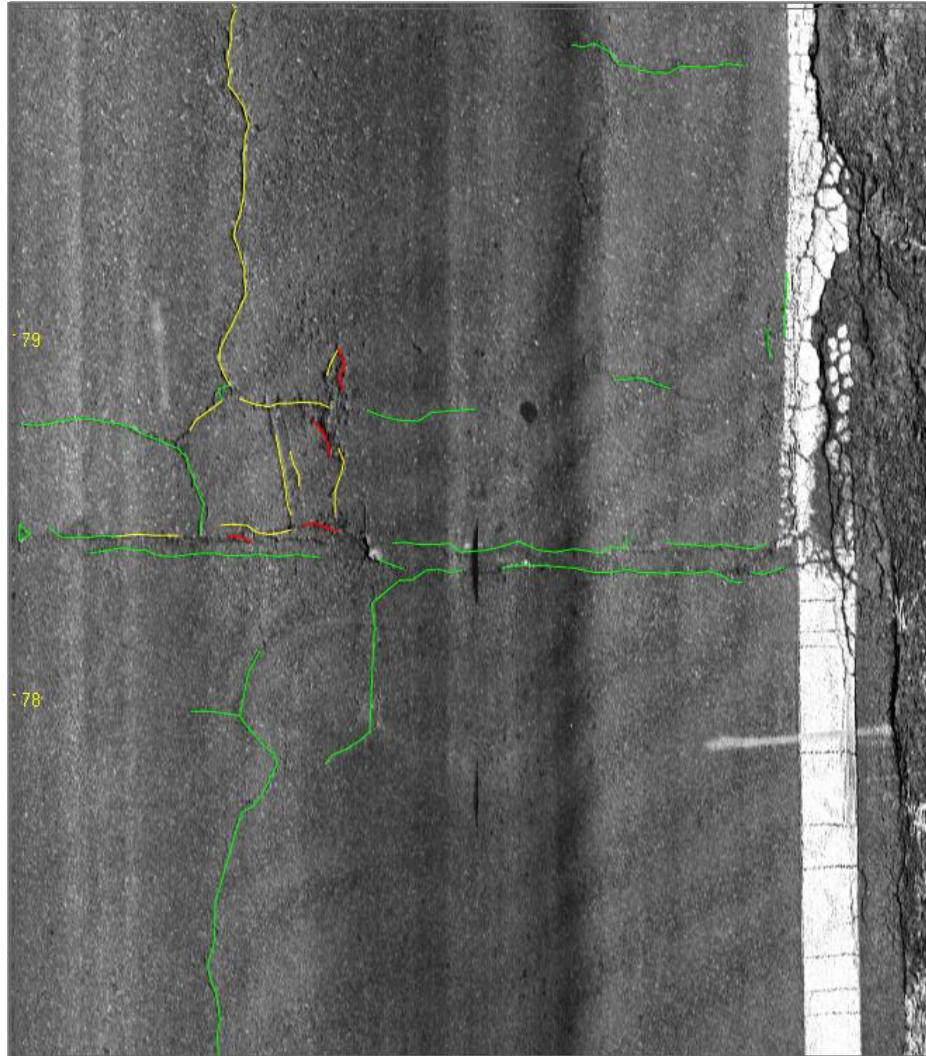
116990 4 ALA 024 5 1 A 6.780 63.1 11/04/2010



3D Pavement Images



Crack Detection / Rating



iVision

Fugro Roadware iVision | Year: 2013 | Level: 4 | Linear Reference: 1860.280

Map

Bing Map | Road | Aerial | Aerial With Labels

Legend

- Current Location
- IRIL
 - [16.626 - 120.000]
 - [120.000 - 240.000]
 - [240.000 - 4190809.405]

ROW

LCMSPavement

Rutting

Legend

- LRUT
- RRUT

Y-axis: Values (0.000 to 0.350)
X-axis: Chainage (0.000 to 37000.000)

iVision v3.3.443.2013 Professional - Database Schema v3.2

