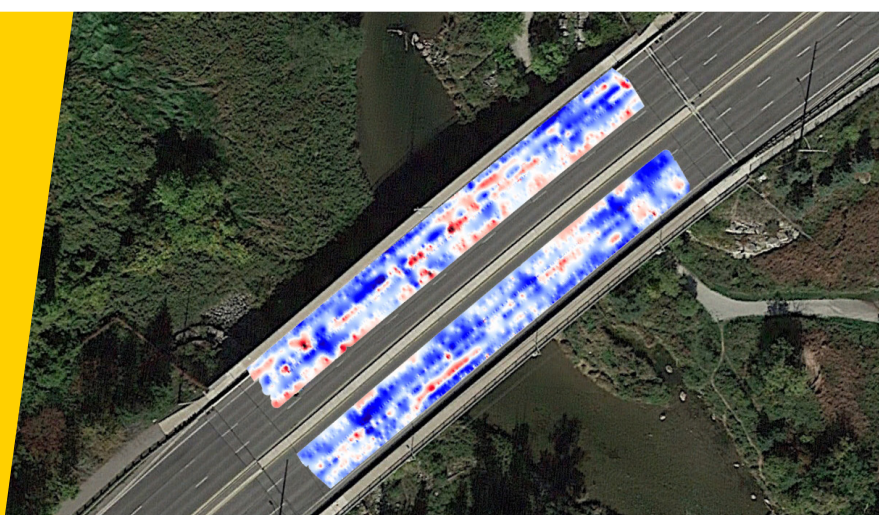


GROUND PENETRATING RADAR FOR INFRASTRUCTURE ASSESSMENT

INNOVATIVE SOLUTIONS
FOR PAVEMENT, BRIDGE
& CONCRETE INSPECTION
CHALLENGES



SENSORS & SOFTWARE
from RADIODETECTION



The Infrastructure Challenge

44%

of America's major roads are in "poor to mediocre" condition in 2017.

TRIP: Transportation Research Group, 2017

D

The grade for US roads in the 2017 Infrastructure Report Card by the American Society of Civil Engineers

9%

of the 607,380 bridges listed in the National Bridge Inventory were classified as structurally deficient in 2017.

TRIP: Transportation Research Group, 2017

\$740 Billion

The current backlog in needed road, highway and bridge improvements.

AASHTO 2015 Report

Finding cost-effective and efficient methods for inspecting, monitoring and rehabilitating existing infrastructure has become vital.



The traditional method of subsurface investigation, coring, is destructive and provides information only at single random points. GPR, a proven technology, offers a continuous image of the subsurface providing invaluable information for asset management planning. GPR can:

- Image asphalt and concrete at centimeter intervals
- Delineate layer thicknesses
- Accurately locate embedded objects such as rebar, post-tension cables and conduits
- Identify localized, anomalous features such as deep cracks, voids and deterioration

Sensors & Software GPR:

- Easy to use, flexible operation
- Ground-coupled GPR to provide the best quality, deepest penetration and highest resolution data possible.
- Intuitive and powerful processing software to efficiently analyse and report results
- Geo-referenced data collection for integration into GIS systems
- Industry recognized GPR expertise and support to help you maximize your GPR returns



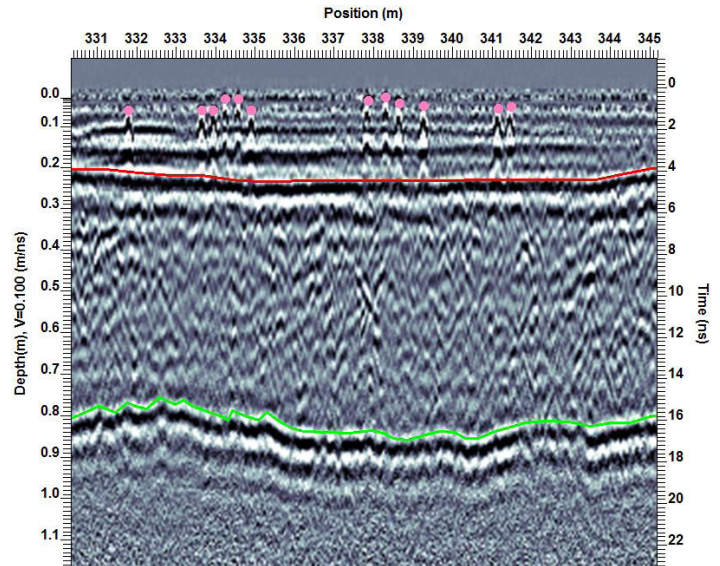
Overall Value of NDT Technology in Bridge Deterioration Detection

NDT Technology	Overall Value	Value
Ground-penetrating radar	2.5	1
Ultrasonic surface waves	1.8	2
Impact echo	1.5	2
Half-cell potential	1.2	3
Galvanostatic pulse measurement	1.0	3
Electrical resistivity	1.3	3
Infrared thermography	1.2	3
Chain dragging/hammer sounding	1.2	3

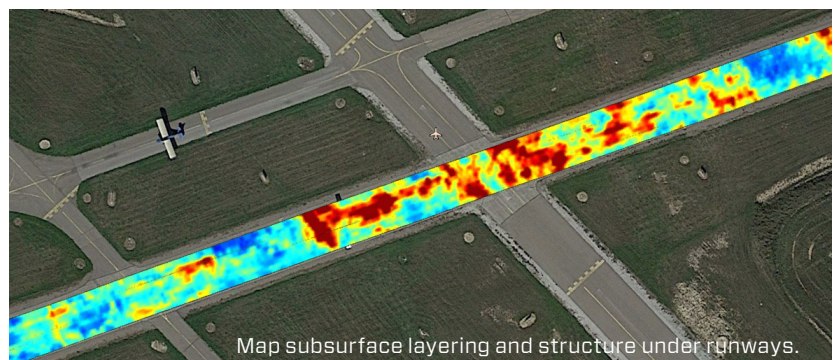
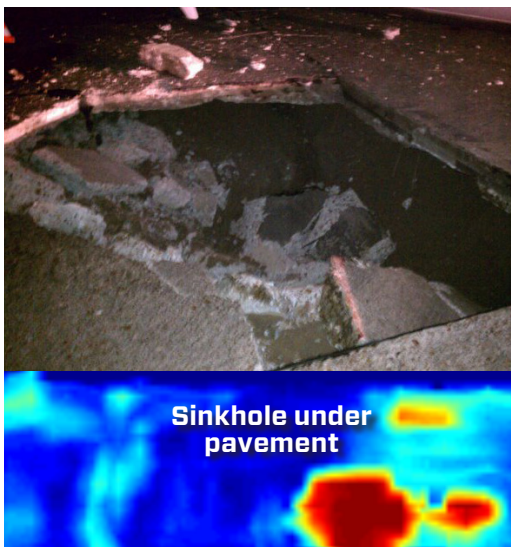
Road and Runway Inspections

GPR reveals local construction practice and potential hazards, enabling informed decisions for maintenance and repair expenditures.

- Measure pavement structure - obtain continuous subsurface imaging to delineate the top and thickness of asphalt, base, and sub-base layers
- Determine construction practices, including concrete under pavement, joints and road cuts that are not visible from the surface.
- Locate targets buried under the road, including utilities, and other embedments.
- Detect and map hidden hazards like sinkholes and voids before they become a safety concern.
- Quickly generate reports highlighting your results.



Data collected with the Noggin 1000 SmartChariot showing shallow road sensors and pavement layering.

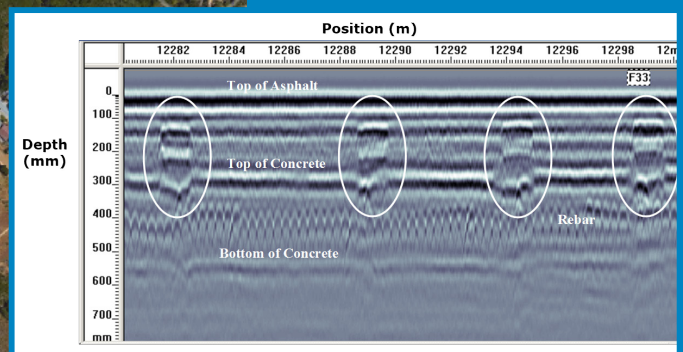
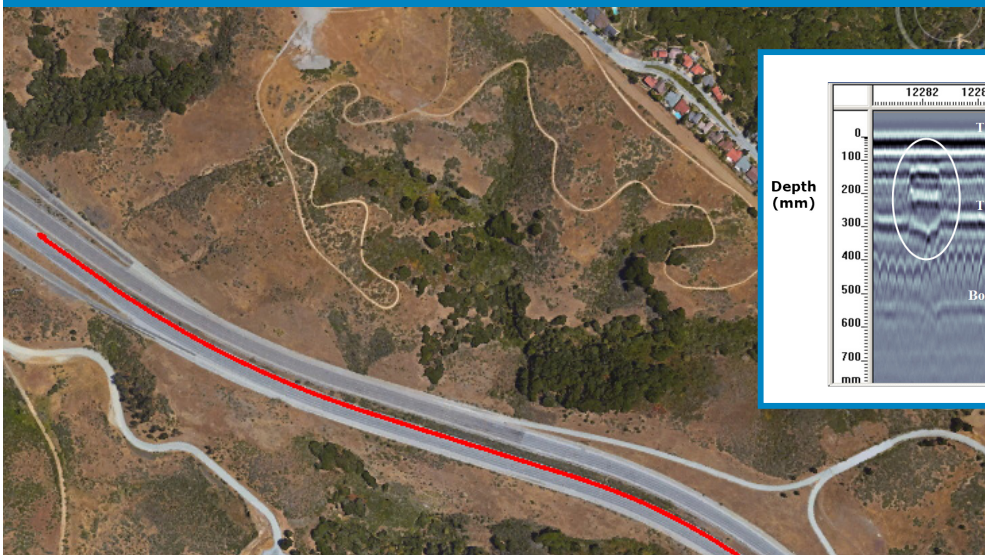


Map subsurface layering and structure under runways.

Layer	Minimum Thickness (mm)	Maximum Thickness (mm)	Average Thickness (mm)
Asphalt	170	250	202
Granular	169	309	240

Example of automated summary table of analyzed data.

Georeferenced data collection and intuitive software allows survey paths to be plotted in Google Earth™ at the press of a button.



Data from a major highway shows road cuts not visible on the surface and identifies the asphalt and concrete layers.

Bridge Deck Deterioration

GPR provides insights into bridge deck deterioration and rebar corrosion to effectively prioritize repair efforts

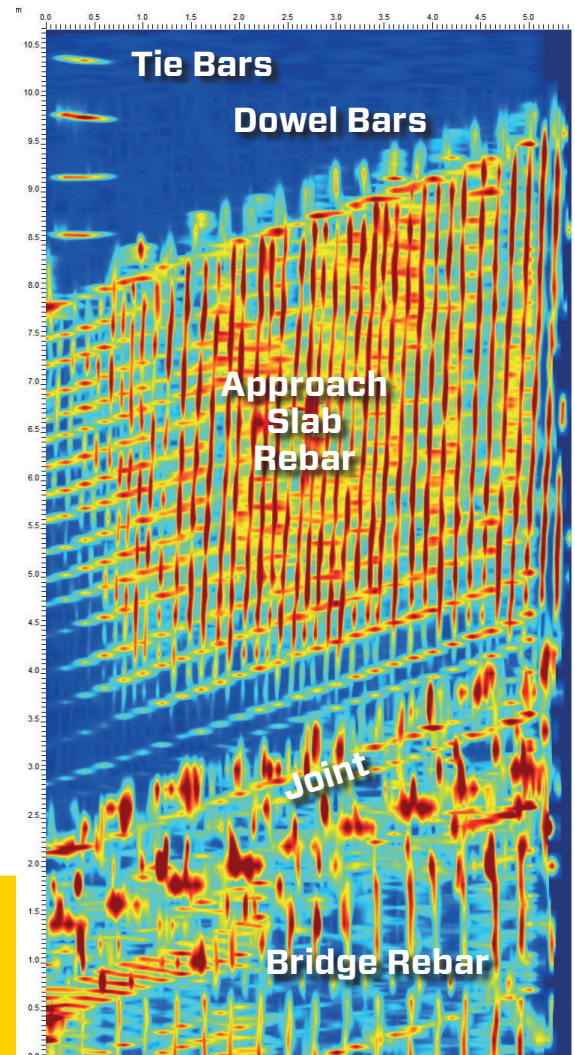
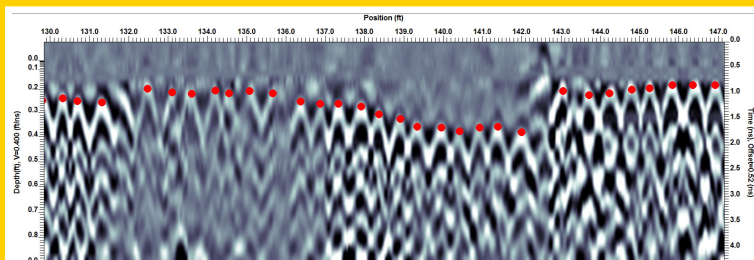
- Visualize and measure subsurface rebar structure, including spacing and cover
- Determine anomalous areas and guide core locations
- Easily create signal attenuation and deterioration index maps according to the ASTM D-6087 standard using the EKKO_Project Software and Bridge Deck Condition report module
- Identify inconsistencies and potential quality issues in bridge construction
- Determine dowel bar placement and orientation

Statistical Summary:

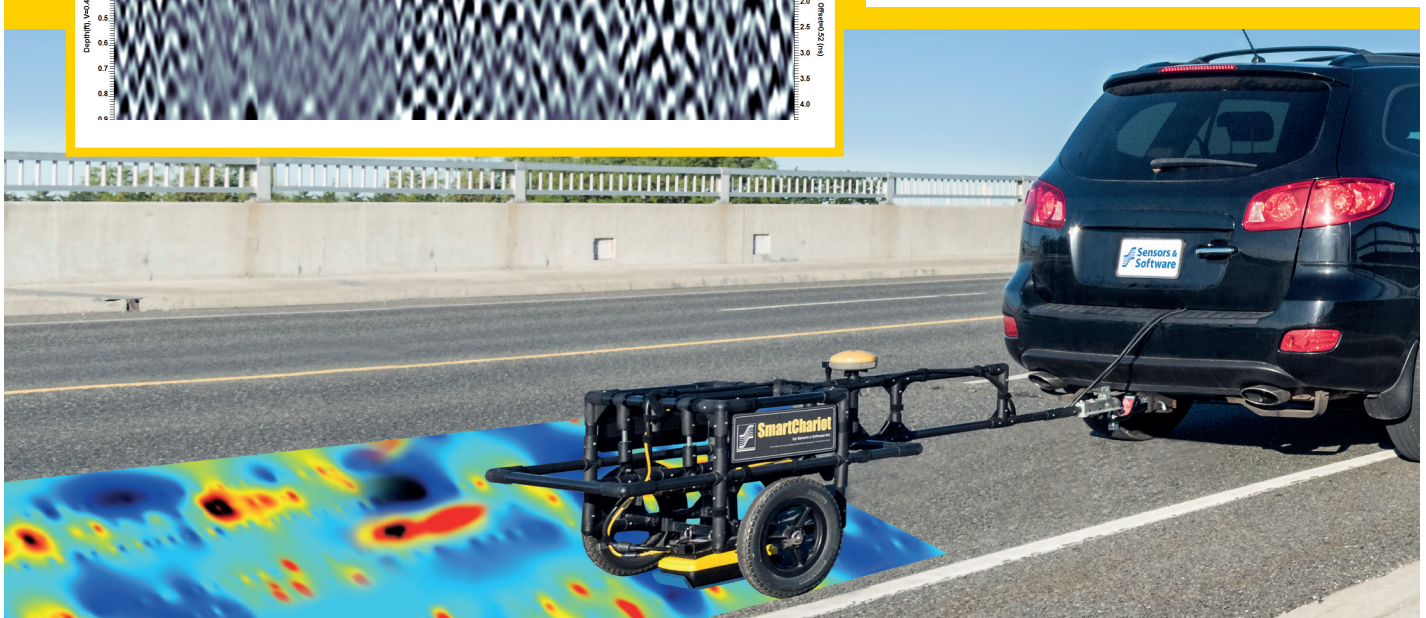
	GPR Amplitude (dB)	Reinforcement Depth (ft)	Reinforcement Spacing (ft)
Minimum	-1.418	0.154	0.301
Maximum	30.711	0.475	10.947
Average	3.280	0.257	0.593

Automatically generated bridge deck statistics

Cross-section shows an area of a bridge deck where the depth of rebar cover quickly increases more than 2.5 inches over about 5 feet - useful information for quality control on bridge deck construction.



GPR depth slice showing bridge deck structural components.

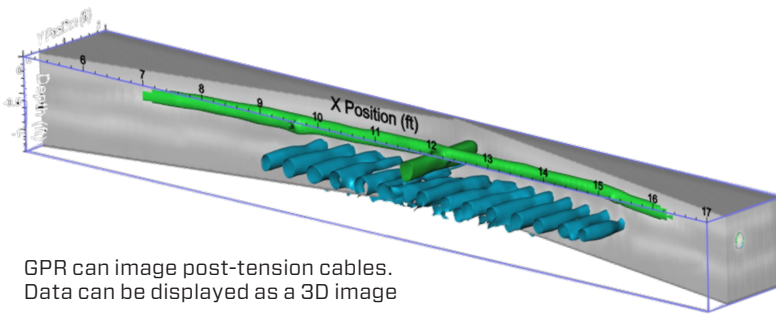


Bridge deck deterioration map.

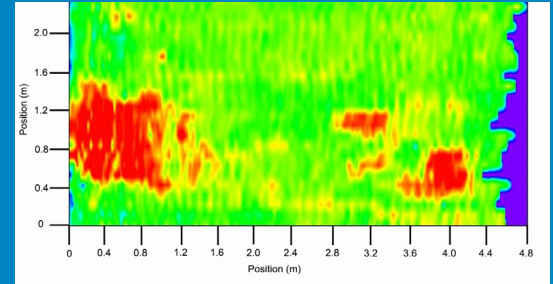
Infrastructure Assessment

Analyze the interior structural conditions of concrete to find problems before they become a safety concern

- Quickly scan areas for embedments and post-tension cables to ensure safety during cutting & coring
- Assess corrosion and deterioration to prioritize corrective action
- Assess internal concrete structure to verify construction practices
- Map structural components to aid in design and planning
- Detect voids or cavities under concrete



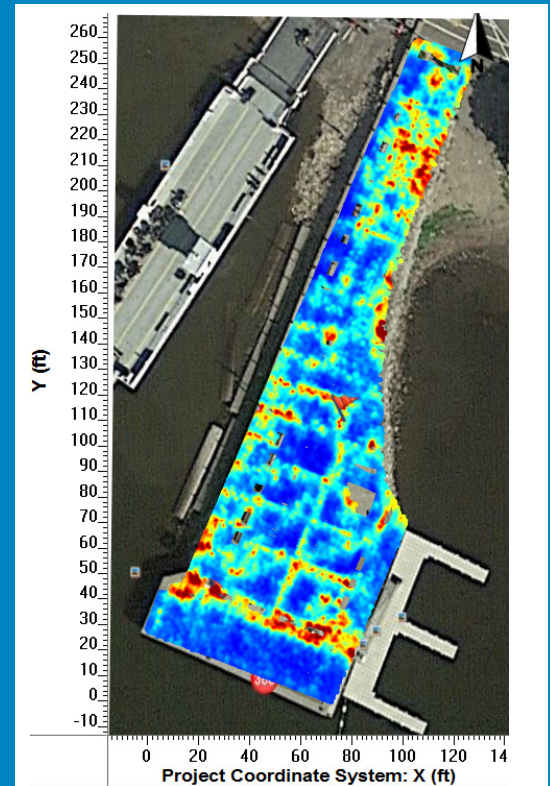
GPR survey at a bus terminal revealed missing dowel bars between concrete slabs, quickly identifying where to focus repair efforts.



Voids under a concrete floor.



Quickly collect grid data to visualize structural components on vertical supports.



GPR survey of a concrete pier to locate subsurface voids after the pier was submerged underwater by major flooding. Problem areas were easily identified and corrective action was taken to ensure public safety.

GPR Systems

We offer a range of solutions for pavement, concrete and bridge deck inspections.



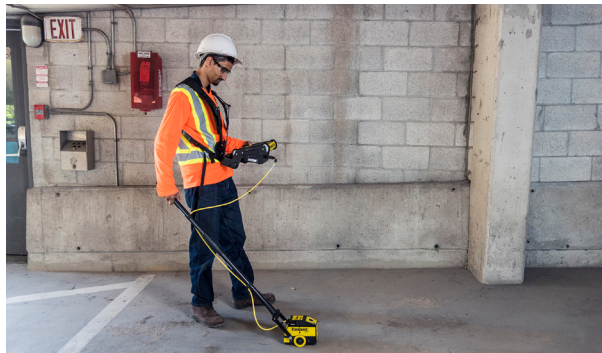
SmartChariot™ - inspect roads and bridges at medium driving speeds. Attaches to any vehicle with a hitch and includes a mount for GPS.



RoadMap™ - collect single or multi-channel GPR data at highway speeds on roads, bridges and highways; avoiding road closures.



SmartCart® - provides rapid data collection of lines and grids. Ideal for highly accurate, localized infrastructure surveys.



SmartHandle™ - easily inspect the as-built condition of concrete floors, walls, columns and ceilings.

Custom engineering:

Sensors & Software's GPRs are modular and can be used to create unique custom configurations or multi-channel array systems.



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