# Safety Supplements

**>Non-destructive technology can help secure a safer transportation infrastructure.**

**Seven years ago, the overpass** collapse in Laval, Québec, that led to the death of five people brought to light severe issues with the state of the country's bridges and transportation infrastructure.

More recently, a crack in the Champlain Bridge to Montreal that forced more than 160,000 commuters to find alternate routes to work reaffirms a need for greater emphasis on early detection before a crisis occurs.

Surprisingly, despite these concerns, regular inspection of transportation infrastructure is still not mandated in many provinces. Furthermore, when inspection does occur, it is commonly carried out using traditional methods such as a visual inspection of structural elements followed by selective core sampling. These methods can be ineffective for a variety of reasons. Visual data is highly subjective and influenced by technician training and interpretation. Coring is often costly and fails to provide a quantifiable, representative sample of the entire inspection area.

In response to these challenges, municipalities and engineering firms across the country are beginning to incorporate non-destructive technologies into the inspection process to supplement traditional techniques. Combined with inspection data, project stakeholders are able to achieve a more substantive dataset on subsurface conditions and subsequently make more informed decisions around infrastructure rehabilitation spending and project prioritization.

## The Role of GPR

Effectively planning a road or bridge rehabilitation program requires gathering and interpreting a considerable amount of data on a number of factors that may include asphalt, concrete and granular thickness; pavement or concrete damage; moisture in the concrete; rebar positioning and thickness, among others.

It can be difficult to achieve a representative sample of this data through traditional inspection techniques alone, such as cores or boreholes, because this approach often fails to capture a continuous profile of a stretch of road or bridge deck. For example, localized sampling may not account for variations in pavement layer thickness over a vast area that could have been caused by previous rehabilitation or maintenance.

Ground penetrating radar (GPR) is increasingly being leveraged to close these information gaps and provide a more complete picture of infrastructure health. It's a non-destructive technology that works by transmitting high frequency radio waves into the ground or structure and analyzing the reflected energy to create a profile of the subsurface features. The reflections are caused by a contrast in the electrical properties of subsurface materials which can be indicative of changes in water content, void spaces in the ground, rebar or post tension cable corrosion, asphalt deterioration and other factors.

Once collected, analyzed and visualized, this data can then be used to make informed decisions around the design and execution of maintenance work for many different types of traffic infrastructure. It also can be used to better understand patterns of deterioration and the effectiveness of maintenance programs over time, thus reducing the risk of an unexpected failure.

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unique ability to detect deterioration and other subsurface anomalies before they develop into serious concerns," said Dr. Peter Annan, P.Eng, Ph.D Geophysics, Founder, Sensors & Software. "Techniques such as GPR, when applied to bridge deck deterioration assessment, reveal changes in subsurface properties that allow suspicious areas to be targeted for further evaluation and preventative remediation. More traditional methods such as chain drag, for example, will detect deterioration only once the concrete or bridge deck has already become cracked or delaminated."

**Detecting Deterioration**

GPR also was applied to conduct a bridge deck inspection and deterioration analysis for sections of Toronto's Gardiner Expressway: a major artery that runs 11 miles from the Don Valley Parkway to the Queen Elizabeth Way (QEW). In operation since 1955, structural concerns have prompted recommendations to rehabilitate and in some cases, replace raised sections of the Expressway.


GPR data can be used to make decisions about maintenance for the many types of traffic infrastructure.

To inspect the vast and geometrically complex structure, GPR was applied to analyze all continuous east and west bound lanes of a 15km raised section along with corresponding access ramps. High-resolution GPR observations were collected from curb to curb, less than a metre apart at a speed of 40km per hour. Six lines of data were captured for each vehicle lane and over 1.3 million targets within the project area were processed and georeferenced to assess deterioration. Data was then digitally recorded to produce colour-coded, contour maps for each section which were included with an evaluation report.

The data also was used to create a bridge deck deterioration index that indicated the percentages of each section that appeared to be above the deterioration threshold. Methodology prescribed by standard ASTM D 6087–08 was leveraged and augmented by depth compensation to account for existing inconsistencies along the bridge deck.

To ensure accuracy, data was correlated with existing coring data and Ontario Structure Inspection Manual (OSIM) inspection records. With more than 200,000 commuters relying on the Gardiner Expressway each day, this made it possible to acquire data with no measureable impact on traffic flow.

"High-resolution GPR data is a key component of the inspection workflow," Annan said. "When calibrated with coring and similar control data, a greater density of information is obtained, thus empowering more informed decisions around maintenance, rehabilitation and design. The ability to gather more information at the outset greatly reduces the likeliness that plans will need to be rethought at later stages of a project."

With a majority of the country's infrastructure reaching the 50-year mark and beyond, non-destructive geophysical techniques are becoming integral to ensuring the safety of roads and bridges. GPR offers a quick and cost-effective method for capturing high-resolution data that supplements information gathered through traditional techniques. It reveals anomalies deep below the surface and provides vital information to assist with key decisions around infrastructure rehabilitation.

Furthermore, with traffic gridlock costing the city of Toronto alone an estimated $7 to $11 billion per year, non-destructive inspection techniques allow municipalities and other project stakeholders to avoid or reduce closures, helping to alleviate further strain on Canada's congested roads.

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