Stantec

Airfield Pavement Forensic Investigations

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Agenda

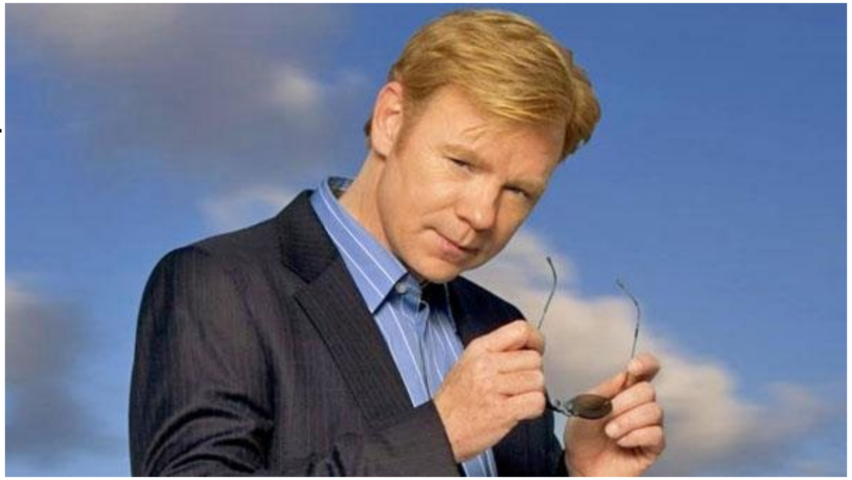
1. Pavement Forensics
2. Non-Destructive
   - GPR
   - HWD
3. NDT Trial survey
4. Capabilities and Limitations
5. Case review
6. Q&A

Airfield Pavement Forensic Investigation

American Society of Civil Engineers (ASCE 86) defines forensic engineering as "the application of the engineering sciences to the investigation of failures or other performance problems."

The objective is to determine **responsibility** and **causation** of distresses in order to appropriately address them with a cost-effective engineering solution.

The investigation collects data and determines the <u>**why?**</u> of the failure<u>**:**</u>
<u>**inadequate design, materials, construction workmanship, lack of maintenance, change or increase in use or a combination of these factors**</u>



Getting some *concrete* evidence…

Forensics

Airfield Pavement Forensic Investigation

Basic info to obtain **prior** to engaging or conducting the investigation:

- Construction History:
  - Plans and specifications
  - Date of each layer construction
  - Description of each layer:
  - material thickness and mix design
  - Construction QC and reports

- Past geotechnical reports and subgrade evaluation data

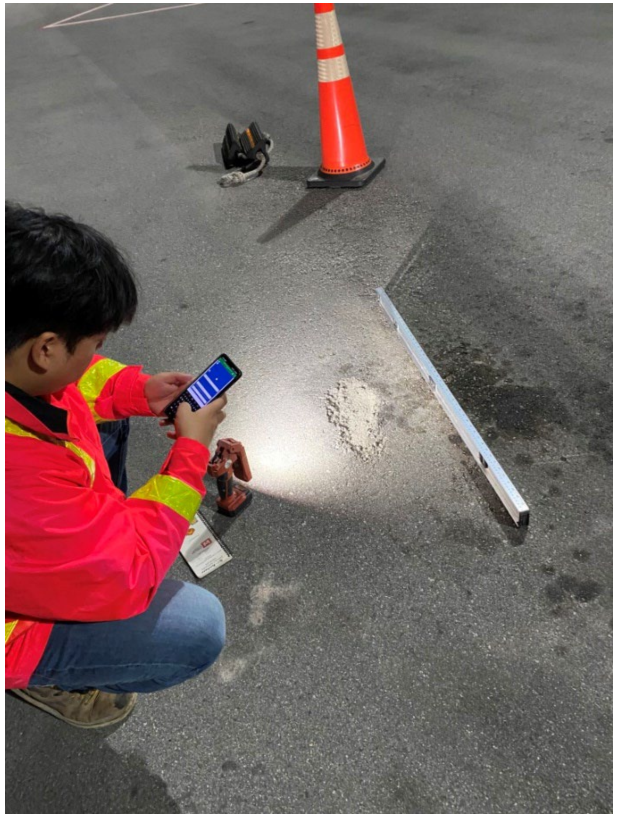
- Serviceability, fleet and traffic volumes. AOM published data

- Environmental conditions (variance since design)

NDT

Non-Destructive Testing

The intent is to conduct the investigation with **minimal or no impact** to Airfield operations. For this reason, NDT testing has been the topic of multiple research papers.



- Visual qualification and quantification of pavement distresses
- (using standardized methodology)

- Ground Penetrating Radar GPR (air or ground coupled)

- Heavy Weight Deflectometer testing

- Sounding

- Leading to limited confirmation coring or
- trenching at distress locations

Capabilities

Distress Surveys NDT trial by Stantec

(completed in 2019)

The objective of the trial was to establish a repeatable NDT protocol for the identification of full depth concrete repair solutions on composite pavements without the need for disruptive interventions. GPR and HWD surveys were conducted before and after trench milling; revealing the extent of subsurface distresses at joints and cracks.

Capabilities

Distress Surveys NDT trial by Stantec

(completed in 2019)

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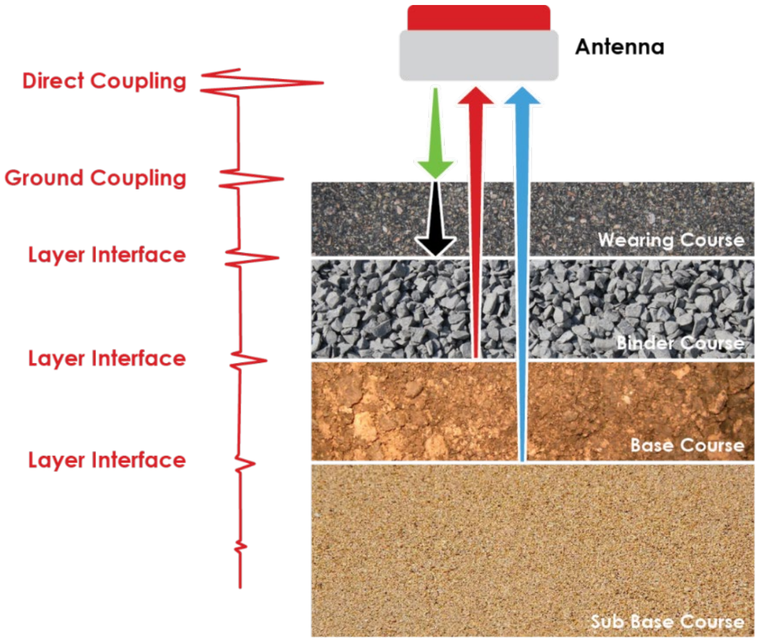
GPR survey was completed to determine:

- Condition of the concrete joint
- Potential Voids
- Reinforcement Deterioration
- Deteriorated Joints
- Potential faulting
- Other pavement inconsistencies at the joint



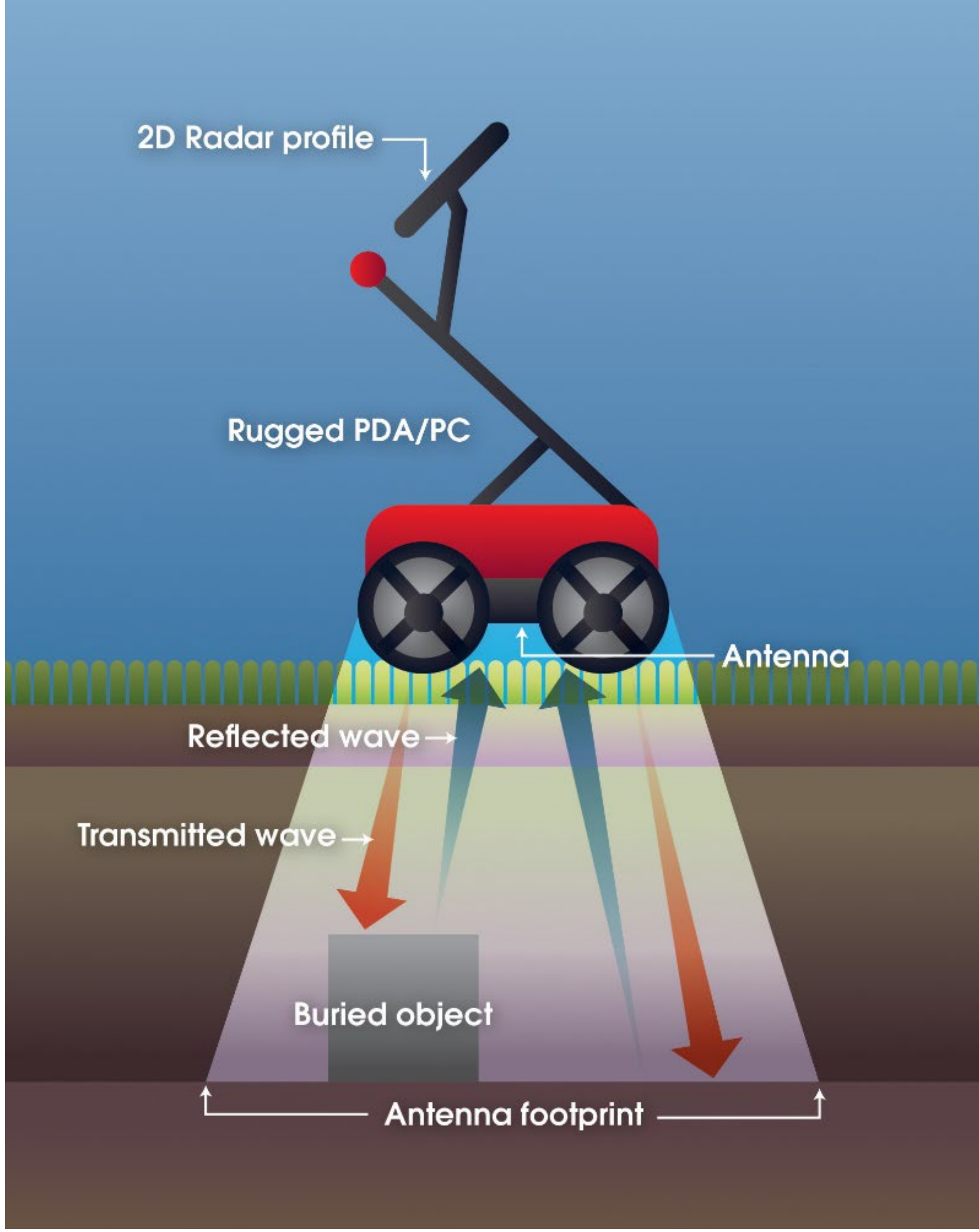
Practical range of operation

- From 1.0 ft to 1,000 ft in depth
- Function of the antenna frequency

Reflections are produced when the pulse encounters a material with a different dielectric constant

Air Coupled GPR

Applications: roads, highways, and runways

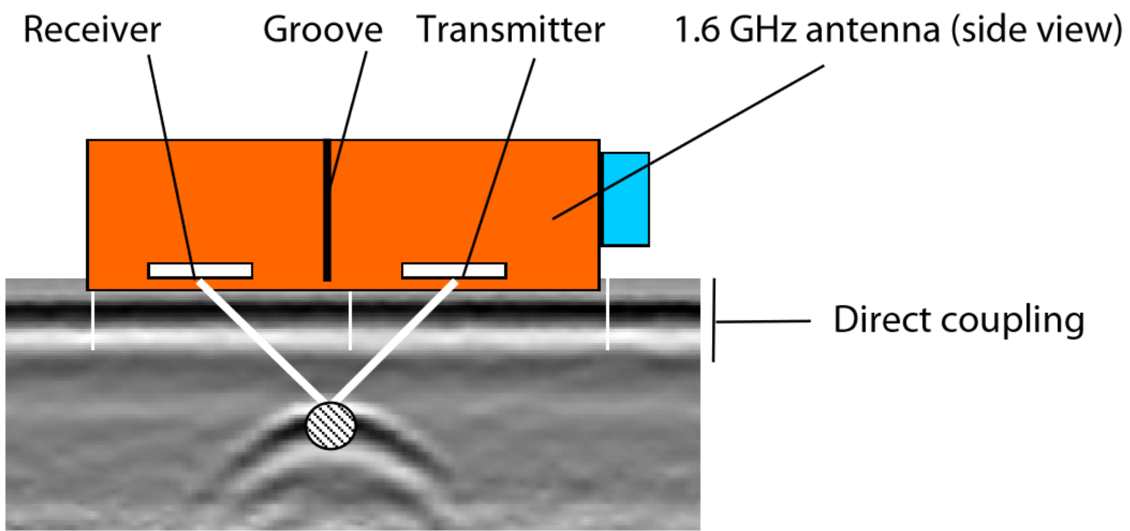


Ground Coupled GPR

Applications: buried objects, utilities, etc.

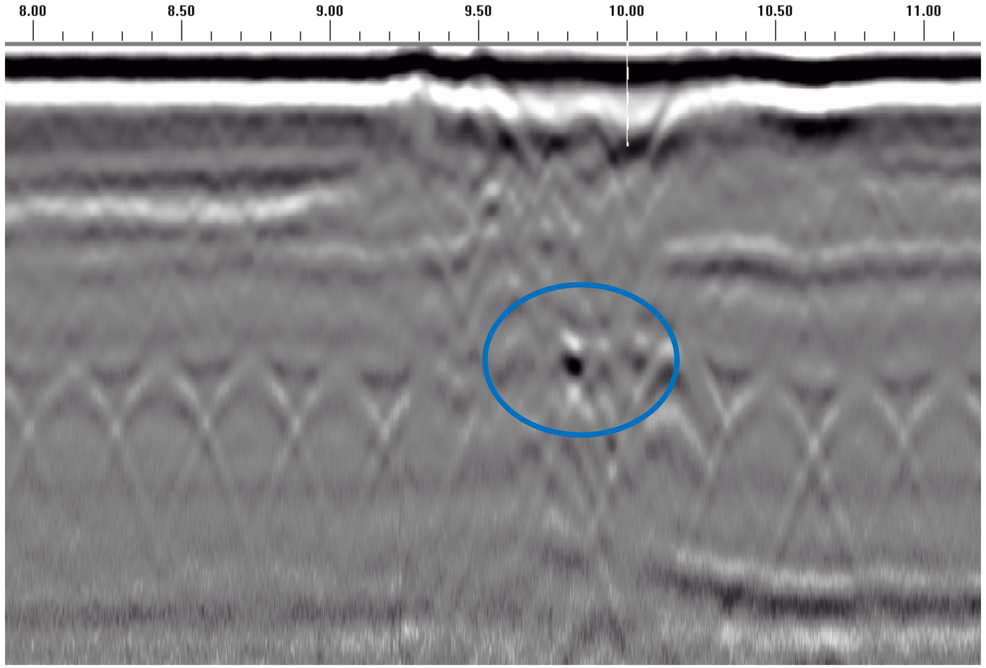
Void Detection

- Ground-Coupled GPR (400 MHz and/or 1,600 MHz antenna)
- Air pockets that the GPR signal cannot penetrate
  - Ex. Beneath concrete at approaches to a structure
  - Ex. Beneath the concrete at the joint



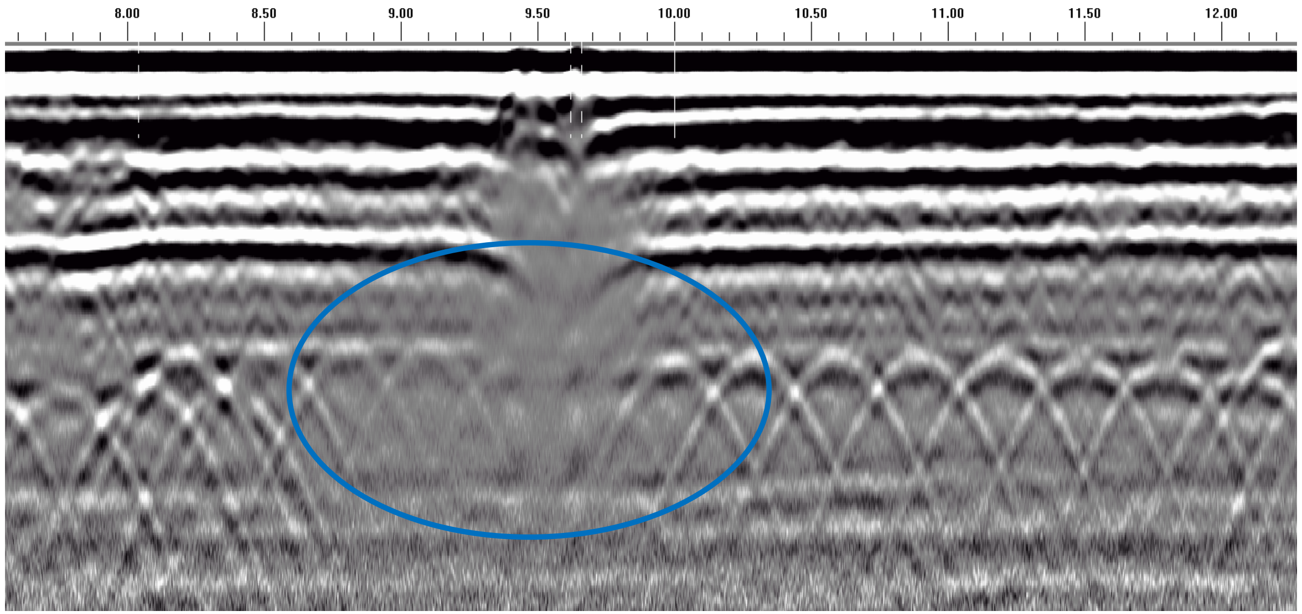
Types of Distresses

Void Anomalies

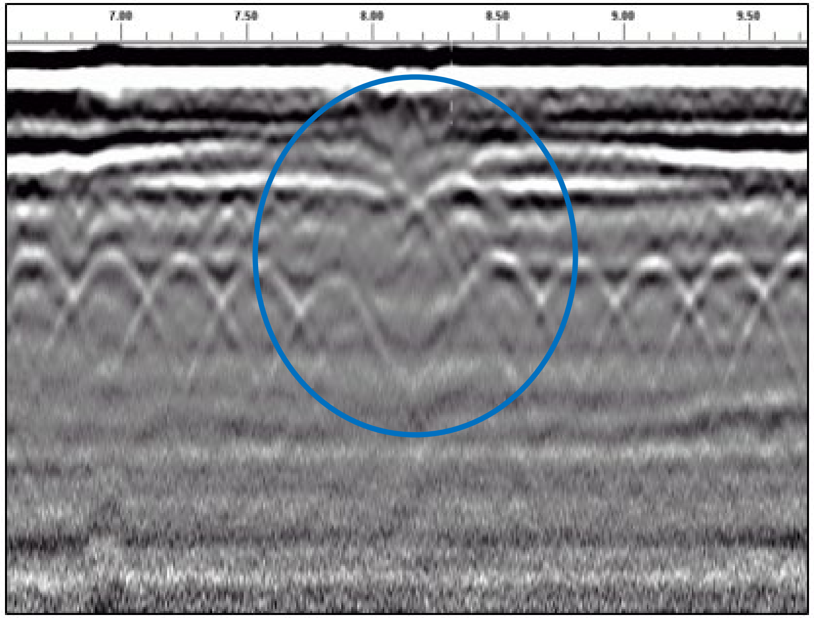


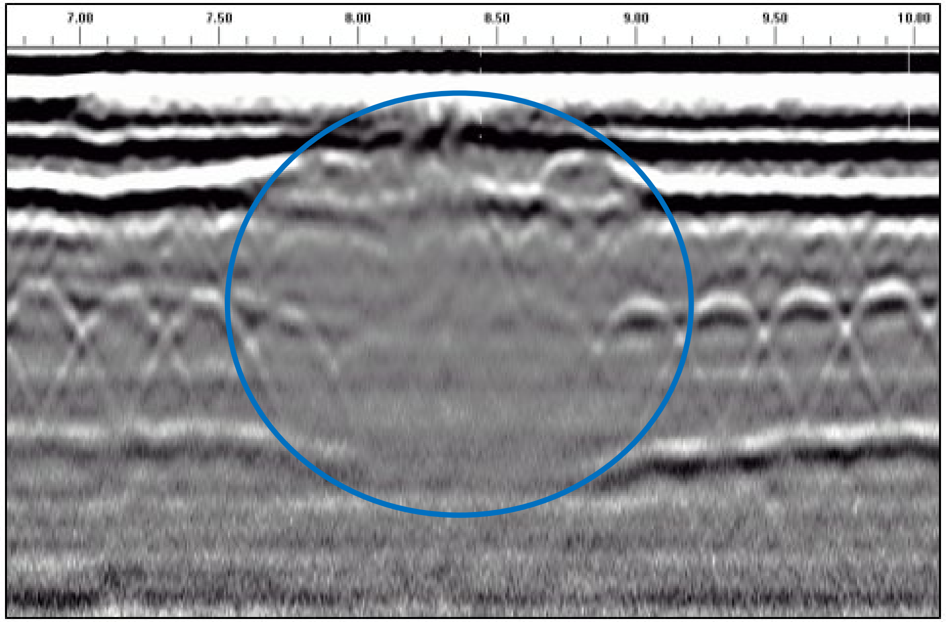
Types of Distresses

Reinforcement Deterioration



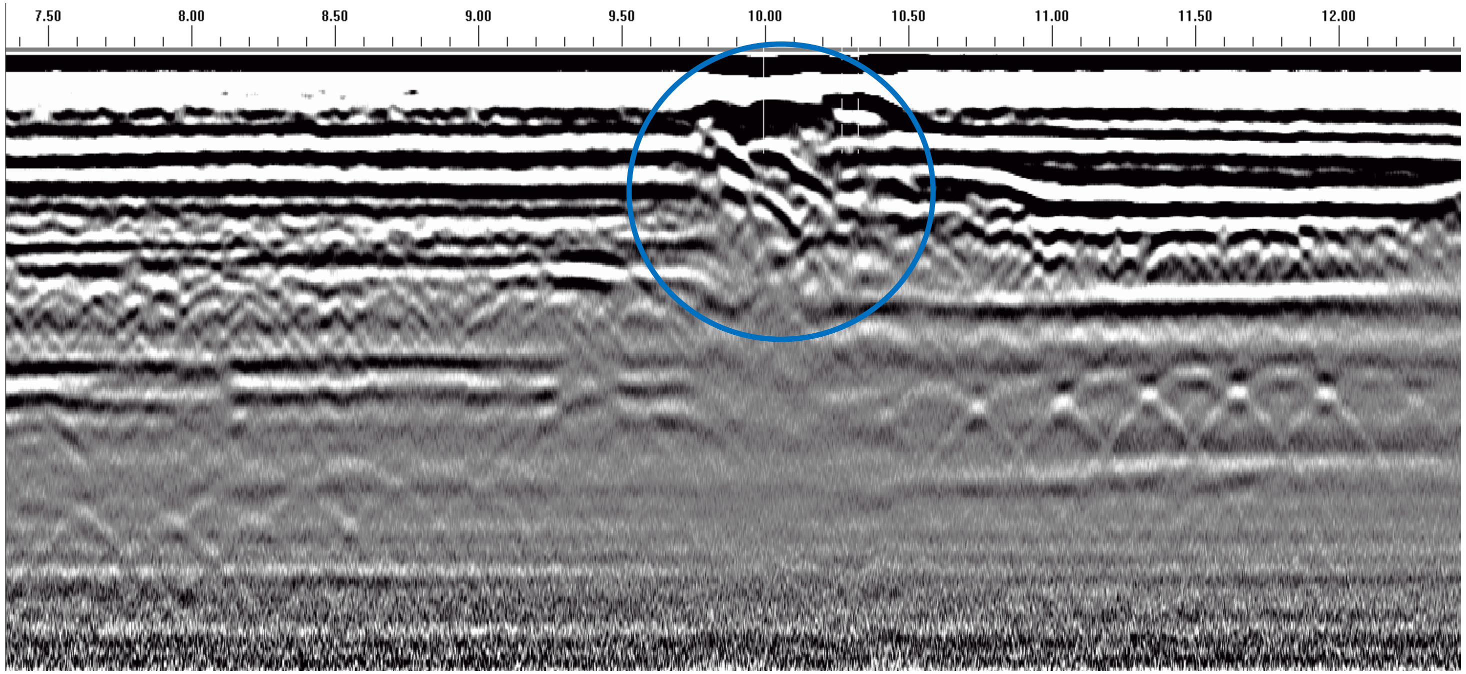
Deteriorated Joints





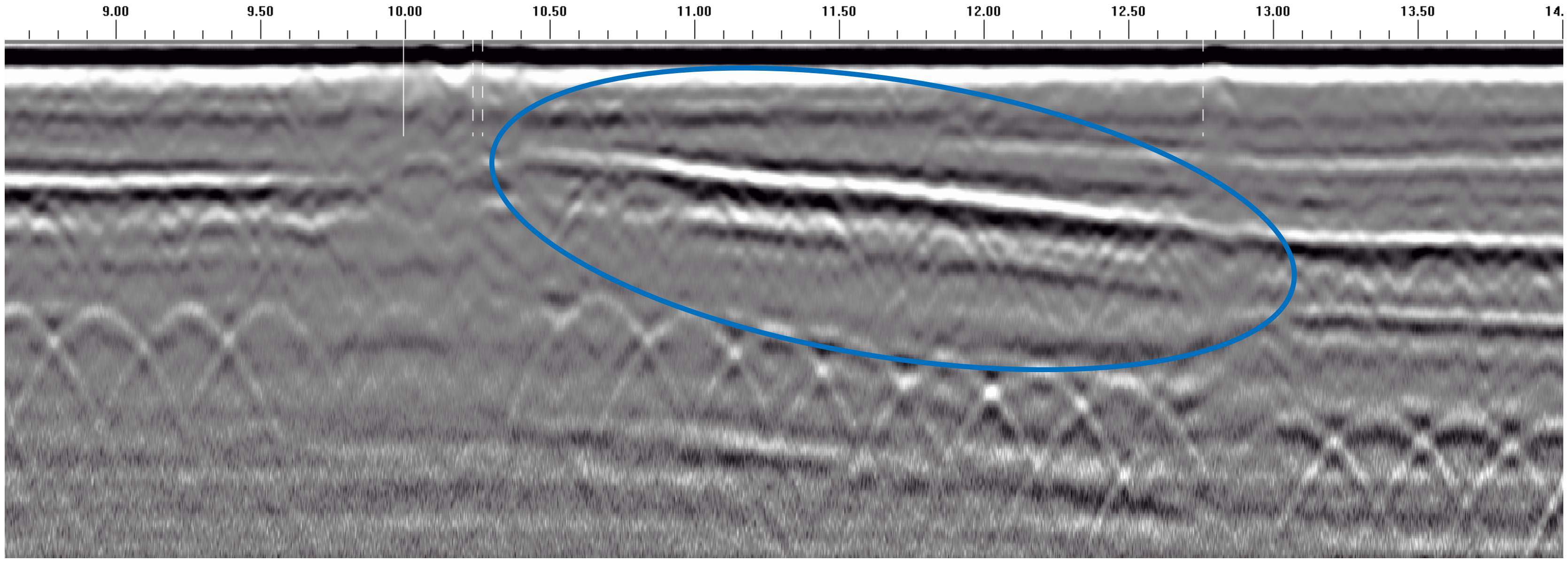
Types of Distresses

Discontinuous Asphalt Layer



Types of Distresses

Faulting



Results

Location 13

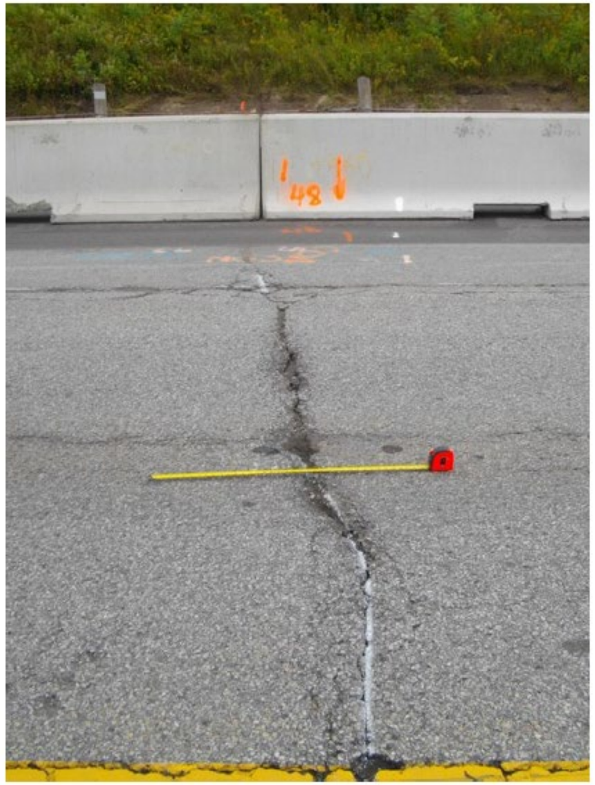
Falling/Heavy Weight Deflectometer

Applications: roads, highways, airports, subgrade resilient modulus, load transfer efficiency, PLR, etc.

HWD

HWD testing

Guidelines were modified to include four additional loading levels only reachable through HWD testing at 100, 150, 200, and 250 kN in addition to the standard 43, 53, 71 kN FWD loads.



Limitations

GPR:

The results of the distress survey indicated that identifying joints on a composite pavement with a thick asphalt layer can be difficult. Only 10 of the existing 31 joints were correctly identified as joints and 22 concrete cracks were incorrectly identified as joints.

The GPR testing confirmed the presence of steel reinforcement in the original concrete construction and dowels at the joints. It also revealed that slab repairs were doweled into the original concrete. It should be noted that the GPR can only locate steel and the type of steel was interpreted to be either reinforcement or dowels based on the spacing in conjunction with historical construction records.

HWD:

Increasing the load level had no visible correlation with Load Transfer Efficiency (LTE) values. In general, the LTE values were the same regardless of load. Weak correlations between LTE and distress, both on the composite and concrete surfaces, were observed.

Case Study

Canadian Greenfield Airport built in 2007

The Runway displayed signs of transverse thermal cracking, paver joint longitudinal cracking and rutting in 2016.

Consultants attributed this to a rise in traffic and the asphalt mid-life crisis.

Detailed investigations did not proceed.

A 70mm full surface overlay was completed using a municipal asphalt mix with anti-strip additives in 2017. The asphalt binder was downgraded due to local availability.

As construction was phased, 6 transverse cracks reappeared before the full completion of the project in 2017.
By 2018, close to 30 full width transverse cracks had reappeared.

Case Study

Following a maintenance program, the Airport requested a forensic investigation and repair feasibility study.

Upon review of record documents, it was suspected that construction workmanship, materials ad advanced moisture damage may have caused the early deterioration of the Runway.

A full survey of the surface was performed including GPR, coring and dynamic core splitting was performed.

Case Study

Case Study

The GPR investigation revealed that the runway pavement layers were relatively consistent in thickness. However, the base gravel layer was generally thinner than expected from project records.

Looking closely at split cores, it was evident that the original asphalt had advanced moisture damage issues.

The cause of the distresses were therefore attributed to the quality of materials and stripping.

The 2017 overlay had no chance to survive through its expected life-cycle.

This represents a **capital loss of $5M** for the Operator/Owner.

The 2022 cost of the field investigation and reporting was **$19k**; highlighting the importance of doing your homework.

Questions?

Q&A