Big Data Approaches in the Nondestructive Evaluation of Concrete Spillways

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Introduction

The Background

- The function of concrete chute spillways is to ensure the safe travel of flowing water from a dam to designated downstream locations

The Problem

- Concrete degradation, rebar corrosion, and geological issues threaten the health and functionality of spillways

Introduction

The Challenge

- Determining the likelihood and scale of these threats on structures as large as spillways in a cost-effective manner

Introduction

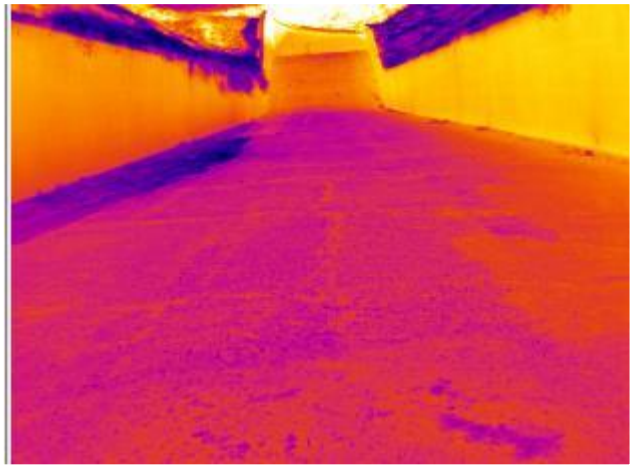
The Solution

- Big Data Approaches in Nondestructive Evaluation

Acoustic Methods

Ground Penetrating Radar

High-Definition Video

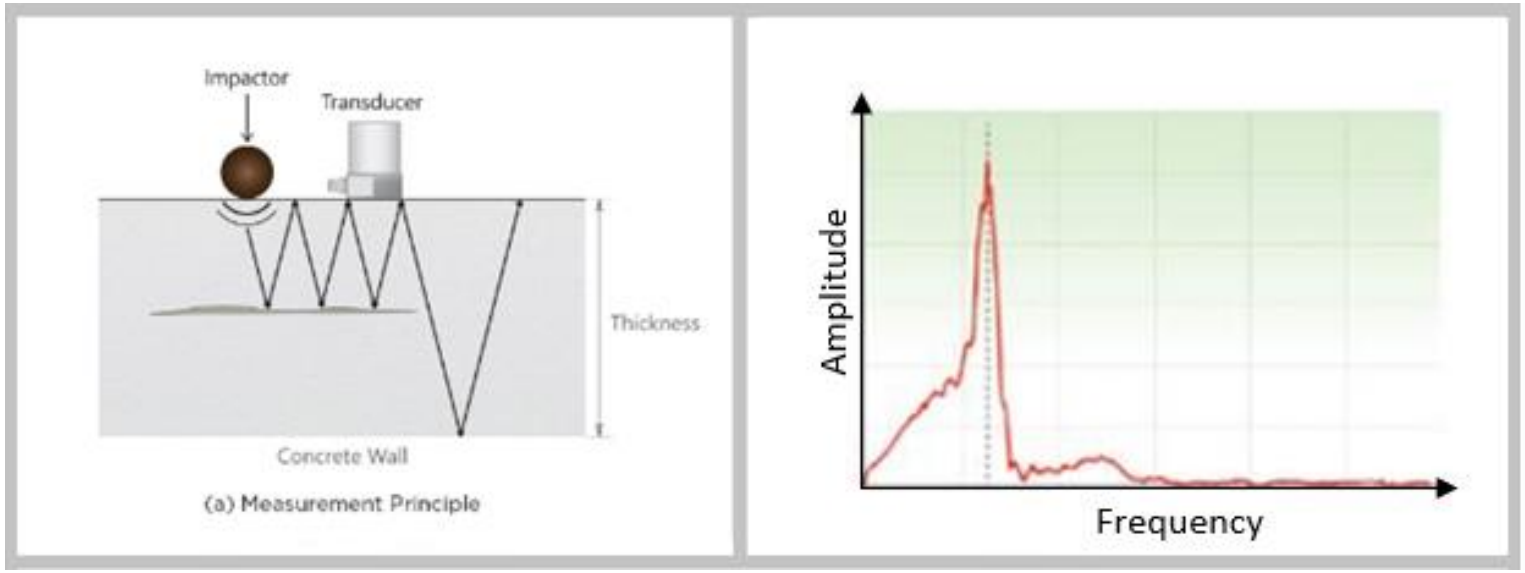


Infrared Thermography

Traditional Acoustic Methods

Impact Echo Testing

- Uses mechanical waves to evaluate the characteristics of the concrete by measuring its response to an impact
- ASTM C1383



Traditional Acoustic Methods

Hammer Sounding – Chain Drag

- Uses mechanical waves to evaluate the condition of the concrete by listening to the audible response of concrete to impact
- ASTM D4580

Traditional Acoustic Methods

Advantages

- Impact Echo is well-suited to determining the thickness of concrete slabs and gather objective digital data for analysis.
- Hammer sounding and chain drag are well-suited to determining general concrete integrity with a clear audible indicator for defects.

Disadvantages

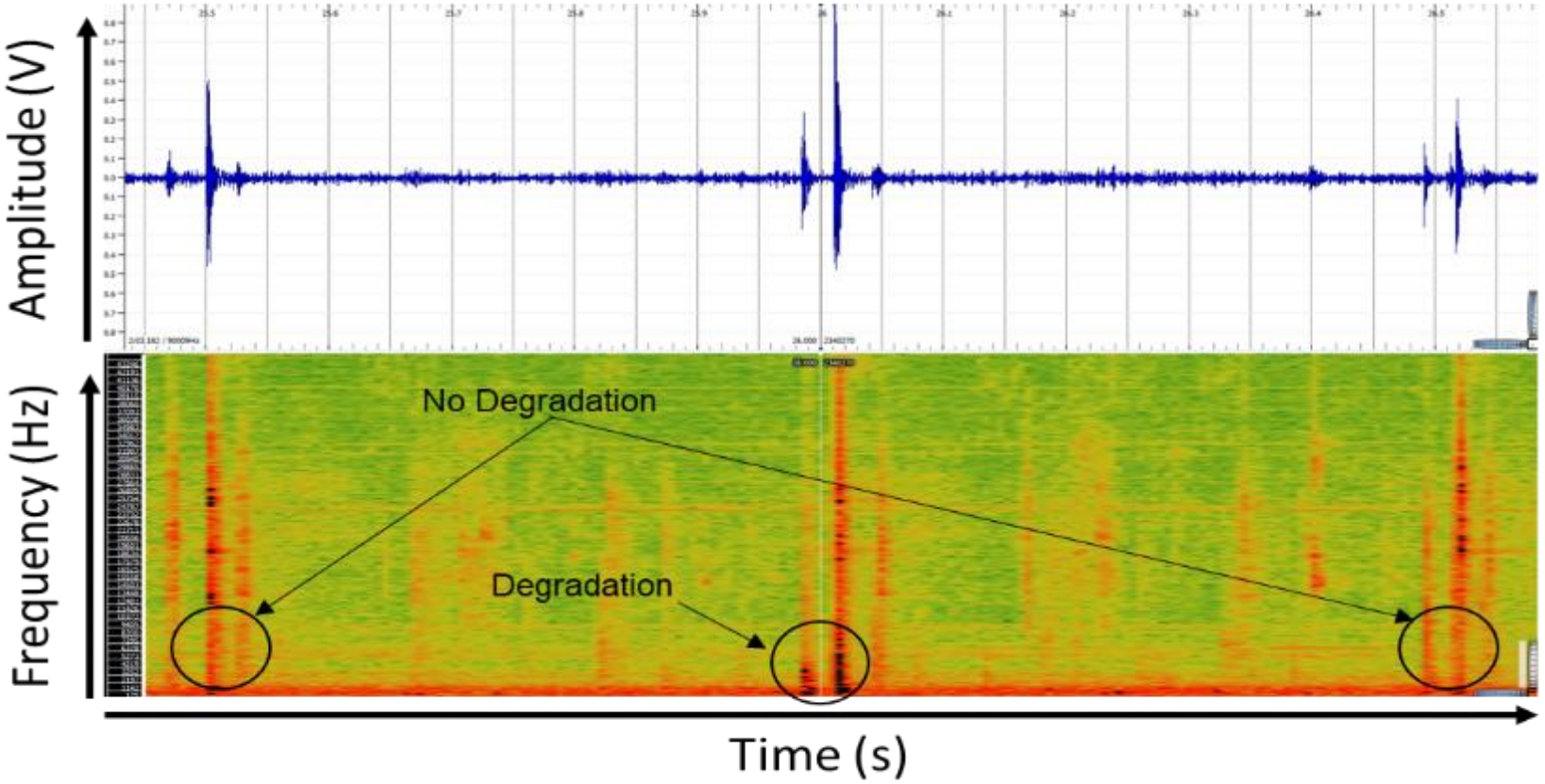
- Impact Echo is a point test that is typically performed manually using ground-coupled sensors
- Hammer sounding and chain drag do not produce a digital record of the data gathered and are subjective with the respect to the operator.

Big Data Acoustic Methods – SounDAR

Borrowing from a similar need in the bridge deck inspection world, Deck Acoustic Response (SounDAR) was developed by BDI to leverage the principles and advantages of traditional impact echo, hammer sounding, and chain drag while minimizing the disadvantages through the addition of a mobile system with parallel impactors.

Big Data Acoustic Methods – SounDAR

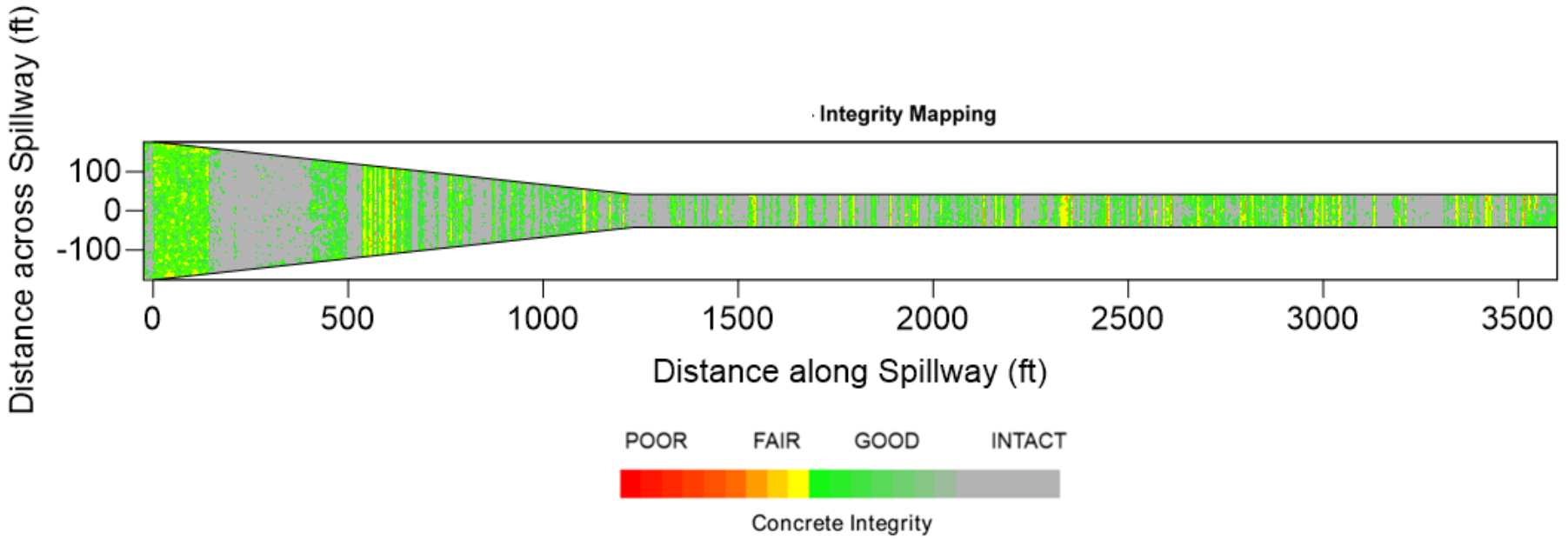
SounDAR takes the objective digital data collection of impact echo and combines it with the frequency evaluation of chain drag to identify concrete degradation.



Big Data Acoustic Methods – SounDAR

The model for concrete delamination used by SounDAR was developed for concrete bridge decks, but the principles remain the same for concrete spillways as well.

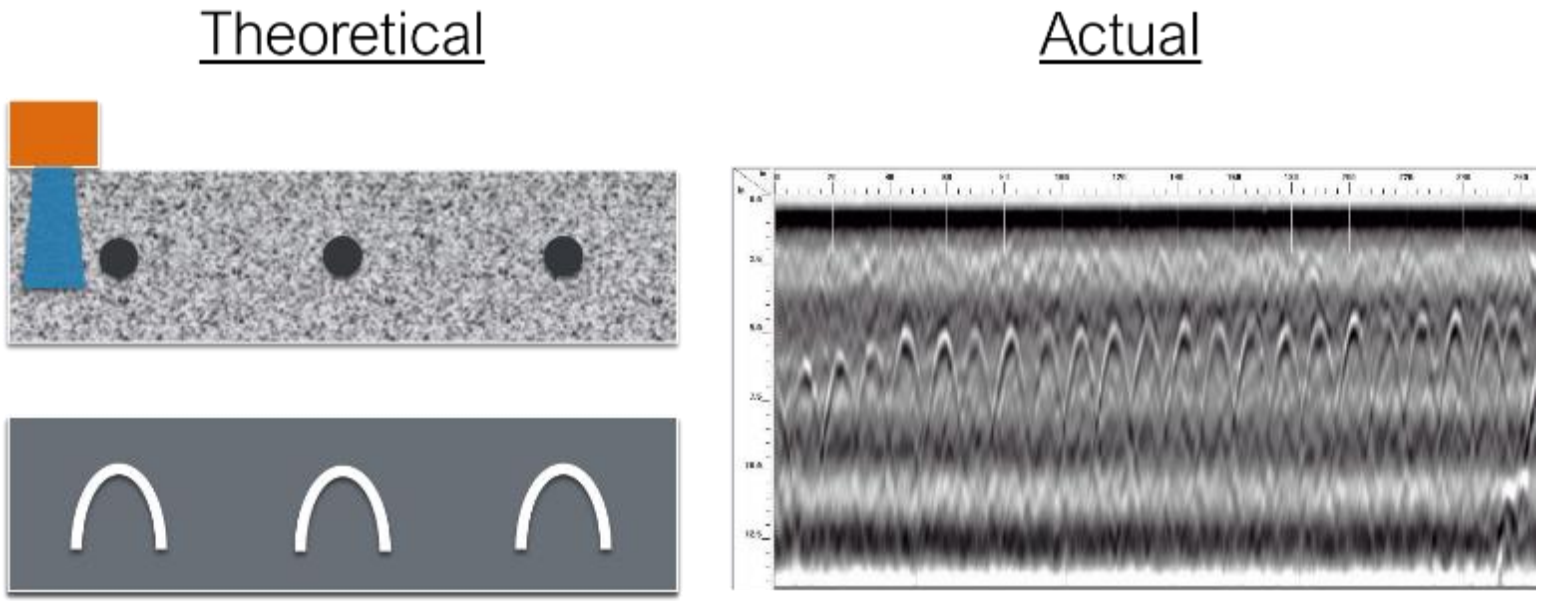
- The mobile nature of the system coupled with the analysis model allows for data to be collected and processed in hours instead of weeks.



Ground Penetrating Radar

Theory of Operation

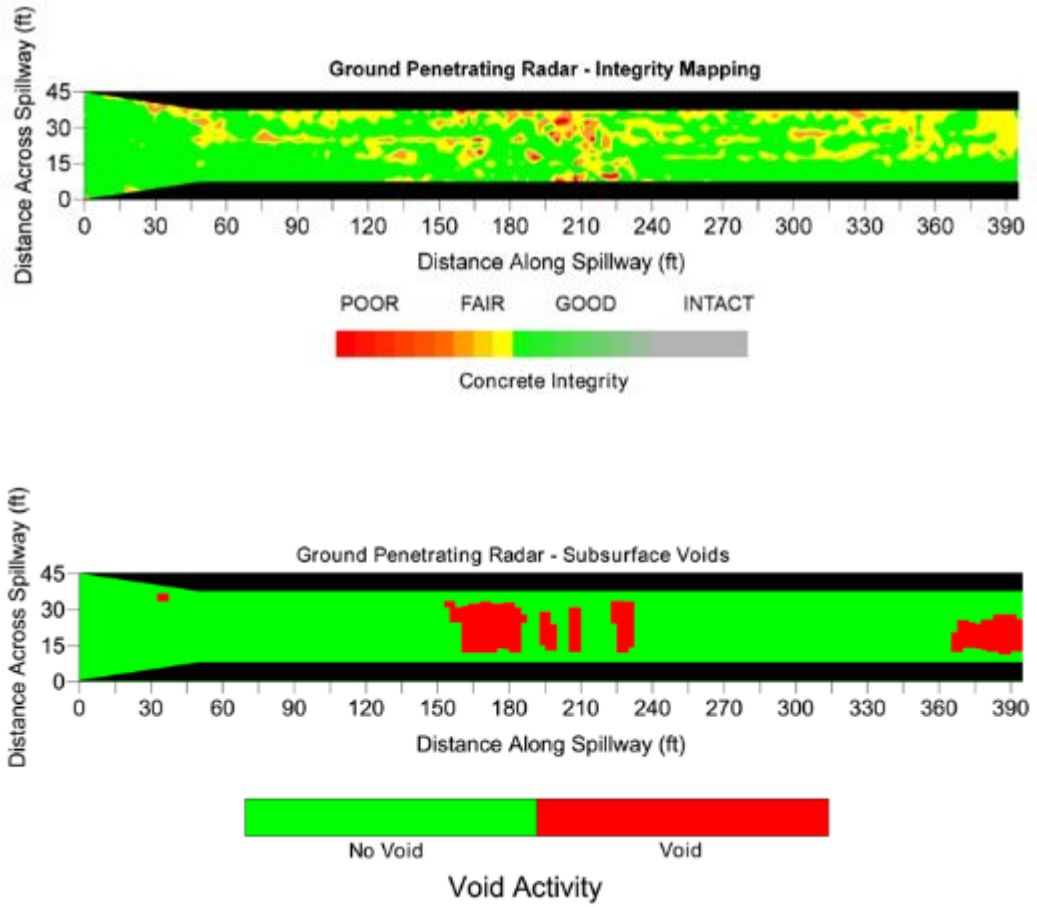
- Uses electromagnetic waves to evaluate the condition of the concrete and spillway subsurface by measuring the reflections from the various features below the GPR antenna
- ASTM D6087



Ground Penetrating Radar

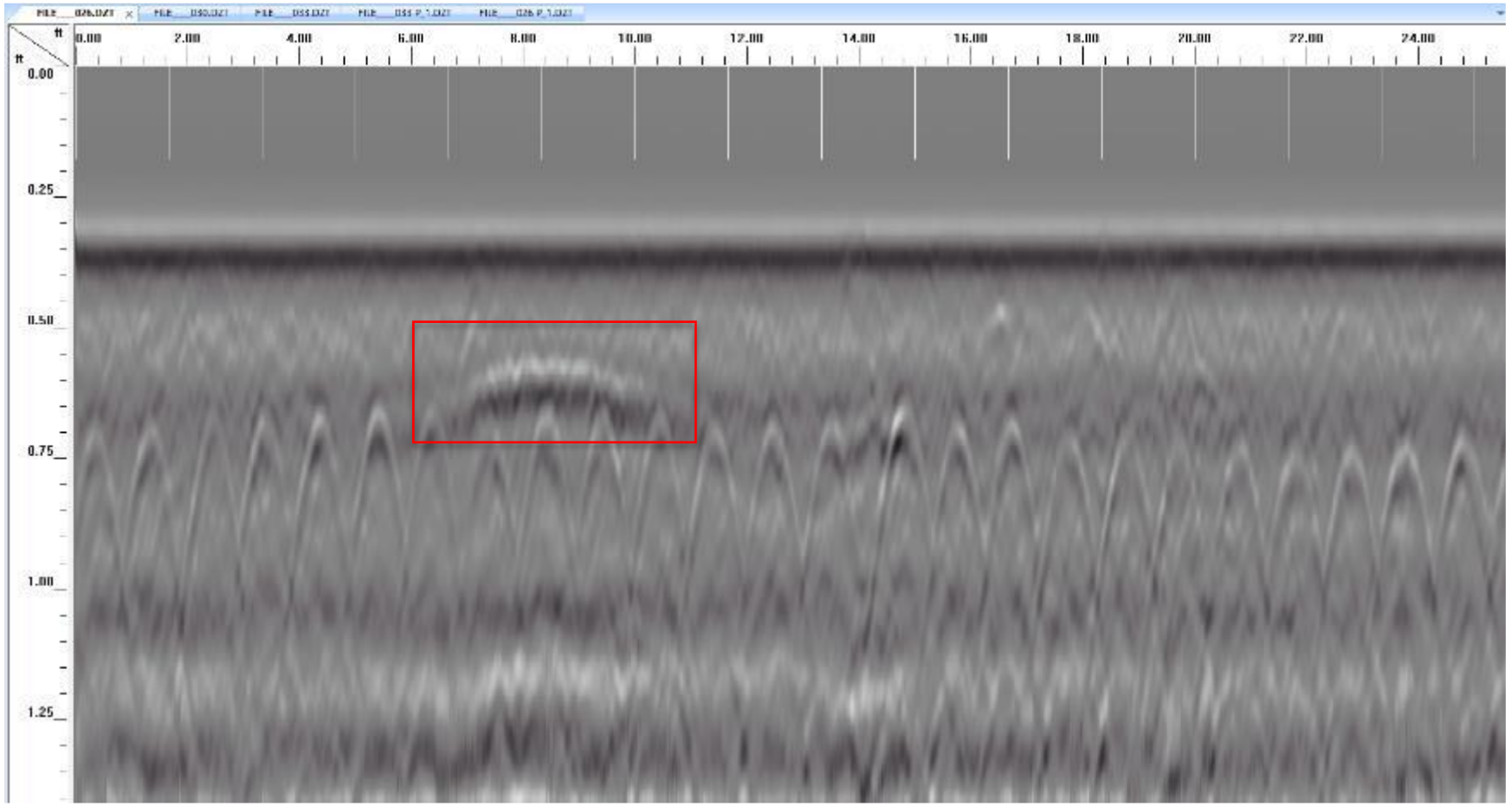
Applications for Spillways

- Detection of defects in concrete slabs as a function of rebar integrity and presence of subsurface anomalies
- Detection of geological anomalies such as voids, depending on the moisture content of the soil



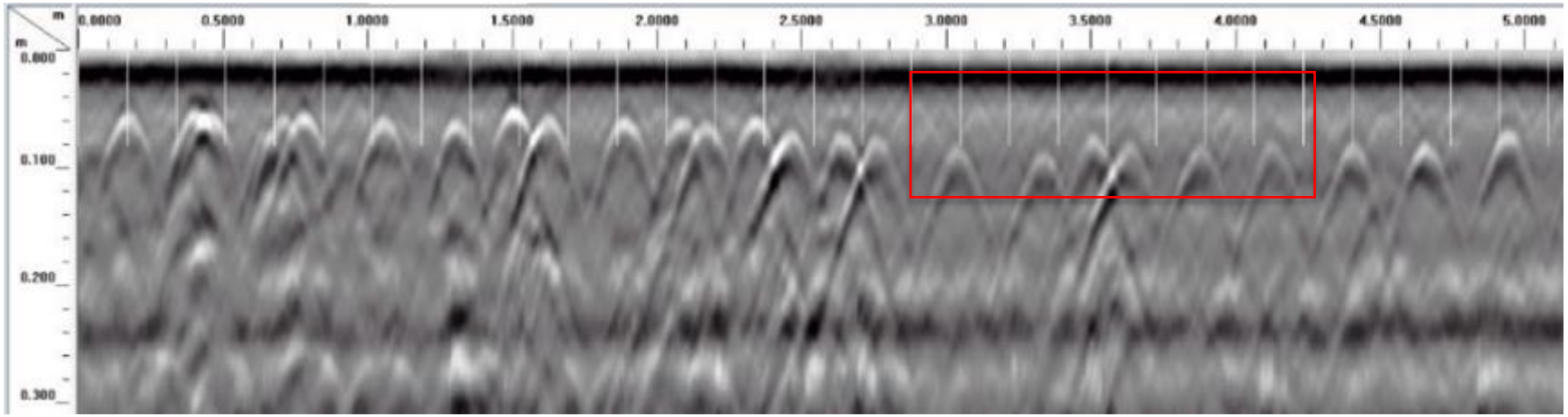
Ground Penetrating Radar

Example of possible void in concrete

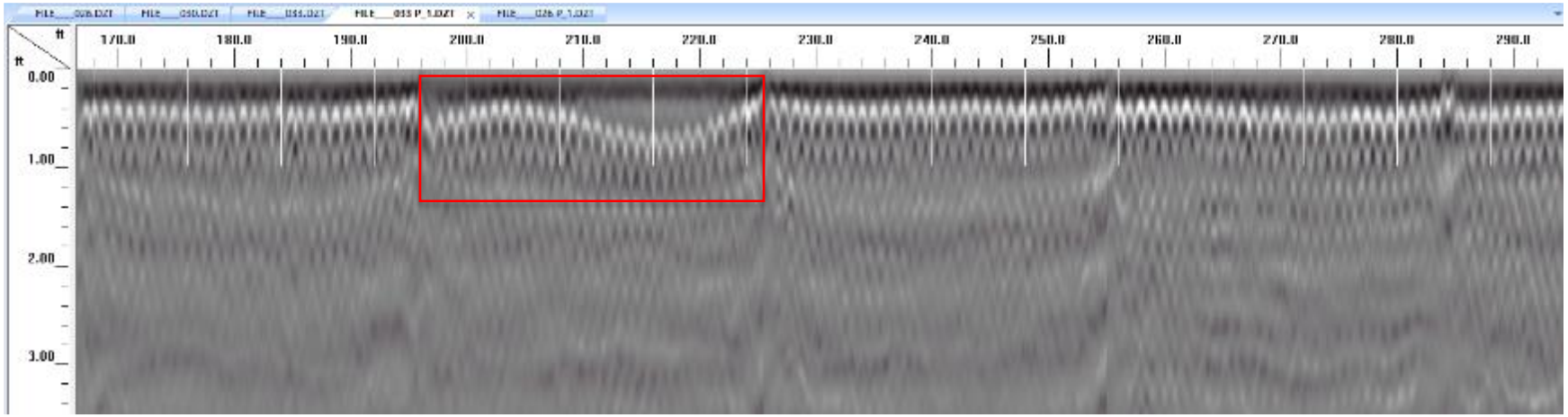


Ground Penetrating Radar

Example of possible delamination at rebar

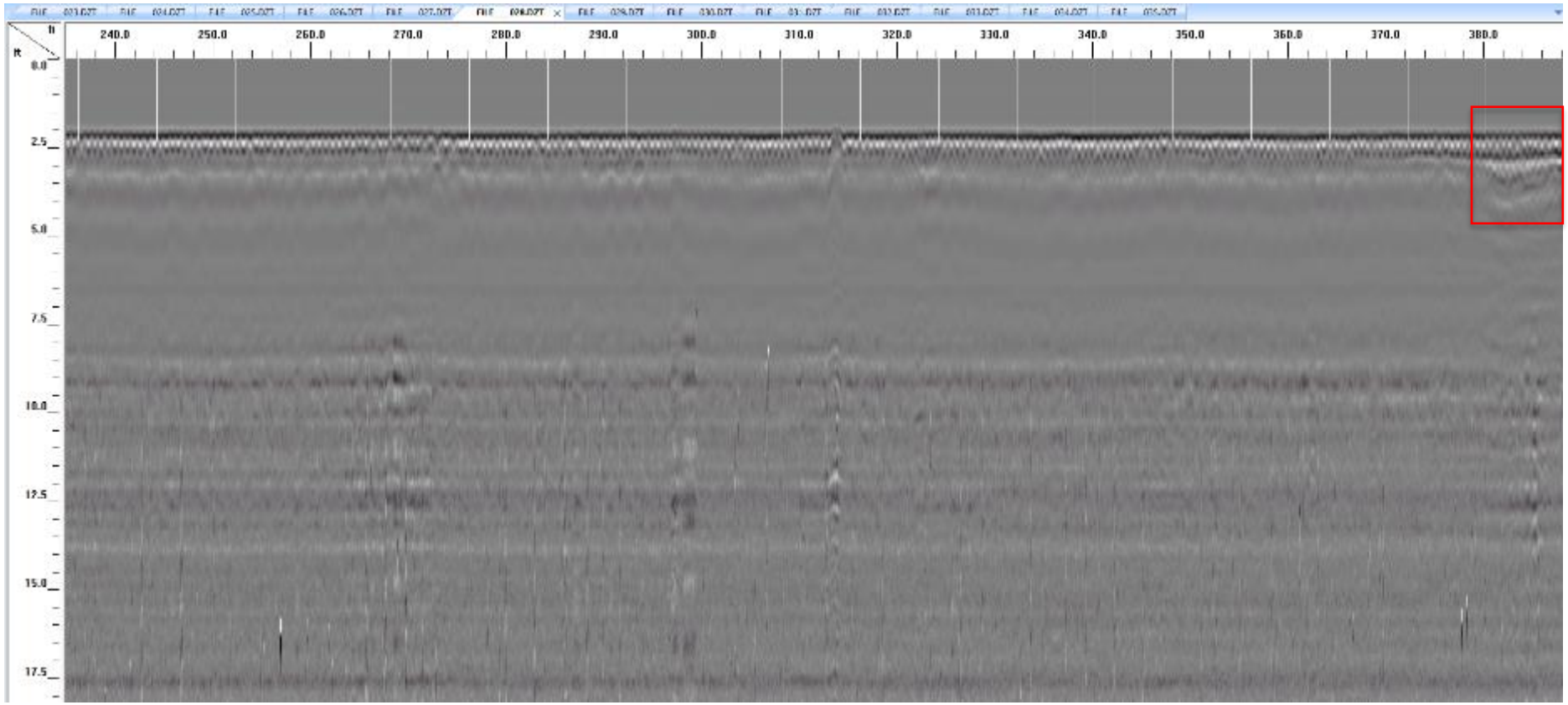


Example of irregularity in rebar grid



Ground Penetrating Radar

Example of validated subsurface void



Ground Penetrating Radar

Example of validated subsurface void

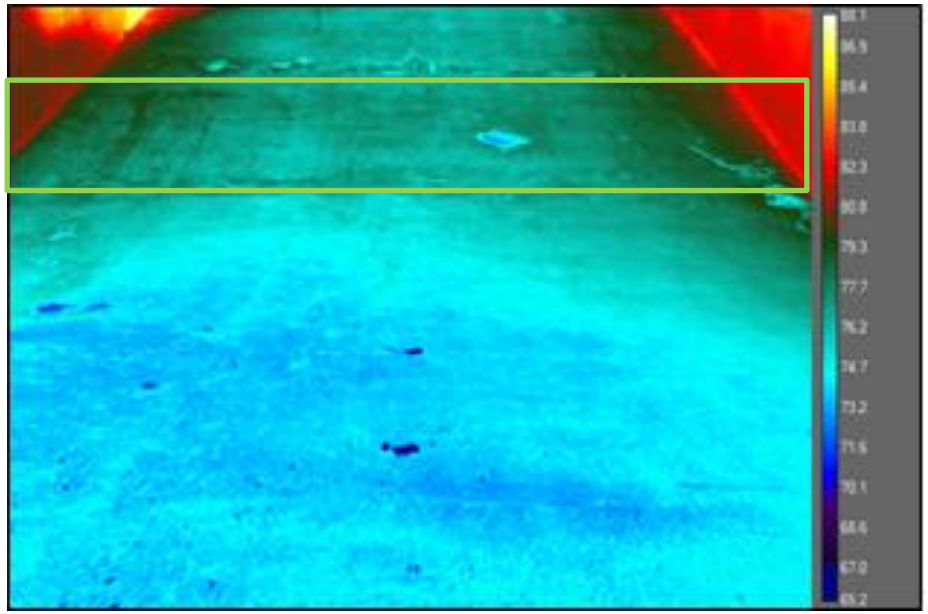
High-Resolution Imaging

While a comprehensive number of photos are taken at each job site to give context to our visual inspection results, high-definition video and images gathered in a systematic way can also be used to provide stitched images of the spillway for review.

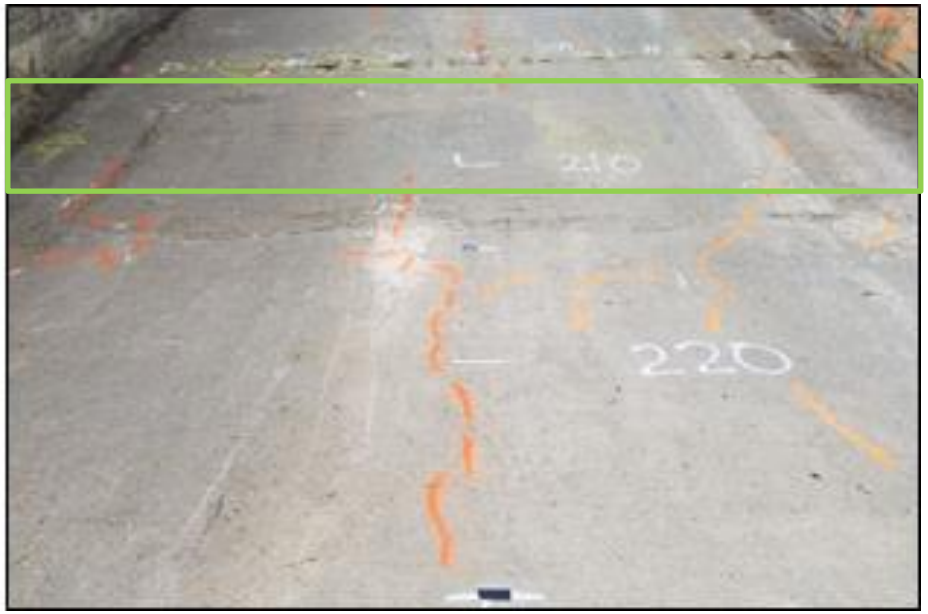
- **Helpful for recording field markings**

Infrared Thermography

Measures the infrared energy emitted from a concrete slab to determine its thermal properties and identify any irregularities



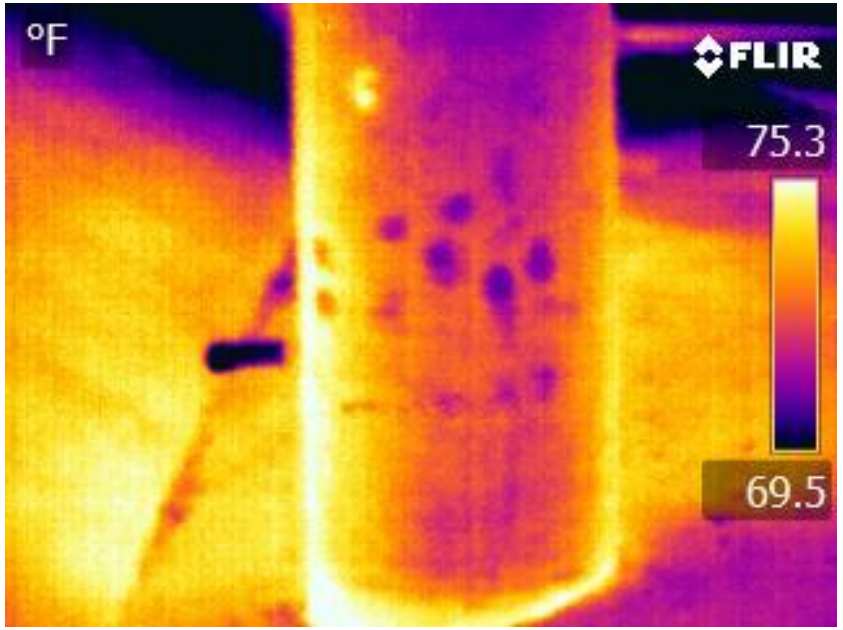
Infrared Image



Visual Image

UAV Technology

Pairing high-resolution and IR imaging with unmanned aerial vehicles (UAV's) can further assist with the data collection process.



UAV Technology

The growing affordability of high-res cameras makes it possible to track spillway features from high-altitude, which can be combined with GPS routing of UAV.

Hovering

Zoomed In

Thank you for your attendance!

RAW DATA. REFINED RESULTS.