

Housekeeping

Chris Mundell
Structures Moonshot Delivery Lead, AtkinsRéalis

June 2025

THE

STRUCTURES MOONSHOT

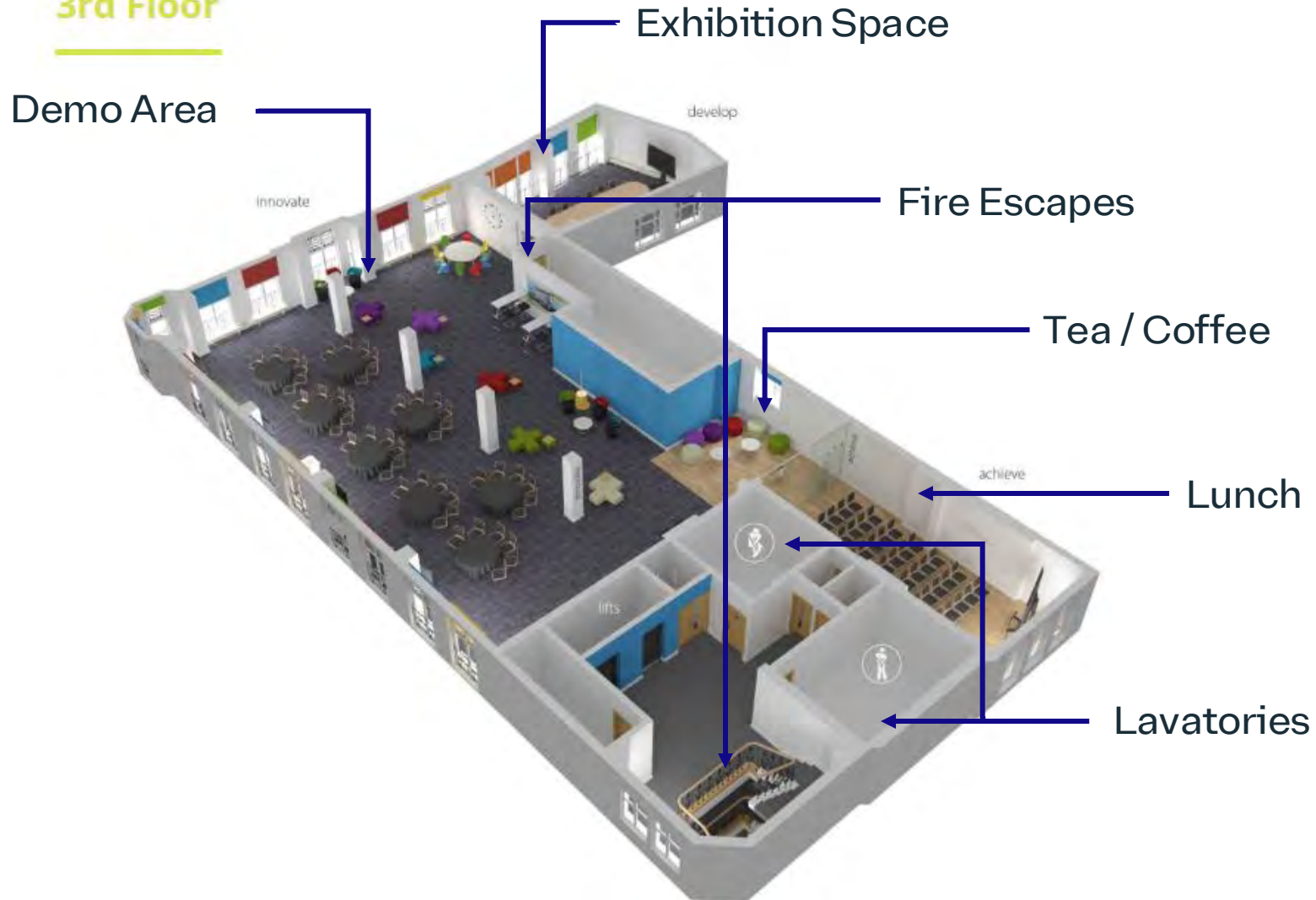
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS

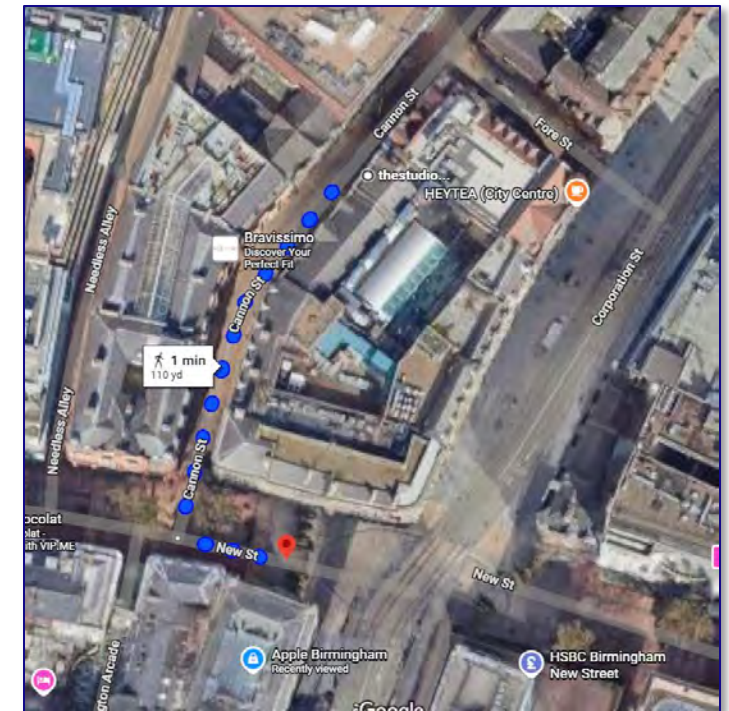


Housekeeping

3rd Floor



In case of emergency: Evacuation Point:
Adjacent to the **Apple Store, New Street**



Conference Agenda

THE
STRUCTURES
MOONSHOT
PROJECT



WELCOME & PROJECT OVERVIEW

R&D TRIALS AND RESULTS

NON-DESTRUCTIVE TESTING PRESENTATIONS: MOONSHOT FINDINGS

RESULTS FEDERATION AND SUMMARY

June 16th

- 9:00 Registration
- 9:15 Welcome & Overall Ambition
- 9:30 Keynote 1 – Moonshot II Project Overview
- 10:20 ----- Break -----
- 10:40 R&D Trials : Innovative Inspection Techniques Overview
- 10:50 RF Induced Ultrasound, Electric Impedance - Sentec
- 11:05 Guided Ultrasonic Waves – Omnia Integrity
- 11:35 Muon Tomography - GScan
- 12:05 Q&A: Panel Session
- 12:30 ----- Lunch & Breakout -----
- 13:30 Huntingdon Viaduct NDT Trials: Overview
- 13:40 Ultrasonics, Tomography, Impact Echo, Ground Penetration Radar (GPR), Acoustic Emission - MISTRAS | Screening Eagle | Allied Associates
- 14:25 Ground Penetration Radar (GPR) - Bridgology
- 14:40 Climbing Crawler Robots - HausBots
- 14:55 NDT Trials: Additional testing results
- 15:10 Q&A: Panel Session
- 15:35 ----- Break -----
- 16:05 Data Federation and Interpretation Approach
- 16:35 NDT Trials: Summary of Technology Performance
- 17:05 Day 1 Round Up
- 17:15 ----- Networking Session -----

June 17th

- 9:00 Welcome & Overview of Day 2
- 9:10 Overview of Testing on Wickwick Bridge
- 9:20 GNR – X-ray Diffractometry (XRD)
- 9:35 University of Strathclyde - Adaptive Lighting for the Inspection of Concrete Structures (ALICS)
- 9:50 Wickwick Trials: Q&A Session
- 10:00 Muon Tomography Trials on In-Service Structures
- 10:20 ----- Break -----
- 10:50 NDT Practitioner's Toolkit
- 11:20 Moonshot III: Network Deployment & Further Development
- 11:50 Conclusions & Round Up
- 12:20 Closing Remarks
- 12:30 ----- End -----

IMPLEMENTATION SESSION: TECHNOLOGY IN PRACTICE

KEY OUTPUTS, CONCLUSIONS, AND CLOSING REMARKS

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Day 1 - Welcome Address

Mike Wilson
Executive Director for Safety, Engineering and Standards
National Highways

June 2025





Delivering the Moonshot Ambition

Colin George,
Deputy Head of Structures, National Highways
June 2025

A collage of images related to infrastructure and engineering. It includes a close-up of a worker in a hard hat and safety vest, a large concrete structure with rebar, a computer monitor displaying a software interface, a table with various materials and tools, a large grid with numbers and colored squares, and a man speaking at a podium.

Structures Moonshot Data Schedule>				
	E	F	G	H
	Tool	Element	Defect Type	Confide
e	MISTRAS Tablet UT	Tendon	Corrosion	High
e	MISTRAS Tablet UT	Tendon	Good Condition	High
	Proseq PD8052	Grout	Voids	High
	Proseq PD8052	Grout	Voids	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

Bridges stock largely built in the 1960s and 1970s



Increased traffic, winter maintenance and poor water management.

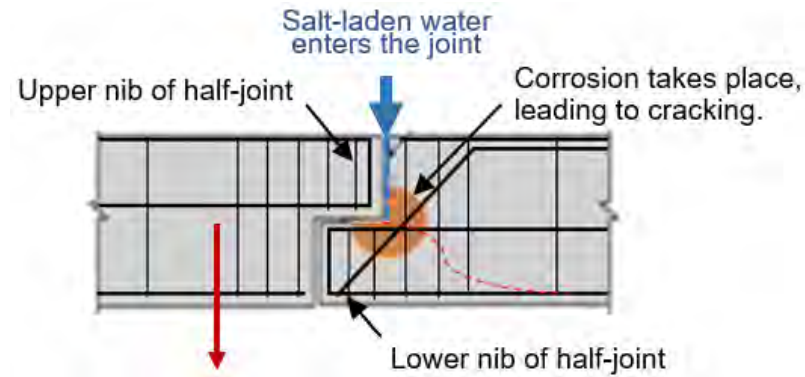


The Challenge

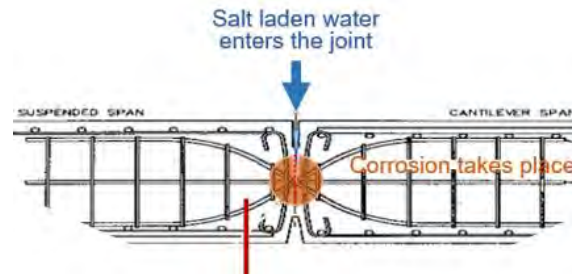


Priority Risk Structures

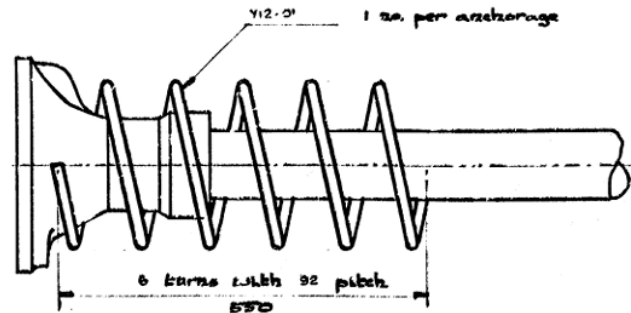
Half-joint Bridges:



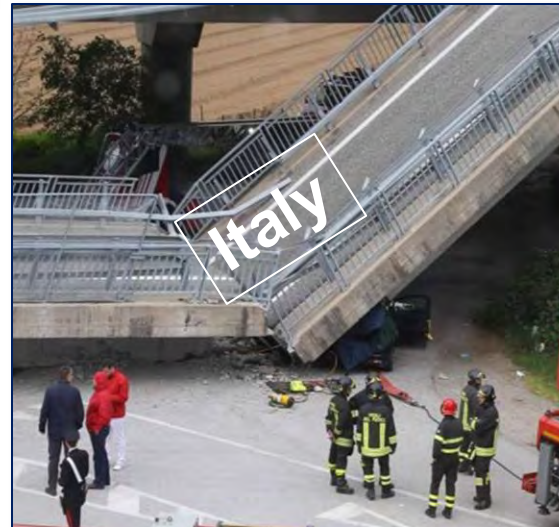
Deck Hinge Bridges:



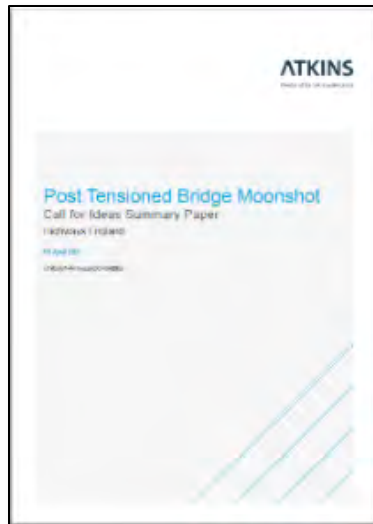
Post Tensioned Bridges



Risks and consequences of not meeting the challenge



Feasibility Studies



Feasibility Studies Commissioned and Completed



Viaduct Demolition



Recovered Section

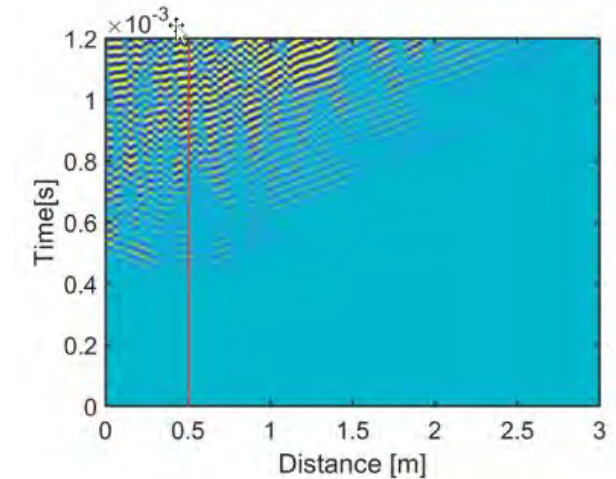
Workstreams

Development of Innovative Technologies

- We commissioned work on lower TRL technologies that have potential to support our aspirations.

The Huntingdon Railway Viaduct Trials present two opportunities:

- The ability to verify the conclusions drawn from 20 years of monitoring (e.g. Have wire breaks occurred in the post-tensioning system, and have they occurred where the acoustic emission system indicated?)
- A test bed for established and emerging technologies/methods (relatively high TRL technologies), with direct verification of results possible through careful hydro-demolition.



Thank you

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Structures Moonshot Data Schedule>

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	Proseq PD8052	Grout	Voids	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

Huntingdon Viaduct Test Samples and Approach

Chris Mundell - AtkinsRéalis

June 2025



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Huntingdon Viaduct – History



Construction Date – 1975

Total Length – 225.8m (6 spans)

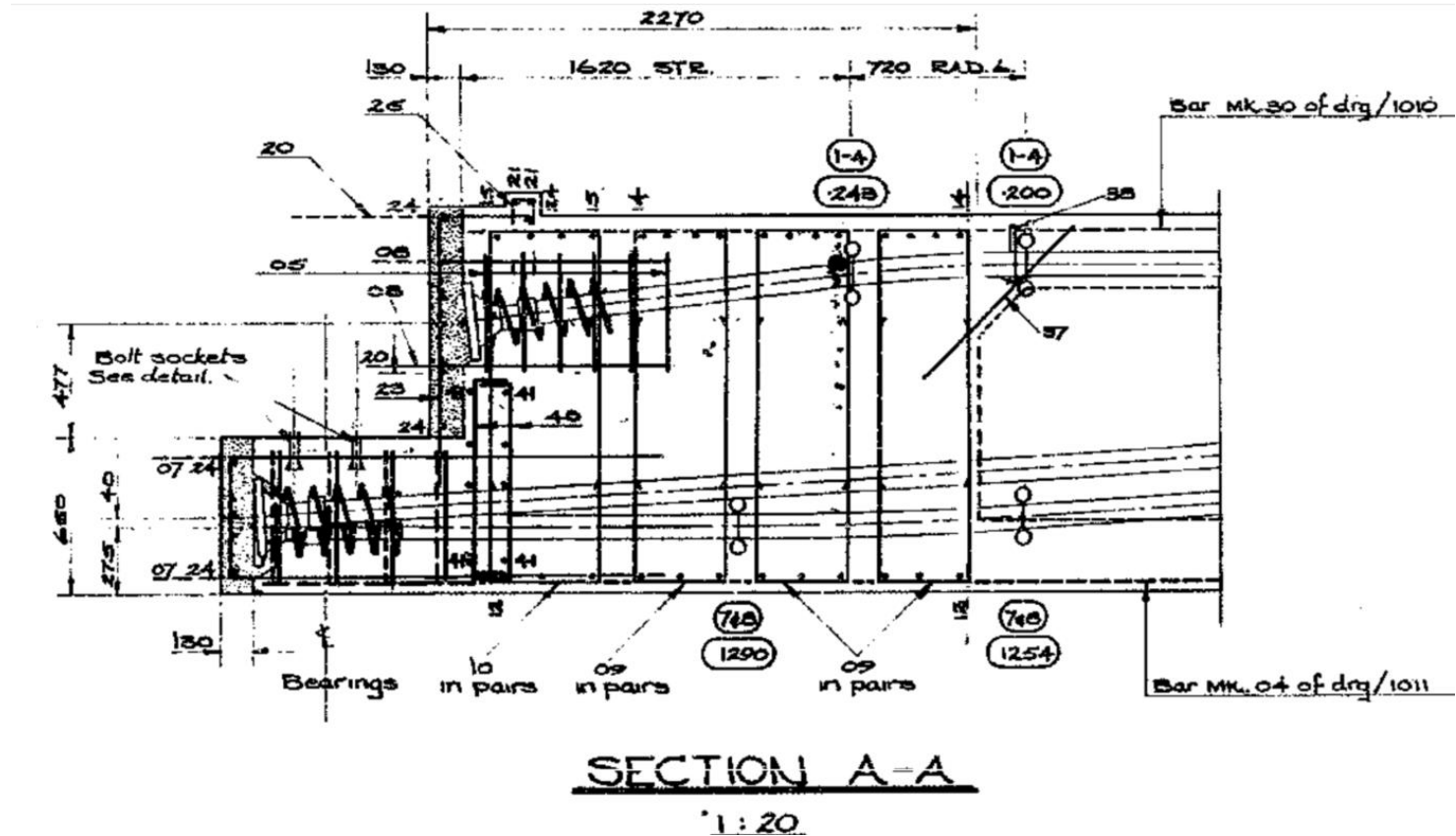
Main Span – 64.3m

Carried – A14 (4 lanes)

Crosses – East Coast Main Line
& Brampton Road



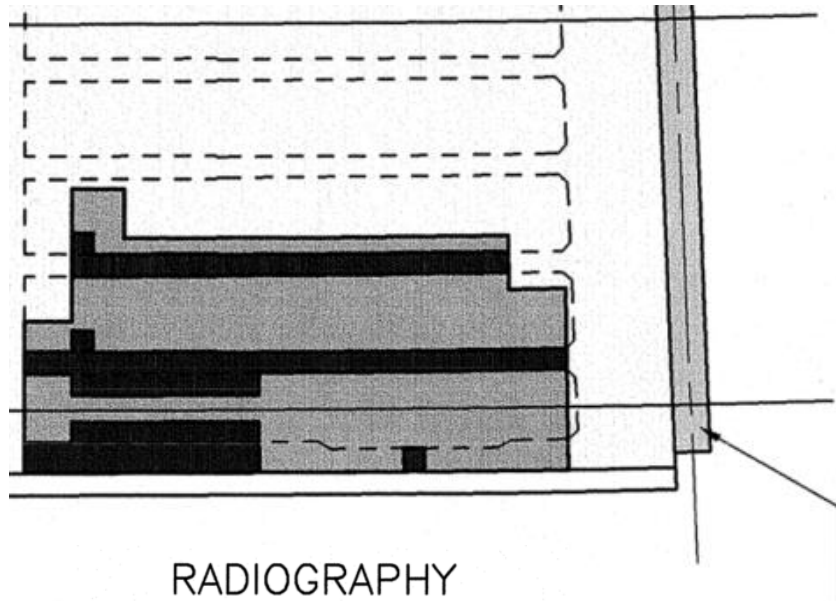
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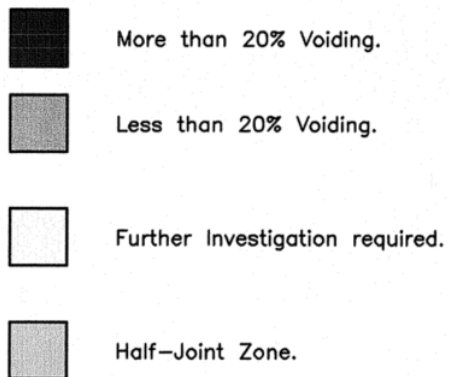
Huntingdon Viaduct – History

Activity	Contractor	Date Carried out	Location	Key Observations
Structural Health Monitoring installed	Pure Technologies (now Xylem)	1998 to 2020	6 'Zones', covering the north and south monoliths (Note that the Moonshot samples were removed from Zone 2 and Zone 5)	The largest number of detected wire breaks occurred in Zones 2 and 5 – 43 confirmed wire breaks (CWB) and 5 possible wire breaks (PWB) between 1998 and 2020 (52 CWBs and 10 PWBs recorded in total).
Visual Inspection	AECOM	2020	Monolith half-joints	Inspection of the re-entrant corner along the of the joint following the removal of the main span.
LVDT crack measurement	<u>Strainstall</u>	2001 to 2020	Monolith half-joints	
PTSI	Amey	2017	Spans 3 and 5 (longitudinally post-tensioned) West span (1), span 2 and span 6 (transversely post-tensioned)	
Structural Assessment	URS	2014		
Endoscope Inspection		2012	Monolith half-joints	
Facia inspection		2010	Monolith half-joints	
PTSI	Thorburn Colquhoun	2000		
Structural Assessment	Mouchel	1995		

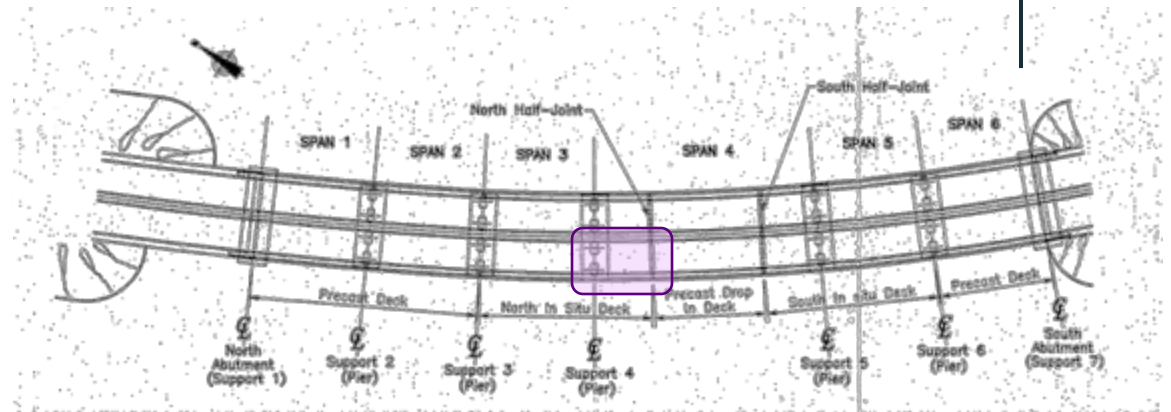
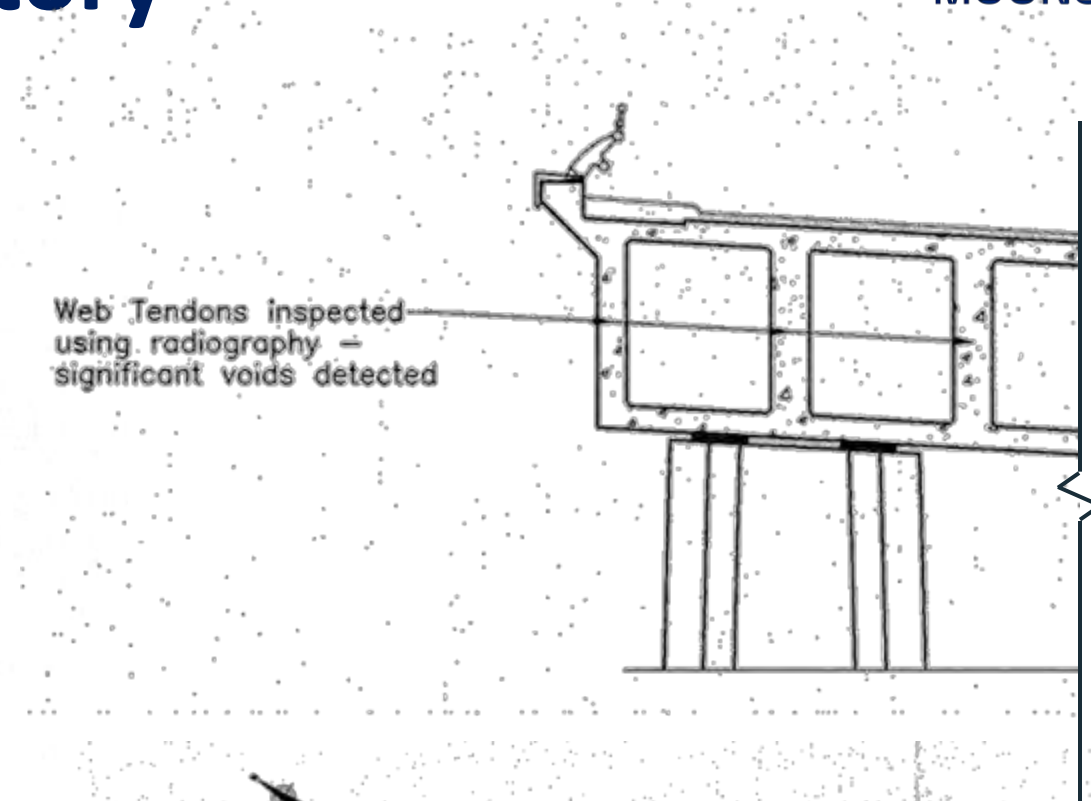
Huntingdon Viaduct – History



RADIOGRAPHY



10 out of 40 Anchorages within half-joint radiographed. (No significant voids detected)
Radiographs relate to lower row of anchorages. Upper row not radiographed.



Huntingdon Viaduct – History

James Fisher
Testing Services

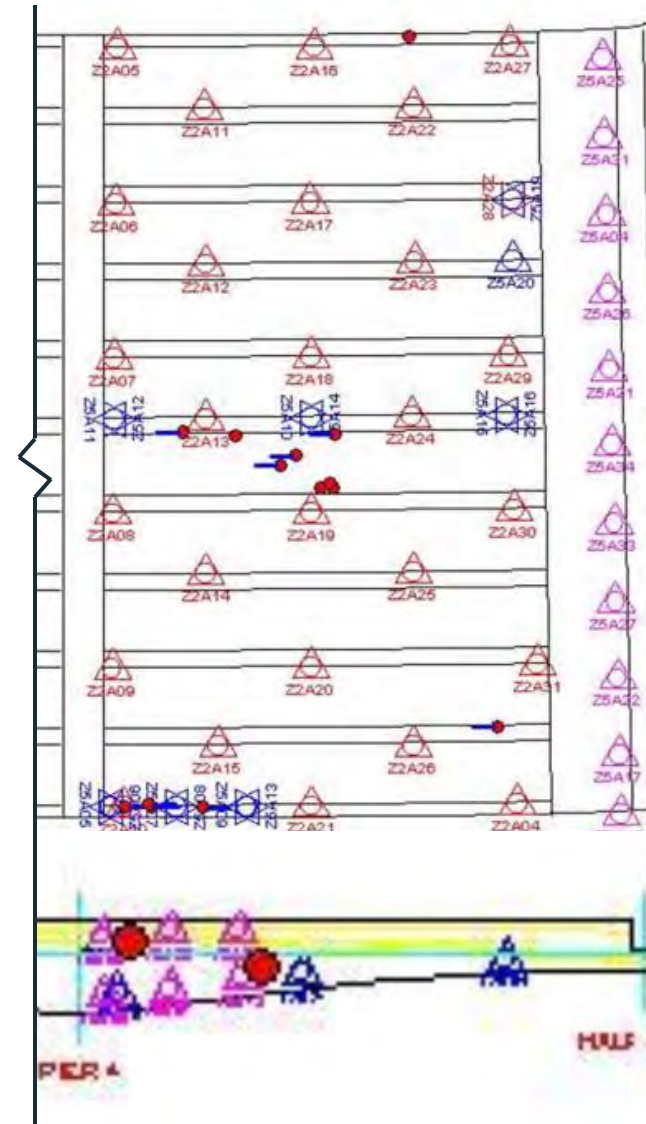
James Fisher Testing Services Limited
A14 Huntingdon Railway Viaduct Monitoring
09 January 2020

www.jftesting-services.com



Zone	No. of wire breaks
Zone 1 - North Back Span	1
Zone 2 - North Cantilever Span (Includes Zone 5)	33
Zone 3 - South Cantilever Span	9
Zone 4 - South Back Span	3
TOTAL	46

2018 Events:		
None		
2019 Events:		
02/04/2019 01:28	Possible Wire Break	Zone 2 (North Cantilever Span)
19/05/2019 12:54	Wire Break	Zone 2 (North Cantilever Span)
19/05/2019 12:55	Wire Break	Zone 2 (North Cantilever Span)
25/07/2019 12:15	Wire Break	Zone 3 (South Cantilever Span)
13/10/2019 03:19	Wire Break	Zone 3 (South Cantilever Span)

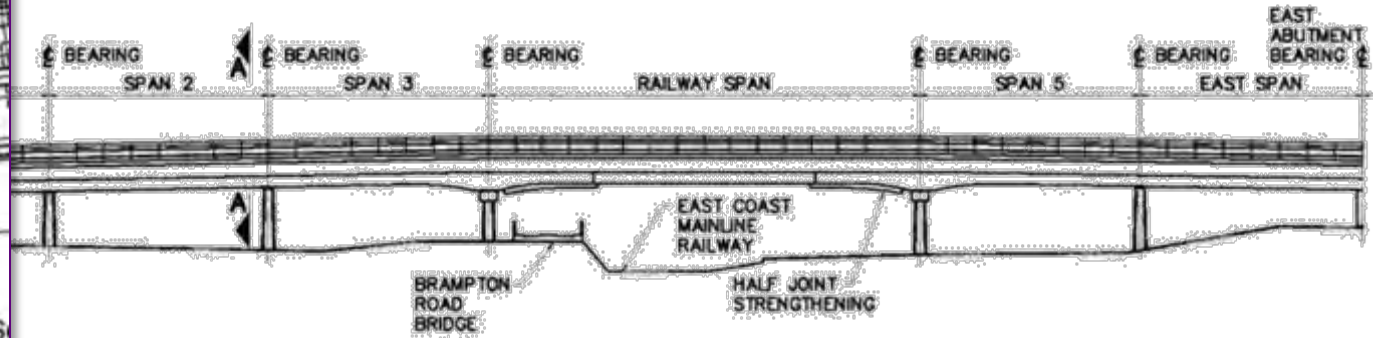
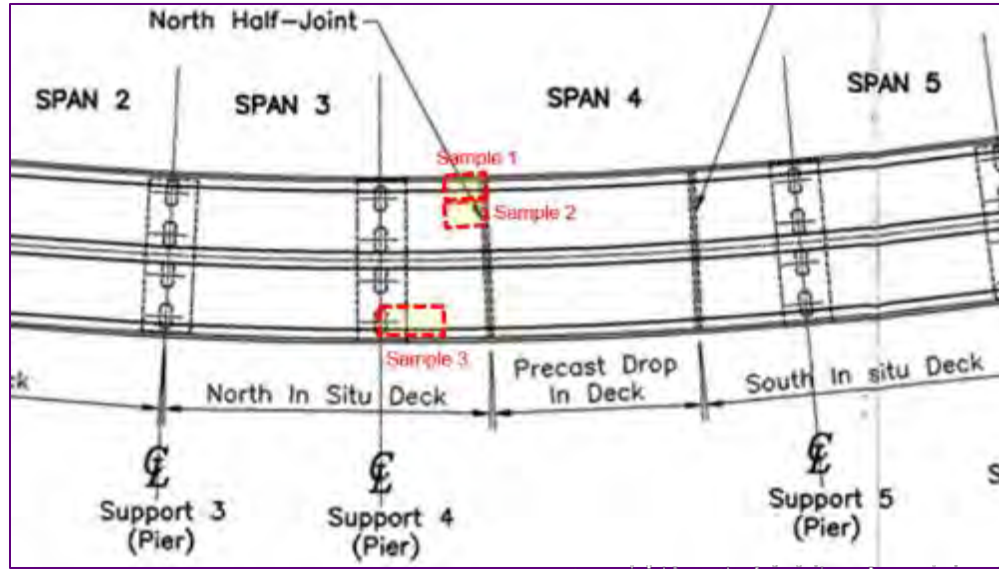


Huntingdon Viaduct – History

- Temporary strengthening carried out in 2003
- Concerns of the condition of the main cantilever half joints
- Beams increased from 750mm to 1775mm
- £11m scheme completed in August 2013



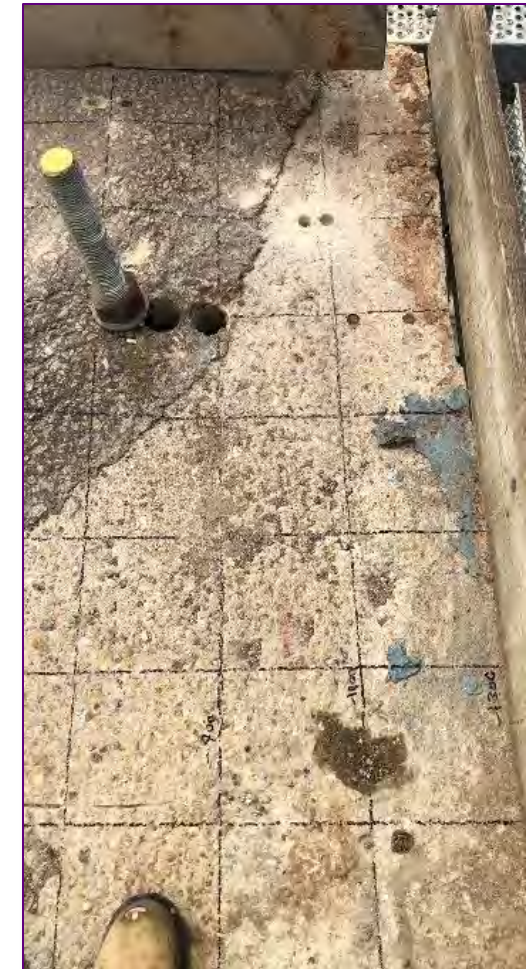
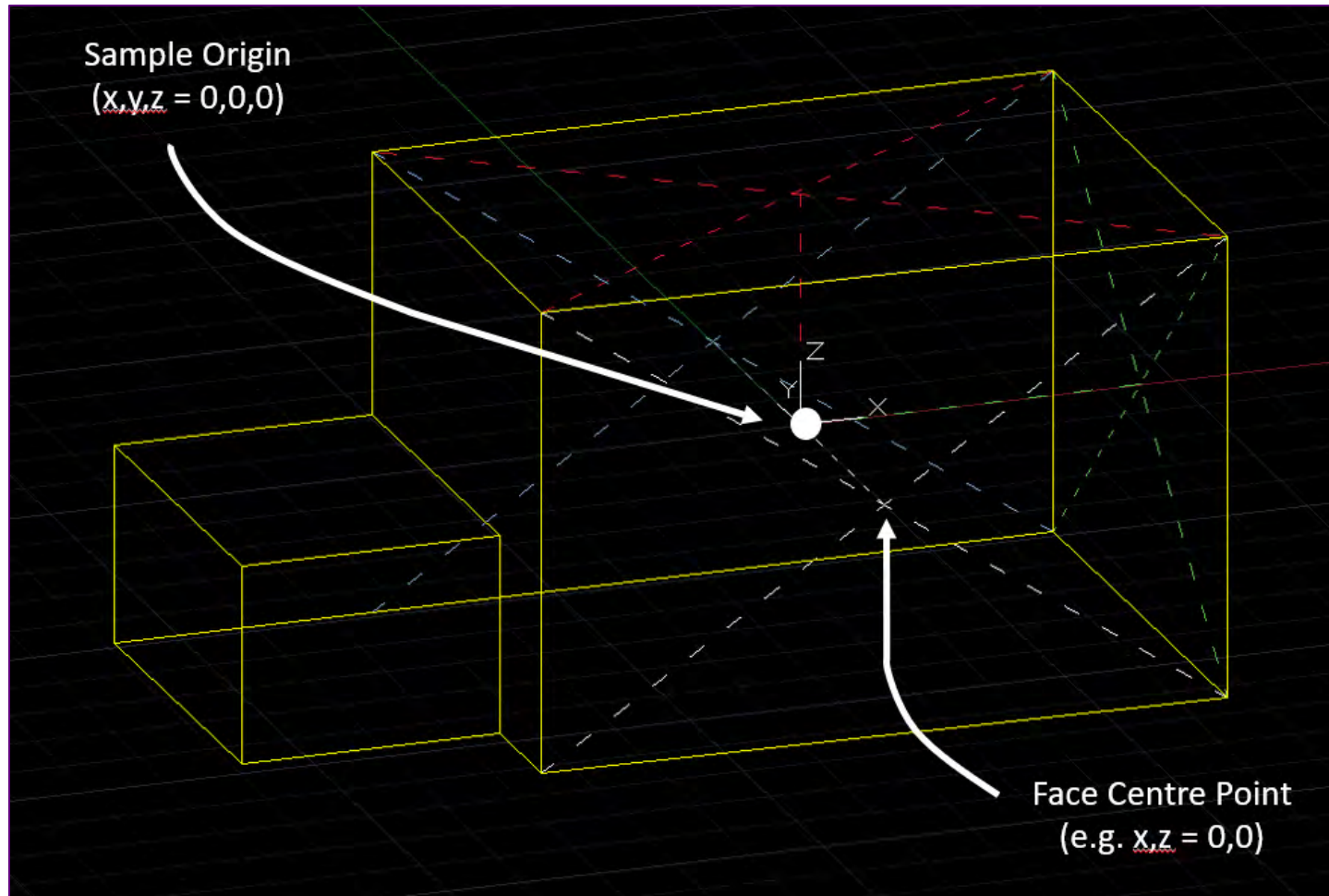
Huntingdon Viaduct – Sample Extraction



Huntingdon Viaduct – Sample Extraction



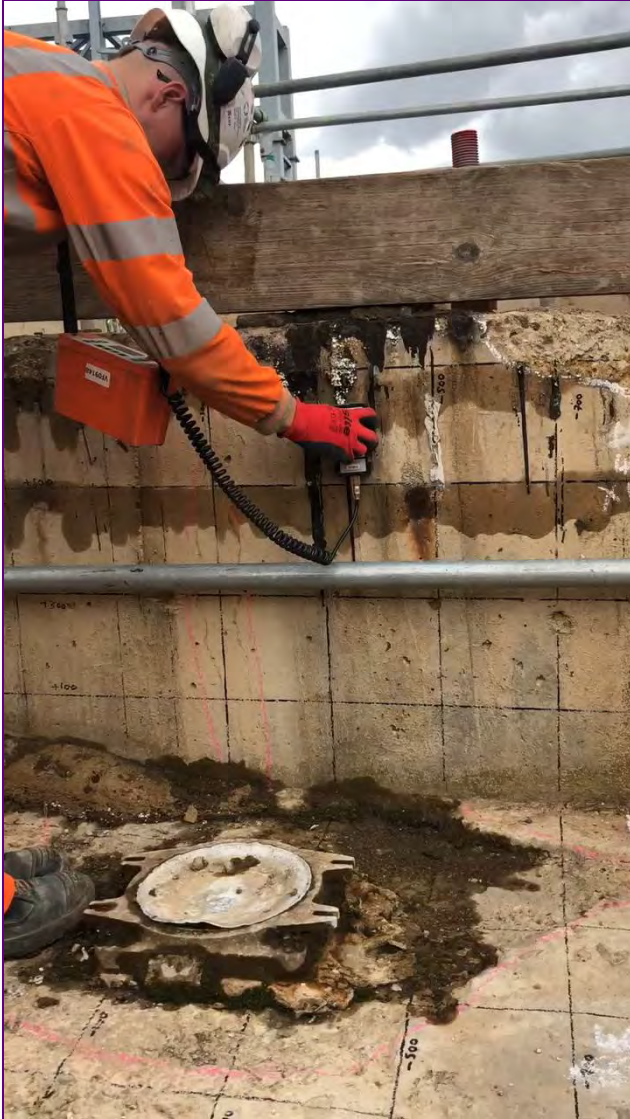
Defect Naming Convention and Reporting



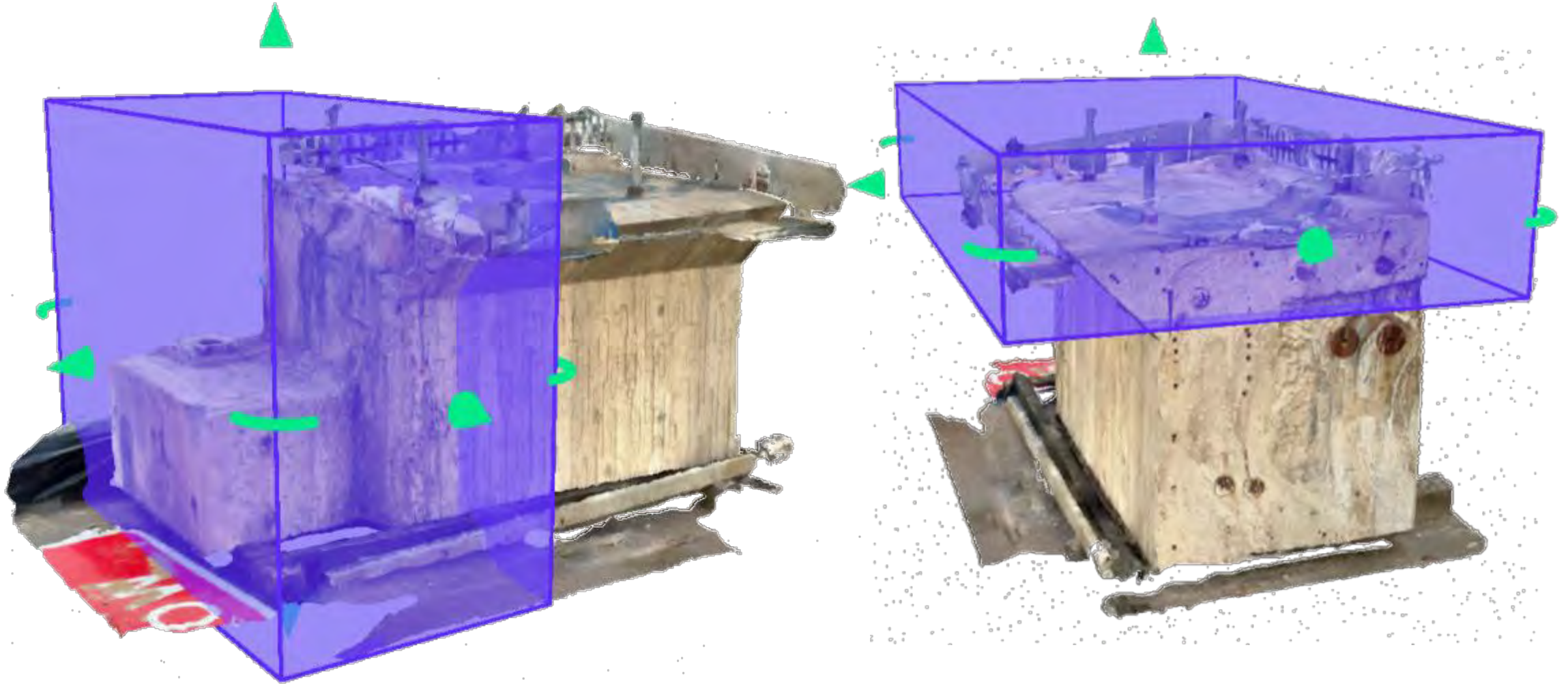
Toddington Site - Setup & Access



Non-Destructive Testing



Hydrodemolition – Sample 1



Hydrodemolition Findings – Sample 1



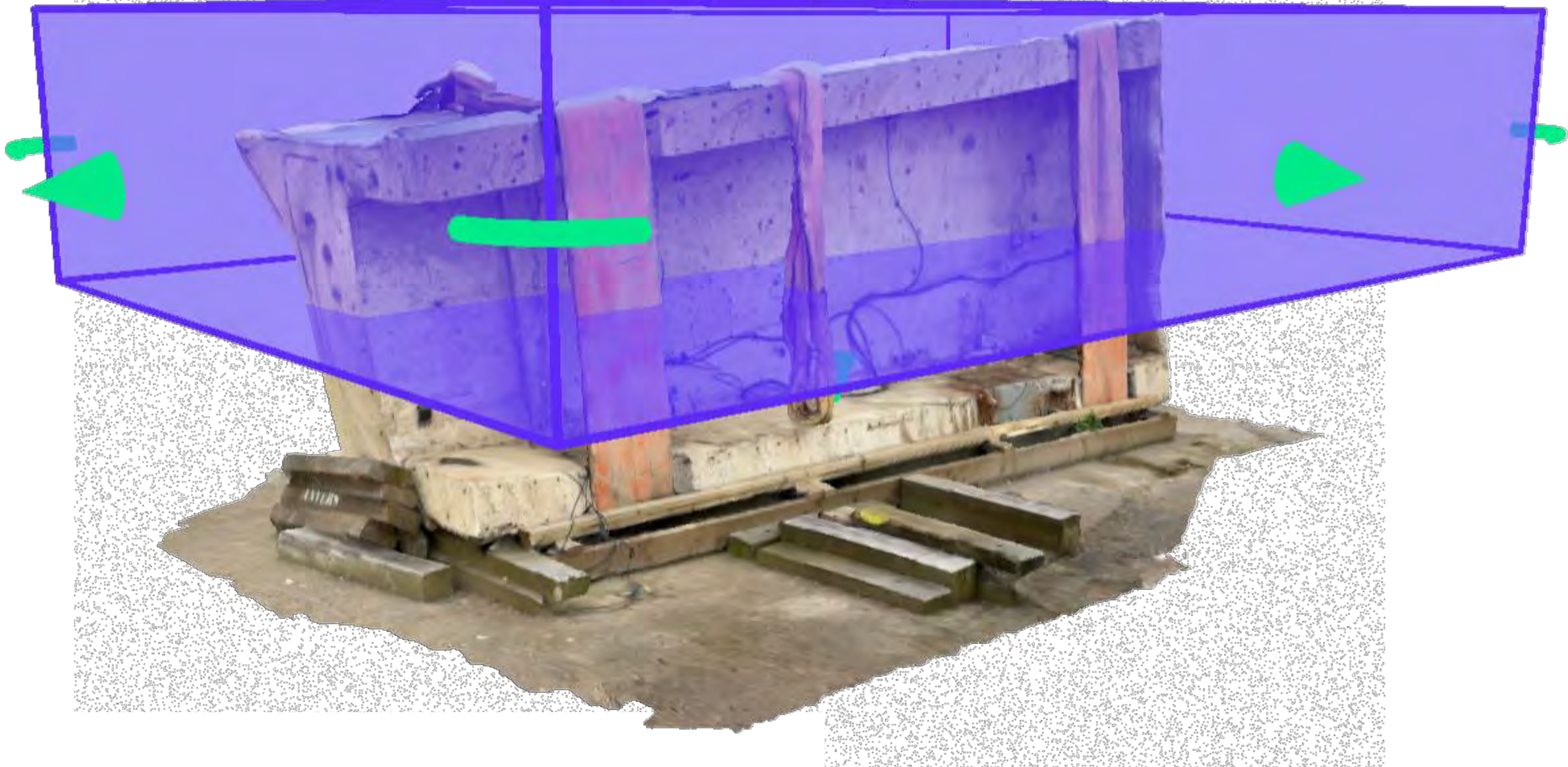
Hydrodemolition Findings – Sample 1



Hydrodemolition Lidar Scanning



Hydrodemolition – Sample 3



Hydrodemolition Findings – Sample 3



Extracted Tendons and Samples



Questions

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	Proseq PD8052	Grout	Voids	High
	Proseq PD8052	Grout	Voids	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High



Huntingdon Viaduct Tendons Bellshill Lab Investigation

Michael Doody - AtkinsRéalis

June 2025



Inspection Process Summary

Structures Moonshot – Huntington NDT Trials

Tendon Inspection Proforma

(This form shall be completed once per duct sample)

Inspectors	MN / MD		
Date of Test	08 / 04 / 2024		
Tendon Details			
Sample Number	1	Chainage at End 1 (mm)	~
Tendon/Duct Number	2	Chainage at End 2 (mm)	
Duct Length (mm)	1000		

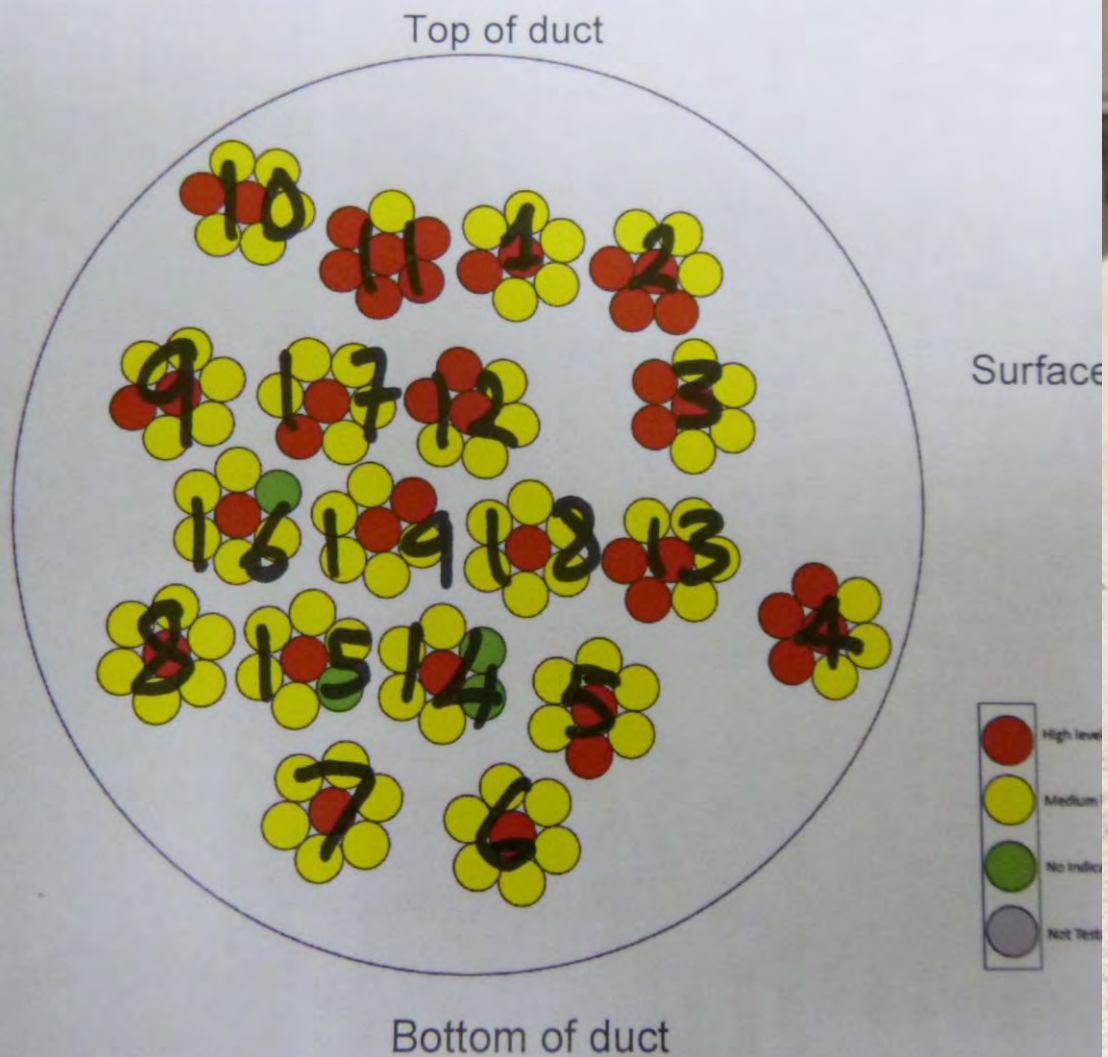
STEP 1: Pre-Opening Inspection									STEP 2: Post Duct Opening Inspection								
General Observations									General Observations								
Duct already sectioned at 3, 6, 9 & 12 o'clock positions. Duct material appeared perforations and minimal distortion. Tendon had been bound with cable ties in the strands appeared relatively undisturbed when 0 chainage cut end compared to the drawing.									Tendon already sectioned in the as received condition at 3 & 9 o'clock. Uppermost portion of duct removed. Voiding evident within grout – 'self levelled void' being present on the uppermost portion. Grout appeared uniformly light grey / white in color and dense in nature. Grout appeared brittle and readily fragmented when handled.								
Points of Interest/Defects Identified									Points of Interest/Defects Identified								
ence	grout / Wire	umber (cable)	umber (cable)	e (mm)	ion o'clock)	defect (mm)	s (mm) (cable)										

STEP 3: Grout Removal and Strand and Wire Inspection											
General Observations											
All strands removed and subject to powered wire brushing operation to remove corrosion / adherent grout. Overview images of intact / cleaned strands displayed. Each strand subject to unwinding operation. Light corrosion product evident on strand / wire interiors and king wire. No measurable loss of section noted at any location on any wire / strand.											
Points of Interest/Defects Identified											
e	strand /	ber (le)	ber (le)	mm)	ock)	(mm)	mm) (le)				





Surface		
B	N/A	Regular wire end inspection

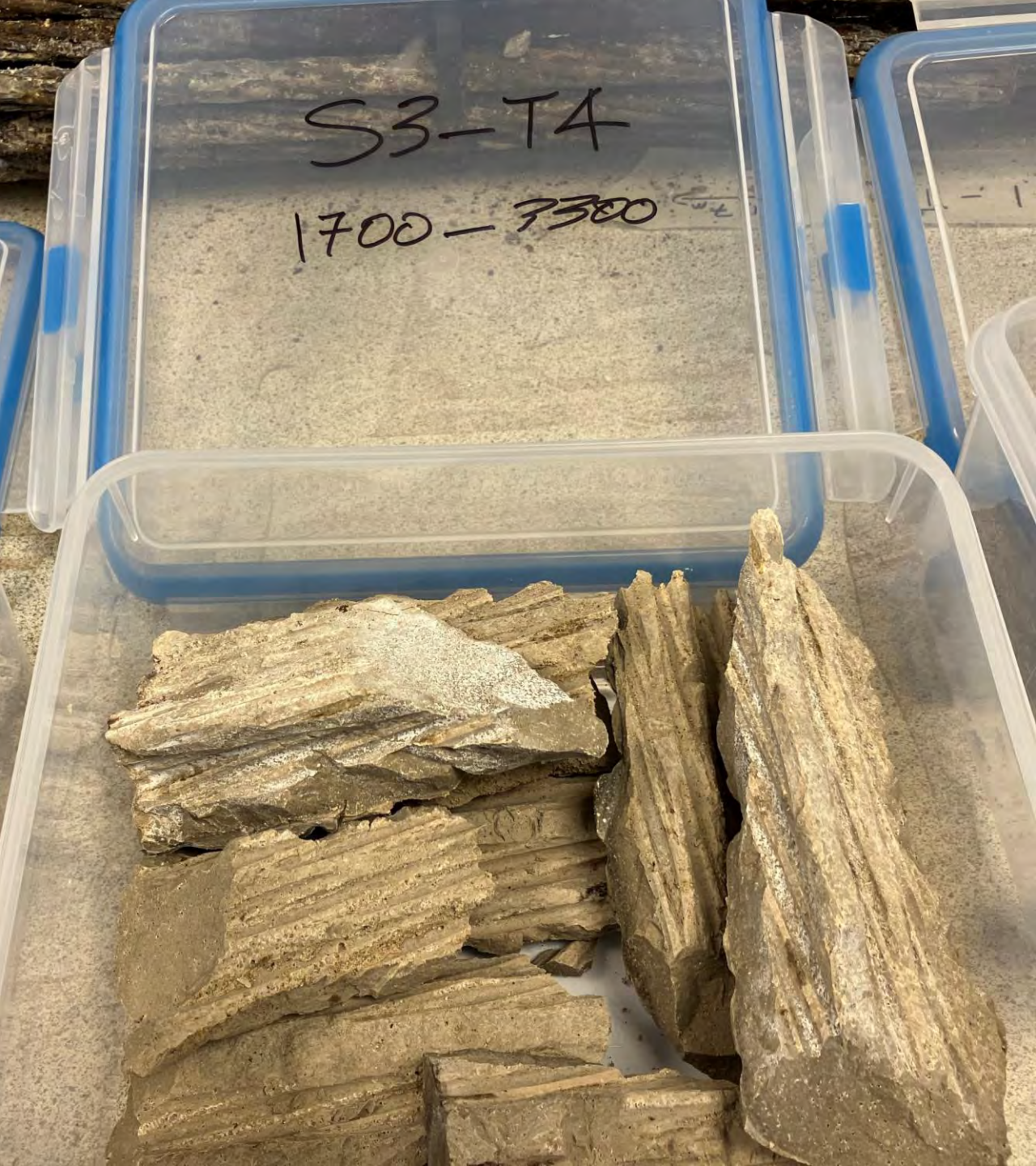


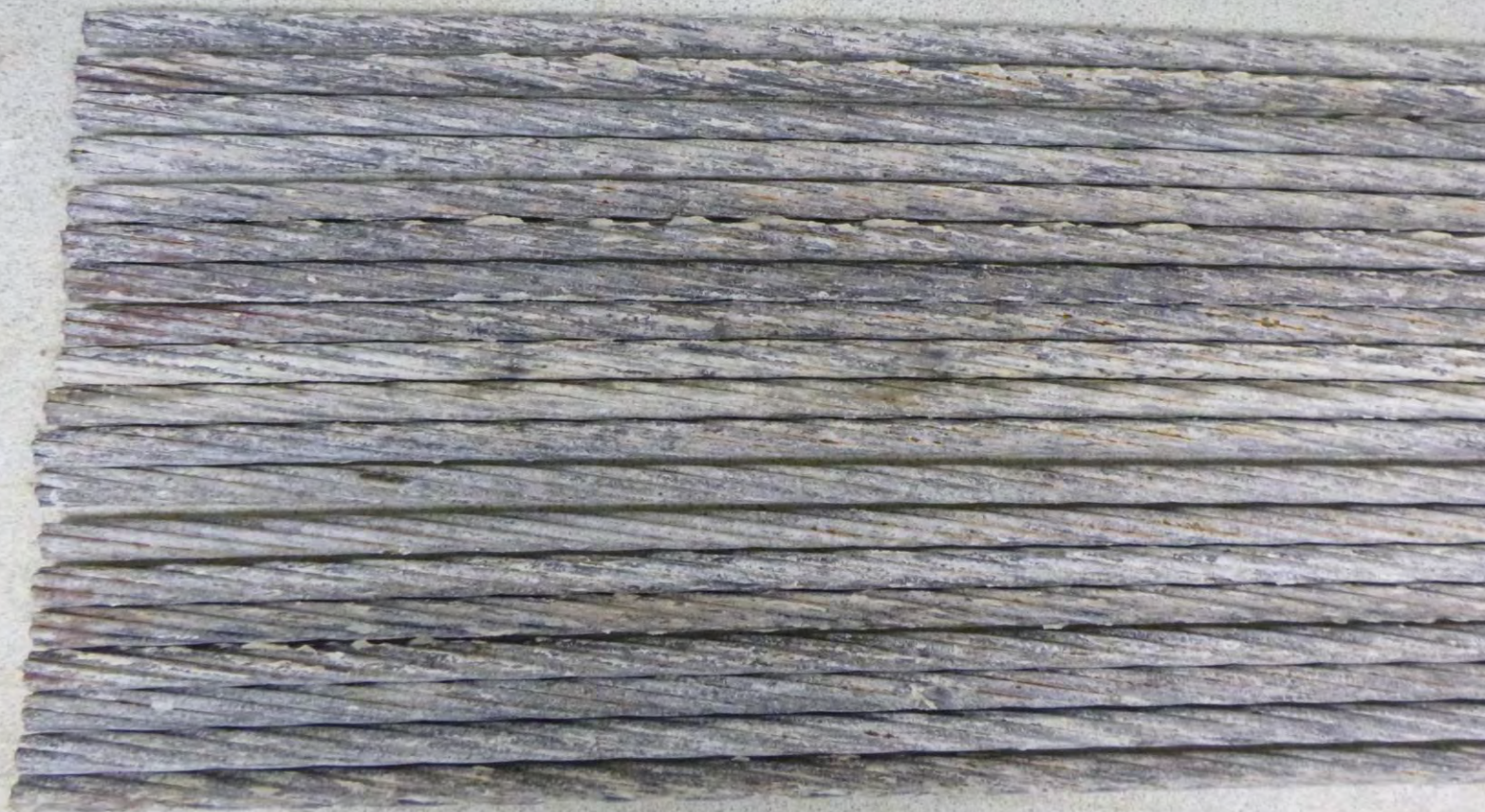
UT inspected.

indication being present









S3-T4
43-62 →

- 19
- 18
- 17
- 16
- 15
- 14
- 13
- 12
- 11
- 10
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1



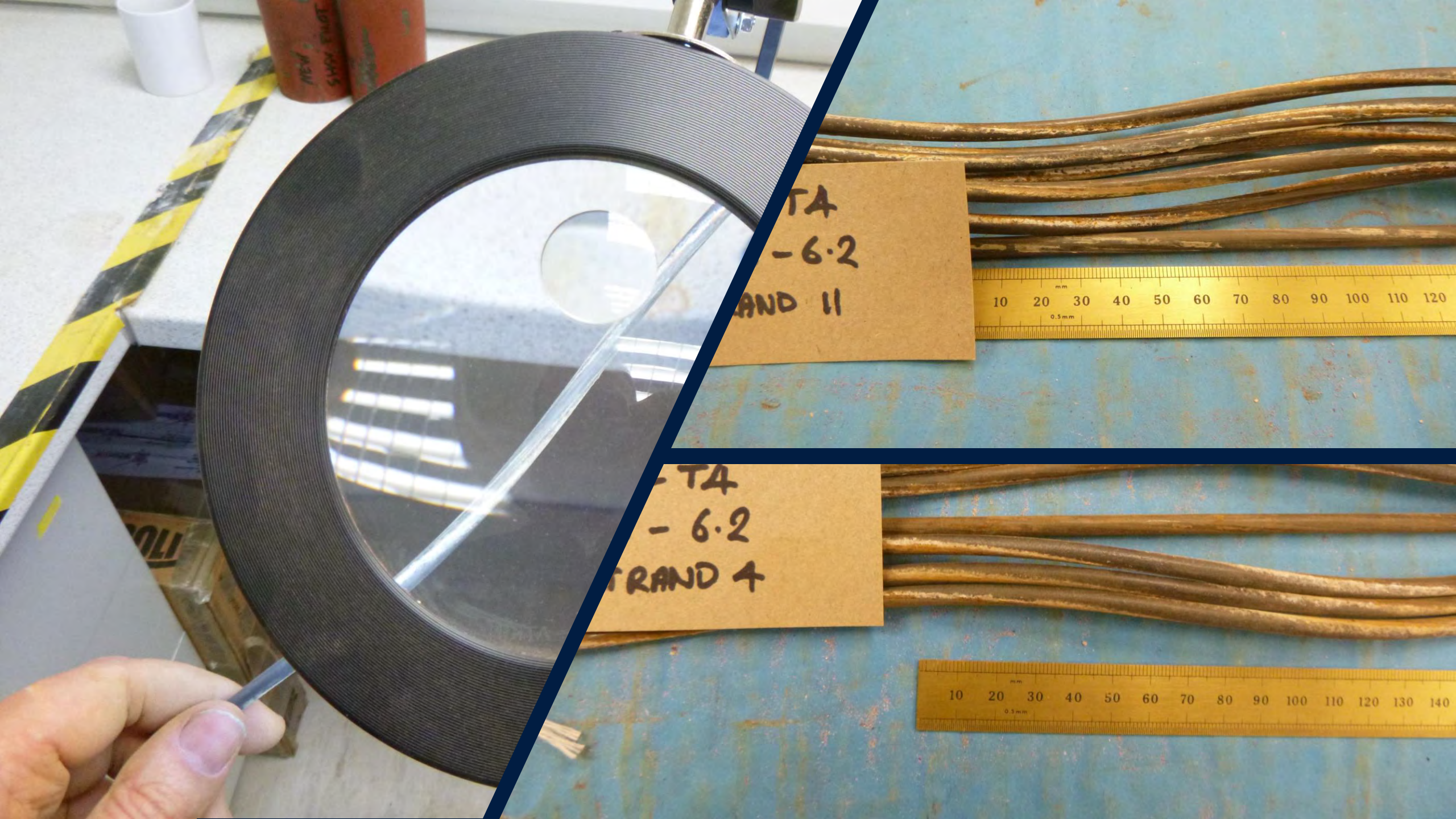
53-14
4.8-6.2
STRAND 19
4.8-6.2
STRAND 18
4.8-6.2
STRAND 17
4.8-6.2
STRAND 16
4.8-6.2
STRAND 15
4.8-6.2
STRAND 14
4.8-6.2
STRAND 13
4.8-6.2
STRAND 12
4.8-6.2
STRAND 11
4.8-6.2
STRAND 10
4.8-6.2
STRAND 9
4.8-6.2
STRAND 8
4.8-6.2
STRAND 7
4.8-6.2
STRAND 6
4.8-6.2
STRAND 5
4.8-6.2
STRAND 4
4.8-6.2
STRAND 3
4.8-6.2
STRAND 2
4.8-6.2
STRAND 1



15
12
11
10
9
8
7
6







TA
- 6.2
STRAND 11

TA
- 6.2
STRAND 4

All strands subject to full unwinding operation. Defective regions itemised as follow:

Reference Figure	Strand Number	Chainage (mm)	Approx % Loss of Section	Description
1	1	270 - 400	N/A	0 - 270mm wires missing due to tensile fracture of all wires in strand. Fractures appeared brittle and not attributable to section loss – no additional broken wires in evidence.
		570	0 - 25	Swelling on Strand / Grout forced into interior. No additional broken wires evident when fully unwound although generally corroded.
2	2	580	N/A	Swelling on Strand / Grout forced into interior
		1470	0 - 25	Swelling on Strand / Grout forced into interior – no broken wires in evidence when unwound.
3	3	600	50 - 75	Strand exterior in heavily corroded condition. Significant / major section loss on outermost wires at 600mm chainage.
		1010	N/A	Tensile break in king wire at 1010mm chainage.
4	4	140	N/A	Crack in outer wire – wire appeared to be in buckled condition.
		300	0 - 25	Section loss on all outermost wires evident when unwound. No breaks in king wire.
5	5	N/A	0 - 25	Wires generally very corroded but no major sectional loss. No breaks in king wire.
6	6	N/A	0 - 25	Wires generally very corroded but no major sectional loss. No breaks in king wire.
7	7	670	0 - 25	Wires severed by coring operation at ~670mm chainage. Wires generally corroded but no major loss of section
8	8	670	0 - 25	Wires severed by coring operation at ~670mm chainage. Wires generally corroded but no major loss of section
9	9	670	0 - 25	2 wires severed by coring operation at ~670mm chainage. Wires generally corroded but no major loss of section
10	10	N/A	0 - 25	Wires generally corroded. No breaks recorded.
11	11	N/A	0 - 25	Wires generally corroded. No breaks recorded.
12	12	N/A	0 - 25	Wires generally corroded. No breaks recorded.
13	13	N/A	0 - 25	Wires generally corroded. No breaks recorded.
14	14	460	0 - 25	Break in king wire 460mm chainage. Fracture appeared brittle in nature, not attributable to sectional loss. Surrounding wires in corroded condition but not deformed / stretched and displayed typical sectional loss.



Opening Order	Sample	Tendon	Chainage			Length	Date Opened in lab	General Strand / Wire Observations
3	1	1	0	-	1	1	29/03/2024	Significant voiding of the grout evident, light surface corrosion of wires
	1	1	1	-	1.5	0.5	03/04/2024	Grout OK, white / powdery, Light surface corrosion
	1	2	0	-	1	1	07/04/2024	Grout voiding at 12'O clock position, Strands and wires all in average condition - surface corrosion
	1	3	0	-	1.7	1.7	07/04/2024	Tendon in very poor overall condition, strands cut (cored) / corroded wires in evidence, Two broken king wires - surrounding wires intact
6	3	1	0	-	1.7	1.7	24/04/2024	Grout voiding at 12'O clock position, Strands and wires all in average condition - surface corrosion
	3	1	1.7	-	3.2	1.5	24/04/2024	Grout voiding at 12'O clock position, Strands and wires all in average condition - surface corrosion
	3	1	3.2	-	4.7	1.5	11/04/2024	Grout intact throughout and at ends, Strands and wires all in good condition
	3	1	4.7	-	6.15	1.45	11/04/2024	Grout intact throughout and at ends, Strands and wires all in good condition
7	3	2	0	-	1.7	1.7	25/04/2024	Grout segregation / bleeding (sands) at 12'O clock position, Strands and wires all in good condition
	3	2	1.7	-	3.4	1.7	25/04/2024	Grout segregation / bleeding (sands) at 12'O clock position, Strands and wires all in good condition
	3	2	3.4	-	4.6	1.2	17/04/2024	Grout intact @3400 end, loose at 4600 end, Strands and wires all in good condition
	3	2	4.6	-	6.2	1.6	17/04/2024	Poor grout, no significant corrosion except local to 6200 end with minor section loss to wires. Aligns with where minor loss of grout also observed
8	3	3	0	-	1.7	1.7	26/04/2024	Grout segregation / bleeding (sands) at 12'O clock position, Strands and wires in poor condition (section loss and corrosion)
	3	3	1.7	-	3.4	1.7	26/04/2024	Grout segregation / bleeding (sands) at 12'O clock position, Strands and wires in poor condition (section loss and corrosion)
	3	3	3.4	-	4.7	1.3	02/05/2024	Grout segregation / bleeding (sands) at 12'O clock position, Strands and wires all in average condition (surface corrosion)
	3	3	4.7	-	6.2	1.5	02/05/2024	Grout segregation / bleeding (sands) at 12'O clock position, Strands and wires all in average condition (surface corrosion)
5	3	4	0	-	1.7	1.7	04/04/2024	Poor grout, no significant corrosion / pitting to wires observed
	3	4	1.7	-	3.3	1.6	07/04/2024	Grout intact throughout and at ends, Strands and wires all in good condition
	3	4	3.3	-	4.8	1.5	07/04/2024	Grout intact throughout and at ends, Strands and wires all in good condition
	3	4	4.8	-	6.2	1.4	07/04/2024	Grout intact throughout and at ends, Strands and wires all in good condition
2	3	5	0	-	1.7	1.7	27/03/2024	Minimal grout, One wire break ST.17
	3	5	1.7	-	3.2	1.5	02/04/2024	Minimal grout, some wire pitting
	3	5	3.2	-	4.7	1.5	02/04/2024	Grout over half length of duct, duct steel poor, surface corrosion to wires
	3	5	4.7	-	6.25	1.55	03/04/2024	Grout intact throughout and at ends, Strands and wires all in good condition
4	3	6	0	-	1.6	1.6	03/04/2024	Tendon in very poor overall condition, strands and broken / corroded wires in evidence
1	3	7	0	-	1.6	1.6	21/03/2024	Grout largely intact - different materials - minor pitting to wires noted
	3	7	1.6	-	3.2	1.6	22/03/2024	Grout largely intact - different materials - minor pitting to wires noted
	3	7	3.2	-	4.8	1.6	22/03/2024	Grout largely intact - different materials - surface corrosion to wires noted
	3	7	4.8	-	6.07	1.27	27/03/2024	Grout largely intact - different materials - surface corrosion to wires noted

Thank You

R&D Trials : Innovative Inspection Techniques Overview

Bernard McGrath - Amentum

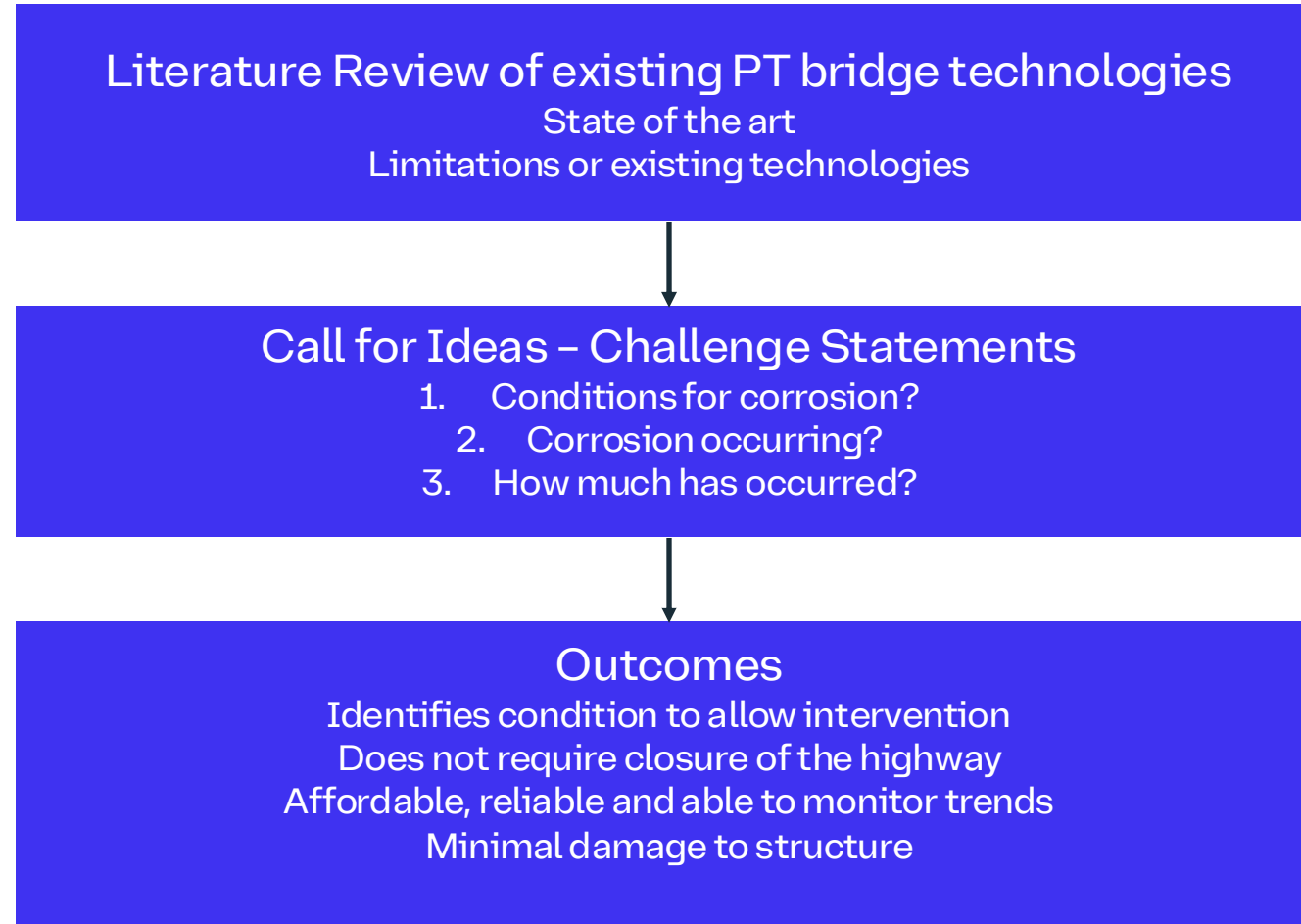
June 2025

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Call for Ideas for New Technologies



Assessment of Ideas

- **Objective Scoring of Ideas**
 - 10 criteria
 - Assigned % weighting
 - 3 defined scoring levels
- **Ideas Grouped into three categories**
 - Well aligned
 - Potential transformational implications
 - Possible candidate
 - Promise but not developed enough
 - Not aligned
- **Deploy / Develop**
 - Available -> A14 trials
 - Develop - > R&D programme

R&D Technologies Commissioned

- **Direct Impedance Measurement** **Sentec Ltd**
- **RF Induced Ultrasound** **Sentec Ltd**
- **Guided Wave Technology** **Omnia Integrity Ltd**

Methodology

- **Distinct 'phases' with specific outcomes and funding requirements**
 - Theoretical analysis
 - Laboratory tests
 - Field tests
- **Parallel progression with hold points assessment**

Subsequent commission

- **Muon Technology** **Gscan Ltd**

Two NDT methods

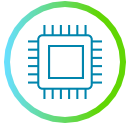
Radio frequency
induced ultrasound

Electrical Impedance

Riccardo Di Pietro

September 25

Sentec - Product developers since 1997



Technology & Product developers



Main focus – smart sensing



Based in Cambridge UK, Europe's leading technology hub



State of the art facilities



Secure and stable – part of \$8.1B Xylem group

World class development team

Physics

Electronics

Mechanical Design

Software and Firmware

Design for Manufacture

Programme Management



Lucy Electric & Sentec – a ten-year partnership

Development of innovative condition monitoring technologies for the electricity network

Roles for the National Highways Moonshot:



Implementation partner



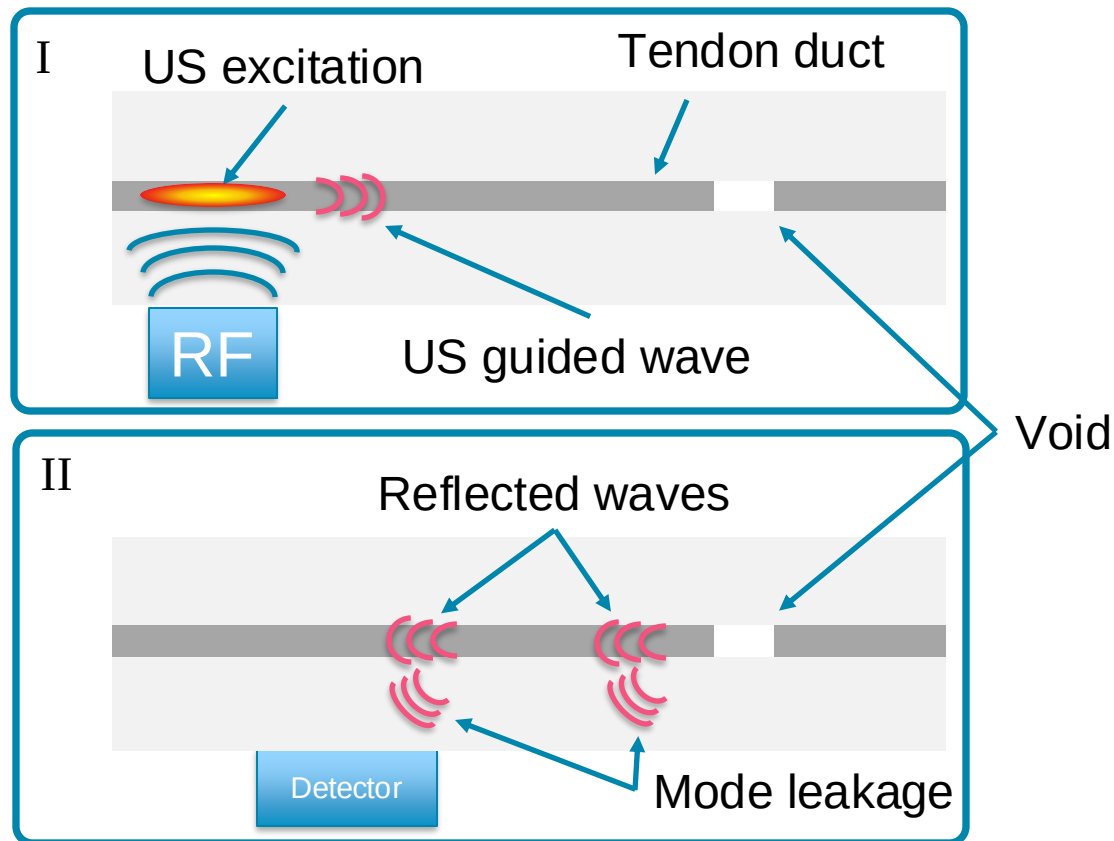
Technology and product development partner



Feasibility evaluation of two methods

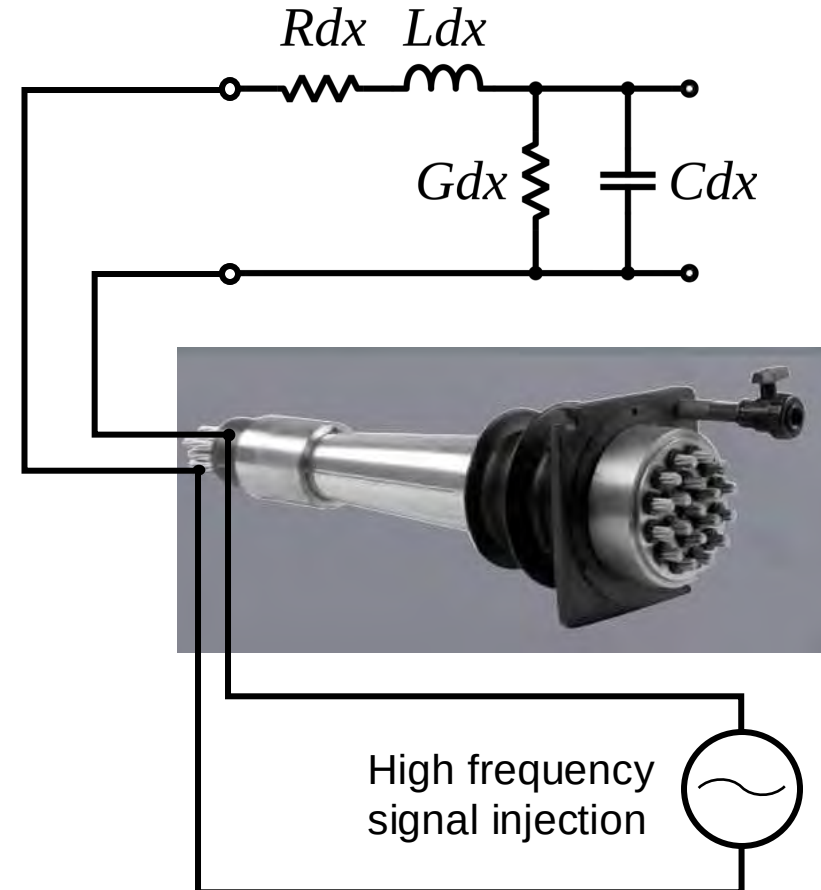
Radio Frequency (RF) induced ultrasound (US)

Use RF excitation to generate US contactless in the tendon



Electrical impedance

Detect signal reflections from abrupt changes tendon composition

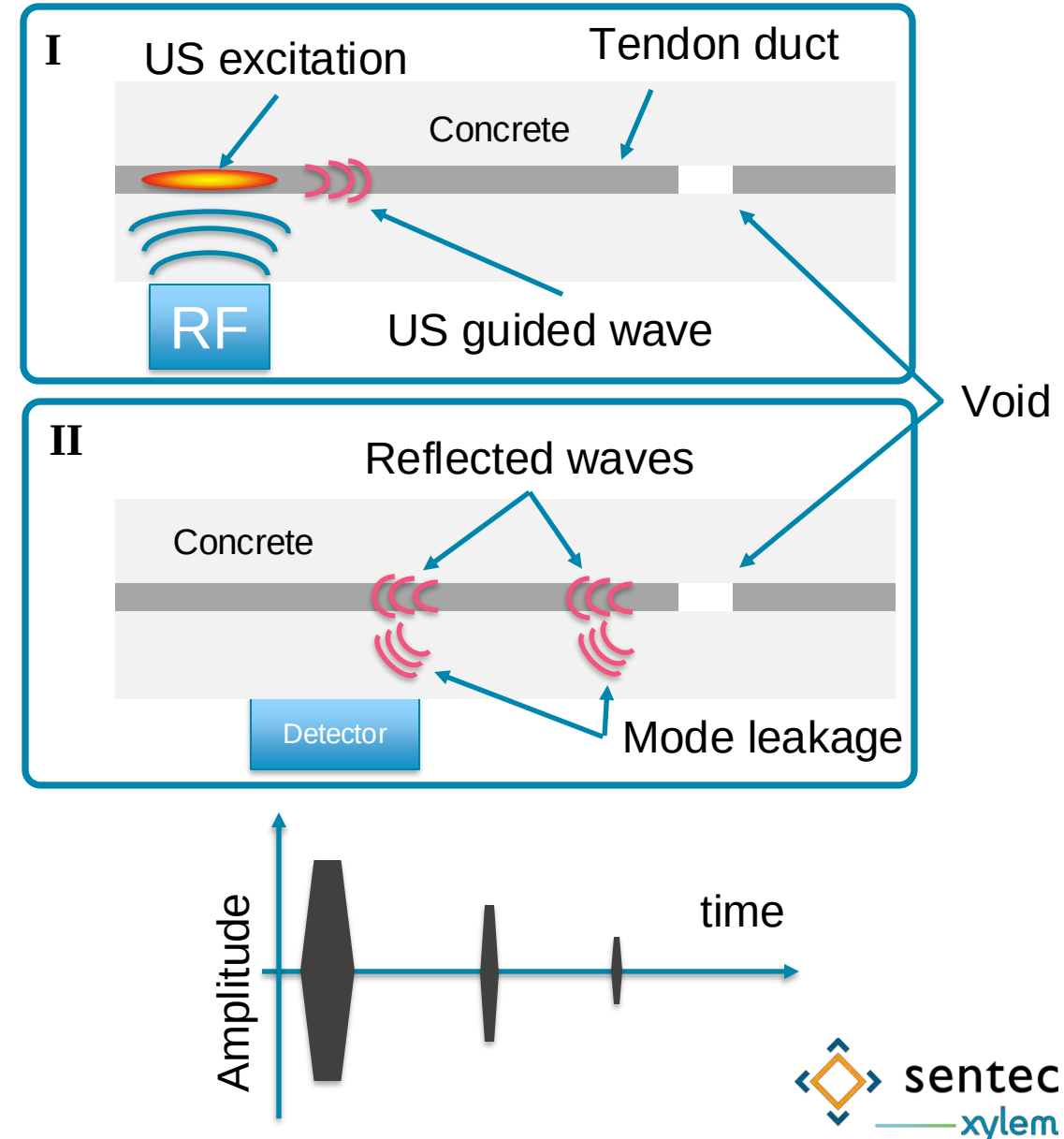


Radio frequency induced ultrasound



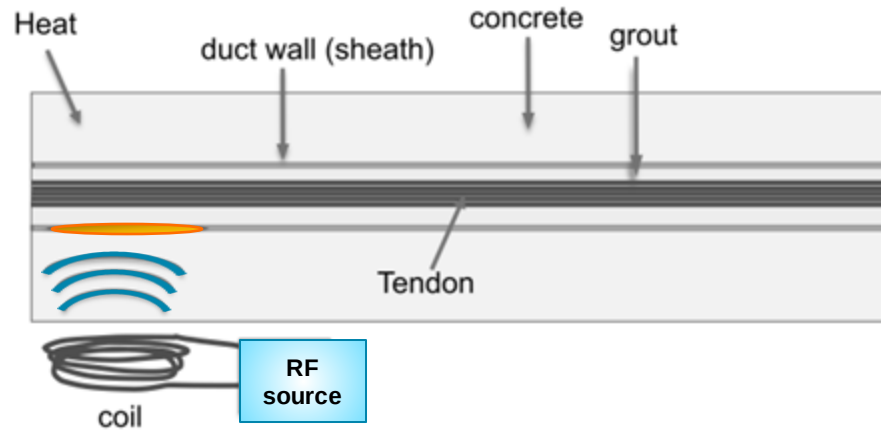
Radio Frequency (RF) induced ultrasound (US)

- I** Noncontact generation of guided US waves in tendons
 - ⇒ Uses pulsed RF generator placed on concrete surface to locally excite steel tendons and produce acoustic waves
 - II** Defects/discontinuities reflect acoustic signal, which can be measured externally
 - ⇒ Uses a detector (piezo transducer, laser velocimetry, etc.) placed on the concrete surface
- + Retrofittable system – Excitation and detection are carried out at the surface of the concrete
- May need multiple transmitter/receiver units to cover the length of the bridge (a pair covers 20 to 100 m)



Near field coil excitation vs. far field RF excitation

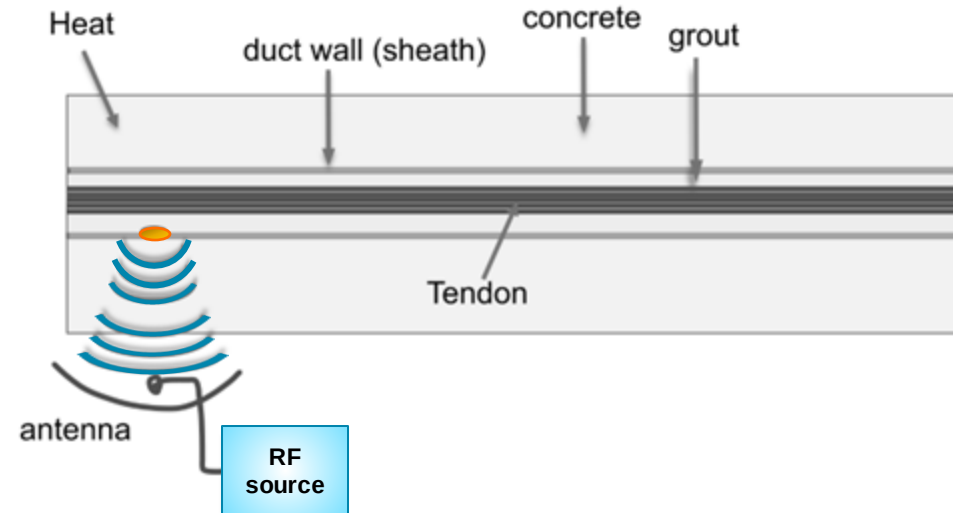
1. Near field magnetic field from a coil



More robust excitation geometry

- Easy to generate high intensity pulse
- Better coupling between antenna and tendon / duct
- Efficiency increases with increasing power

2. Far field EM radiation from an antenna

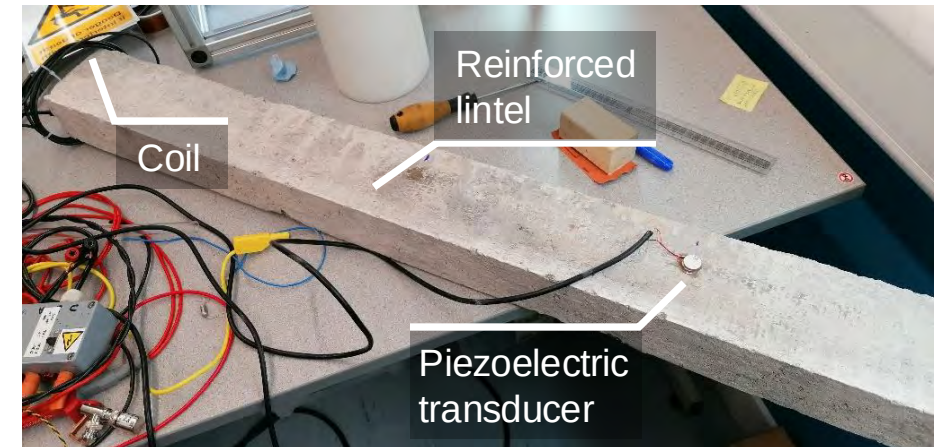
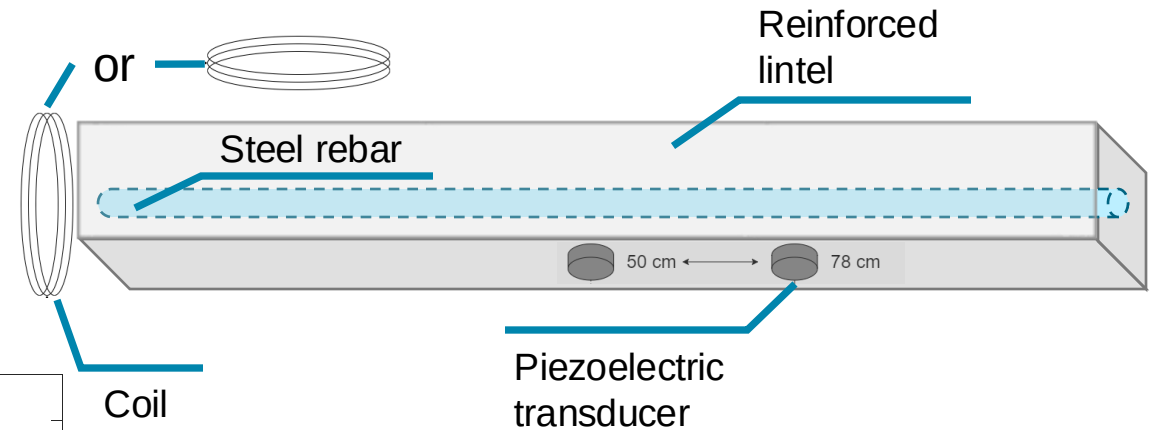
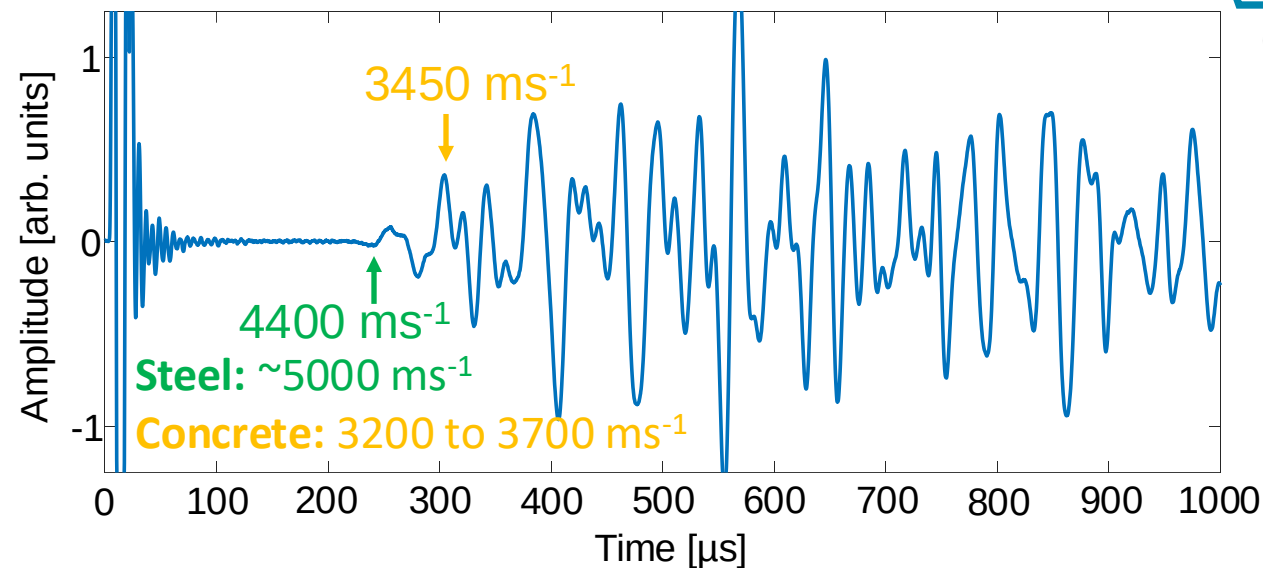


Limitation in excitation method

- Analysis shows absorption is too high at the frequencies required for small spot size
- Could be used for generating ultrasound in the concrete

Proof of principle – Coil generated signal through lintel

- Broadband pulse excites resonant modes in the rebar and slab
- Signal generation measured up to 50 cm stand-off excitation.

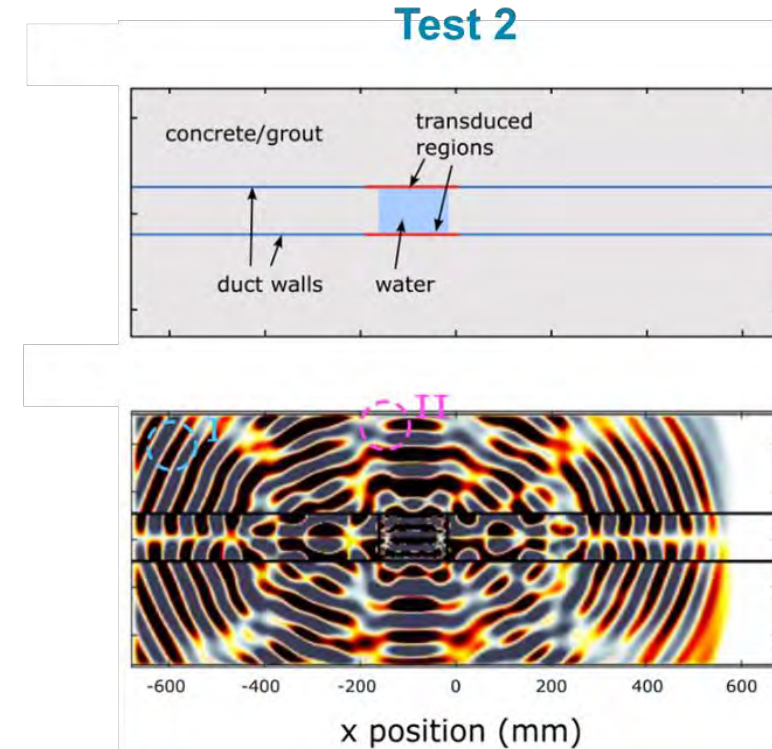
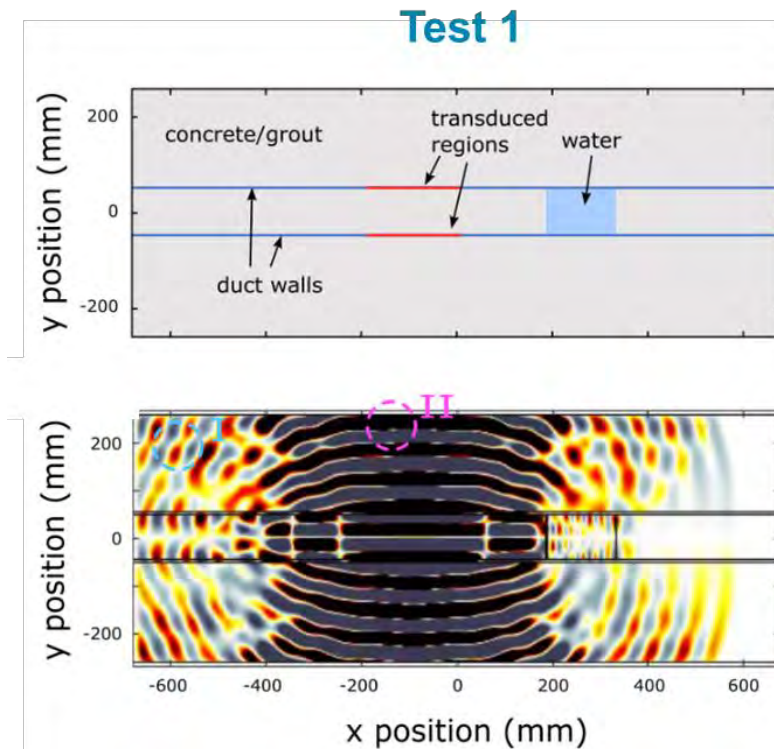


Successful non-contact generation of US pulses in buried metal structure

Proof of principle – Modelling the detection of discontinuities in grout

Test 1 Detector away from discontinuity – reduced signal propagation after the discontinuity

Test 2 Detector on the discontinuity – enhanced signal scattering in all direction



Identified 2 potential methods for detection – scanning or array

Conclusions and possible next steps

Successful noncontact excitation of US pulses in buried metal structures:

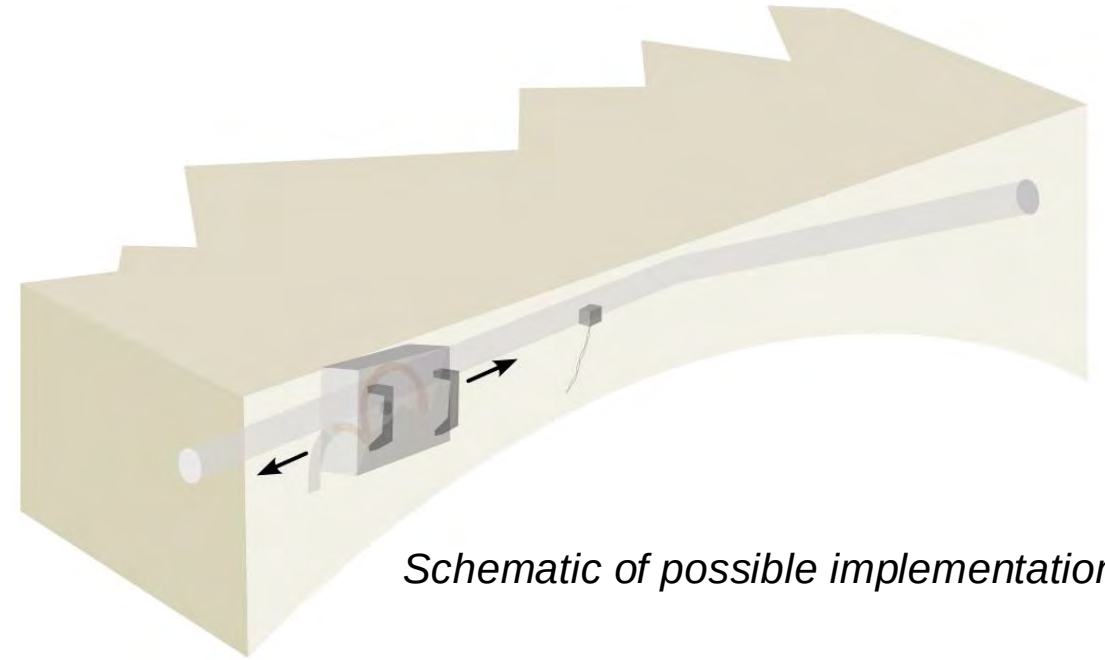
- Signals are transmitted and received at the concrete surface
- No exposure of duct required

Potential design implementation:

- 1) Transmit coil + detection transducer swept along the length of the bridge
- 2) Transmit coil swept along the length of the bridge + detection transducer(s) strategically placed along the length of the duct, on the concrete surface

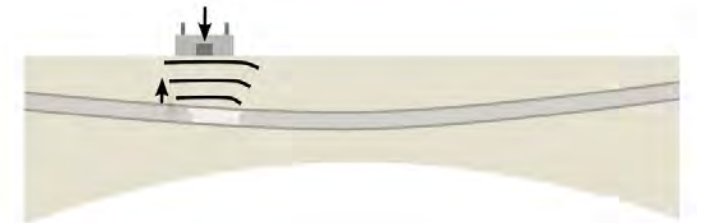
Potential future work:

- Further expand bandwidth and power of coil generation
- Assess feasibility on large scale structures

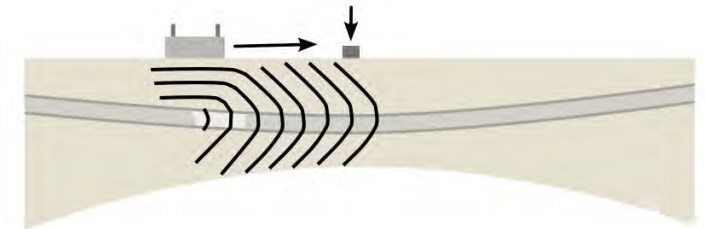


Schematic of possible implementations

Design 1



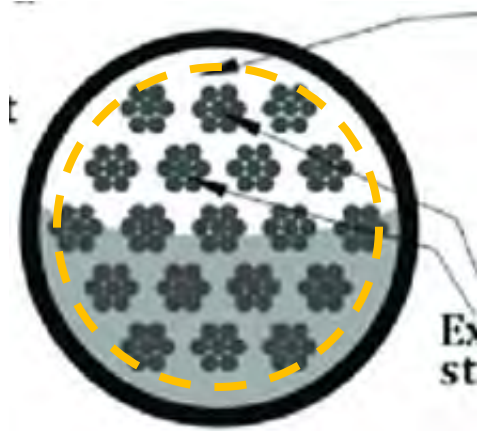
Design 2



Electrical impedance



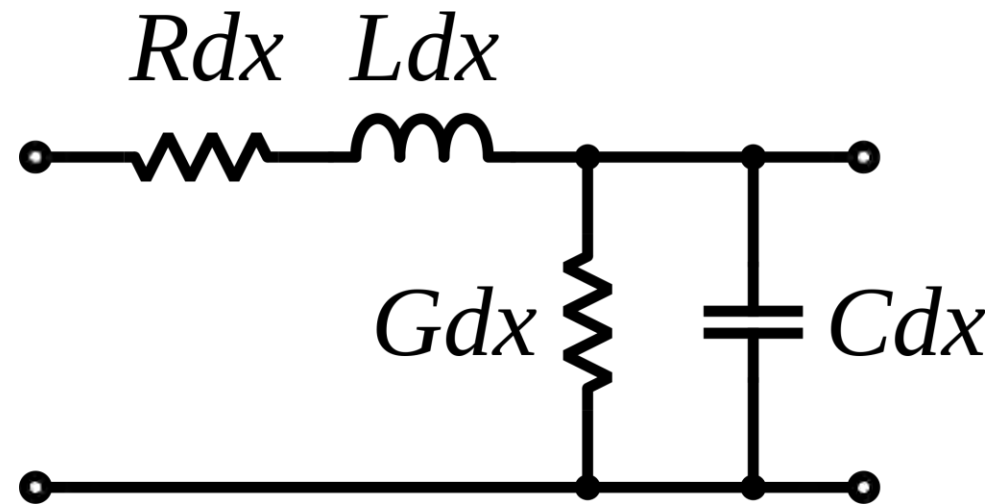
Model current transport in tendon / duct as transmission line



The tendon / duct system can be modelled as a coaxial transmission line

The dashed line is the effective conductor diameter

Equivalent circuit model for transmission lines



Transmission line impedance

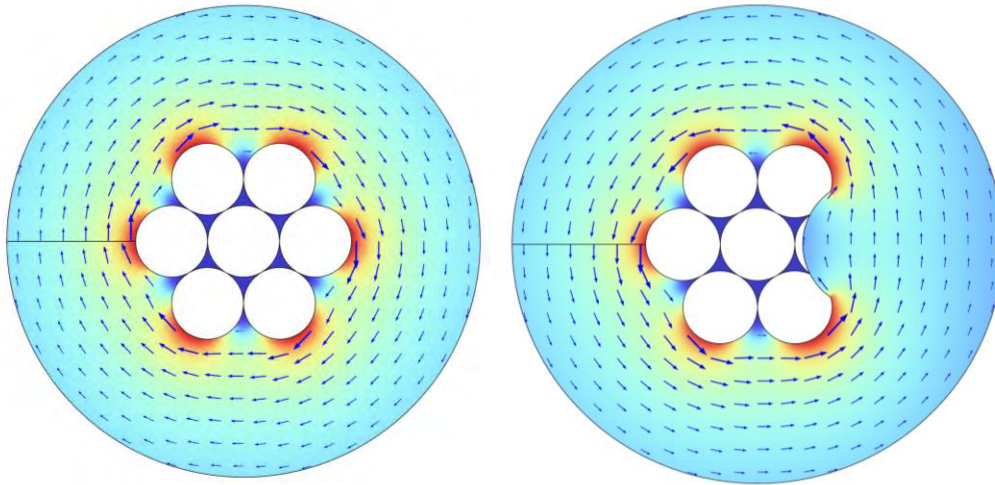
$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

Factors influencing electrical properties:

- R and L: **tendon and duct wall continuity, strand breakage**
- G and C: **water content and grout degradation**

Proof of principle – Impact of discontinuities on electrical impedance

Effect of tendon corrosion:

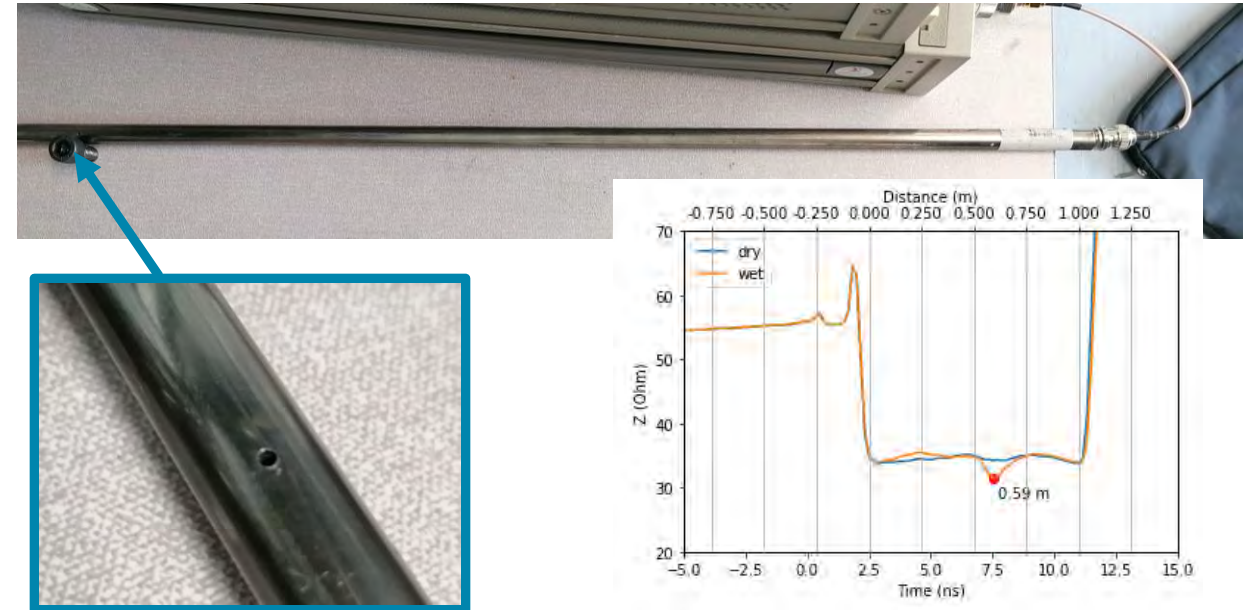


Pristine tendon

Loss of one strand

5% increase in impedance for loss of a full strand – **cannot detect corrosion**

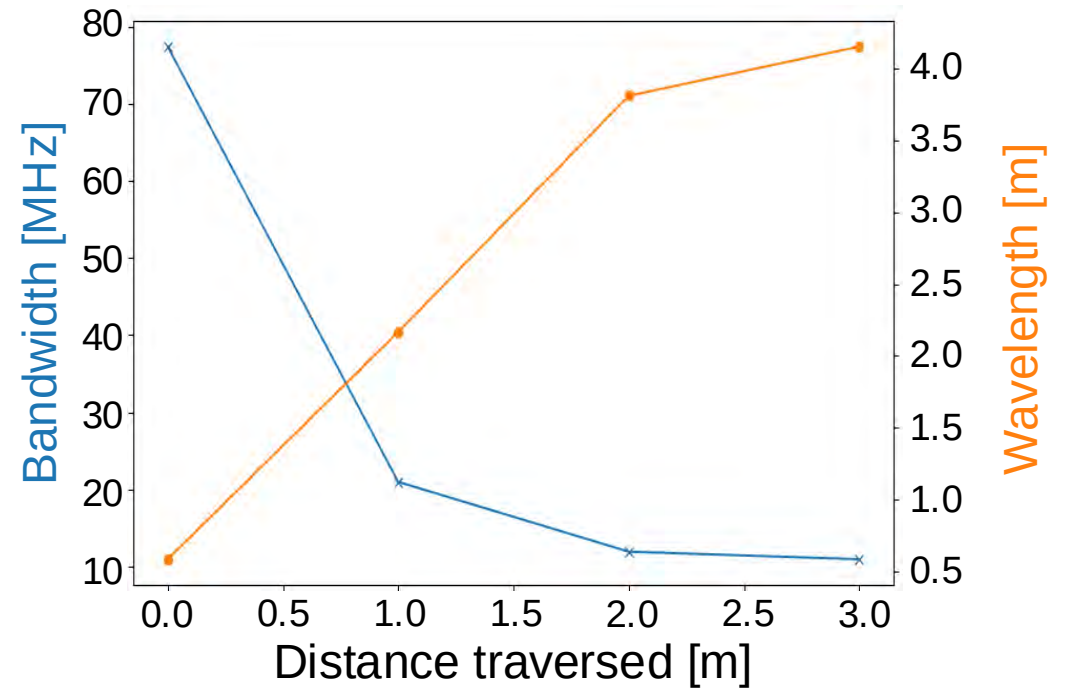
Effect of water ingress:



12% decrease in impedance with small defects – **easier to locate defect?**

Proof of principle – Impact of grout on electrical impedance

Grout is a lossy, low-impedance dielectric:
Dampens changes in impedance caused by
water ingress vs. initial assessment



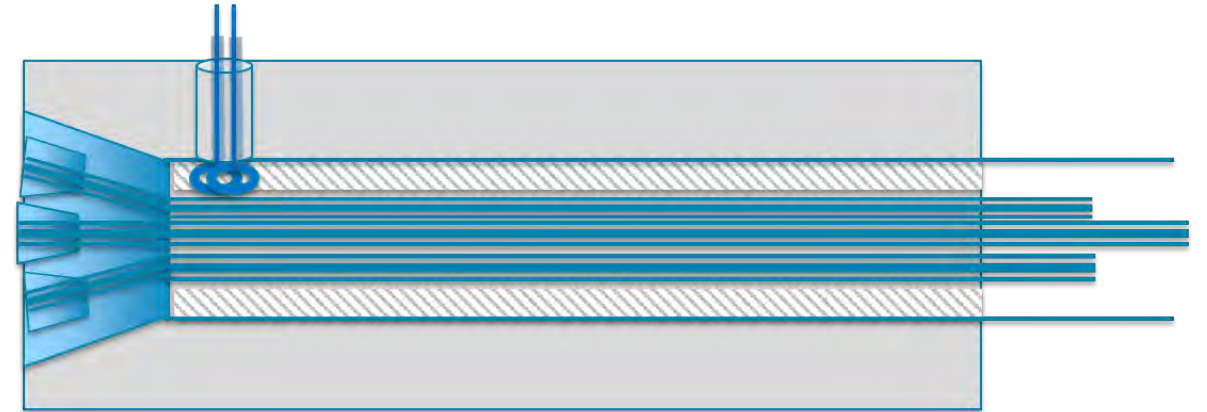
- Grout properties limit signal bandwidth to ~10 MHz – limits defect location to ~1 m
- Fault detection and location relies on having a clear baseline for comparison

Electrical connection to the tendon

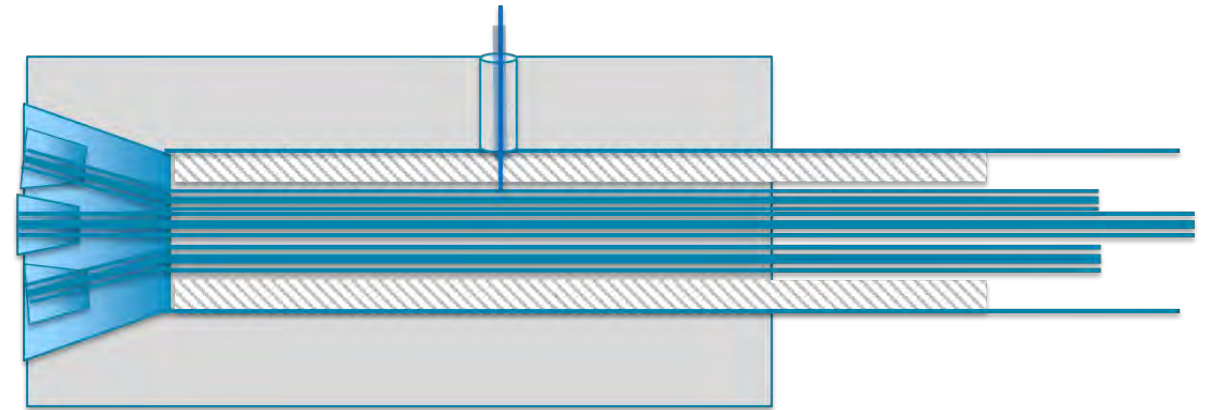
Retrofitting the system to a tendon requires exposing the tendon

- Signals can be induced with current loops (no direct contact to the tendon), but still require insertion underneath the duct
- Voltage signals require direct contact with duct and tendon

Loop drive & pickup (can be right by anchor):



Voltage drive & pickup (away from anchor):



Conclusions and possible next steps

Fundamental limits are:

- Lower limit of detection
- Installation - invasive method

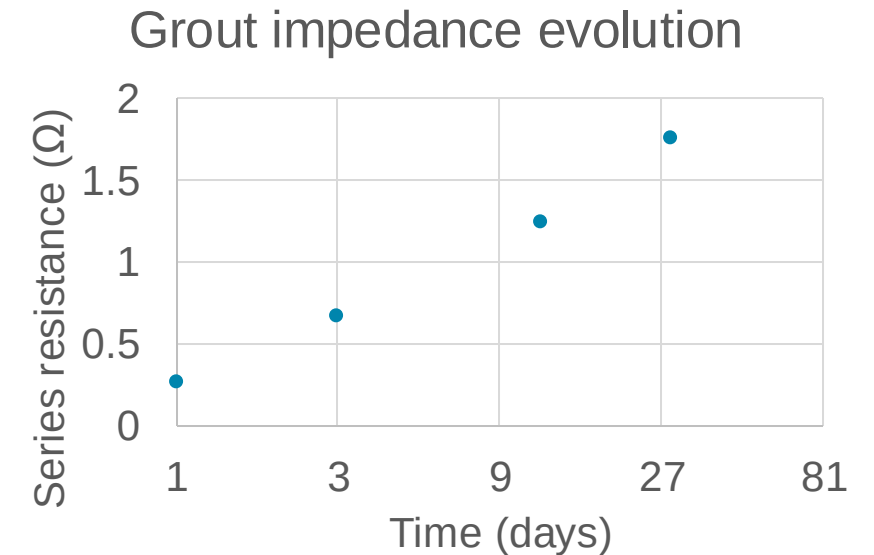
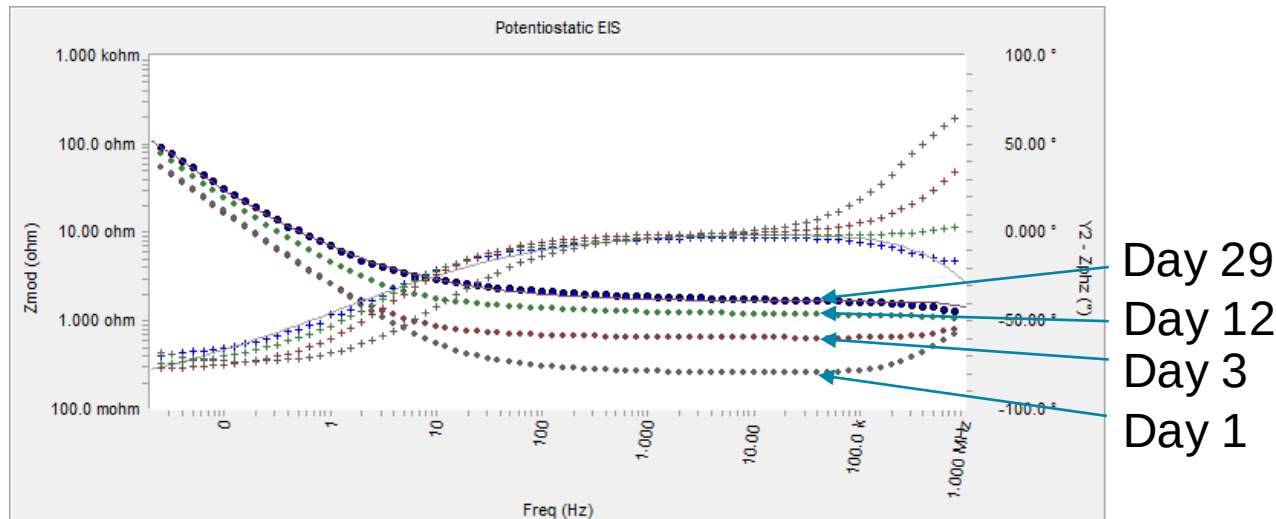
No sufficient improvements over the status quo

HOWEVER:

Electrical impedance is sensitive to **bulk** grout / concrete properties

- Can monitor grout setting
- Could detect grout degradation

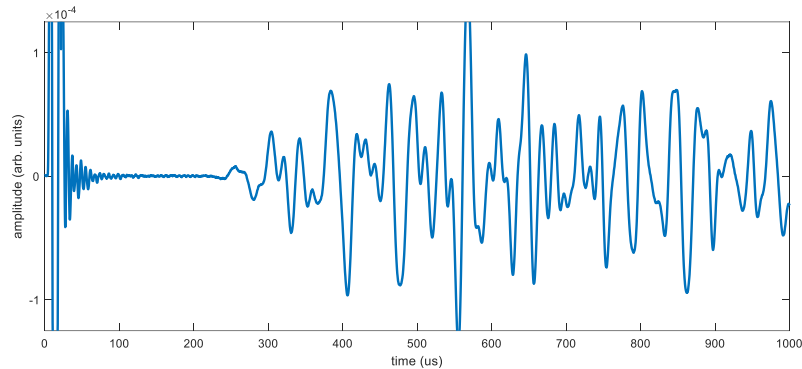
Possible use case?



Overall conclusions

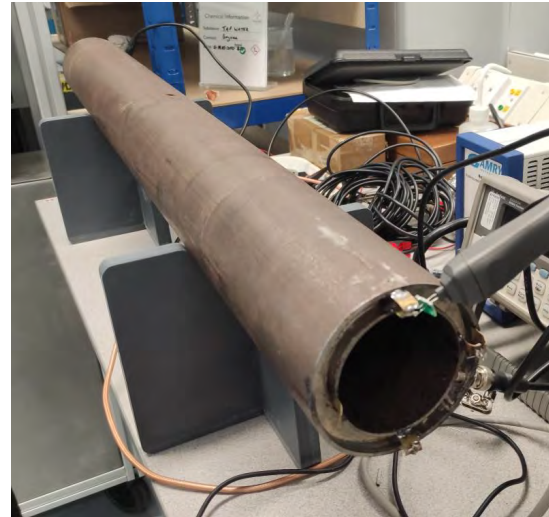
RF induced ultrasound

Successfully demonstrated
US generation and detection
in buried structures



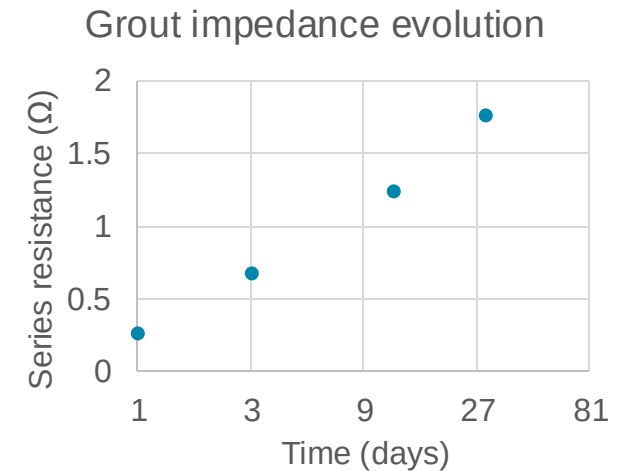
Electrical impedance

Assessed performance and
key limitations



Electrochemical impedance

Long term monitoring of bulk
grout / concrete conditions



Please get in touch for feedback or questions!

Riccardo Di Pietro
Technical Director

riccardo.dipietro@xylem.com

Sentec

Radio House
St Andrews Road
Cambridge
CB4 1DL
United Kingdom

t. +44 (0) 1223 303 800

e. info@Sentec.co.uk

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A wide-angle, high-angle photograph of the Golden Gate Bridge in San Francisco. The bridge's iconic red-orange towers and suspension cables are prominent, stretching across the frame from the foreground on the left towards the right. The bridge spans a deep blue body of water, with the San Francisco city skyline visible in the distance under a clear sky. The foreground shows the rugged, rocky edge of the bridge's approach.

Muon Flux Technology / Atmospheric Ray 3D Tomography

Sander Sein

Agenda

1.

Technology
Principles

2.

Toddington Site Trials
on Sample 3

3.

Findings from
Sample 3

4.

Second trials on the
mockup beam

5.

Findings from
mockup beam

6.

Development of MFT
during the Structures
Moonshot project

GScan

3D imaging technology of critical and hidden structures for critical structures in the built world (bridges, tunnels, nuclear, Oil & Gas)

Established

2018

Locations

UK, DE, EE

Team

40 Top talents incl **7** PhDs



Cambridge,
UK



Tallinn,
Estonia



Munich,
DE



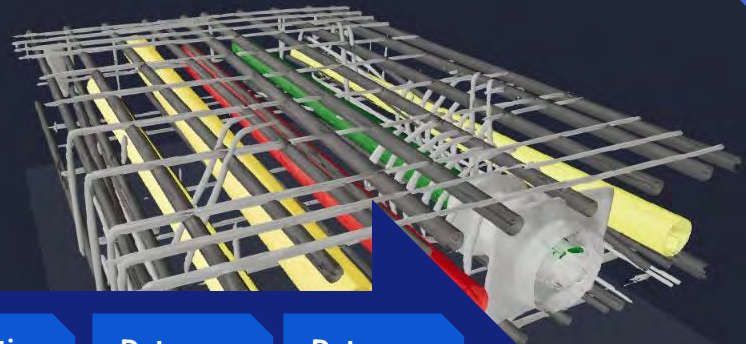
Tartu,
Estonia

We want to transform the asset management principles

GSCAN

We can start putting more trust into the data of existing structures

- Spatially known locations
- More accurate deterioration models
- Reduced safety factors



Data

Clear
Relationships

Probabilistic
Calculation
Model

Real
Behaviour

Quantitative
Knowledge

Data
Analytics

Data
Driven
Decisions

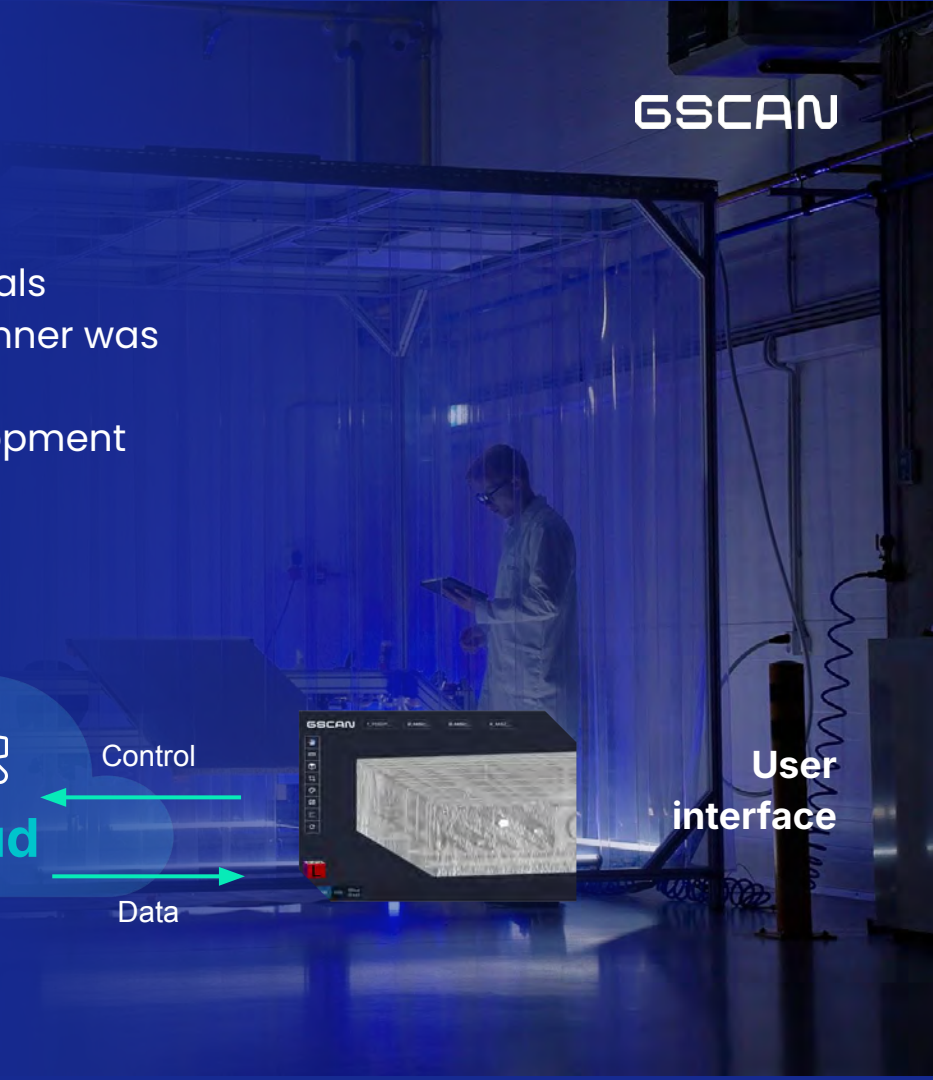
Technology

- Patented approach to detect low-z materials
- Commercialized production line – first scanner was completed in March 2023
- Continuous hardware and software development
- Find the optimal deployment solutions – measurements and service

**Hodoscope
set**



**User
interface**

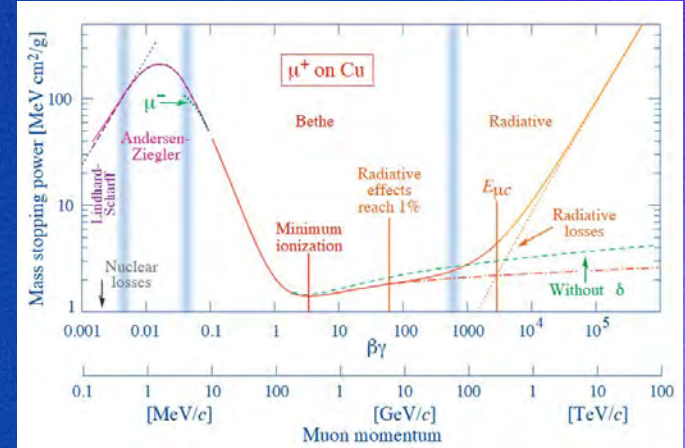
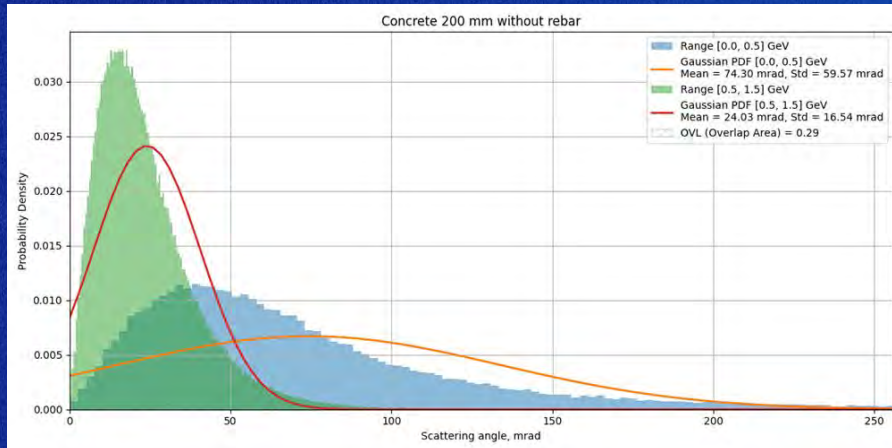


Technology

GSCAN

Mouns have random **direction** and **energy**.
Materials are causing two phenomenon:

- Scattering
- Absorption



We are **GSCAN**

Scan anything.
Detect everything.

Tracking the muons

- Scintillation fibres react to charged particles
- Plastic enables lightweight and compact design
- Small size of the fiber enables good tracking resolution 0,1 mm and 1 mrad
- Three layers of detection media enables to filter out particles based on the energy range

Plastic Scintillating Fiber (PSF)



Tracks into data

Data readout is now performed using customised, home-made DAQ direct readout with strict-budget design condition.

SiPM-array



Front-end read-out board



Business confidential
You will see it (and much more)
when you are visiting us in our
factory in Estonia

An image of a three-detector plane tracker, an assembly of 6 fibre-mats

Data of value

GSCAN

1.

Signal correction

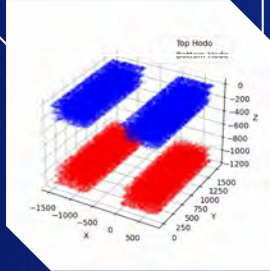
Adjust/correct electronics signal.



2.

Alignment

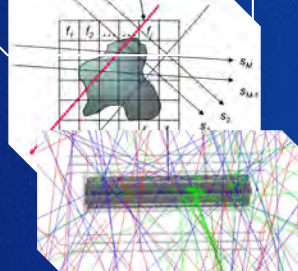
Positioning to each-other.
Physical build imperfections.



3.

Reconstruction

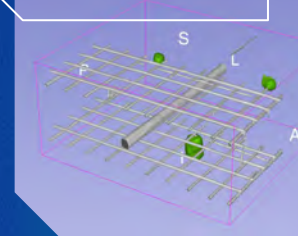
Fill 3D volume of interest with muons behaviour.



4.

Object detection

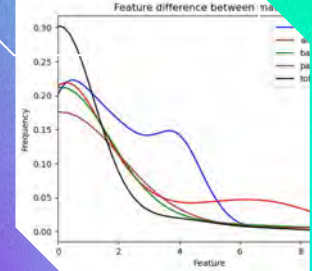
Detect objects of interest.



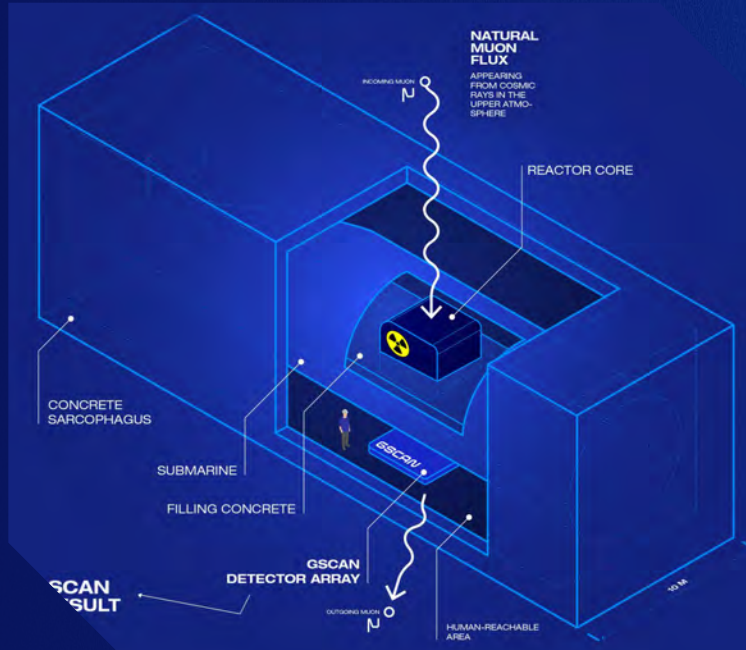
5.

Materials analysis

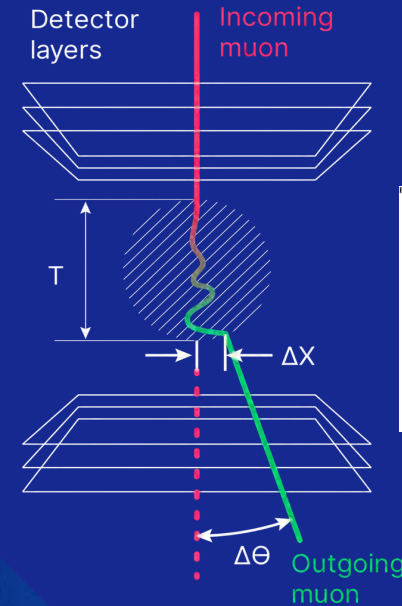
Estimate the material properties.



Measurement principles



One sided - absorption of muons (only density)



Two (or more) sided - absorption and scattering of muons (density and atomic number)

Periodic Table 1-118

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H	He																
2	Li	Be	B	C	N	O	F	Ne										
3	Na	Mg	Al	Si	P	S	Cl	Ar										
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
7	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

Structures Moonshot Toddington

Measurements Oct – Nov 2023



Measurements Oct – Nov 2023

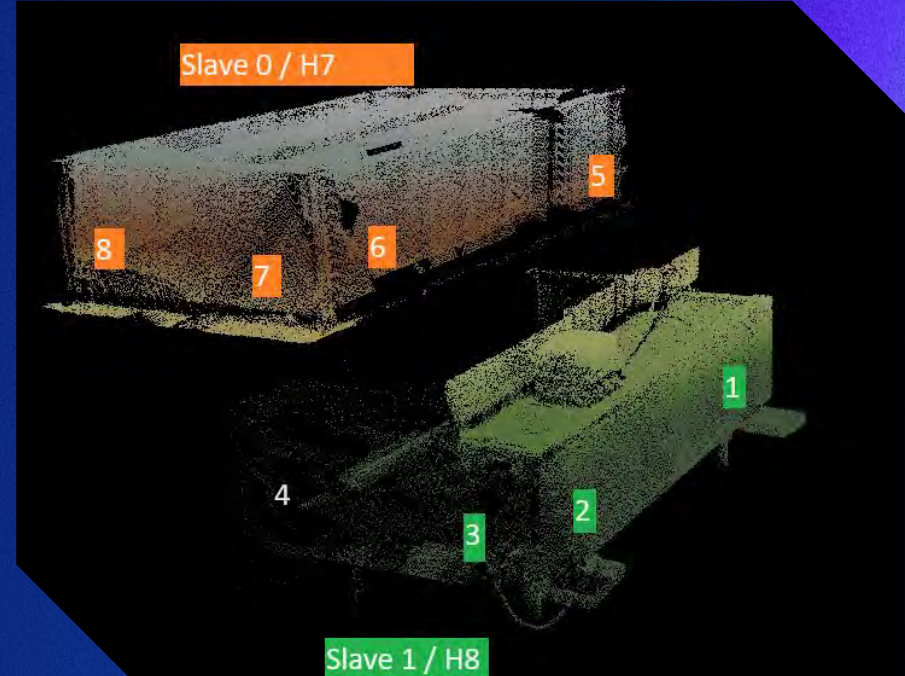
Total measurement time within 6 weeks

Position 1

- 220 h out of 456 h (19 days)
- **Measurement efficiency 48,2%**

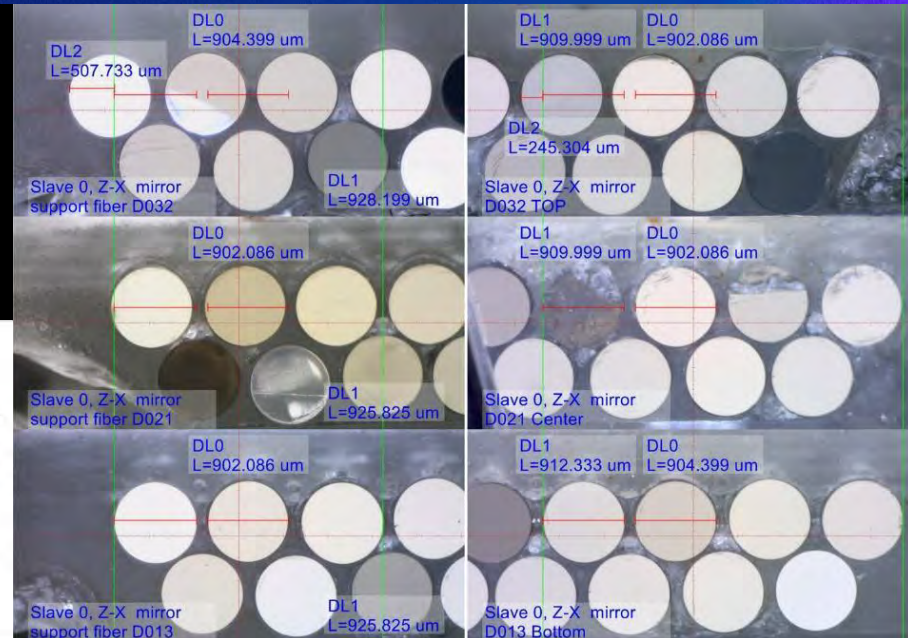
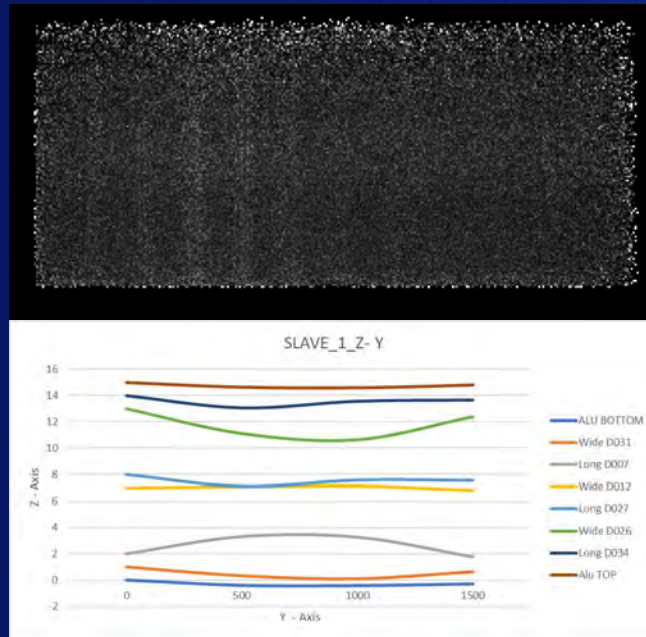
Position 2

- 350 h out of 456 h (19 days)
- **Measurement efficiency 76,8%**



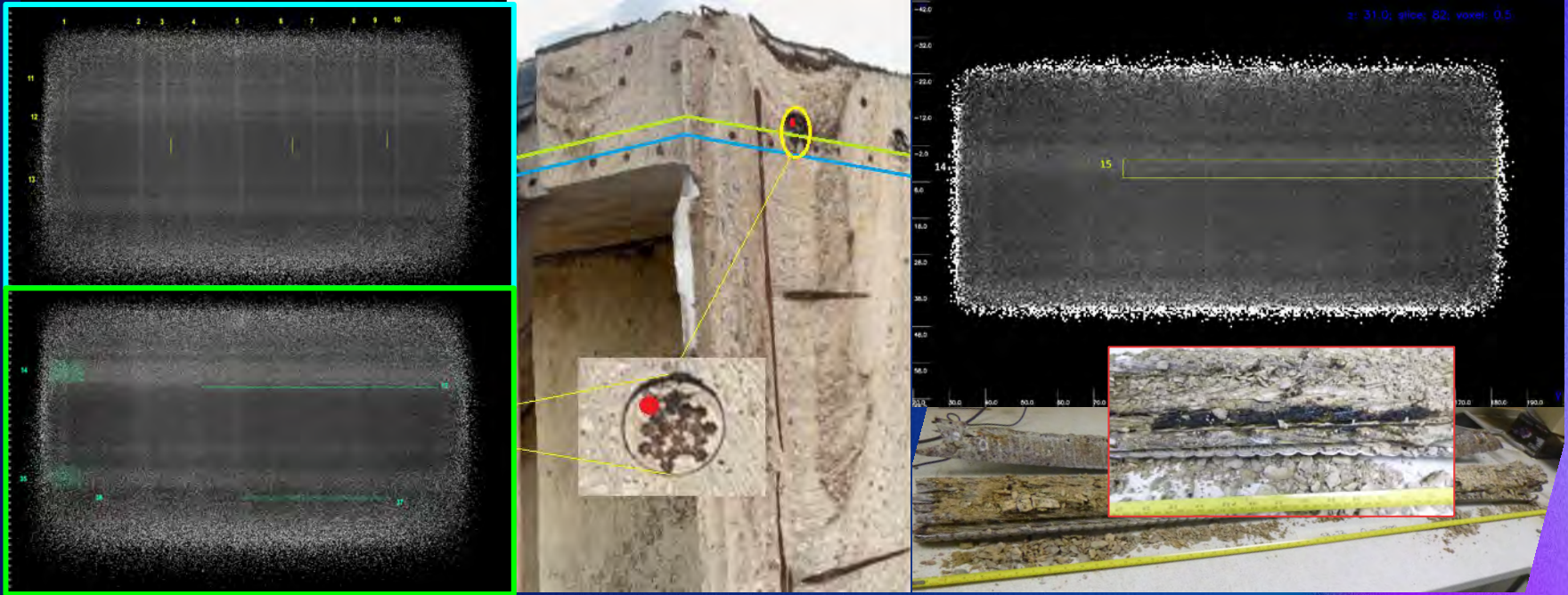
Measurements Oct – Nov 2023

Data processing was troublesome, but led us to ML alignment.



Results in December 2023

GSCAN



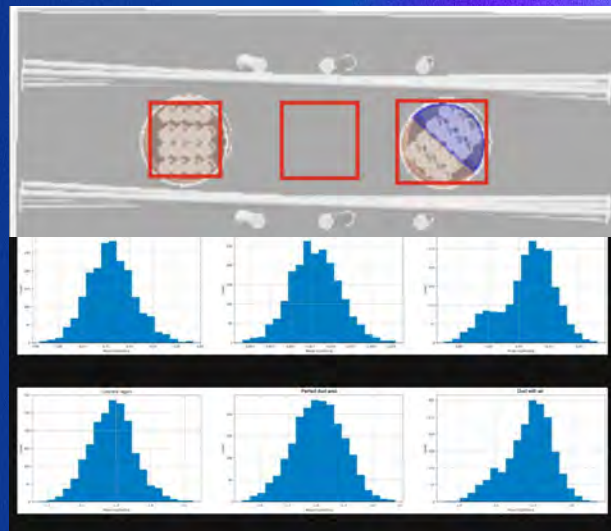
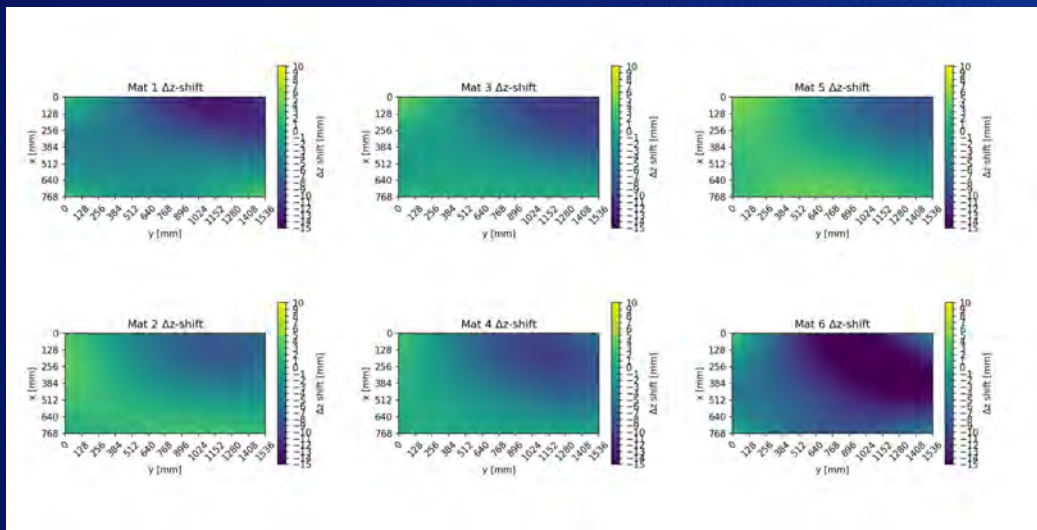
Improvements

Dataset analysis and adjustment

More data 23M hits to 27M hits

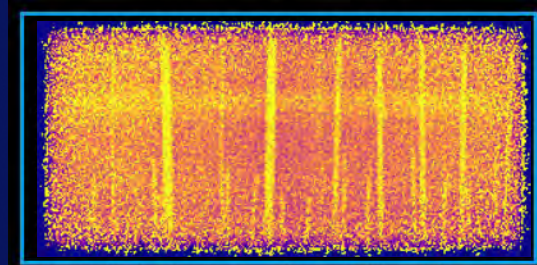
ML algorithms

First exploration of different scenes

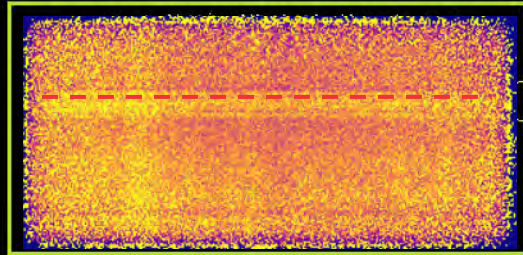


Results in April 2024

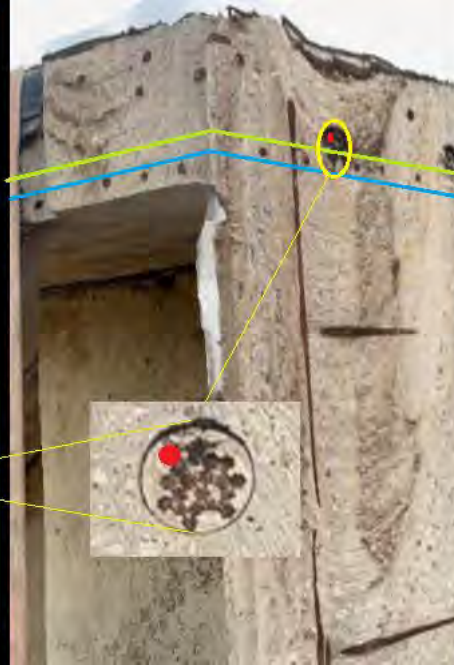
GSCAN



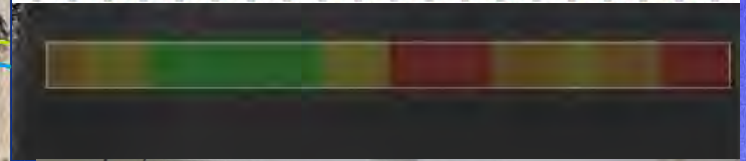
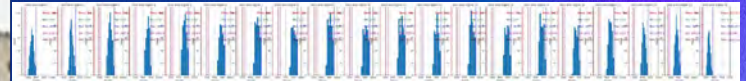
Longitudinal and transverse rebars with different diameter



Post-tensioning duct and internal strands (lighter lines)

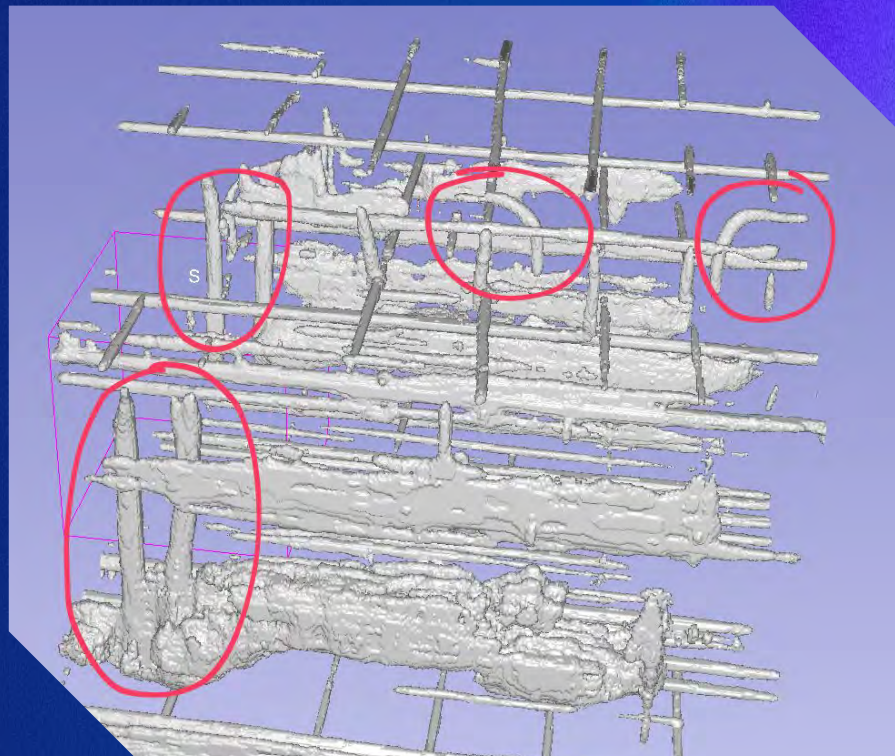


ML application



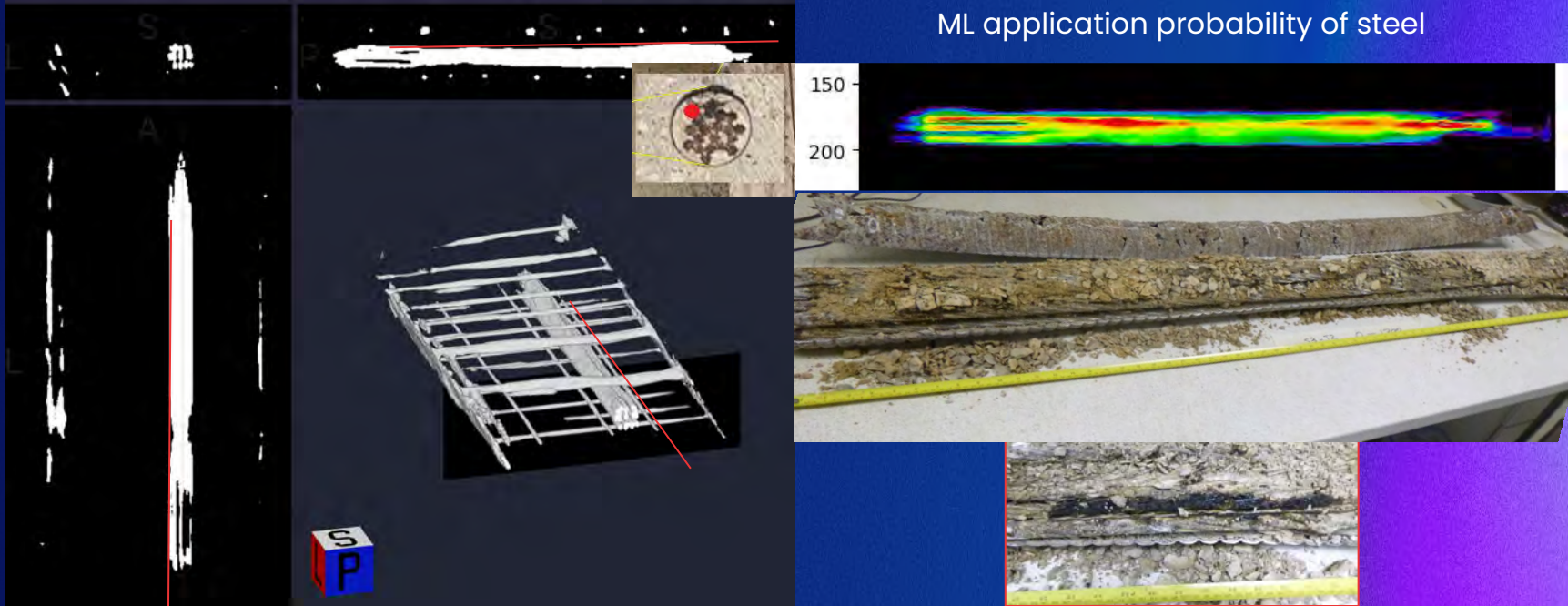
Improvements in ML algorithms

Algorithms were trained on multiple simulated scenes with meticulously defined ground truth data, enabling them to recognize various structures and potential defects within the steel.



Results in December 2024

GSCAN

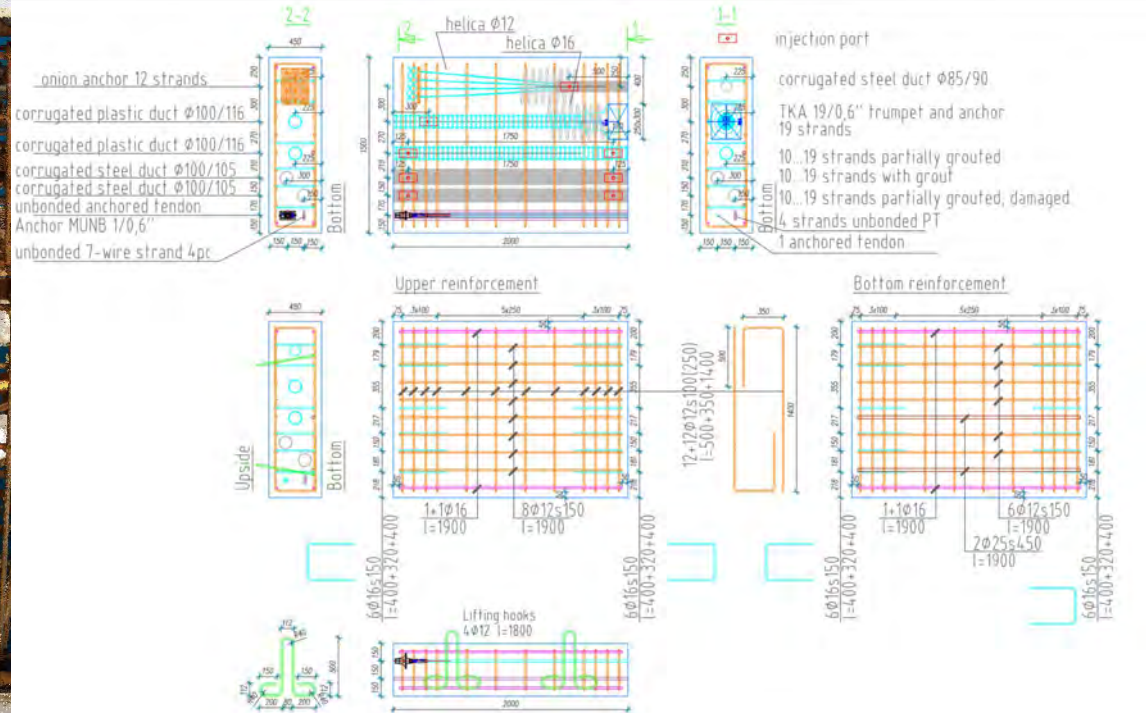


GSCAN

Structures Moonshot Tõrvandi

Mockup beam

GSCAN

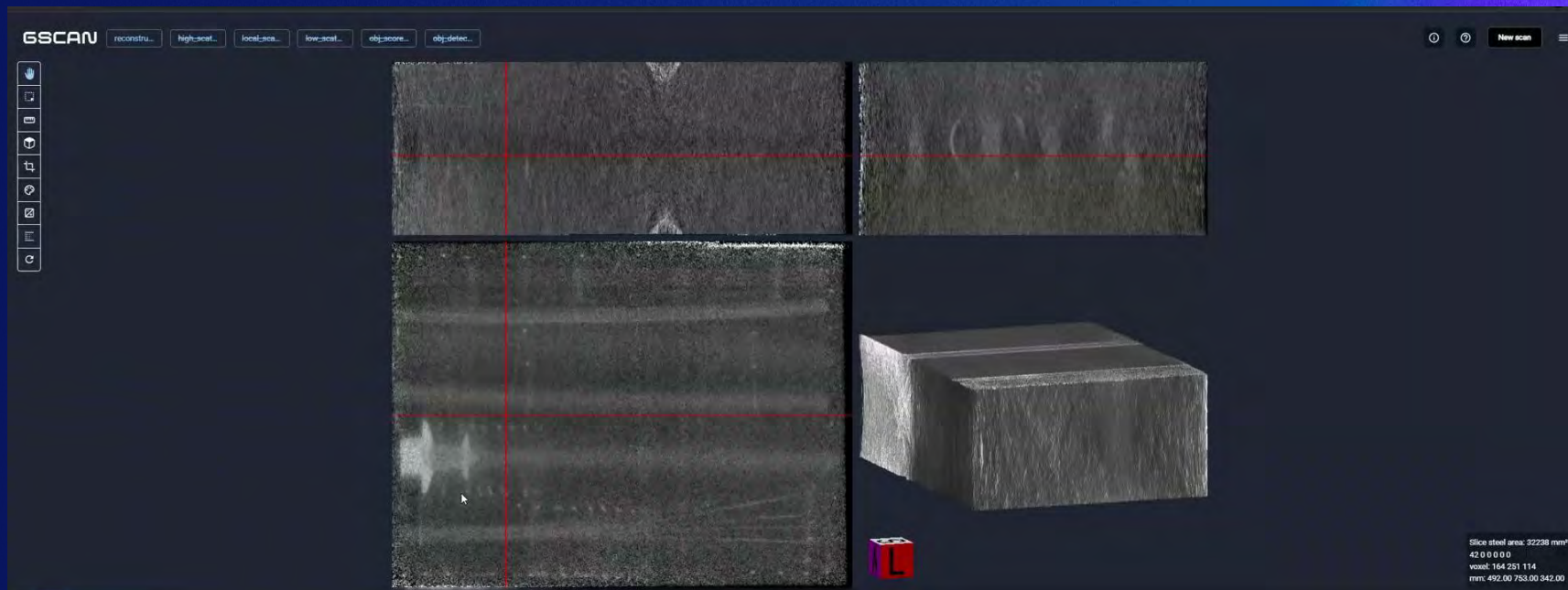


Measurements Nov 2024–Jan 2025

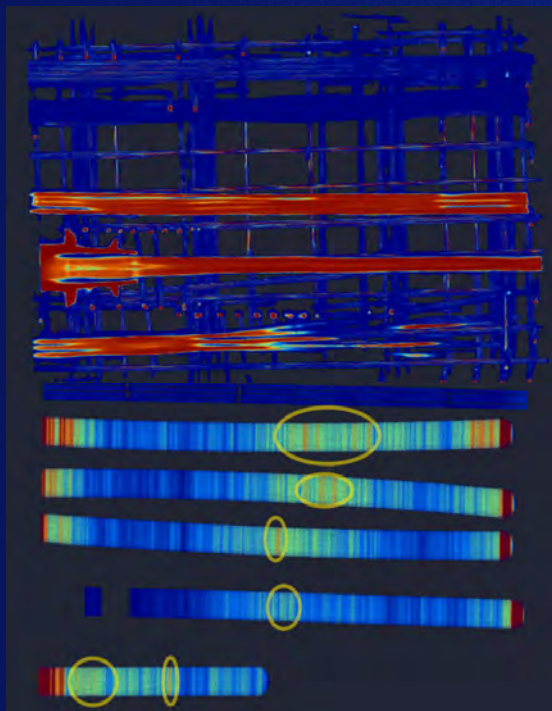


Results in February 2025

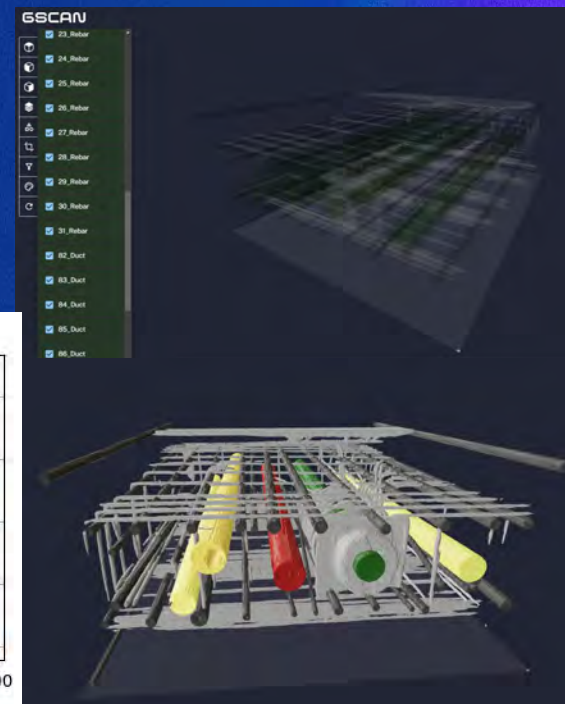
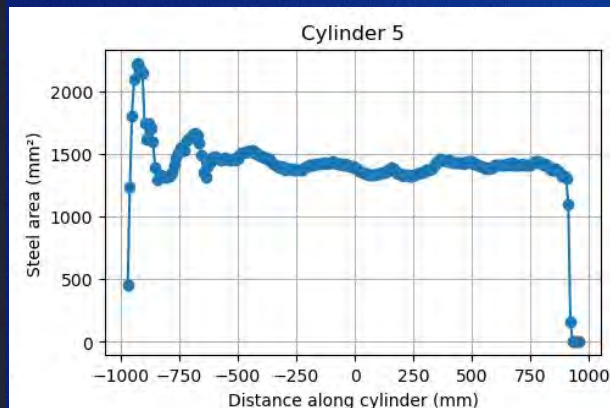
GSCAN



Results in February 2025



There are multiple ways
to translate the data into
information



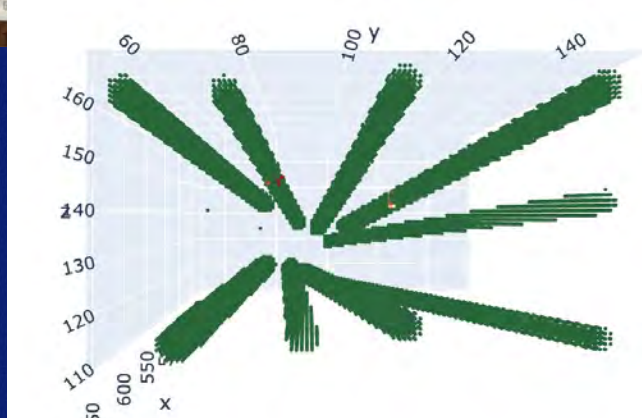
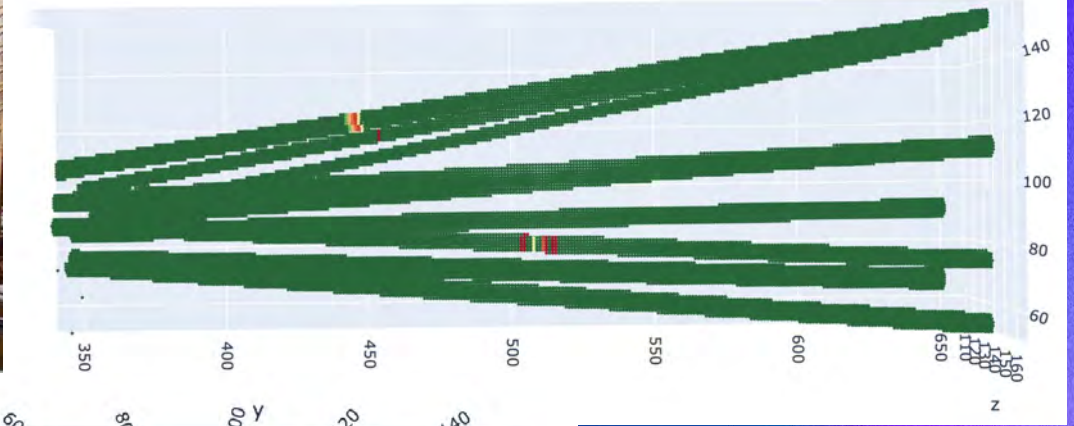
Mockup beam – reality

GSCAN



Results in June 2025 – cuts

GSCAN



Results in June 2025 – missing grouting

GSCAN



Results in June 2025 – steel in PT ducts

GSCAN

Designed vs. determined (average)

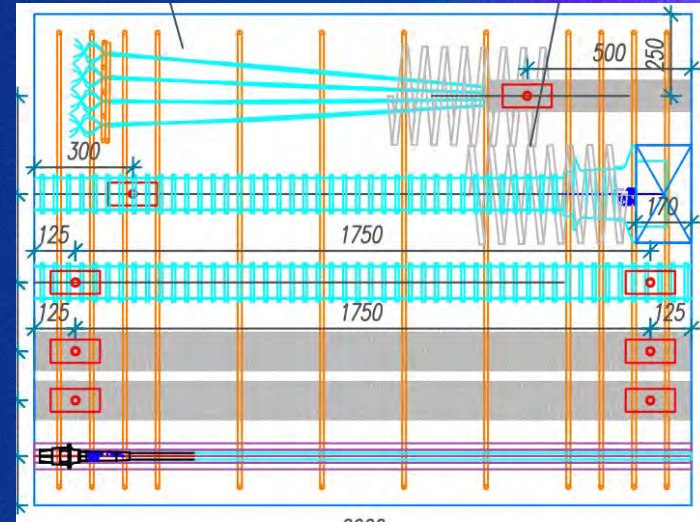
Plastic with 19 strands 2850 mm² vs 2600 mm²

Plastic with 16 strands 2400 mm² vs 2192 mm²

Steel with 19 strands 3655 mm² vs 3583 mm²

Steel with 12 strands 2190 mm² vs 1855 mm²

~10% underestimation, but getting closer



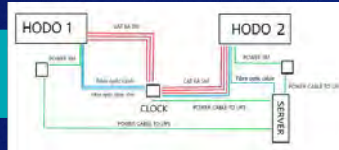
Structures Moonshot Muon Flux Development

Rapid Technology Development (TRL6-→TRL8)

GSCAN

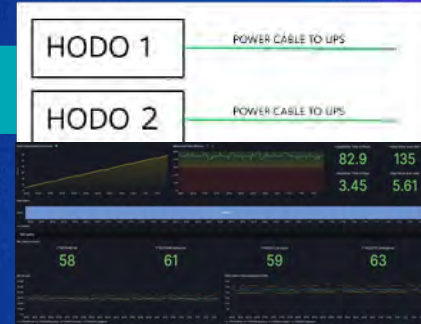
First scanner was ready in March 2023 – now we have 20 + First bridges already scanned

Hardware

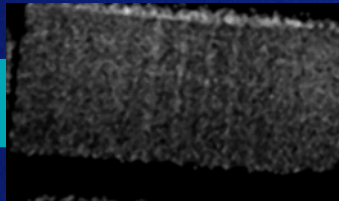


Data acquisition

Yes



Data processing



Thank you! Questions?

GSCAN

New scan



Scanning

2h 30m

ENTER POSITION

Terminate scanning

Complete scanning

Huntingdon Viaduct Testing Approach

Chris Mundell - AtkinsRéalis

June 2025

THE
**STRUCTURES
MOONSHOT**

PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS



Output Focused Specification

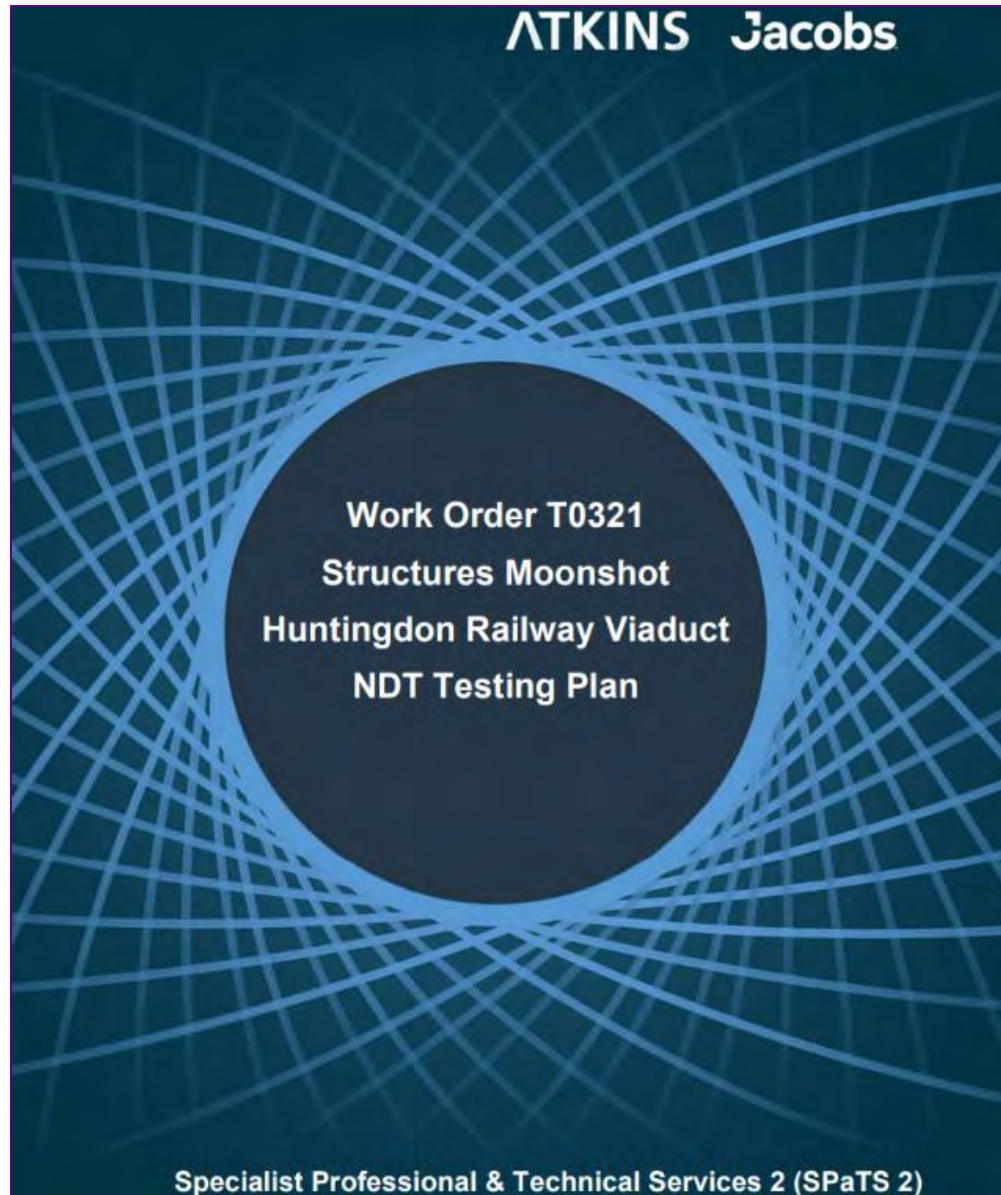
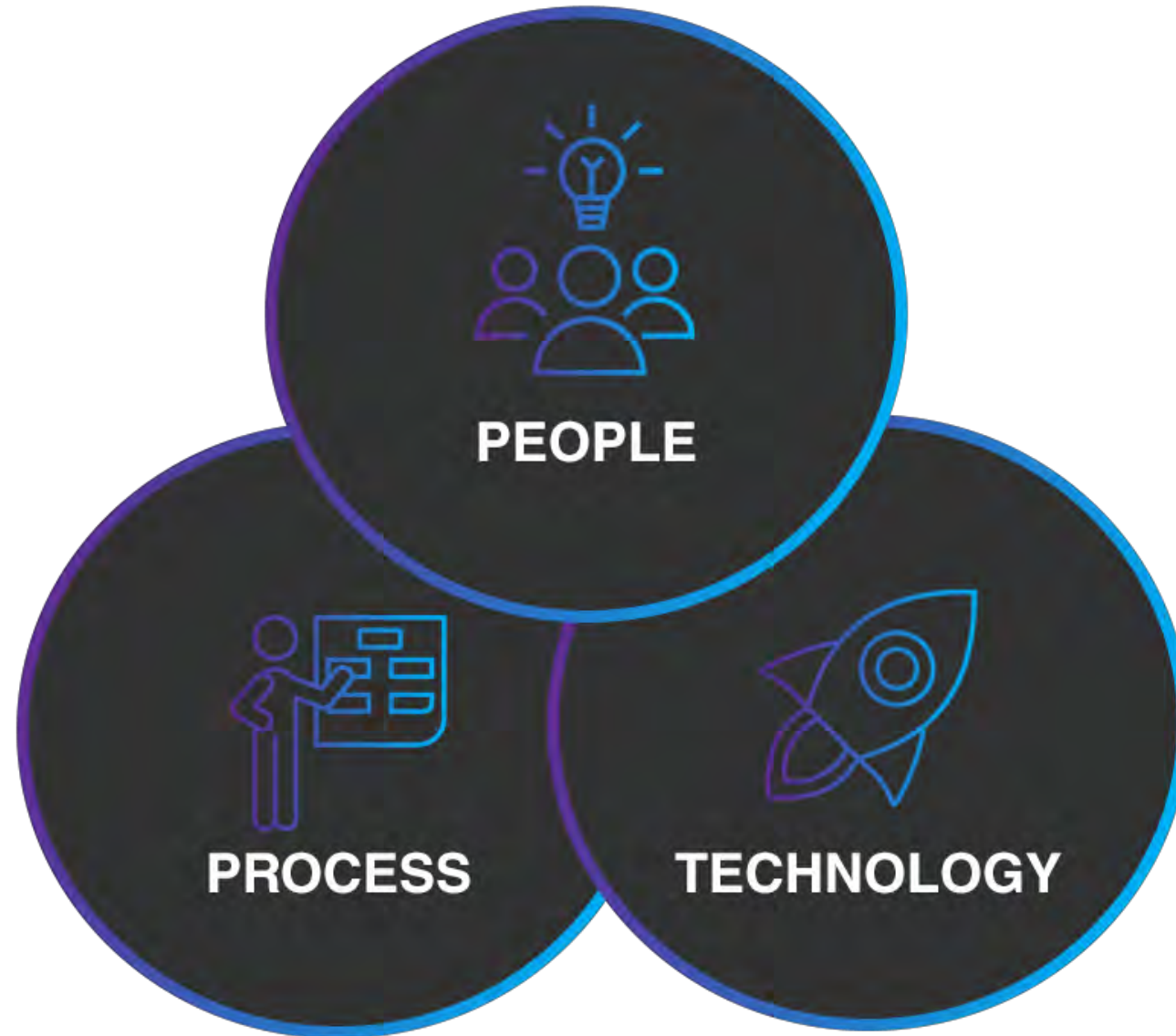


Table of Contents

- 1. Introduction**
- 2. Required Outcomes**
 - 2.1. Overarching Requirements
 - 2.2. Hierarchy of Desired Outcomes
 - 2.3. Defect Identification Level of Confidence
 - 2.4. Performance Assessment
 - 2.5. Provision of Testing Details by Testing Service Providers
 - 2.6. Video Capture of Testing and Apparatus
- 3. Sample Details**
 - 3.1. Site Location and Details
 - 3.2. Sample Details and Information
 - 3.3. Testing Requirements
 - 3.4. Post Tensioning System
- 4. Coordinate System / Referencing**
 - 4.1. General Approach
 - 4.2. Naming Conventions
 - 4.3. Face References – Sample 1
 - 4.4. Face References – Sample 2
 - 4.5. Face References – Sample 3
- 5. Testing Specification**
 - 5.1. General
- 6. Testing Outputs**
 - 6.1. General
 - 6.2. Deliverables

People, Process & Technology



Hierarchy of Testing Outcomes

Hierarchy Level	Description	Applicability		Value
1	Locating and identifying physical properties	HJ	PT	Increasing Value of Data
1.1	Locate the strands and/or the rebar approximately	✓	✓	
1.2	Identify sizes of strand and/or rebar	✓	✓	
1.3	Identify duct type		✓	
1.5	Map all strands and rebar completely and accurately – position and sizes (stretch target)	✓	✓	
1.6	Identify chemical and physical properties of the materials (e.g. Section 3.7.5 and 3.7.6 of CS 465)	✓	✓	
2	Conditions for corrosion			
2.1	Locate any absence of duct grouting		✓	
2.2	Identify areas where the reinforcement is at high risk of corrosion, e.g. loss of concrete passivation or high chlorides	✓	✓	
2.3	Identify areas where the tendons are at high risk of corrosion, e.g. loss of concrete passivation or high chlorides		✓	
3	Indications of damage			
3.1	Identify discontinuities in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages	✓	✓	
3.2	Identification of plastic deformations of reinforcement (e.g. necking)	✓		
3.3	Measurement of surface cracking at re-entrant corners (width, length, depth)	✓		
3.4	Measurement of cracking along length of re-entrant corners (width, length, depth)	✓		
4	Pinpoint location and quantify magnitude of deterioration			
4.1	Corrosion locations	✓	✓	
4.2	Magnitude and shape of section loss from corrosion at each location	✓	✓	
4.3	Wire break locations		✓	
4.4	Number of wire breaks at each location		✓	
5	Other behaviour to detect if possible			
5.1	Bond slip between steel and concrete (should have occurred at least in cutting samples)		✓	
5.2	Re-anchoring of strands (should have occurred at least in cutting samples)		✓	

Type of test	Activity/Test Type
Mechanical Wave	Acoustic Emission Monitoring (AEM)
Optical	Initial visual inspection
Electromagnetic	<u>Covermeter survey</u>
Optical	Hyperspectral Imagery
Particle sensors	FTIR hydrogen gas monitoring
Optical	Portable X-Ray (PTX)
Electromagnetic	Chloride mapping
Mechanical Wave	Anchorage guided wave
Mechanical Wave	Advanced Impact Echo
Electromagnetic	Ground Penetrating Radar (GPR)
Optical	Infra-red thermography (IRT)
Electrochemical	Half Cell Potential Survey
Magnetic	Magnetic Flux Leakage (MFL)
Mechanical Wave	Joint fracture evaluation
Mechanical Wave	Advanced ultrasonics (ELOP & Pundit)
Electromagnetic	GSSI StructureScan Mini (GPR)
Core sampling	Chloride core samples
Electrochemical	Electrical resistivity
Optical	DIC (during demolition)
Optical	Demolition & inspection

Expected Testing Outcomes

Testing Method																	
Investigation Process	Cover meter Survey	Hammer Tapping	FTIR Gas Monitoring	Hyperspectral Imaging	Digital Image Correlation	Infrared Thermography	Advanced Impact Echo	Chloride Mapping	GPR	Magnetic Flux Leakage	GSSI Scan	Joint Fracture Evaluation	Advanced Ultrasonics	Anchorage Guided Wave	Half Cell / Resistivity	Portable XRay	Muon Tomography
Locating and Identifying the Internal Elements																	
Can the method be used to locate:																	
Rebar (position, size, layout)																	
Ducts and Tendons																	
Duct and Tendon Types																	
Voids within the grout/duct																	
Voids in the Concrete																	
Conditions for Corrosion (i.e., loss of concrete passivation/high chlorides/other)																	
Can the method be used to determine is the conditions of corrosion are present including the identification and classification of <u>high risk</u> areas at:																	
Rebar Locations																	
Tendon Locations)																	
Identification of Discontinuities																	
Can the method be used to identify and locate:																	
Discontinuities or plastic deformation in rebar (corrosion, necking or breakages)																	
Discontinuities in tendons (corrosion or breakages)																	
Identification of Deterioration																	
Can the method be used to identify and locate:																	
Corrosion locations																	
Degree of section loss																	
Other Behaviour																	
Can the method be used to identify and locate:																	
Detect Bond Slip between tendon / Grout																	
Detect Re-anchoring of strands																	
Other																	

Defect Naming Convention and Reporting

What to define?	Reference	Example
A particular <u>Sample</u>	a	Sample 2 (<i>Sample two</i>)
A particular sample's <u>face</u> where the NDT test was applied	$a.b$	Face 3.B (Face B of Sample three)
The coordinates of the <u>survey point</u> as an x,y,z	$a.b.x.y.z$	Survey Point 1.B.200.300.300 (A location at x,y,z 200,300,300 for sample 1, as recorded from Face B)
A <u>tendon</u> within a particular test piece	$a.n$	Tendon 2.3 (The third tendon in test sample two)
A chainage along a tendon measured with Face B	$a.n.m$	Tendon 2.3.500 (500mm along the third tendon on sample 2)
where $\left\{ \begin{array}{l} a \text{ can be 1, 2 or 3} \\ b \text{ can be A, B, C, D, E or F} \\ x, y, z \text{ are dimensions (+ve or -ve) in mm} \\ n \text{ can be 1, 2, ...} \\ m \text{ is a dimension (+ve) in mm} \end{array} \right.$		
Notes: - x, y and z coordinates are measured from the origin of the sample, as described in Section 5.6 of this document. Dimensions can be positive or negative depending on the position of the defect. - Tendon chainages are measured from Face B – refer to Sections 5.6. Tendon chainages will always be positive measurements.		

Defect Identification Level of Confidence

- **High**
 - Survey data clearly be interpreted as a **specific condition or defect**
 - High degree of confidence.
 - Extent of the defect/observation can be **clearly defined to within +/- 50mm**
- **Medium**
 - Survey data indicates a specific condition or defect,
 - However, this could also be **interpreted in several different ways.**
 - Extent of the defect/observation can be defined to a **resolution of +/- 100mm**
- **Low**
 - Survey data indicates **a point of interest,**
 - Exact cause/condition cannot be identified.
 - Boundaries of defect/observation resolution cannot be guaranteed to an **accuracy of 300mm or less**

Performance Assessment (Project Team)

- Finding the most defects, confirmed via hydrodemolition.
- Providing a favourable true-positive to false-positive call ratio.
- Providing a favourable true-negative to false-negative call ratio.
- Providing additional information of value, e.g. tendon position, chloride distribution.
- The operators' confidence in their own findings.

Testing Undertaken

Test Type	Equipment	Scope	Provider
Dust Sampling (Chloride Reference)	N/A	Original Spec	VSL, Bridgology
Tapping	N/A	Original Spec	CTS
Cover meter Survey	Elcometer 331 Cover Meter	Original Spec	CTS
Electrical Resistivity	Proceq Resipod	Original Spec	CTS
GPR	Proceq GP8000	Original Spec	VSL, Bridgology
GPR	Proceq GP8800	Additional Test	Screening Eagle (via Mistras)
GPR	Proceq GP8000	Additional Test	Screening Eagle (via Mistras)
Joint Fracture Evaluation	Bespoke	Original Spec	Screening Eagle (via Mistras)
Ultrasonic Pulse Echo (Concrete)	Proseq PD8050	Original Spec	Screening Eagle (via Mistras)
Impact Echo	Proseq PI8000	Original Spec	Mistras
Anchorage Guided Wave	Bespoke	Additional Test	Mistras
Acoustic Emissions	Bespoke	Additional Test	Mistras
FTIR Gas Monitoring	Gasmet GT5000 Terra Portable Gas Analyser	Original Spec	RAU
Hyperspectral Imaging	Hyperspectral Camera (400 - 1000nm wavelength)	Original Spec	University of Bristol (via RAU)
Field Spectrometry	Spectral Evolution RS3500 Field Spectrometer (350 - 2500nm wavelength)	Additional Test	Pro-Lite Technology (via RAU)
Raman Spectrophacy	Wasatch Photonics 785nm Raman Spectrometer	Additional Test	Pro-Lite Technology (via RAU)
Gamma Ray Spectrometry	ImiTec ARARM Gamma Ray Sensor	Additional Test	RAU
Portable Xray Fluorescence (PXRF)	ThermoFisher Niton XL3t GOLDD+ analyser	Original Spec	RAU
Ultrasonics (Concrete)	ELOP	Additional Test	Allied Associates (via Mistras)
GPR	GSSI Flex NT	Original Spec	Allied Associates (via Mistras)
GPR	GSSI Structure Scan Mini XT	Additional Test	Allied Associates (via Mistras)
GPR	Proceq GP8000	Open Invite	Screening Eagle
GPR	Proceq GP8800	Open Invite	Screening Eagle
Half-cell potential survey	Proceq Profometer Corrosion	Open Invite	Screening Eagle
Visual Inspection	Bespoke 1080p/30x optical zoom	Additional Test	HaasBots, MTC

THE STRUCTURES MOONSHOT PROJECT



MOONSHOT – Huntingdon Railway Viaduct NDT Trials at M1 National Highways Toddington Yard

Jon Watson and Tim Bradshaw – MISTRAS

Markus Denton-Masih and Shirley Underwood – Screening Eagle

James and Norman Bell – Allied Associated Ltd (distributors of Elop and GSSI)

16th June 2025

The Studio, 7 Cannon Street, Birmingham B2 5



MISTRAS - WHO WE ARE

- Global non-destructive testing, inspection and monitoring company, founded in 1985.
- 5,000 staff (\$750M USD/2024) globally / 55 staff (£8M GBP/2024) in the UK.
- Highly accredited and certified company carrying out infield inspection and monitoring services.
- Leader in development of applications and in the use of advanced inspection technology for Hidden Critical Elements (HCE).
- Active participant in industry working groups.



2017



2017



2020



2022



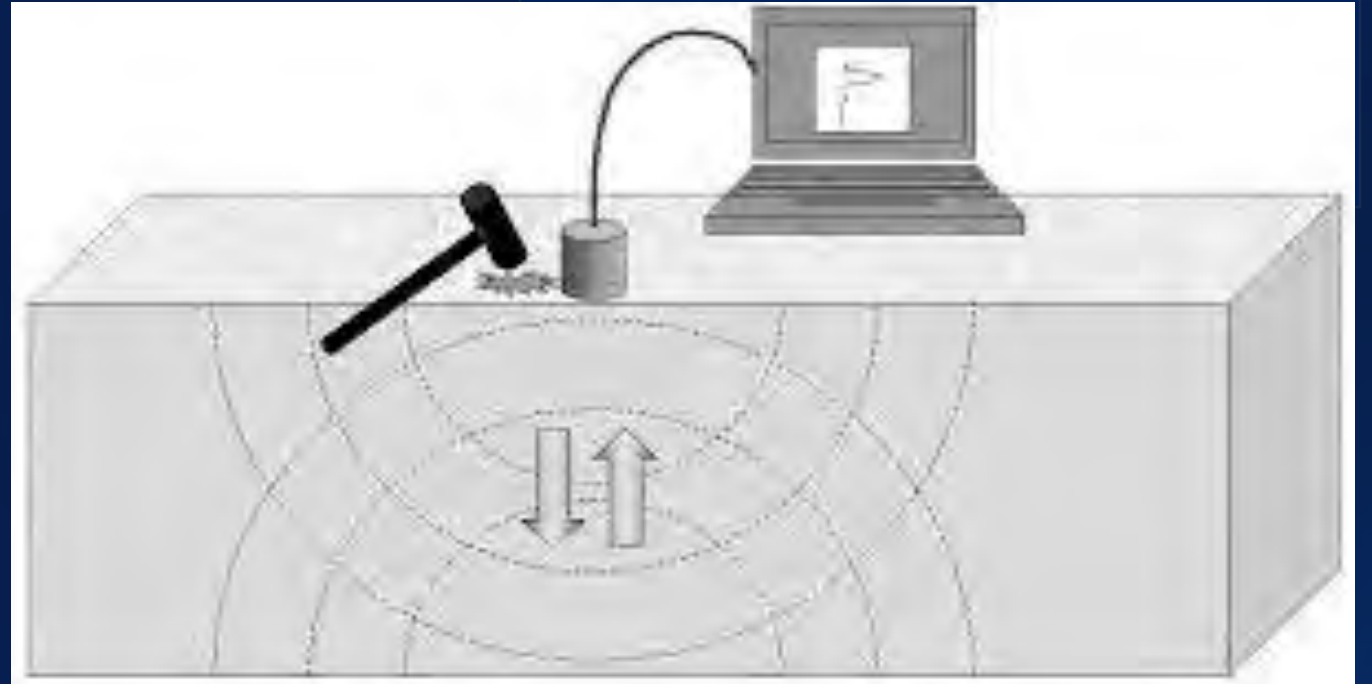
2022

- MISTRAS contracted by VSL (for AtkinsRéalis-Jacobs JV) to evaluate several advanced NDT techniques on A14 HRV samples.
- MISTRAS collaborated with instrumentation manufacturers to best apply the technologies.

ID	Inspection / Monitoring Technique	Instrument Manufacturer	System Name	Testing By
1	Impact Echo (IE)	Impact Echo Instruments Ltd, USA	Impact Echo Rev 3	MISTRAS
2	Rolling Ultrasonic Tomography	Elop Technology	Insight	MISTRAS / Allied Associates
3	Ground Penetrating Radar (GPR)	Screening Eagle / GSSI	GP8000 (S.E.) / Mini-XT & Flex-NX	Allied Associates / Screening Eagle
4	Ultrasonic Pulse Echo	Screening Eagle	Pundit PD8050	MISTRAS / Screening Eagle
5	Ultrasonics of Wires	MISTRAS	TabletUT™	MISTRAS
6	Acoustic Emission	MISTRAS	Express8 AEwin™	MISTRAS

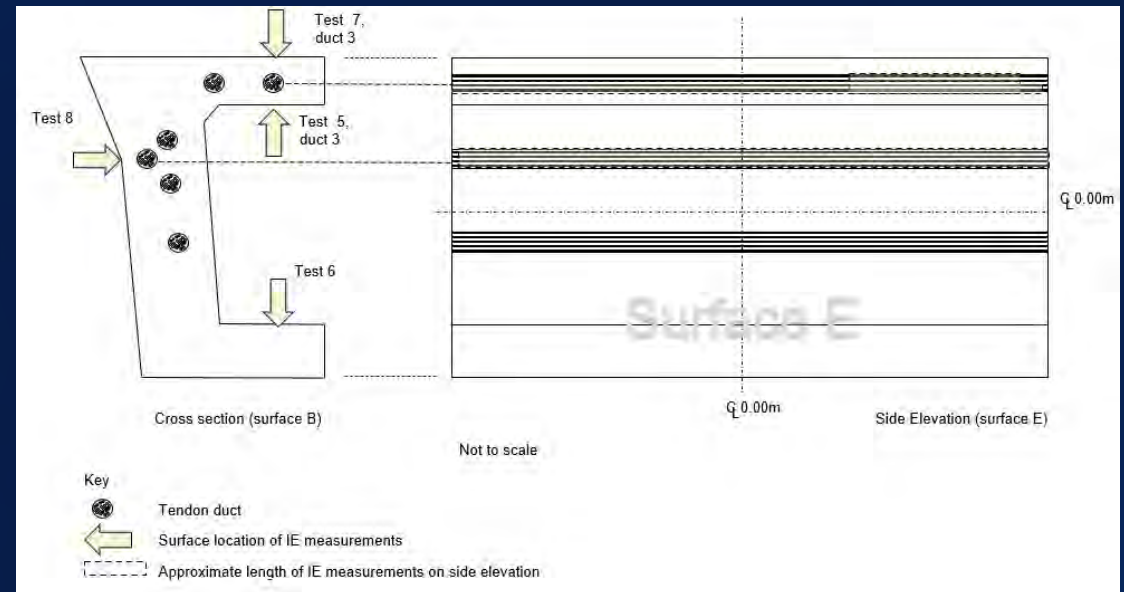
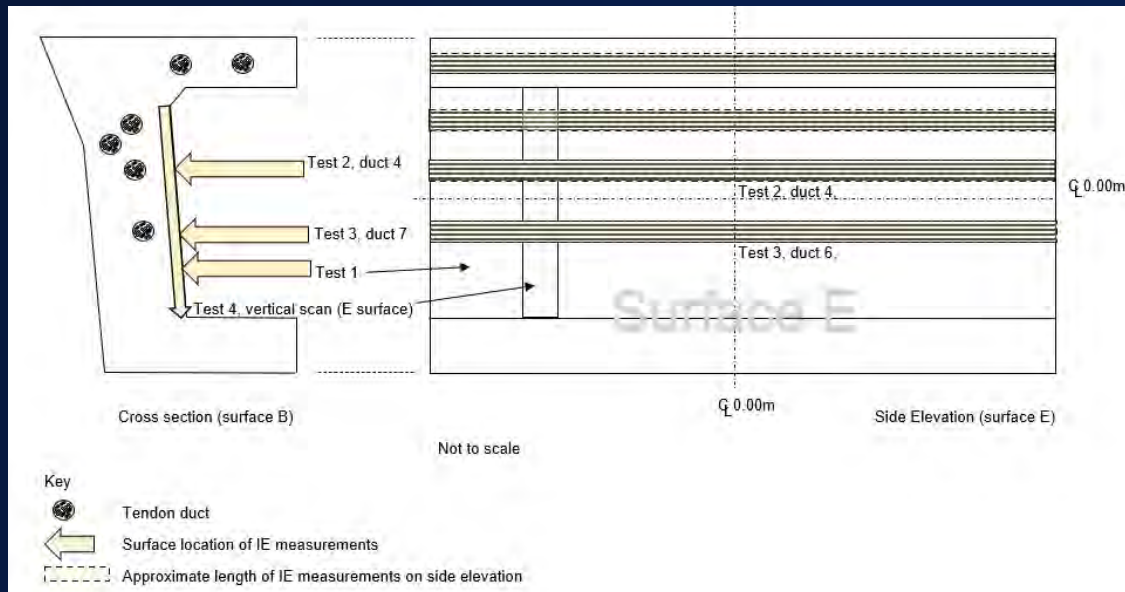
1 - Impact Echo – Technology Overview

- The Impact Echo (IE) test uses an impact generated stress waves propagating through concrete and being reflected by internal flaws and external surfaces.
- Stress wave generated through impact of a small steel ball (4-10mm diameter) on the concrete surface.
- Transducer placed adjacent to the impact site records the surface vibrations.
- Displacement v time waveform is converted to plots of amplitude vs frequency.
- These are evaluated to establish the presence and depth of the reflective indication.
- The technique is used across the world to detect voids in concrete and PT ducts.



1 - Impact Echo – Trials and Testing

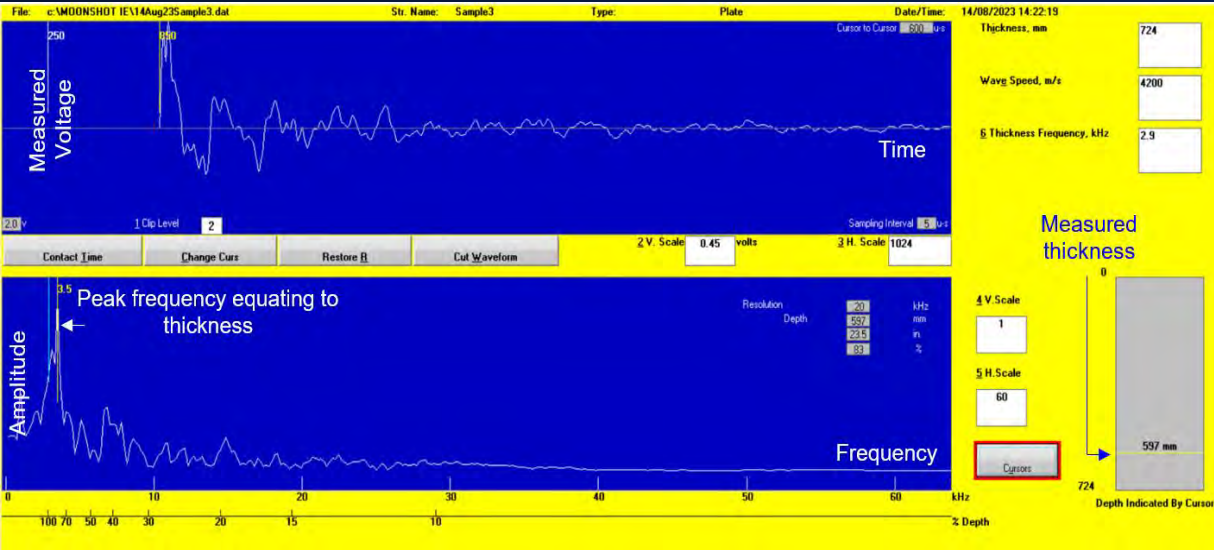
- GPR used to detect and mark out the duct location.
- IE is easy and quick to operate, ~40m of duct tested in ~4hrs.
- Point measurement every 200mm along the duct.
- Simple data with minimal processing.
- Written procedures for manual signal analysis.



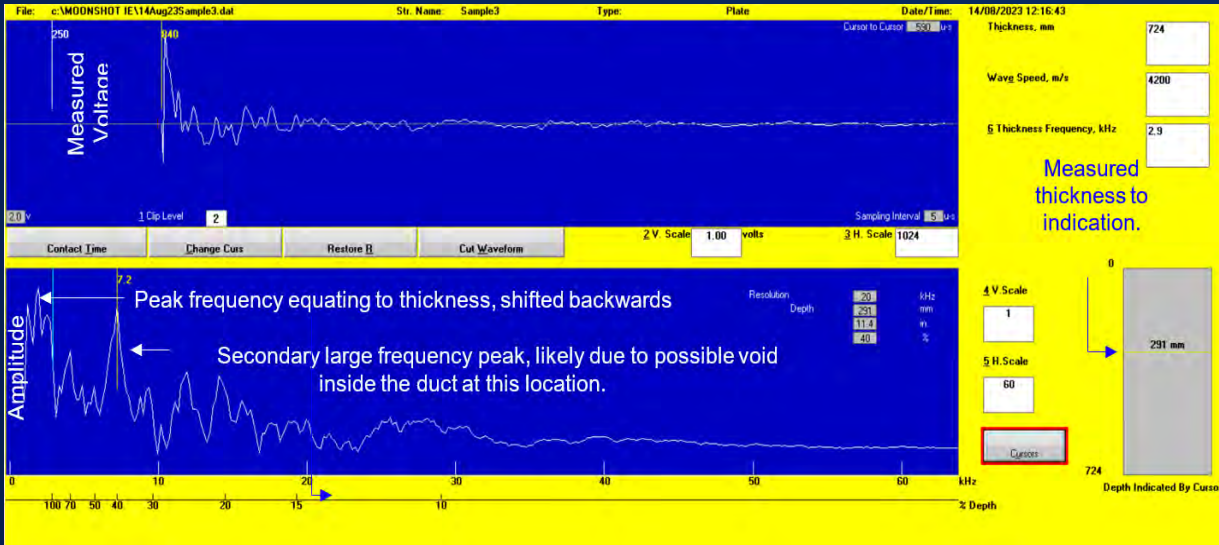
1 - Impact Echo – Key Results and Outputs



Example of likely defect free duct test point



Example of likely voided duct at a test point



Duct 4

Duct 7

(X)	-2900	-2800	-2700	-2600	-2500	-2400	-2300	-2200	-2100	-2000	-1900	-1800	-1700	-1600	-1500	-1400	-1300	-1200	-1100	-1000	-900	-800	-700	-600	-500	-400	-300	-200	-100	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	
300																																											
250																																											
200																																											
150																																											
100																																											
50																																											
0																																											
-50	283		171		219		672		597		597		538		597		538		597		N/A		336		384		371		371		269		173		371		307		384		299		
-100																																											
-150																																											
-200																																											
-250	640		683				233		640		366		269		602		602		293		316		632		317		632		336		597		597		262		597		566		566		269
-300																																											
-350																																											
-400																																											
-450																																											
-500																																											
-550																																											
-600																																											
BEAM																																											

Key

672

Expected full thickness, no defect. Thickness shown in mm. Where lower value is shown, this is due to a notable duct resonance, not necessarily a defect.

290

Expected full thickness with minor subsurface indication. Depth of possible small void or flaw in mm.

283

Major subsurface indication, possible flaw or void. Depth of indication shown in mm.

N/A

No measurement possible, due to obstruction.

Linear length of sample – web surface E

1 - Impact Echo – Comparison of Results Against Actuals

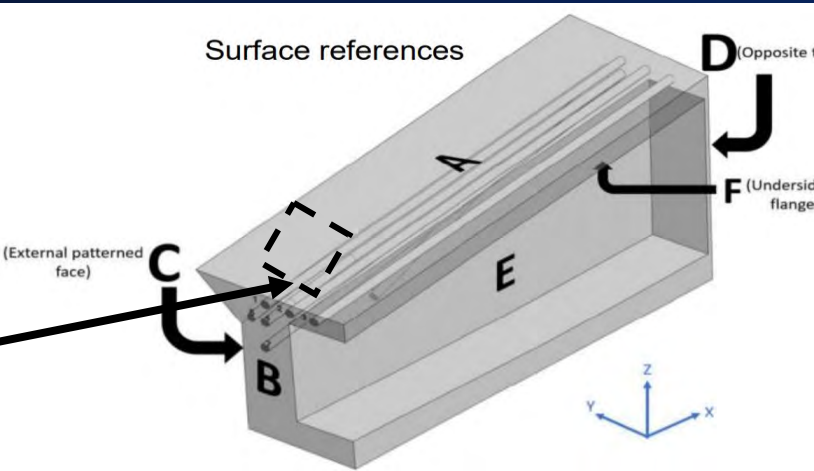
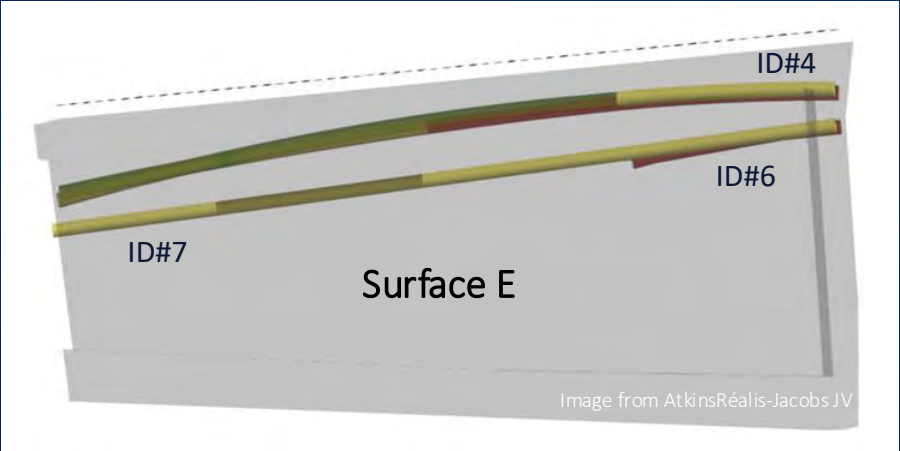
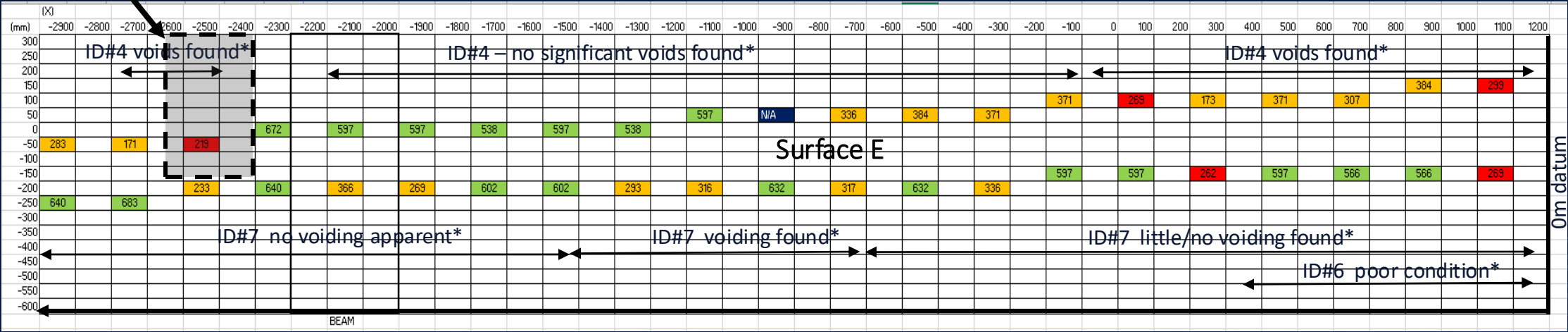


Image from AtkinsRéalis-Jacobs JV



Note – tendon position shown is slightly elevated vs reality.

Duct 4
Duct 7

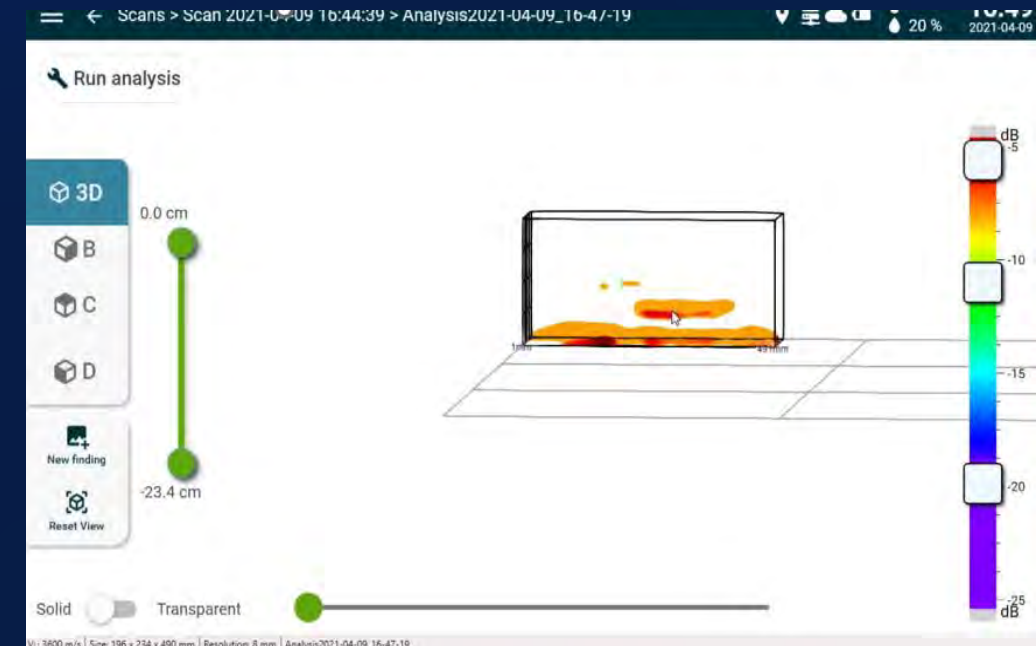
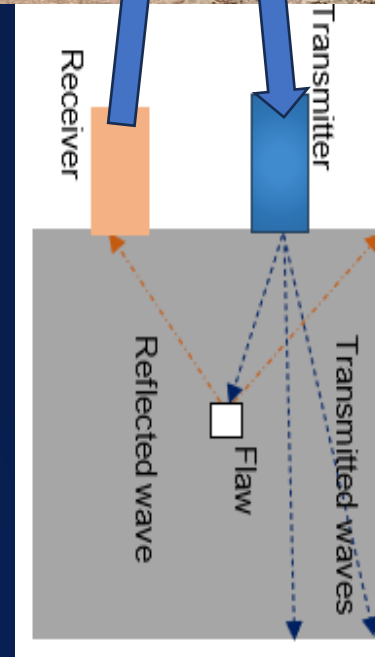


Linear length of sample – web surface E

*Ducts are longer than sample so correlation is approximate.

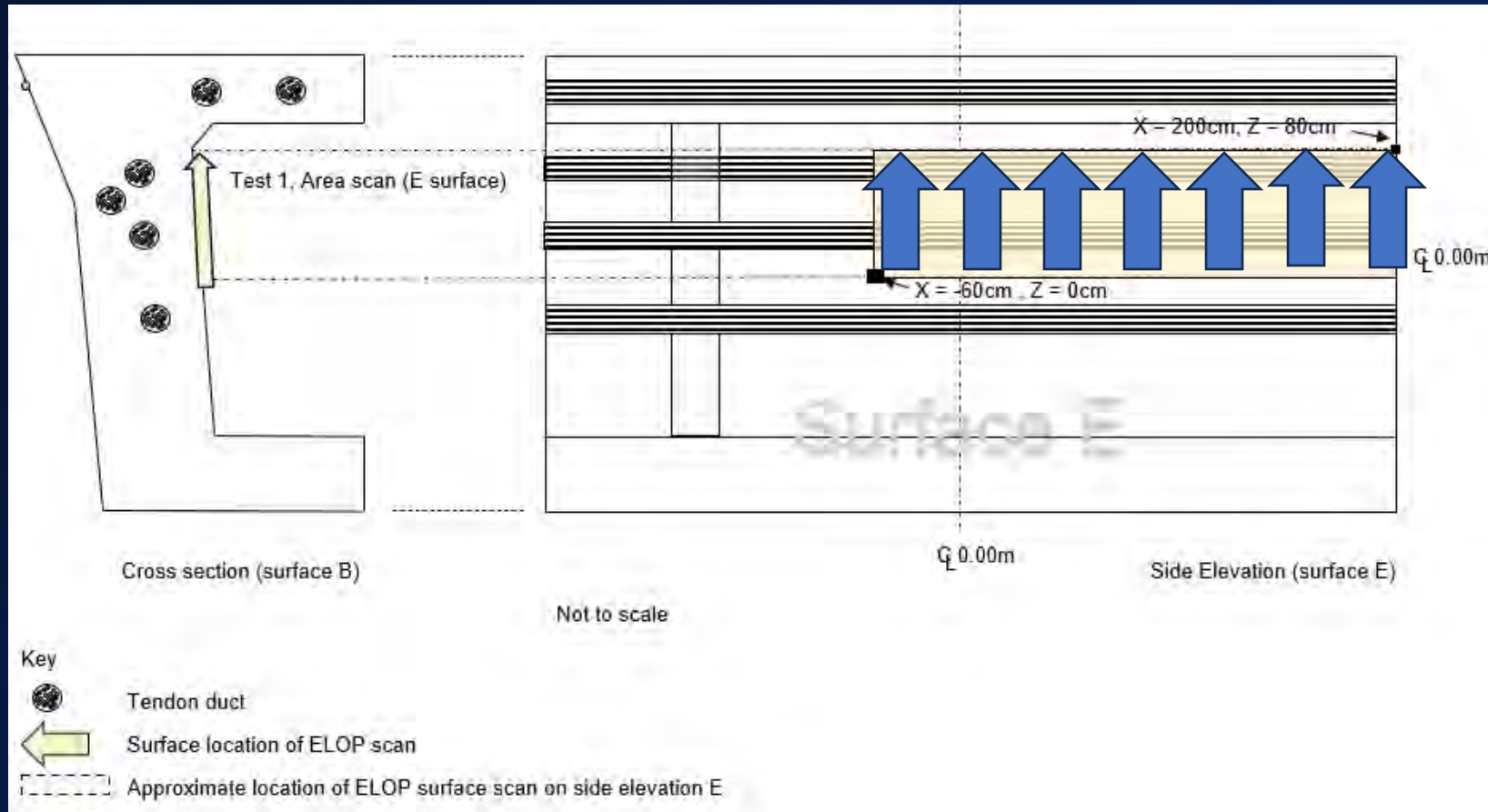
2 – Rolling Ultrasonic Tomography – Technology Overview

- Insight system, by Elop Technology.
- Dry-coupling rolling ultrasound using low frequency pressure wave signals with pulse-echo transducers.
- Comprised of tablet and scanner.
- Records and displays 2D & 3D data in real time.
- Cover large areas quickly, from 20cm to 100cm per second, depending on speed mode.
- Concrete and structural application areas include measurement of thickness, detects voids, delamination, debonding, tendon ducts, honeycombing etc.



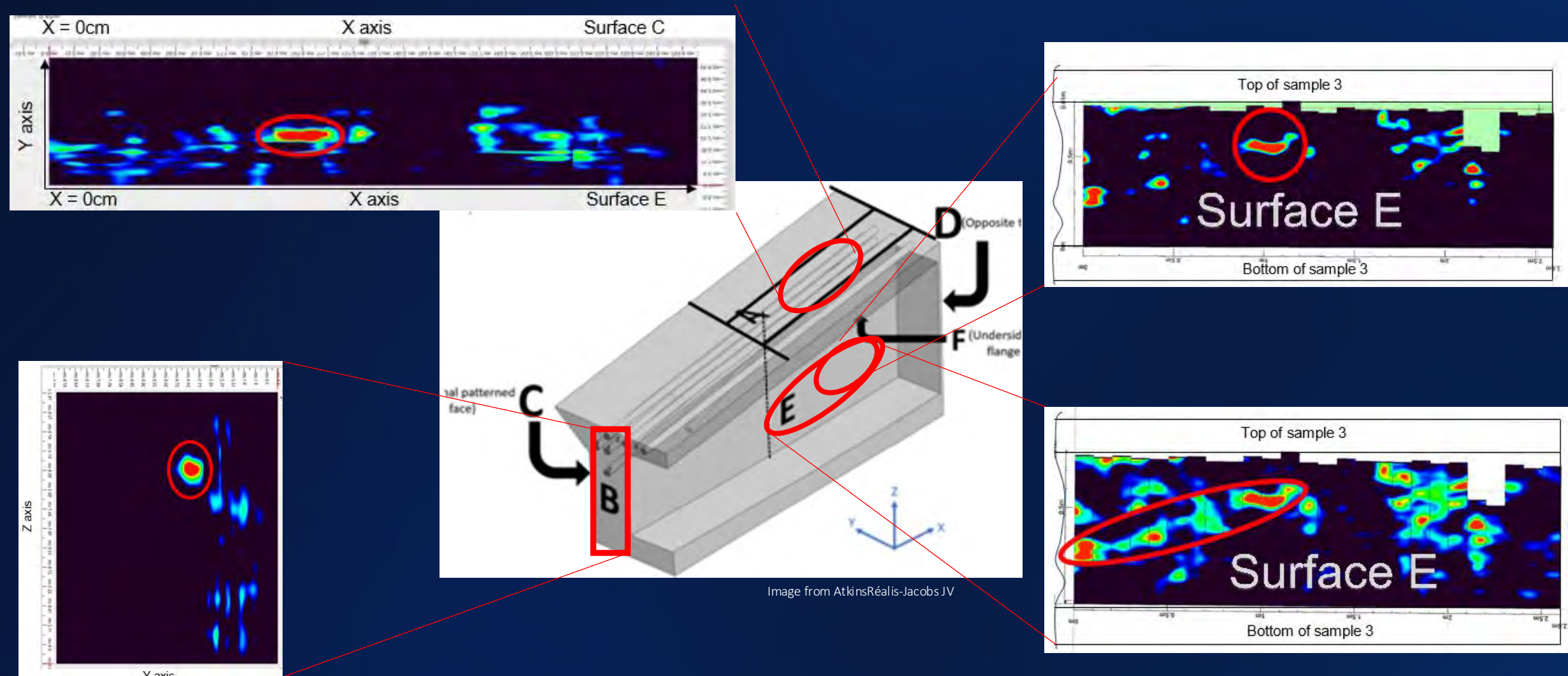
2 – Rolling Ultrasonic Tomography – Trials and Testing

- Duct locations are found with GPR and marked out.
- A linear scan was carried in vertical strips (500m wide), then stitched together to form an image of the ducts in the web.

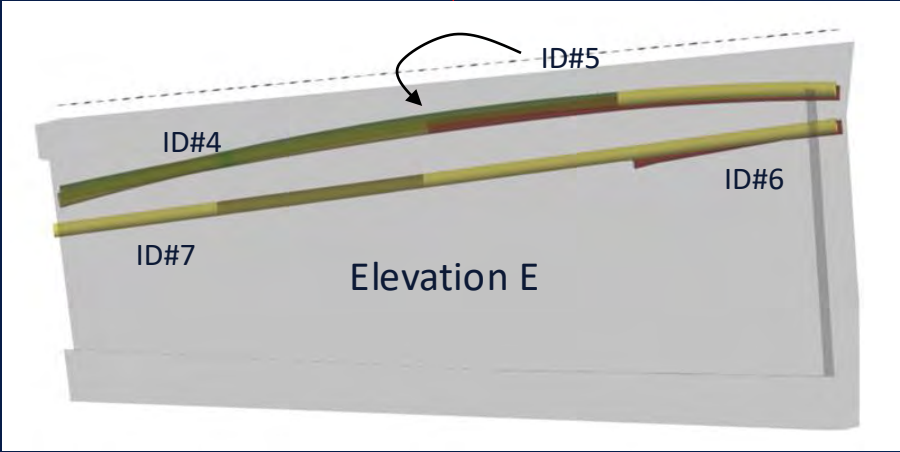
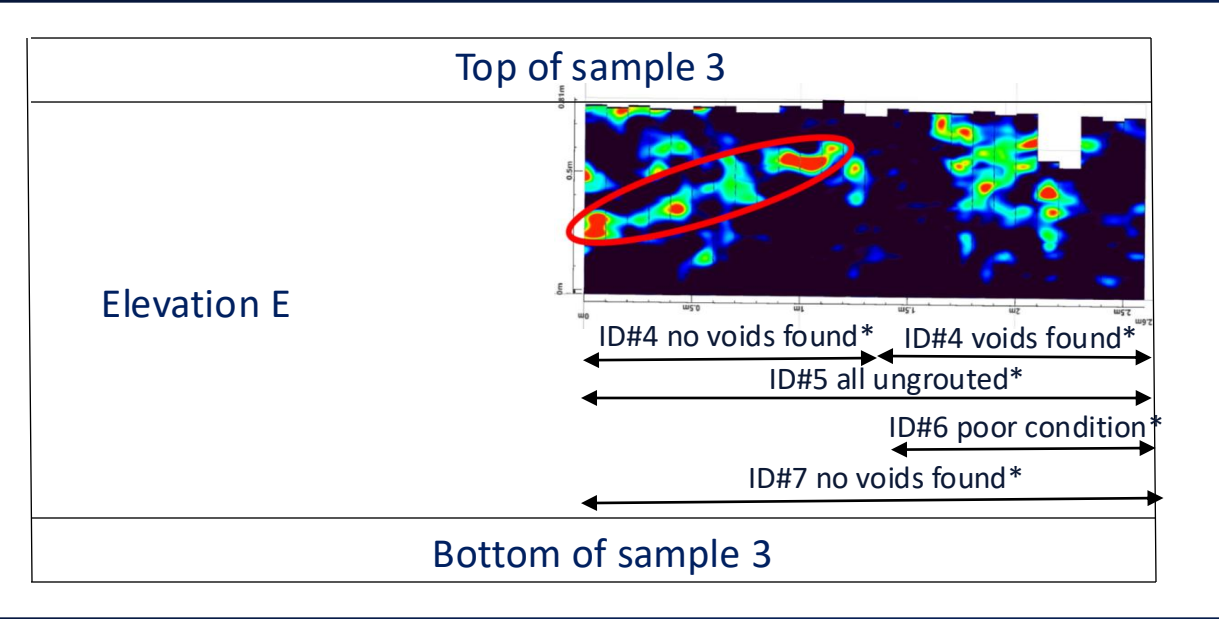
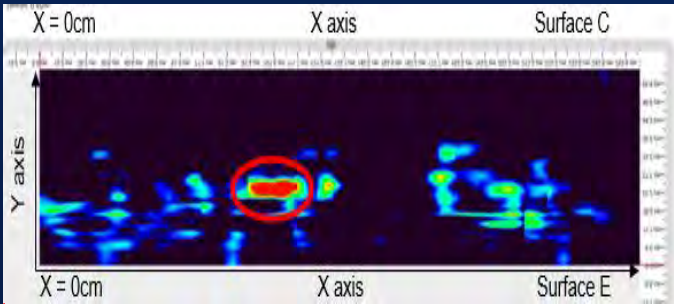
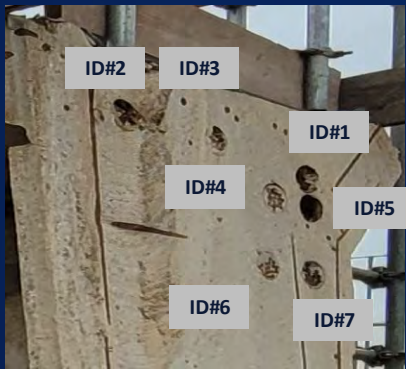
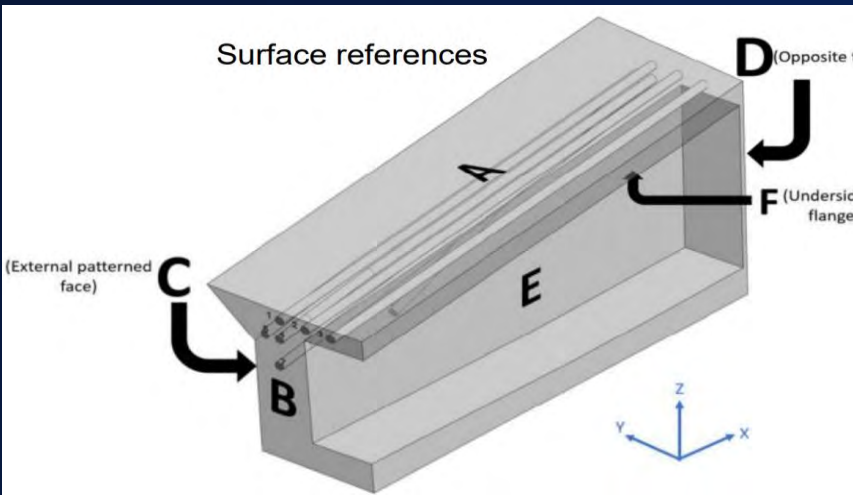
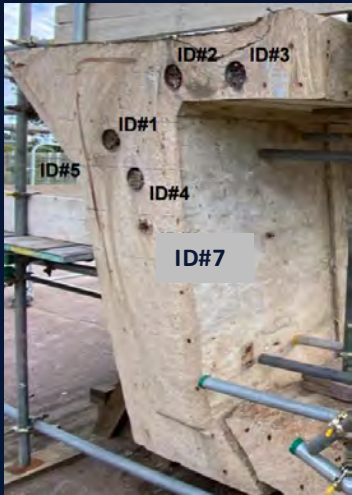


2 – Rolling Ultrasonic Tomography – Key Results and Outputs

- Suspected voids are shown in various tomography views.



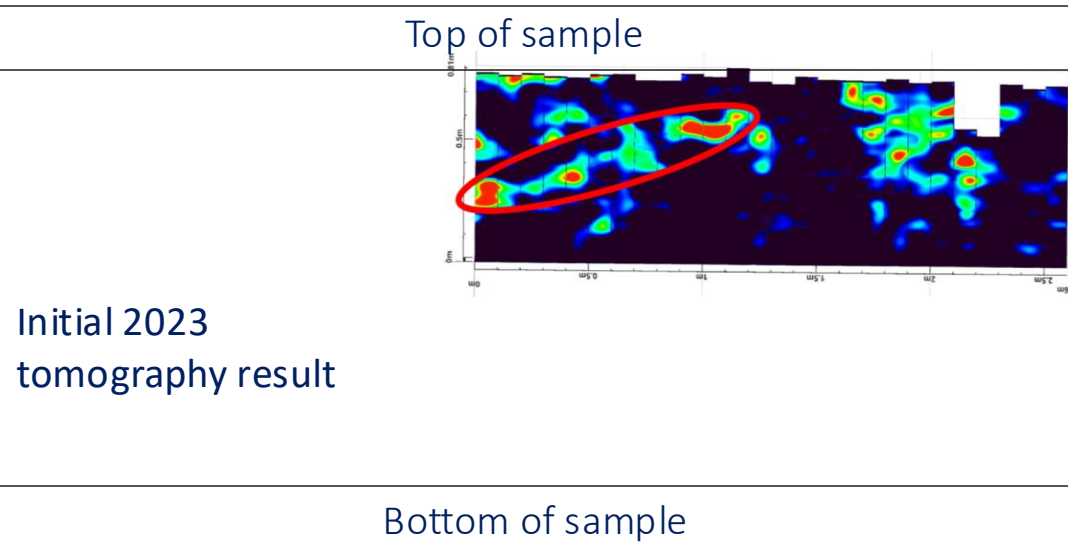
2 – Rolling Ultrasonic Tomography – Comparison of Results Against Actuals



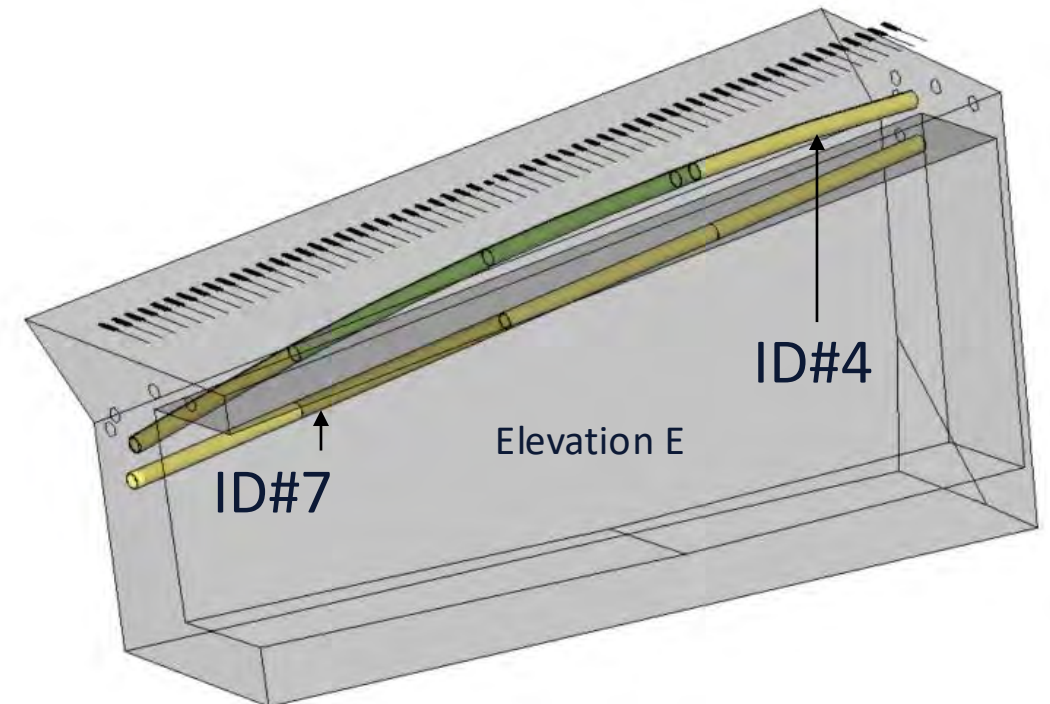
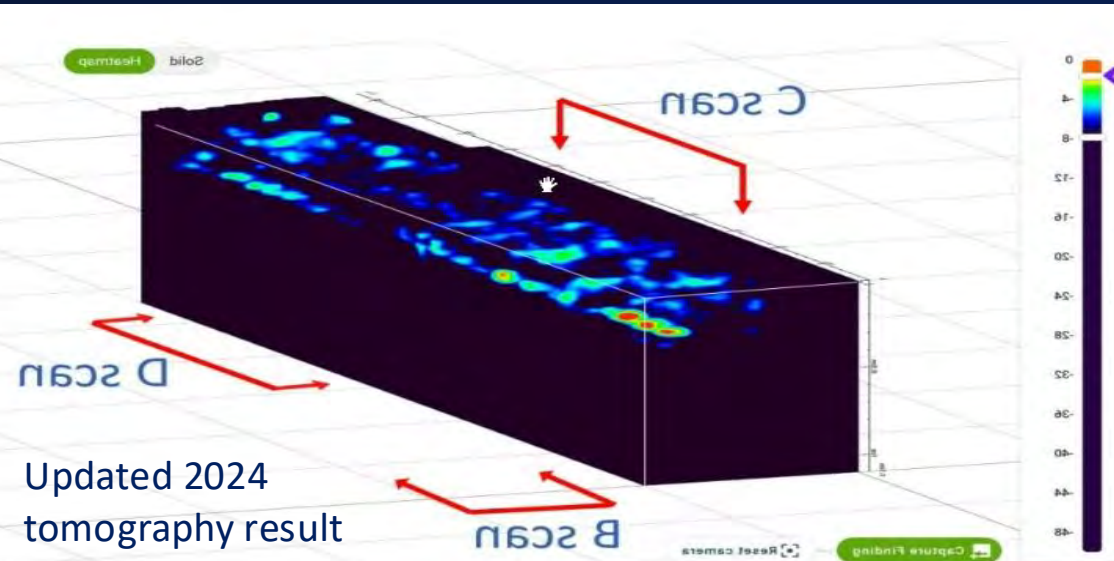
*Ducts are longer than sample, so correlation is approximate.

Image from AtkinsRéalis-Jacobs JV

2 – Rolling Ultrasonic Tomography – Further Development of Technology



- Updated Insight software allowing updated 3D view of results.
- More visual result, which is better correlated with Atkins findings.



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2	Rolling Ultrasonic Tomography	Elop	Insight	MISTRAS / Allied Associates
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5	Ultrasonics of Wires	MISTRAS	TabletUT™	MISTRAS
6	Acoustic Emission	MISTRAS	Express8 AEwin™	MISTRAS



Introduction: About us

Speakers



Markus Denton-Masih

Solutions Consultant



Imaging

Ground Penetrating Radar & Ultrasound Pulse Echo



GP8800



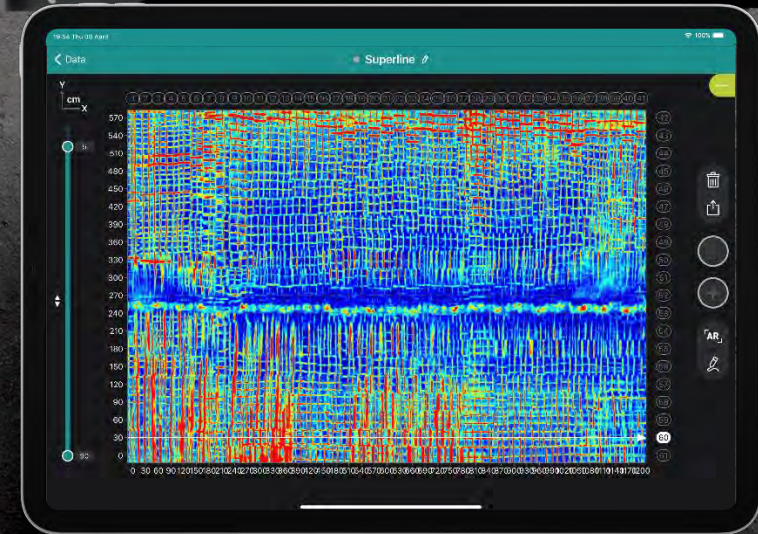
GP8000



PD8050



GP8100

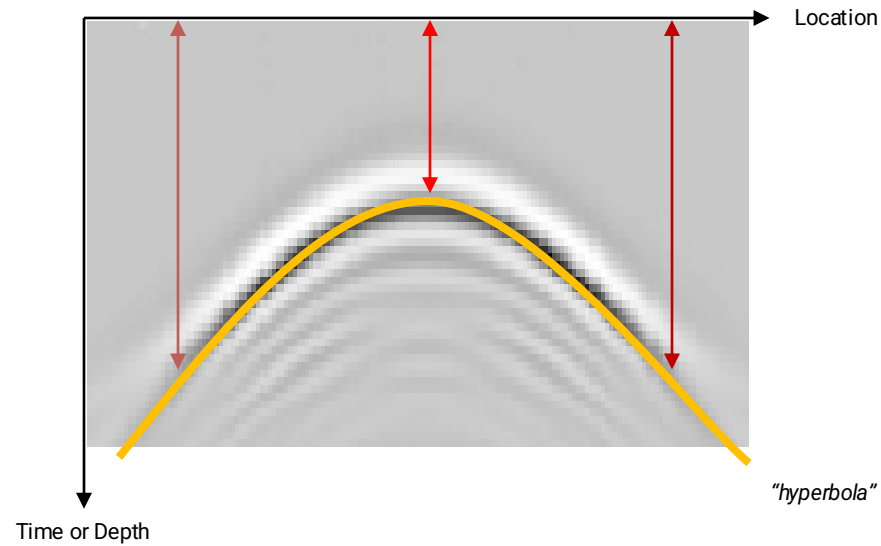
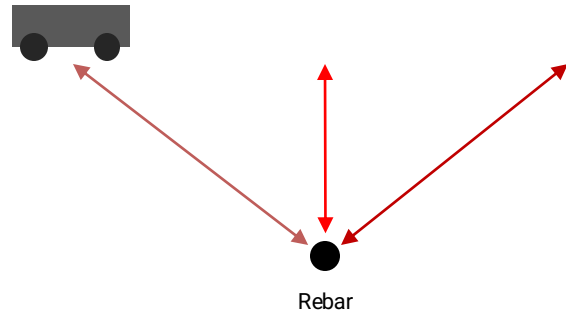




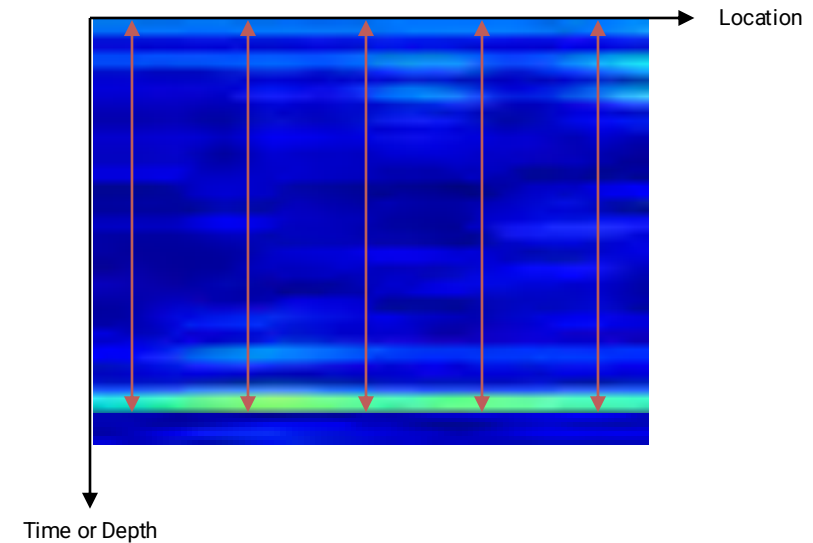
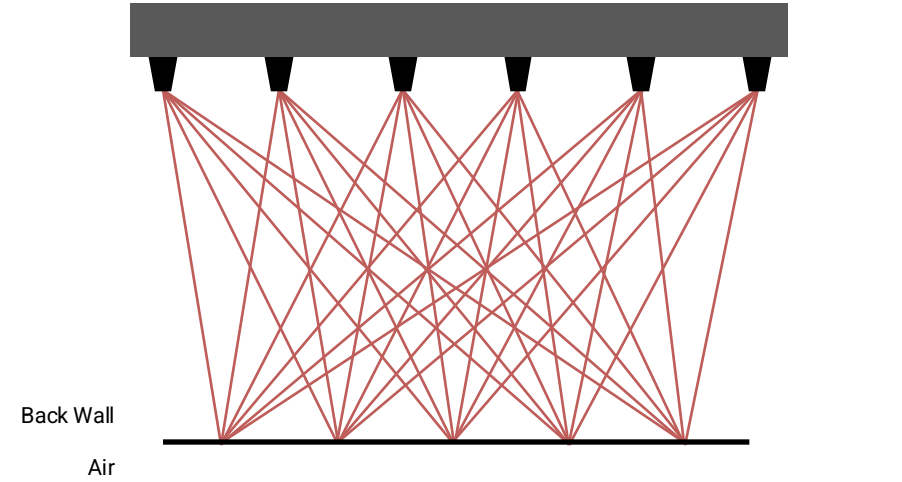
Imaging

Ground Penetrating Radar & Ultrasound Pulse Echo

GPR (Radio Wave)



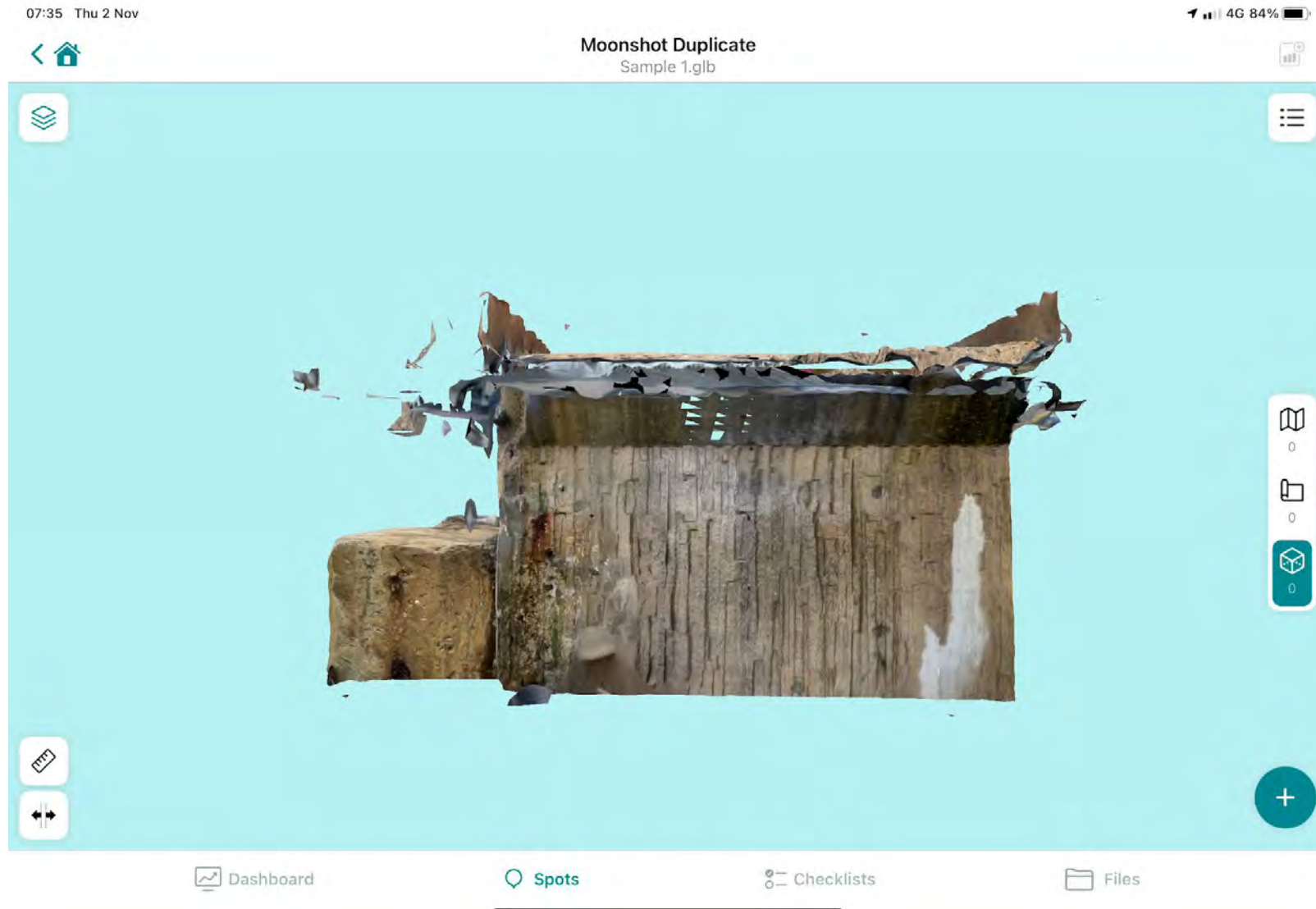
Ultrasound Pulse Echo





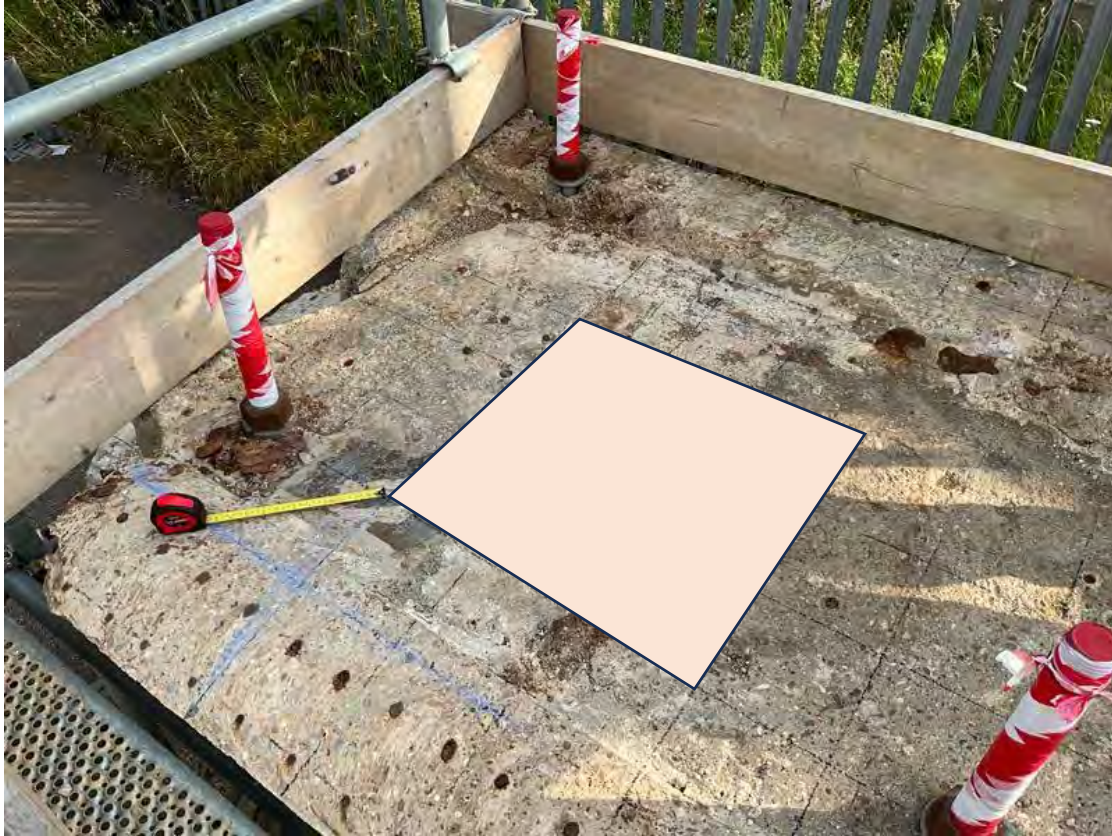
Project Moonshot

Onsite Data recording and Logging





Sample 1 Top GPR Findings



Rebar placement defect



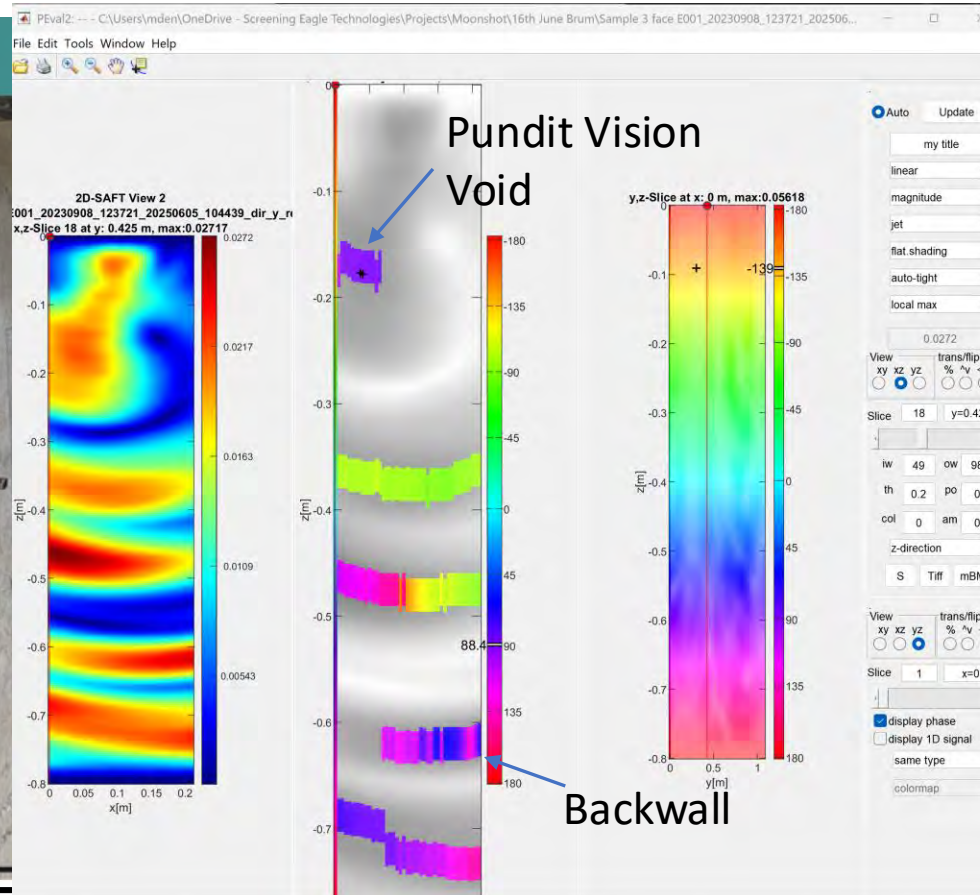
Sample 3 side E

Pulse Echo to Find Void

Inspect 12:09 Thu 17 Aug

Done

Image





Sample 3 Side E

GPR for Reinforcement

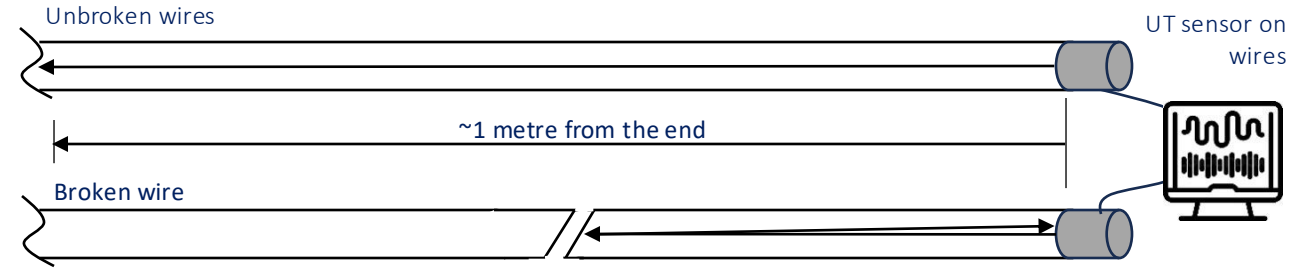


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6	Acoustic Emission	MISTRAS	Express8 AEwin™	MISTRAS

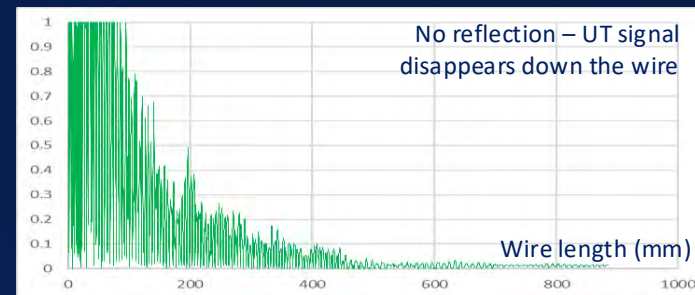
5 – Ultrasonics of Wires – Technology Overview

- The test technique uses a probe mounted to the exposed end of a wire which pulses a special signal generated by an Ultrasonic system (Pulse Echo).
- Inspects from 0.0m < ~1m length of a wire (variable) for wire breaks.
- Trial for quantification and validation is important.
- The ultrasonic signal travels down the wire to ~1m from the probe and any signals that are reflected from strand/wire defects or material interfaces are captured and recorded by the same probe and system.
- Software and analyses procedure is used to evaluate the received data for evidence of indications.

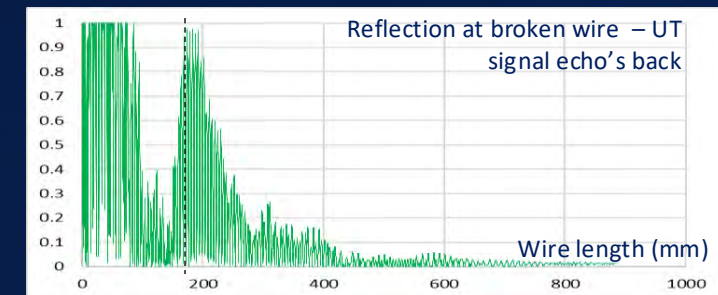
Principle of Ultrasonic Measurement on Wires



Example of testing on anchorage wires



Wire with no break



Wire with likely break at 180mm

5 – Ultrasonics of Wires – Trials and Testing

- Testing carried out on Sample 1.
- Wires are sanded flat.
- Wires tested 1 by 1, with 5mm diameter probe.

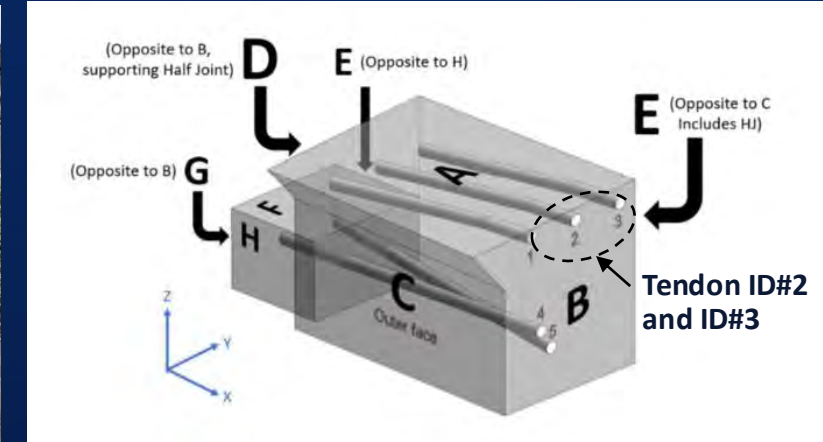


Image from AtkinsRéalis-Jacobs JV

Sample ID 1 and tendon ID's



Ultrasonic testing



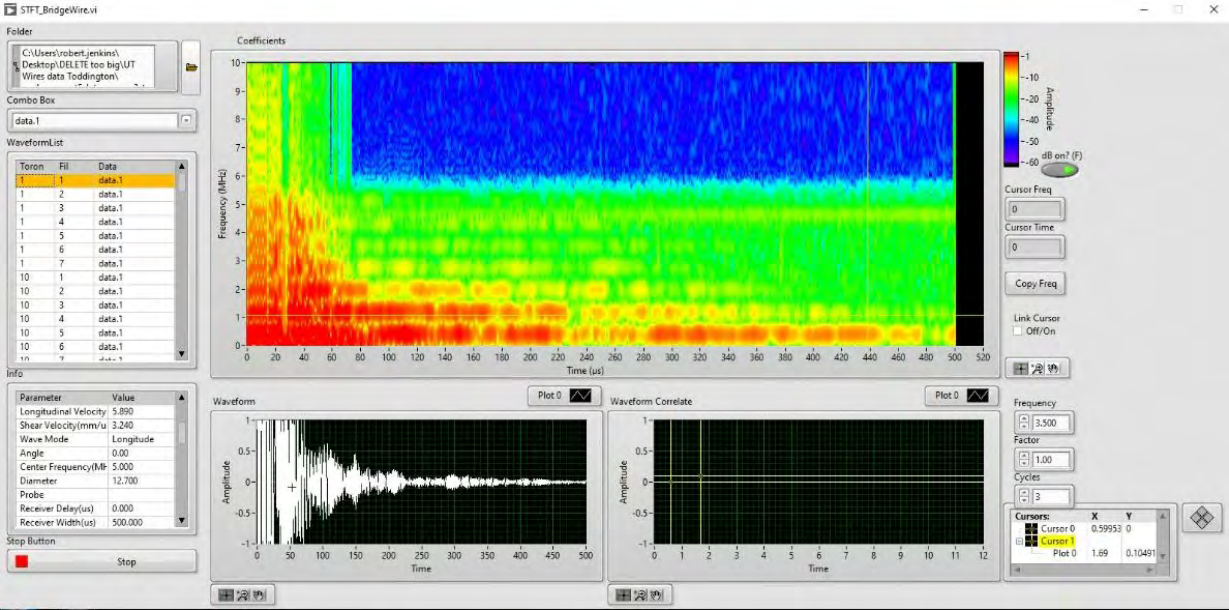
Sensor on wire



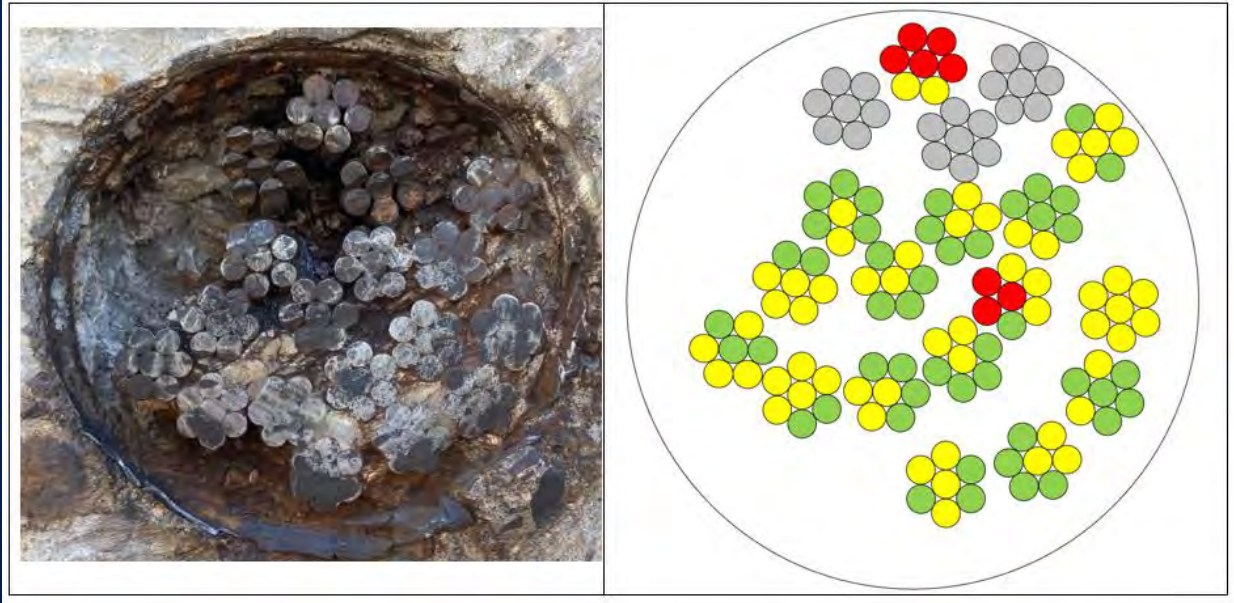
Tablet UT system

5 – Ultrasonics of Wires – Key Results and Outputs

- Example of raw sign and frequency spectrum from 1 wire



- Example of reporting format



Comparison of UT Results vs Investigation

- Poor correlation!



5 – Ultrasonics of Wires – Further Development of Technology

- Wire testing of removed anchorages taken from HRV sample 1
 - with grout
 - without grout
- Improve the procedure for ultrasonic testing for future works.



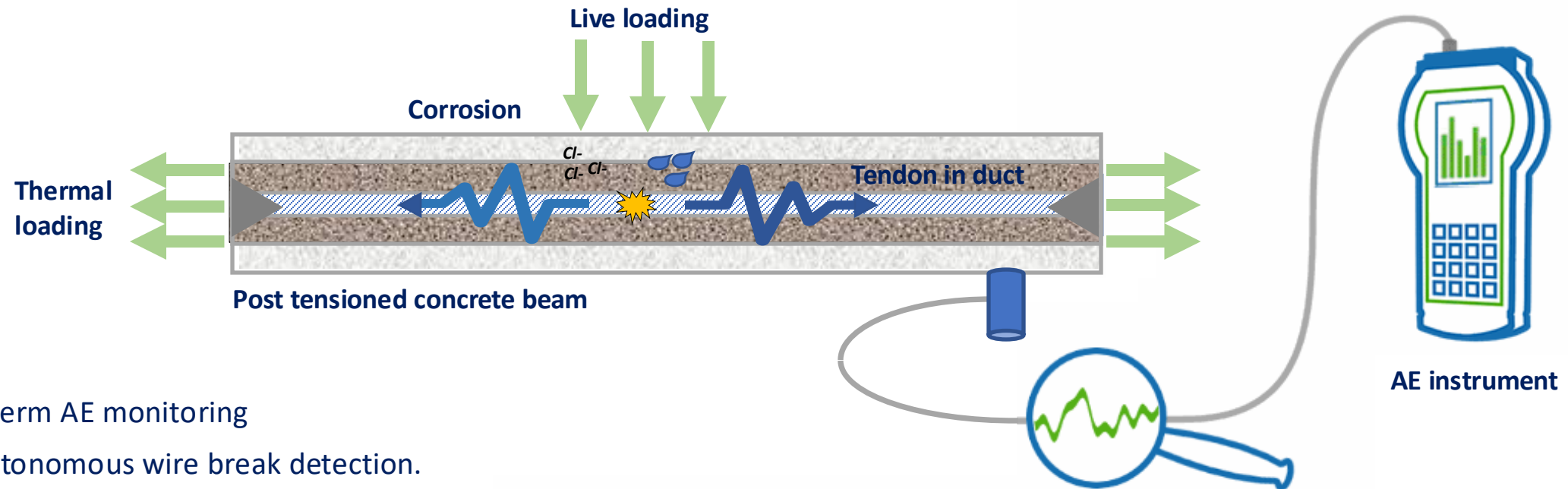
Image from AtkinsRéalis-Jacobs JV

6 – Acoustic Emission – Technology Overview

“Acoustic emissions are transient elastic waves generated by the rapid release of energy from localized sources within a material”

reference: ASTM E1316

Wire breaks caused by deterioration of tendons inside post tensioned concrete create AE shock waves that are detected by surface mounted AE sensors which are fixed every 5-10m to structures.

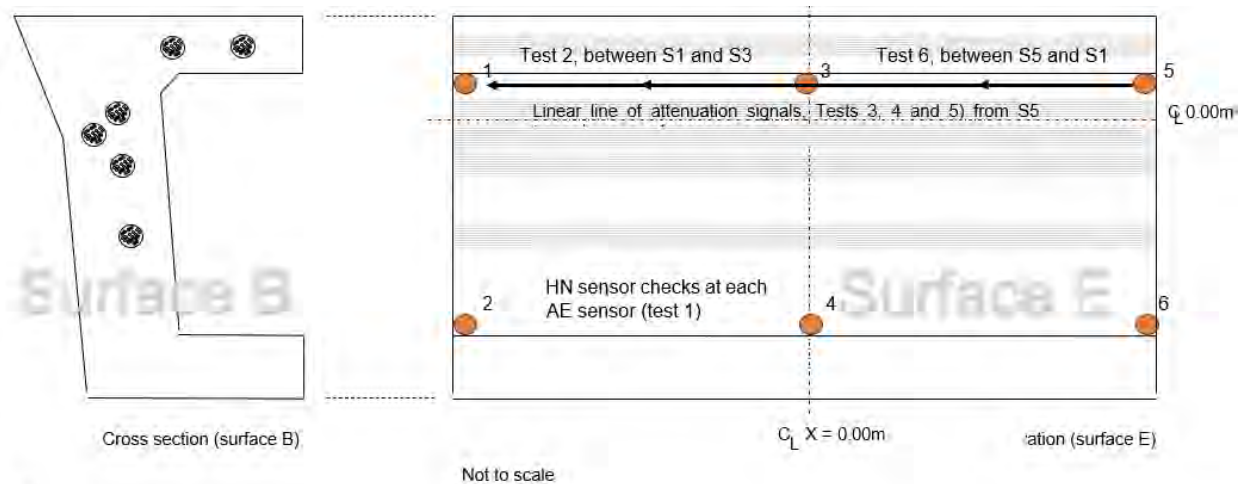


Long term AE monitoring

- Autonomous wire break detection.
- Positions the epi-centre of wire breaks and 'hot spots'.
- Enables 100% volumetric condition monitoring of PT systems.

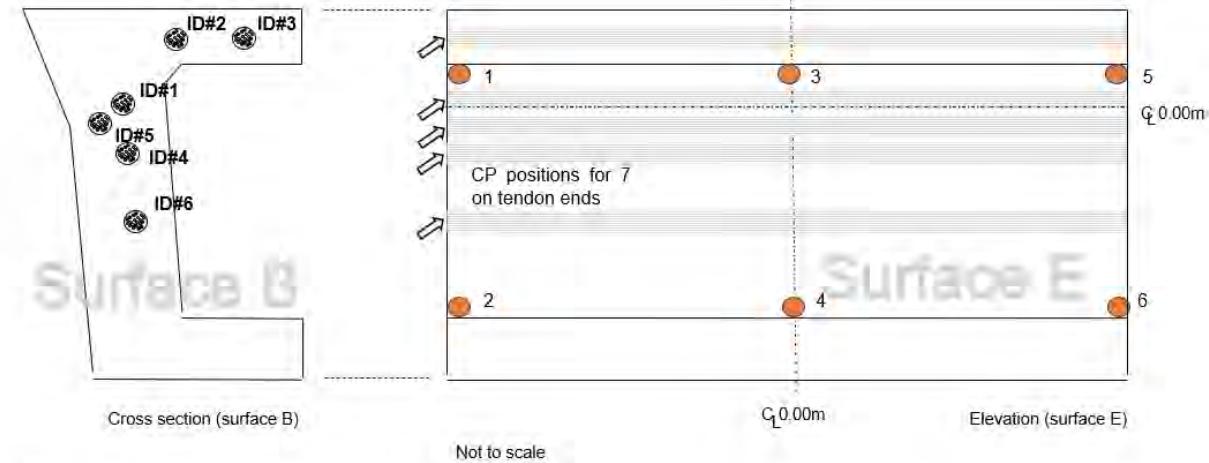
6 – Acoustic Emission – Overview of Trials and Testing

- AE monitoring is passive – so testing used simulated wire break source – spring loaded impactor.
- AE sensors are mounted on concrete surface and cabled to a MISTRAS Express-8 AE system for measurement.
- Simulated wire breaks made on concrete surface and exposed (de-tensioned) cable ends.
- AE source location and signal characterisation carried out the specimen (using simulated wire break source).



Key

- Tendon duct end (surface B)
- Position of tendon duct inside sample 3 concrete
- ✱ Centre punch on concrete surface E

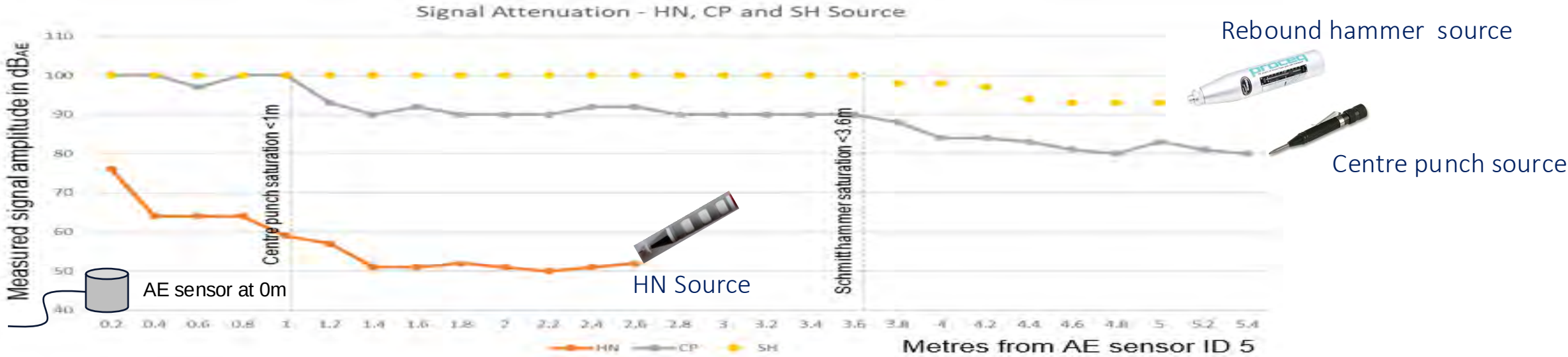


Key

- Tendon duct end (surface B)
- Position of tendon duct on surface E, inside sample 3 concrete
- ➡ Centre punch on strand end

6 – Acoustic Emission – Key Results and Outputs

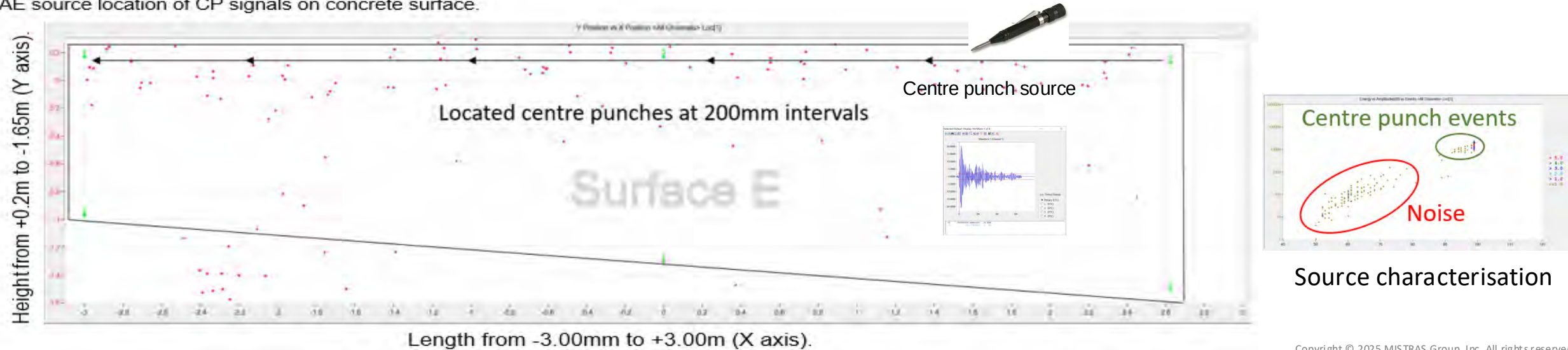
Attenuation Results



Location Results

Results

AE source location of CP signals on concrete surface.

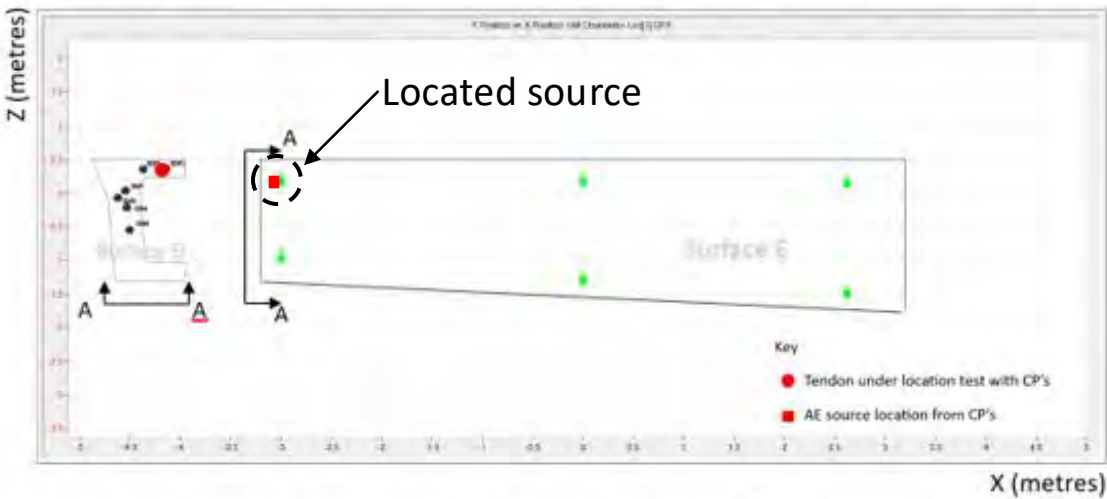


6 – Acoustic Emission – Key Results and Outputs

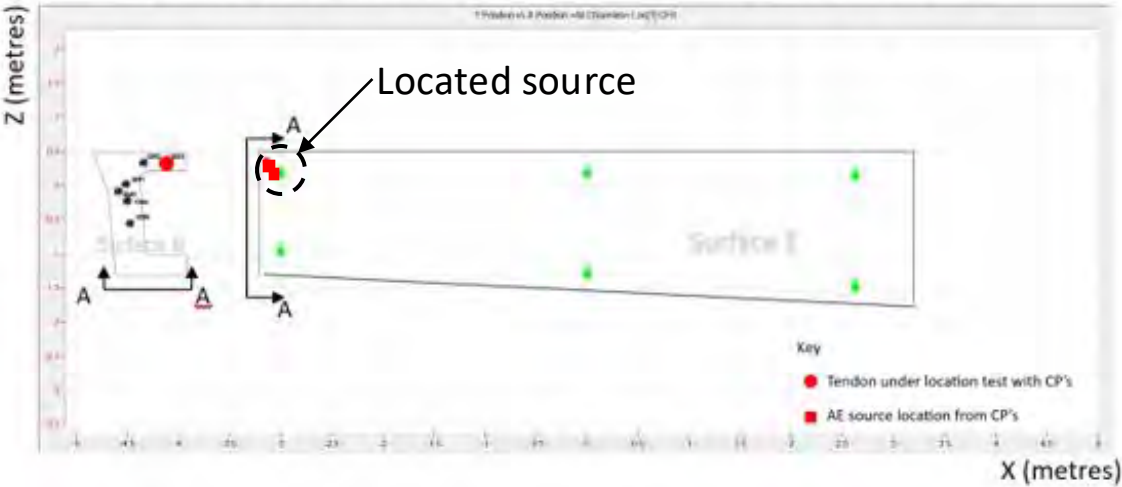
Location Results

Results

Tendon 3 - AE source location of CP signals on GROUTED strand end



Tendon 3 - AE source location of CP signals on UNGROUTED strand end



Tendon ID 3 on Surface B



Centre punch source



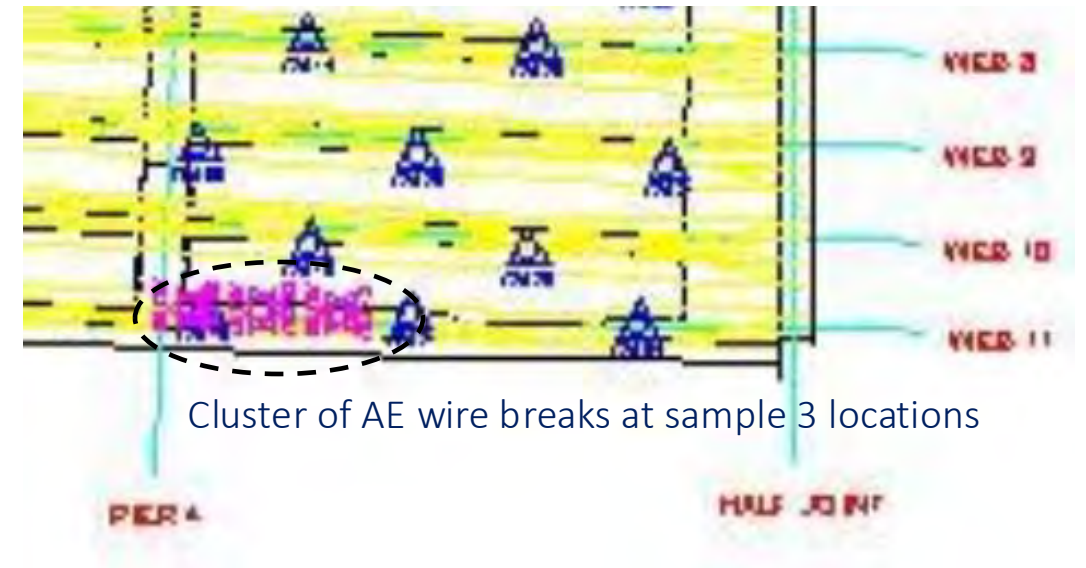
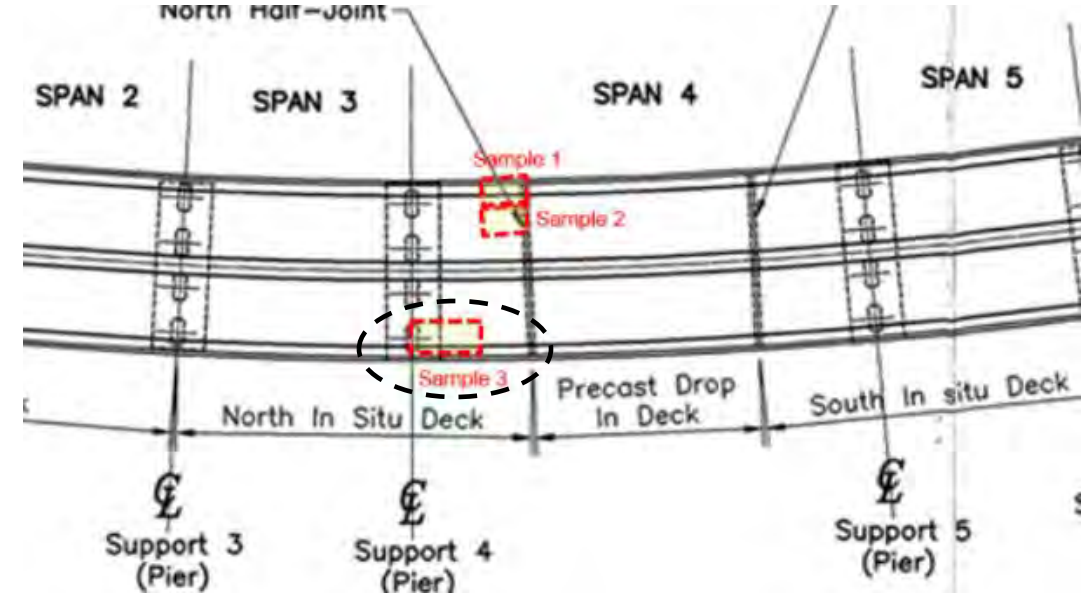
Duct ID#3 found to be part (1/2) grouted along whole length.

6 – Acoustic Emission – Comparison of Results Against

- MISTRAS simulated wire breaks on Sample 3 were accurately located to within +/-10cm and discernible from other sources of noise.
- Pure Technologies AEM of HRV between 1998 to 2020 detected 52 wire breaks, 28 in Zone 2 of which around 15 are near/at Sample 3*. *with a reported location 'inaccuracy of in excess of 1m'.
- During AtkinsRéalis partial duct investigations, broken wires were found within the specimen, with multiple breaks found concentrated in duct 6.

Table 3.1. Wire break events from May 1998 to March 2020 from TRL report

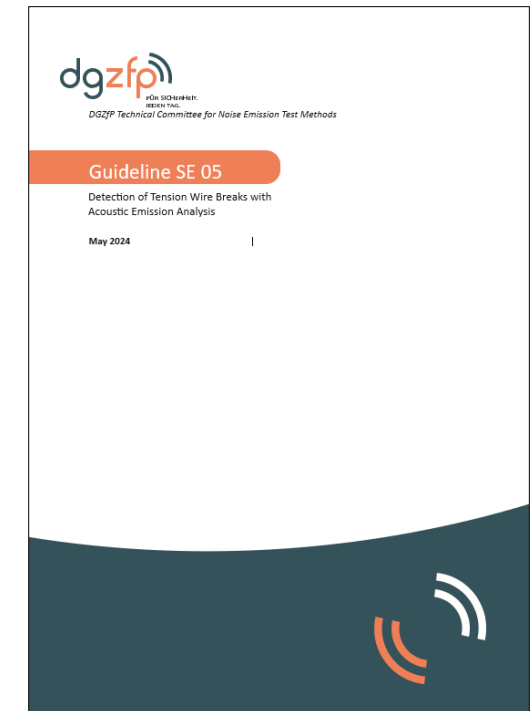
Location	Wire Break	Possible Wire Break
Zone 1	2	0
Zone 2	28	4
Zone 3	5	4
Zone 4	2	1
Zone 5	15	1
Zone 6	0	0
Overall	52	10



Cluster of AE wire breaks at sample 3 locations

6 – Acoustic Emission – Further Development of Technology

- AEwin64 software – enhanced performance and upgraded graphics.
- New MicroSHM – 4 channel AE system for low cost AE monitoring.
- Publishing of wire break best practise guides to assist bridge owners.
- 9 new post tension AE wire break projects since 2023, adding further industrial experience.



- The application of advanced NDT and AE monitoring has been effectively demonstrated.
- There was correlation between NDT results and forensic investigation of grouting in the ducts.
- **GPR** is essential in locating rebar and duct locations, prior to other testing.
- **Impact Echo** is 'simple' and reliable with a valuable role to play in void detection.
- **Advanced ultrasonic NDT** provides detailed information on duct voids – interpretation and display of data requires greater care.
- Practical testing work benefits from battery powered, light weight, robust and well designed systems.
- The original **Acoustic Emission** monitoring from 1998 to 2020 on the HRV was validated, with multiple wire breaks found in Sample 3. MISTRAS AE testing showed significant improvement in AE source location and source characterisation.

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- Trial and calibration of any testing is **essential** to develop and confirm a successful application (especially with many variables in structures).
- **Conventional destructive inspection is limited** to small areas – while modern non-invasive inspection technologies and AE monitoring can be applied over significantly larger volumetric areas and causing no damage to the structure.

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- **Thank you to National Highways, the team at AtkinsRealis Jacob JV, VSL and all involved in this project.**



MOONSHOT – Huntingdon Railway Viaduct NDT Trials at M1 National Highways Toddington Yard

Jon Watson and Tim Bradshaw – MISTRAS

Markus Denton-Masih and Shirley Underwood – Screening Eagle

James and Norman Bell – Allied Associated Ltd (distributors of Elop and GSSI)

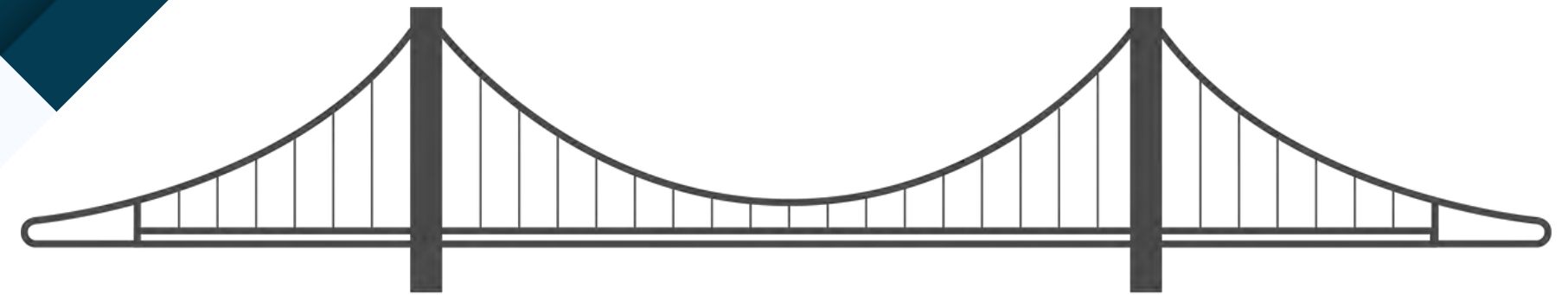
16th June 2025

The Studio, 7 Cannon Street, Birmingham B2 5



NATIONAL HIGHWAYS STRUCTURES MOONSHOT PROJECT

BRIDGOLOGY'S GPR WORKFLOW



BRIDGOLOGY

Presented By:

DR. ALEXIS KALOGEROPOULOS – CEO, BRIDGOLOGY SA

June 16, 2025 | The Studio, Birmingham

HOSTED BY THE ATKINSRÉALIS / JACOBS JOINT VENTURE

THE CHALLENGE

EFFICIENT STRUCTURAL ASSESSMENT WITH GPR

- High accuracy
- Minimal traffic disruption
- Scalable for network-wide deployment
- Cost-effective diagnostics

Our solution:

A standardized GPR workflow enabling layer-by-layer analysis for actionable insights.



WHAT IS BRIDGOLOGY?

Concrete Radiologist

**GPR diagnostics for Civil Engineers
by Civil Engineers**

**Based in Switzerland, with offices
in Sweden and Thailand**

**350+ structures assessed across
10+ countries in 12 Years**



OUR ROLE IN THE GPR ECOSYSTEM

Bridgology bridges the gap between raw GPR data and strategic decision-making. Our standardized workflow ensures consistent data acquisition, expert interpretation, and clear insights to guide proactive maintenance planning.

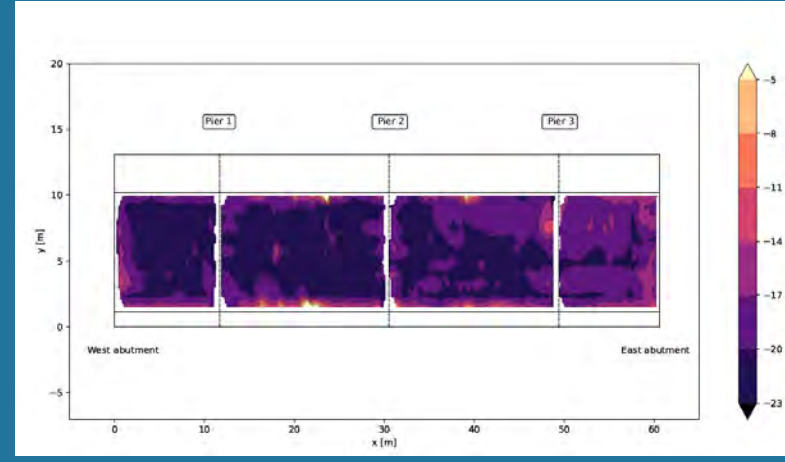


SCANNING TEAMS

Role: Scanning teams

Responsibility: Conduct field measurements following Bridgology's standardized protocols

Output: Raw radargrams

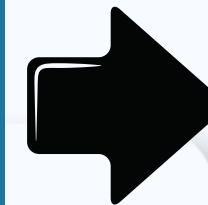


BRIDGOLOGY

Role: Data Interpretation & Mapping

Responsibility: Analyze radargrams and produce structural diagnostic maps

Output: Actionable insights to support maintenance and decision-making



CONSULTANTS / OWNERS

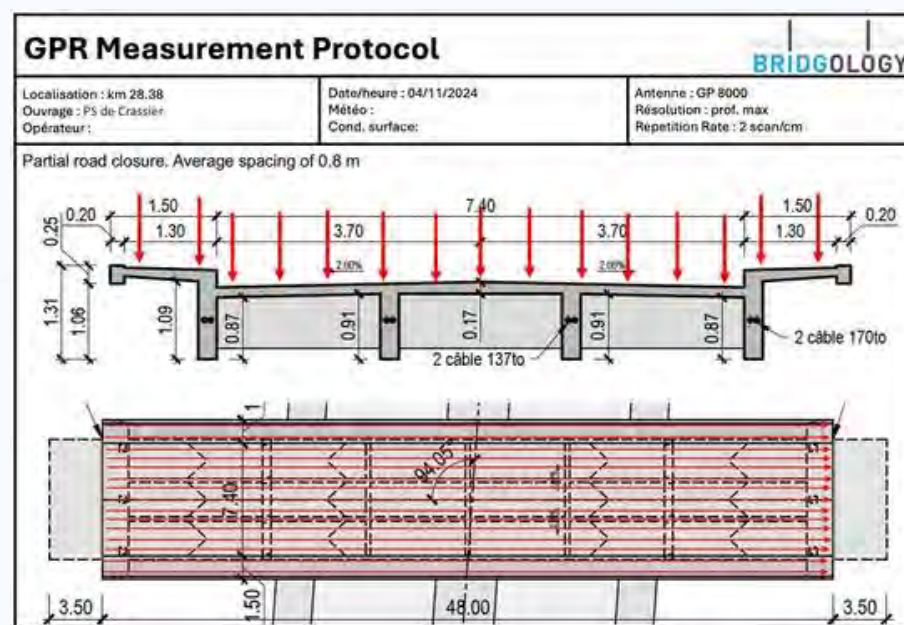
Role: Maintenance Planning

Responsibility: Use diagnostic outputs to plan interventions and prioritize actions

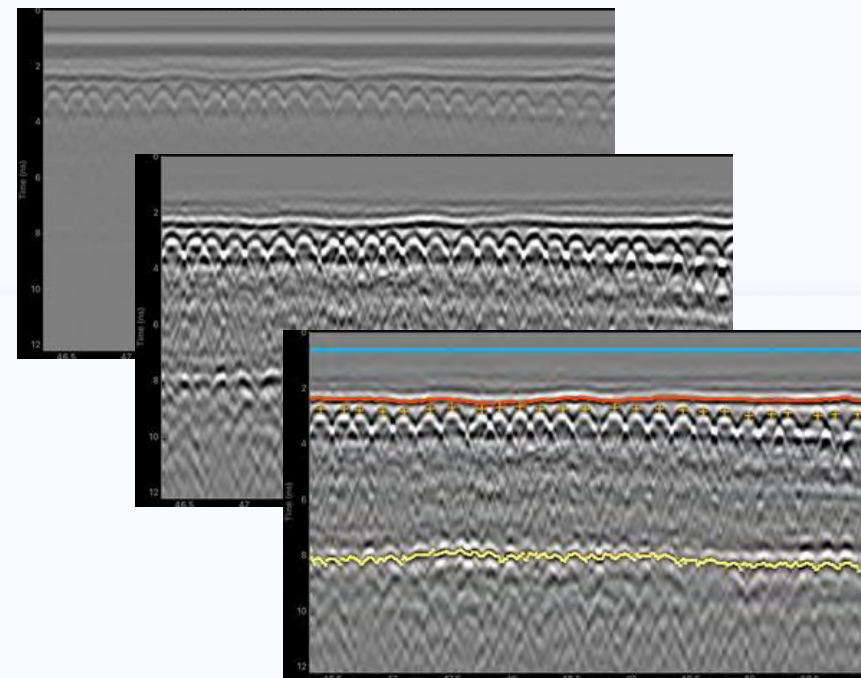
Output: Informed decisions for long-term asset management

BDGPY – BRIDGOLOGY'S IN-HOUSE SOFTWARE SUITE

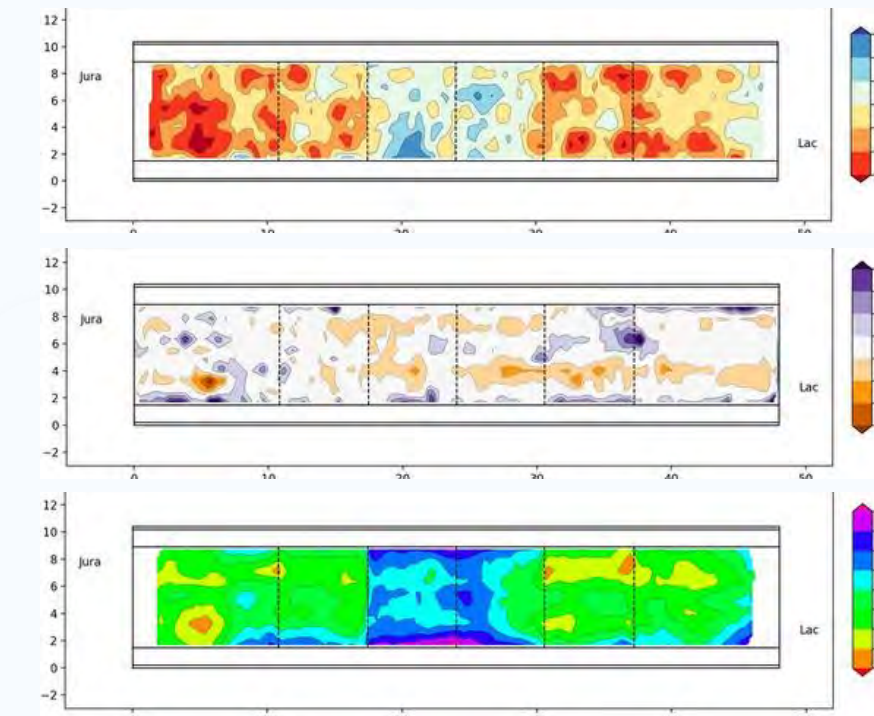
Bridgology's proprietary software, BDGpY, powers our diagnostics workflow from field to final report. Purpose-built for concrete radiology, it ensures reliable, repeatable, and high-impact results.



SURVEY PROTOCOL

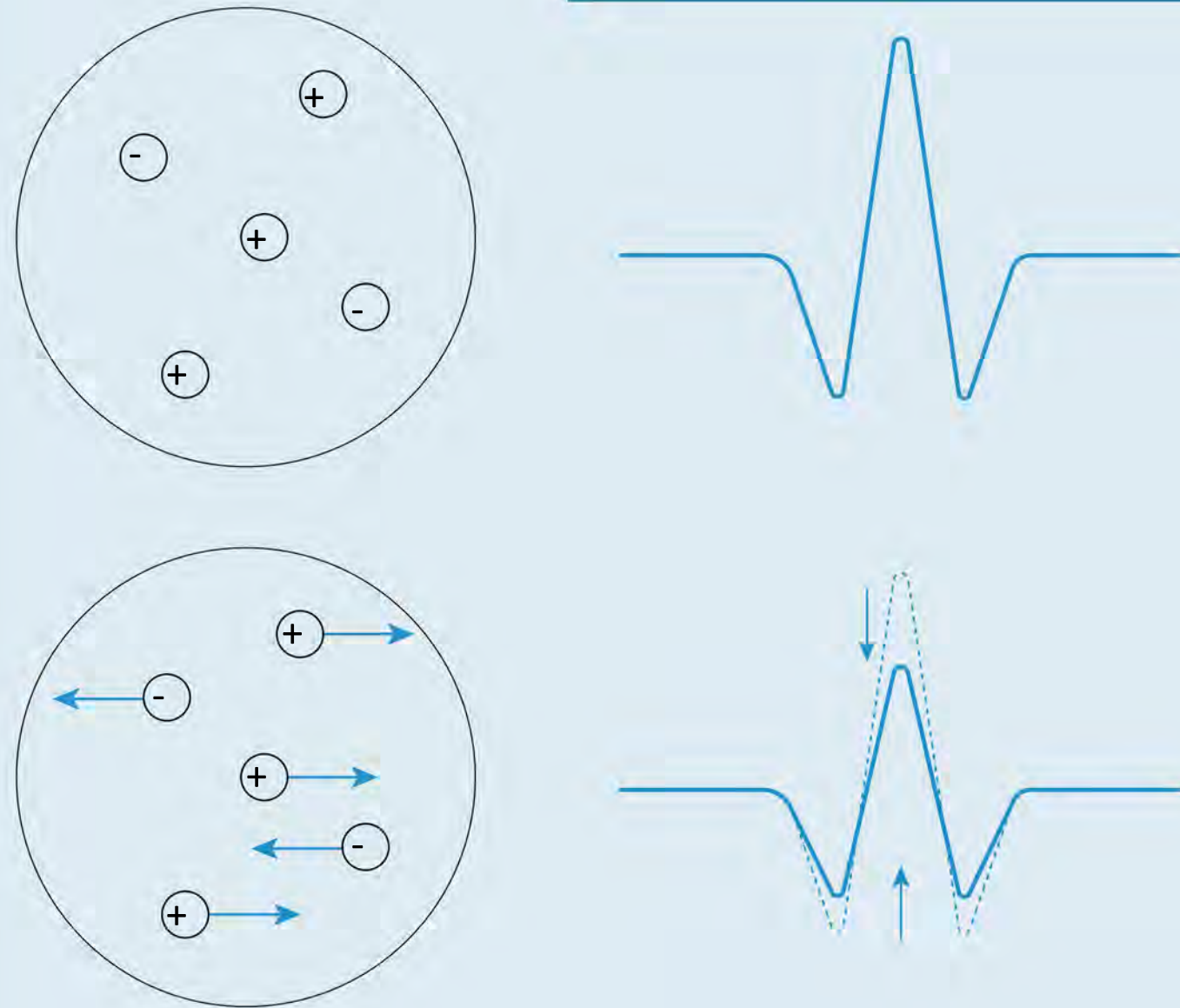


**SIGNAL PROCESSING
& FEATURE EXTRACTION**

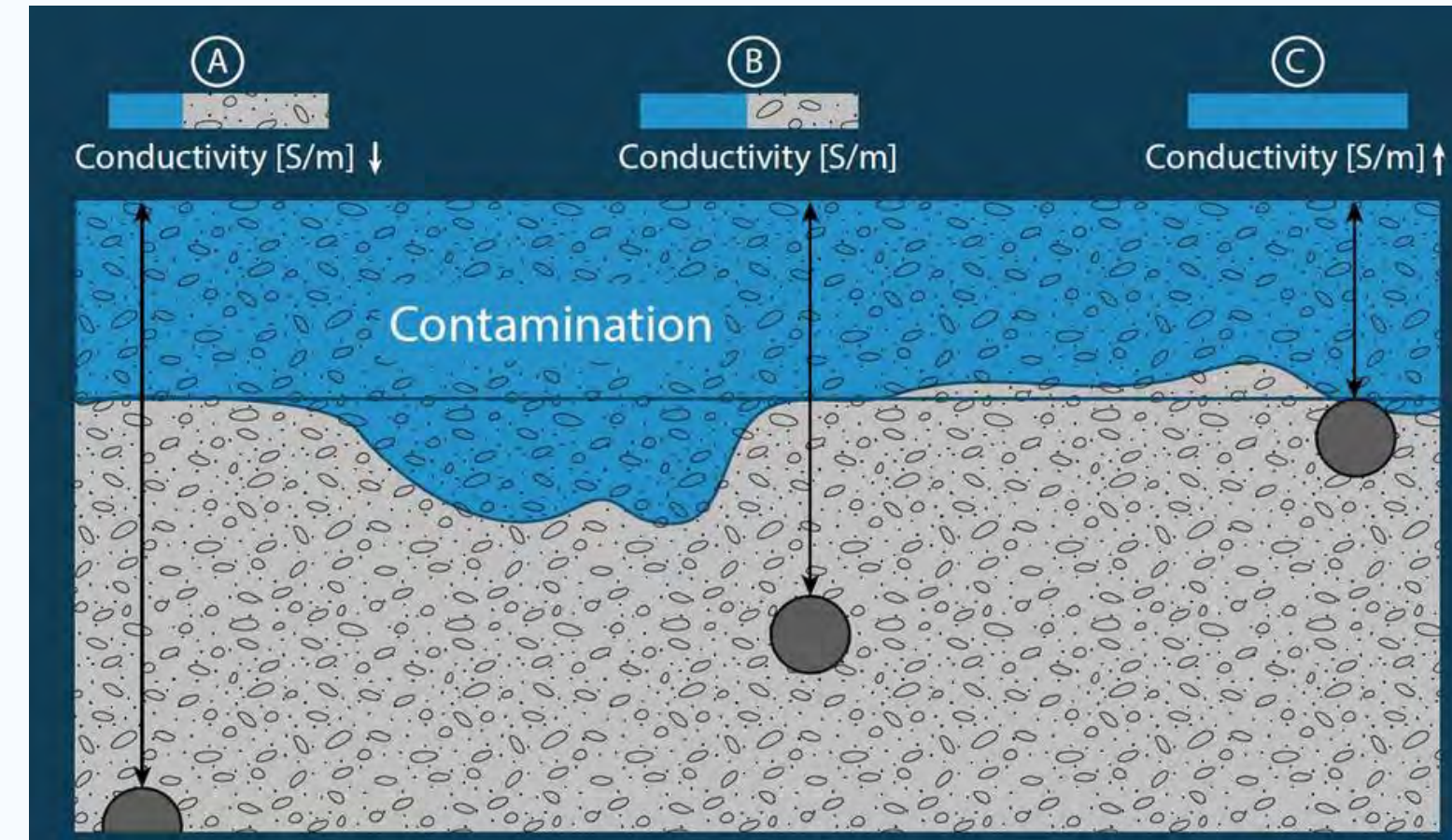


MAP PRODUCTION

Conductivity



The method for calculating conductivity from GPR data was developed in Dr. Alexis Kalogropoulos's thesis (EPFL Thesis No. 5354, 2013), providing a robust framework for concrete analysis.



The conductivity of the concrete cover reflects the risk of corrosion of the reinforcing bars:

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability}$$

With:

Risk = Measured conductivity [S/m].

Hazard = Conductance [S], directly proportional to the contamination (% Cl-)

Vulnerability = exposure of the reinforcing bars to contamination, inversely proportional to the coating thickness.

Thus, with equal contamination, conductivity decreases when the coating is thick (A) and increases when the coating decreases (C). Conversely, for the same coating thickness, conductivity increases for high contamination and decreases for lower contamination.

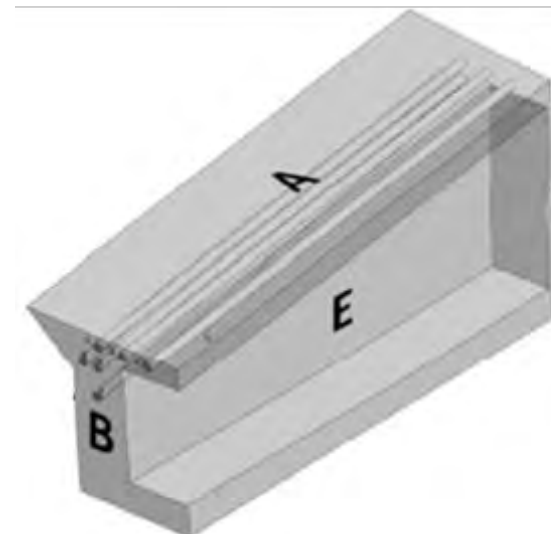
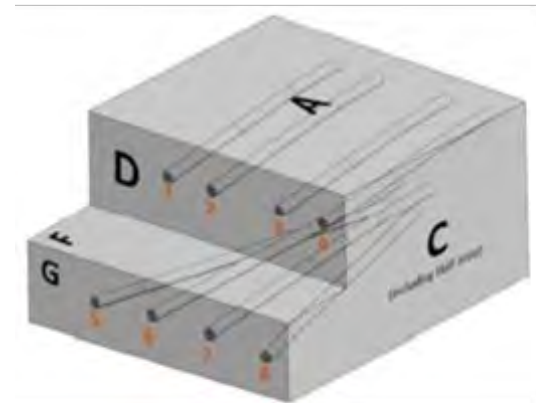
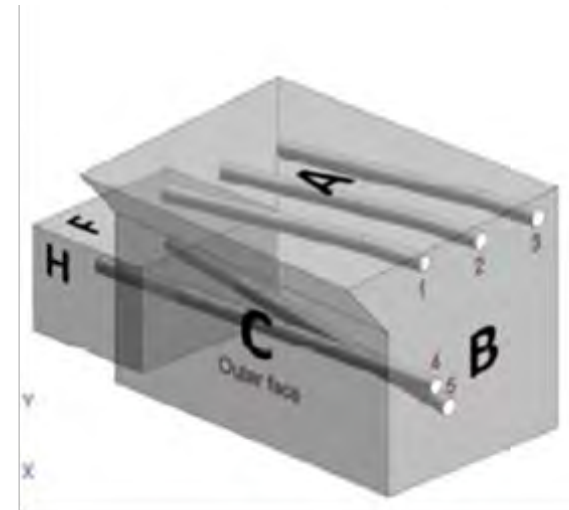
MOONSHOT RESULTS

Data collection

3

Table 1: Table of the measurement and analysis

Sample Nr	Face	Measured	Analysed
Sample 1	A	Yes	Yes
Sample 1	B	Yes	No
Sample 1	C	Yes	Yes
Sample 1	D	Yes	No
Sample 1	E	Yes	Yes
Sample 1	F	Yes	Yes
Sample 1	G	Yes	No
Sample 1	H	Yes	No
Sample 2	A	Yes	Yes
Sample 2	B	Yes	No
Sample 2	C	Yes	Yes
Sample 2	D	Yes	Yes
Sample 2	E	Yes	Yes
Sample 2	F	Yes	Yes
Sample 2	G	Yes	Yes
Sample 2	H	Yes	Yes
Sample 3	A	Yes	Yes
Sample 3	B	Yes	No
Sample 3	C	Yes	Yes
Sample 3	D	No	-
Sample 3	E	Yes	No
Sample 3	F	Yes	No

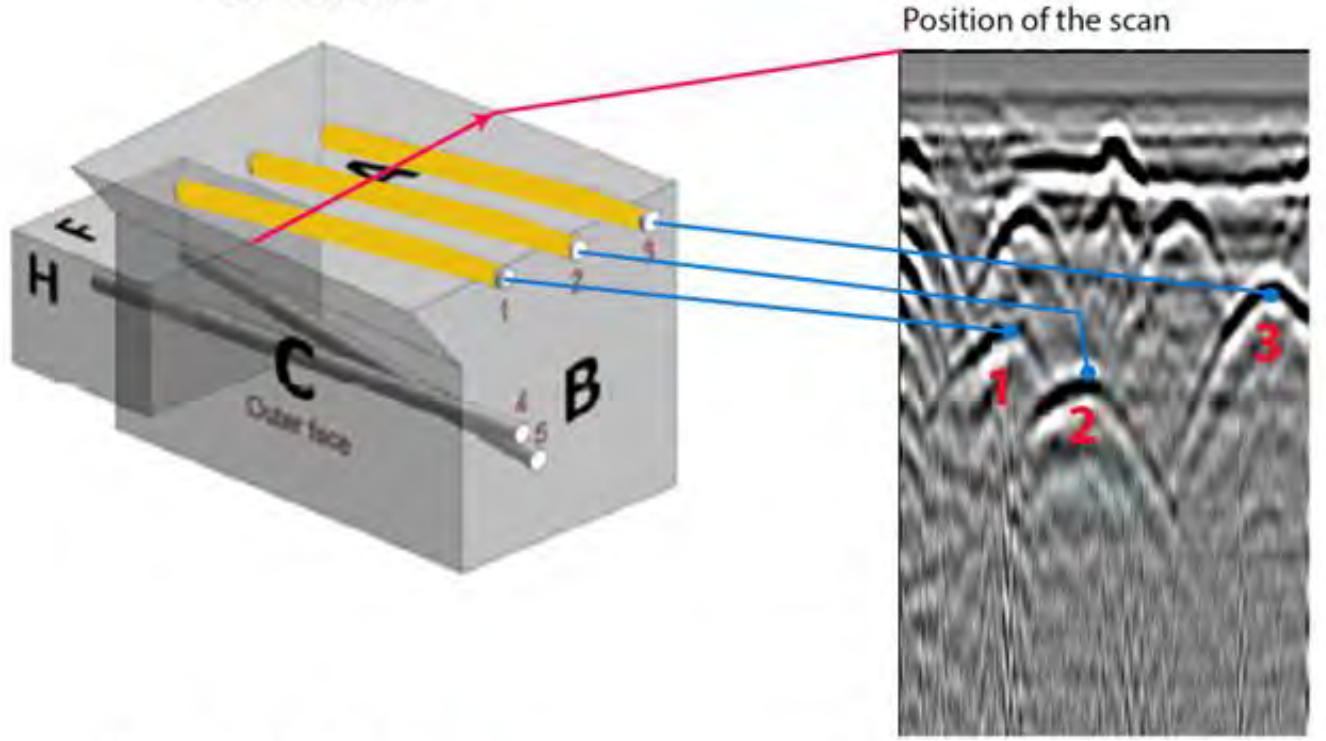


GP 8000

Sample 1 – Face

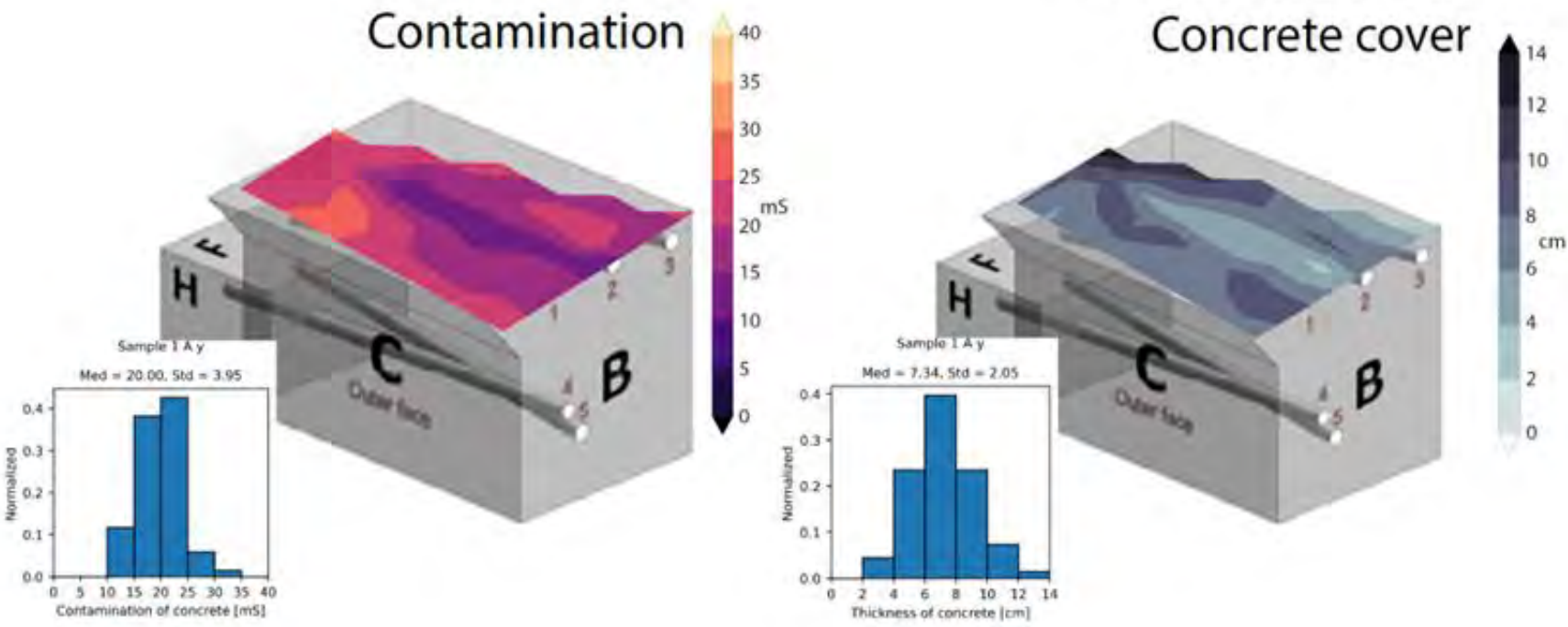
A

Elements

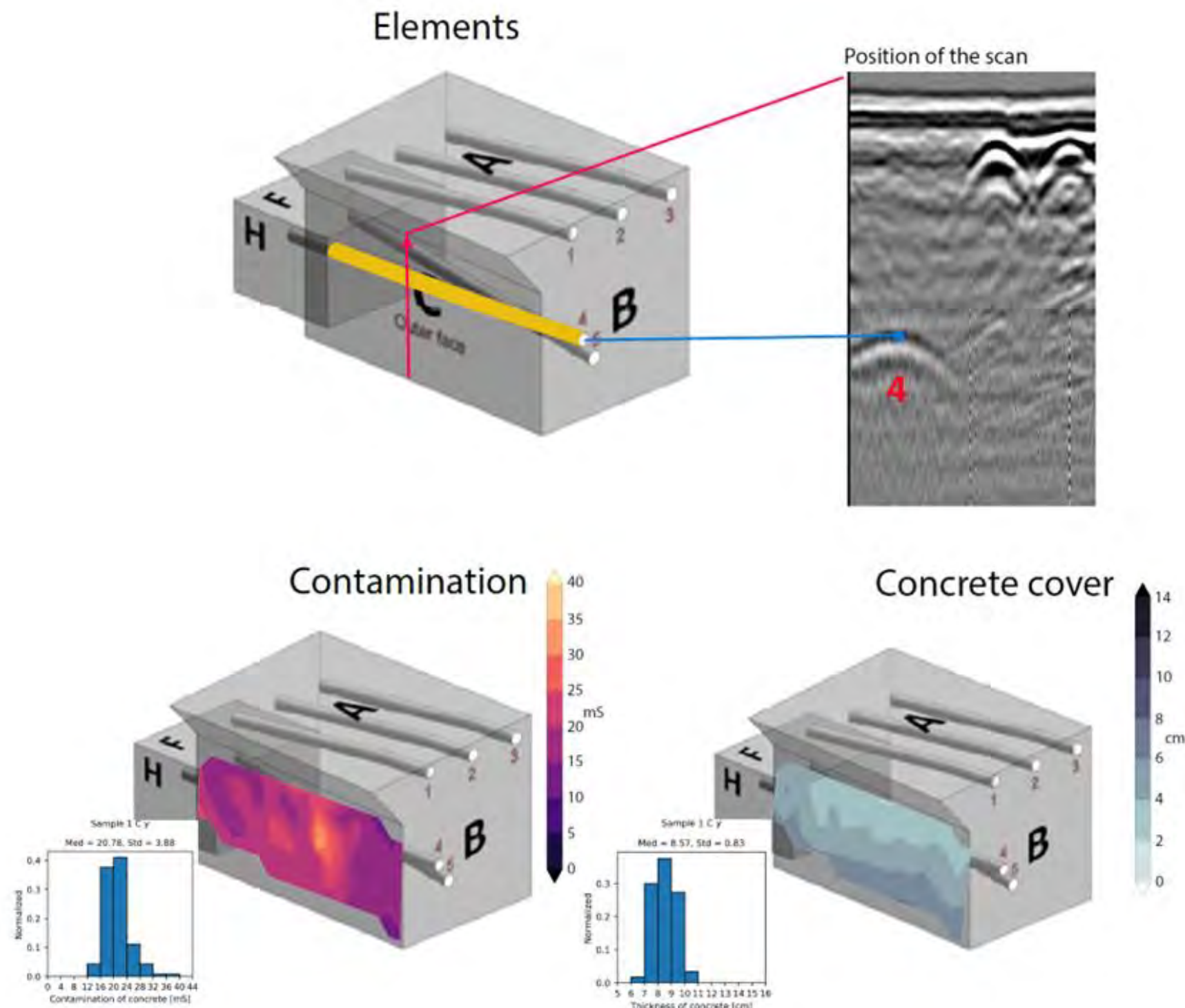


Contamination

Concrete cover



Sample 1 – Face C

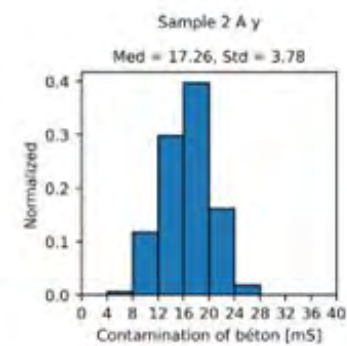
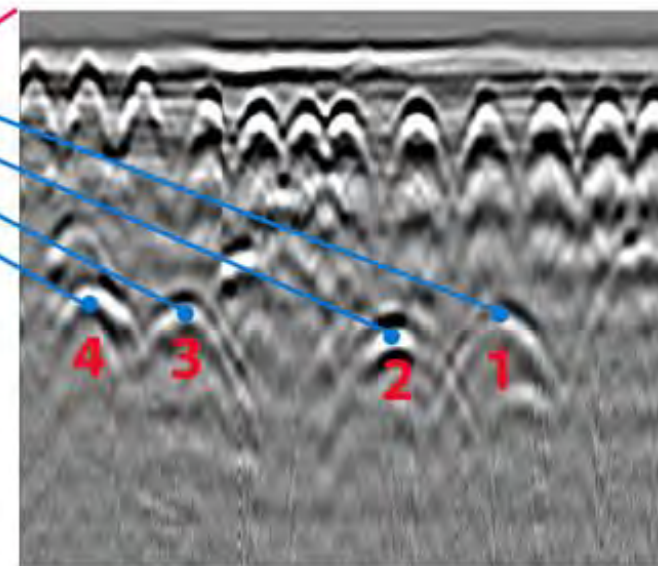
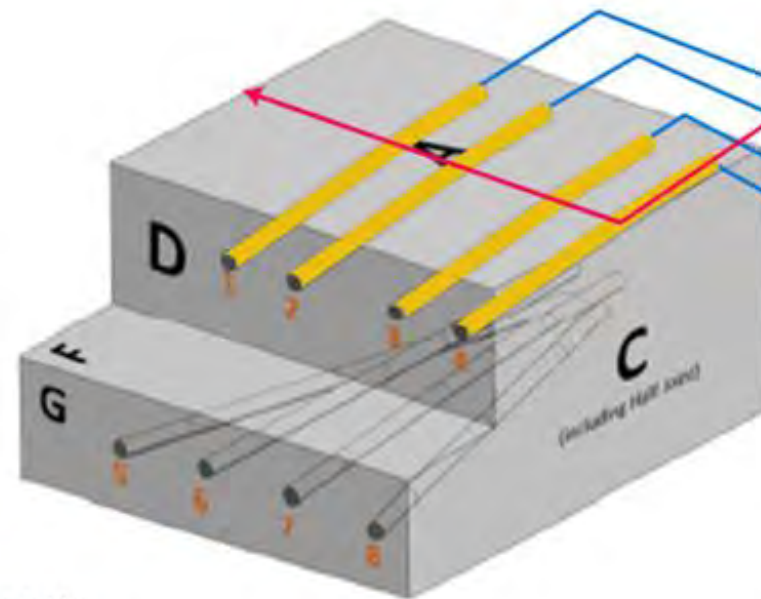


Sample 2 – Face

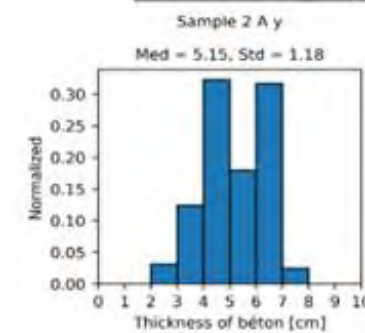
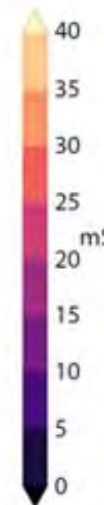
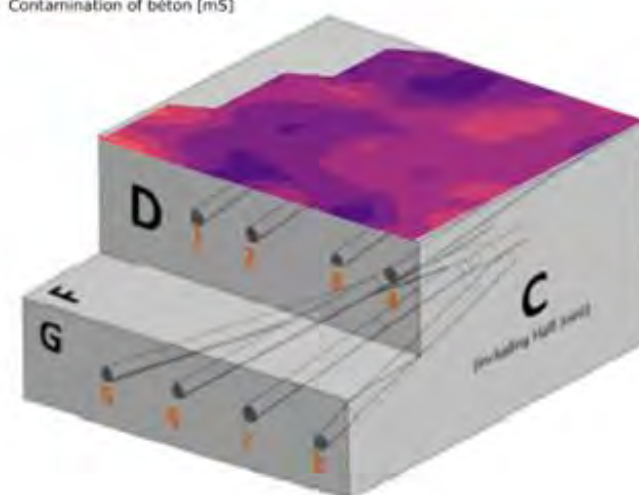
A

Elements

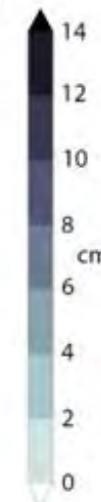
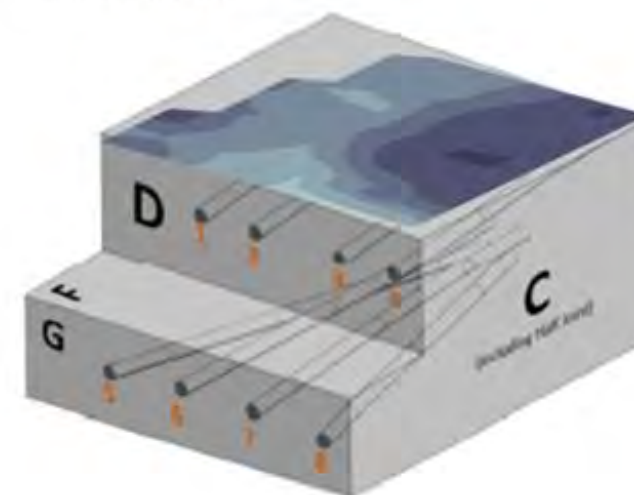
Position of the scan



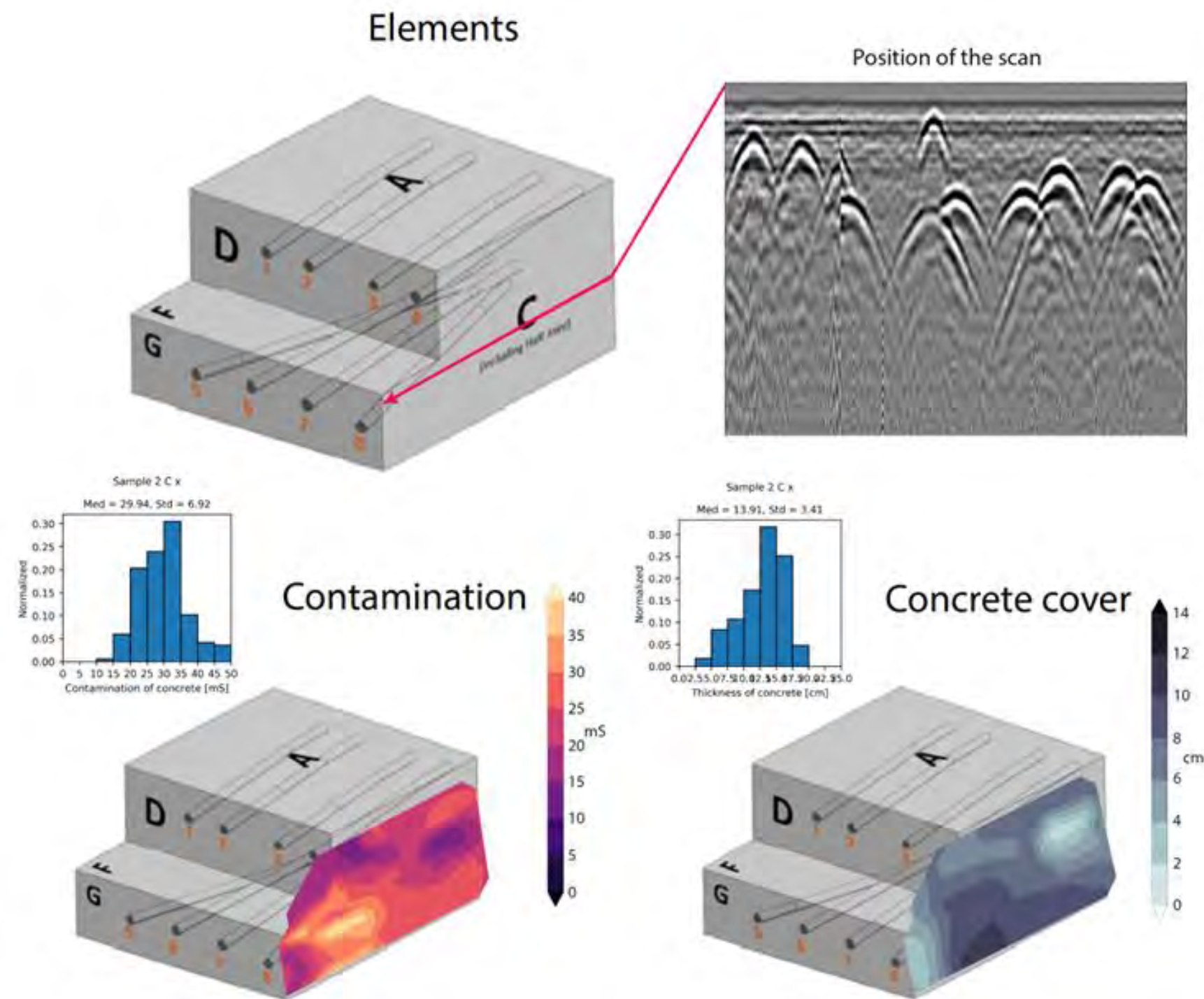
Contamination



Concrete cover



Sample 2 – Face C





RECENT RESULTS

WATERPROOFING CONDITION ASSEMENT

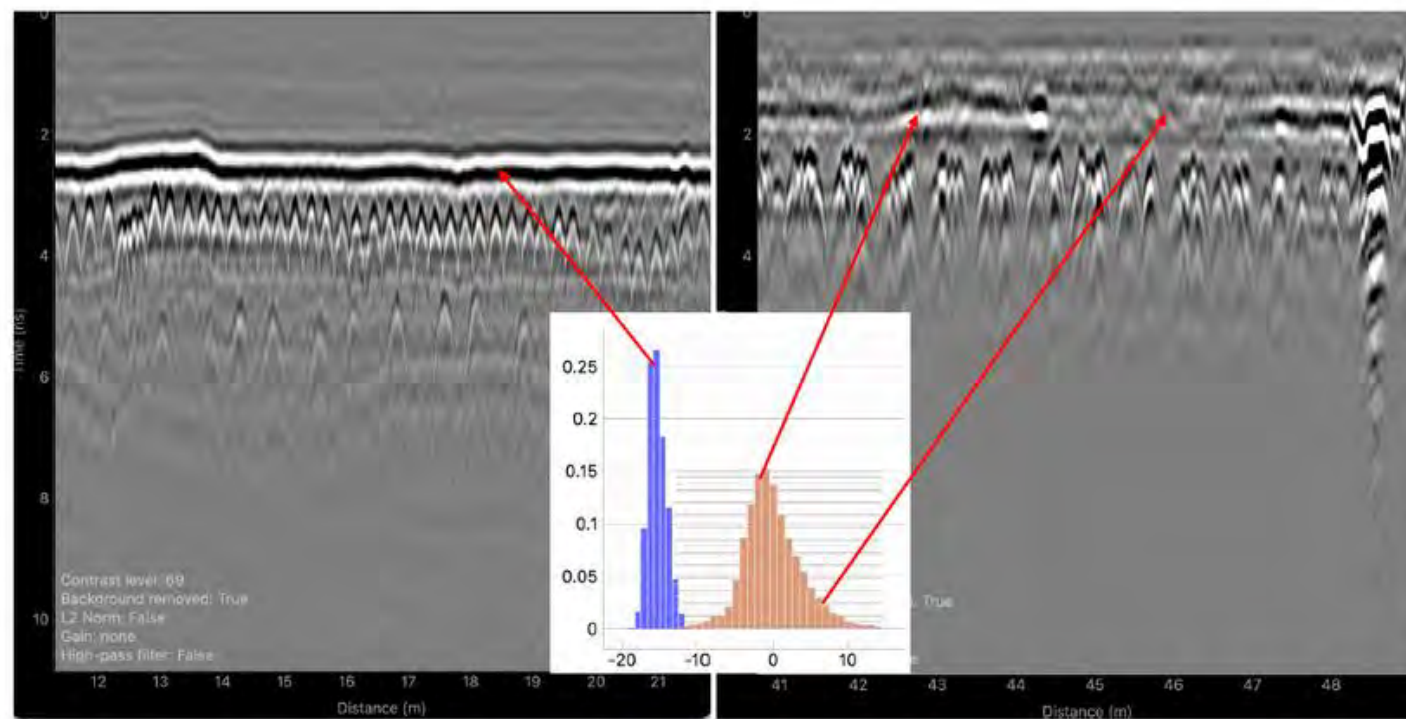
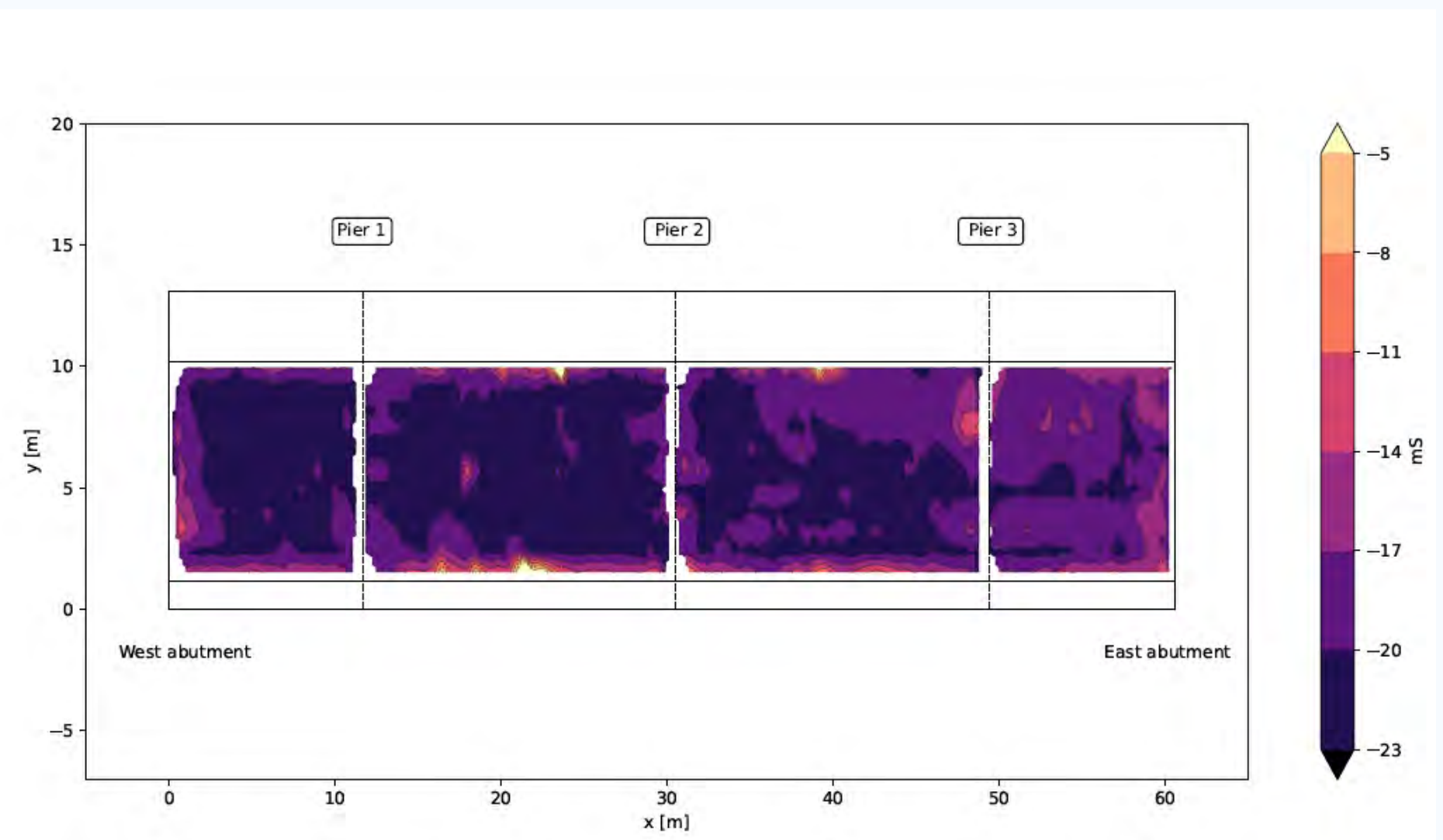
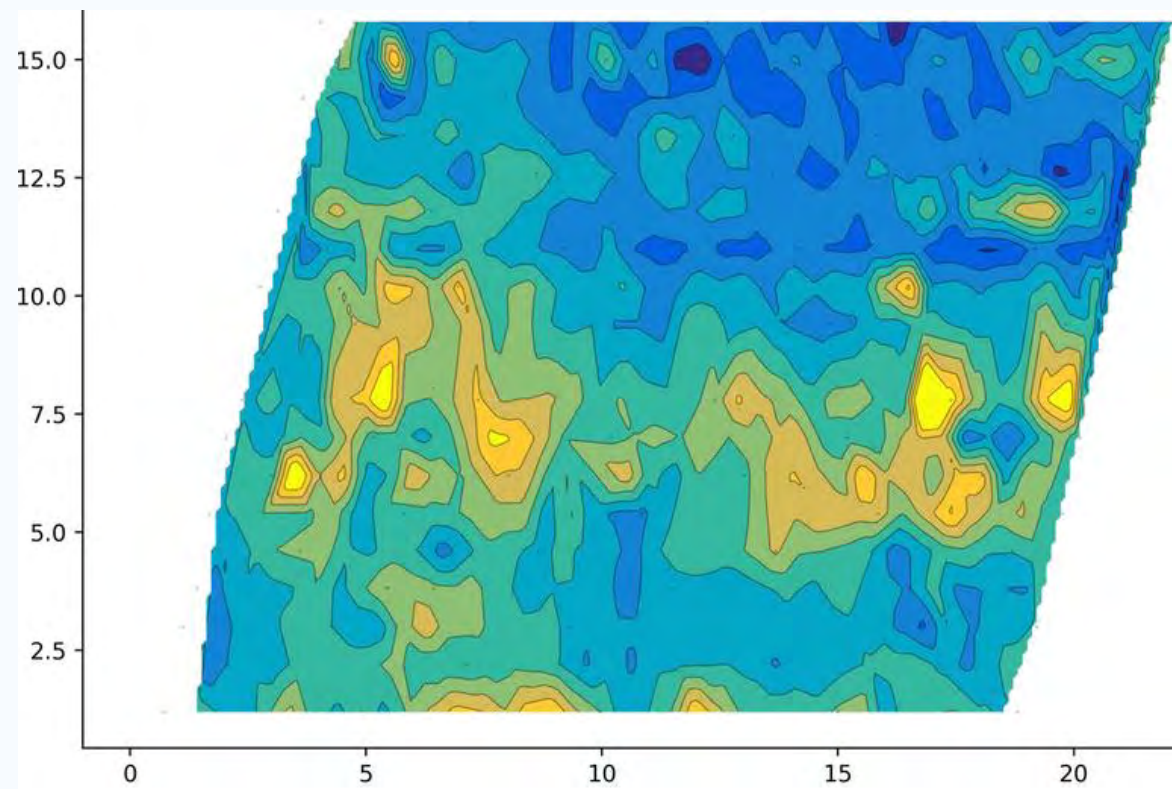


Figure 12: Comparison of the waterproofing state with a newly refurbished deck (left) and a deck with advanced damages (right). The graph shows the distribution of the asphalt conductance.



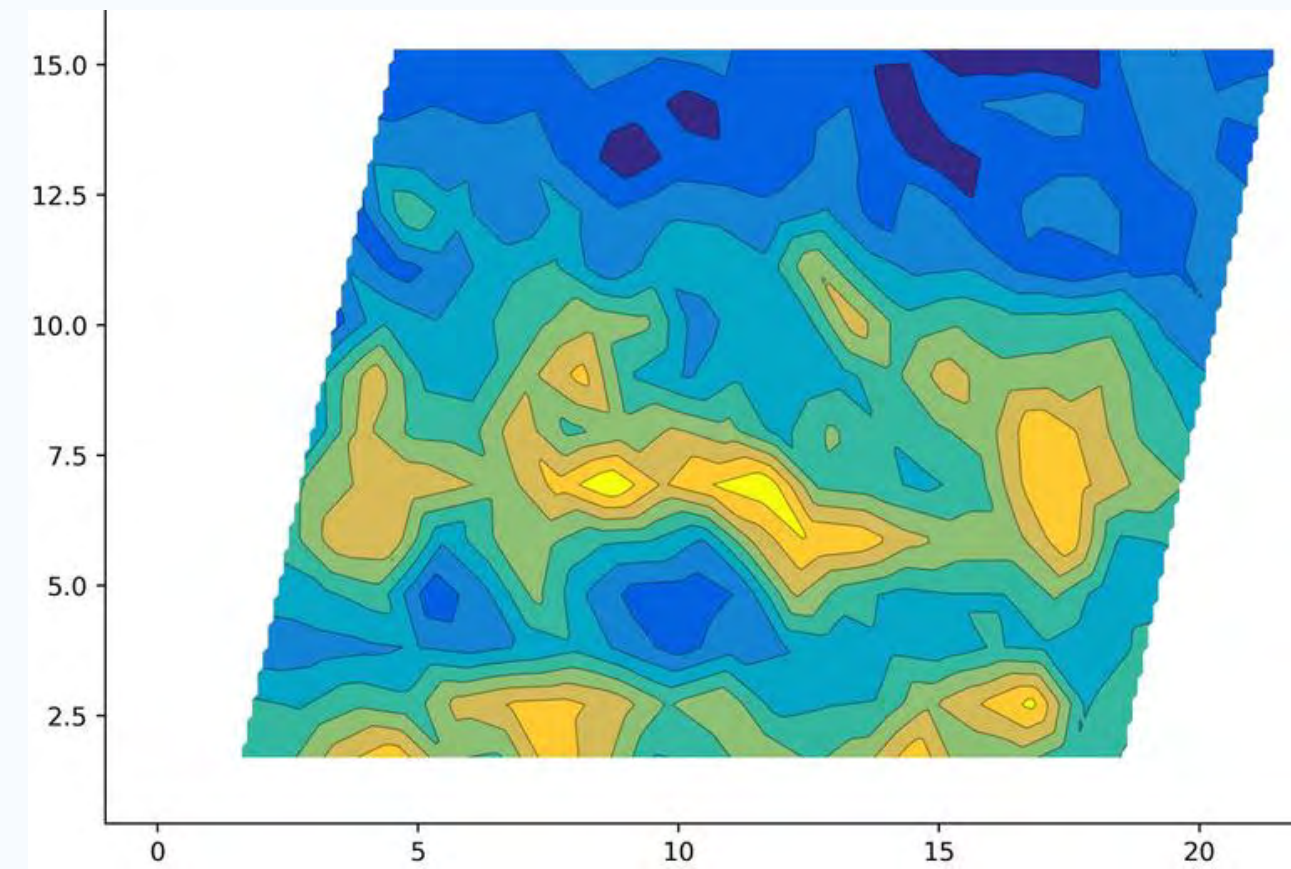
GPR VS HALF CELL POTENTIAL

Efficient and quick data acquisition (4 hours)
Independent of asphalt layer presence



2024 GPR
study

2014 Initial half-cell potential measurement:
Removal of the asphalt and weaterproofing
Temporary asphalt since 2014 without any waterproofing



2014 half-cell potential
study

CONCLUSION

Key takeaways

Structured workflow allows swift and accurate data collection
Data processing with BDGpY allow **multi-layer analysis**.
Maps allow a global vision of the structure, targeted probing,
and statistics.

Bridgology delivers actionable insights to optimize
inspection campaigns and support long-term asset
management.



THANK YOU

FOR YOUR ATTENTION
AND PARTICIPATION



CONTACT INFORMATION:



+41 79 297 40 54



ak@bridgology.com



www.bridgology.com



Le Grand-Chemin 73
Epalinges 1066 Switzerland



We design and build robots to inspect and maintain critical infrastructure



Agenda:

- Company overview
- An overview of the technology
- Description of the trials conducted as part of the Structures' Moonshot project
- Presentation of key results
- Development of the technology since the trials

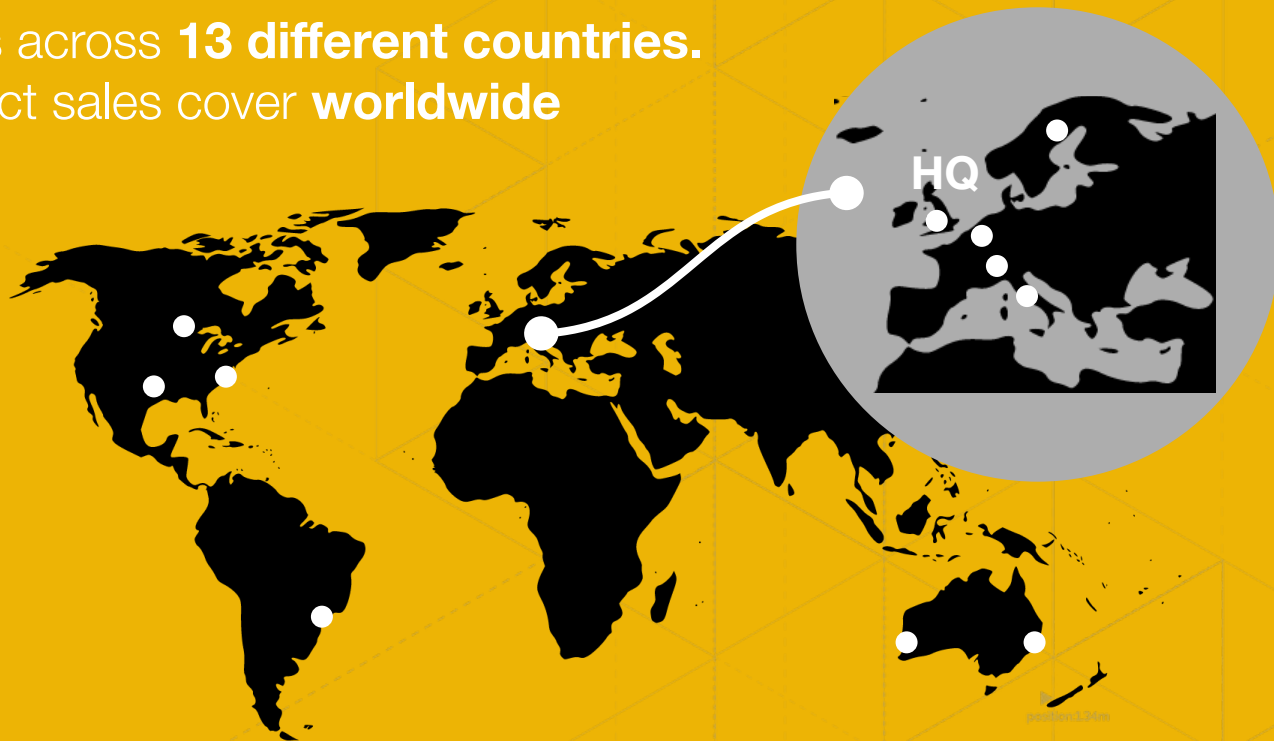




- Founded in **2016**. Close on a **decade** of robotic deployment experience.
- Patented technology from university research
- **Team of 10** including aerodynamics and mechatronics experts with **deep understanding** of aerodynamic downforce
- **6 years** of intense and unique technology development, available on the market from 2022
- Based in UK, operating globally
- Deployed on **+60 projects**
- **6 robots** and crawlers in house fleet
- **8 robots** and crawlers deployed with customers
- New product launch - September

60+ successful projects across **13 different countries.**
Our services and product sales cover **worldwide** operations

- HQ in UK
- Brazil
- United States
- Germany
- Australia
- Canada
- Netherlands
- Sweden
- Italy
- Singapore





Technology Overview



AEROGRIP™

TECHNOLOGY



What is AEROGRIP™



- **Hybrid airflow and suction**

High airflow, with the downforce benefits of low pressure designed and built to drone standards with redundancy, back-up and flight control systems

- **Semi - rigid airflow guiding skirt**

Provides up to **150% extra downforce**, without the need for a total vacuum seal

- **Turbulence enhancing surface geometry**

Provides up to **90% extra** downforce

- **NDT**

With a constant connection to the surface, the HB2 can carry up to **6 kg** of payload for NDT equipment. Drones often limited to 'spot checking'



- **Regulations**

Crawler robots do not fall under expensive and complex CAA, EASA or FAA regulations

- **Stability**

The HB2 can operate in many weather conditions including rain and up to **45 mph** wind. And provide steady constant data in confined spaces



Platform modularity



HB2

Negatives:

- Payload of 6kg (4kg at 25m tether)

Benefits:

- Increased maneuverability down to 1.8m surface diameter

Recommended for:

- Remote visual
- UT (A-scan/ B-scan)
- Light payloads on small diameter assets



HB3

Negatives:

- Reduced maneuverability on smaller diameter assets

Benefits:

- Payload of up to **25kg**

Recommended for:

- Corrosion mapping
- Scanning
- Large area coverage



1 robot - many inspections





Disclaimer

I was personally not involved in these trials, and HausBots role is a robotics manufacturer, not experts on NDT sensors or probes. For specific technical information, I can provide high level overview, but would point you towards the probe manufacturer for NDT specifics.





Trials conducted





Camera Specifications

Overview

A 30X zooming pan tilt camera for 360 degree viewing, and integrated lighting system with long and short range high power LEDs

Stills

Sensor Frame Resolution (Megapixels)

2MP

Sensor Type

Sensor Frame Resolution (Megapixels)

Optical Zoom

30X

Video

Maximum Frame Size

1920x1080

Maximum Frame Rate

30fps

Compressed Video Format

H.264

Transmission method

RTSP

Resolution at Max Zoom (lp/mm)

Defect resolution

65 micron (close) 0.6mm at 10m



Sensors Deployed



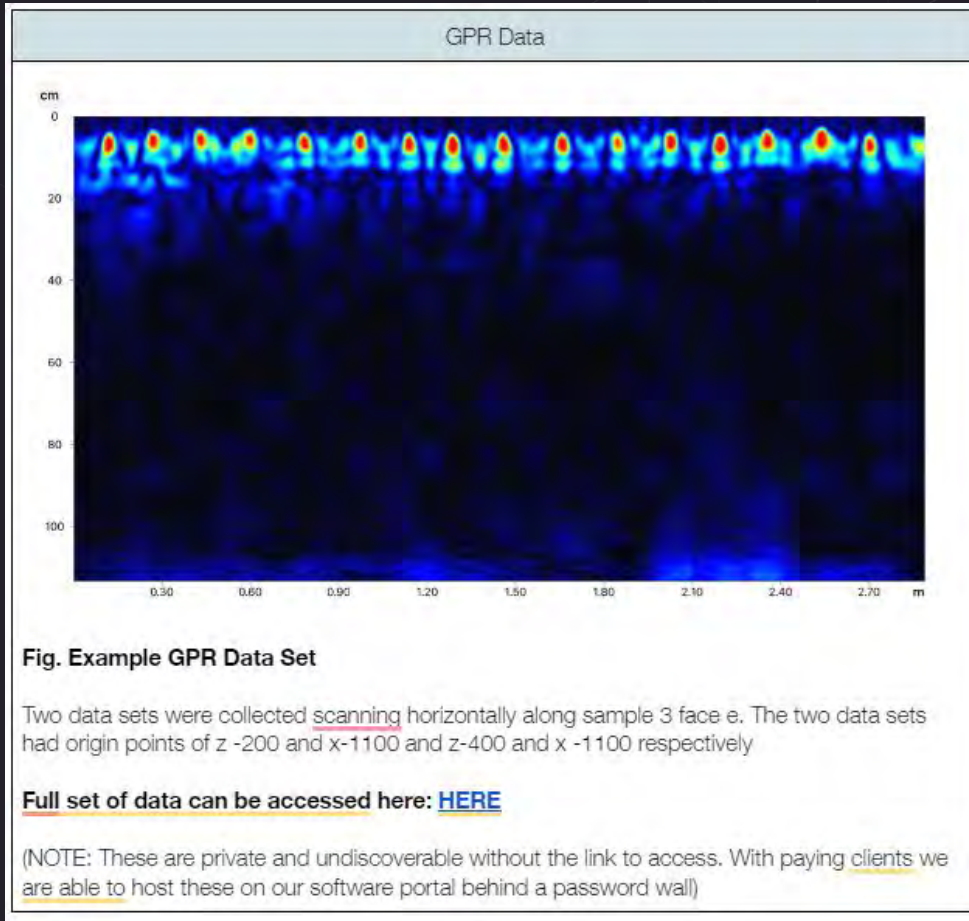
GPR Specifications

Product Name	GP8000
Manufacturer	Proceq
Serial Number	PM08-005-0081
Software Version	4.9.1
Hardware Revision	B0

position:1.34m

color:#281213

position:0.113



▶
position:1.34m

▶
position:0.113



Cover Meter Specifications

Product Name	PM-650 AI
Manufacturer	Proceq
Serial Number	UP01-009-0746

position:1.34m

color:#281213

position:0.113

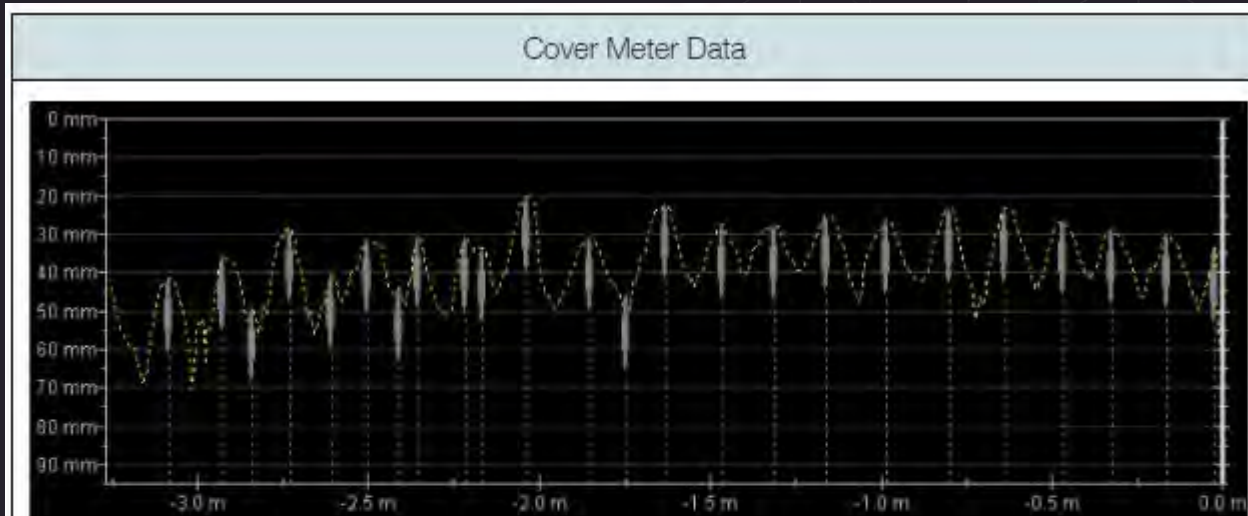


Fig. Example Cover Meter Data Set

Two data sets were collected scanning horizontally along sample 3 face e. The two data sets had origin points of z -200 and x-1300 and z-400 and x -1300 respectively

Full set of data can be accessed here: [HERE](#)

(NOTE: These are private and undiscoverable without the link to access. With paying clients we are able to host these on our software portal behind a password wall)



Half Cell Specifications

Product Name	PM-650 AI
Manufacturer	Proceq
Serial Number	UP01-009-0746

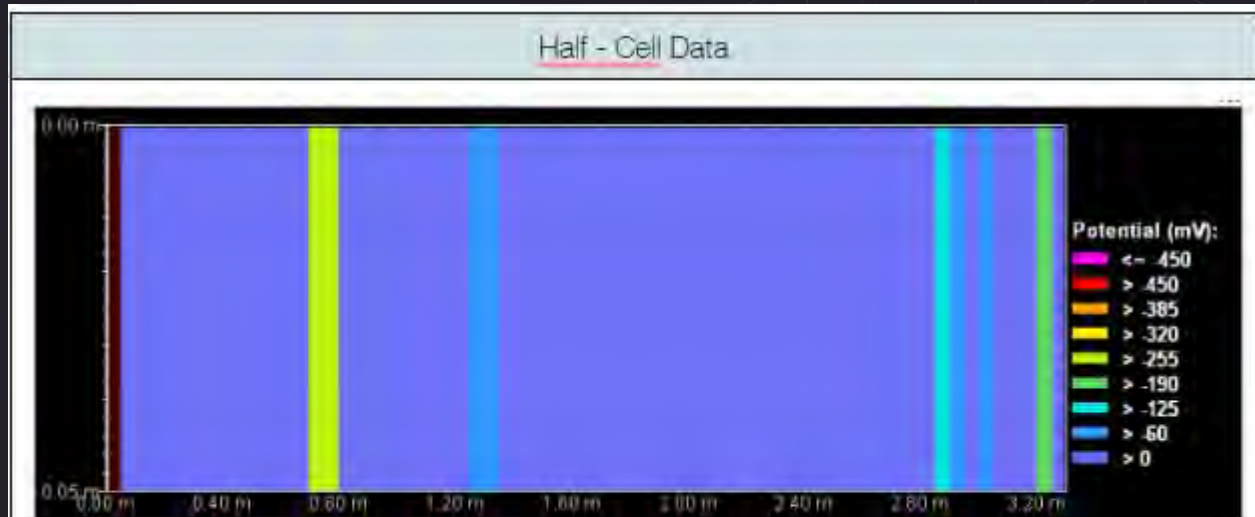


Fig. Example Half Cell Data Set

Two data sets were collected scanning horizontally along sample 3 face e. The two data sets had origin points of z -200 and x -1100 and z -400 and x -1100 respectively

Full set of data can be accessed here: [HERE](#)

(NOTE: These are private and undiscoverable without the link to access. With paying clients we are able to host these on our software portal behind a password wall)

position:134m

position:0.113



Key results



1. **Robot can climb with stability on a variety of surfaces.**

2. **Robot can climb inverted**

This capability was successfully demonstrated on sample 3 face F

3. **Robot can demonstrate control and stability with mounted NDT sensors**

This capability was successfully demonstrated

4. **Data collected is presented in acceptable format with location of data capture recorded**

This capability was successfully demonstrated





Development since trials

- New robotic platforms launched (HB2 and HB3)
- New sensor integrations (Ultrasonic tomography + more)
- Robotic deployed concrete NDT has become business as usual in many industries worldwide thanks to HausBots



Case study - Power

- **What?**

Concrete integrity **Services** provided using MIRA and GPR

- **Who?**

EDF

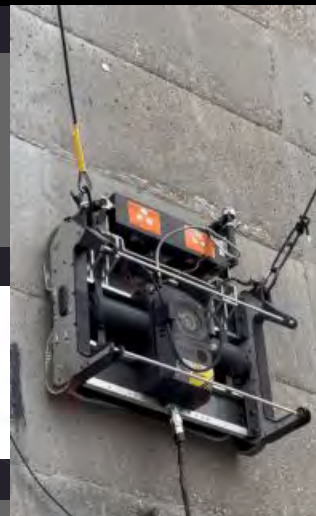


- **Financial benefits and ROI**

Collected 250m of GPR line scans and 70 MIRA B-scans in 2 days. Estimated scaffolding saving: **£60,000**

No humans left the ground to undertake this inspection, enhancing site safety.

Estimated time saving: **2 weeks** vs traditional speed.



Case study - Cement

- **What?**

Concrete integrity **Services** provided using half-cell potential and cover meter ferrous scanning

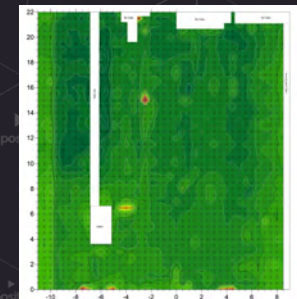
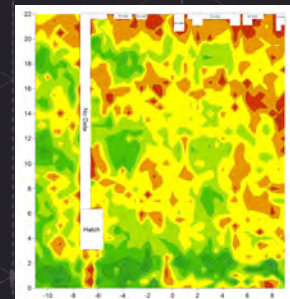
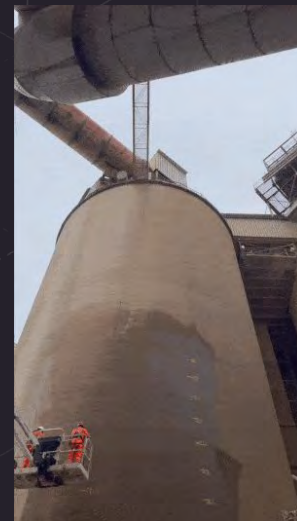
- **Who?**

Tarmac (CRH) cement manufacturer



- **Financial benefits and ROI**

5 days per silo using the robot, 20 days traditional. Minimal site disruption using robotics compared to scaffolding, cherry pickers etc. Using HausBots the main plant road stayed open, which transports **£500,000** of product per day. Scaffolding or cherry pickers would close the road Quotation of **£100,000** for scaffolding of 1 silo.



Case study - Transport



USA Federal Highway Authority - One of many business as usual deployments on FHWA structures



Case study - Transport



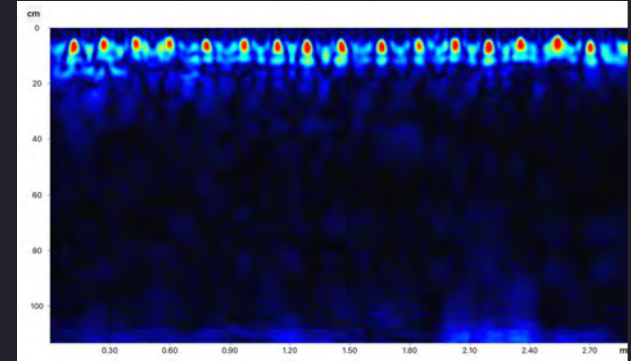
Case Study

Amey

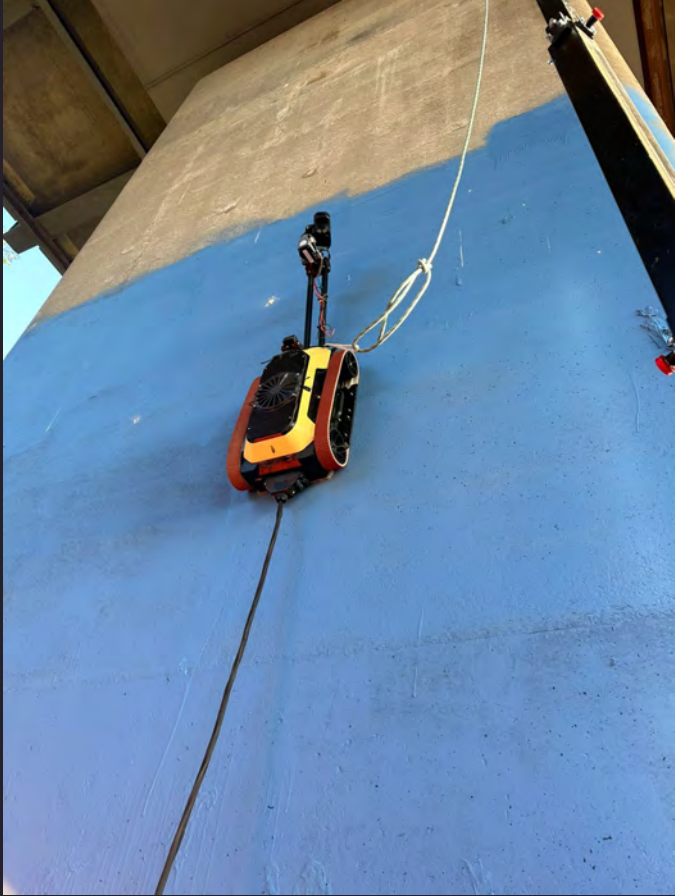
haus
bots

Avonmouth Crossing

- GPR Inspection
- Trial project



Bearing inspection



Bearing inspection



Appendix



▶
position:1.34m

▶
door #281221

▶
position:0.113

Other Benefits

Health and Safety

The implementation of the HB1 on this project reduced working at height by 90%

Haulage Traffic

The main traffic thoroughfare for the site was not blocked due to the small footprint of the HB1 team. The traditional MEWP would have needed to block the main route and cost the site valuable manufacturing time

C. 100% Asset Inspection Coverage

The HB1 provided the only economically viable option to inspect almost 100% of the asset. Other methods would be too slow or costly. The reliability manager got as much data as possible to make an informed decision, not just spot areas

Wind and Weather

45mph gusting winds were present during this project. The HB1 operated significantly higher than a drone (20mph wind max) or a MEWP (25mph wind max) and got the project completed on time in 5 days.



NDT Trials: Additional Technology Results

Chris Mundell - AtkinsRéalis

June 2025

THE
**STRUCTURES
MOONSHOT**
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS



Toddington Testing Partners

THE
STRUCTURES
MOONSHOT
PROJECT



Visual Inspection

Cover Meter Survey:
Elcometer 331 Cover Meter

Electrical Resistivity:
Proceq Resipod

Half-Cell Potential:
Proceq Profometer Corrosion

Chloride contamination and
carbonation depth



Defect 1



Defect 2



Defect 3



Defect 4



Defect 5



Defect 6

Visual Inspection

Cover Meter Survey:
Elcometer 331 Cover Meter

Electrical Resistivity:
Proceq Resipod

Half-Cell Potential:
Proceq Profometer Corrosion

Chloride contamination and
carbonation depth



	-900	-700	-500	-300	-100	+100	+300	+500	+700	+900
+500	34	29	54	51	37	38	48	52	32	32
+300	60	56	80	38	25	50	36	19	50	34
+100	62	54	48	57	60	64	54	50	43	50
-100	83	0*	54	64	69	65	52	0*	53	48
-300	61	71	70	57	40	0*	36	36	33	34
-500	67	59	60	56	48	46	40	0*	36	40
-700	60	48	46	40	42	38	0*	38	34	60
-900	84	68	62	64	50	56	48	38	35	40

Depth of cover (mm)

Note: * in an
area of spalling.

Visual Inspection

Cover Meter Survey:
Elcometer 331 Cover Meter

Electrical Resistivity:
Proceq Resipod

Half-Cell Potential:
Proceq Profometer Corrosion

Chloride contamination and
carbonation depth



	-900	-700	-500	-300	-100	+100	+300	+500	+700	+900
+500	115	20.2	6.5	19.1	4.2	23.2	15.5	20.2	5.9	33.8
+300	57.4	7.5	58.2	2.0	20.8	19.5	6.1	10.7	11.5	3.1
+100	37.4	43.9	1.1	19.0	31.2	20.2	14.2	13.1	13.4	10.1
-100	10.36	25.2	22.1	7.9	27.2	26.1	26.8	10.1	17.1	25.5
-300	10.36	25.2	22.1	7.9	27.2	26.1	26.8	10.1	17.1	25.5
-500	80.2	32.9	19.3	27.0	39.7	33.4	23.2	12.6	22.2	20.1
-700	19.6	15.2	20.4	24.8	15.6	17.2	11.5	12.9	18.2	7.2
-900	11.6	19.2	10.3	18.9	24.3	2.9	9.7	5.7	18.6	20.2

Resistivity (kΩcm)

Visual Inspection

Cover Meter Survey:
Elcometer 331 Cover Meter

Electrical Resistivity:
Proceq Resipod

Half-Cell Potential:
Proceq Profometer Corrosion

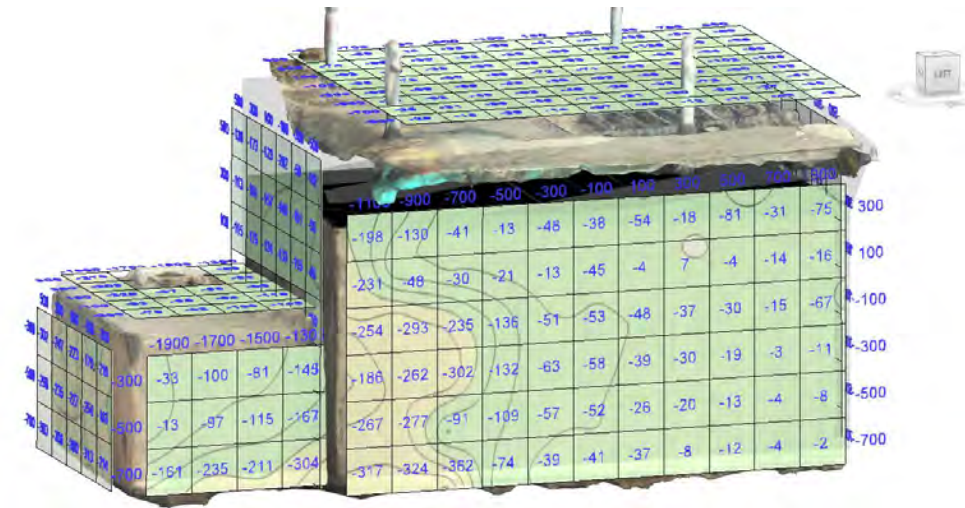
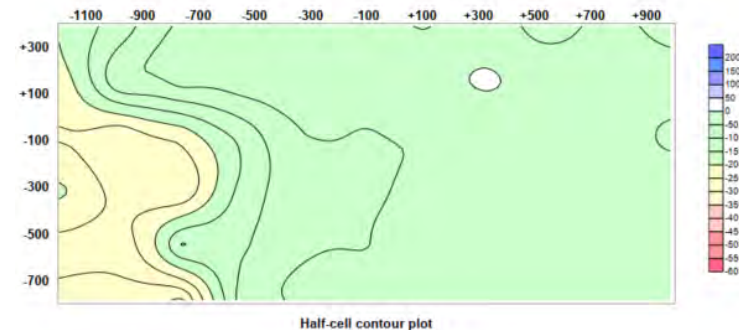
Chloride contamination and
carbonation depth



Sample 1 – Face C
Temperature: 10.7°C

	-1100	-900	-700	-500	-300	-100	+100	+300	+500	+700	+900
+300	-198	-130	-41	-13	-48	-38	-54	-18	-81	-31	-75
+100	-231	-48	-30	-21	-13	-45	-4	7	-4	-14	-16
-100	-254	-293	-235	-136	-51	-53	-48	-37	-30	-15	-67
-300	-186	-262	-302	-132	-63	-58	-39	-30	-19	-3	-11
-500	-267	-277	-91	-109	-57	-52	-26	-20	-13	-4	-8
-700	-317	-324	-362	-74	-39	-41	-37	-8	-12	-4	-2

Half-cell potential (mV)



Visual Inspection

Cover Meter Survey:
Elcometer 331 Cover Meter

Electrical Resistivity:
Proceq Resipod

Half-Cell Potential:
Proceq Profometer Corrosion

Chloride contamination and
carbonation depth

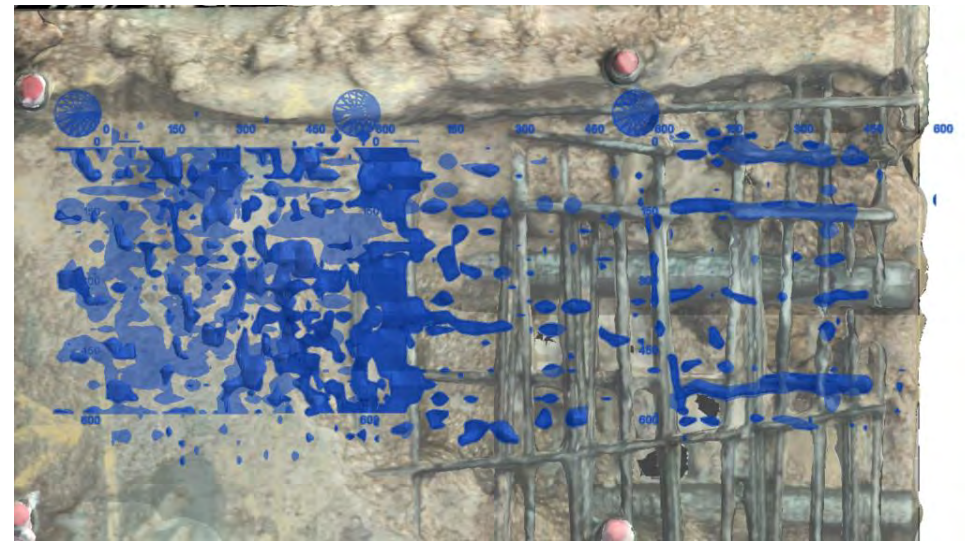
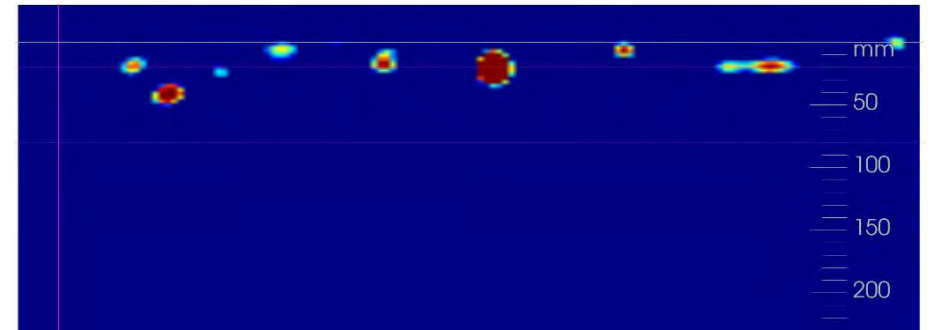


Laboratory testing – Sample 1

Sample Location No.	Sample Location	Sample offset	Depth of carbonation (mm)	Cement content (% by mass of sample)	Chloride ion content (% by mass of cement)		
					Depth from surface of concrete (mm)		
					5-25	25-50	50-75
1	Face A	(+X900 +Y100)	<5	21.4	0.62	0.27	0.16
1	Face C	(-X1100 -Z700)	<5	-	1.97	1.73	1.62
1	Face D	(-Y500 -Z700)	<5	-	1.14	1.08	0.95
1	Face E	100mm crack distance from outer face	<5	-	0.86	0.93	-
1	Face E	200mm crack distance from outer face	<5	-	0.74	0.97	-
1	Face E	300mm crack distance from outer face	<5	-	0.24	0.20	-
1	Face F	(-X1900 +Y500)	<5	-	2.90	2.35	1.89
1	Face G	(-Y100 -Z700)	<5	-	1.19	0.64	0.12
1	Face H	(-X1300 -Z700)	<5	-	1.11	0.88	1.06

A determined cement content as shown were used to calculate the chloride ion content.

Cover Meter Survey:
PS 1000 X-Scan Concrete scanner



Magnetic Flux Leakage



Magnetic Flux Leakage

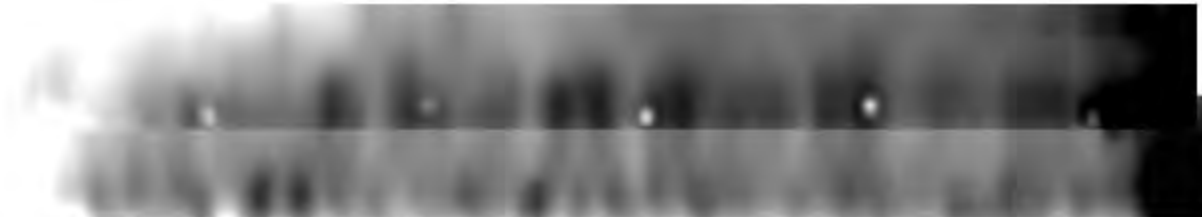


figure 6-1: Combined magnetic picture of the two measuring tracks of face A



figure 6-3: The magnetic picture from figure 6-1 with marking of the position of tendons 1 to 3



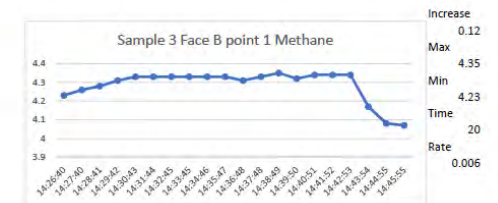
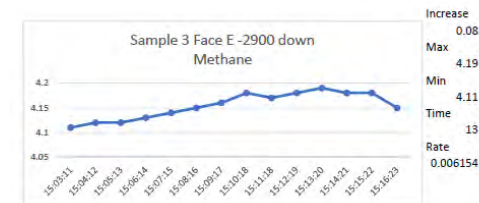
figure 6-5: The magnet picture of face E with the tendons 4 and 7

FTIR Gas Monitoring

Portable Xray Fluorescence (PXRF)

Hyperspectral Imaging

Field & Raman Spectroscopy



FTIR Gas Monitoring

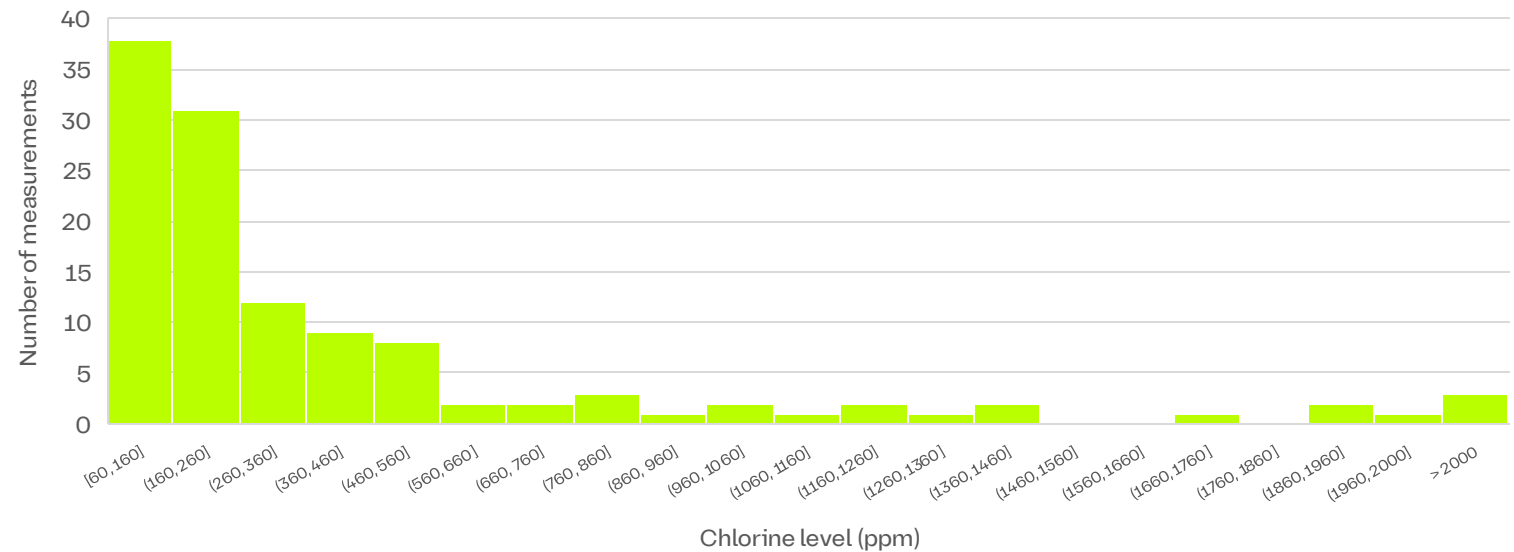
Portable Xray Fluorescence (PXRF)

Hyperspectral Imaging

Field & Raman Spectroscopy



Histogram showing the frequency of chlorine levels across all pXRF samples

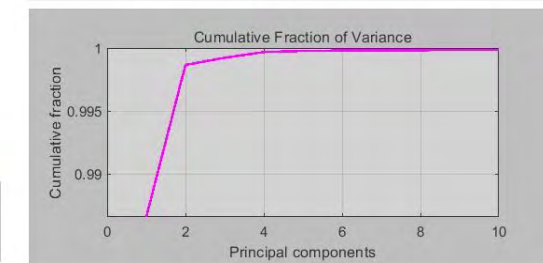
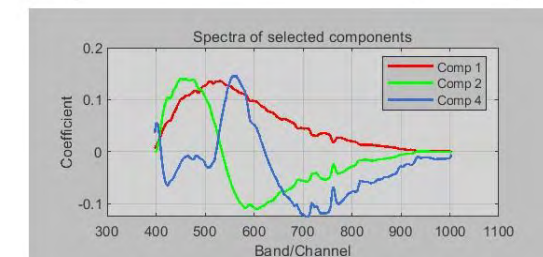
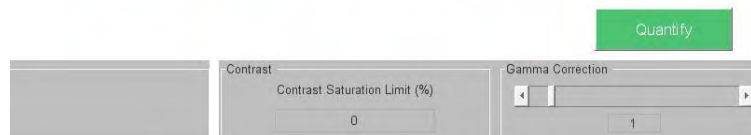
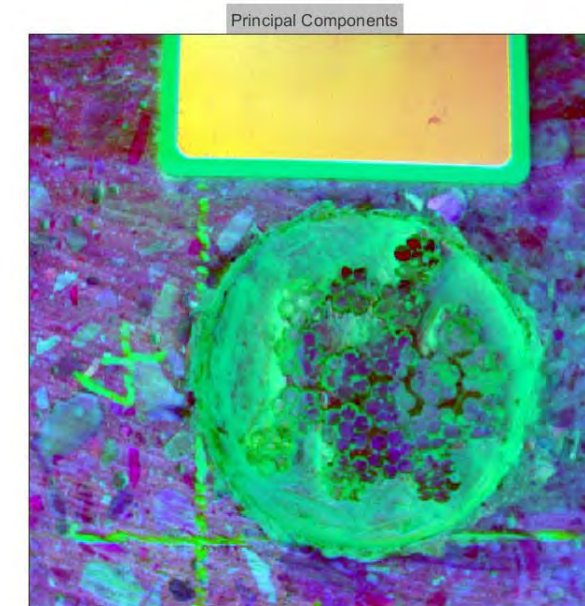
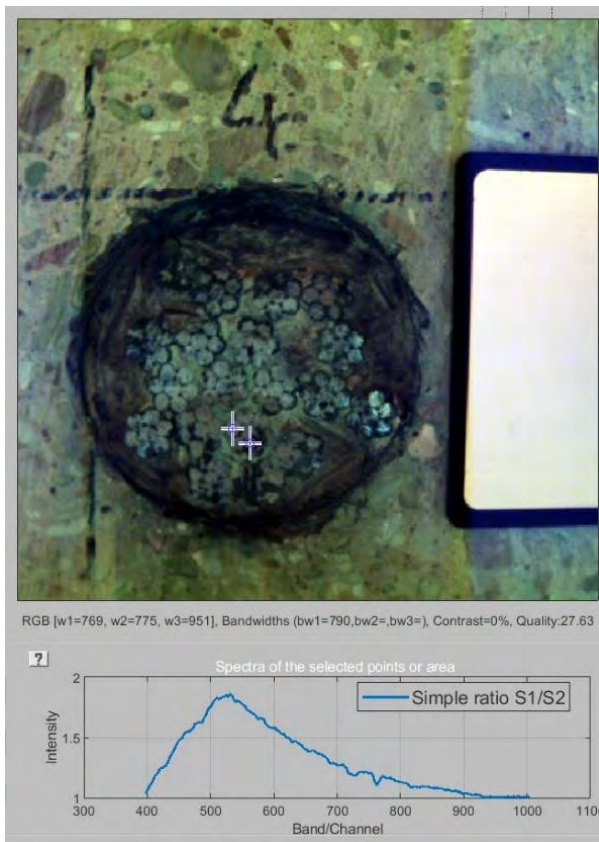


FTIR Gas Monitoring

Portable Xray Fluorescence (PXRF)

Hyperspectral Imaging

Field & Raman Spectroscopy

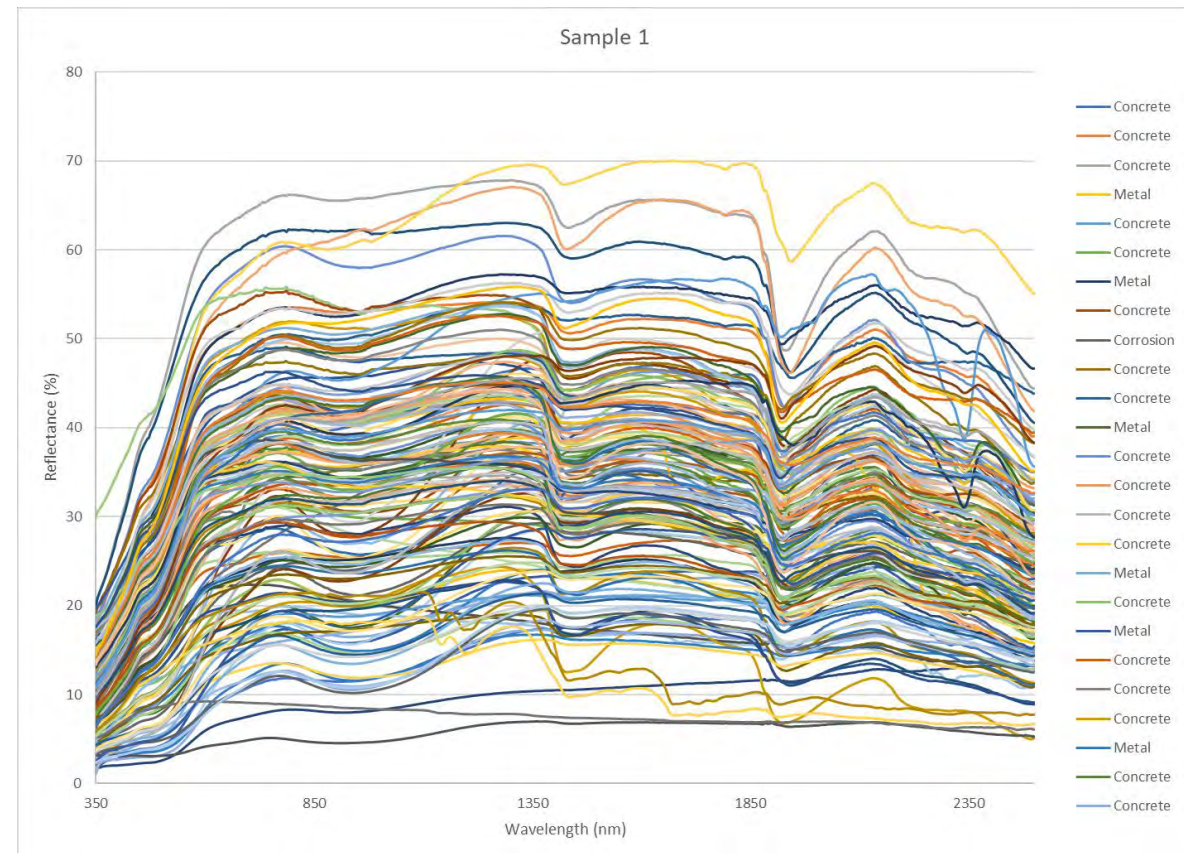


FTIR Gas Monitoring

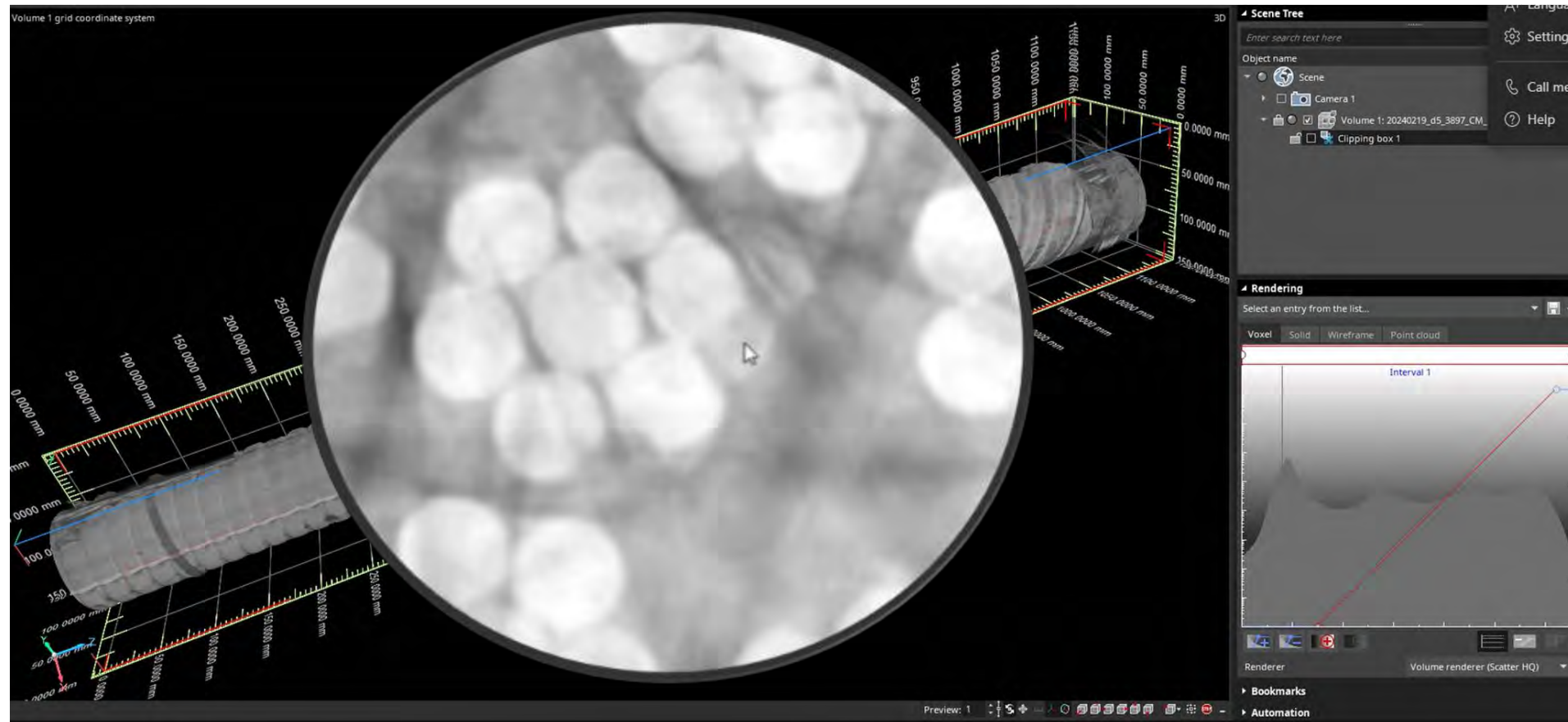
Portable Xray Fluorescence (PXRF)

Hyperspectral Imaging

Field & Raman Spectroscopy



X-ray Computed Tomography (XCT)



Subject Matter Experts: Experts in Collaboration!



NDT Trials: Panel Discussion

June 2025

THE
**STRUCTURES
MOONSHOT**
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS



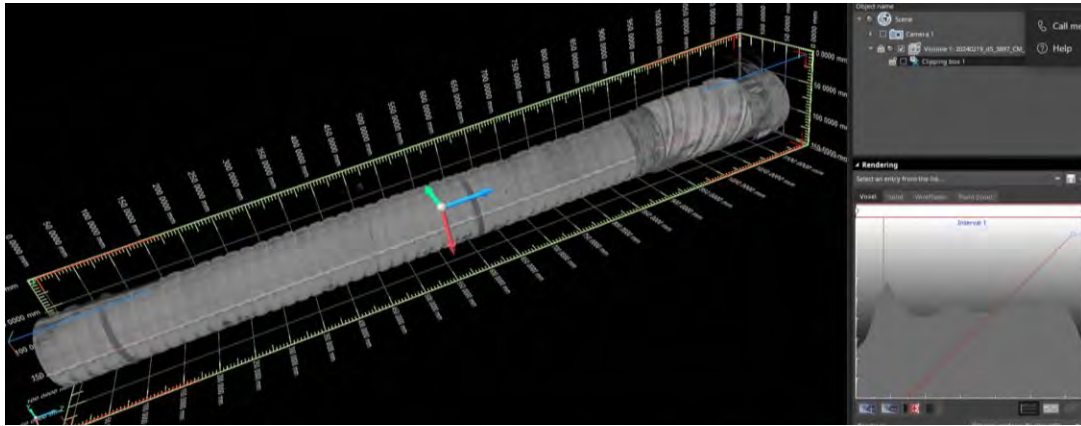


Data Federation & Interpretation Approach

Shams Ghazy - AtkinsRéalis

June 2025

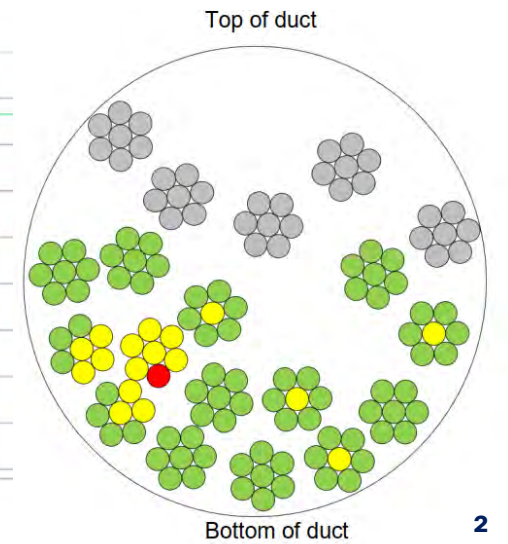
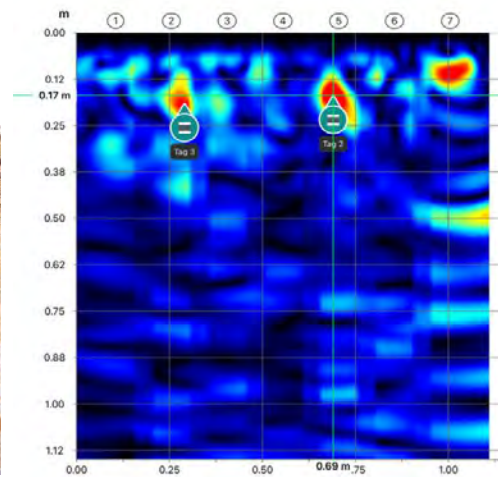
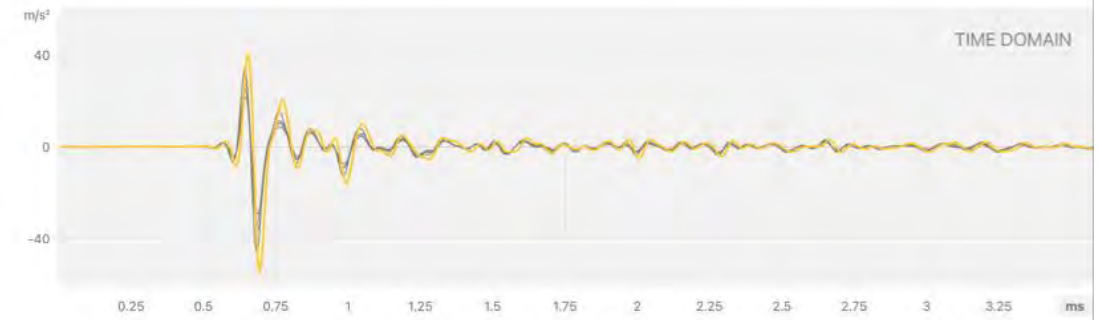
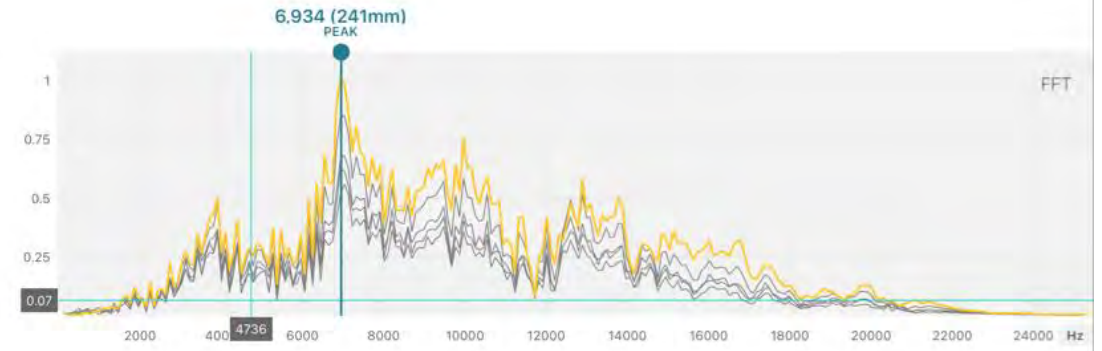
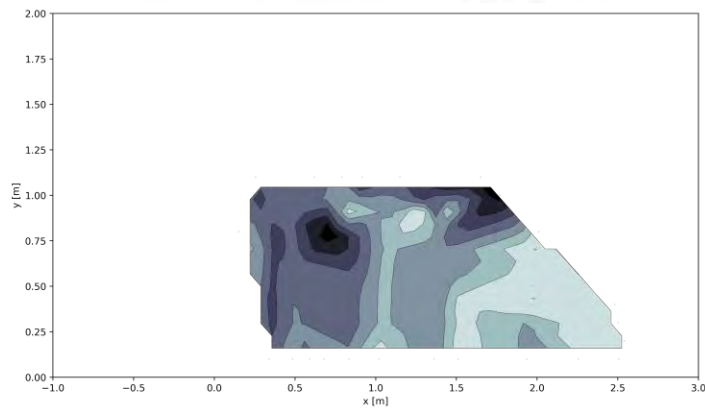
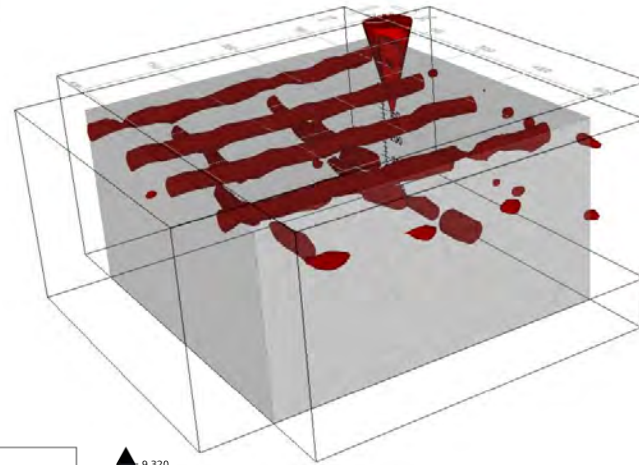


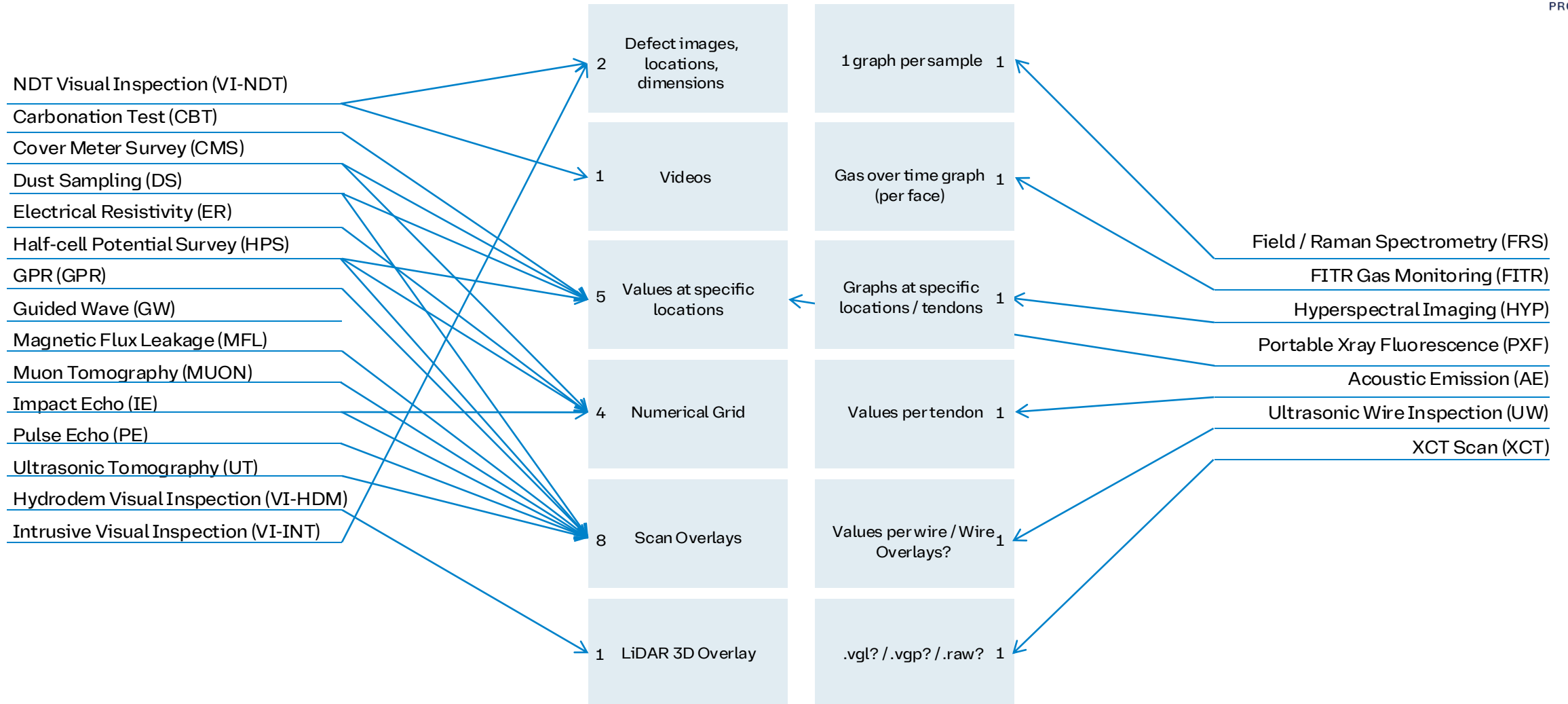


	-900	-700	-500	-300	-100	+100	+300	+500	+700	+900
+500	34	29	54	51	37	38	48	52	32	32
+300	60	56	80	38	25	50	36	19	50	34
+100	62	54	48	57	60	64	54	50	43	50
-100	83	0*	54	64	69	65	52	0*	53	48
-300	61	71	70	57	40	0*	36	36	33	34
-500	67	59	60	56	48	46	40	0*	36	40
-700	60	48	46	40	42	38	0*	38	34	60
-900	84	68	62	64	50	56	48	38	35	40

Depth of cover (mm)

Note: * in an area of spalling.



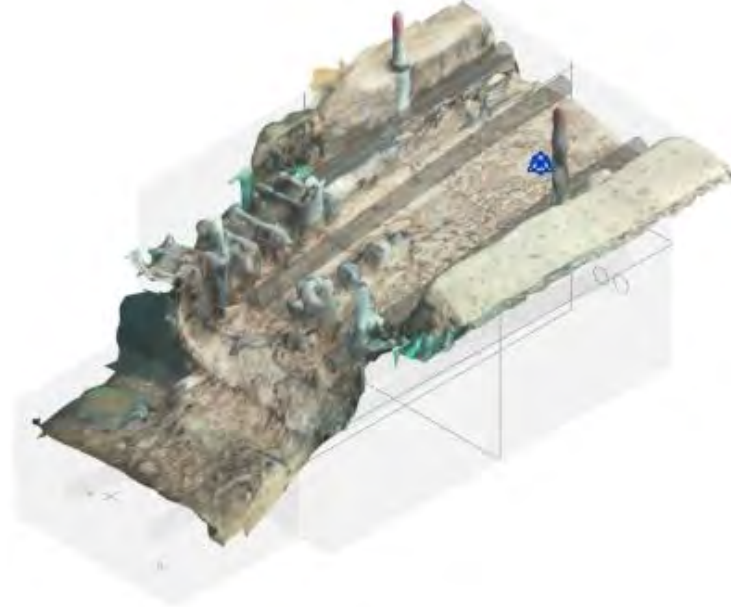


Hydrodemolition LiDAR Scans

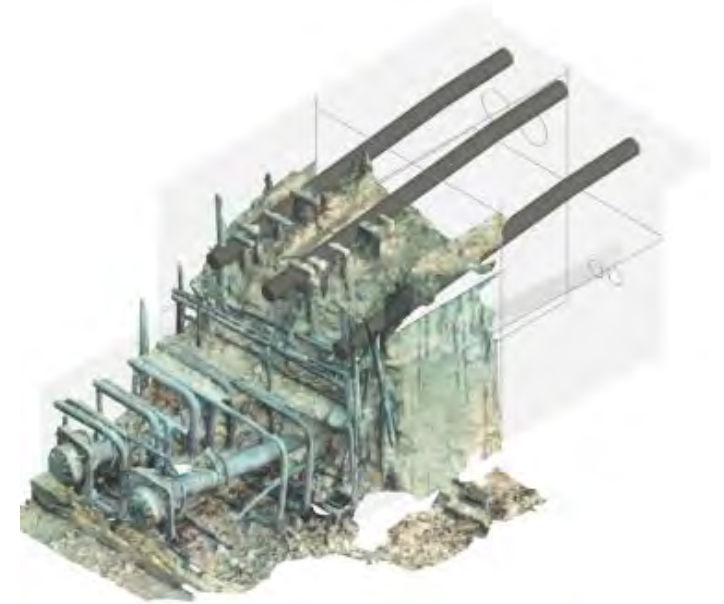
 Polycam



November 22nd



November 27th



November 29th

Intrusive Inspection Results

Ducts



Grout



Tendons



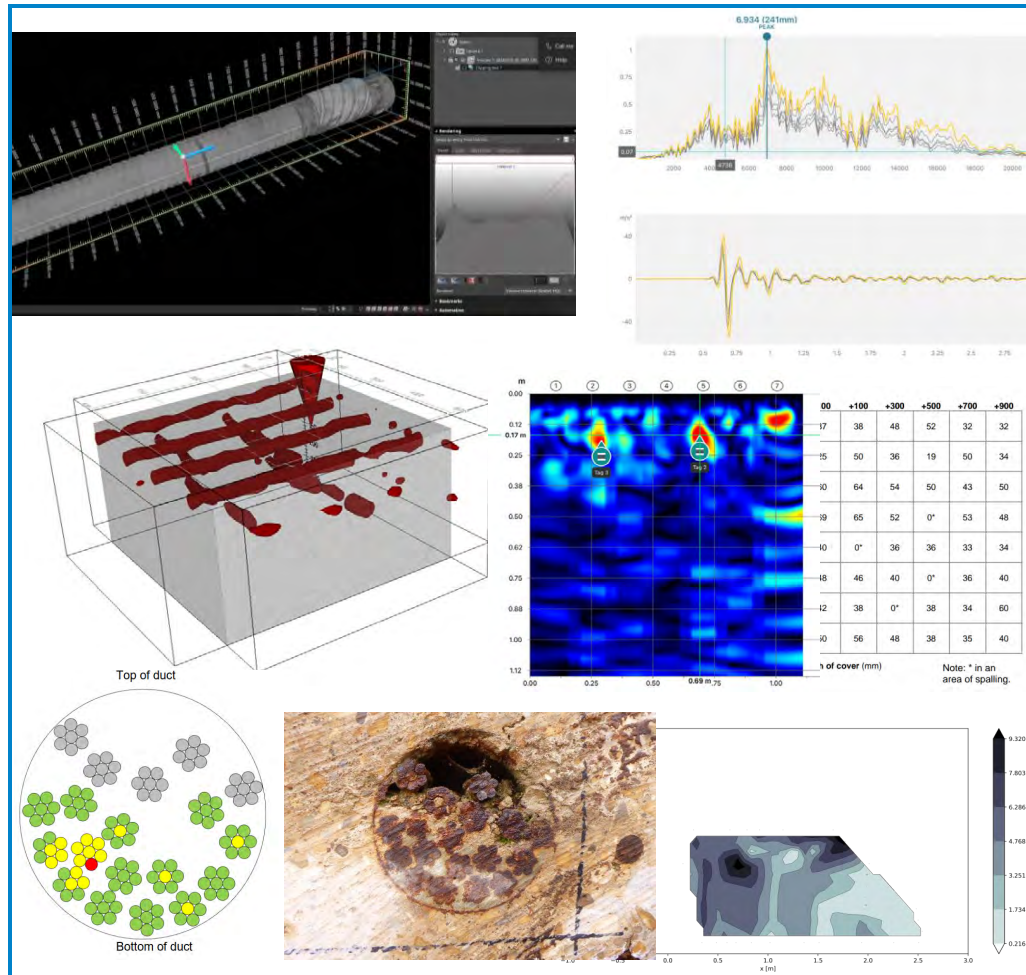
Strands



Intrusive Inspection Results

Structures Moonshot – Huntington NDT Trials			
Tendon Inspection Proforma			
<i>(This form shall be completed once per duct sample)</i>			
Inspectors	MN / MD		
Date of Test	08 / 04 / 2024		
Tendon Details			
Sample Number	1	Chainage at End 1 (mm)	0
Tendon/Duct Number	3	Chainage at End 2 (mm)	1700
Duct Length (mm)	1700		
STEP 1: Pre-Opening Inspection			
General Observations			
Duct material already removed. Strands bound with cable ties and appeared to have moved from service position. No 12 o'clock position marked. Chainage marked only on outermost wrapping material. Minimal / remnant grout present between strands. Arc shaped portions missing on several strands, consistent with a core sample being extracted at ~690mm chain position, transverse to the orientation of the strands. Strands appeared generally heavily corroded.			

All strands subject to full unwinding operation. Defective regions itemised as follow:				
Reference Figure	Strand Number	Chainage Chainage (mm)	Approx % Loss of Section	Description
1	1	270 - 400	N/A	0 – 270mm wires missing due to tensile fracture of all wires in strand. Fractures appeared brittle and not attributable to section loss – no additional broken wires in evidence.
		570	0 - 25	Swelling on Strand / Grout forced into interior. No additional broken wires evident when fully unwound although generally corroded.
2	2	580	N/A	Swelling on Strand / Grout forced into interior
		1470	0 - 25	Swelling on Strand / Grout forced into interior – no broken wires in evidence when unwound.
3	3	600	50 - 75	Strand exterior in heavily corroded condition. Significant / major section loss on outermost wires at 600mm chainage.
		1010	N/A	Tensile break in king wire at 1010mm chainage.
4	4	140	N/A	Crack in outer wire – wire appeared to be in buckled condition.
		300	0 - 25	Section loss on all outermost wires evident when unwound. No breaks in king wire.
5	5	N/A	0 – 25	Wires generally very corroded but no major sectional loss. No breaks in king wire.
6	6	N/A	0 - 25	Wires generally very corroded but no major sectional loss. No breaks in king wire.
7	7	670	0 - 25	Wires severed by coring operation at ~670mm chainage. Wires generally corroded but no major loss of section

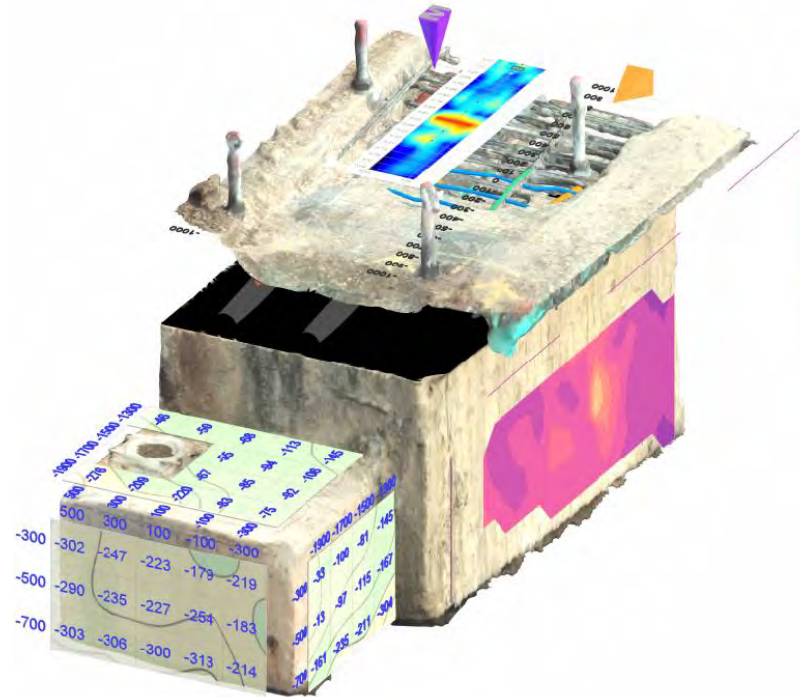


Non-Destructive
Testing Results



Actual defects recorded
during hydrodemolition and
intrusive inspection

Non-Destructive
Testing Results

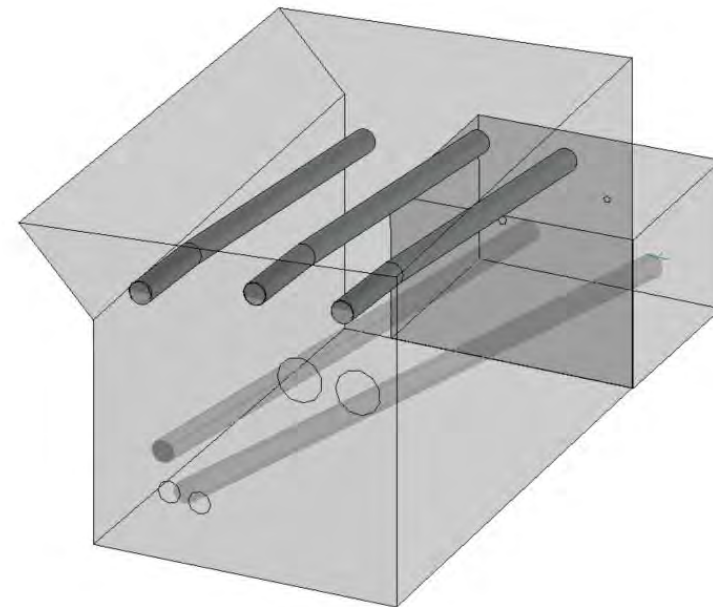


Actual defects recorded
during hydrodemolition and
intrusive inspection

Data federation solution requirements

Requirements

3D Representation of Each
Sample

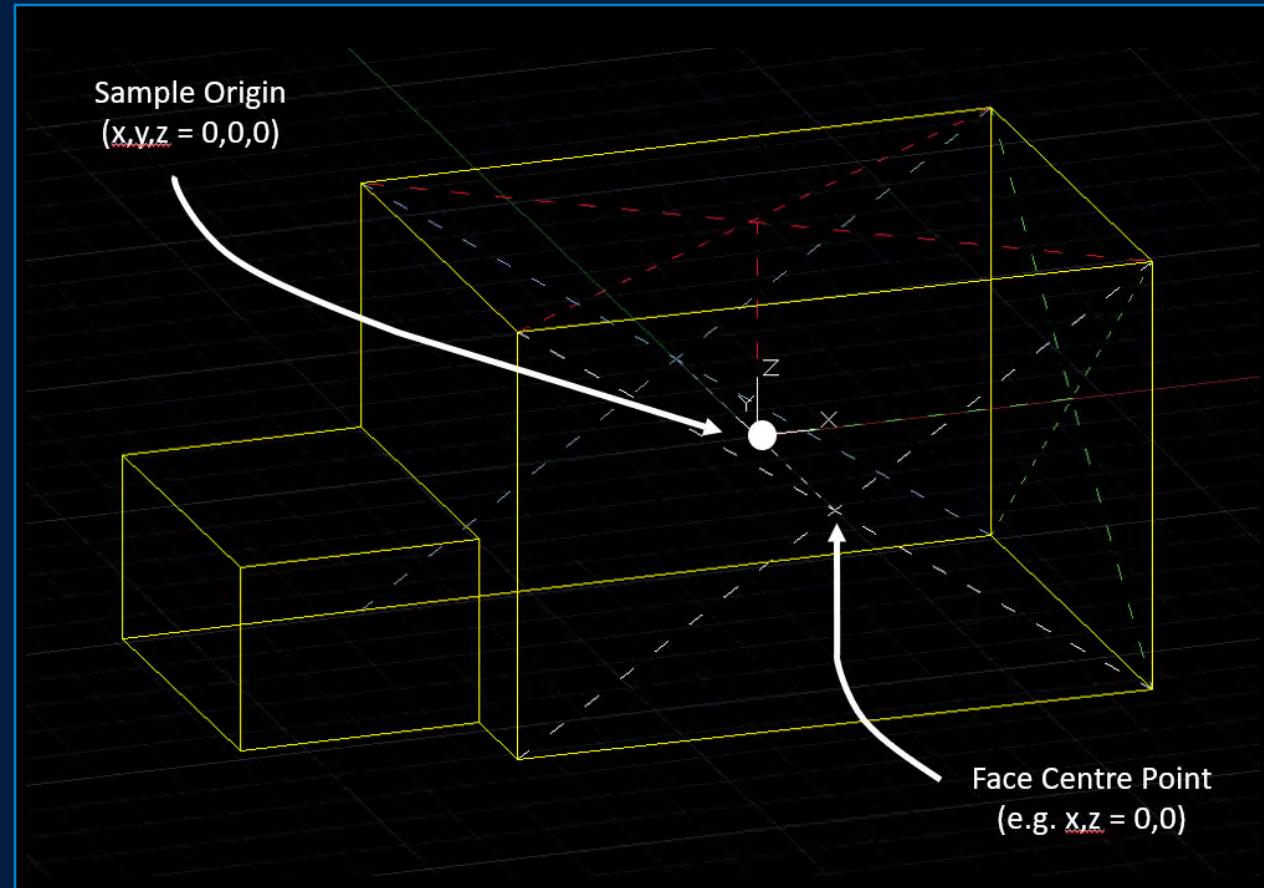


Data federation solution requirements

Requirements

3D Representation of Each
Sample

Coordinate System
Integration



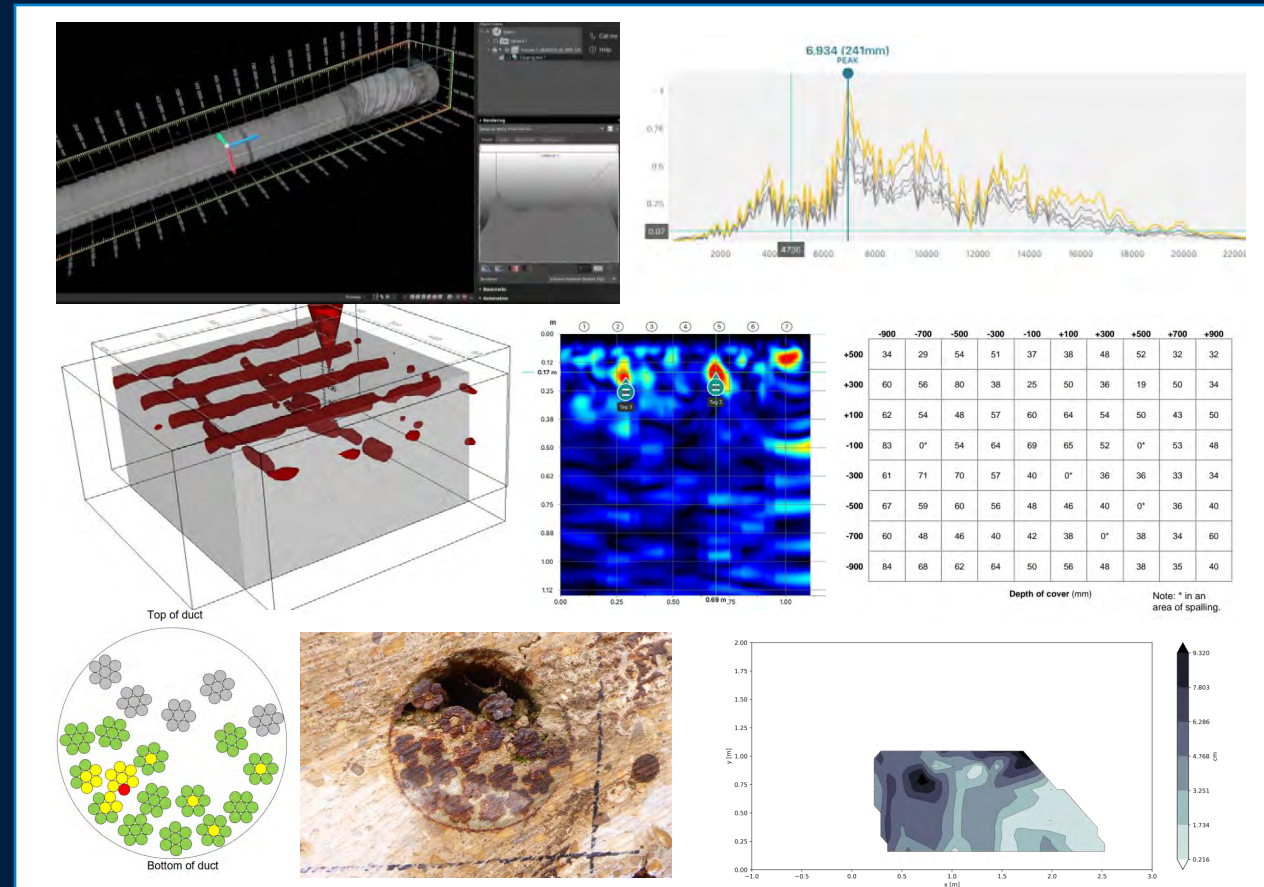
Data federation solution requirements

Requirements

3D Representation of Each
Sample

Coordinate System
Integration

Flexible Data Import
Capabilities



Data federation solution requirements

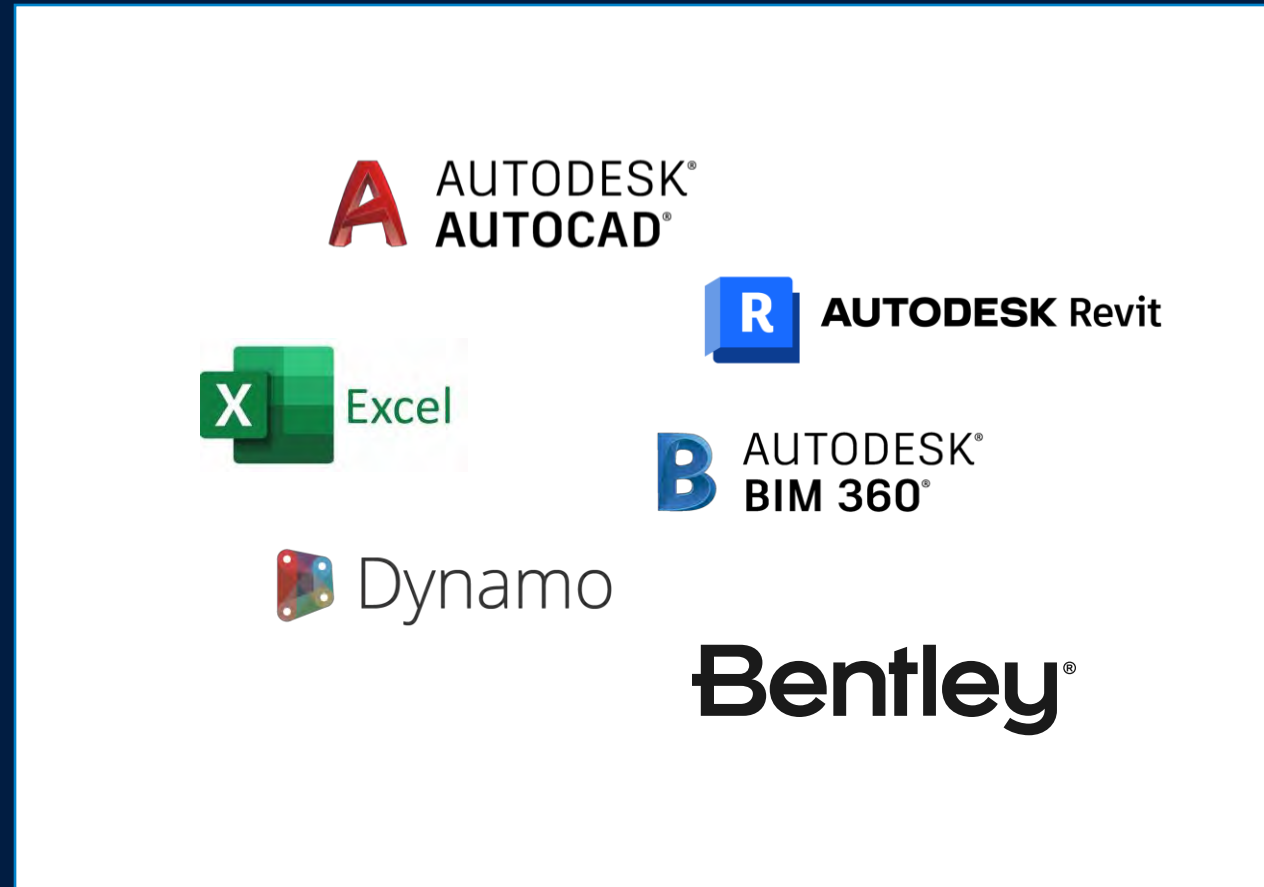
Requirements

3D Representation of Each
Sample

Coordinate System
Integration

Flexible Data Import
Capabilities

Compatibility with Existing
Expertise



Data federation solution requirements

Requirements

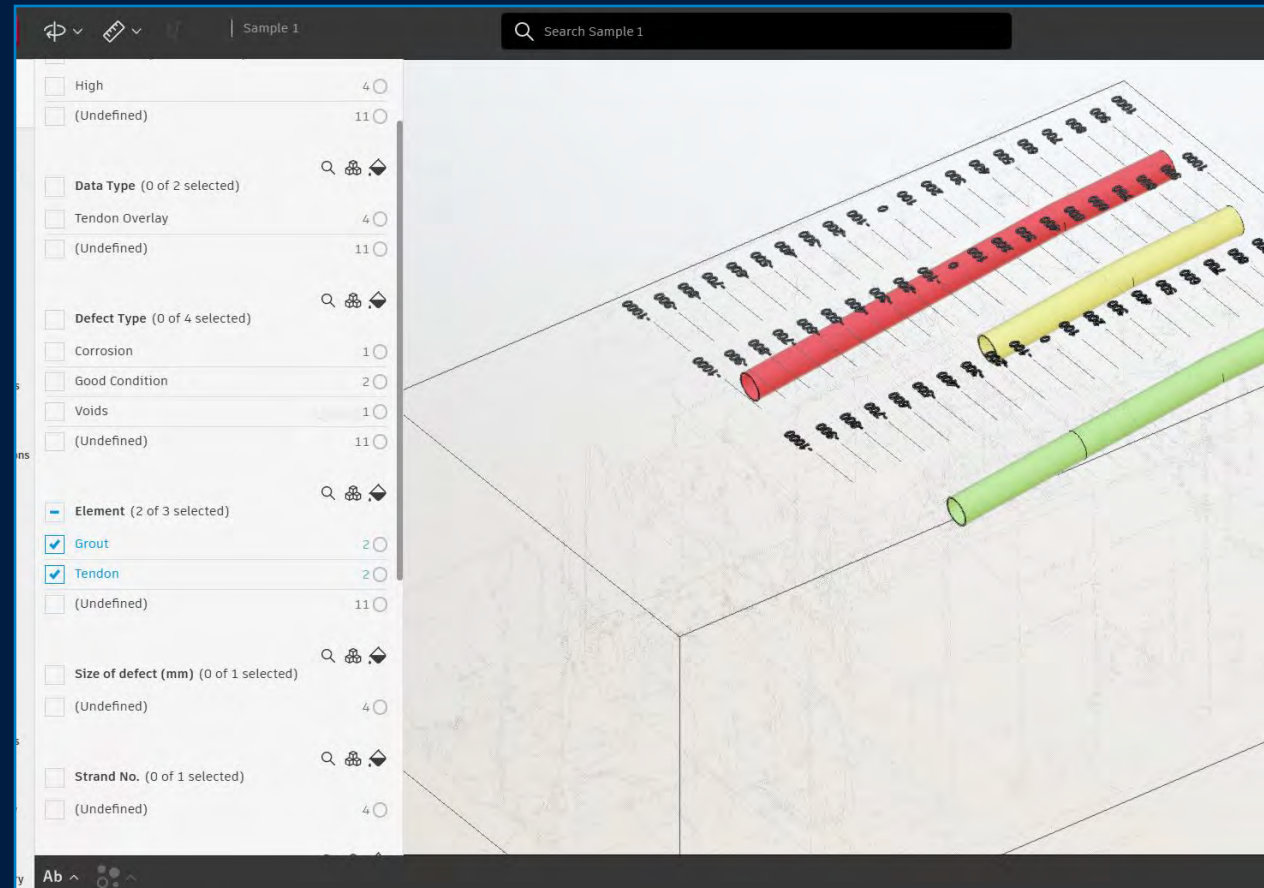
3D Representation of Each
Sample

Coordinate System
Integration

Flexible Data Import
Capabilities

Compatibility with Existing
Expertise

Data Layering and Toggle
Functionality



Data federation solution requirements

Requirements

3D Representation of Each
Sample

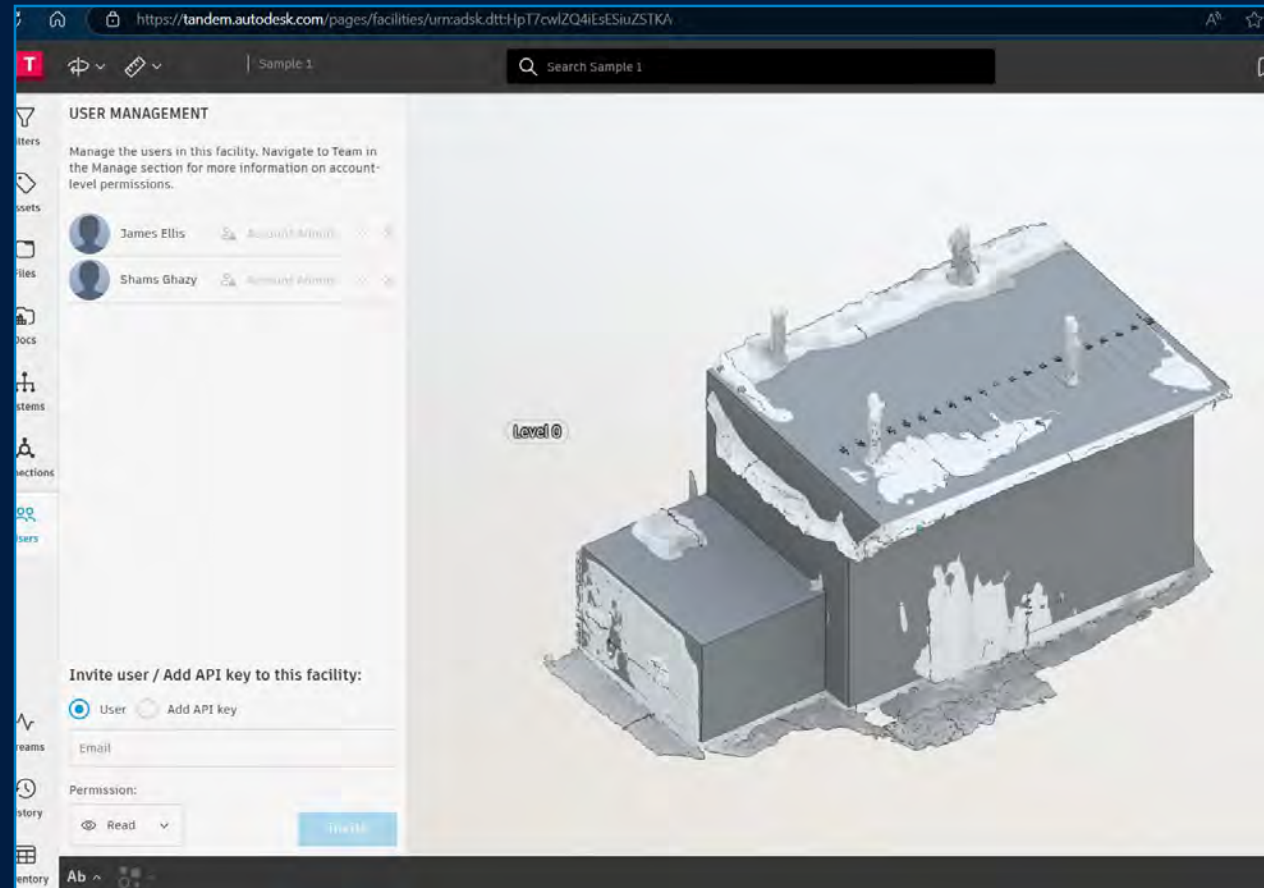
Coordinate System
Integration

Flexible Data Import
Capabilities

Compatibility with Existing
Expertise

Data Layering and Toggle
Functionality

Accessibility



Federation Challenges

- Engagement with **Autodesk and Bentley** revealed it's an industry-wide gap

- Dealing with **large / heavy** datasets of **different formats, orientation, scale, and resolution**.

- Overcoming **software limitations** such as importing texture or overlaying/draping images onto surfaces.

- Suppliers' use of **proprietary software** and lack of availability of an **accessible software** that doesn't require special expertise.

- **Processing each dataset individually** to ensure it is correctly imported with the right orientation and position.

- No appropriate **metadata schema** available so needed to develop a schema to **tag the defects for identification**.

Metadata Schema

	Sample	Zone	Provider	Source	Tool	Element - Type	Confidence
Description	Bridge Sample on which test was conducted	Face or Tendon on which test was conducted	The NDT supplier that conducted the test	The type of NDT method	The specific equipment used for the test	The structural element which the NDT is targeting and the type of measurement it is taking	The supplier's confidence level in the accuracy of the result
Example	Sample 1	Face A	Bridgology	Ground Penetration Radar (GPR)	Proceq GP8000	Concrete - Cover	Medium

Import Workflows

		Data Cleaned and uploaded to BIM360	Pre-Processing	Import into Revit	Revit Processing	Integrated in Digital Twin
Workflow	1	3D DXF		1. Check DXF data within AutoCAD and extrude any lines which need to be solids for easy viewing within Revit.	1. Import DXF file into a Revit family 2. Position DXF files within Revit correctly 3. Position family on model	1. Verify data in digital twin with Supplier
Workflow	2	Image / Video Attachment			1. Locate created family for specific data 2. Position on grid for given co-ordinates 3. Fill out metadata and attach BIM360 link to Image / Video attachment	1. Verify data in digital twin with Supplier
Workflow	3	Image Overlay		1. Work out scaling of image 2. Create black and white silhouette image	1. Create surface for material within family 2. Set up material and apply to surface 3. Position family on model	1. Verify data in digital twin with Supplier
Workflow	4	LiDAR Scan		1. Open .obj file within Autodesk ReCap photo 2. Orientate correctly and export	1. Import .obj file 2. Position using similar location points 3. Update Material name and re-apply	1. Verify data in digital twin with Supplier
Workflow	5	Numerical Grid		1. Organise data in Excel, in order of import for Dynamo script	1. Create numerical grid family, mirroring Excel sheet 2. Run Dynamo script to import data from Excel	1. Verify data in digital twin with Supplier
Workflow	6	Tendon Condition			1. Create extrusion along tendon, using chainage for length and location 2. Add data to family containing extrusion	1. Verify data in digital twin with Supplier
Workflow	7	Values at Specific Locations			1. Locate created family for specific data 2. Position on grid for given co-ordinates 3. Fill out metadata	1. Verify data in digital twin with Supplier
Workflow	8	Point Cloud		1. Check point cloud data within Recap 2. Clean up point cloud if required	1. Attach point cloud file saved from Autodesk ReCap 2. Position point cloud in model	1. Verify data in digital twin with Supplier

Layering Software Solutions

Pros

- Color-coded system
- Clash detection

- Web-Based accessibility
- Ease of use

- Customisability
- Integrated solution

Cons

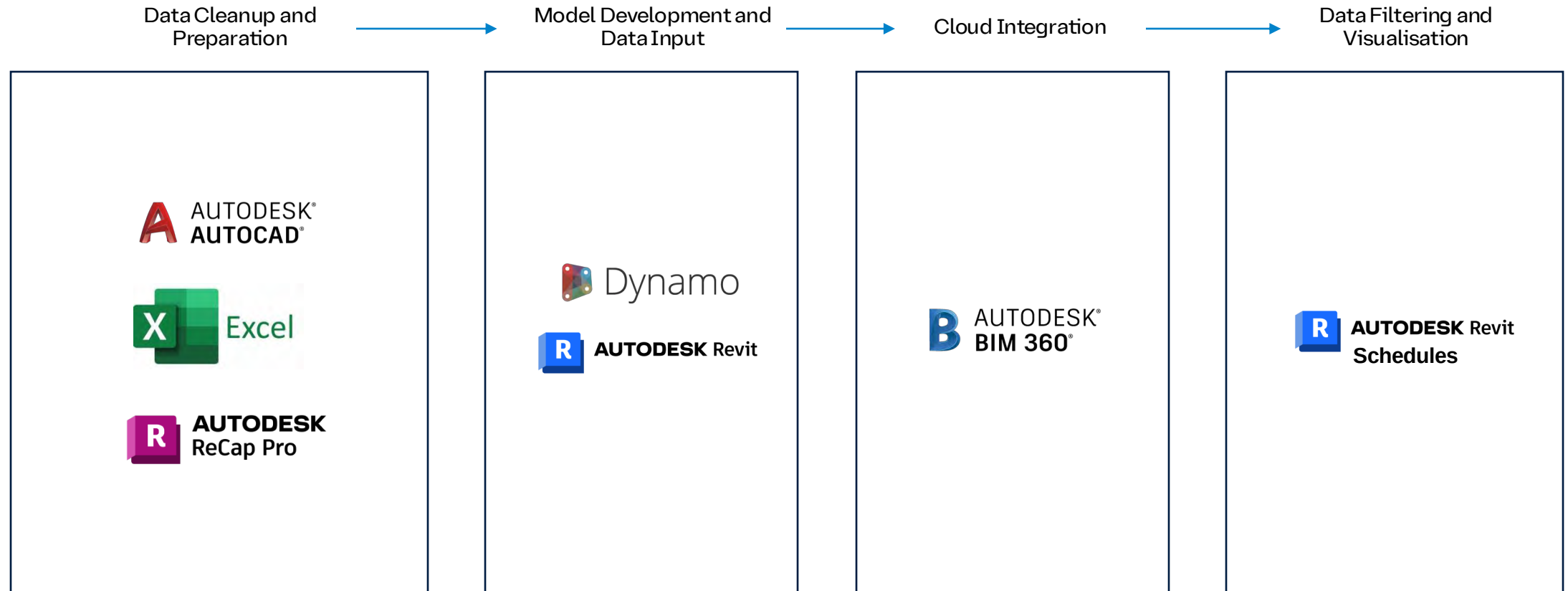
- Limited usability
- Visualisation challenges

- Static data integration issues
- Material loss

- Lack of accessibility



Digital Twin Development



Federated Data Model

File Architecture Structure Steel Precast Systems Insert Annotate Analyze Massing & Site Collaborate View Manage Add-Ins BIM Track® Modify Modify Schedule/Quantities

Properties Defect ID Format Unit Calculated Combine Parameters Insert Delete Resize Hide Unhide All Insert Data Row Merge Unmerge Image Clear Group Ungroup Freeze Shading Borders Reset Font Align Horizontal Align Vertical Highlight in Model Split & Place

Properties Parameters Columns Rows Titles & Headers Appearance Element Split

Modify Schedule/Quantities

Project Browser - Sample1_All_Scans_R2 - SH

- Views (all)
- Floor Plans
 - Level 0
 - Level 1
 - Site
- Ceiling Plans
- 3D Views
 - 1.00
 - 1.04
 - 1.06
 - 1.10
 - 1.11
 - 1.14
 - 1.19
 - 1.22
 - 1.24
- Model Only
- Elevations (12mm Circle)
 - East
 - North
 - South
 - West
- Sections (Building Section)
 - Section 1
 - Section 2
 - Section 3
- Drafting Views (Detail)
- Legends
- Schedules/Quantities (all)
 - Structures Moonshot Data Schedule
 - View List
- Sheets (all)
 - A100 - Unnamed
- Families
 - Analytical Links
 - Annotation Symbols
 - Bridge Cables
 - Cable Trays
 - Casework
 - Ceilings
 - Conduits
 - Curtain Panels
 - Curtain Systems
 - Curtain Wall Mullions
 - Detail Items

Structures Moonshot Data Sched...

<Structures Moonshot Data Schedule>

A	B	C	D	E	F	G	H	I	J	K
Defect ID	Zone	Provider	Source Survey	Tool	Element	Defect Type	Confidence	Data Type	Scan Visibility	Image on BIM360
S1_T2_MTS_UW_MUT_T#1_H_01	Tendon 2	Mistras	Ultrasonic Wire Inspe	MISTRAS Tablet UT	Tendon	Corrosion	High	Tendon Overlay	☐	
S1_T3_MTS_UW_MUT_T#4_H_01	Tendon 3	Mistras	Ultrasonic Wire Inspe	MISTRAS Tablet UT	Tendon	Good Condition	High	Tendon Overlay	☐	
S1_FA_SE_PE_PPD_G#1_H_01	Face A	Screening Eagle	Pulse Echo	Proseq PD8052	Grout	Voids	High	Image Attachment	☐	https://docs.b36
S1_FA_SE_PE_PPD_G#1_H_01	Face A	Screening Eagle	Pulse Echo	Proseq PD8052	Grout	Voids	High	Image Overlay	☒	
S1_FA_CTS_VI-NDT_NA_C#4_H_02	Face A	CTS	NDT Visual Inspection	N/A	Concrete	Other	High	Image Attachment	☐	https://docs.b36
S1_FA_CTS_VI-NDT_NA_C#4_H_01	Face A	CTS	NDT Visual Inspection	N/A	Concrete	Other	High	Image Attachment	☐	https://docs.b36
S1_FB_CTS_VI-NDT_NA_C#1_H_01	Face B	CTS	NDT Visual Inspection	N/A	Concrete	Cracking	High	Image Attachment	☐	https://docs.b36
S1_FB_CTS_VI-NDT_NA_G#1_H_01	Face B	CTS	NDT Visual Inspection	N/A	Grout	Voids	High	Image Attachment	☒	https://docs.b36

1.00 1.04 1.06 1.10 1.11 1.14 1.19 1.22 1.24

Properties

Schedule

Schedule: Structures Moonshot | Edit Type

Identity Data

View Template <None>

View Name Structures Moonshot ...

Dependency Independent

Phasing

Phase Filter Show All

Phase New Construction

IFC Parameters

Export to IFC By Type

Data

Defect ID

Zone

Provider

Source Survey

Tool

Element

Defect Type

Confidence

Image on BIM360 - 1

X coordinate -300.000000

Y coordinate

Z coordinate

Sample No

Image on BIM360 - 2

Data Type

Other

Fields Edit...

Filter Edit...

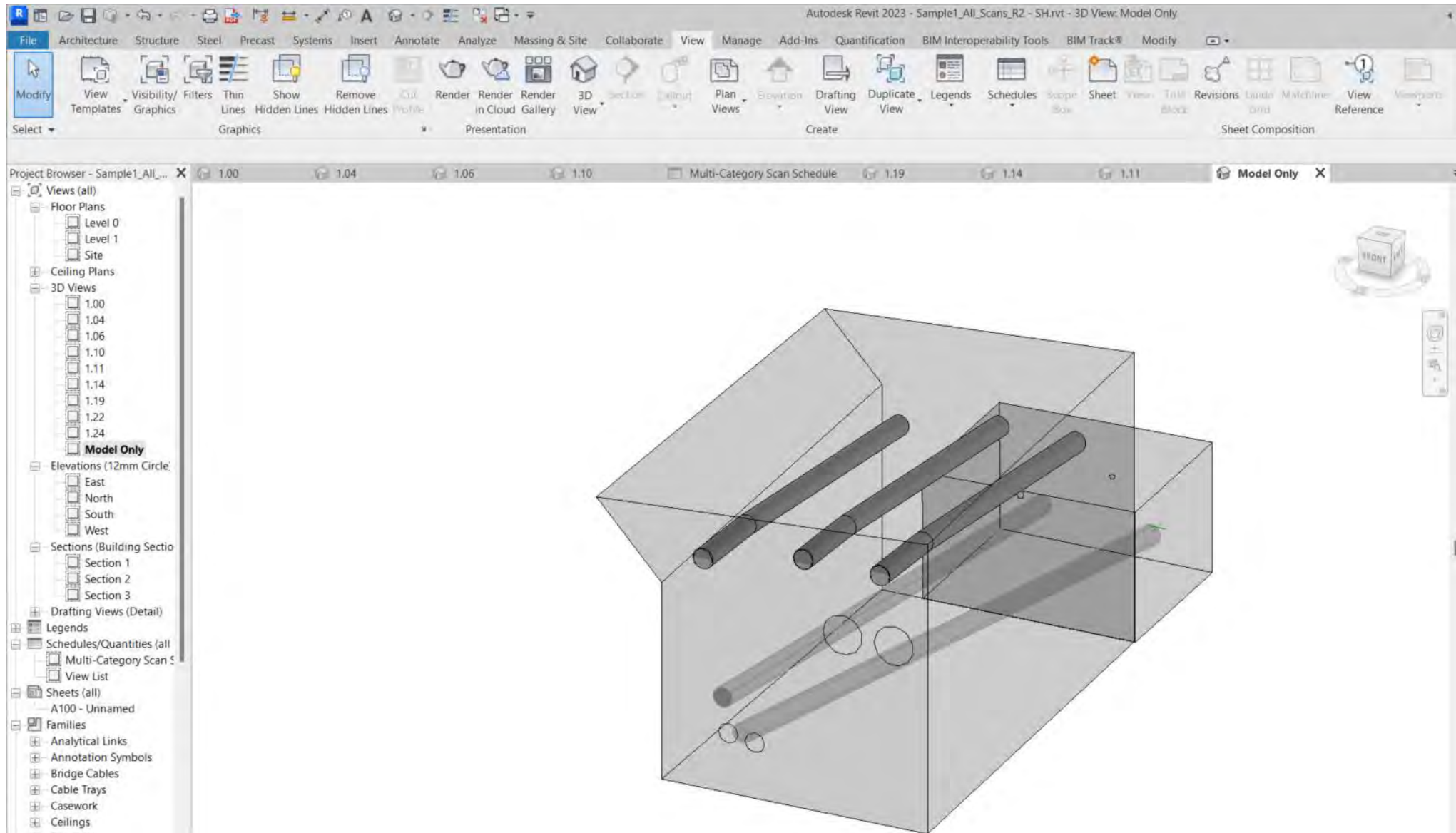
Sorting/Grouping Edit...

Formatting Edit...

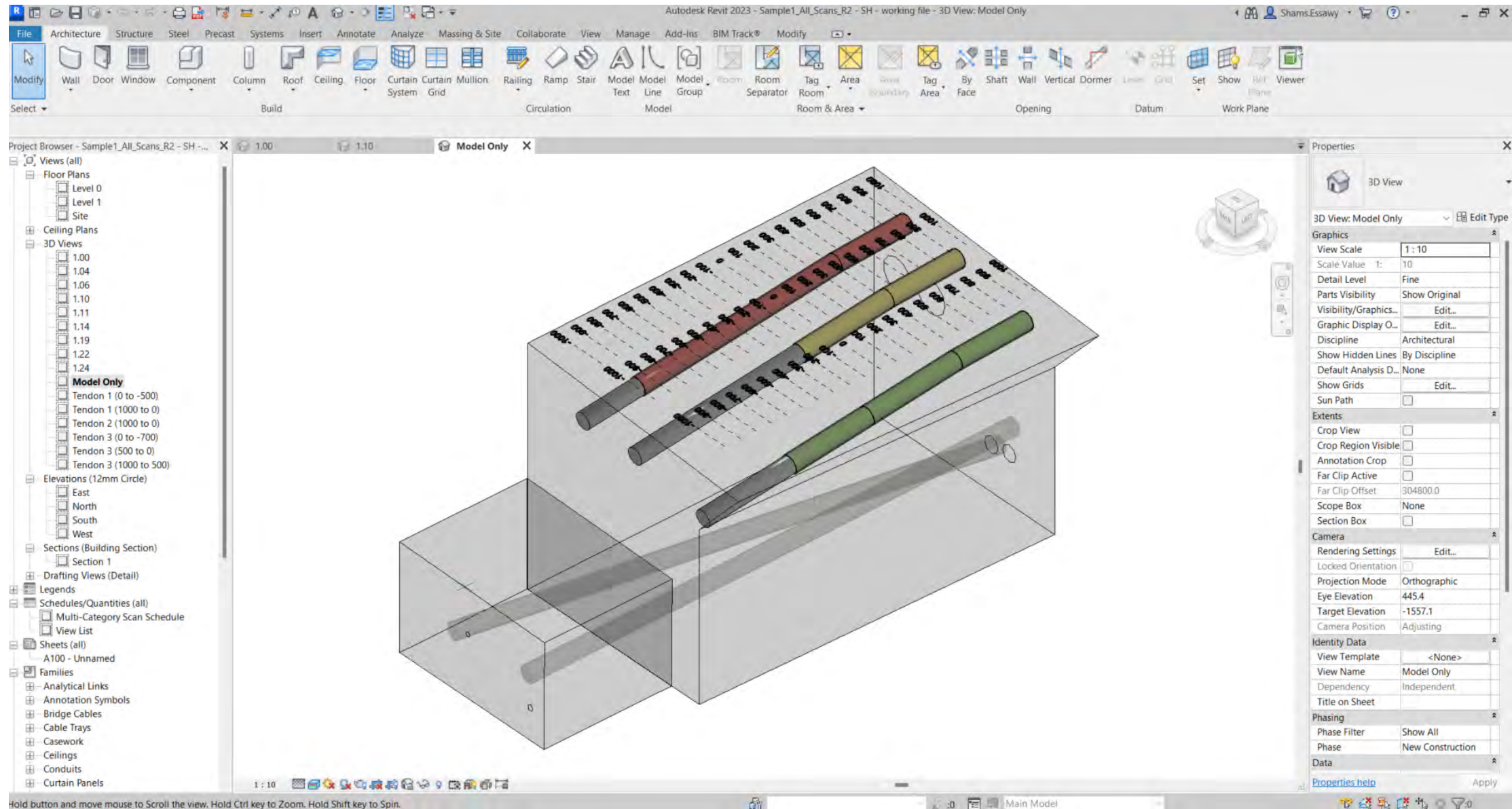
Appearance Edit...

Properties help

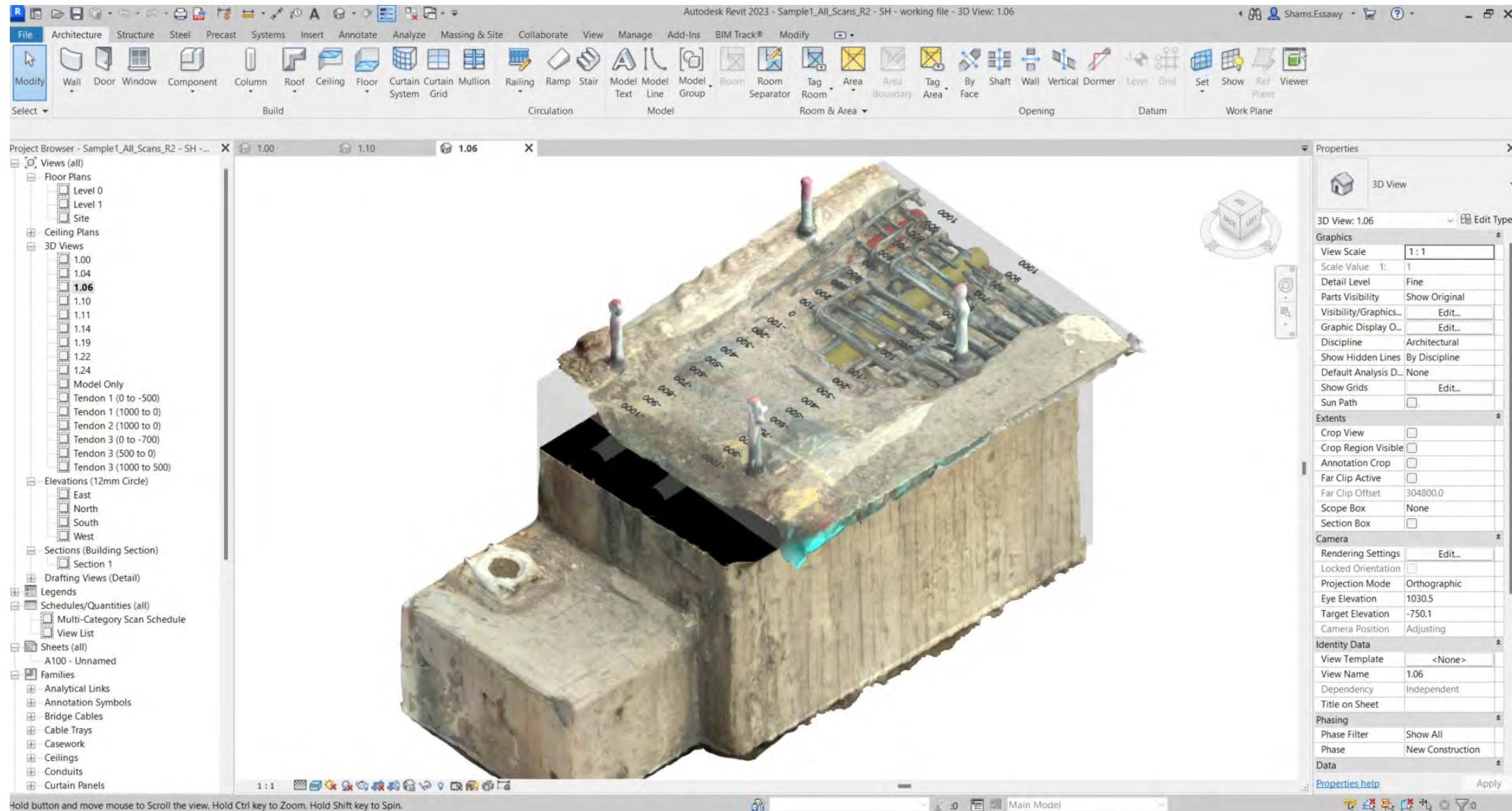
Federated Data Model



Federated Data Model



Federated Data Model



Federated Data Model

Autodesk Revit 2023 - Sample1_All_Scans_R2 - SH - working file - 3D View: 1.06

File Architecture Structure Steel Precast Systems Insert Annotate Analyze Massing & Site Collaborate View Manage Add-Ins BIM Track® Modify

Select Modify Wall Door Window Component Column Roof Ceiling Floor Curtain System Curtain Mullion Railing Ramp Stair Model Text Model Line Model Group Room Room Separator Tag Room Area Area Boundary Tag Area By Face Shaft Wall Vertical Dormer Level Grid Set Show Ref Plane Viewer

Build Circulation Model Room & Area Opening Datum Work Plane

Project Browser - Sample1_All_Scans_R2 - SH - ...

- Views (all)
- Floor Plans
 - Level 0
 - Level 1
 - Site
- Ceiling Plans
- 3D Views
 - 1.00
 - 1.04
 - 1.06
 - 1.10
 - 1.11
 - 1.14
 - 1.19
 - 1.22
 - 1.24
- Model Only
 - Tendon 1 (0 to -500)
 - Tendon 1 (1000 to 0)
 - Tendon 2 (1000 to 0)
 - Tendon 3 (0 to -700)
 - Tendon 3 (500 to 0)
 - Tendon 3 (1000 to 500)
- Elevations (12mm Circle)
 - East
 - North
 - South
 - West
- Sections (Building Section)
 - Section 1
- Drafting Views (Detail)
- Legends
- Schedules/Quantities (all)
 - Multi-Category Scan Schedule
 - View List
- Sheets (all)
 - A100 - Unnamed
- Families
 - Analytical Links
 - Annotation Symbols
 - Bridge Cables
 - Cable Trays
 - Casework
 - Ceilings
 - Conduits

Multi-Category Scan Schedule

Category	Face	CTS	Covermeter	Elcometer 331 C	Concrete	Cover	High	Numerical Grid			
S1_FH_CTS_CMS_ECM_C#5_H_01	Face H	CTS	Electrical Resistivity	Proceq Resipod	Concrete	Other	High	Numerical Grid			https://docs.b36
S1_FH_CTS_ER_PR_C#4_H_01	Face H	CTS	Half-cell potential	Proceq Profomet	Concrete	Other	High	Image Overlay			https://docs.b36
S1_FH_CTS_HPS_PPC_C#4_H_01	Face H	CTS	Half-cell potential	Proceq Profomet	Concrete	Other	High	Numerical Grid			https://docs.b36
S1_FH_CTS_VI-NDT_NA_R#1_H_02	Face H	CTS	NDT Visual Inspection	N/A	Reinforcement	Corrosion	High	Image Attachment		https://docs.b36	https://docs.b36
S1_FH_CTS_VI-NDT_NA_C#4_H_05	Face H	CTS	NDT Visual Inspection	N/A	Concrete	Other	High	Image Attachment		https://docs.b36	https://docs.b36
S1_FH_CTS_VI-NDT_NA_C#4_H_02	Face H	CTS	NDT Visual Inspection	N/A	Concrete	Other	High	Image Attachment		https://docs.b36	https://docs.b36

1.00 1.04 1.06 1.10 1.11 1.14 1.19 1.22 1.24

3D View: 1.06

Graphics

View Scale: 1:1

Scale Value: 1

Detail Level: Fine

Parts Visibility: Show Original

Visibility/Graphics: Edit...

Graphic Display Opt...: Edit...

Discipline: Architectural

Show Hidden Lines: By Discipline

Default Analysis Dis...: None

Show Grids: Edit...

Sun Path: ☐

Extents

Crop View: ☐

Crop Region Visible: ☐

Annotation Crop: ☐

Far Clip Active: ☐

Far Clip Offset: 304800.0

Scope Box: None

Section Box: ☐

Camera

Rendering Settings: Edit...

Locked Orientation: ☐

Projection Mode: Orthographic

Eye Elevation: -361.8

Target Elevation: -750.1

Camera Position: Adjusting

Identity Data

View Template: <None>

View Name: 1.06

Dependency: Independent

Title on Sheet: ☐

Phasing

Phase Filter: Show All

Phase: New Construction

Data

Defect ID:

Zone:

Properties help Apply

1:1

Click to select, TAB for alternates, CTRL adds, SHIFT unselects.

Main Model

Federated Data Model

Strand Numbering (diagram showing strands and associated photo)

End 1

Chainage (mm)

0



Fractured Wires on Tendon #1

d from service
terial. Minimal /
consistent with a
strands. Strands



- Elevations (12mm Circle)
 - East
 - North
 - South
 - West
- Sections (Building Section)
 - Section 1
- Drafting Views (Detail)
- Legends
- Schedules/Quantities (all)
 - Multi-Category Scan Schedule
 - View List
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 - Annotation Symbols
 - Bridge Cables
 - Cable Trays
 - Casework
 - Ceilings
 - Conduits

1:1

Click to select. TAB for alternates. CTRL adds. SHIFT unselects.

Main Model

Data
Defect ID
Zone
Properties help

Apply

Data Analysis

Sample 1	Tendon 1	0 to -500
----------	----------	-----------

Element				Ducts								Concrete												
Defect Type				Corrosion			Cracking/ Perforation		Moisture/ Presence of Water	Good Condition	Cover / Location		Cracking		Chlorides		Voids			Other	Good Condition	Cover		
Supplier	Testing Method	Equipment		Detection	Location Accuracy	Extent Accuracy	Detection	Location Accuracy	Detection	Detection	Detection	Location Accuracy	Detection	Location Accuracy	Detection	Extent Accuracy	Detection	Location Accuracy	Extent Accuracy	Detection	Detection	Detection	Extent Accuracy (mm)	
Adlun/Rosic / Sobotec	Hydrodynamic Survey - LIDAR Scan	iPhone 13 Pro Max	Result	No	N/A	N/A	No		No	Yes	Yes	BT vertically, 14mm from Face C									Yes	60		
	Concrete Testing (Sobotec)	N/A	Notes								Measured in Hydrom L10											Measured in Hydrom L04 right ab		
			Result																					
	Visual Inspection	N/A	Notes	No	N/A	N/A	No	N/A	No	Yes	N/A	N/A												
CTS	Visual Inspection / Hammer Tapping	N/A	Expected Detection?	No			No		No	No	No		Yes		No		Yes			No	No	No		
			Result										No	N/A			No	N/A	N/A					
			Notes										Barrel crack rate	N/A			No debris	N/A	N/A					
			Deviation Score									N/A 0	N/A 0				N/A 0	N/A 0						
	Concrete Survey	Dremer 331 Core Meter	Expected Detection?	No			No		No	No	Yes		No		No		No	N/A	0	No	No	Yes	60	
			Result								No	N/A									Yes	60		
			Notes								Unable to do	N/A									-	Take above the head	0.00	
			Deviation Score								N/A 0	N/A 0									-		2	
	Electrical Resistivity	Proceq Respad	Expected Detection?	No			No		No	No	No		No		No		Yes	N/A	11.85	No	No	No		
			Result										No	N/A		No	N/A	Values in kΩ-cm						
			Notes										Moderate	N/A										
			Deviation Score										2	0			0							
	Concrete embedment tests	N/A	Expected Detection?	No			No		No	No	No		No		No		Yes	N/A	<5	No	No	No		
			Result													No	N/A	0	0					
			Notes														N/A	0	0					
			Deviation Score														0	0						
	Diamond Sampling (Dust)	N/A	Expected Detection?	No			No		No	No	No		No		Yes		No	0	0	No	No	No		
			Result												Yes									
Notes														Average of Chloride ion con	N/A									
Deviation Score														2	0									
Half-cell potential survey	Proceq Profometer Corrosion	Expected Detection?	Yes			No		No	No	No		No		No		No	0		No	No	No			
		Result	No	N/A	>100																			
		Notes			Low risk of corrosion																			
		Deviation Score	2	0	2																			
Surveying Engle	GPR	Proceq GP8000	Expected Detection?	No			No		No	No	Yes	10 vertically, 15mm from Face C	No		No		Yes	N/A	N/A	No	No	Yes	60	
			Result							Yes	Yup far off				No	N/A	N/A	N/A			Yes	60		
			Notes							N/A	30				No voids	N/A	N/A	N/A			-	Take above the head	3.00	
			Deviation Score							-1					0		0				2			
VSL, Bridgeology	GPR	Proceq GP8000	Expected Detection?	No			No		No	No	Yes		No		No		Yes	0	0	No	No	Yes	60	
			Result							No	N/A				No	N/A	N/A	N/A		Yes	Between 40 to 60mm			
			Notes							Unable to do	N/A				No voids	N/A	N/A	N/A			Only a single pipe	Up to 20mm		
		Deviation Score							N/A	N/A						N/A	N/A	N/A						
		Proceq GP8000 + Dust Sampling	Expected Detection?	No			No		No	No	No	Yes		No		Yes		0	0	0	No	No	No	
			Result											No	between 70 to 15 mm									
Notes												Low risk of N/A	N/A	N/A	N/A	N/A	N/A							

Data Analysis

1 Detection

Detection is applicable for all defects and will be scored as follows:

Expected Detection	Result	Score
Yes	Correct (True Positive / Negative)	2
No	Correct (True Positive / Negative)	1
No	None	0
No	Incorrect (False Positive / Negative)	-1
Yes	Incorrect (False Positive / Negative)	-2

2 Location Accuracy

- Cracking (Concrete and Ducts) - Orientation of grout voiding - Location of strands with wire breaks - Location of voids (Grout and Concrete) - Location of corrosion (Strands, Tendons, Reinforcement, Ducts)		
Deviation	Description	Score
0 - 10mm	Very Accurate	2
10 - 20 mm	Moderately Accurate	1
>20 mm	Poor	-1

3 Extent Accuracy

Not Applicable for scoring	0
----------------------------	---

- Corrosion Extent (Strands, Tendons, Reinforcement, Ducts) - Voids (Grout and Concrete) - Loose Grout - Chlorides (Grout and Concrete)		
Deviation	Description	Score
0-5%	Very Accurate	2
5-10%	Moderately Accurate	1
>10%	Poor	-1

- Section Loss (Strands, Tendon, Reinforcements)		
Deviation	Description	Score
0-2%	Very Accurate	2
2-5%	Moderately Accurate	1
>5%	Poor	-1

- Number of Wire Breaks		
Deviation	Description	Score
100% match with lab results	Very Accurate	2
90 to 99% match	Moderately Accurate	1
<90% match	Poor	-1

Concrete Cover Reinforcement Position and Layout		
Deviation	Description	Score
0-5mm	Very Accurate	2
5-10mm	Moderately Accurate	1
>10mm	Poor	-1

Data Analysis

Strands										
Corrosion						Section Loss				
Detection		Location Accuracy			Extent Accuracy		Detection		Extent Accuracy	

Tendon									
Corrosion			Section Loss		Wire Break			Good Condition	Other
Detection	Location Accuracy	Extent Accuracy	Detection	Extent Accuracy	Detection	Location Accuracy	Extent Accuracy	Detection	Detection

Grout									
Voids / UngROUTed			Chlorides		Moisture	Loose		Good Condition	Other
Detection	Location Accuracy	Extent Accuracy	Detection	Extent Accuracy	Detection	Detection	Extent Accuracy	Detection	Detection

Ducts									
Corrosion			Cracking/ Perforation		Moisture/ Presence of Water	Good Condition	Cover / Location		
Detection	Location Accuracy	Extent Accuracy	Detection	Location Accuracy	Detection	Detection	Detection	Location Accuracy	

Concrete										
Cracking		Chlorides		Voids			Other	Good Condition	Cover	
Detection	Location Accuracy	Detection	Extent Accuracy	Detection	Location Accuracy	Extent Accuracy	Detection	Detection	Detection	Extent Accuracy (mm)

Reinforcement									
Corrosion				Section Loss / Necking		Good Condition	Position / Layout		
Detection	Location Accuracy	Extent Accuracy	Detection	Extent Accuracy	Detection	Detection	Location Accuracy		

Anchorage										
Position / Layout										
Detection				Location Accuracy						

Data Analysis

Hierarchy Level	Description	Applicability		Value
1	<i>Locating and identifying physical properties</i>	HJ	PT	Increasing Value of Data
1.1	Locate the strands and/or the rebar approximately	✓	✓	
1.2	Identify sizes of strand and/or rebar	✓	✓	
1.3	Identify duct type		✓	
1.5	Map all strands and rebar completely and accurately – position and sizes (stretch target)	✓	✓	
1.6	Identify chemical and physical properties of the materials (e.g. Section 3.7.5 and 3.7.6 of CS 465)	✓	✓	
2	<i>Conditions for corrosion</i>			
2.1	Locate any absence of duct grouting		✓	
2.2	Identify areas where the reinforcement is at high risk of corrosion, <u>e.g.</u> loss of concrete passivation or high chlorides	✓	✓	
2.3	Identify areas where the tendons are at high risk of corrosion, <u>e.g.</u> loss of concrete passivation or high chlorides		✓	
3	<i>Indications of damage</i>			
3.1	Identify discontinuities in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages	✓	✓	
3.2	Identification of plastic deformations of reinforcement (<u>e.g.</u> necking)	✓		
3.3	Measurement of surface cracking at re-entrant corners (width, length, depth)	✓		
3.4	Measurement of cracking along length of re-entrant corners (width, length, depth)	✓		
4	<i>Pinpoint location and quantify magnitude of deterioration</i>			
4.1	Corrosion locations	✓	✓	
4.2	Magnitude and shape of section loss from corrosion at each location	✓	✓	
4.3	Wire break locations		✓	
4.4	Number of wire breaks at each location		✓	
5	<i>Other behaviour to detect if possible</i>			
5.1	Bond slip between steel and concrete (should have occurred at least in cutting samples)		✓	
5.2	Re-anchoring of strands (should have occurred at least in cutting samples)		✓	

Approach Limitations

- **Human error** in data collection, processing, alignment, and interpretation.

- Use of Autodesk Revit requires specific expertise and license access, limiting **user accessibility**.

- Diversity of data collected limited the applicability of quantitative comparison, leading to a more **qualitative assessment**.

Lessons Learnt & Future Recommendations

Geo-referencing

Consistent Data
Formats & Resolution

Standard Metadata
Schema

Development of Data
Management Software
for Inspection Data

Stakeholder
Collaboration

Thank You

ANY QUESTIONS?

NDT Trials: Summary of Technology Performance

Chris Mundell - AtkinsRéalis

June 2025

THE
**STRUCTURES
MOONSHOT**
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS



Heatmap Summary of NDT Performance Across Defect Types

		Allied Associates (via Mistras)		CTS					GScan	HausBots, VTC			Hilti	IFDB	Mistras			Screening Eagle (via Mistras)				RAU			University of Bristol (via RAU)	Pro-Lite Technology (via RAU)		VSL, Bridgology		The MTC / University of Southampton		
		Ultrasonics (Concrete)	GPR	Visual Inspection / Hammer Tapping	Cover meter Survey	Electrical Resistivity	Concrete carbonation tests	Chloride Sampling (Dust)	Half-cell potential survey	Muon Tomography	Visual Inspection	Cover meter Survey	GPR	Half-cell potential Survey	Cover Meter Survey	Magnetic Flux Leakage	Ultrasonic Measurements (Steel Tendon)	Acoustic Emission	Impact Echo	Impact Echo	Ultrasonic Pulse Echo (Concrete)	GPR	FTIR Gas Monitoring	Portable Xray Fluorescence (PXRF)	Gamma Ray Spectrometry	Hyperspectral Imaging	Field Spectrometry	Raman Spectrophacy	GPR		XCT Scan ²	
		ELOP	GSSI Flex NX	N/A	Elcometer 331 Cover Meter	Proceq Resipod	N/A	N/A	Proceq Profometer Corrosion	Hodoscopes Generation 1	Hausbots 1080p/30x optical zoom	Proceq Profometer PM8000	Proceq GP8000	Proceq Profometer Corrosion TBC	PS 1000 X-Scan Concrete scanner		Mistras Proprietary	EXPRESS-8 (Mistras Proprietary)	Impact Echo Instruments System		Proceq PI8000	PD8050	Proceq GP8000	Gasmet GT5000 Terra Portable Gas Analyser	ThermoFisher Niton XL3t GOLDD+ analyser	IraTec ARARM Gamma Ray Sensor	Hyperspectral Camera (400 - 1000nm wavelength)	Spectral Evolution RS3500 Field Spectrometer (350 - 2500nm wavelength)	Wasatch Photonics 785nm Raman Spectrometer	Proceq GP8000	Proceq GP8000 + Dust Sampling	XCT Scan
1		Locating and identifying physical properties																														
1.1	Locate the strands / tendons																															
1.1.1	Locate the rebars																															
1.2	Identify sizes of strands / tendons																															
1.2.1	Identify sizes of rebars																															
1.3	Identify duct type																															
1.4	Map all strands and rebar completely and accurately –position and sizes (stretch target)																															
1.5	Identify chemical and physical properties of the materials (e.g. Section 3.7.5 and 3.7.6 of CS 465)																															
2		Conditions for corrosion																														
2.1	Locate any absence of duct grouting																															
2.2	Identify areas where the reinforcement is at high risk of corrosion, e.g. loss of concrete passivation or high chlorides																															
2.3	Identify areas where the tendons are at high risk of corrosion, e.g. loss of concrete passivation or high chlorides																															
3		Indications of damage																														
3.1	Identify discontinuities in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages																															
3.2	Identification of plastic deformations of reinforcement (e.g. necking)																															
3.3	Measurement of surface cracking at re-entrant corners (width, length, depth)																															
3.4	Measurement of cracking along length of re-entrant corners (width, length, depth)																															
4		Pinpoint location and quantify magnitude of deterioration																														
4.1	Corrosion locations																															
4.2	Magnitude and shape of section loss from corrosion at each location																															
4.3	Wire break locations																															
4.4	Number of wire breaks at each location																															
5		Other behavior to detect if possible																														
5.1	Bond slip between steel and concrete (should have occurred at least in cutting samples)																															
5.2	Re-anchoring of strands (should have occurred at least in cutting samples)																															



Detection Categories

1

Locating and identifying physical properties

Locate and identify **strands, tendons, and rebars**

Detect the **type of duct**

Identify chemical and physical properties of the materials (**Section 3.7.5 and 3.7.6 of CS 465**)

2

Conditions for corrosion

Locate any **absence of duct grouting**

Identify areas where the **reinforcement or the tendons are at high risk of corrosion**

3

Indications of damage

Identify **discontinuities** in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages

Identification of **plastic deformations** of reinforcement (e.g. necking)

Measurement of **surface cracking and cracking along the length of re-entrant corners** (width, length, depth)

4

Pinpoint location and quantify magnitude of deterioration

Corrosion locations

Magnitude and shape of section loss from corrosion at each location

Wire break locations

Number of wire breaks at each location

5

Other behavior to detect if possible

Bond slip between steel and concrete (should have occurred at least in cutting samples)

Re-anchoring of strands (should have occurred at least in cutting samples)

Locating and identifying physical properties

Category #1

1

Locating and
identifying
physical
properties

Locate and identify
**strands, tendons, and
rebars**

Detect the **type of duct**

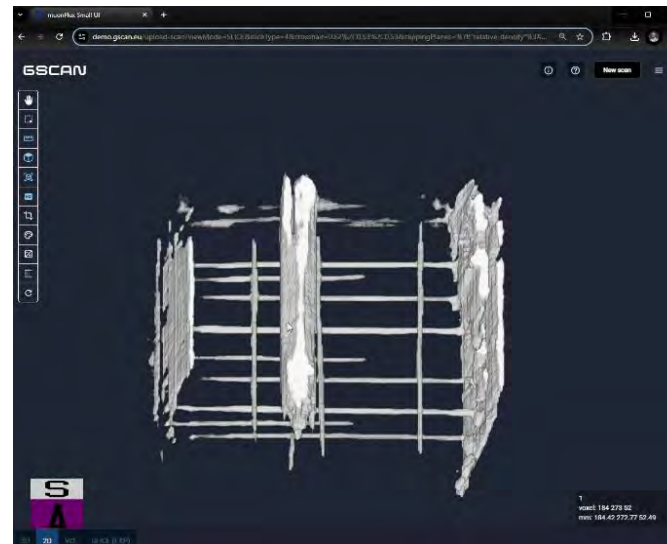
Identify chemical and
physical properties of the
materials (**Section 3.7.5
and 3.7.6 of CS 465**)

	-900	-700	-500	-300	-100	+100	+300	+500	+700	+900
+500	34	29	54	51	37	38	48	52	32	32
+300	60	56	80	38	25	50	36	19	50	34
+100	62	54	48	57	60	64	54	50	43	50
-100	83	0*	54	64	69	65	52	0*	53	48
-300	61	71	70	57	40	0*	36	36	33	34
-500	67	59	60	56	48	46	40	0*	36	40
-700	60	48	46	40	42	38	0*	38	34	60
-900	84	68	62	64	50	56	48	38	35	40

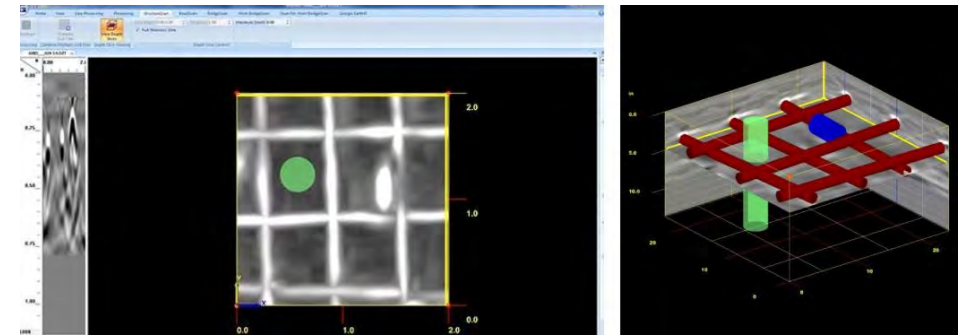
Depth of cover (mm)

Note: * In an area of spalling.

Cover Meter Survey:
Elcometer 331 Cover Meter



Muon Tomography:
GScan Hodoscopes Generation 1



Ground Penetrating Radar (GPR):
GSSI Flex NX



Ground Penetrating Radar (GPR):
Proceq GP8000

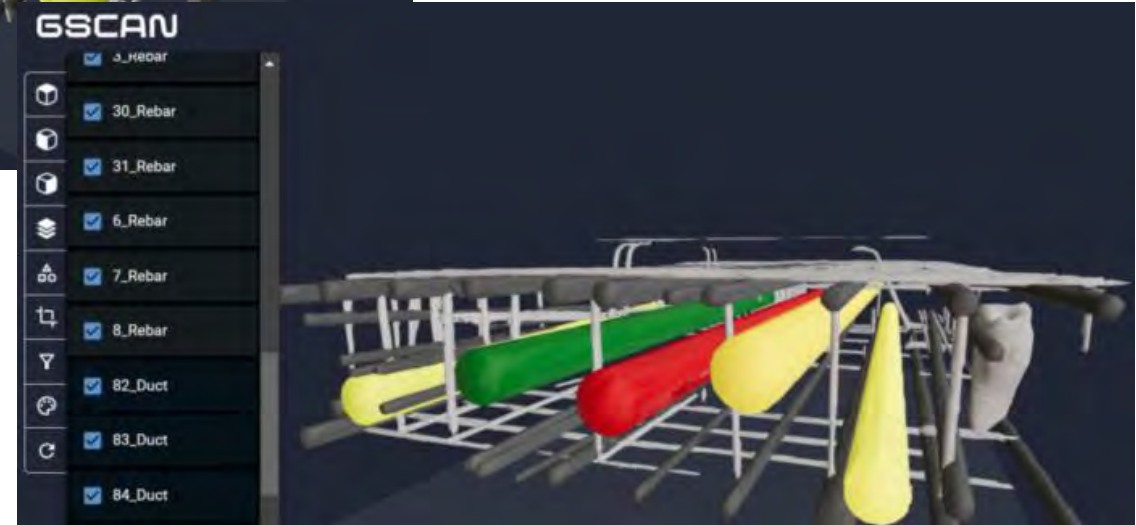
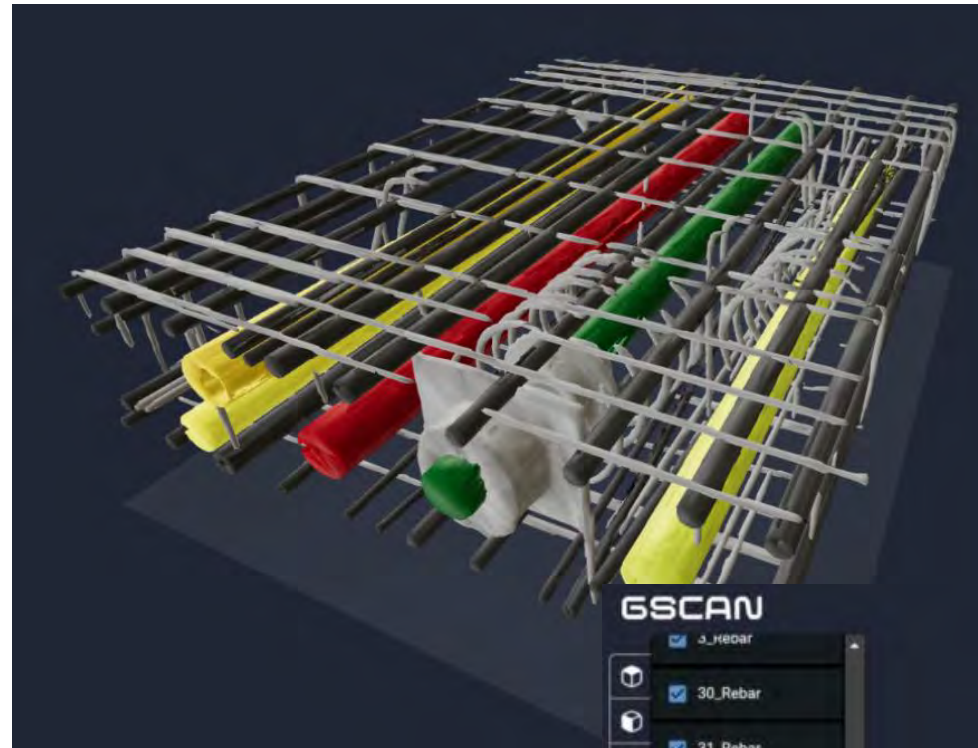
1

Locating and identifying physical properties

Locate and identify **strands, tendons, and rebars**

Detect the **type of duct**

Identify chemical and physical properties of the materials (**Section 3.7.5 and 3.7.6 of CS 465**)



Muon Tomography:
GScan Hodoscopes Generation 2

1

Locating and identifying physical properties

Locate and identify **strands, tendons, and rebars**

Detect the **type of duct**

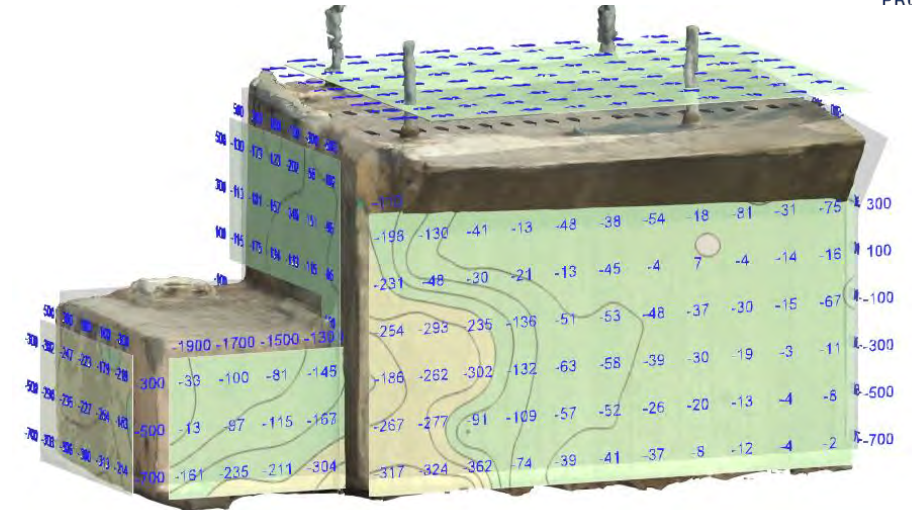
Identify chemical and physical properties of the materials (**Section 3.7.5 and 3.7.6 of CS 465**)

Laboratory testing – Sample 1

Sample Location No.	Sample Location	Sample offset	Depth of carbonation (mm)	Cement content (% by mass of sample)	Chloride ion content (% by mass of cement)		
					Depth from surface of concrete (mm)		
					5-25	25-50	50-75
1	Face A	(+X900 +Y100)	<5	21.4	0.62	0.27	0.16
1	Face C	(-X1100 -Z700)	<5	-	1.97	1.73	1.62
1	Face D	(-Y500 -Z700)	<5	-	1.14	1.08	0.95
1	Face E	100mm crack distance from outer face	<5	-	0.86	0.93	-
1	Face E	200mm crack distance from outer face	<5	-	0.74	0.97	-
1	Face E	300mm crack distance from outer face	<5	-	0.24	0.20	-
1	Face F	(-X1900 +Y500)	<5	-	2.90	2.35	1.89
1	Face G	(-Y100 -Z700)	<5	-	1.19	0.64	0.12
1	Face H	(-X1300 -Z700)	<5	-	1.11	0.88	1.06

A determined cement content as shown were used to calculate the chloride ion content.

Chloride contamination and carbonation depth

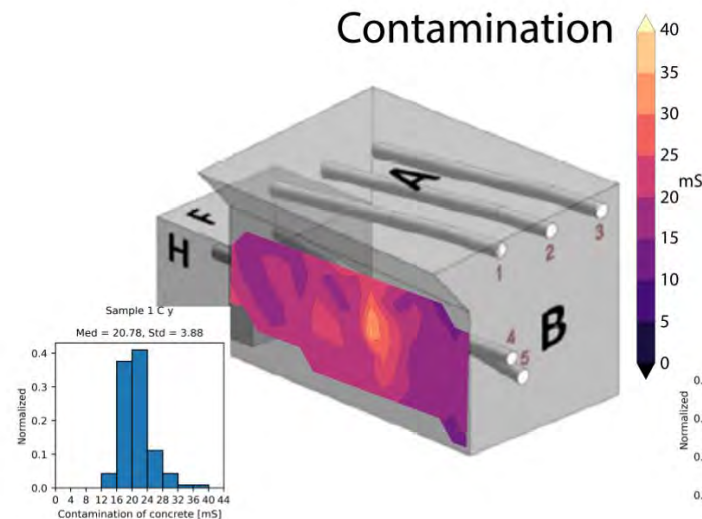


Half-cell potential survey: Proceq Profometer Corrosion

	-900	-700	-500	-300	-100	+100	+300	+500	+700	+900
+500	115	20.2	6.5	19.1	4.2	23.2	15.5	20.2	5.9	33.8
+300	57.4	7.5	58.2	2.0	20.8	19.5	6.1	10.7	11.5	3.1
+100	37.4	43.9	1.1	19.0	31.2	20.2	14.2	13.1	13.4	10.1
-100	10.36	25.2	22.1	7.9	27.2	26.1	26.8	10.1	17.1	25.5
-300	10.36	25.2	22.1	7.9	27.2	26.1	26.8	10.1	17.1	25.5
-500	80.2	32.9	19.3	27.0	39.7	33.4	23.2	12.6	22.2	20.1
-700	19.6	15.2	20.4	24.8	15.6	17.2	11.5	12.9	18.2	7.2
-900	11.6	19.2	10.3	18.9	24.3	2.9	9.7	5.7	18.6	20.2

Resistivity (kΩcm)

Electrical Resistivity: Proceq Resipod



Ground Penetration Radar: Proceq GP8000 + Dust Sampling

Conditions for corrosion

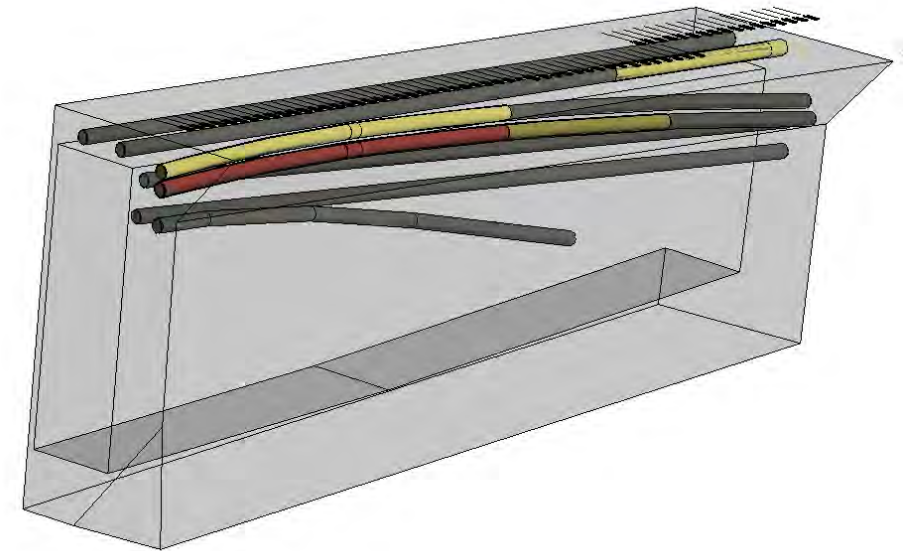
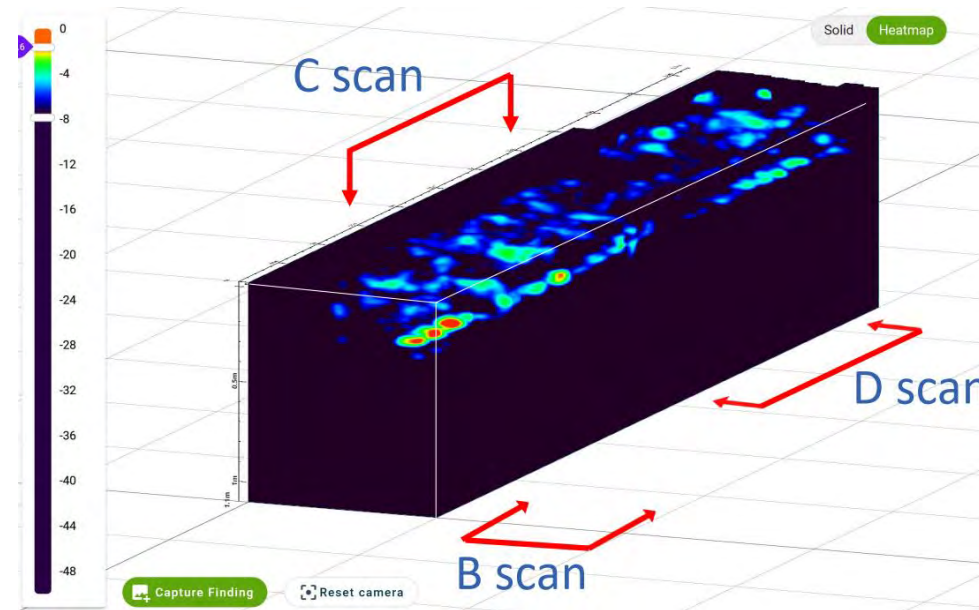
Category #2

2

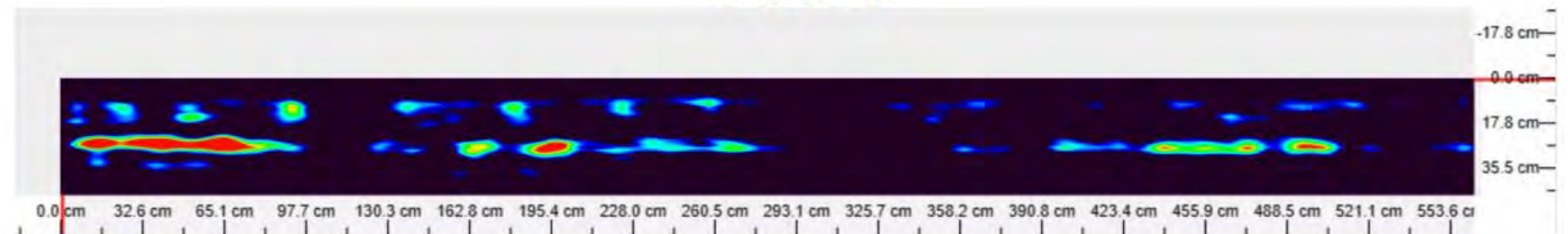
Conditions for corrosion

Locate any **absence of duct grouting**

Identify areas where the **reinforcement or the tendons are at high risk of corrosion**



D SCAN



Ultrasonics (Concrete): **ELOP Insight**

2

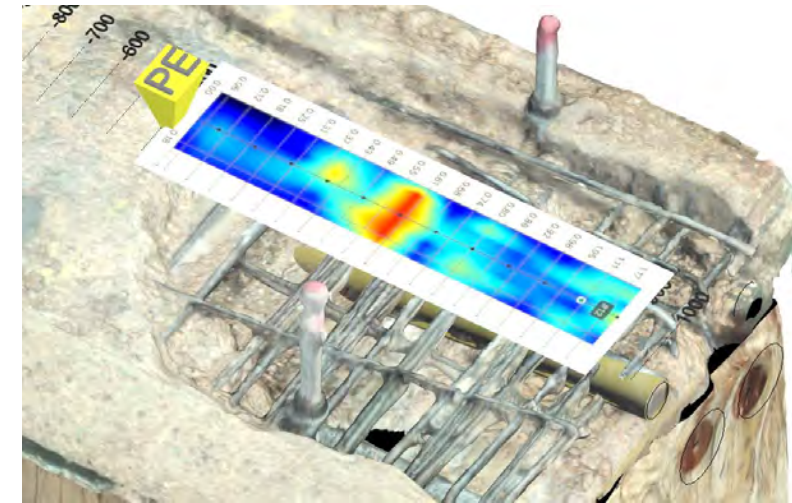
Conditions for corrosion

Locate any **absence of duct grouting**

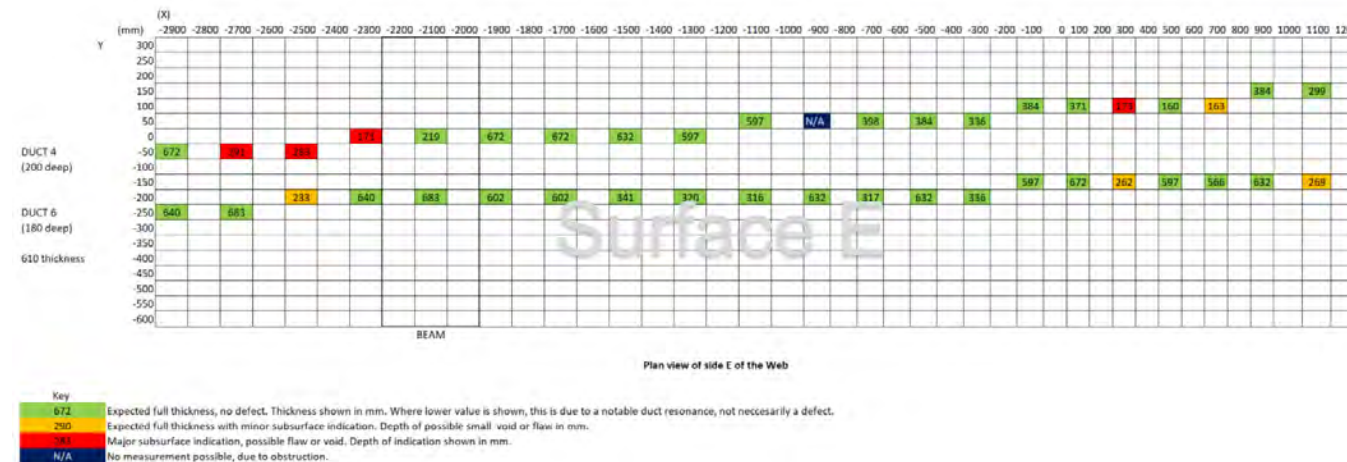
Identify areas where the **reinforcement or the tendons are at high risk of corrosion**



Muon Tomography:
GScan Hodoscopes Generation 1



Ultrasonic Pulse Echo: **Proceq Pundit PD8050**



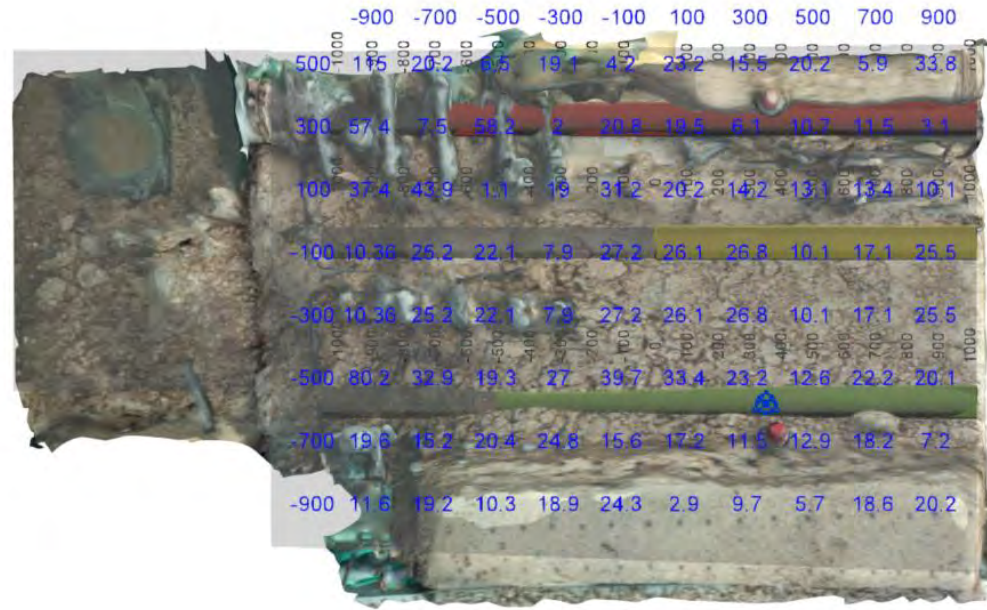
Impact Echo: **Physical Acoustics (MISTRAS Proprietary)**

2

Conditions for corrosion

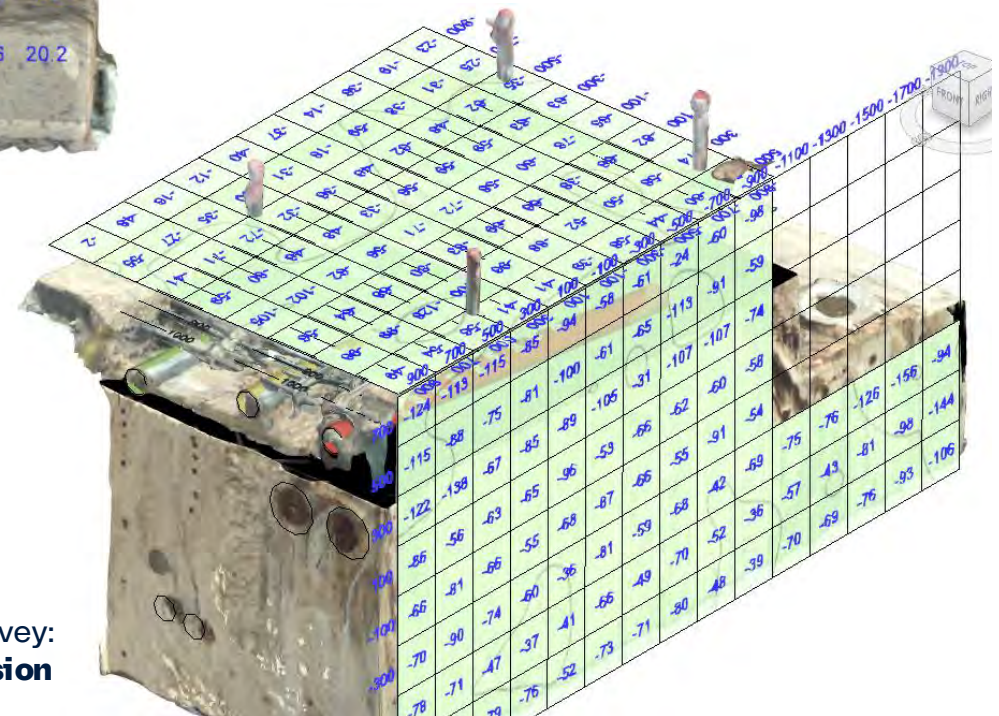
Locate any **absence of duct grouting**

Identify areas where the **reinforcement or the tendons are at high risk of corrosion**



Electrical Resistivity:
Proceq Resipod

Half-cell potential survey:
Proceq Profometer Corrosion



2

Conditions for corrosion

Locate any **absence of duct grouting**

Identify areas where the **reinforcement or the tendons are at high risk of corrosion**

Ultrasonic Measurements (Steel Tendon): Mistras Proprietary

Table 3: Test 2 results.

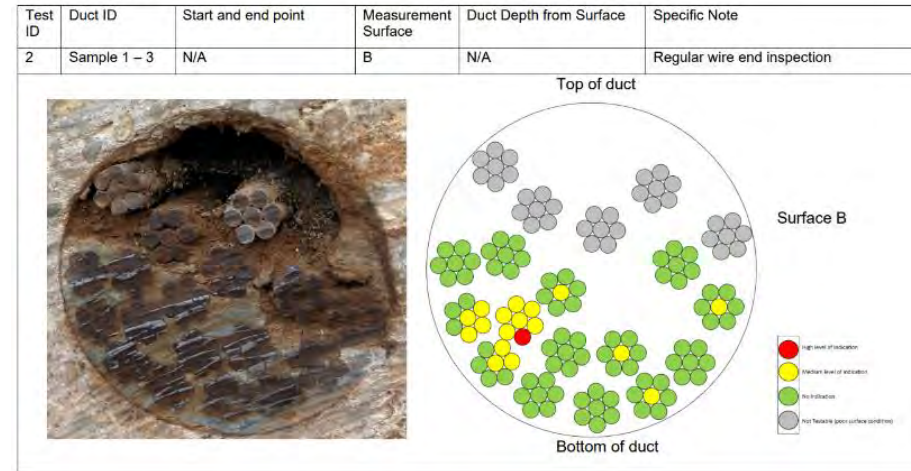
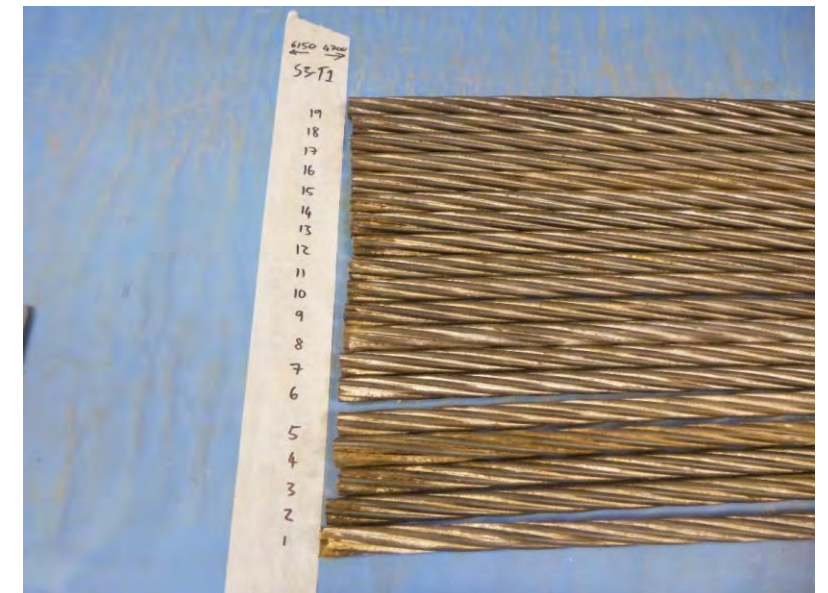
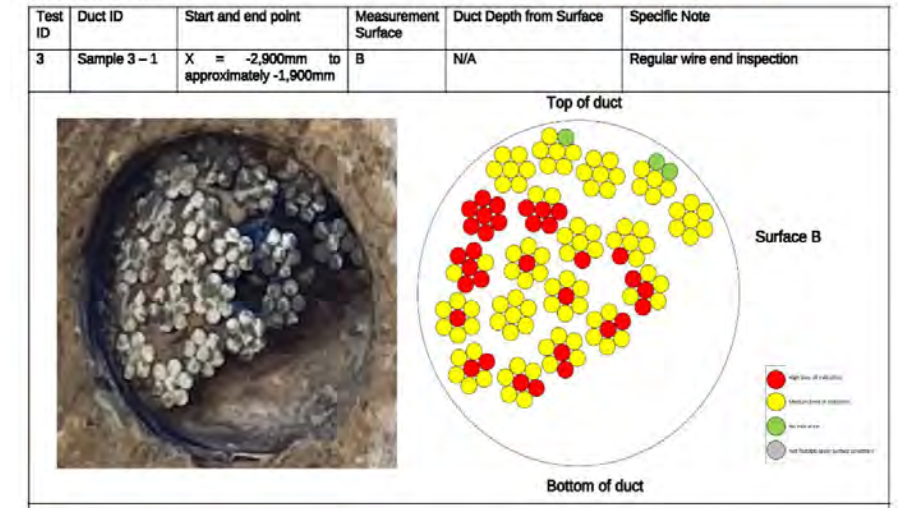


Table 4: Test 3 results.



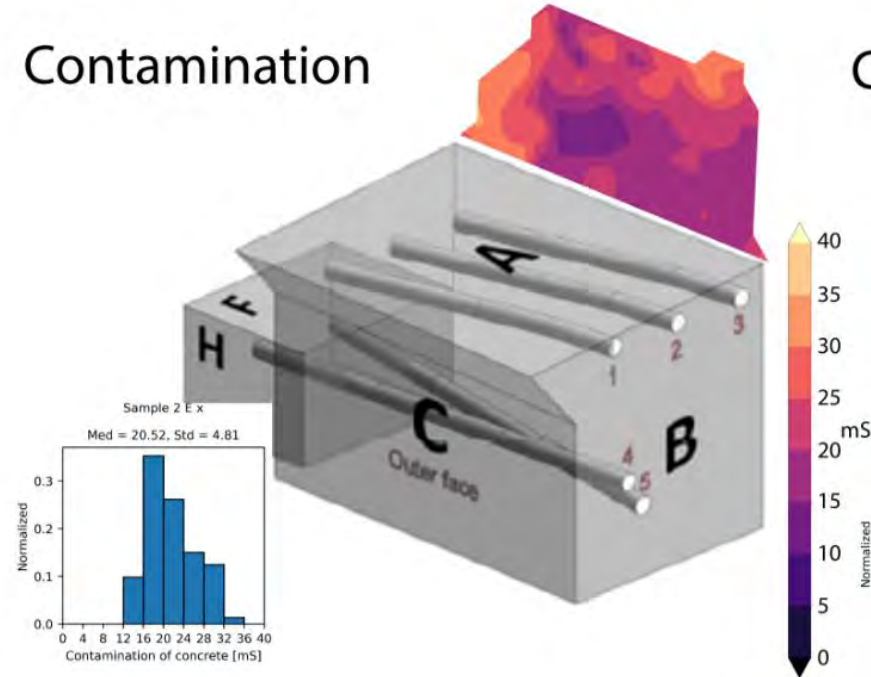
2

Conditions for
corrosion

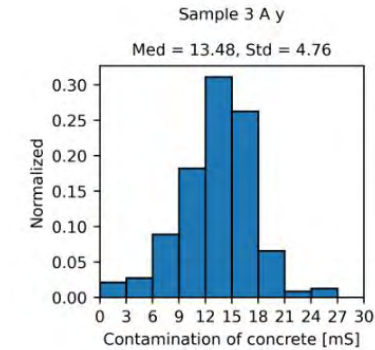
Locate any **absence of
duct grouting**

Identify areas where the
**reinforcement or the
tendons are at high risk
of corrosion**

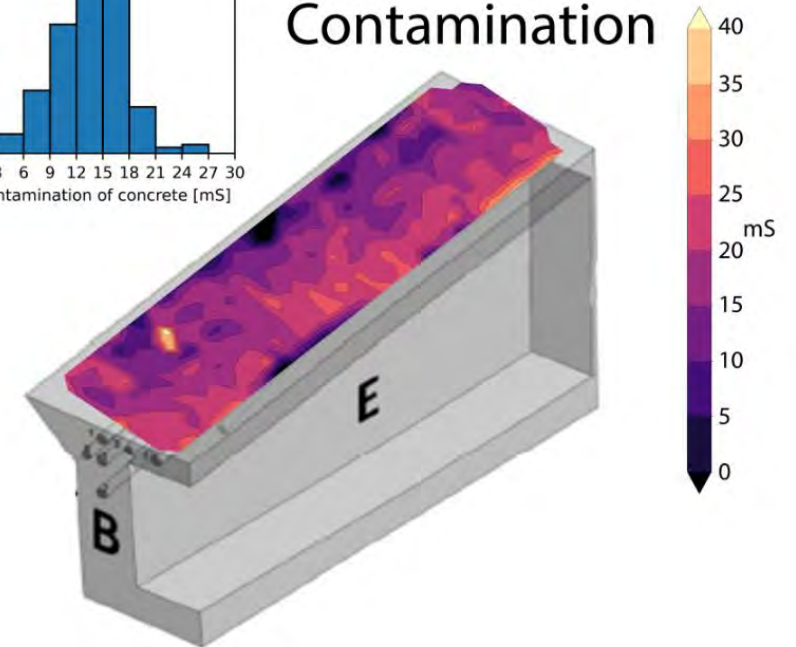
Contamination



C



Contamination



Ground Penetration Radar:
Proceq GP8000 + Dust Sampling

Indications of damage

Category #3

3

Indications of damage

Identify **discontinuities** in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages

Identification of **plastic deformations** of reinforcement (e.g. necking)

Measurement of **surface cracking and cracking along the length of re-entrant corners** (width, length, depth)



Acoustic Emission:
EXPRESS-8 (Mistras Proprietary)

3

Indications of damage

Identify **discontinuities** in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages

Identification of **plastic deformations** of reinforcement (e.g. necking)

Measurement of **surface cracking and cracking along the length of re-entrant corners** (width, length, depth)



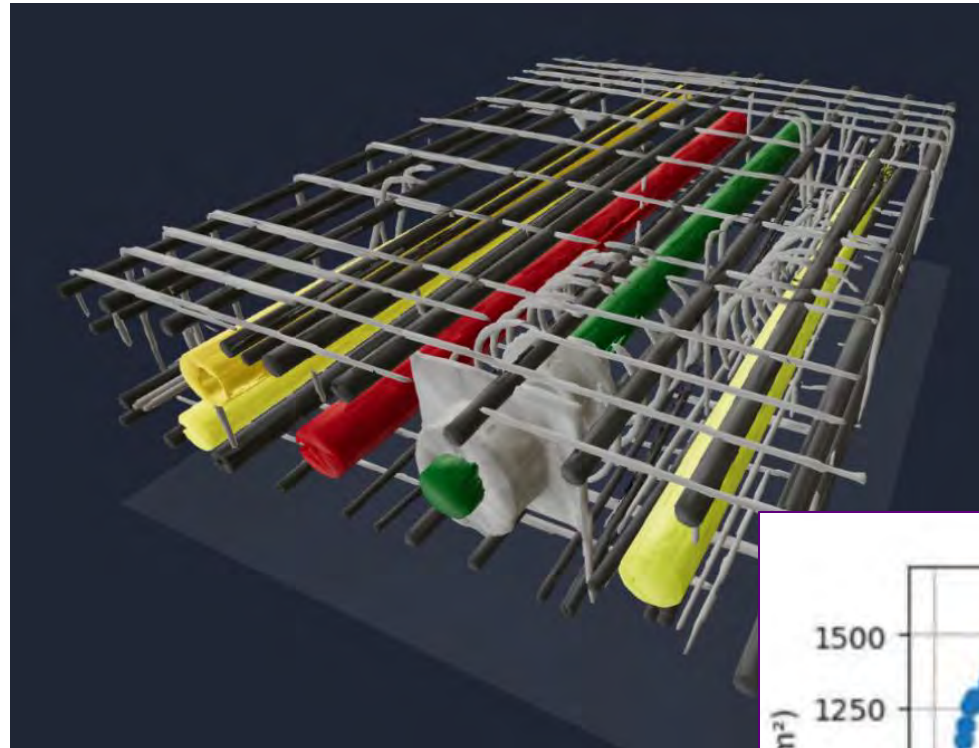
3

Indications of damage

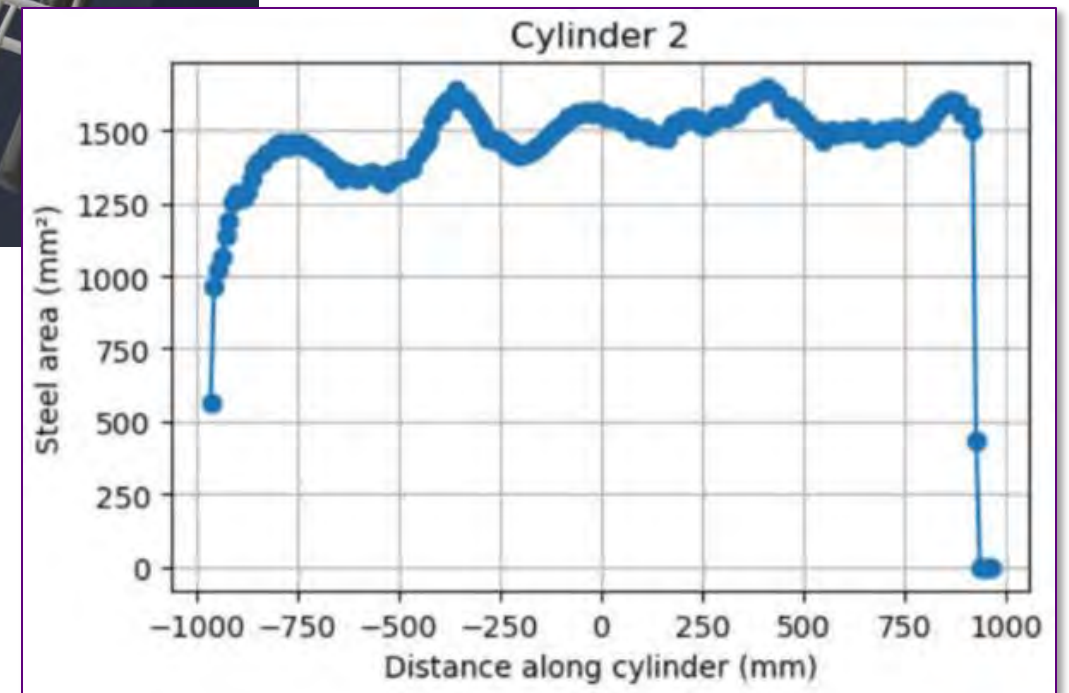
Identify **discontinuities** in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages

Identification of **plastic deformations** of reinforcement (e.g. necking)

Measurement of **surface cracking and cracking along the length of re-entrant corners** (width, length, depth)



Muon Tomography
Volume of Steel Measurements
GScan Hodoscopes Generation 2



3

Indications of damage

Identify **discontinuities** in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages

Identification of **plastic deformations** of reinforcement (e.g. necking)

Measurement of **surface cracking and cracking along the length of re-entrant corners** (width, length, depth)



Impact Echo
Proseq PI8000

Pinpoint location and quantify magnitude of deterioration

Category #4

4

Pinpoint
location and
quantify
magnitude of
deterioration

Corrosion locations

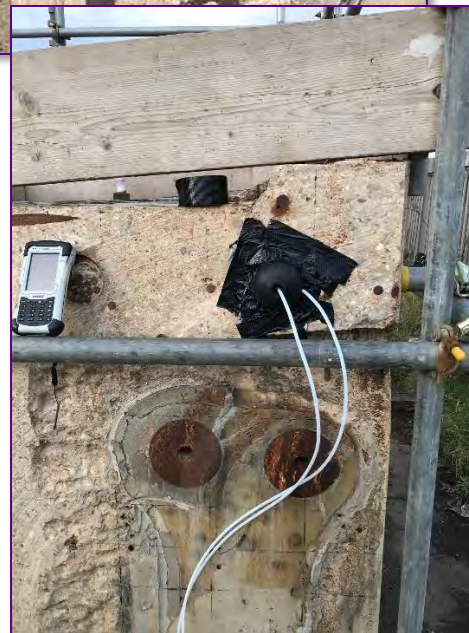
Magnitude and shape of section loss from corrosion at each location

Wire break locations

Number of wire breaks at each location



Portable X-Ray
Fluorescence
(exposed tendons only)
ThermoFisher Niton XL3t



FTIR Gas Monitoring (exposed tendons only)
Gasmet GT5000



4

Pinpoint
location and
quantify
magnitude of
deterioration

Corrosion locations

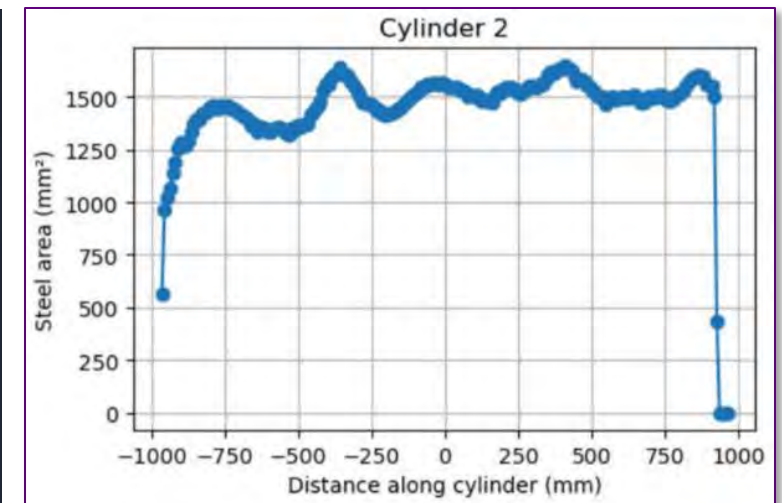
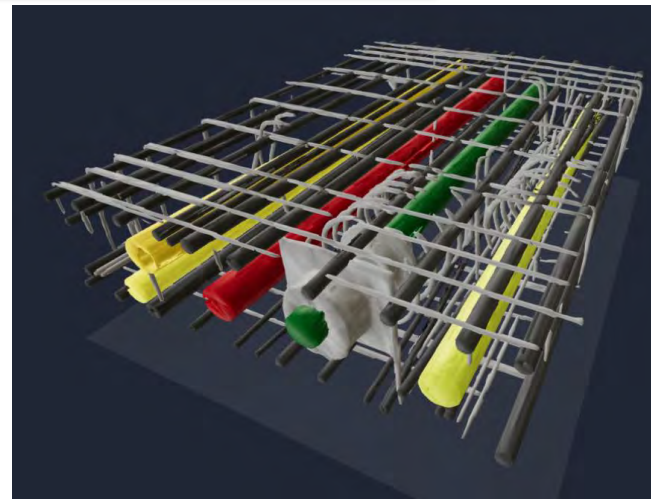
**Magnitude and shape of
section loss** from
corrosion at each
location

Wire break locations

Number of wire breaks
at each location



Guided Wave
(indicative)
Omnia Vigor System



Muon Tomography
Volume of Steel Measurements (indicative)
GScan Hodoscopes Generation 2

4

Pinpoint
location and
quantify
magnitude of
deterioration

Corrosion locations

**Magnitude and shape of
section loss** from
corrosion at each
location

Wire break locations

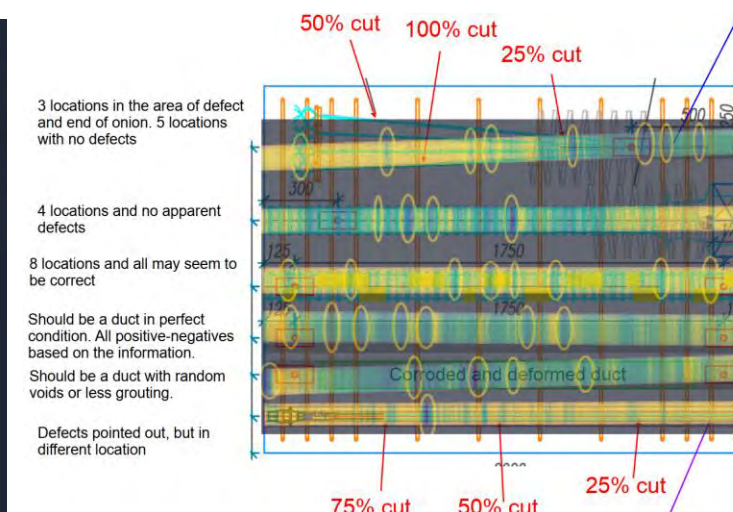
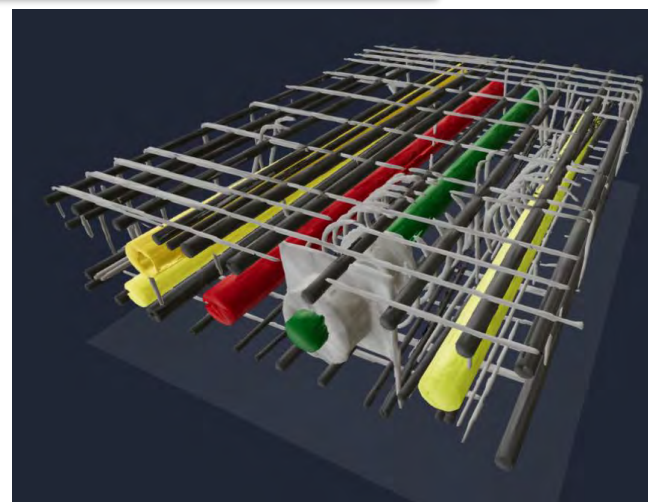
Number of wire breaks
at each location



Guided Wave
(indicative)
Omnia Vigor System



Acoustic Emission Monitoring
e.g. **Mistras Sensor Highway III**



Muon Tomography
Volume of Steel and Defect and Anomaly Detection
GScan Hodoscopes Generation 2

4

Pinpoint
location and
quantify
magnitude of
deterioration

Corrosion locations

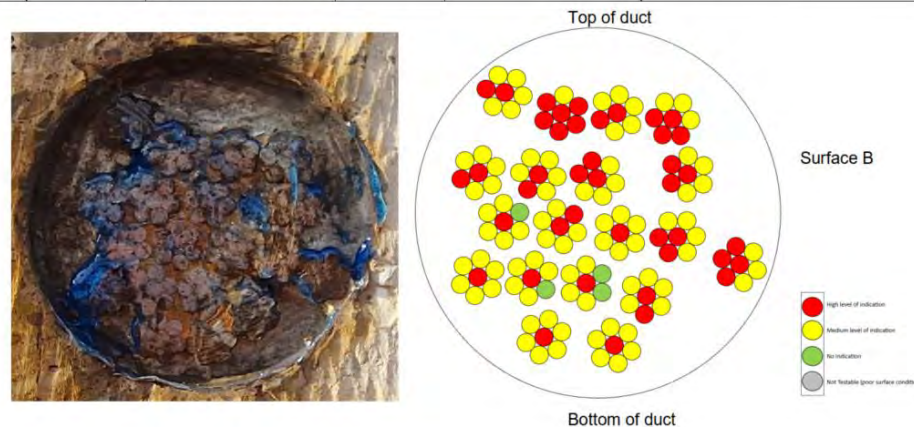
**Magnitude and shape of
section loss** from
corrosion at each
location

Wire break locations

Number of wire breaks
at each location

Ultrasonic Guided Wave (indicative) Mistras Proprietary Technology

Test ID	Duct ID	Start and end point	Measurement Surface	Duct Depth from Surface	Specific Note
6	Sample 3 – 4	X = -2,900mm to approximately -1,900mm	B	N/A	Regular wire end inspection



For Sample 3, Duct 4, 100% (133) of the wires could be UT inspected.
32% (42 wires) were classed as having a high level of an indication being present.
66% (88 wires) were classed as having a medium level of an indication being present.
2% (3 wires) were classed as having no indication present.



Acoustic Emission Monitoring
e.g. **Mistras Sensor Highway III**

Other behavior to detect if possible

Category #5

5

Other behavior
to detect if
possible

Bond slip between steel
and concrete

**Re-anchoring of
strands** following wire
breaks



Summary

High Consistency
Moderate Consistency

Low Consistency
Not Applicable

Not Tested

1

Locating and identifying physical properties

Locate and identify **strands, tendons, and rebars**

Detect the **type of duct**

Identify chemical and physical properties of the materials (**Section 3.7.5 and 3.7.6 of CS 465**)

2

Conditions for corrosion

Locate any **absence of duct grouting**

Identify areas where the **reinforcement or the tendons are at high risk of corrosion**

3

Indications of damage

Identify **discontinuities** in reinforcing and/or prestressing steel that may be indicative of corrosion or breakages

Identification of **plastic deformations** of reinforcement (e.g. necking)

Measurement of **surface cracking and cracking along the length of re-entrant corners** (width, length, depth)

4

Pinpoint location and quantify magnitude of deterioration

Corrosion locations

Magnitude and shape of section loss from corrosion at each location

Wire break locations

Number of wire breaks at each location

5

Other behavior to detect if possible

Bond slip between steel and concrete (should have occurred at least in cutting samples)

Re-anchoring of strands (should have occurred at least in cutting samples)

Discussion

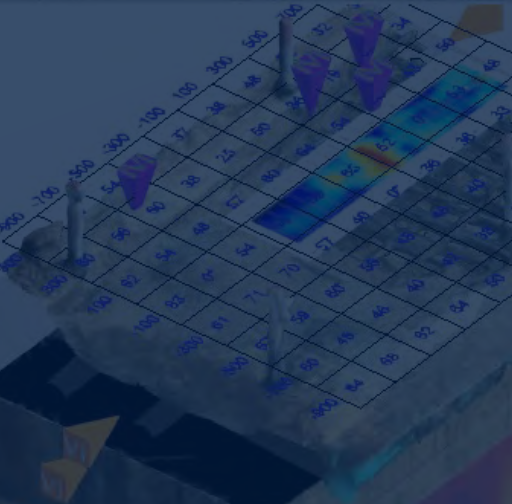
THE STRUCTURES MOONSHOT PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS

Structures Moonshot Data Schedule>

	E	F	G	H
	Tool	Element	Defect Type	Confide
e	MISTRAS Tablet UT	Tendon	Corrosion	High
e	MISTRAS Tablet UT	Tendon	Good Condition	High
	Proseq PD8052	Grout	Voids	High
	Proseq PD8052	Grout	Voids	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

1.11 1.14 1.19



Day 1 – Closing Remarks

Colin George
Deputy Head of Structures for Safety, Engineering and Standards
National Highways

June 2025

Insert Clear Group Ungroup Freeze Shading Borders Reset
Image Cell Header
Titles & Headers

Structures Moonshot Data Schedule>

	E	F	G	H
	Tool	Element	Defect Type	Confide
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	Proseq PD8052	Grout	Voids	High
	Proseq PD8052	Grout	Voids	High
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n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

1.11 1.14



Housekeeping

Chris Mundell
Structures Moonshot Delivery Lead, AtkinsRéalis

June 2025

THE

STRUCTURES MOONSHOT

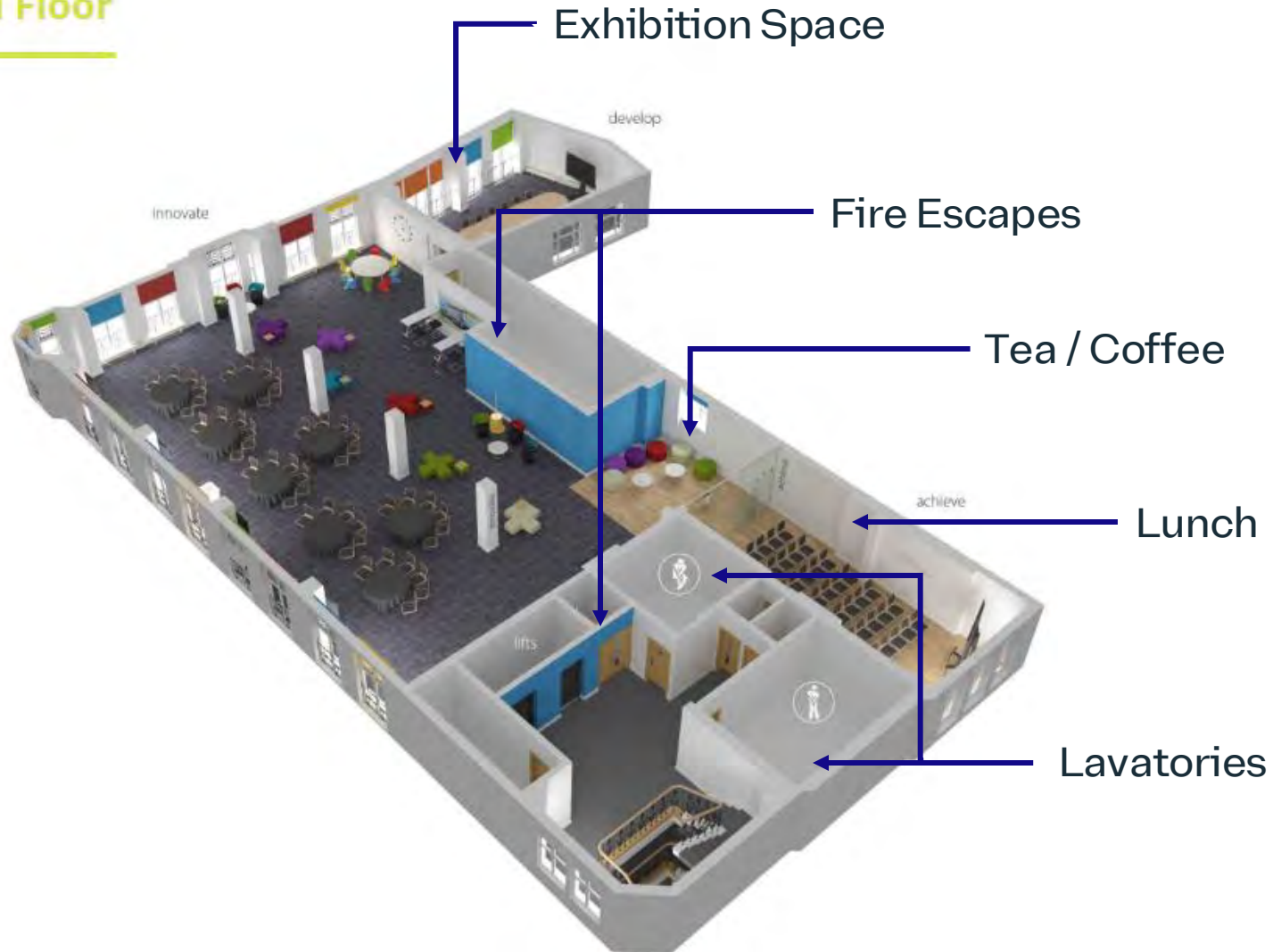
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS



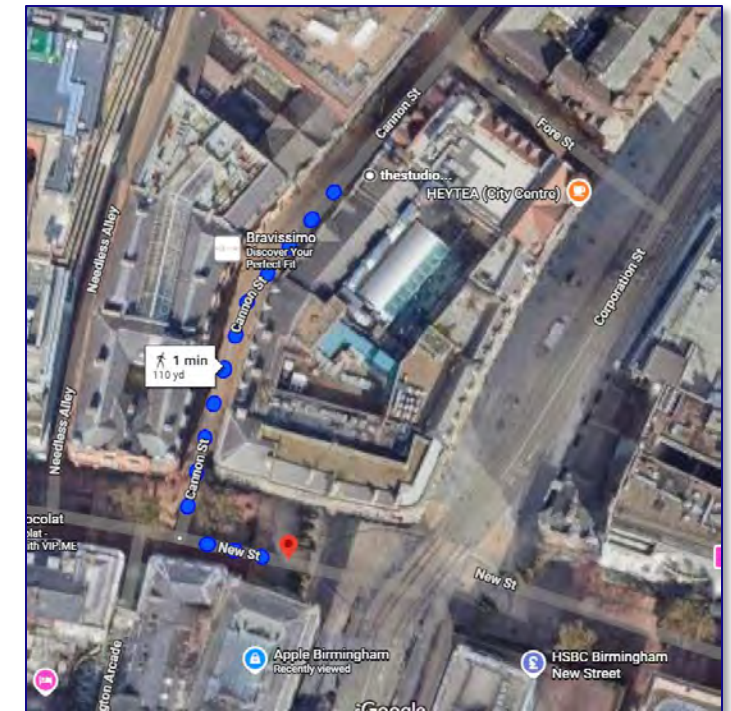
Housekeeping

3rd Floor



In case of emergency: Evacuation Point:

Adjacent to the **Apple Store, New Street**



Day 2 - Welcome Address

Nana Bamfo
Senior Structures Advisor for Safety, Engineering and Standards
National Highways

June 2025

Insert Clear Group Ungroup Freeze Shading Borders Reset
Image Cell Header
Titles & Headers

Structures Moonshot Data Schedule>

	E	F	G	H
	Tool	Element	Defect Type	Confide
e	MISTRAS Tablet UT	Tendon	Corrosion	High
e	MISTRAS Tablet UT	Tendon	Good Condition	High
	Proseq PD8052	Grout	Voids	High
	Proseq PD8052	Grout	Voids	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

1.14



Conference Agenda

THE
STRUCTURES
MOONSHOT
PROJECT



WELCOME & PROJECT OVERVIEW

R&D TRIALS AND RESULTS

NON-DESTRUCTIVE TESTING PRESENTATIONS: MOONSHOT FINDINGS

RESULTS FEDERATION AND SUMMARY

June 16th

- 9:00 Registration
- 9:15 Welcome & Overall Ambition
- 9:30 Keynote 1 – Moonshot II Project Overview
- 10:20 ----- Break -----
- 10:40 R&D Trials : Innovative Inspection Techniques Overview
- 10:50 RF Induced Ultrasound, Electric Impedance - Sentec
- 11:05 Guided Ultrasonic Waves – Omnia Integrity
- 11:35 Muon Tomography - GScan
- 12:05 Q&A: Panel Session
- 12:30 ----- Lunch & Breakout -----
- 13:30 Huntingdon Viaduct NDT Trials: Overview
- 13:40 Ultrasonics, Tomography, Impact Echo, Ground Penetration Radar (GPR), Acoustic Emission - MISTRAS | Screening Eagle | Allied Associates
- 14:25 Ground Penetration Radar (GPR) - Bridgology
- 14:40 Climbing Crawler Robots - HausBots
- 14:55 NDT Trials: Additional testing results
- 15:10 Q&A: Panel Session
- 15:35 ----- Break -----
- 16:05 Data Federation and Interpretation Approach
- 16:35 NDT Trials: Summary of Technology Performance
- 17:05 Day 1 Round Up
- 17:15 ----- Networking Session -----

June 17th

- 9:00 Welcome & Overview of Day 2
- 9:10 Overview of Testing on Wickwick Bridge
- 9:20 GNR – X-ray Diffractometry (XRD)
- 9:35 University of Strathclyde - Adaptive Lighting for the Inspection of Concrete Structures (ALICS)
- 9:50 Wickwick Trials: Q&A Session
- 10:00 Muon Tomography Trials on In-Service Structures
- 10:20 ----- Break -----
- 10:50 NDT Practitioner's Toolkit
- 11:20 Moonshot III: Network Deployment & Further Development
- 11:50 Conclusions & Round Up
- 12:20 Closing Remarks
- 12:30 ----- End -----

IMPLEMENTATION SESSION: TECHNOLOGY IN PRACTICE

KEY OUTPUTS, CONCLUSIONS, AND CLOSING REMARKS

THE
STRUCTURES
MOONSHOT
PROJECT

Overview of Testing on Wickwick Bridge

Lewis Bunch
Bridge Engineer, AtkinsRéalis

June 2025

THE
**STRUCTURES
MOONSHOT**
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS



The Structure

- Located 6 Miles Northeast of Bristol
- Constructed in 1966
- Carried the A432 over the M4
- Post Tensioned Concrete Structure
- 180 Total Tendons

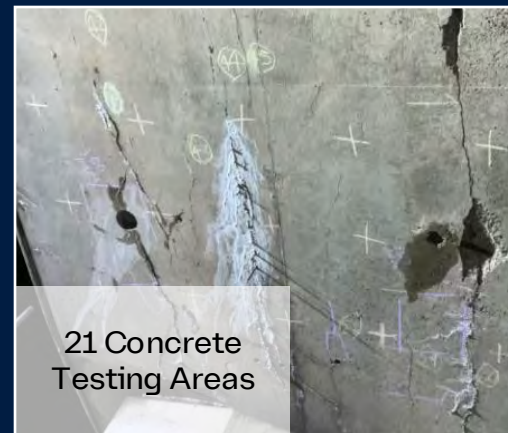
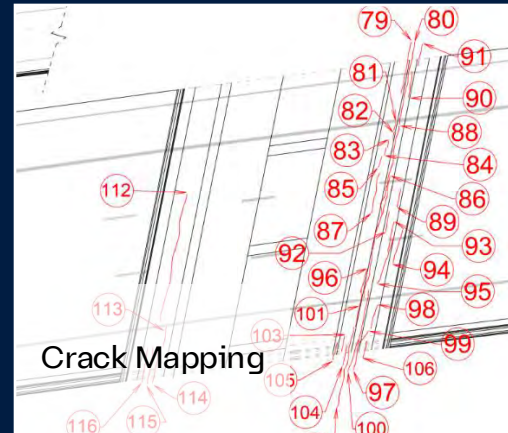


Condition

- Severe Longitudinal Cracking.
- Differential Clearance Indicating Non-Monolithic Deck.
- PTSI Identified Excessive Voiding in Pre-Tensioned Ducts.
- Various Corrosion Products.
- Significant Water Egress from Exposed Pre-Tensioned Ducts.
- Structure Assessed as Category 0 at SLS and Closed to Public.
- Catalyst for Condition not Fully Understood.
- Demolished in March 2025.



Previous Testing Conducted



The Opportunity

- National Highways granted AtkinsRéalis the opportunity to undertake NDT Testing
- Trialling novel testing with HTA, GNR Analytical Group and the University of Strathclyde.
- Where possible, measurements were aligned with previous testing conducted on the structure.





BADMINTON BRIDGE PTSI TRIAL OF NDT

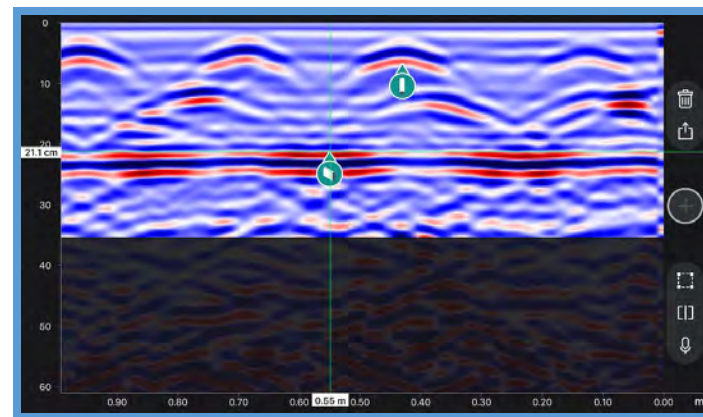
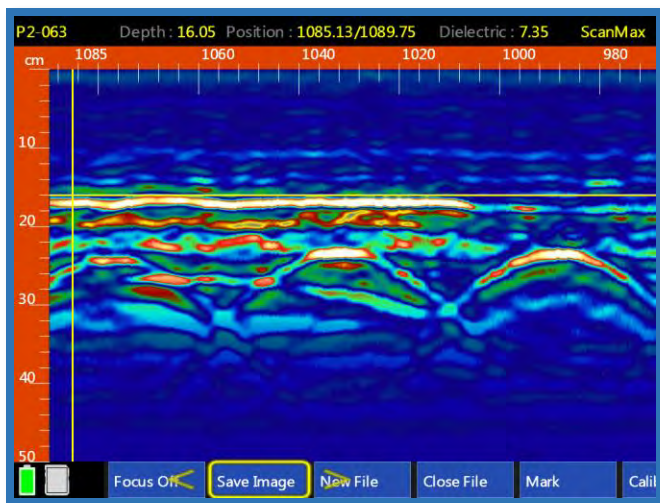
For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk



GROUND PENETRATING RADAR APPLICATION

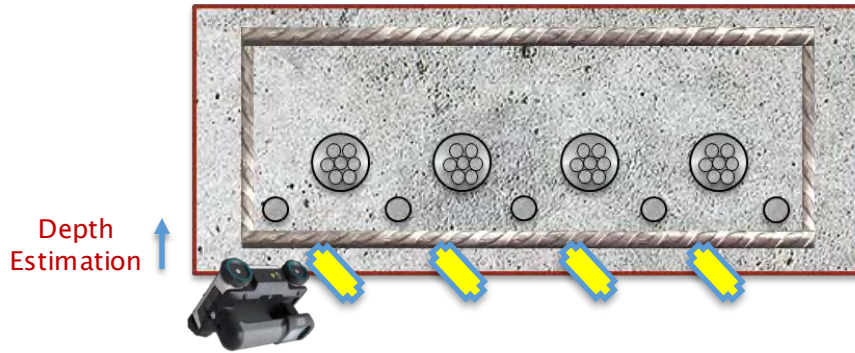
Other Applications:

- Reinforcement and post-tensioning location
- Material thicknesses
- Void Detection
- Sub-surface location
- Service location



For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

NEW HTA PTSI METHODS – GPR



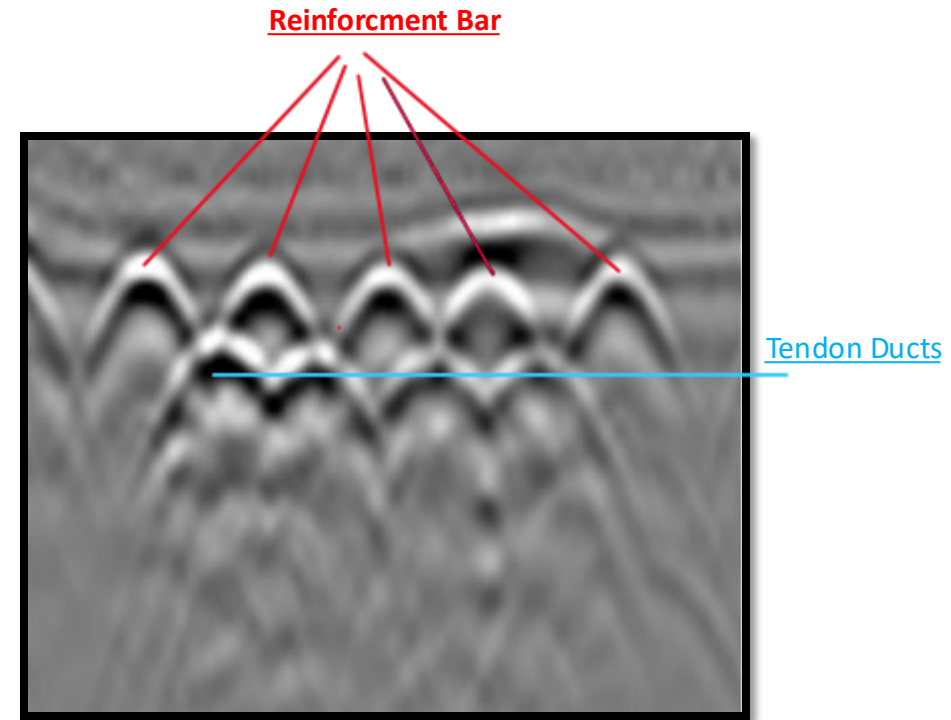
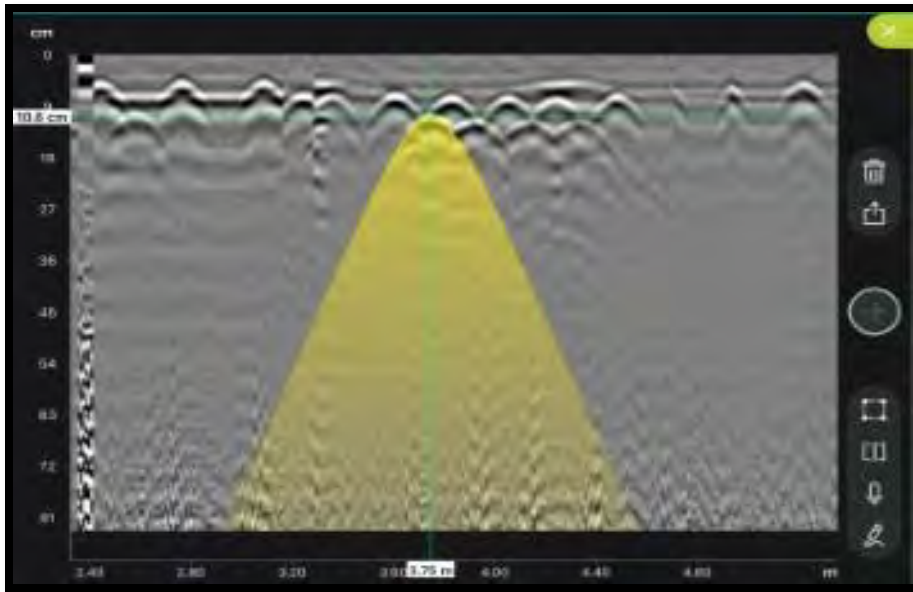
Ground Penetrating Radar provides an accurate determination of the location of post tensioning ducts and provides an estimation of the depth of cover for subsequent breaking out.

This method allows post tension ducts to be found quickly and prevents damage to the ducts or tendons from blind drilling.

For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

GPR & PUNDIT ULTRASOUND PULSE ECHO SCANS FOR BADMINTON BRIDGE

GPR scans taken over the north pier eastbound from the deck of the bridge. As these show, the four tendon ducts running through the structure and over the pier are at a depth of 106mm.



For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

NEW HTA PTSI METHODS

Here's an example of our GPR survey that we carried out on Brent Cross flyover back in 2017. The GPR was used to locate the tendon ducts & reinforcement.



For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

NEW HTA PTSI METHODS – TOMOGRAPHY



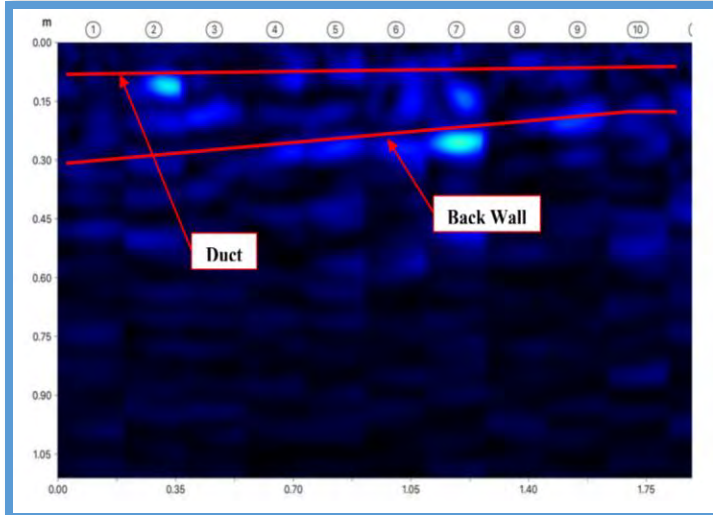
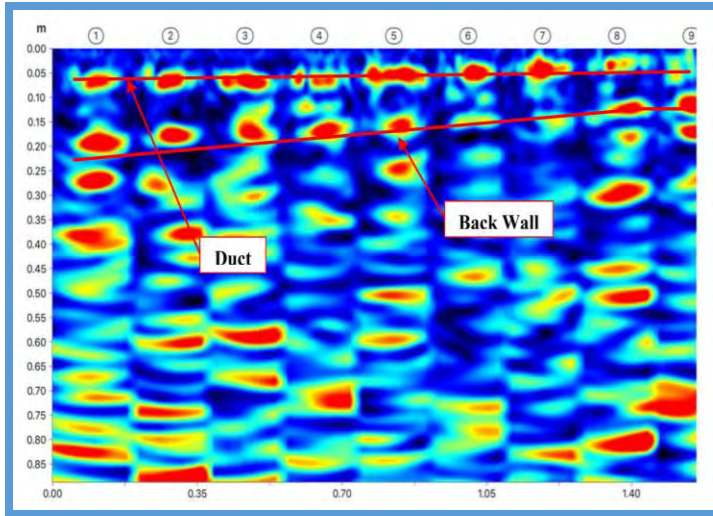
Pundit Pulse Array Live 'Tomography' is used to detect voids and defects – removing the large amount of guesswork used in the traditional approach.

This prevents any breaking out of areas that do not require it and focuses on areas that show potential problems.

For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

PUNDIT ARRAY LIVE 'TOMOGRAPHY'

APPLICATION

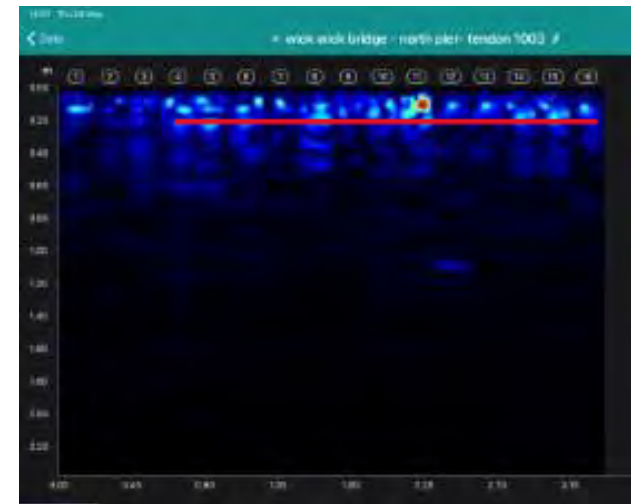
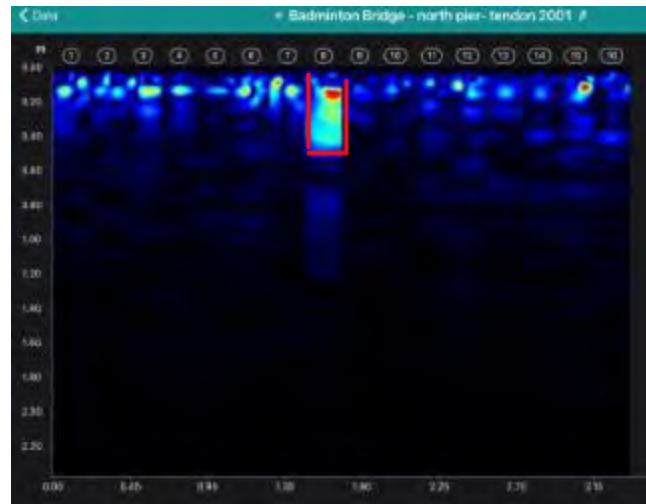
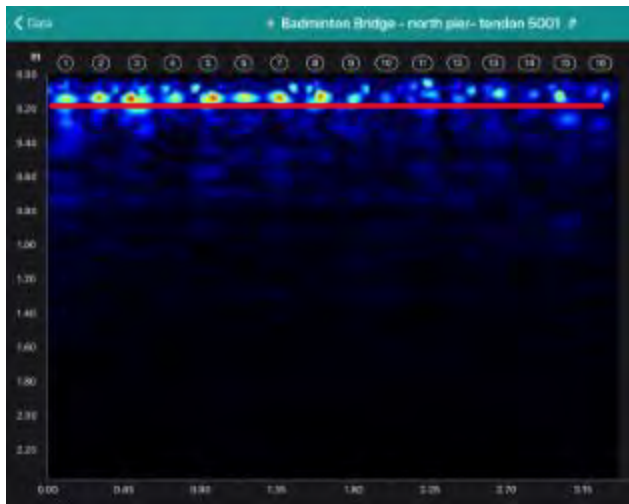


Other Applications:

- Determining the thickness of elements (slabs, abutment walls)
- Void detection
- Delamination determination

For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

PUNDIT ULTRASONIC PULSE ECHO RESULTS – BADMINTON BRIDGE



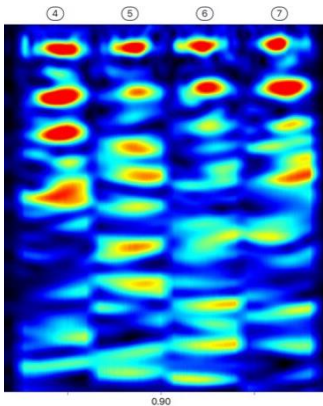
Due to the condition of the structure after the preparation of the bridge being demolished. We were unable to collect clear & accurate data from the pundit tomography. Where the concrete surface had been perforated after the removal of tarmac & waterproofing we was left with a delaminated & spalled surface. As you can see from the highlighted areas on the scans above you can see that there's no clear run of tendon ducts. This is where you can't apply even pressure through the transducers which distributes the ultrasonic waves through the concrete slab.

For definitive answers not guesswork
01707 657 212 testing@hendersonthomas.co.uk

NEW HTA PTSI METHODS

Quicker, cleaner and less destructive. Breakouts are only undertaken where voids and defects are indicated.

This is a perfect example of two tendon ducts within the same structure. As you can see that location A has indicated voided areas on the Pundit and that location B has shown fully grouted ducts. We then carried out two inspections on both areas to calibrate our findings to the Pundit tomography. As you'll see that the tomography was accurate and we was able to pin point the correct areas without causing unwanted destructive works

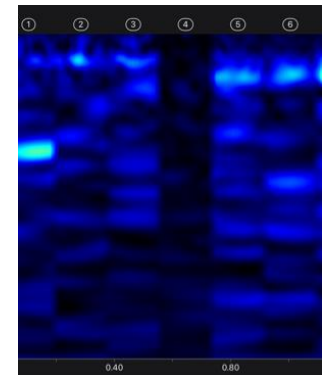


Spot A:
Duct with known void

The Object at Spot A



Spot B:
Duct known to be fully grouted



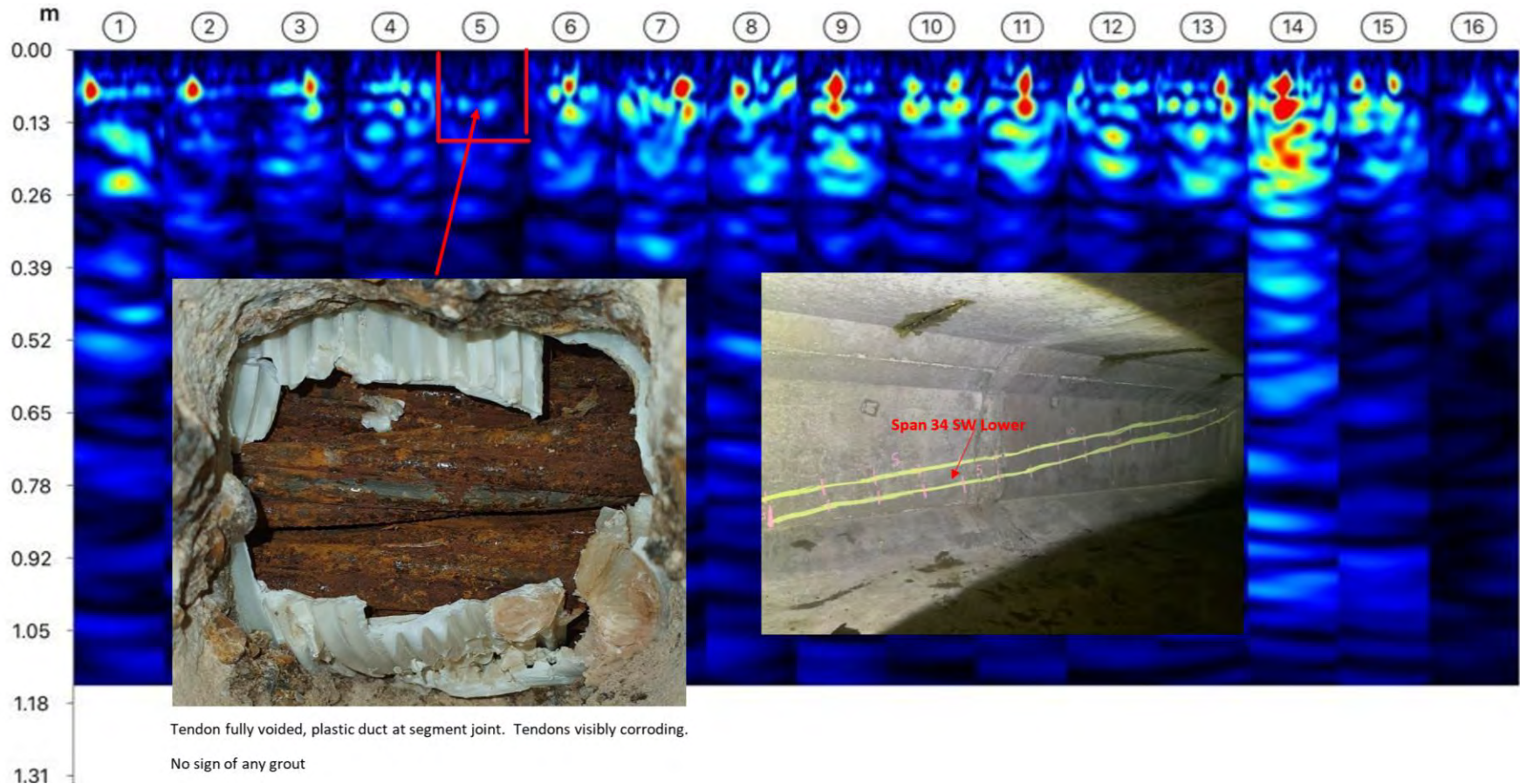
The Object at Spot B



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GPR THEN TOMOGRAPHY THEN EXPOSE

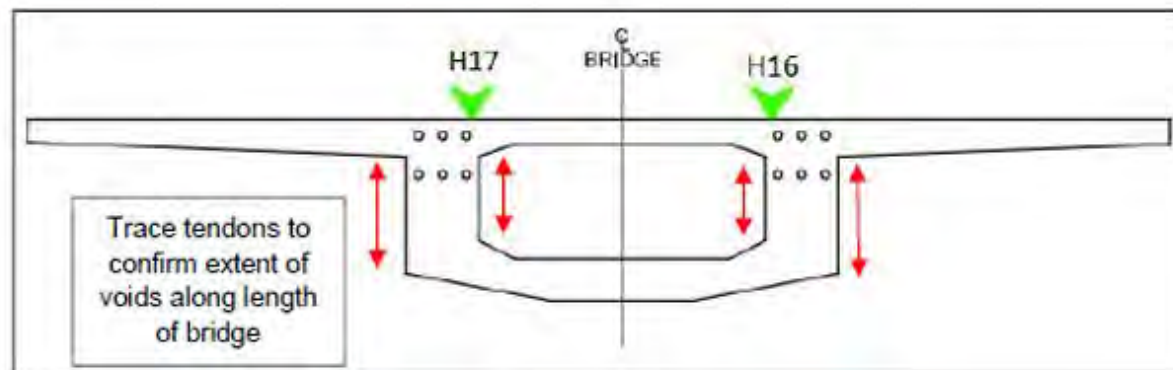
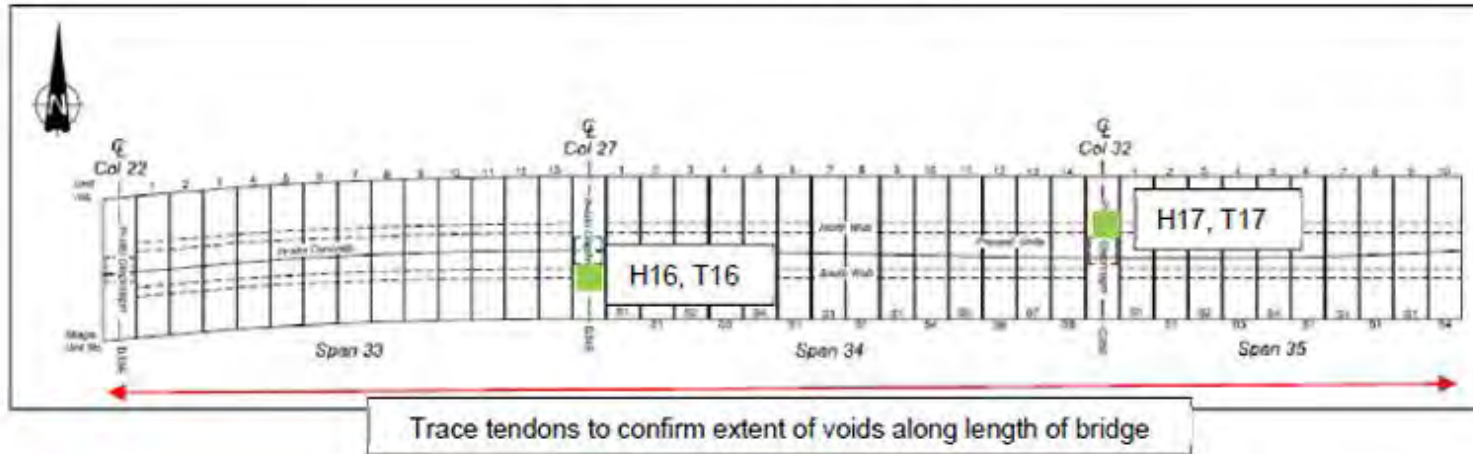
We have another example of a voided tendon duct as shown in grid 5.



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EXAMPLE FOR NDT'S FROM THE GOLDEN VALLEY

Plan View and Section of Structure



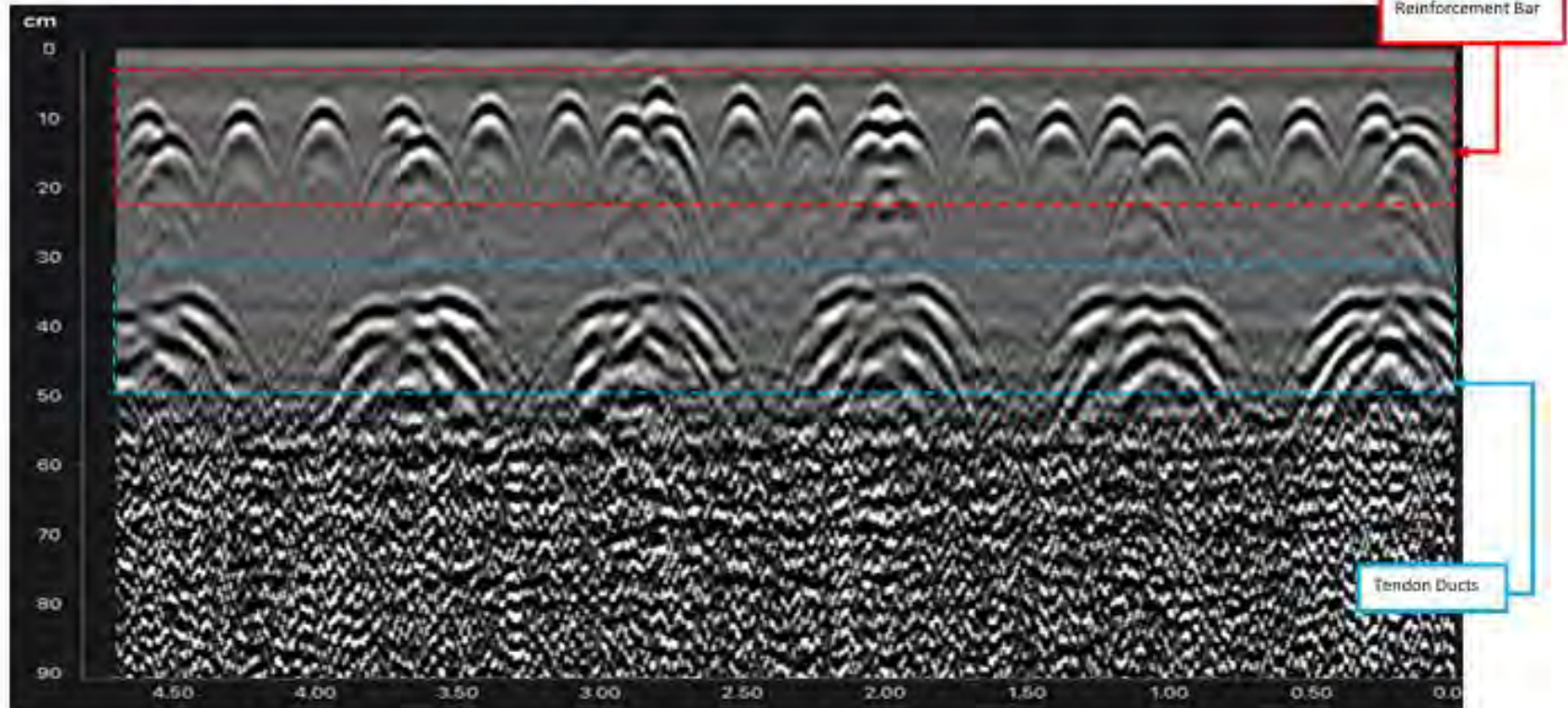
For definitive answers not guesswork
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GOLDEN VALLEY GPR SURVEY

GPR Live scan

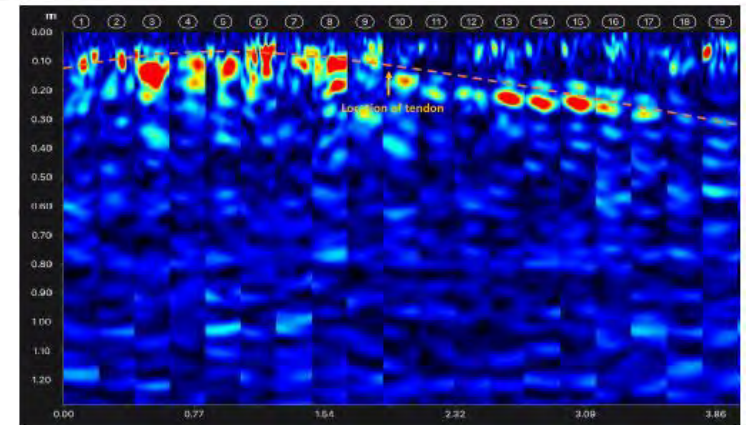
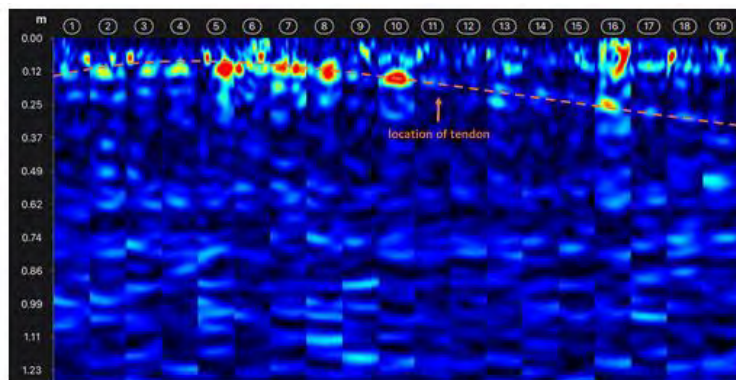
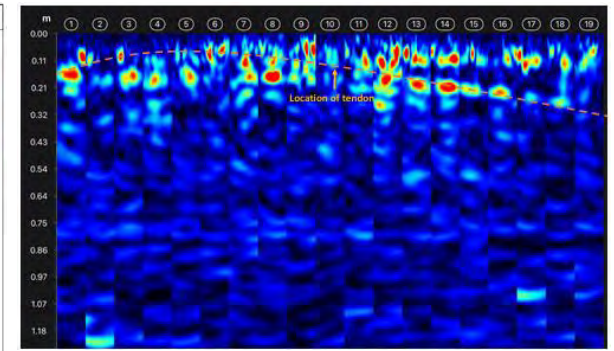
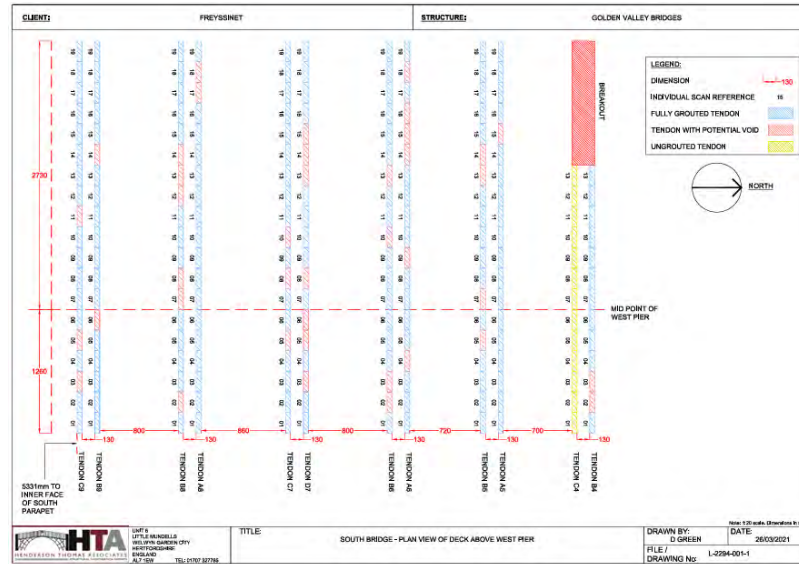
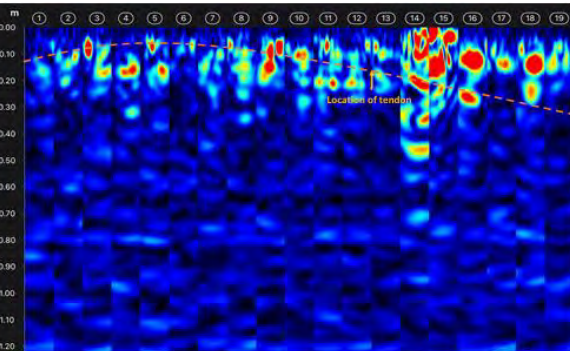
Tendon groups 4 - 9

The GPR scan pictured shows the reinforcement bar and tendon ducts embedded within the concrete. This scan was run transversely across the deck at 2700mm west of the west pier. Although the scan was run transversely across the deck you always scan in a perpendicular direction to the direction of the rebar/tendon. The purpose of this scan is to map out the locations of the tendons so that we can follow their line with the pundit and to help confirm their depth on the pundit. As we can see from the scan the top of the tendon ducts has approximately 350mm cover at this location.



For definitive answers not guesswork
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GOLDEN VALLEY TOMOGRAPHY RESULTS



For definitive answers not guesswork
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University of
Strathclyde
Engineering

Wick Wick Viaduct – Structures Moonshot

ALICS: Adaptive Lighting for the Inspection of Concrete Structures

Department of Civil and Environmental Engineering, University of Strathclyde

Presented by:

Prof Rebecca J Lunn MBE FRSE FREng FICE FIE, rebecca.lunn@strath.ac.uk
Dr Hamish Dow, hamish.dow@strath.ac.uk

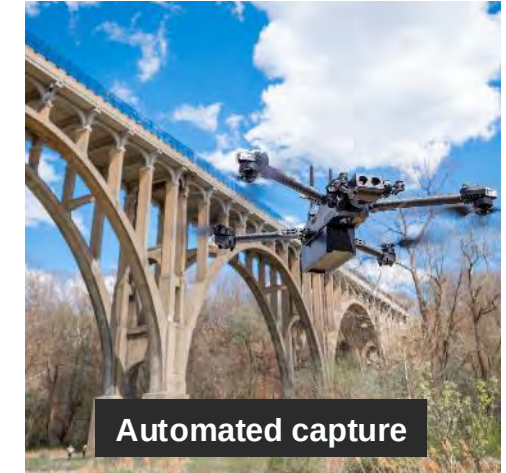
Lighting-assisted Inspections

- AI-powered algorithms can inspect captured inspection images.
- However, these methods are challenged by shadows and inconsistent lighting:

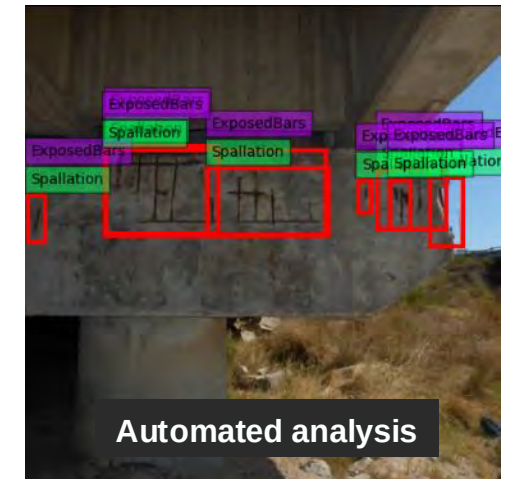


Hidden cracks

False cracks



Automated capture



Automated analysis

Lighting-assisted Inspections



Diffused lighting

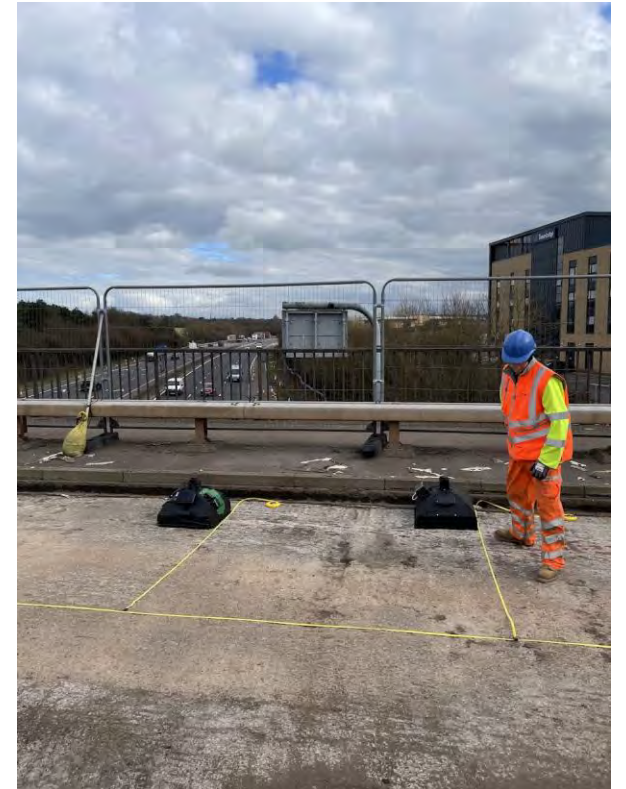
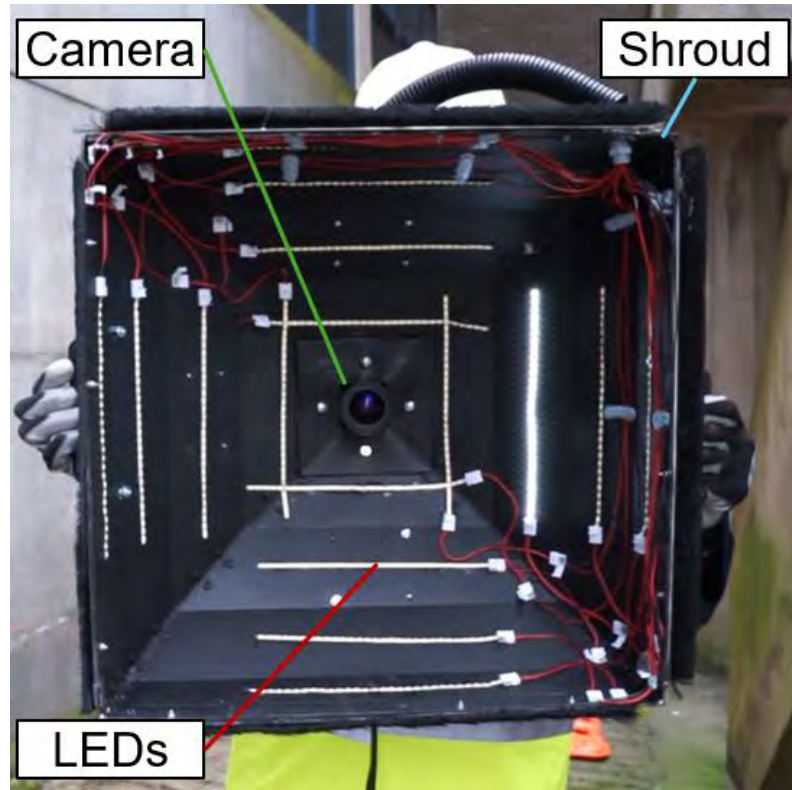


Directional lighting



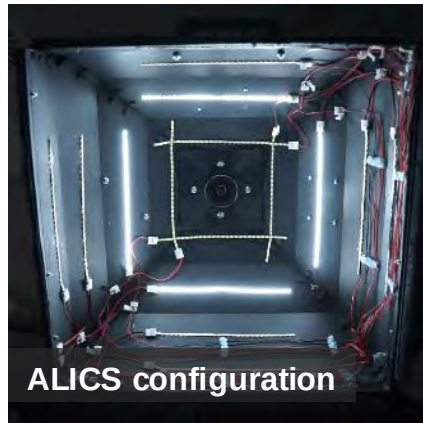
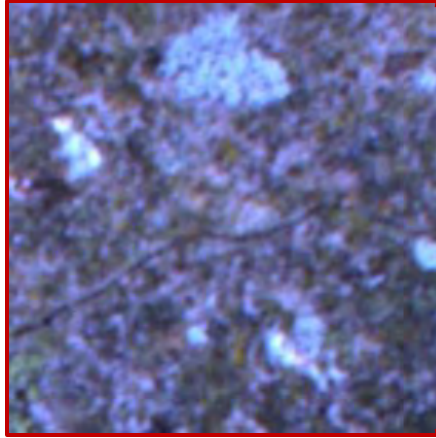
ALICS Hardware

ALICS: Adaptive Lighting for the Inspection of Concrete Structures

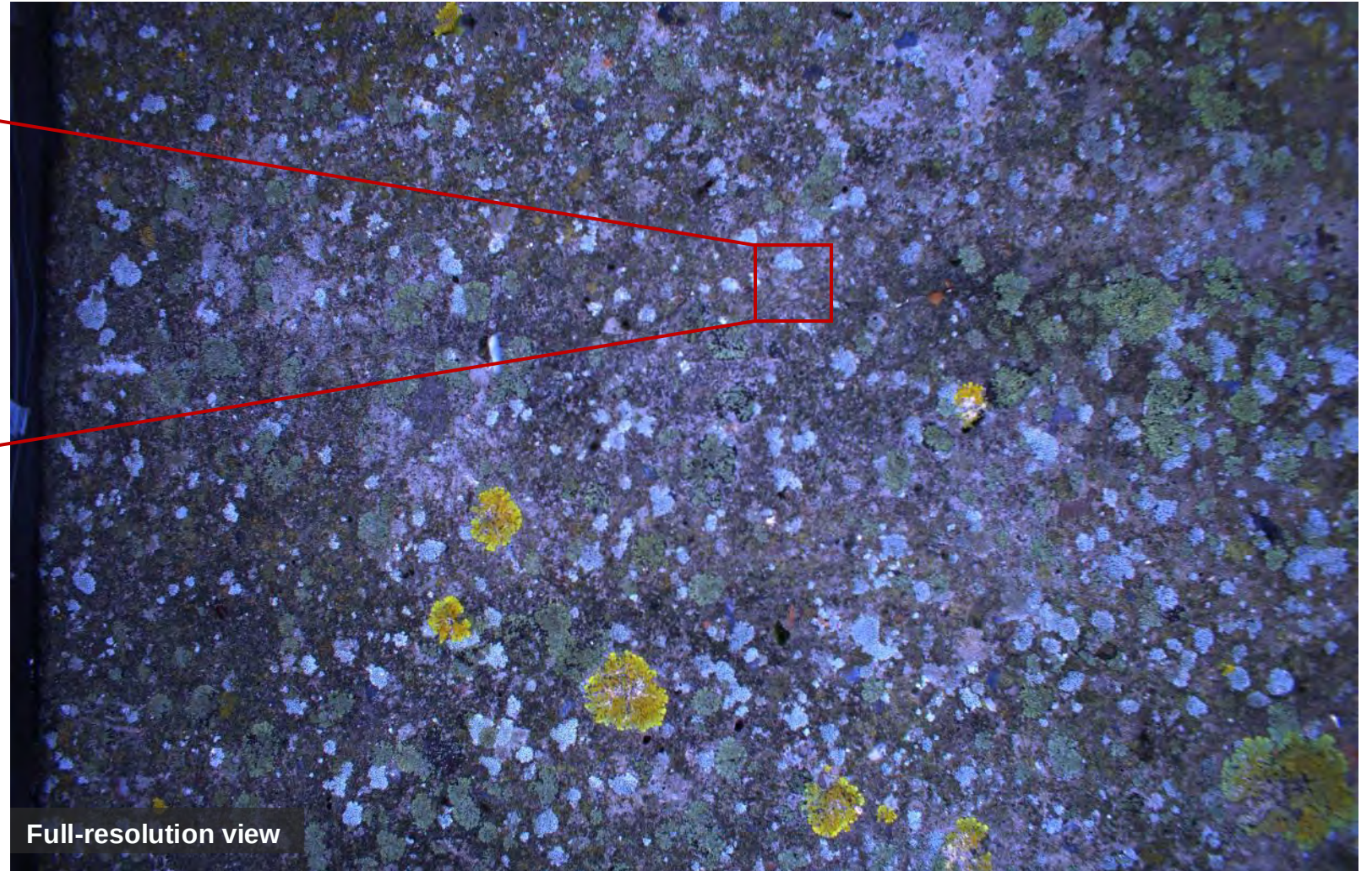


ALICS Software

Diffused Lighting



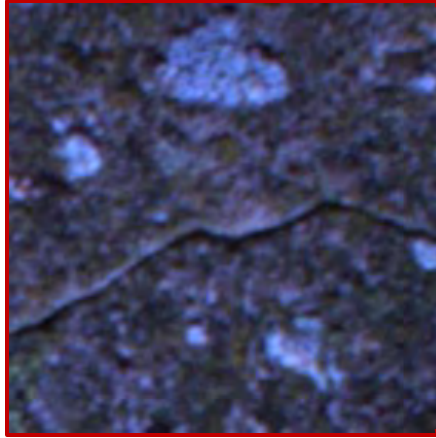
ALICS configuration



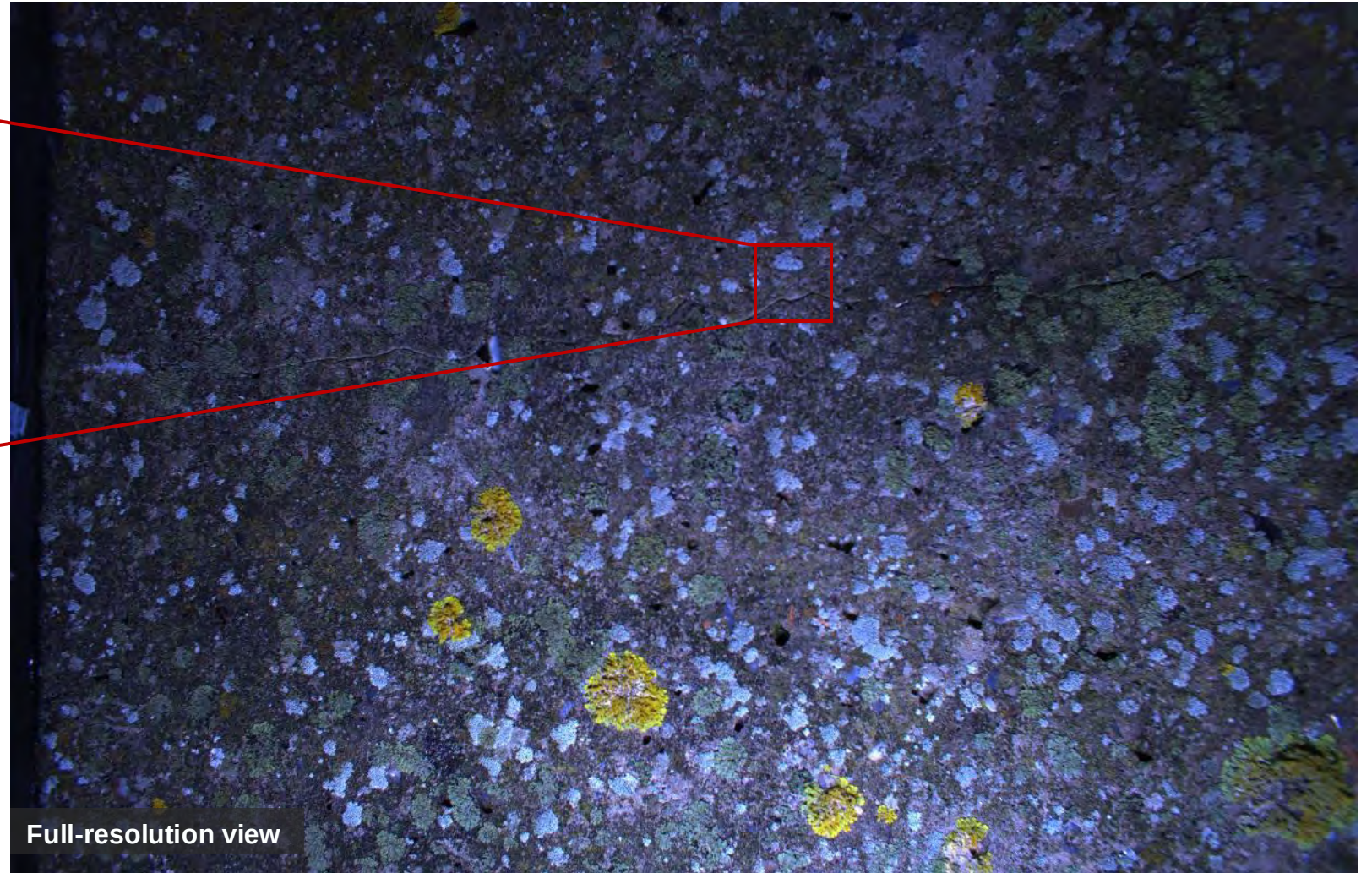
Full-resolution view

ALICS Software

Below Lighting



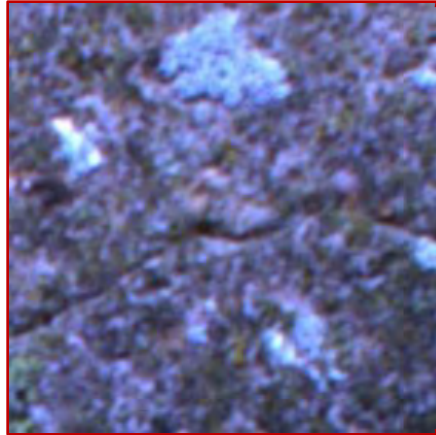
ALICS configuration



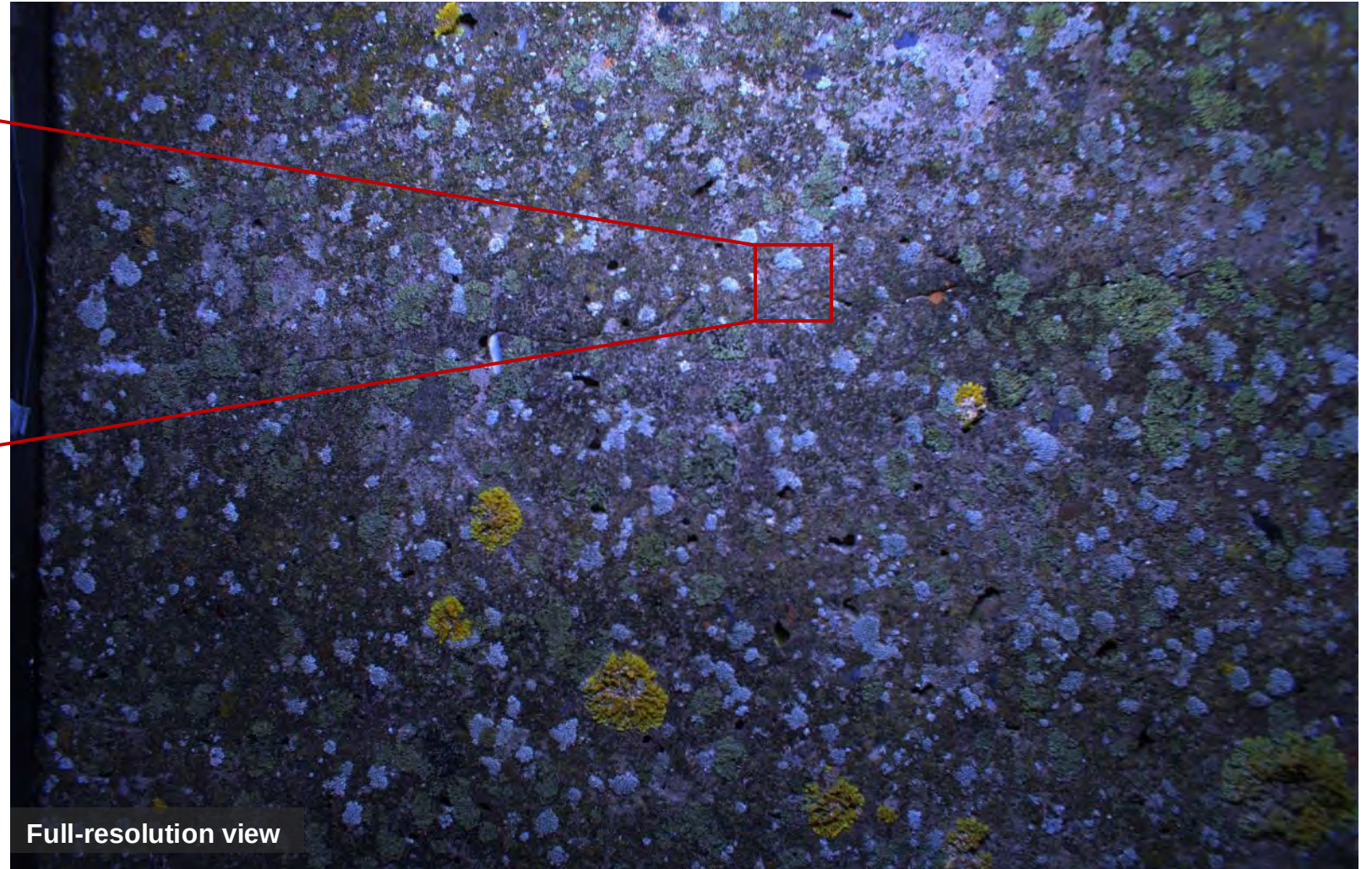
Full-resolution view

ALICS Software

Above Lighting



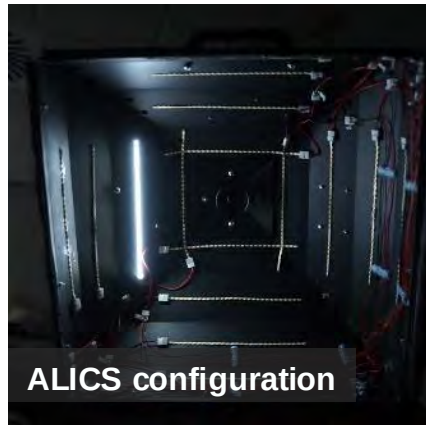
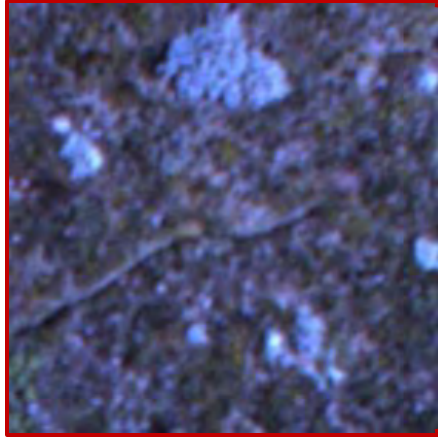
ALICS configuration



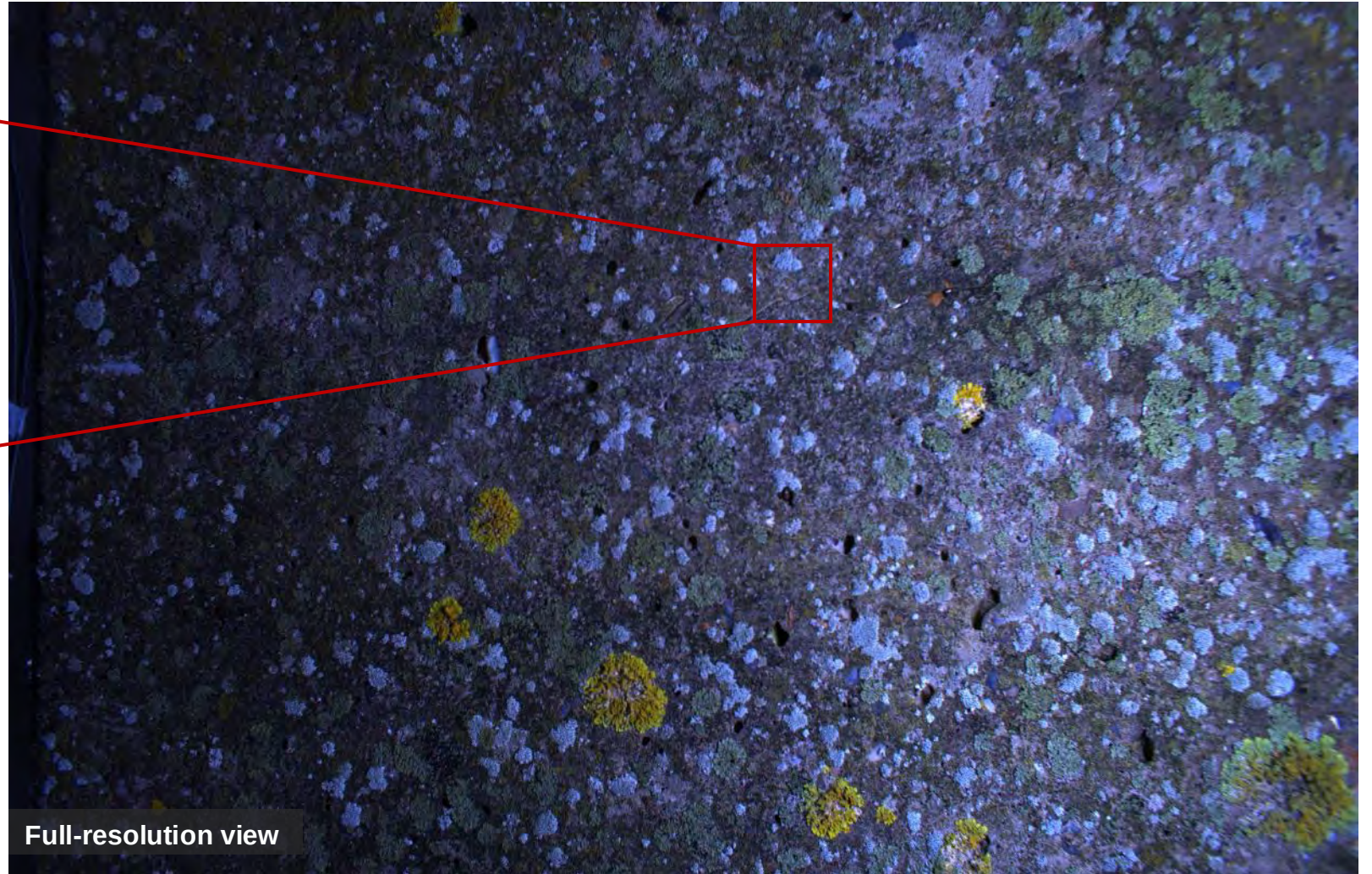
Full-resolution view

ALICS Software

Right Lighting



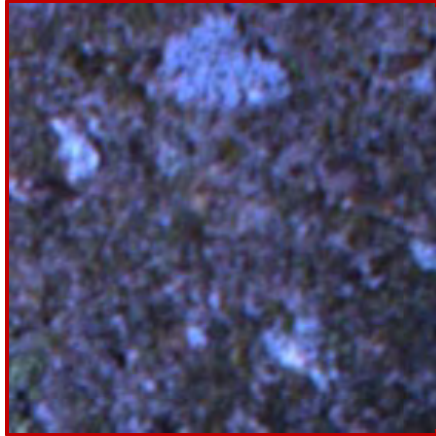
ALICS configuration



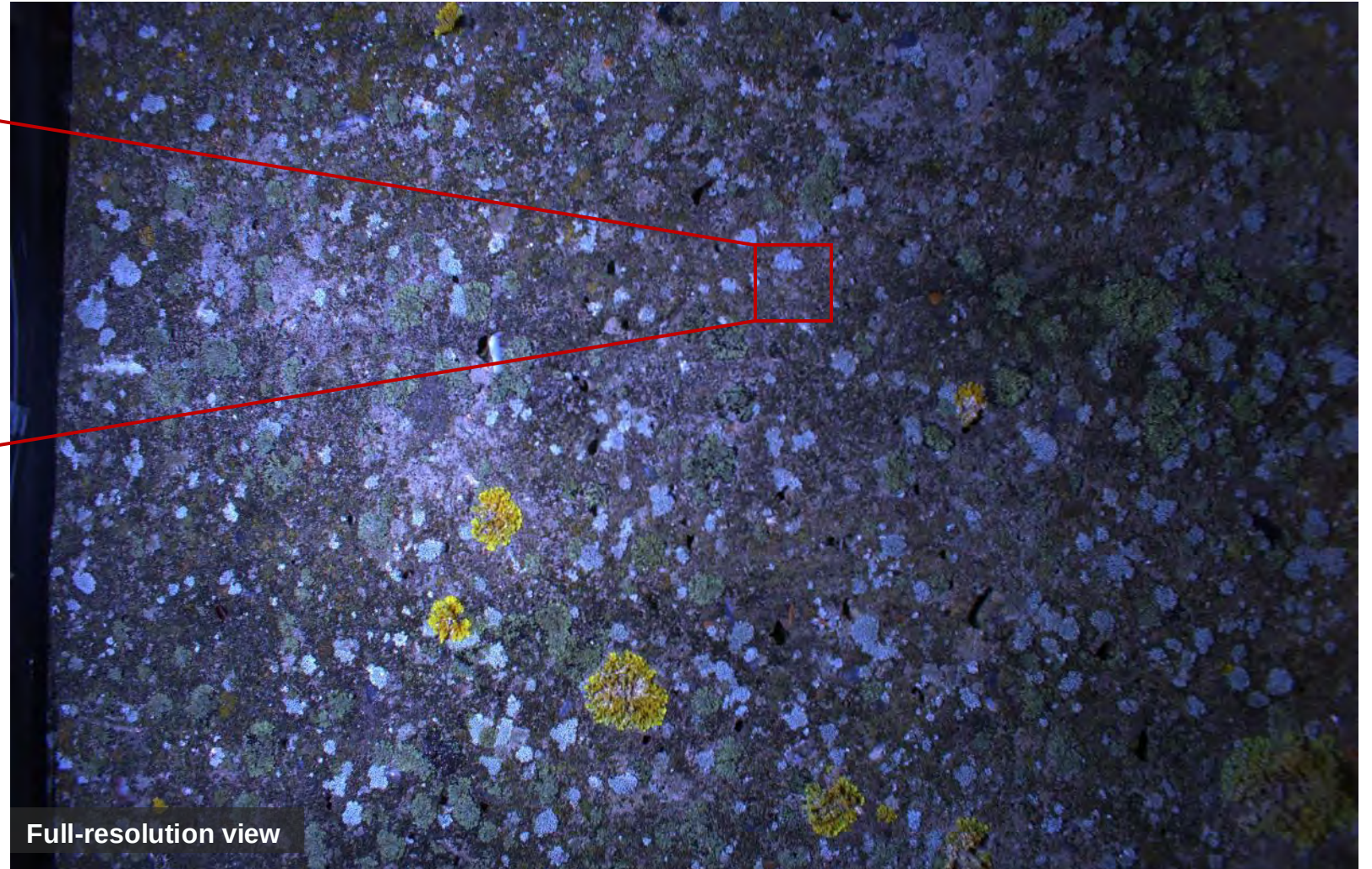
Full-resolution view

ALICS Software

Left Lighting

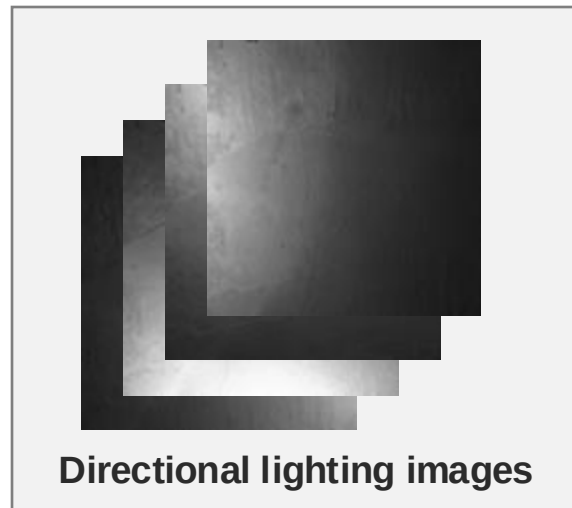


ALICS configuration

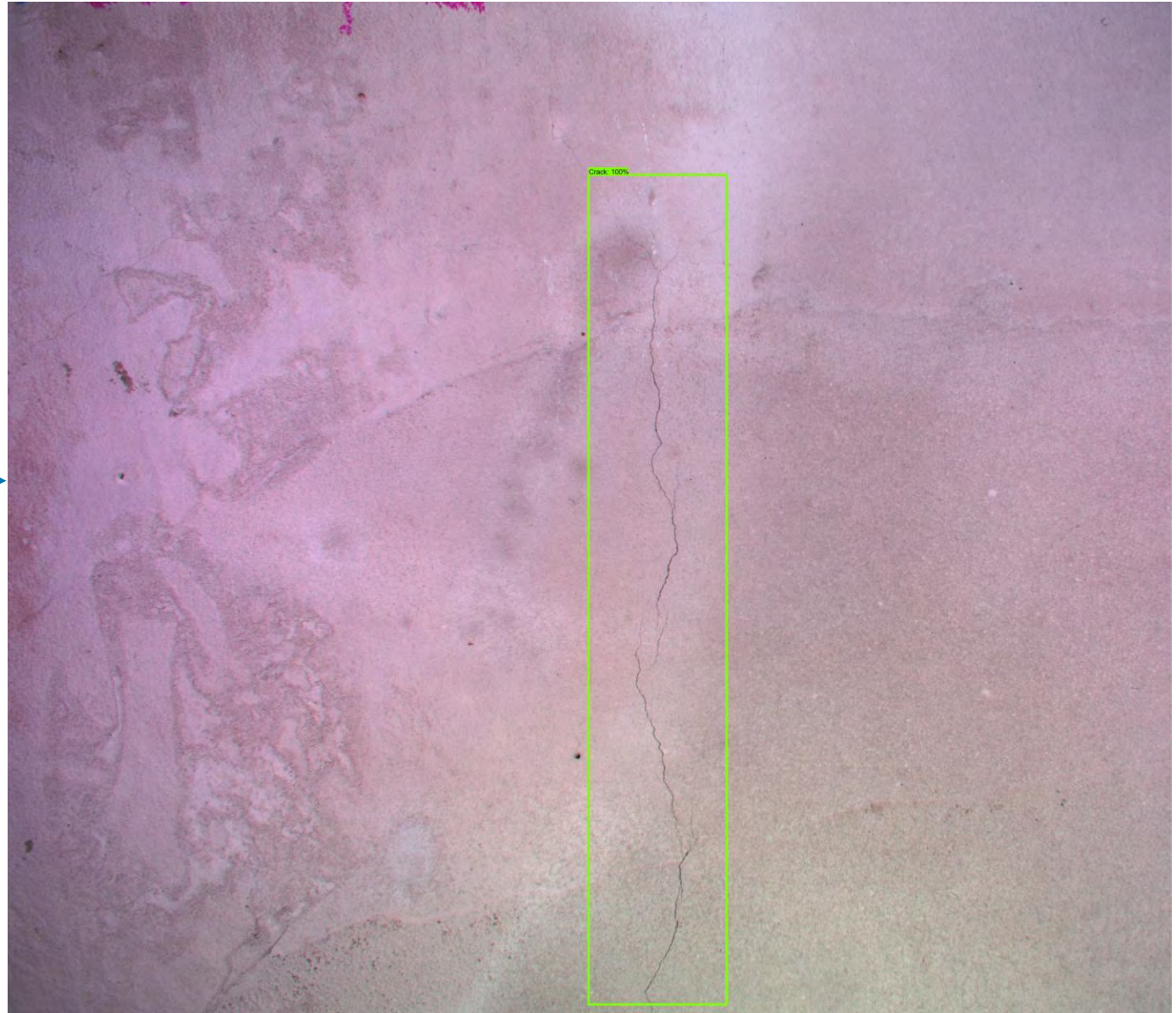
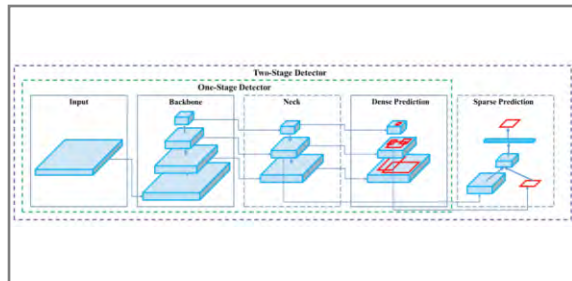


Full-resolution view

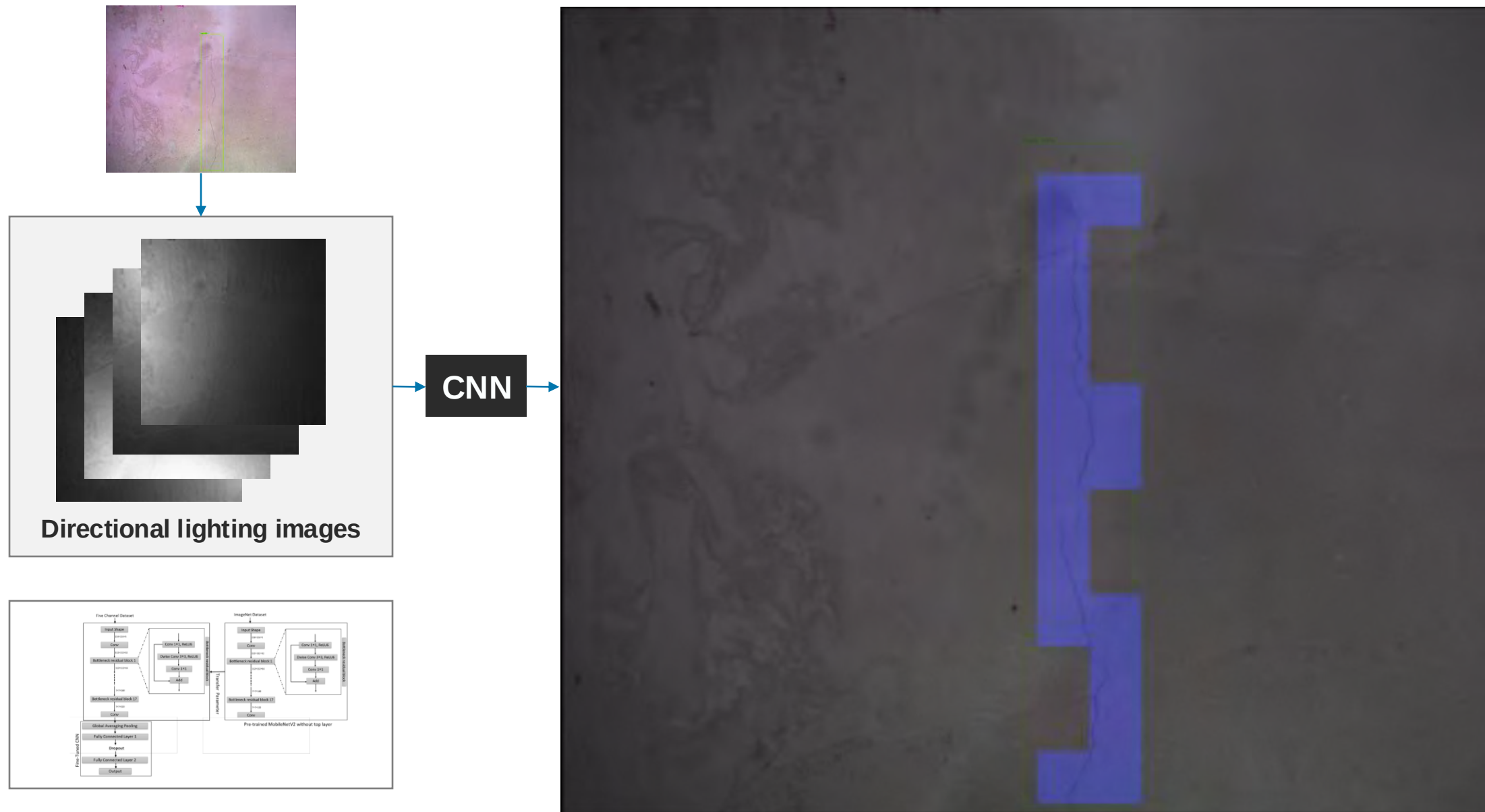
Region-proposal Network



Reg



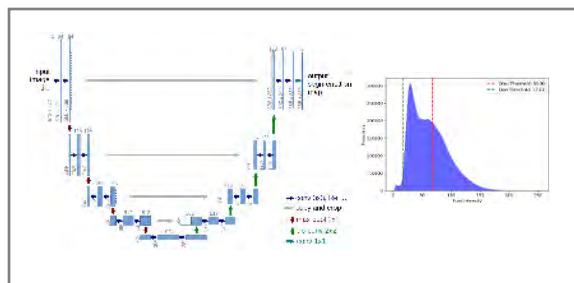
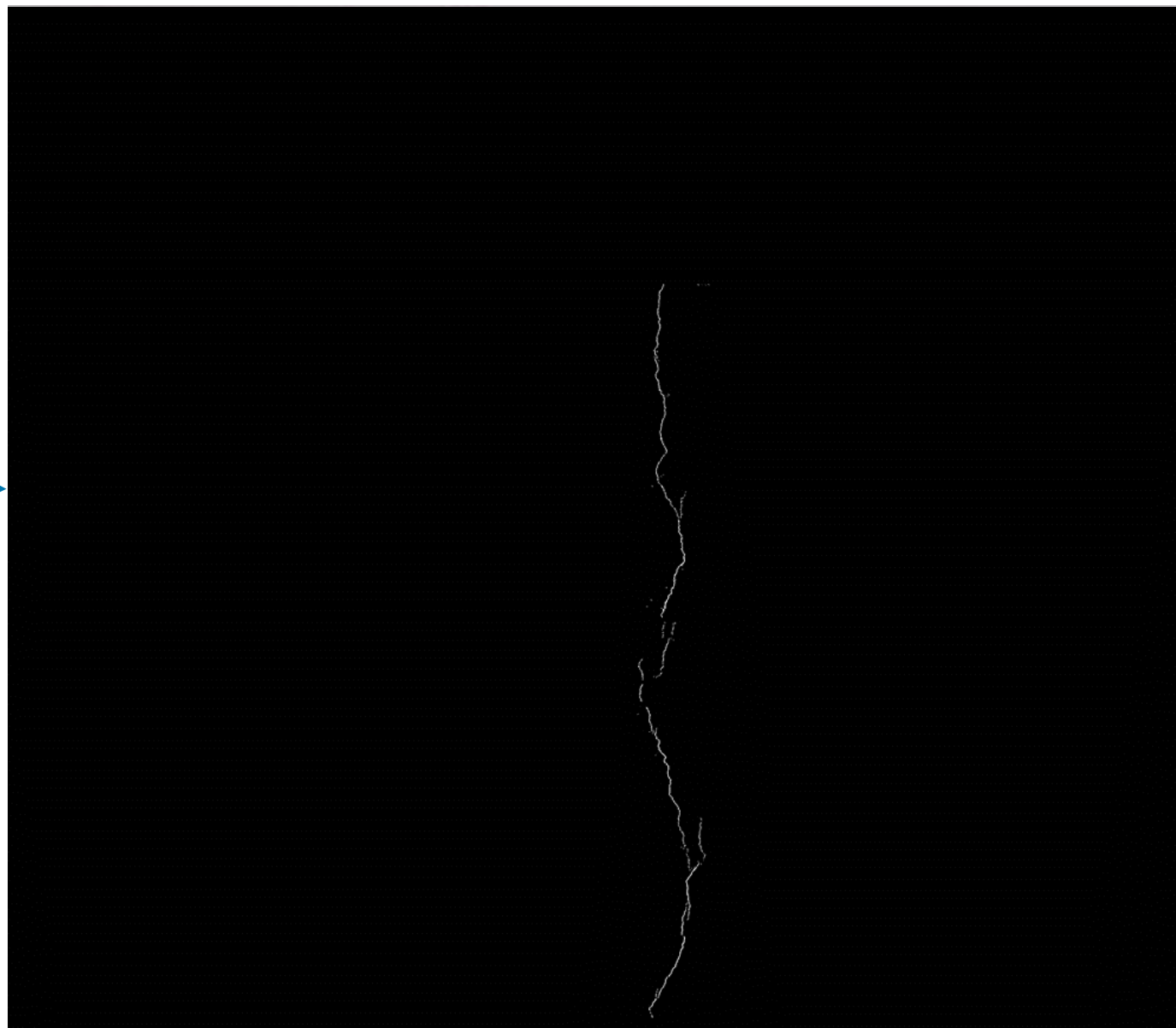
Convolutional Neural Network



Segmentation (Grey-box)



Seg



Inspection Task

Bridge Soffit



Previous work

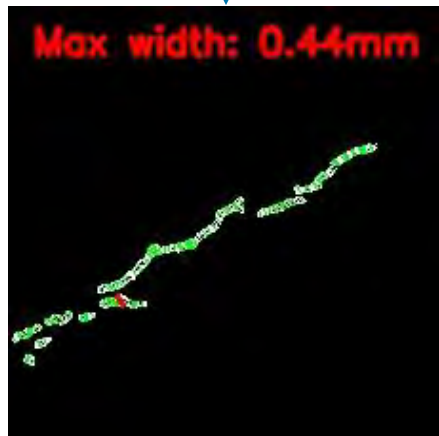
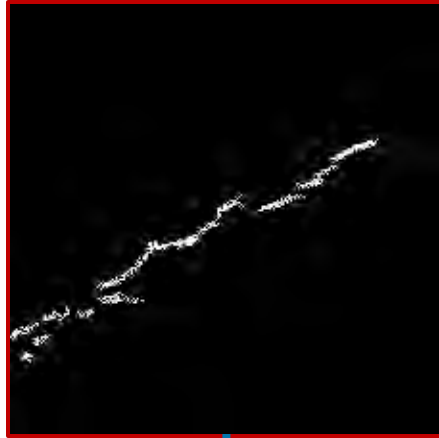
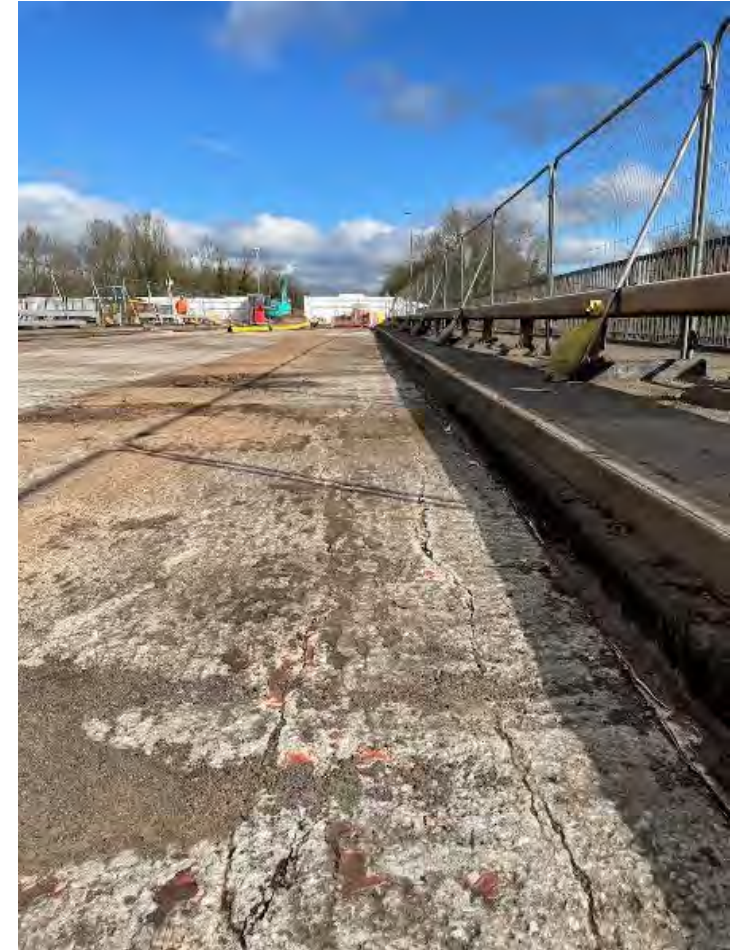


Image from another site

Inspection Task

Bridge Deck – Day of Inspection



Inspection Task

Bridge Deck – Day of Inspection

Challenges:



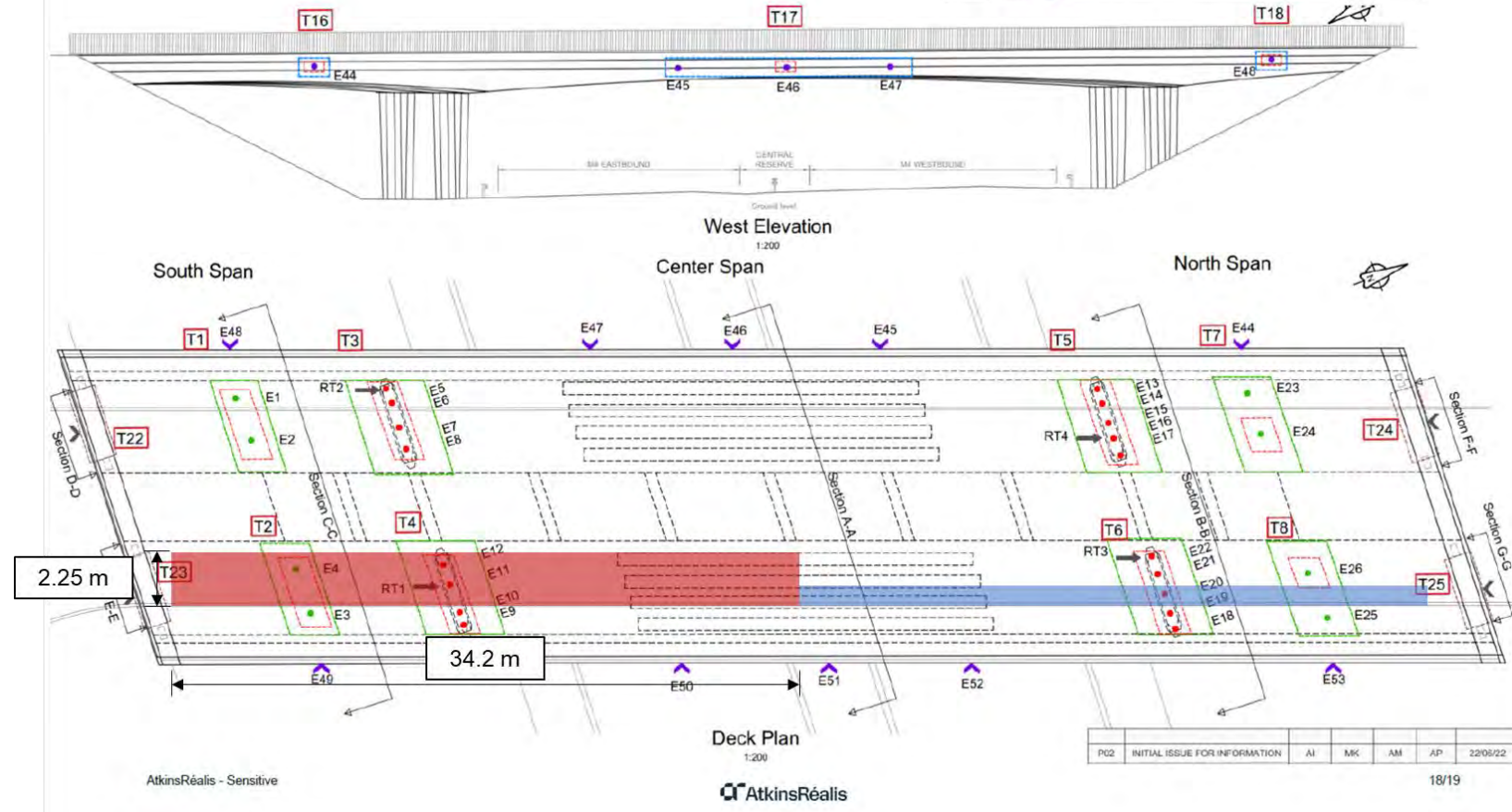
Inspection Task

ALICS Inspection

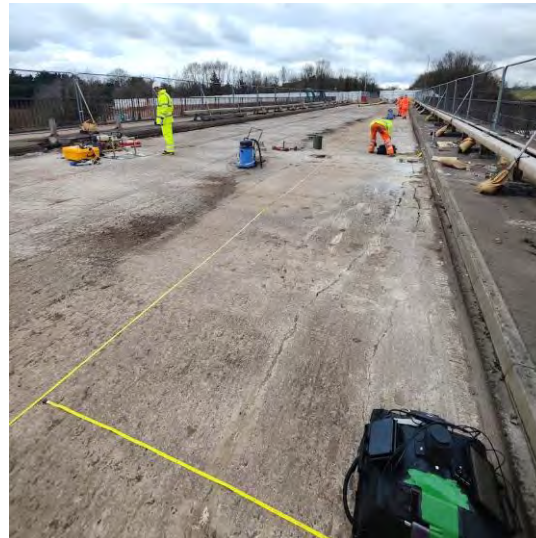
■ Crack map (results presented)

■ Ad hoc crack measurements

KEY			
16	E5-E22	●	Type A - DTE to Longitudinal tendons over high-dust points, from deck level.
27	E27-E33	●	Type B - DTE to Longitudinal tendons at low-dust points, from soffit and deck elevation level.
8	E1-E4, E2-3-E26	●	Type C - DTE to Longitudinal tendons at low-dust points, within trial pits.
14	E34-E67	←	Type D - EAE to longitudinal tendons at deck ends, from deck level.
		□	Deck level - Excavation area to expose ends and anchorages.
		□	Area extent of trial pit, GPR and UPR testing area on deck surface.
		□	Area extent of GPR and UPR testing area on deck soffit and elevation.
		□	Area extent of GPR only, to wind anchorages.
		□	Area extent of CTAs.
6	RT1-RT6	→	Location of residual stress testing.
		□	Chosen EAEs for exposure.
		□	Concrete to be removed for EAE exposure.
8	V1-V8	●	Drill into deck voids from soffit level.



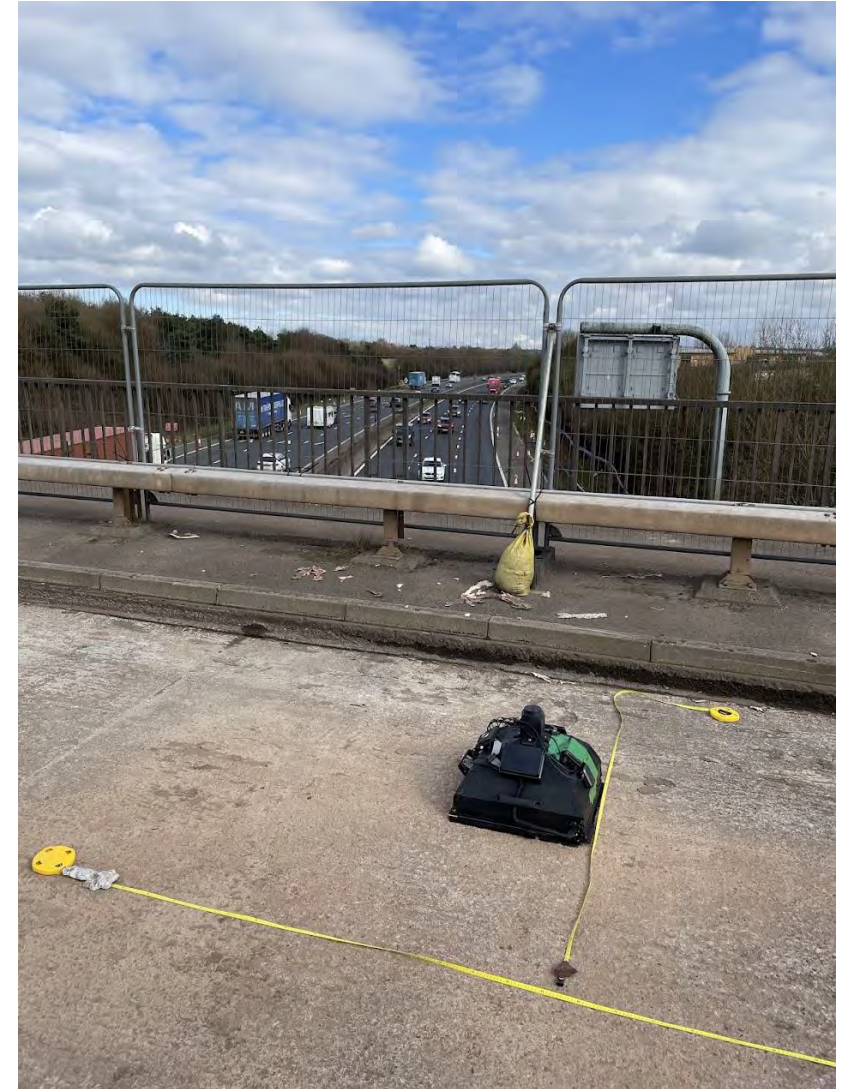
Inspection Method



Inspection Method

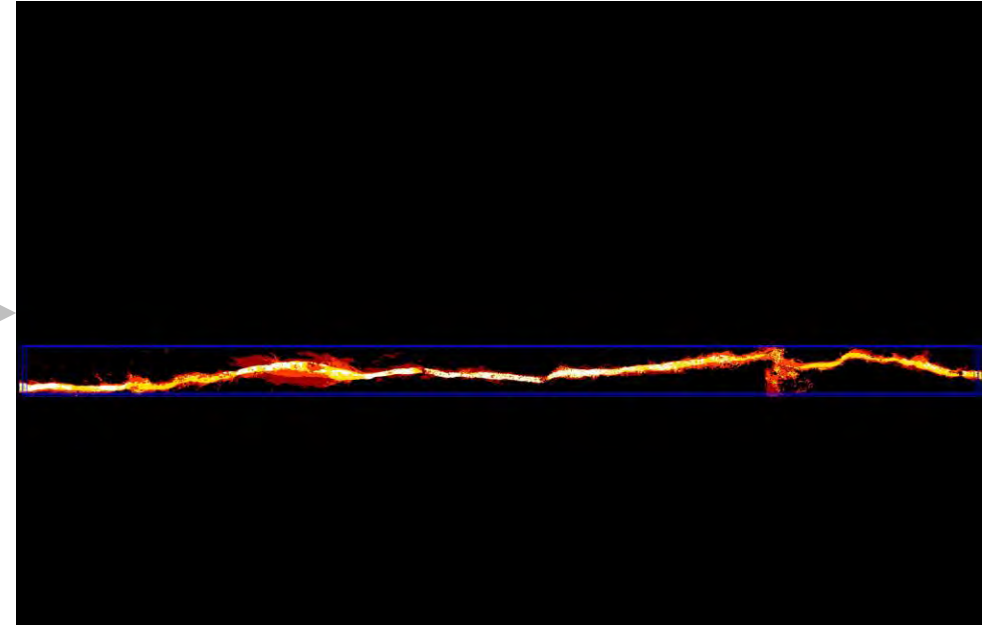
Crack map data:

- 7,600 full-resolution images captured in under 5 hours
- ALICS FOV: 450 mm x 270 mm



Inspection Method

Crack map data



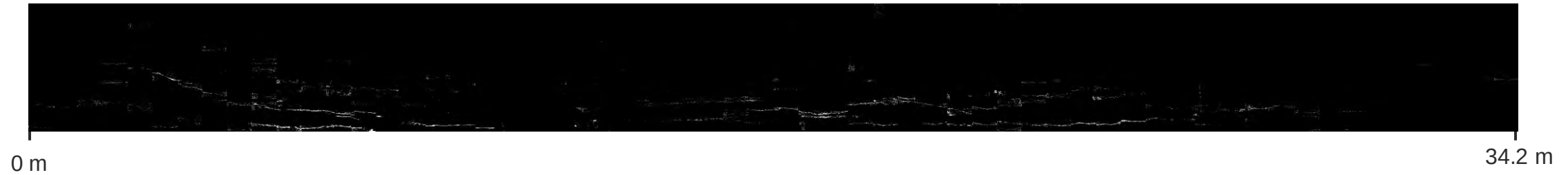
Results

Full results: cracked regions



Results

Full results: cracked pixels (binary)



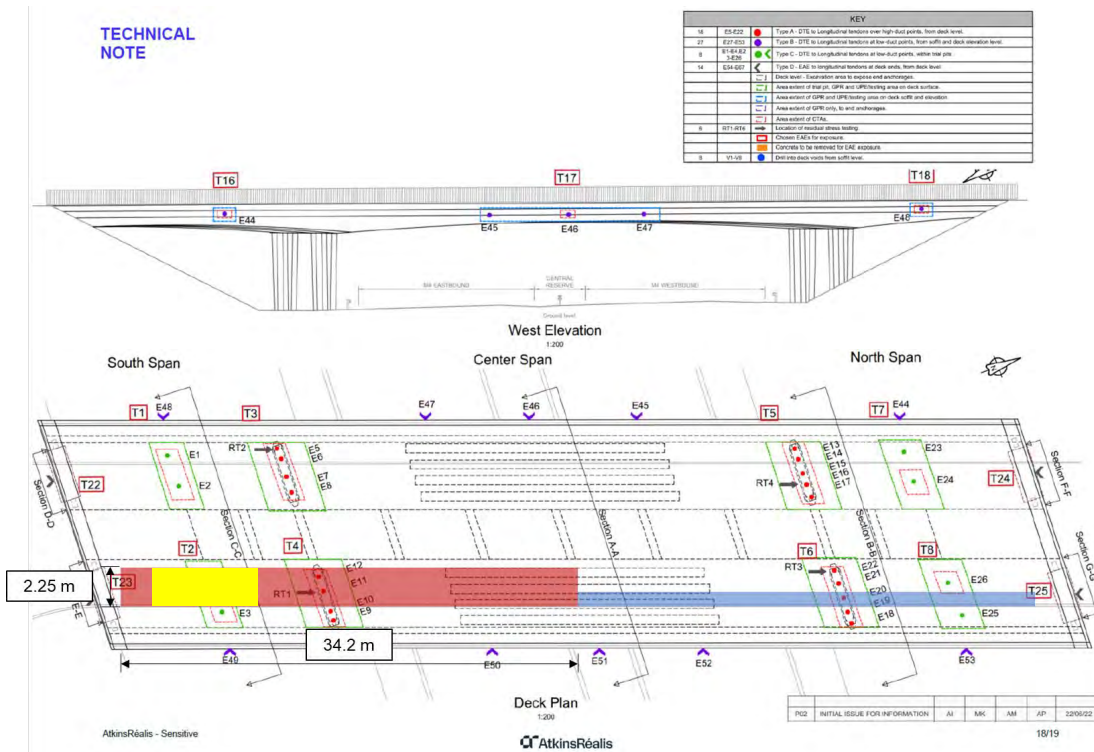
Results

Chainage: 3.3 m – 9.9 m



Results

Chainage: 3.3 m – 9.9 m



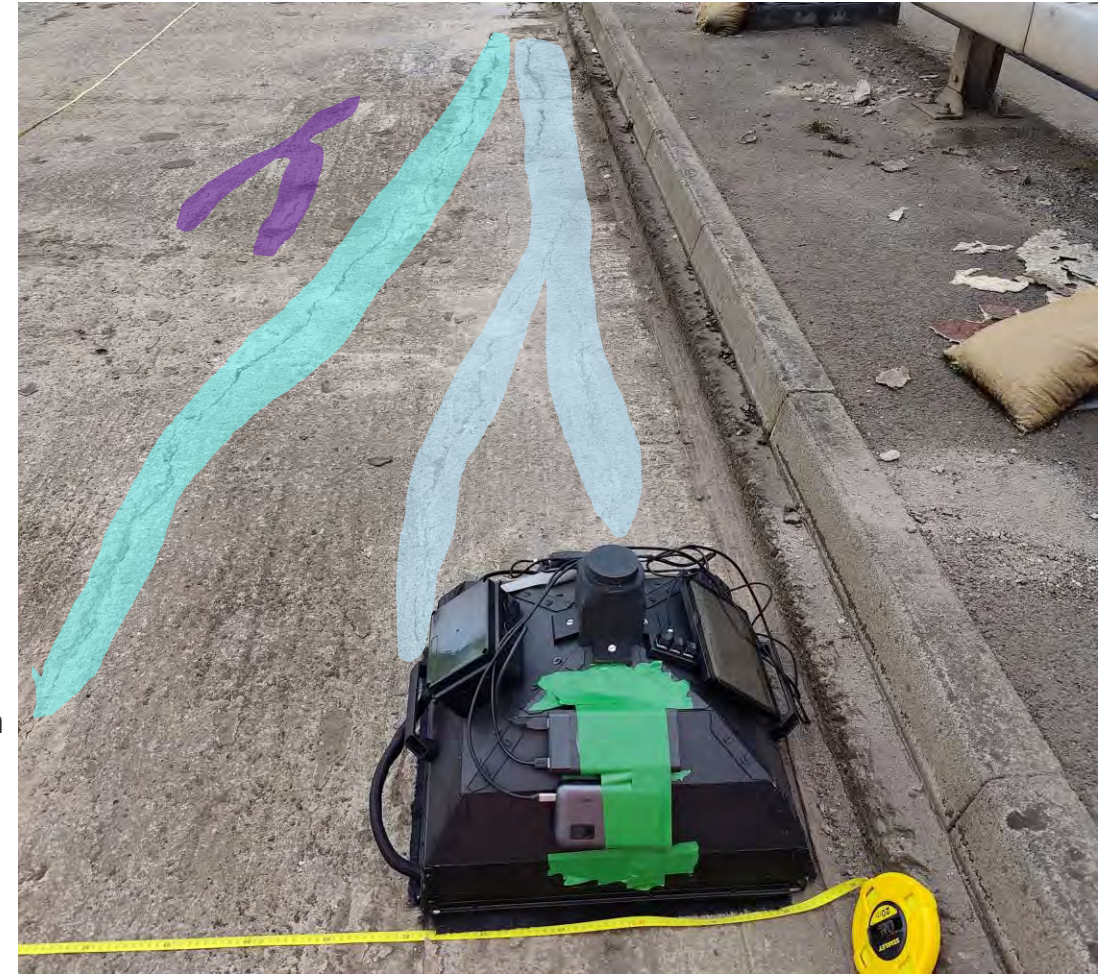
ALICS Inspection

Chainage 3.3 m – 9.9 m



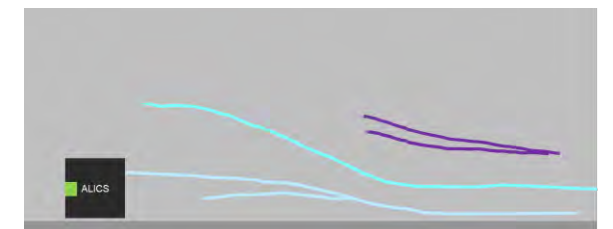
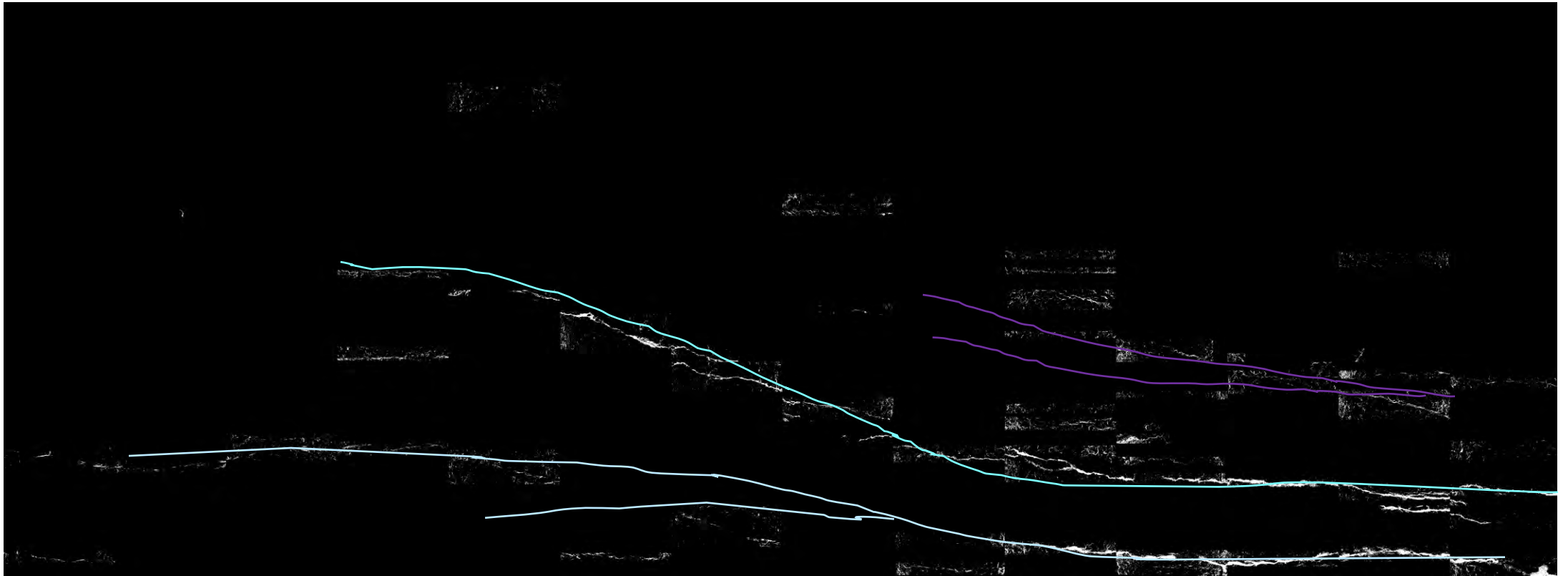
Results

Chainage: 3.3 m – 9.9 m



Results

Chainage: 3.3 m – 9.9 m



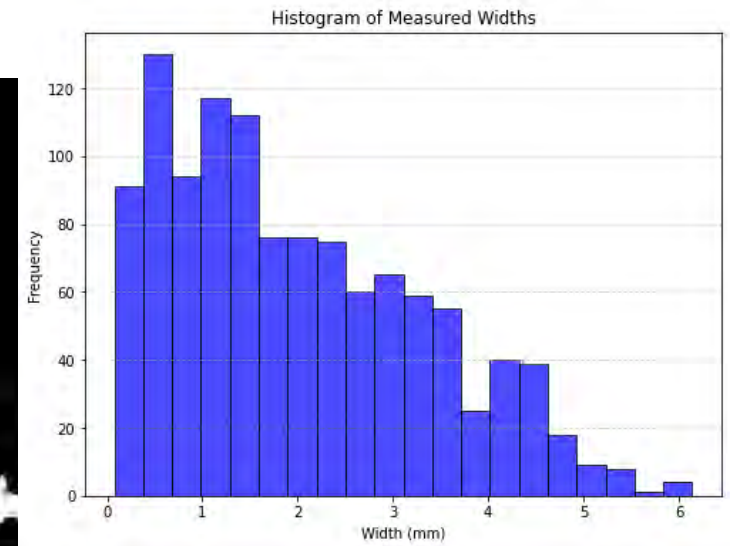
Results

Width measurement



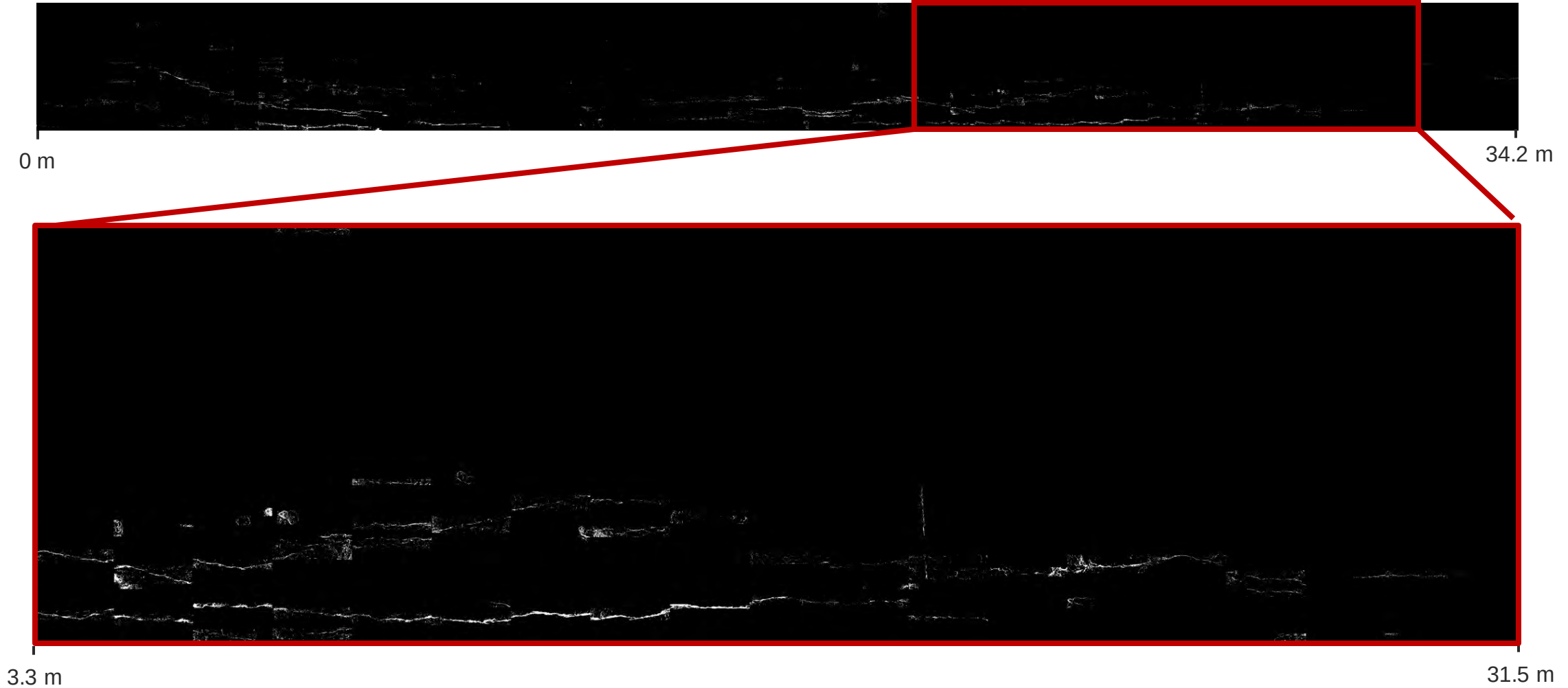
Results

Width measurement - Area 1



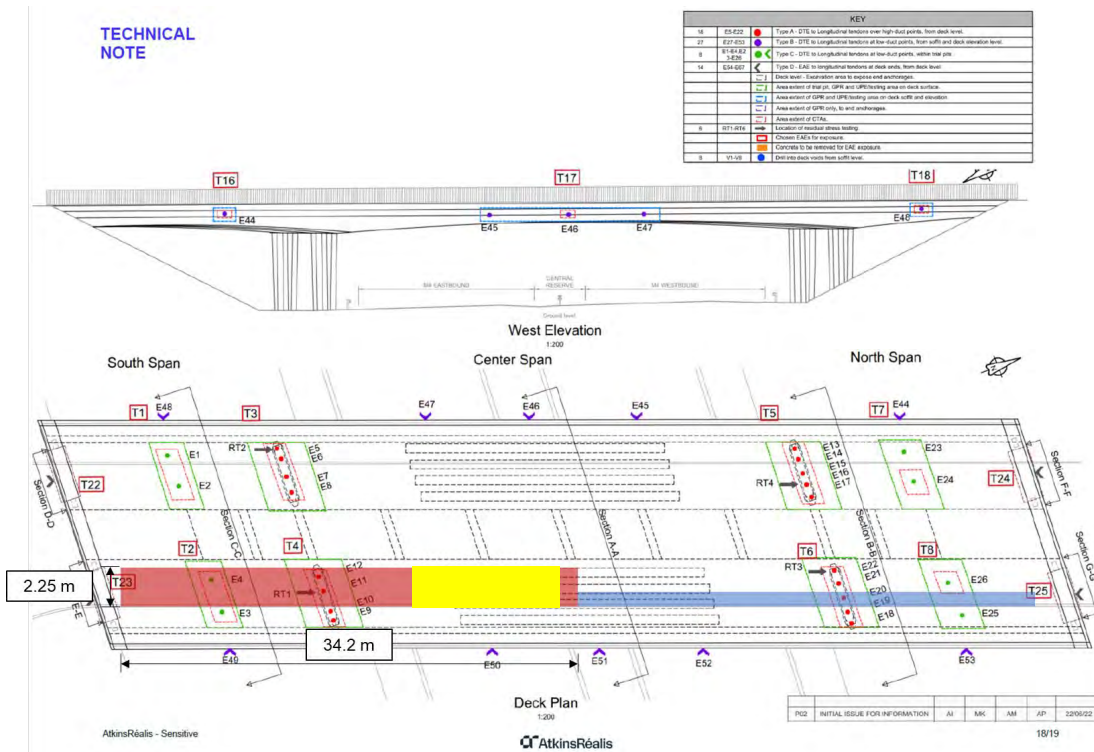
Results

Chainage: 19.8 m – 31.5 m



Results

Chainage: 19.8 m – 31.5 m



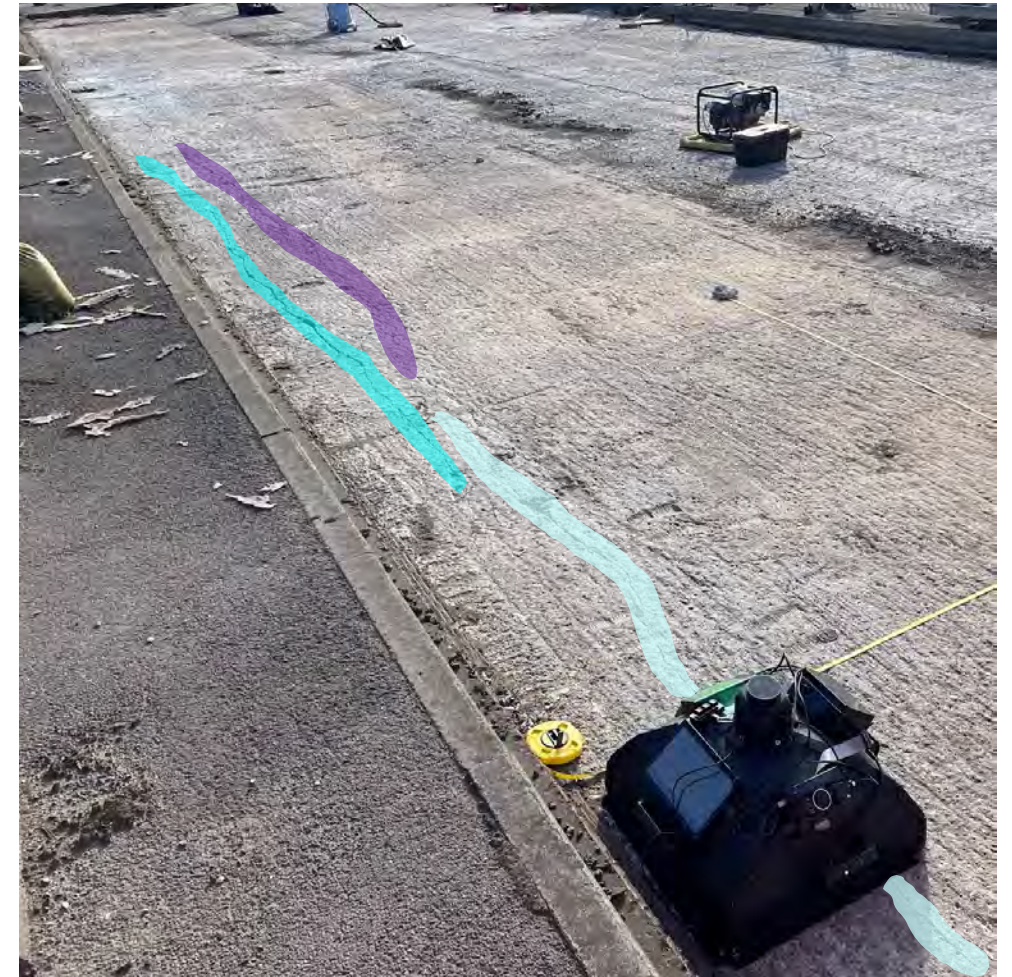
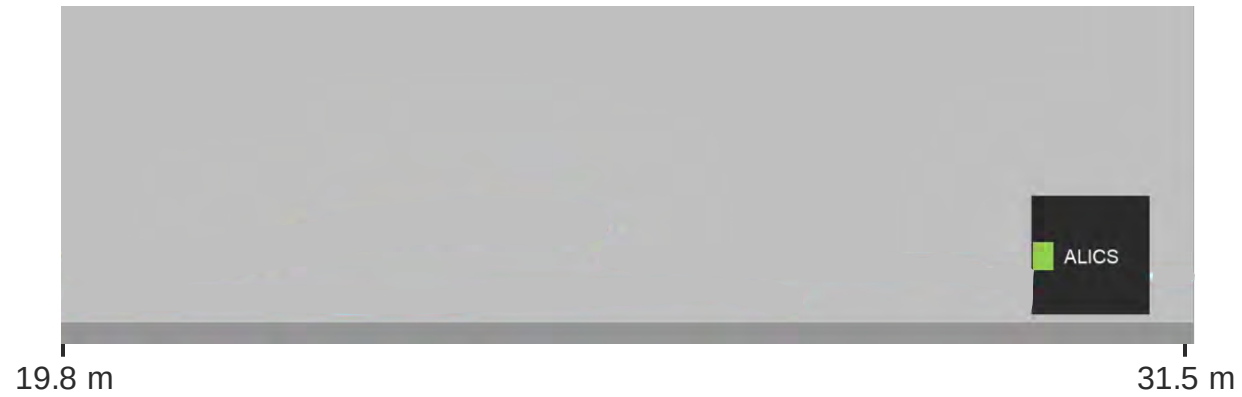
ALICS Inspection

Chainage 19.8 m – 31.5 m



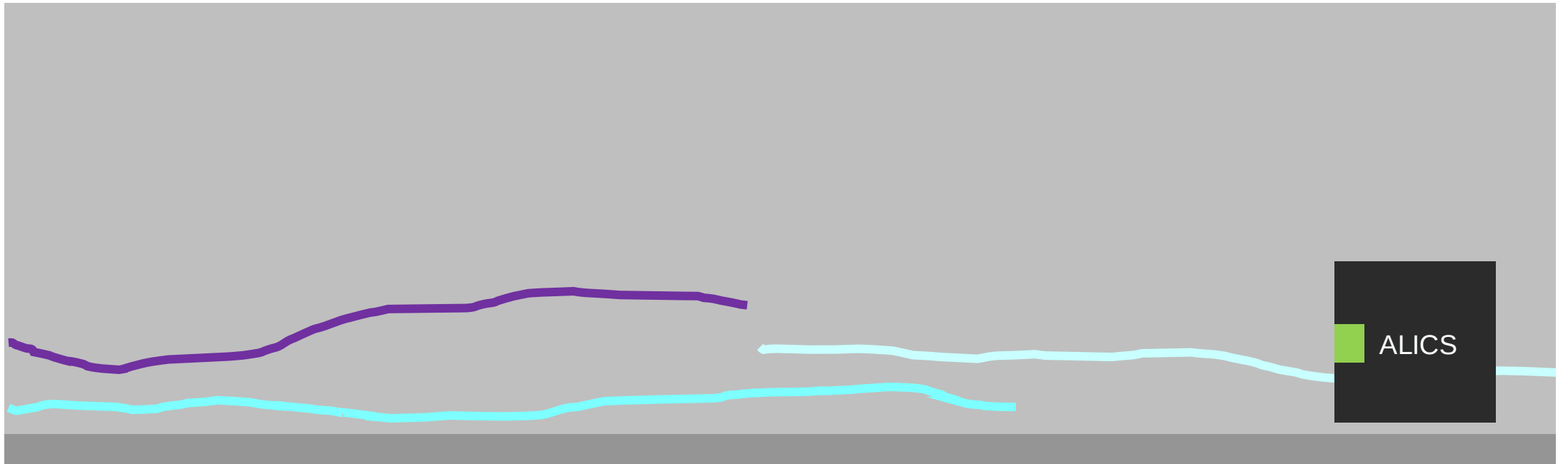
Results

Chainage: 19.8 m – 31.5 m



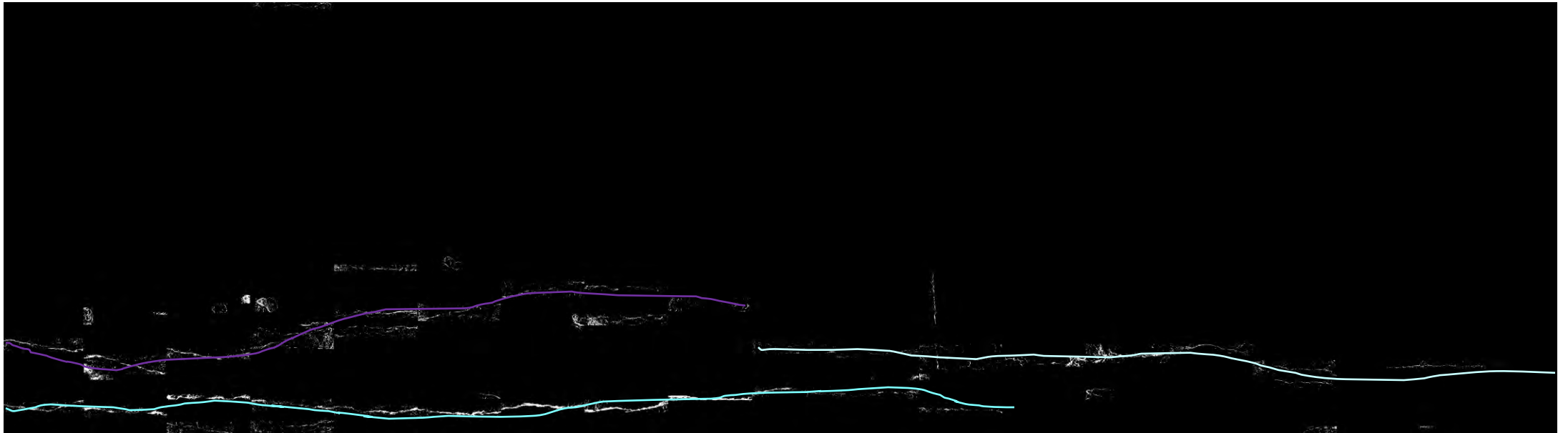
Results

Chainage: 19.8 m – 31.5 m



Results

Chainage: 19.8 m – 31.5 m



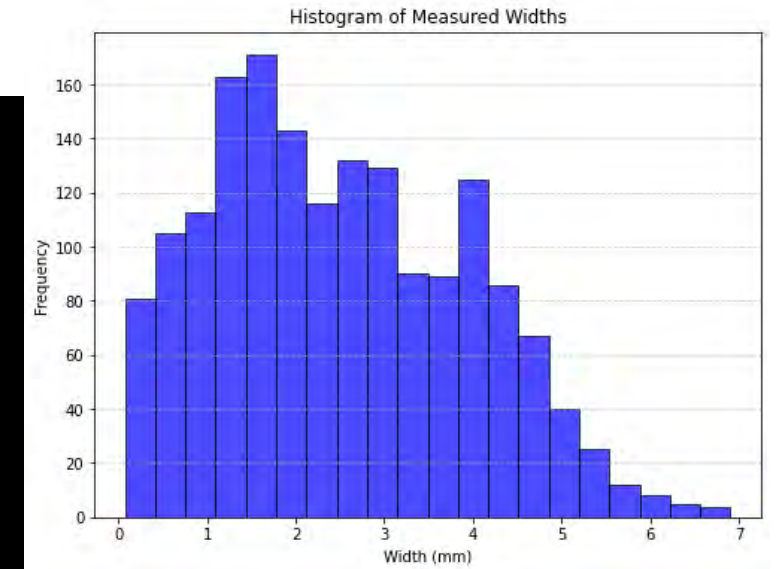
Results

Width measurement



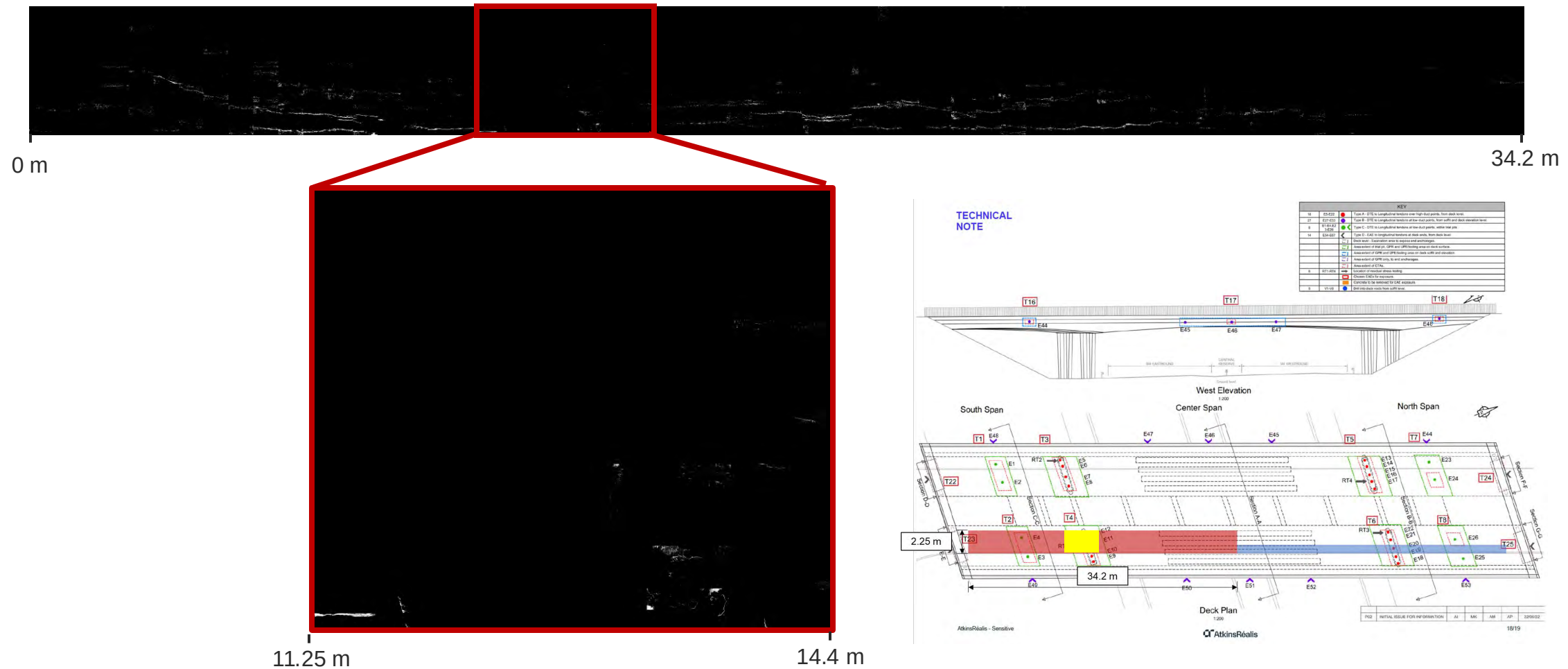
Results

Width measurement – Area 2



Results

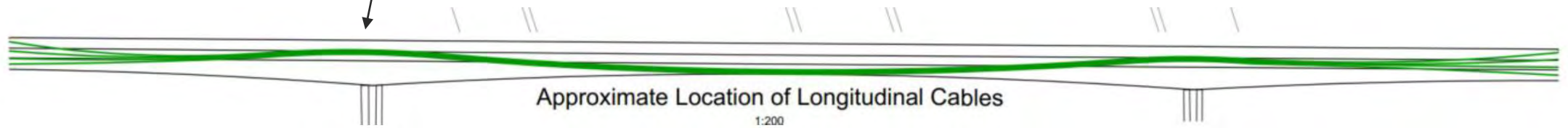
Chainage 11.25 m – 14.4 m (no cracking)



Results

Chainage 11.25 m – 14.4 m

No cracking at cable high point above column

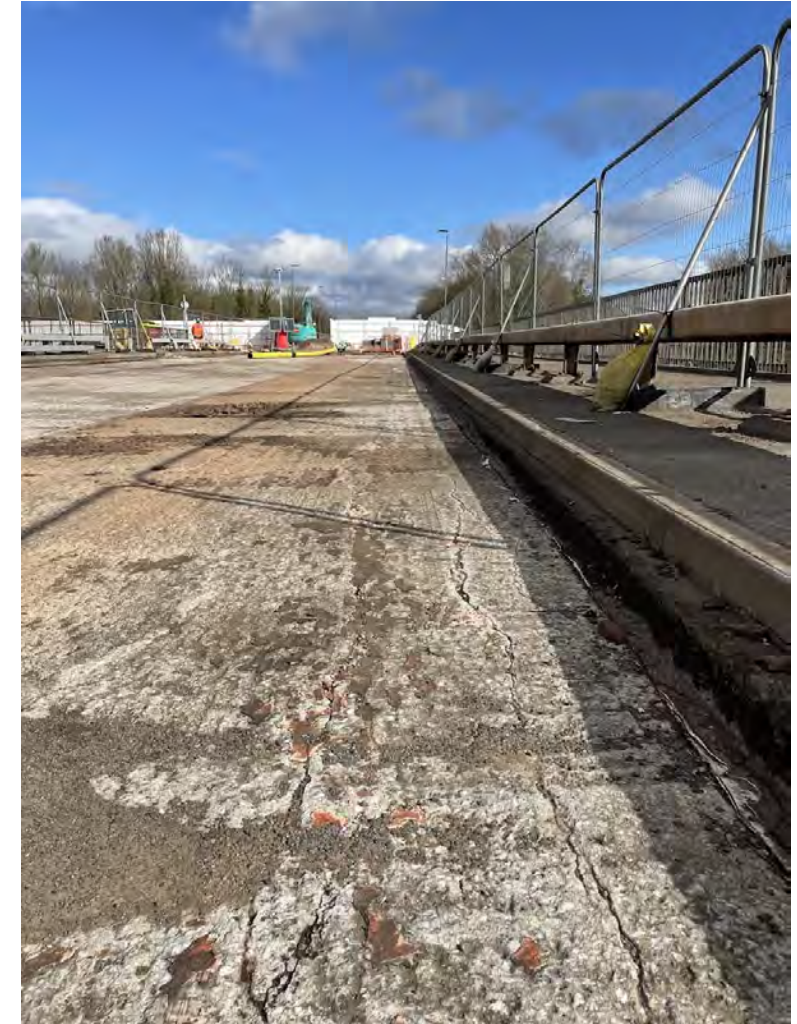


Conclusions



Google maps, 2024

Soffit



Deck

Conclusions

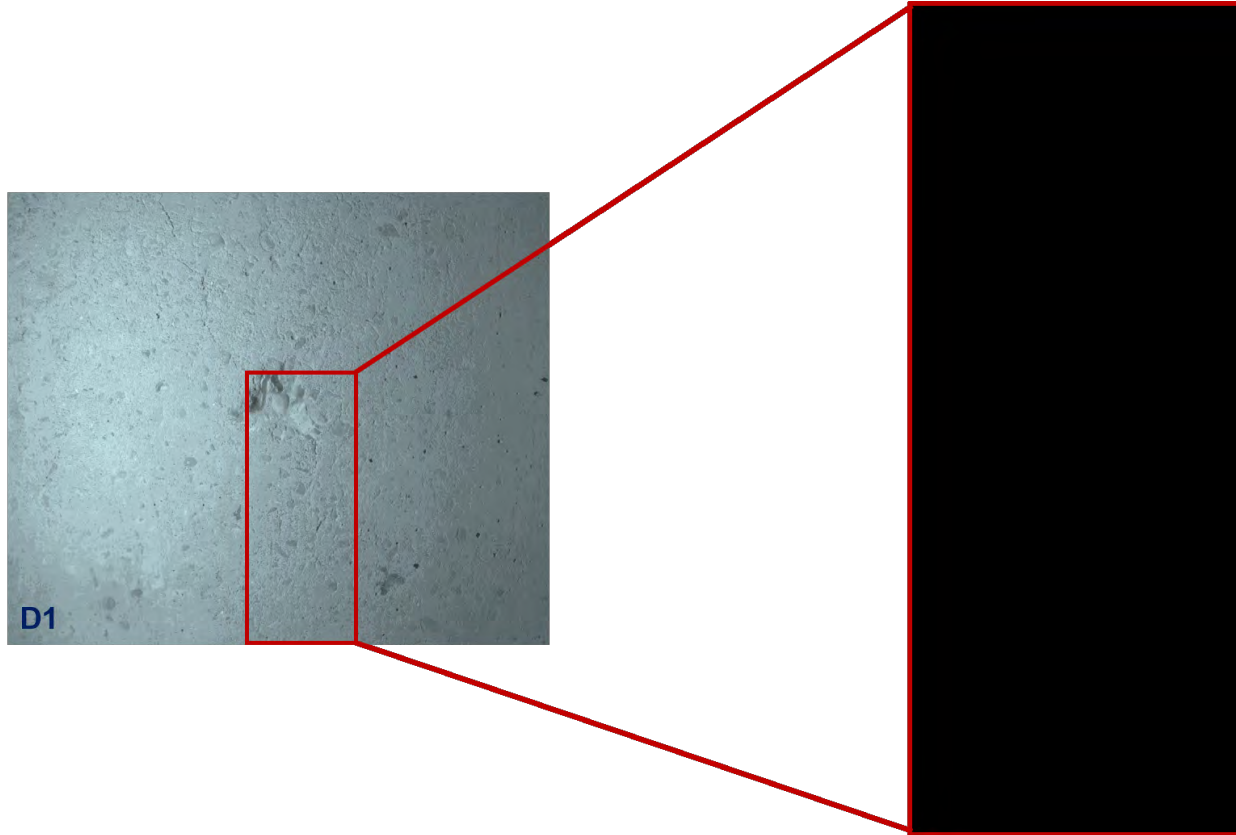
Summary:

- Lighting-enhanced concrete inspection device.
- Deployed at Wick Wick Viaduct.
- Produced crack map of 76 m² in under 5 hours.
- All major defects identified.
- Thank you to:



Future Development

- ALICS allows inspection interval monitoring.
- This was not tested in this trial due to bridge demolition.
- Wide-angle and sub-mm monitoring of cracking on critical elements of a structure (e.g. half-joint).



Future Development

Collaboration opportunities:

- Inspect at a time interval to track defect changes.
- Compare with human inspector reports.
- Bridge soffit with smoother surface and thinner cracks.
- Monitoring of critical areas (e.g. half-joints).
- Robotic deployment of the system.

Commercial work:

- Commercialisation project started October 2024.
- Spin-out in progress.
- User trials and feedback.





University of
Strathclyde
Engineering

GSCAN

A wide-angle photograph of the Golden Gate Bridge in San Francisco, California. The bridge's iconic red-orange towers and suspension cables are prominent, stretching across the frame from the foreground on the left towards the right. The bridge spans a deep blue body of water, with the San Francisco city skyline visible in the distance under a clear sky. The image serves as a background for the title and text.

Muon Tomography Trials on In Service Structures in Estonia

Sander Sein

Agenda

1.

Overview of the
project

2.

Bridges

3.

Deployment

4.

Outcomes

5.

Lessons learnt

6.

Other trials of muon
technology

Estonian Transportation Administration project

Experimental development or the assessment for functional and structural condition of existing bridges

Supported by EU Cohesion Policy 2021–2027

Overview

Motivated by **Structures Moonshot** project and pushed by GScan

1.

Current situation

- Decisions based on visual inspections
- Simple NDT occasionally used during design phase

2.

Duration 16 months and three stages, based on complexity

- Simple structure
- PT structure
- Substructure

3.

Demonstration of MFT and how it affects the sustainability

- More accurate decision making
- Input for design

GScan motivation

From laboratory to reality

Maximise

- Muon tracking efficiency
- Safety
- Resolution

Minimise

- Measurement time
- Human intervention
- Traffic interruption



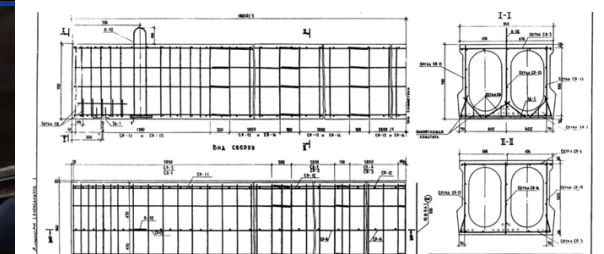
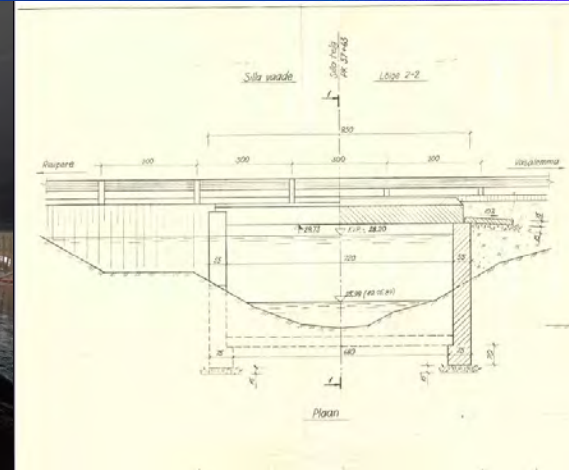
Bridge selection

Main objective of the first phase?

Can we see through the full cross-section

Structure should be

- At least 50 years old
- Simply supported
- Thickness at least 500 mm
- Common or important

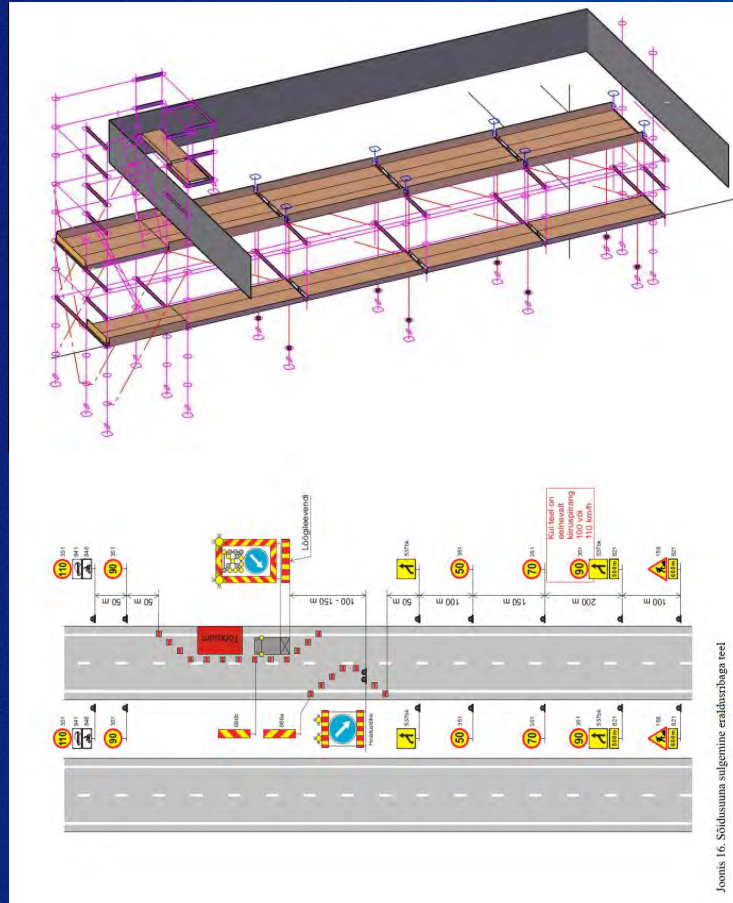


Deployment

Outsource as much as possible to understand the market readiness

Planning

- Positioning the scanners
- Power
- Traffic management
- Security
- Connectivity



Joonis 16. Sõidusuuna sülgemine erandisrühaga teel

Deployment

GSCAN

GScan technology

- Common cargo vehicle for transport
- Two man lift on top of the bridge
- Lifting equipment for under bridge installation



Deployment

GSCAN

External "findings"

- Diesel generator
- 4G/5G cellular



Deployment

GSCAN

Why we have the tent?

- Safety
 - Traffic
 - Visitors
 - Weather

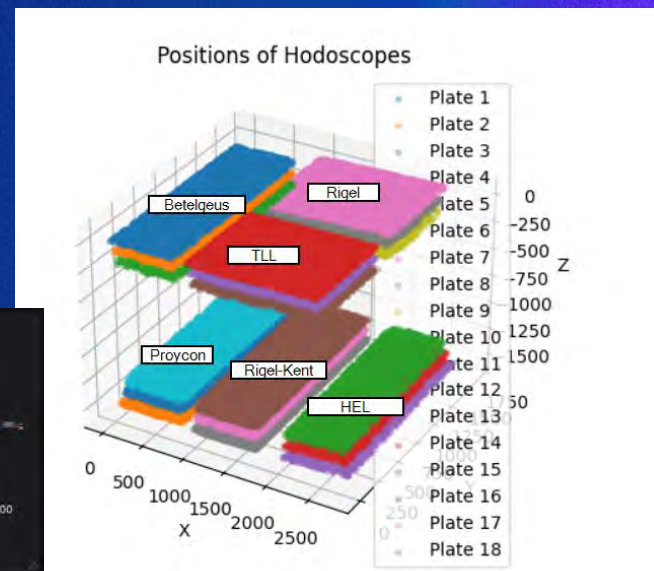


Data acquisition

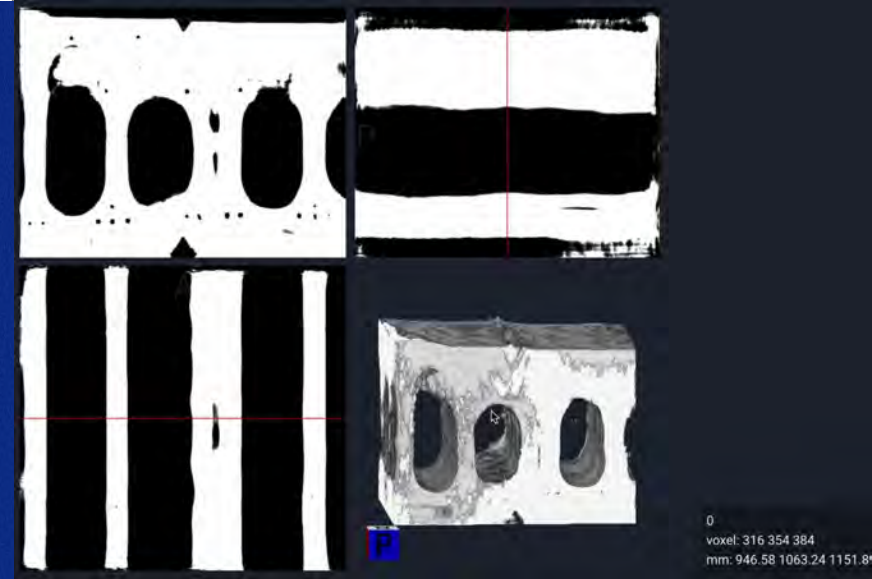
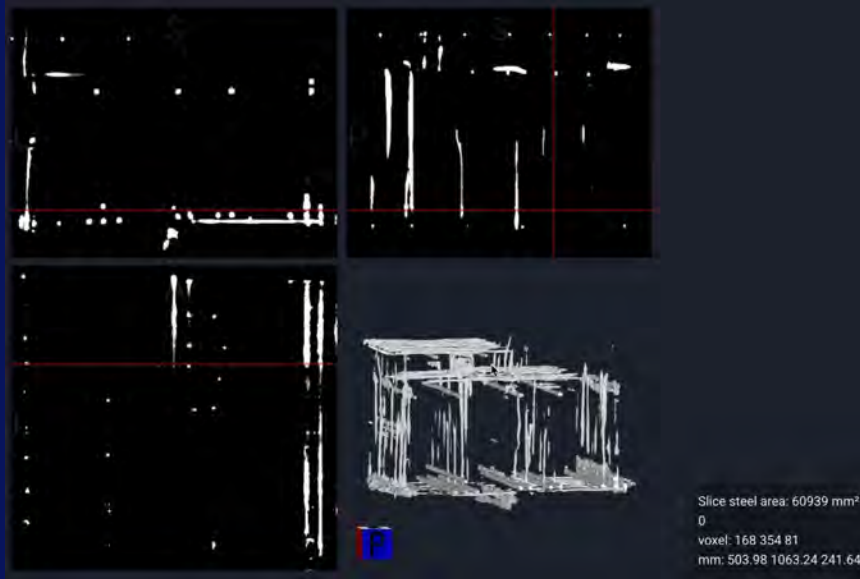
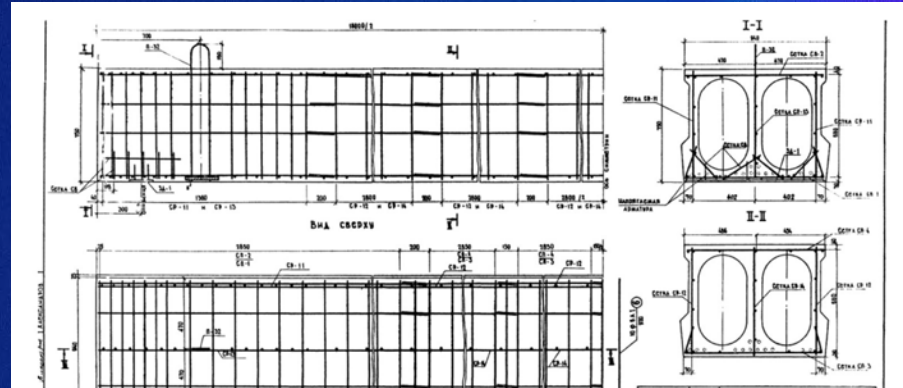
- Position data
- Active monitoring
- 5 minute chunks for data transfer

Measurement efficiency

- 88% first bridge
- 75% second bridge
 - External factors



Outcome Jõgisoo II



Outcome – Munalaskme

GSCAN



Lessons learnt

Real bridges here we come

Hardware is robust and can be moved around on bridges

- Accessibility is still a challenge
- Traffic management will be a limitation
- Connectivity and power will remain the main concerns for successful measurements

To further improve we need to gather more data from real bridges

- To test further use cases and identify limits
- Characterise additional materials
- Identify uncertainties and keep learning





Other developments

Germany, Switzerland and Wales

GSCAN

Muography/Muon Tomography X-raying with cosmic muons

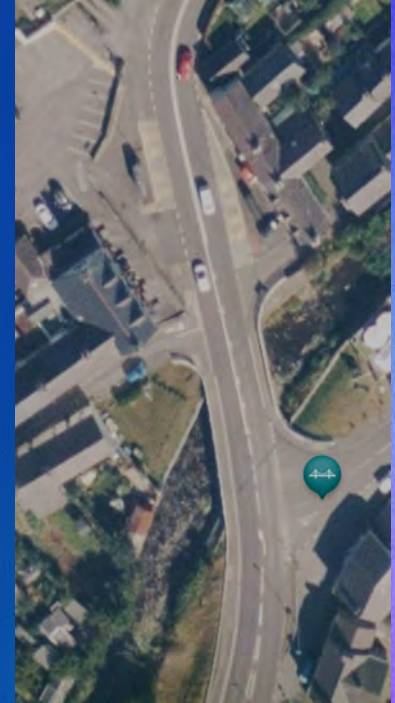
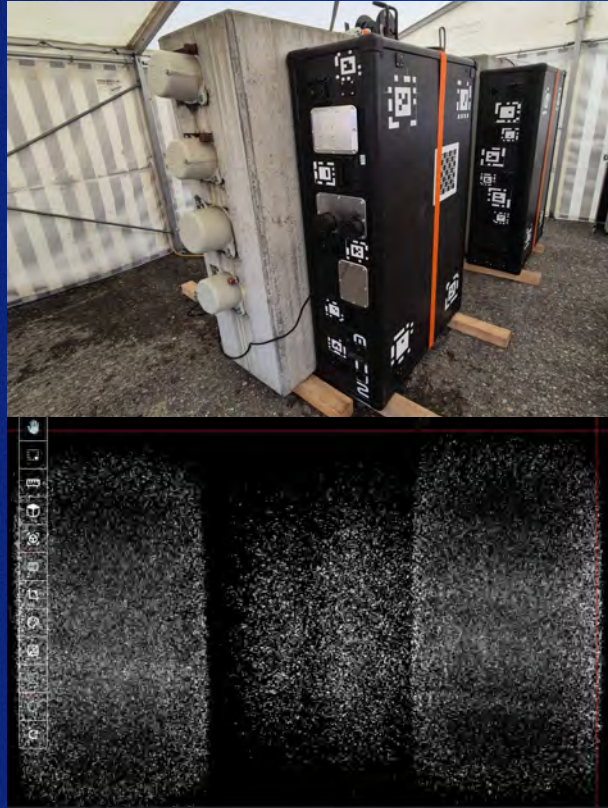
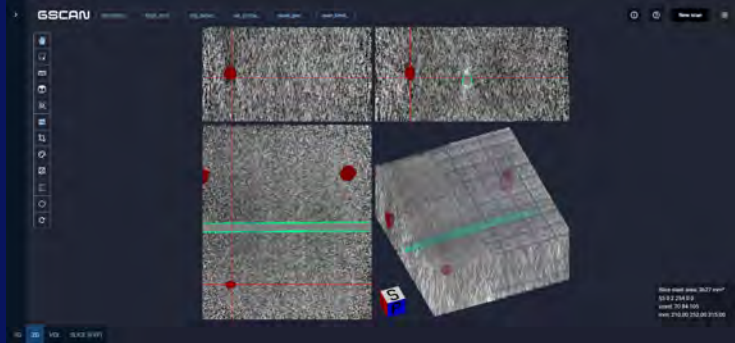
GSCAN BAM



GSCAN muon detectors in BAM lab



Refined results using ML of muon tomography (GSCAN)



Germany, Switzerland and Wales

GSCAN

Muography/Muon Tomography X-raying with cosmic muons

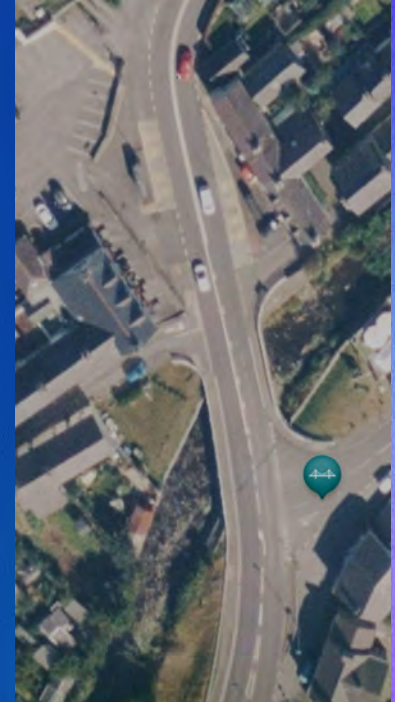
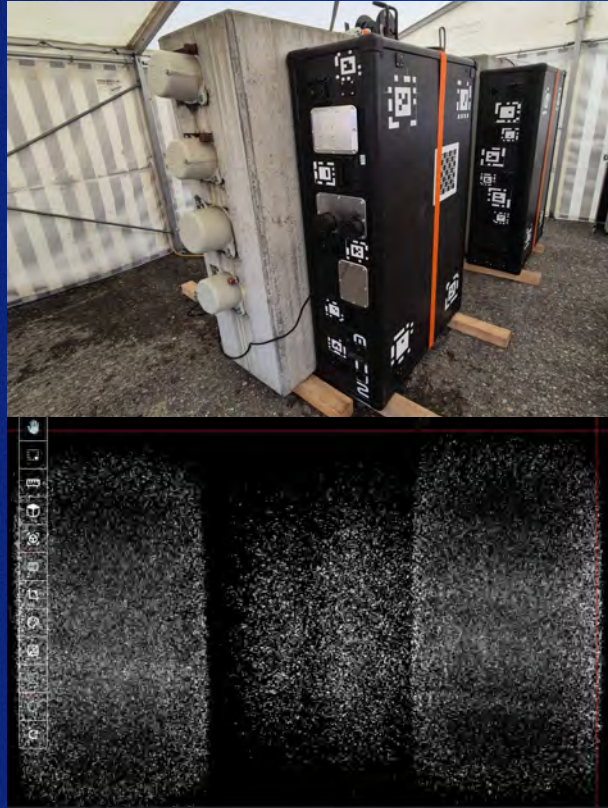
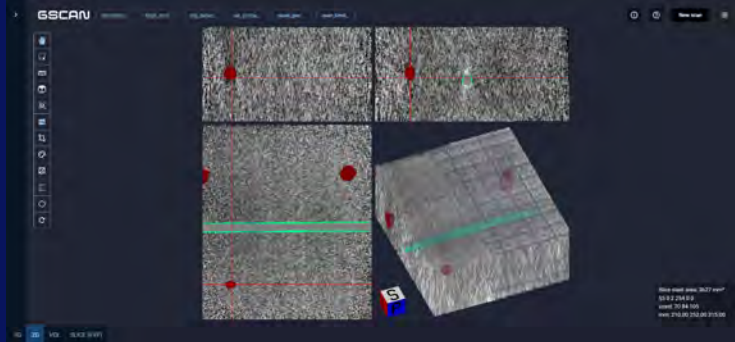
GSCAN BAM



GSCAN muon detectors in BAM lab



Refined results using ML of muon tomography (GSCAN)



Thank you! Questions?

GSCAN

New scan



Scanning

2h 30m

ENTER POSITION

Terminate scanning

Complete scanning

Project Outcomes and The NDT Practitioner's Toolkit

Shams Ghazy - AtkinsRéalis

June 2025

THE
**STRUCTURES
MOONSHOT**
PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS

Structures Moonshot Data Schedule>

	E	F	G	H
	Tool	Element	Defect Type	Confide
e	MISTRAS Tablet UT	Tendon	Corrosion	High
e	MISTRAS Tablet UT	Tendon	Good Condition	High
	Proseq PD8052	Grout	Voids	High
	Proseq PD8052	Grout	Voids	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Other	High
n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

Project Reports



SPATS2-TO321_AJJV_SBR_XX_DO_CB-0001

R&D Trials – Development of Innovative Inspection Techniques for Post-Tensioned Structures

This report covers:

- Sentec report observations summary
- Sentec technique review
- Omnia report observations summary
- Omnia technique review
- Muon tomography overview
- Recommendations for further research & development on the trialled techniques

Project Reports



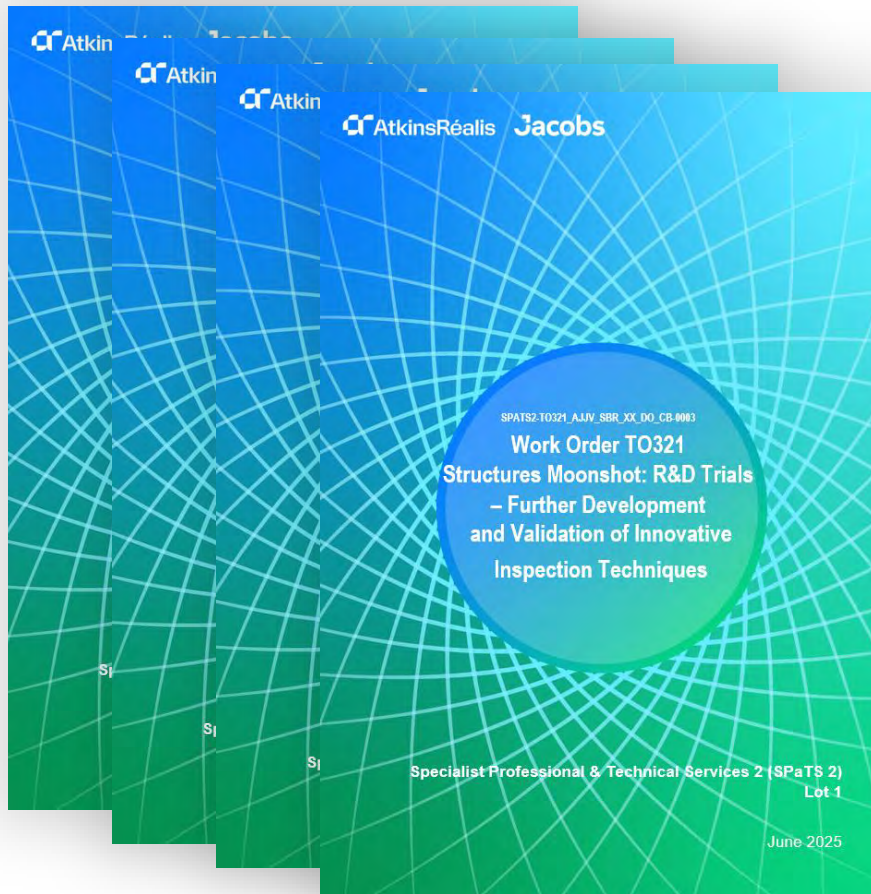
SPATS2-TO321_AJ JV_SBR_XX_DO_CB-0002

Huntingdon Viaduct NDT Trials and Interpretive Report

This report covers:

- Huntingdon trials background and deployment methodology
- Validation methodology
- Factual reporting summary of all NDT outputs received during the Huntingdon Trials
- Intrusive inspection results summary
- NDT data federation and analysis.
- Results interpretation of all NDT trialed on the Huntingdon Samples

Project Reports



SPATS2-TO321_AJJV_SBR_XX_DO_CB-0003

Huntingdon Viaduct NDT Trials and Interpretive Report

This report covers:

- Omnia further trials results
- Omnia technique development through further trials
- Muon tomography further trials results
- Muon tomography development through further trials
- Additional technologies trialed on Wickwick bridge: results and interpretation

Project Reports



SPATS2-TO321_AJJV_SBR_XX_DO_CB-0004

Structures' Moonshot – Technology Performance Summary and Practitioner Toolkit for NDT in Post-Tensioned Structures

This report presents a summary of all technologies trialed as part of the second phase of the Structures Moonshot project, bringing in key outcomes from all reports above. The report includes:

- Technology review and appraisal across all trials – Hierarchy of NDT tools
- Recommendations for integration, further development of technologies, data management, and competence management
- Technology single-page profiles
- Conclusions and Summary

SPATS2-TO321_AJJV_SBR_XX_DO_CB-0001

R&D Trials – Development of Innovative Inspection Techniques for Post-Tensioned Structures

This report covers:

- Sentec report observations summary
- Sentec technique review
- Omnia report observations summary
- Omnia technique review
- Muon tomography overview
- Recommendations for further research & development on the trialed techniques

SPATS2-TO321_AJJV_SBR_XX_DO_CB-0002

Huntingdon Viaduct NDT Trials and Interpretive Report

This report covers:

- Huntingdon trials background and deployment methodology
- Validation methodology
- Factual reporting summary of all NDT outputs received during the Huntingdon Trials
- Intrusive inspection results summary
- NDT data federation and analysis.
- Results interpretation of all NDT trialed on the Huntingdon Samples

SPATS2-TO321_AJJV_SBR_XX_DO_CB-0003

R&D Trials – Further Development and Validation of Innovative Inspection Techniques

This report covers:

- Omnia further trials results
- Omnia technique development through further trials
- Muon tomography further trials results
- Muon tomography development through further trials
- Additional technologies trialed on Wickwick bridge: results and interpretation

SPATS2-TO321_AJJV_SBR_XX_DO_CB-0004

Structures' Moonshot – Technology Performance Summary and Practitioner Toolkit for NDT in Post-Tensioned Structures

This report presents a summary of all technologies trialed as part of the second phase of the Structures Moonshot project, bringing in key outcomes from all reports above. The report includes:

- Technology review and appraisal across all trials – Hierarchy of NDT tools
- Recommendations for integration, further development of technologies, data management, and competence management
- Technology single-page profiles
- Conclusions and Summary

The NDT Practitioner's Toolkit

Preview



Deployment and Further Development

Colin George, Deputy Head of Structures, National Highways

June 2025

Insert Clear Group Ungroup Freeze Shading Borders Reset
Image Cell Header
Titles & Headers

Structures Moonshot Data Schedule>

	E	F	G	H
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e	MISTRAS Tablet UT	Tendon	Corrosion	High
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	Proseq PD8052	Grout	Voids	High
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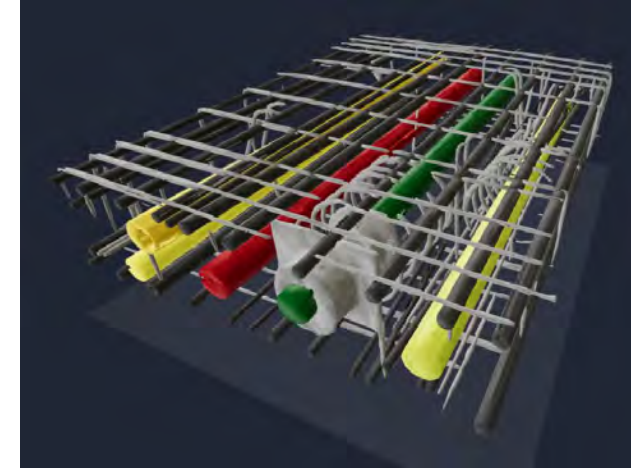
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Taking Stock and Moving Forward

'Working here in the US, I've found that each NDT supplier will say their technology is the right one. Results from your objective evaluation and testing of each one will be invaluable for the transportation industry as we seek to use these tools to evaluate and rehabilitate ageing structures'



Guided Wave

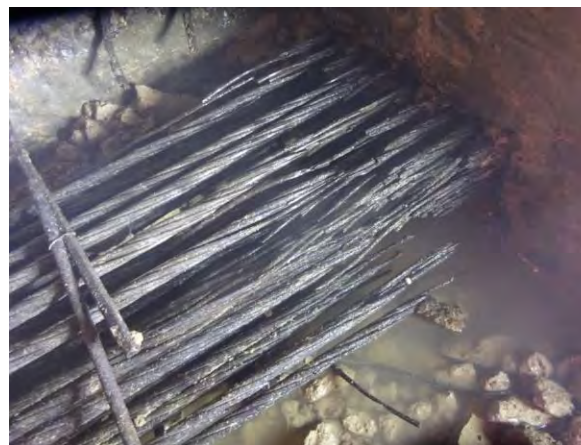


Muon Tomography

Muon Tomography – Huntingdon Sample 2 Validation



Deployment at Priority Risk Structures (1 – Post-tensioned Structures)

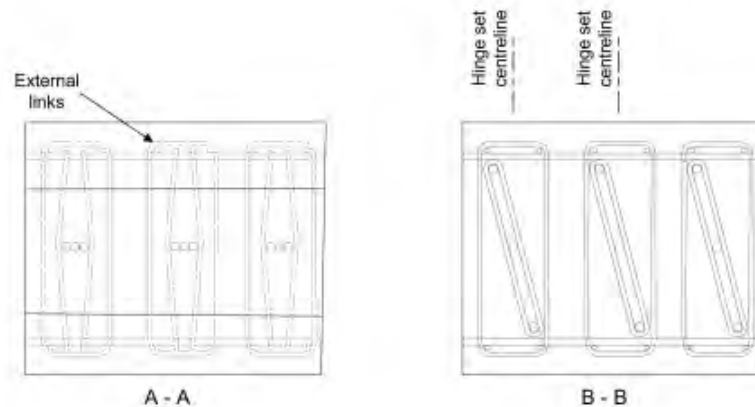
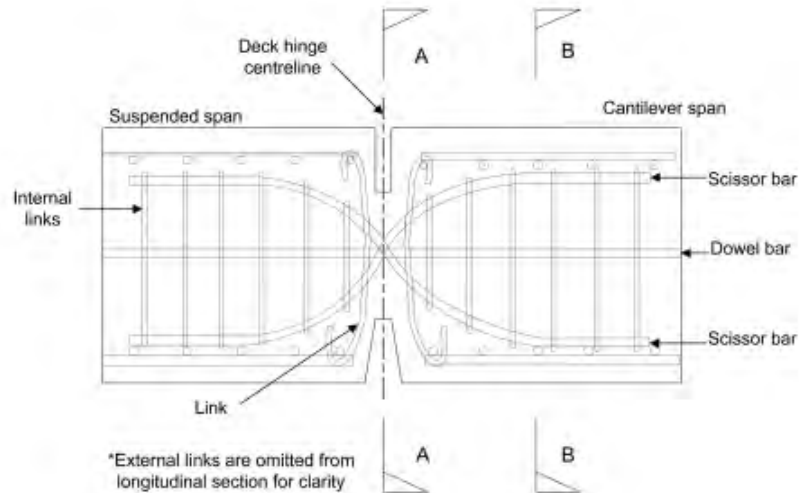


Deployment at Priority Risk Structures (2 – Half-joint Structures)



Deployment at Priority Risk Structures (3 – Hinge-deck Structures)

Figure B.2 Typical deck hinge details



Other trials under consideration (1)

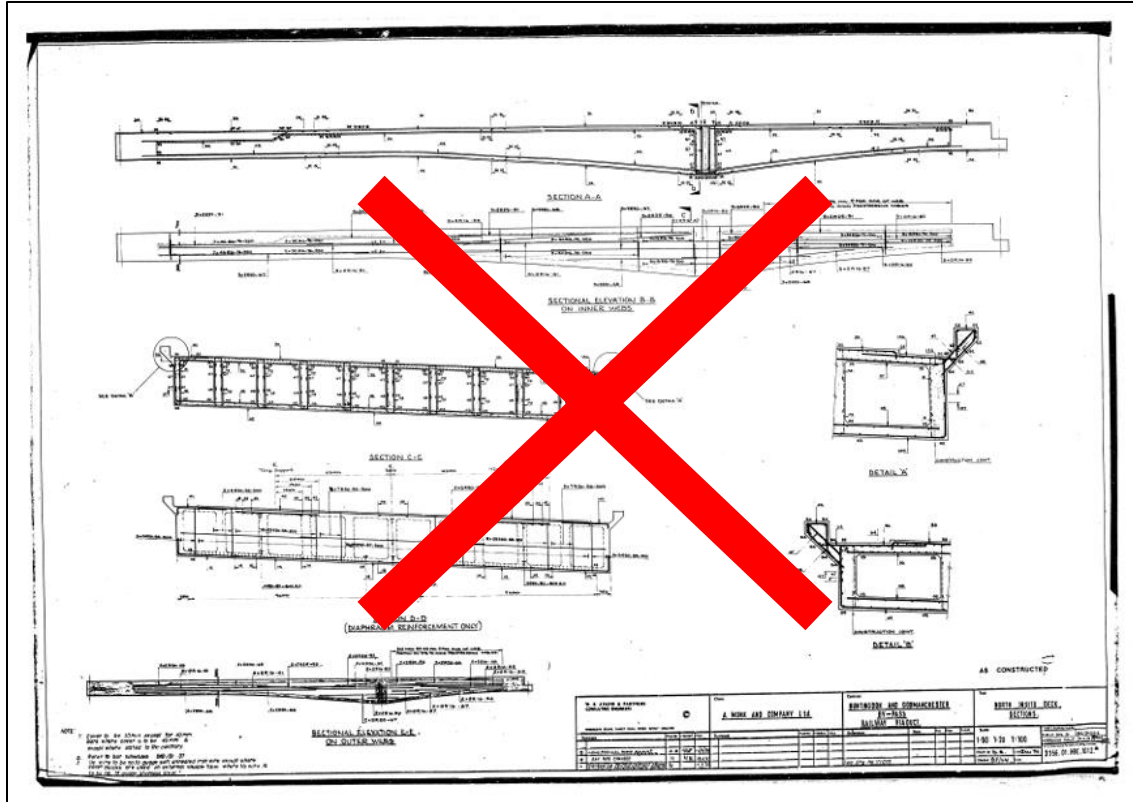


Suspension Bridge Cables

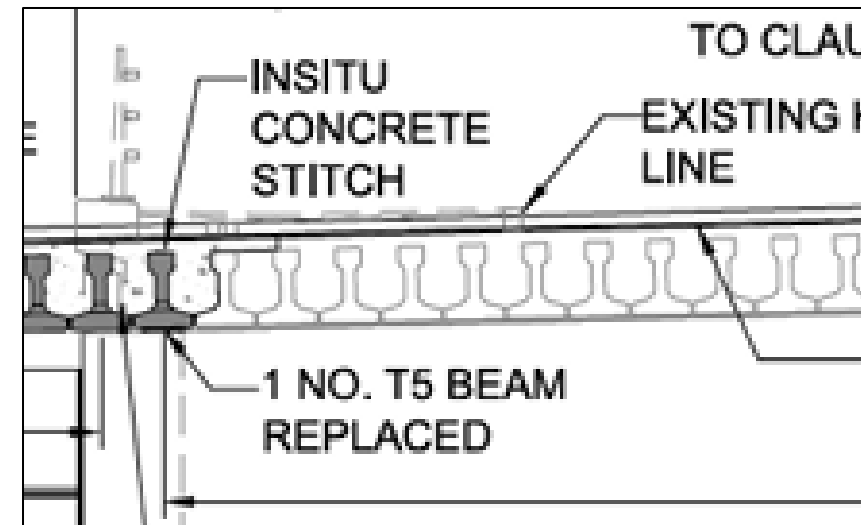


Thaumasite Detection

Other trials under consideration (2)



**Structures with incomplete
as-built records**



**Modifications to structures
with unknown foundations**

Moonshot Conference 2.0



Thank you

THE STRUCTURES MOONSHOT

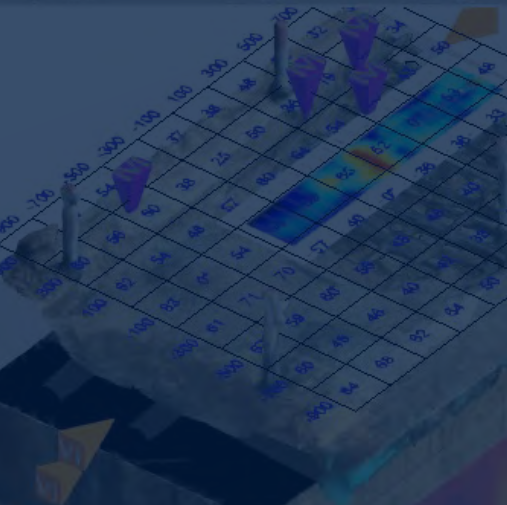
PROJECT

BRIDGES
New Civil Engineer
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Structures Moonshot Data Schedule>

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n	N/A	Grout	Voids	High

1.11 1.14 1.19





Project Conclusions & Reflections

Chris Mundell, AtkinsRealis

June 2025

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Structures Moonshot Data Schedule>

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n	N/A	Concrete	Cracking	High
n	N/A	Grout	Voids	High

The Journey Thus Far...

Priority Actions Status (1/2)

Action #1	Review and improve our approach to managing risk for the post-tensioned bridges.	Catherine Brookes & Peter Hill	Breakpoint: Effective investment prioritisation
	Achievements Started to draft CHE memo, preparing pack to communicate to regions prioritisation guidance.		
Action #2	Capture and share good practice on management of post-tensioned bridges	Pierfrancesco Valerio & Catherine Brookes	Breakpoint: Capability
	Achievements - Sprint 1 – International good practice paper – Chris Mundell - Sprint 2 – Examples of good practice for management of PTS collated from across the regions – Pierfrancesco Valerio		
Action #3	Develop national skills matrix for structures to capture existing skills in the business	Pierfrancesco Valerio & Catherine Brookes	Breakpoint: Capability
	Achievements - Excel skills matrix template created, to be shared with Kate Wood and Amy Williams - Engagement with HR to identify opportunities for integration with PFP/oracle system		
Action #4	Deliver specialist training through guidance and webinars	Pierfrancesco Valerio & Peter Hill	Breakpoint: Capability
	Achievements - Gaps in training identified (based on gaps in knowledge/ expertise around BD54 and lessons learnt from 19-20 PTSI) - Training mediums identified – 'click to learn', webinars, lessons from launch of ACS		
Action #5	Review the existing centralised Operations task force to act as a forum for sharing good practice (w. SES support)	Catherine Brookes	Breakpoint: Capability
	Achievements RDs in the OPT and the Senior m be chairing it. 11 August		

Literature review: Conclusions

Action To Date: Review of 50+ international papers focussing on PT assessment technologies

- Recurrence of similar approaches throughout literature – **there is no 'silver bullet'** with any respective technology - many tools still in R&D phases
- Optimum approach is a **blended use of technology**, each playing to their strengths
- There is **still a need for intrusive investigations** and structural analysis – NDT will work in tandem
- Work presented to Asset Delivery Structures – Asset Management Community in October

The Need: Embedment of better tools as BAU with improved decision making

- Increase the quality, quantum and regularity of condition data we get from PTSI, using remote or automated technologies. **Minimise user disruption, enable better decisions and pro-active maintenance.**
- Existing NDT techniques are not well used within HE, reliance on intrusive techniques (although there are pockets of excellence)
- Targeted and appropriate use of new tools should be coupled with guidance and training** which is reflected in trigger levels for assessments, intrusive investigations and asset renewal plans.

Parallel Workstreams: Tiger Team Workstreams and Moonshot

- Success for any change will need to incorporate learning from Tiger Team workstreams (BD 54 review, Asset Management network formation, training review), and be future proofed to build in Moonshot outcomes

In **2020**, National Highways' (then Highways England's) **Post Tensioned Bridge "Tiger Team"** investigated the state of the nation following the A52 Clifton bridge closure and increases in global incidents, with a goal to:

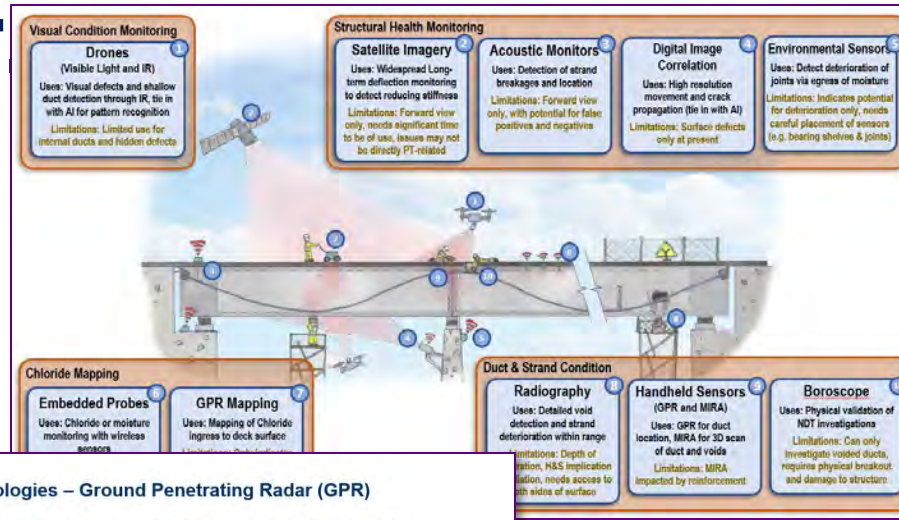
- Review and improve their approach to managing these complex structures, including prioritisation
- Capture best practice on their management
- Develop a national skills matrix
- Deliver specialist training
- Understand the current position and share knowledge where it is needed

The Journey Thus Far

The Tiger Team commissioned a global literature review, which covered +40 papers discussing PT assessment technologies globally

Key Findings:

- Recurrence of similar approaches throughout literature – **there is no 'silver bullet'** with any respective technology
- **Optimum approach is a blended use** of technology, each playing to their strengths
- **Cannot yet safely remove the need for intrusive investigations** or structural analysis – NDT will work in tandem
- Much of the **research is contradictory**, with varying capabilities between papers
- Much research is limited to laboratory trials or for external ducts



NDT Common Technologies – Ground Penetrating Radar (GPR)

- Emission of Electromagnetic pulses that are impacted by changes in material electrical conductivities (e.g. rebar, tendon ducts, voids)
- Mixed results from a number of sources
- Key use is in determining where ducts are to pinpoint for other technologies

Asset Management Transformation Programme | highways england

NDT Common Technologies – Ultrasonic Tomography

- Medical derivation, using 'catch-pitch' transducers and receivers
- Collection of three planar images for combination in three-dimensions
- Detection of corrosion in tendons, bond quality and duct voids
- Generation of 3D images
- Portable and easy to use
- Requires flat surface

Asset Management Transformation Programme | highways england

THE STRUCTURES MOONSHOT PROJECT

SNC-LAVALIN

ATKINS
Member of the SNC-Lavalin Group

Asset Management Transformation Project

Post-Tensioned Non-Destructive Testing and Monitoring Techniques - Assessment of Available Methodologies
Highways England

10th September 2020

5195381-ATK-ZZ-DO-S-0001

The Journey Thus Far...

The 'Structures Moonshot' was born!



Highways England Moonshot Call for Research Ideas Post Tensioned Bridges Management

On behalf of Highways England, we would like to invite you to submit your suggestions for new research ideas with the potential to transform the way we detect and measure corrosion in steel structural elements buried in concrete.

Information for applications:

1. An outline document accompanies this call for research ideas which can be downloaded from this link: <https://bit.ly/36aYB2L>. For further information or administrative queries, contact Chris.Mundell@atkinsglobal.com
2. The closing date to research idea applications is the 26th February 2021
3. Applications will be reviewed by a Highways England-appointed panel led by Vlad Palan (Vlad.Palan@highwaysengland.co.uk) and Chris Hendy (Chris.Hendy@atkinsglobal.com).
4. One submission should be made per research idea using this form, but there is no limit to the number of ideas that may be submitted per research institution. It is recommended that users prepare their answer in line with the outline guidance document separately and paste into the descriptive text boxes to avoid potential data loss should the webpage unexpectedly close.
5. Applicants are not required to submit any personal details beyond contact details should further communication be required (including any information as part of point 5 above). These data will not be shared outside of this call for ideas nor used for any other purposes without the express consent of the applicant.

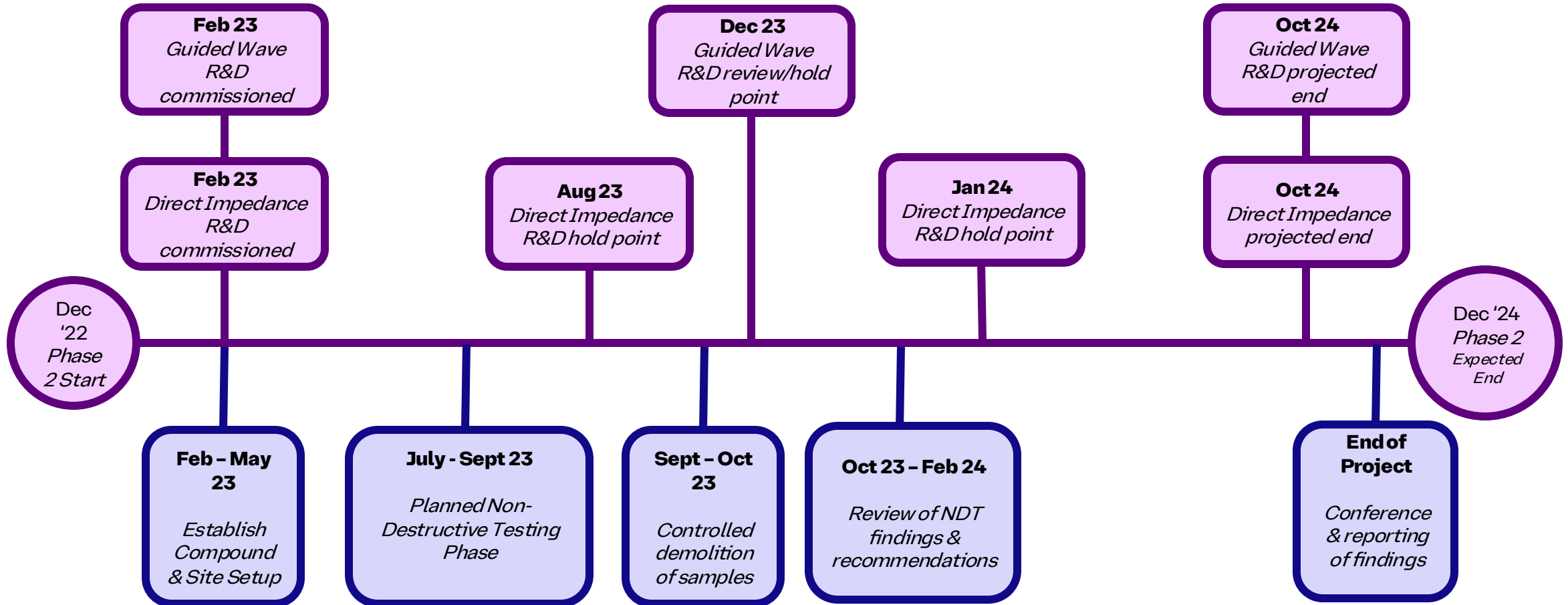
A screenshot of the 'Highways England Moonshot Call for Research Ideas' form. The form is titled 'Post Tensioned Bridges Management' and includes sections for 'Research Idea Details', 'Applicable Problem Statement', 'Research Idea Name', and 'Description of the research idea'. It contains checkboxes for 'Required' and 'If the conditions for corrosion exist and how severe they are', and text boxes for 'Enter your answer'.

In **2021**, a global "Call for Ideas" was held, looking for technologies that could:

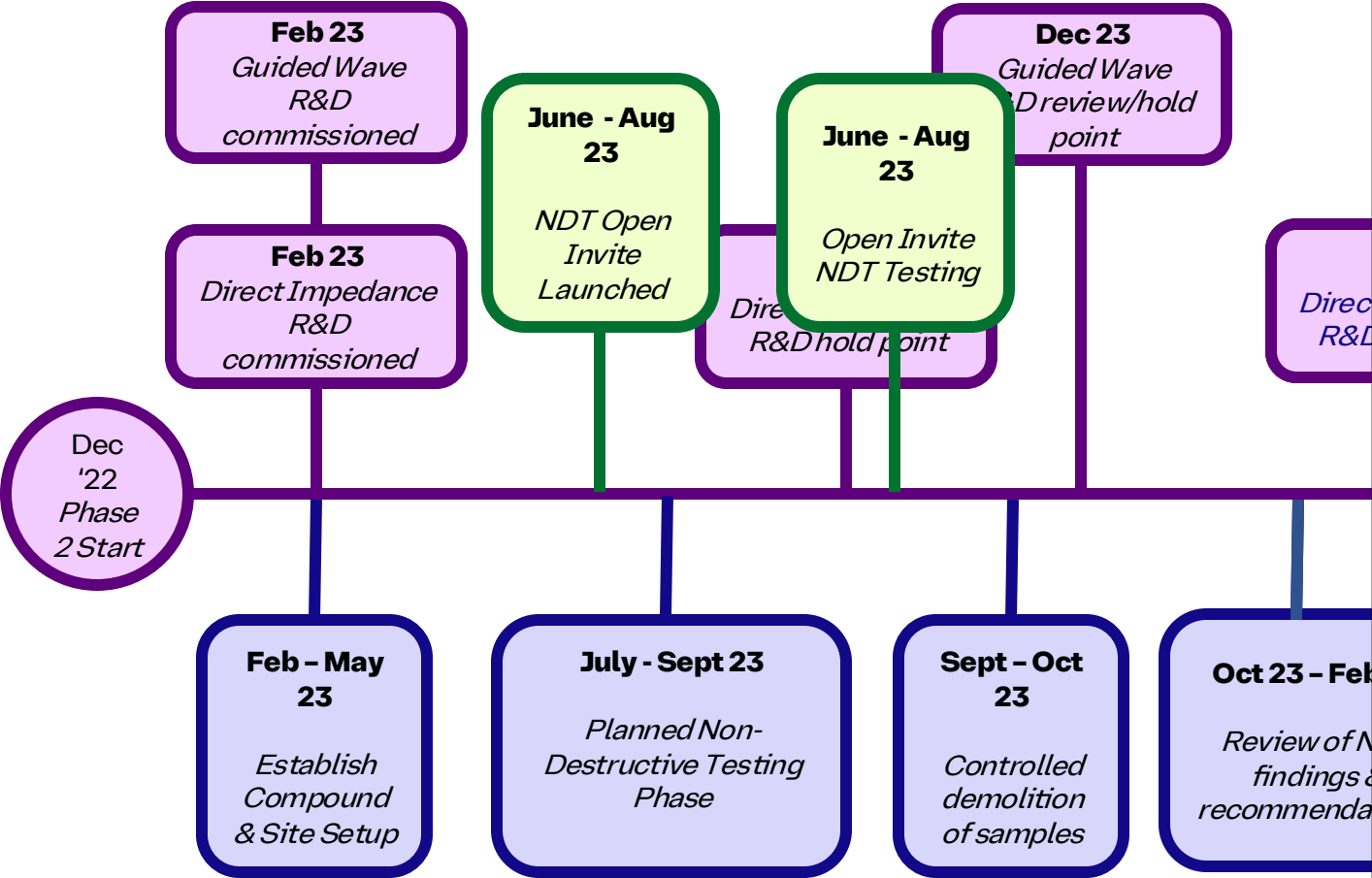
1. **Identify if the conditions for corrosion exist** and how severe they are
2. **Identify if corrosion is actually occurring**
3. **Identify how much corrosion has occurred**

30+ Ideas were submitted, and independently scored across fields such as cost to deploy, scalability, feasibility to identify shortlist technologies for the Moonshot

The Journey Thus Far...



The Journey Thus Far...



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[Our roads](#) [Our work](#) [Road safety](#) [Suppliers](#) [Help centre](#) [Careers](#)

[Home](#) > [Our work](#) > [Innovation and research](#) > [Get involved with innovation](#) > [Competitions](#)

Competitions

Through our competitions, we unlock the knowledge to transform our road network in the future.

We run targeted research and innovation competitions to help us solve some of our challenges. We'll publish details of current competitions on this page. If you think you have a potential solution, we welcome your application.

Current competitions

Finding pioneering ways to take care of bridges

We are looking to revolutionise the way we take care of bridges and other structures by hunting out new and innovative ways that will spot potential defects sooner.

Research has begun to help us on the ambitious journey towards self-monitoring and self-maintaining bridges with cutting-edge technology and modern methods being sought out for testing.

One of the greatest threats to bridges and structures on our road network is the corrosion of steel elements which are often encased in concrete.

This research project, Structures Moonshot, is focusing on two specific features in particular, the steel tendons in post-tensioned structures and reinforcement within concrete half-joints – a 'shelf' constructed at the end of one span to support the adjacent span.

These features can be vulnerable to deterioration but are difficult to access and often require intrusive investigations to assess the condition. This can require lane or road closures causing disruption for motorists.

We want to find solutions that can detect defects sooner and resolve the issues in a less disruptive and a non-destructive way and so we have launched a competition as part of the project to find new innovations and technology.

The project is being taken forward by Atkins-Jacobs Joint Venture (AJJV) which will carry out extensive testing and research to identify the most suitable technologies for conducting advanced forms of Non-Destructive Testing (NDT) on structures.

New ideas are being sought which may include experimenting with machine learning and artificial intelligence to detect critical hidden structural defects. Solutions could range from advanced sensors, imaging technologies and machine learning algorithms.

What is on offer for the successful entrants

Successful entrants will be given a rare opportunity to carry out some real-world testing of their products on sample bridge sections taken from the decommissioned A14 Huntingdon Railway Viaduct. This will provide a platform to showcase their products to us and the wider industry before the sample is demolished which will allow participants to validate their results.

The outcomes of the testing will enable participants to optimise the effectiveness and applicability of their solutions. The results will also be published to enable collaboration and shared learning across the construction industry.

How to register

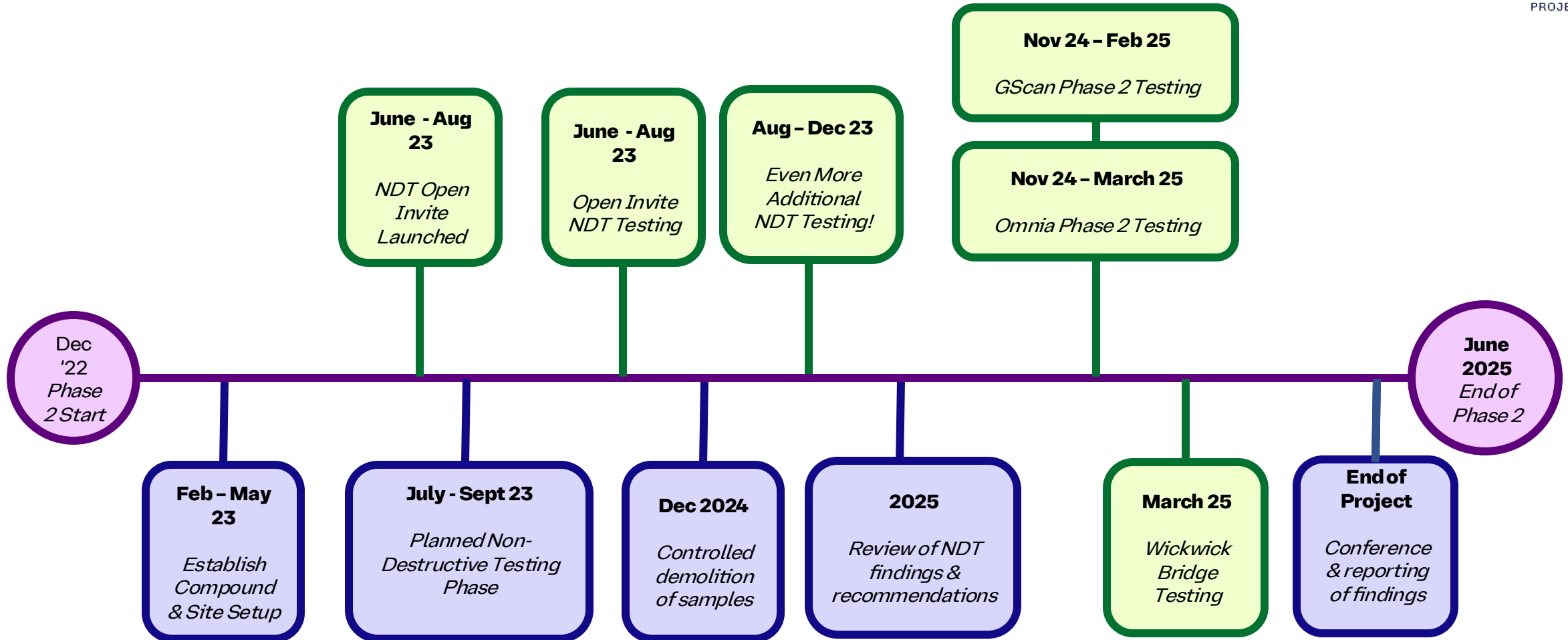
Organisations interested in trialling emerging technology and innovations should submit their entries [via this entry form](#) by 31 July 2023.

Testing will take place in August.

If you have any enquiries or would like to learn more about the project, please contact moonshot.comms@atkinsglobal.com

[Read our privacy notice](#)

The Journey Thus Far...



What Have We Achieved?

We have undertaken **over 60 different NDT tests**, considering people, process and technology, providing one of the most comprehensive studies of NDT technologies and their practical validation to date! Our tests have covered **over 20 different forms of inspections**, from simple visual inspection through to X-ray radiography and muon tomography! We have collaborated with **over 20 different teams and companies worldwide!**

We have **invested in the development of cutting-edge new technologies**, supporting their development from desk studies through to real-world, deployable solutions

We have developed **new means of federating these data together**, enabling holistic data reviews

We have **comprehensively documented all of our work** with reports, presentations, photographs and extensive videos

Our reports **review the reliability of the investigated technologies** in identifying different defects, showing how different solutions can be deployed depending on the structure and the causes for concern

We have **created a suite of user-friendly one-pagers** that will provide asset owners with the key information they need to enable the deployment of the right technologies at the right time

What Have We Achieved?

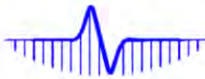
THE
STRUCTURES
MOONSHOT
PROJECT

We have proven that we have a global community of hugely experienced and collaborative NDT specialists who are committed to this problem, and willing to share their expertise to make our Moonshot a reality!

 **AtkinsRéalis**

 **national
highways**

Jacobs


INGENIEURE FÜR DAS BAUWESEN

 SCREENING
EAGLE

 **proceq**

 University of
Strathclyde
Glasgow


ANALYTICAL INSTRUMENTS GROUP

HTA
HENDERSON THOMAS ASSOCIATES
STRUCTURAL INVESTIGATION EXPERTS

 **MISTRAS**

 **VSL**
A member of
Bouygues Construction

 **sentec**
a xylem brand

GSCAN

 **CTS Group**

 **allied**
ASSOCIATES
GEOPHYSICAL LTD

 University of
Southampton

 University of
BRISTOL

 **BRIDGOLOGY**

 **OMNIA**
INTEGRITY

μ-VIS X-Ray
Imaging
Centre
www.muvis.org

HILTI

 Royal
Agricultural
University

 **haus
bots**
protecting the built environment

PRO-LITE
TECHNOLOGY

 **KILNBRIDGE**

What Have We Learned?

We *are* moving towards our moonshot vision where our technology is able to uncover the secrets of our most complex structures, aided by AI and Machine Learning

BUT...

There still isn't one 'silver bullet' – we now have more confidence in our approaches but there is still a need to blend multiple approaches and technologies together

There also still exists the need for both intrusive and numerical studies, but we can now better blend these with our NDT data

...and there is always more to discover and learn!

Thank you

THE STRUCTURES MOONSHOT PROJECT

BRIDGES
New Civil Engineer
CONFERENCE & AWARDS

Structures Moonshot Data Schedule>

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e	MISTRAS Tablet UT	Tendon	Good Condition	High
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	Proseq PD8052	Grout	Voids	High
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Day 2 – Closing Remarks

Peter Hill
Head of Structures for Safety, Engineering and Standards
National Highways

June 2025



Day 2 – Closing Remarks

Peter Hill
Head of Structures for Safety, Engineering and Standards
National Highways

June 2025



Background collage featuring:

- Top left: Construction site with scaffolding and pipes.
- Top center: Laboratory equipment on a bench.
- Top right: Spreadsheet titled "Structures Moonshot Data Schedule" with columns E, F, G, H (Tool, Element, Defect Type, Confidence) and rows for MISTRAS Tablet UT, Proseq PD8052, and N/A.
- Bottom right: A 3D model of a bridge structure.