Revealing hidden voids and unexpected findings on the post-tensioning ducts of concrete bridges

Screening Eagle uncovers surprising results with non-destructive testing on Huntingdon Railway Viaduct in the UK with National Highways

National Highways, a government owned company in charge of operating, improving and maintaining motorways in England, has been at the forefront of leveraging innovation in bridge maintenance. Recognizing the critical need for early detection of structural issues of bridges, they embarked on the groundbreaking research project - Structures Moonshot.

Led by Atkins-Jacobs Joint Adventue (AJJV), the research project set out to discover new technologies and innovative ways to speed up the identification of potential problems in concrete bridges, including hidden voids and deterioration within post-tension ducts.

The Screening Eagle team, in collaboration with AJJV, was privileged to contribute to this project with non-destructive testing (NDT) of the sample bridge sections from the decommissioned A14 Huntingdon Railway Viaduct in England using advanced technologies.

This application note delves into the insights gained from the project, highlighting the effectiveness of NDT in uncovering hidden defects that traditional methods overlook. By understanding the root causes of the bridge's deterioration, it's possible to develop more proactive maintenance strategies and ensure the continued safety and reliability of these vital structures.

Challenge

There were 3 sections of the A14 Huntingdon Railway Viaduct that were surgically removed before the whole bridge was dismantled for planned replacement. The samples were taken to a yard where specialists were invited to conduct different types of tests. The Screening Eagle team participated in the research project with our non destructive testing technologies for concrete bridges.

This had been a particularly problematic bridge in the past, hence the need for replacement. But what were the underlying issues? Was it deterioration in the post-tensioning? Was there an error at the point of construction? These questions can be answered with the help of NDT.

Non-destructive testing on the Huntingdon Railway Viaduct

Solution

Several Screening Eagle Technologies were used in the Structures Moonshot project including the Proceq ground penetrating radar (GPR), Pundit ultrasonic pulse echo (UPE) imaging system, and the Pundit PI8000 impact echo tester.

Using different technologies is part of the process to acknowledge the root cause. For example, GPR excels at locating the reinforcement and PT ducts, while UPE is superb for finding voids and defects. Impact echo can be used to measure in different ways and correlate the results.

The key point is having instant, clear, and accurate insights into the condition of the structure, which is critical for detecting issues faster. Knowing the condition and what could deteriorate the deck quicker can save significant time and costs in the long-term.

Let’s take a look at how the technologies were used and the unexpected results.

First, the team located the post-tension ducts with GPR.

The Proceq GP8800 GPR being used to locate the post-tension ducts

Next, the Pundit PD8050 ultrasonic imaging system was used to detect voids and defects on the post-tension ducts.

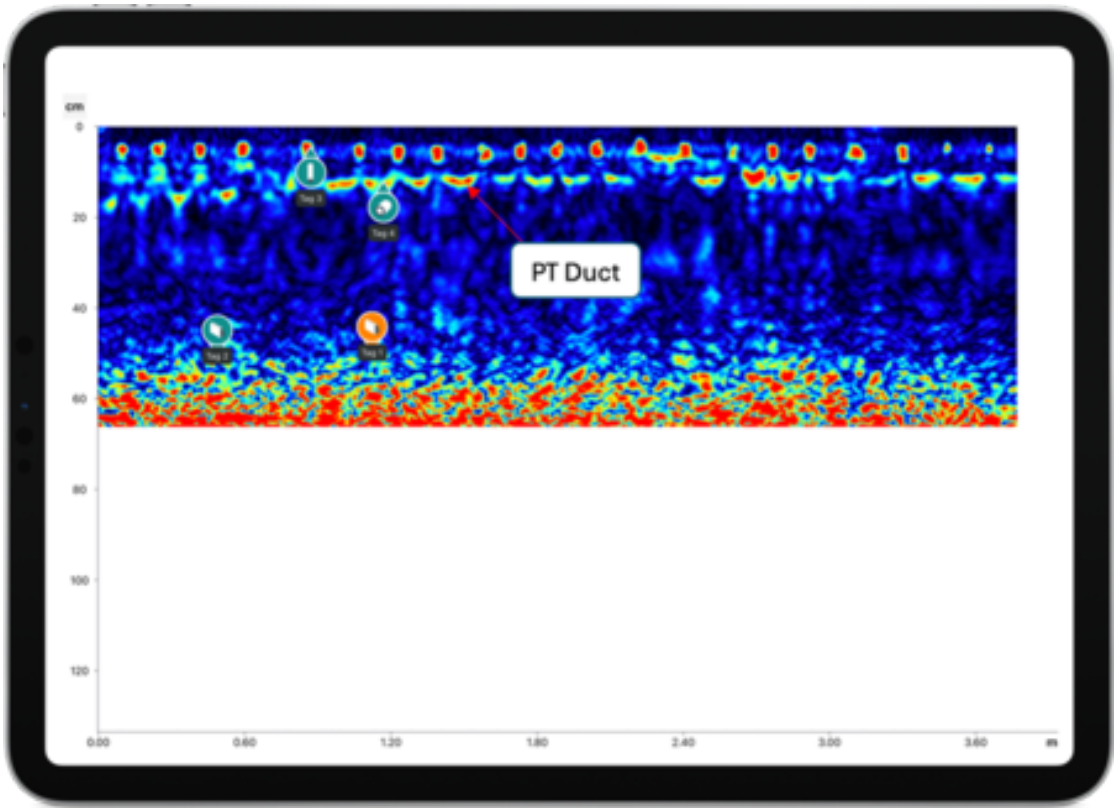
The Pundit PD8050 being used to detect hidden voids in the concrete.

To correlate the results of the PD8050, a spot check with the Pundit PI8000 was also performed to confirm there was definitely a problem, and to validate the back wall depth.

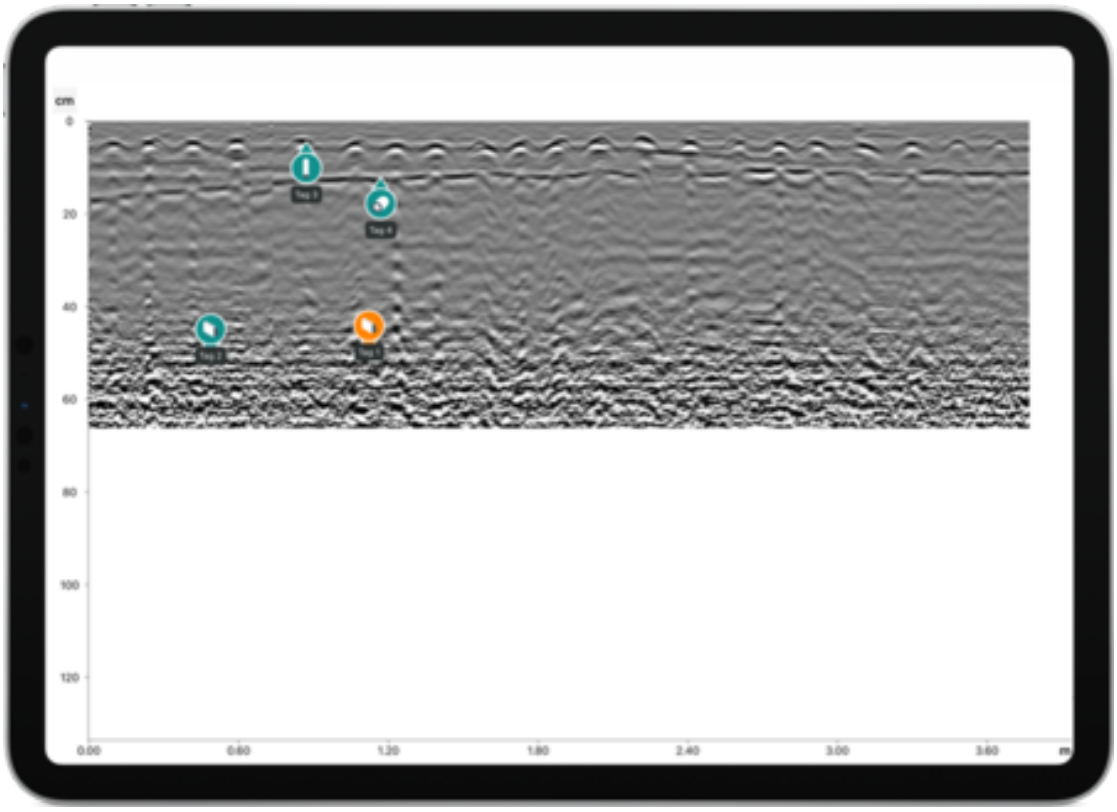
Below are the some of the main findings from this project, proving the functionality of NDT with these advanced technologies.

Results

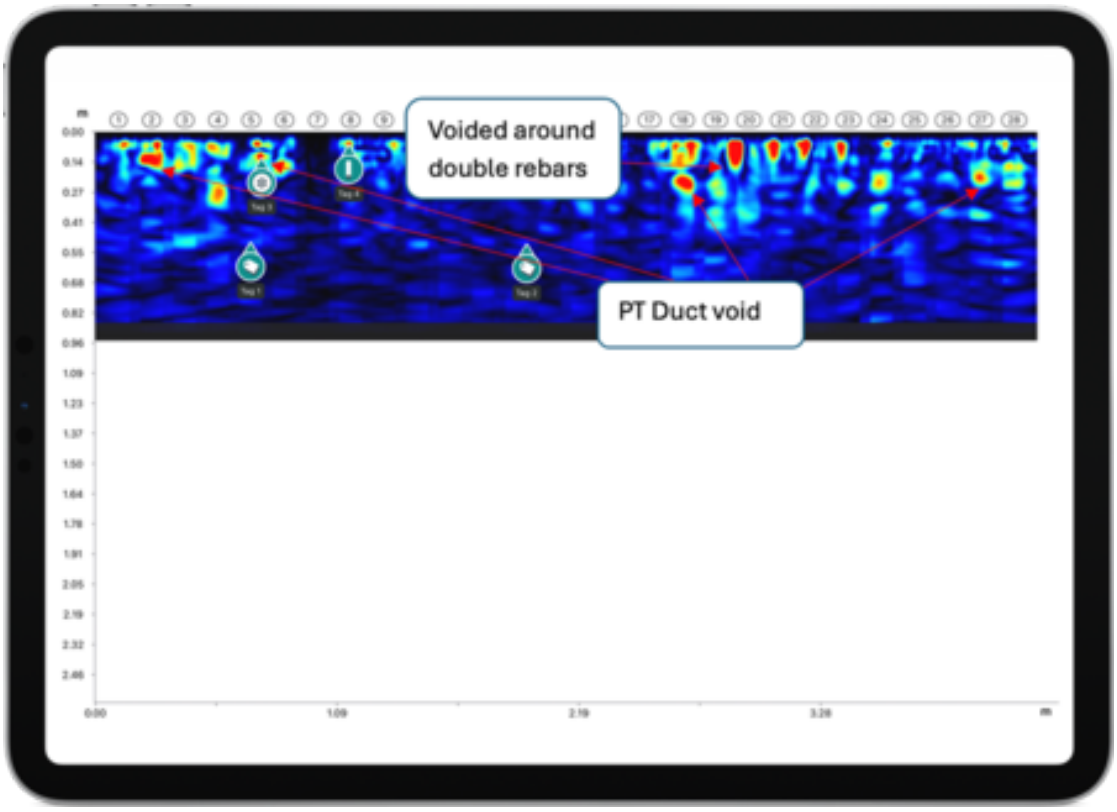
After scanning the area with the Proceq GP8800 GPR, the PT ducts and double reinforcing bars were precisely located. The PD8050 was then used in the same area to detect any potential voiding around the rebar or PT ducts. The results speak for themselves…



GPR Scan with Proceq GP8800 showing the path of the PT duct.



Radargram view showing double reinforcing bars above the PT duct (apart from the last 2 bars on the right.)

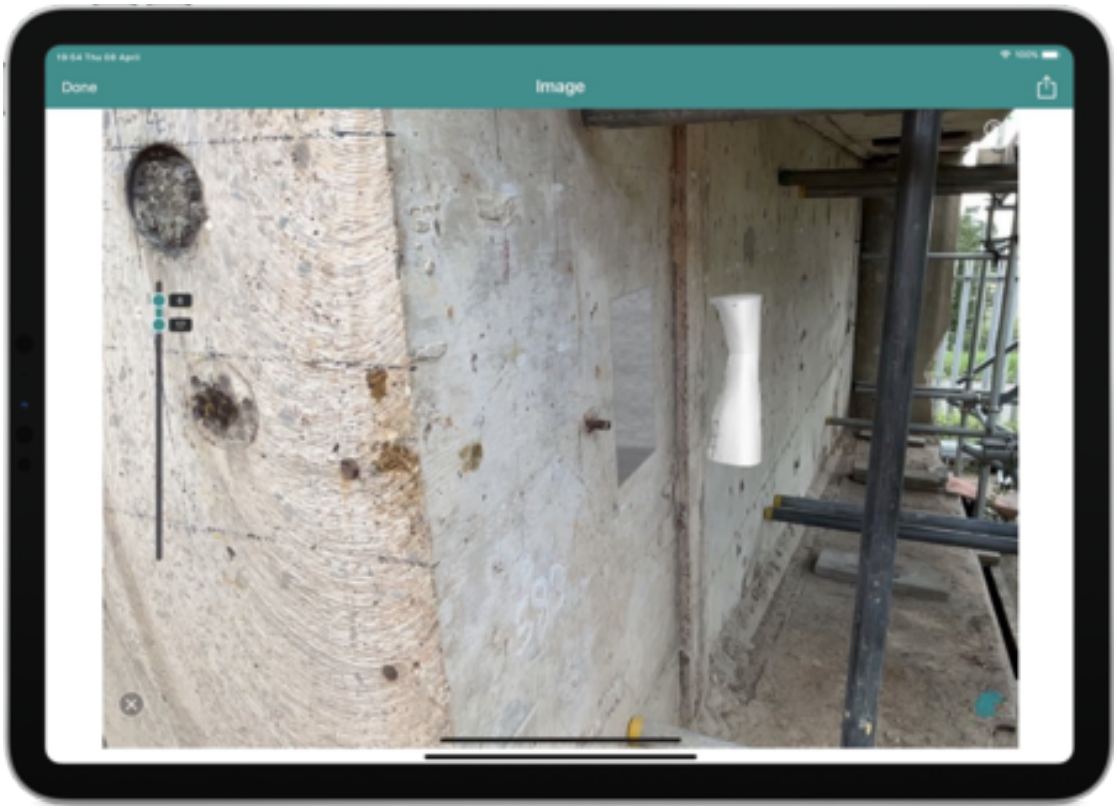


Results from the PD8050 showing localised voiding, taken over the same location as the GPR scans. Additionally the double rebars appear to have voiding around them.

Another area was previously communicated as possibly being voided. Initial scans with GPR showed nothing, but the follow-up tests with the PD8050 and PI8000 both showed air voiding.

Air voiding as shown with Pundit PI8000 ultrasonic impact echo techonology, taken in the same spot as the PD8050.

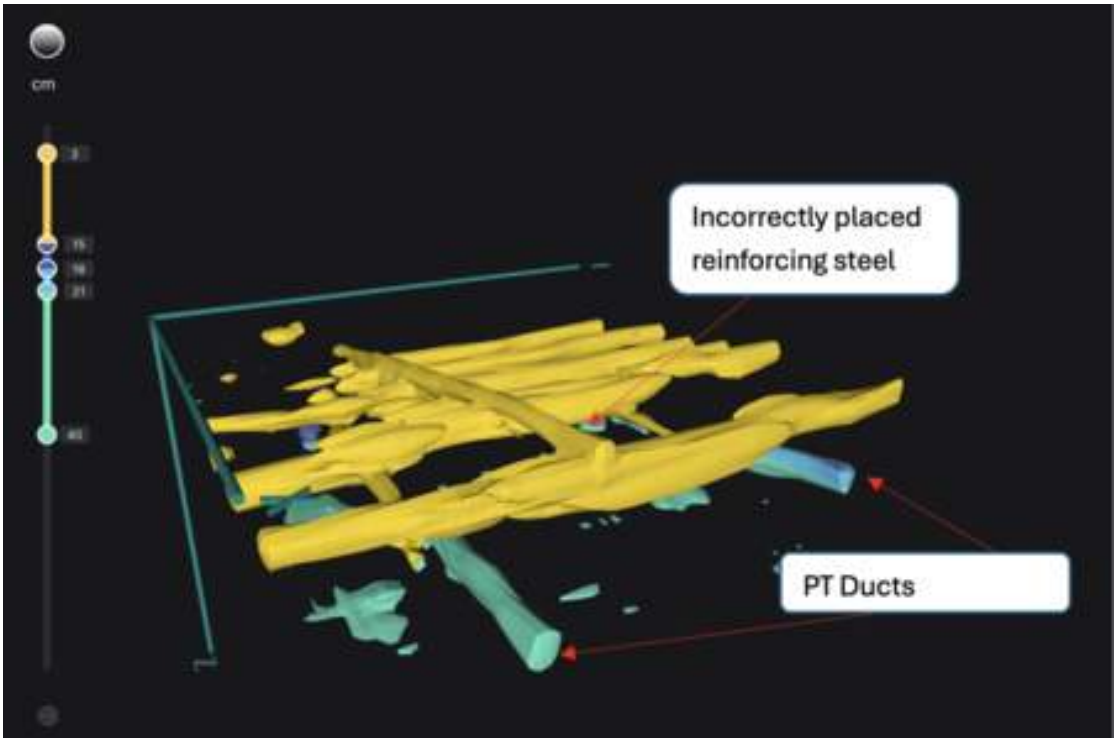
Air voiding as shown with Pundit PI8000 ultrasonic impact echo techonology, taken in the same spot as the PD8050.



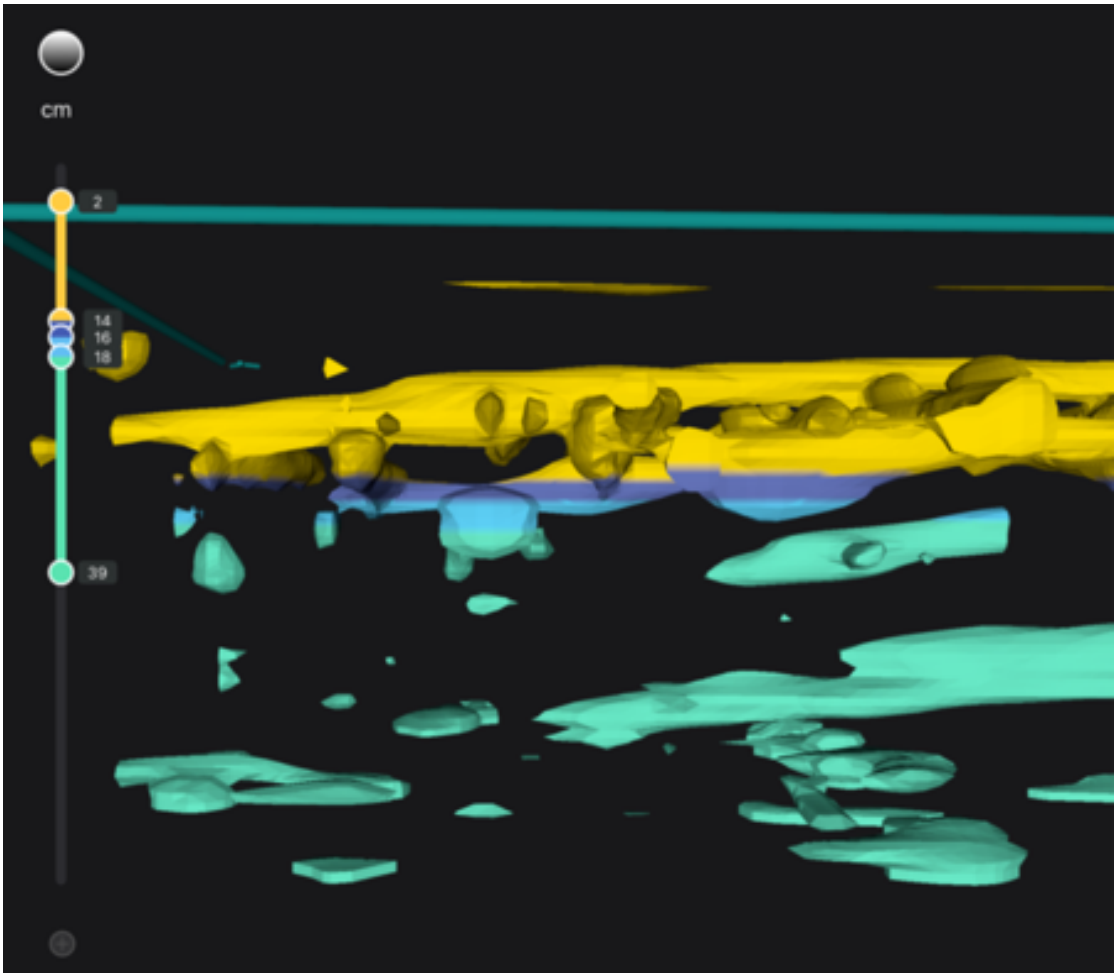
Augmented reality representation of the void taken with the Pundit PD8050 ultrasonic pulse echo technology.

The AR view above shows the possible shape of the void, which appears to be a duct of some type, or perhaps a grouting channel or drain. It is not metal, and does not appear to reflect EM waves from the GPR.

Using multiple NDT technologies such as GPR, ultrasonic pulse echo and impact echo in the same area gives much higher confidence in the results. The next areas revealed some rather unexpected results with the GPR…



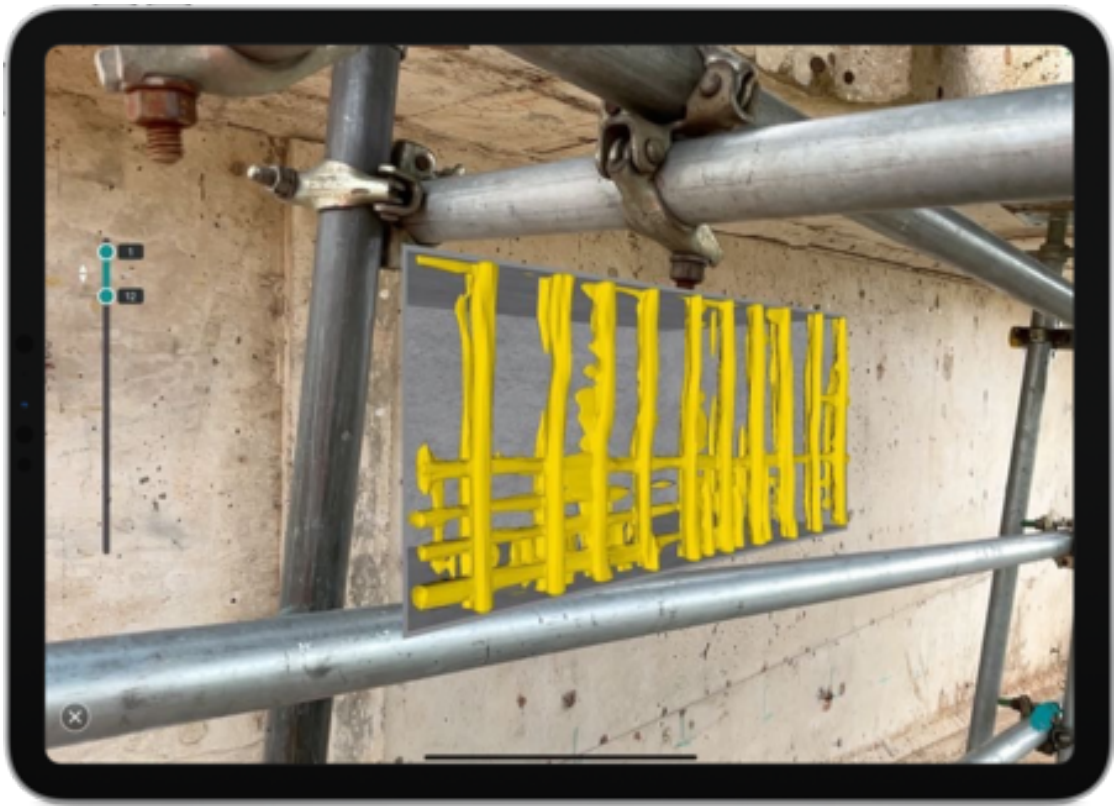
3D scan showing incorrectly placed reinforcing steel



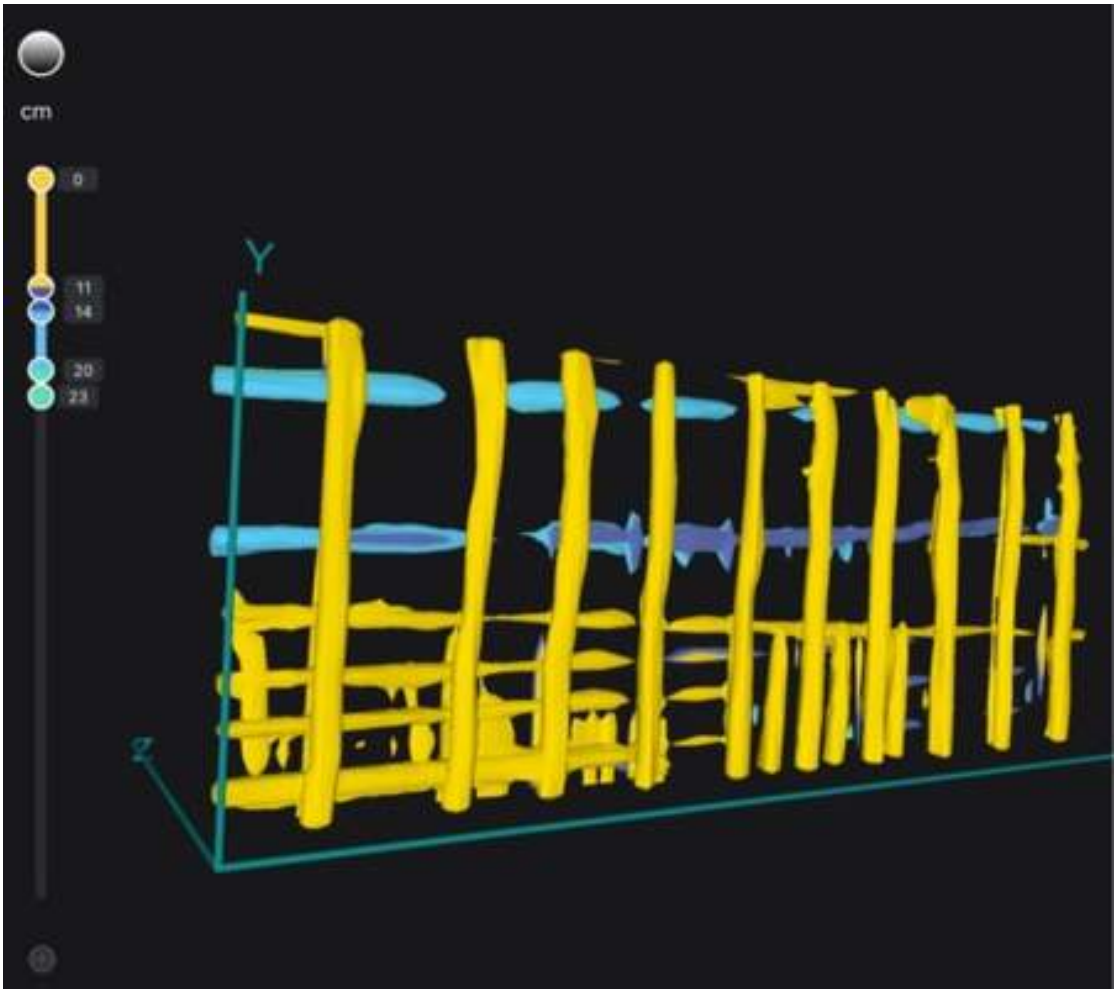
GPR Data displayed on the iPad revealing an incorrectly placed transverse reinforcing steel.

As seen from the results, an unexpected transverse rebar was detected with the Proceq GPR. An incorrectly placed transverse rebar could lead to issues with corrosion due to low cover, or potential structural weakness. Above we can also see the 2 post-tension ducts below the steel reinforcing mesh. They travel from right to left, getting deeper.

Another unexpected find of the bridge was that the rebar configuration seemed to be incorrect in one area.



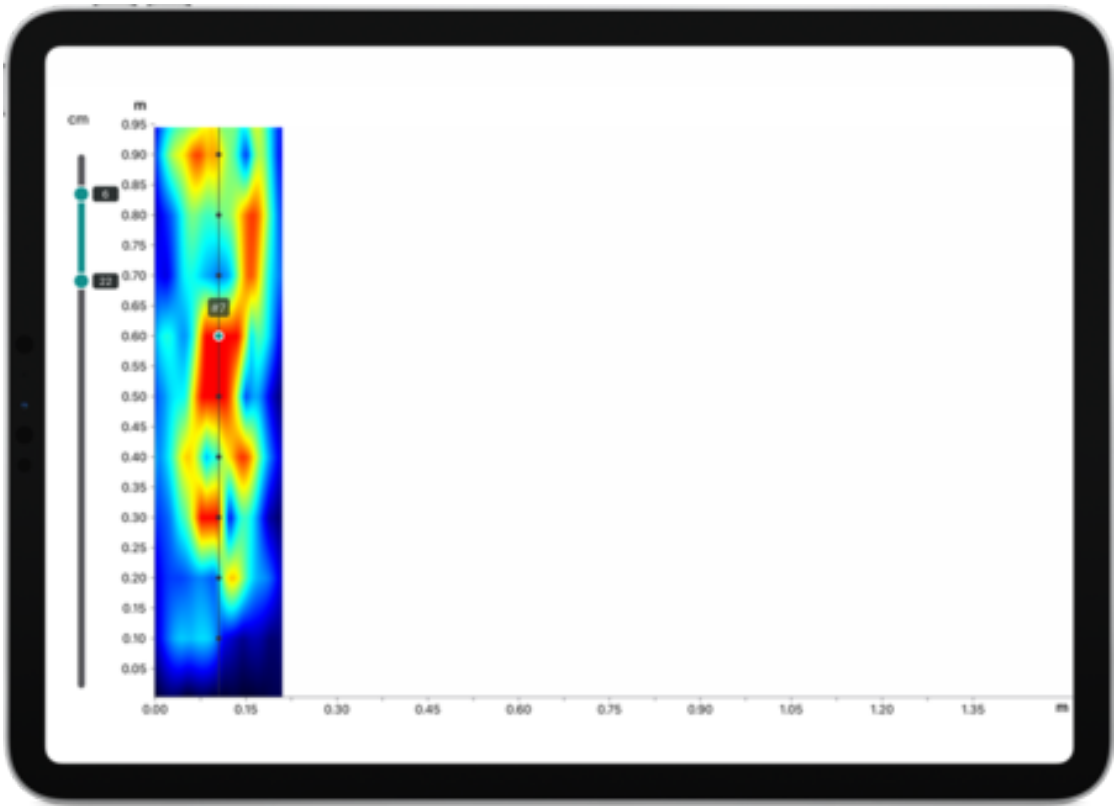
Augmented reality view of the GPR data results showing the rebar configuration with missing horizontal rebar at the top.



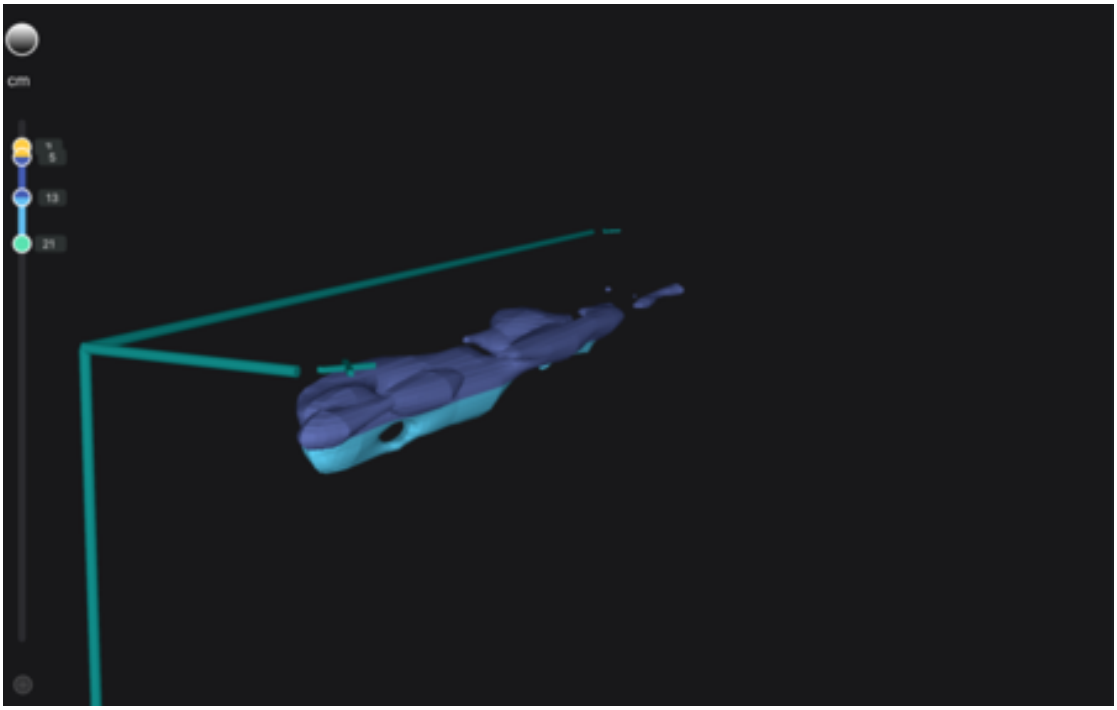
3D view showing PT Ducts sitting under location of missing horizontal reinforcement

Oddly, the GPR data shows that there are no horizontal steel reinforcement over the top of the duct location. This is unlikely to be a design feature and is most likely a construction fault.

At the location below, PD8050 data clearly shows voiding inside the PT duct. This is the red are shown in the scan data.



The red areas indicate where air is present within the duct using UPE technology.



A 3D scan of the test area shown above appears to show voiding of a PT duct.

The PD8050 helps identify locations of the PT duct that can then be opened up with targeted investigations to confirm the NDT findings. The big advantage of using NDT methods is the reduced number of unnecessary openings carried out to what could be well grouted PT ducts. These significant findings highlight the importance of a multi technology approach to NDT, alongside trained inspectors.

Interested in detecting voids and defects in concrete with ease and unrivalled visualization? Contact our team to have your questions answered about the Pundit PD8050 or Proceq GPR.