SOUTH-EAST SCANNING

Site Report for QNP Moura

Structural Assessment Report for QNP Moura

Ground penetrating radar, structural analysis, and utility detection specialists.

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Executive Summary

South-East Scanning conducted a comprehensive ground-penetrating radar (GPR) investigation of a concrete slab at Queensland Nitrates (QNP) in Moura, QLD. This investigation aimed to determine the reinforcement bars' layout, spacing, and cover. The Proceq GP8000 was used to scan and accurately locate the position and depth of the reinforcement, while the Proceq Profometer PM8000 provided estimates of the diameter of the reinforcement bars. The survey revealed variations in the reinforcement layouts, overlapping bars, and potential voids in certain plinths. Due to the considerable depth of the slab and the effects of signal attenuation, some limitations were encountered. Destructive testing is recommended to confirm the diameter of the reinforcement bars, voids, and other structural elements.

Introduction

At the request of the project engineer, South-East Scanning performed a detailed GPR survey of a concrete slab at QNP Moura. This assessment aimed to determine the reinforcement bar layout, spacing, and concrete cover depths across various structure sections. To achieve this, the Proceq GP8000 was employed for high-resolution scanning, while the Proceq Profometer PM8000 was used to provide reinforcement diameter estimates where concrete cover depths were minimal. The scope of this survey included assessments of the top and bottom slab reinforcement, slab edges, slab penetration, supporting columns, and plinths. This report presents the findings and interpretations based on the data collected during the investigation.

Field Methodology

The team used the Proceq GP8000 to detect and map the reinforcement bar placement, orientation, and concrete cover depths. To ensure comprehensive data collection, the scanning process was conducted systematically in both north-south and east-west orientations. The Proceq Profometer PM8000 was used to estimate reinforcement bar diameters in areas where the cover depths were within its penetration capabilities. Given that the Profometer has a maximum penetration depth of 80mm, reinforcement diameter readings were limited to areas with shallow cover. Signal attenuation at greater depths presented challenges in reinforcement detection, particularly in areas with significant overlapping reinforcement.

Challenges

The survey encountered several challenges that influenced data accuracy and interpretation:

- The concrete slab had an approximate depth of 800mm, which resulted in significant signal attenuation. This affected the clarity of deeper reinforcement reflections.
- Obstructions on the slab's top and bottom surfaces limited scanning accessibility in certain sections.
- Overlapping reinforcement, especially near the slab penetration and plinths, complicated the differentiation of individual bars. The high reinforcement density in these regions required advanced data processing to distinguish the bars effectively.
- Significant rainfall had to be accounted for when procuring the requisite data for the 3D scanning surveys to ensure the integrity of the results.

Data Processing and Migration

The data collected with the Proceq GP8000 underwent post-processing to enhance signal clarity and improve reinforcement differentiation. Migration techniques were applied to refine depth estimates and improve the accuracy of bar spacing and orientation analysis. Considering the limitations of electromagnetic induction methods, the Proceq Profometer PM8000 data was carefully reviewed to estimate reinforcement bar diameters.

Data correlation between the GPR scans and Profometer readings helped establish an accurate reinforcement profile across the slab.

Survey Results

Top of Slab

- East to West Orientation: Reinforcement bars with an average spacing of 200mm and a concrete cover depth of approximately 120mm were detected.

  Due to the Profometer's penetration depth limitations, reinforcement bar diameters could not be confirmed in this region. Variations in bar spacing (+/-10mm) were observed, with some areas presenting overlapping reinforcement. The centre of the slab contained significantly overlapping reinforcement, extending to approximately 500mm on either side of the plinths.

  In these areas, spacings were approximately 100mm, and cover depths ranged from 100mm to 120mm. See Figure 1 below.

- North to South Orientation: The reinforcement was arranged in a staggered formation, repeating in a pattern of 5-6 bars with 100mm concrete cover, followed by 5-6 bars with 130mm cover.

  The GPR data and accompanying illustrations in this report provide greater detail on this bar orientation. See Figure 2 below.

- Trimmer bars: An investigation was conducted to detect diagonal trimmer bars around the slab penetration. However, no such bars were identified. Instead, additional reinforcement was found close to the penetration, likely serving the same structural function as trimmer bars to enhance load-bearing capacity.

Slab Underside

- North to South Orientation: In this orientation, the reinforcement layout closely resembled the top slab reinforcement, with the primary difference being the concrete cover depth. The configuration alternated between 5-6 bars with a cover of 50mm and 5-6 bars with a cover of approximately 90mm. The reinforcement bar spacing remained consistent at approximately 200mm, with a variation margin of +/-10%.

  See Figure 3 below for data and interpretation.

- East to West Orientation: Two distinct layers of overlapping reinforcement bars were detected. The first layer had a cover of 50mm, while the second layer had a cover of approximately 70mm. The second reinforcement layer was more pronounced closer to the slab penetration. In contrast, the outer sections of the slab presented only a single reinforcement layer with a cover depth of 70mm. The reinforcement bars across this orientation maintained an average spacing of 200mm.

See Figures 5 and 6 below for data and details.

Slab Edges

- Horizontal Scans (X-axis): Reinforcement bars were detected with close spacing, ranging between 100mm and 200mm. The cover depth alternated between 50mm and 100mm in different sections.
- Vertical Scans (Y-axis): Four horizontal reinforcement bars, with cover depths ranging from 75mm to 120mm, were identified.
- See site photos 9 and 10 below for the scanning location.

Columns

- The four supporting columns contained horizontal reinforcement with 50mm concrete cover and spacings of 400mm.
- Vertical reinforcement comprised five bars, spaced approximately 200mm apart, with 75mm cover.
- See site photo 11 below for the scanning location.

Plinths (Top of Slab)

- Reinforcement bars were arranged with a 200mm spacing pattern, with cover depths varying across different areas.
- The eastern side of the plinth exhibited indications of voiding at depths of 40mm and 70mm. Further investigation will be necessary to confirm the extent of the voiding.

Reinforcement Bar Diameter

- The Proceq PM8000 Profometer was used on the underside of the slab, where cover depths were minimal, to estimate reinforcement bar diameters. The data set (Figure 3) presents a cross-section view, with each dot representing a reinforcement bar. The average cover reading was determined to be 36mm.
- Due to the inherent limitations of the Profometer, reinforcement bar diameter estimates require verification through core drilling.
- A recommended location for destructive testing has been identified on the top of the slab (Site photo 12).
- See Figures 7 and 8 below for Profometer data.

Plinth 2 - Bolt Penetration Depth

- Bolt penetration depth was measured at 450mm. See Figures 16 and 17 below.
- Post-processing analysis indicated minor dielectric variability within the plinth. However, the data beyond the reinforcement was insufficiently clear for a definitive assessment.
- Destructive testing, including drilling, will be necessary to verify the internal composition and homogeneity of the plinth.

Concluding Remarks

This GPR investigation successfully assessed the concrete slab reinforcement layout, including bar orientations, spacing, and cover depths. While the survey results offer valuable insights, the inherent limitations of GPR and electromagnetic induction methods must be acknowledged. Potential voiding in specific plinths and estimated reinforcement bar diameters should be confirmed through destructive testing. Structural engineers should conduct further evaluations based on these findings to ensure the structure's integrity.

Disclaimer

GPR is a non-destructive testing (NDT) method used to evaluate reinforcement layouts in concrete structures. While GPR effectively identifies reinforcement positioning, spacing, and cover, it has inherent limitations, including signal attenuation and difficulty distinguishing overlapping bars. The Proceq Profometer PM8000 estimates reinforcement diameters through electromagnetic induction but is limited to shallow cover depths.

The findings presented in this report should be considered preliminary. Structural integrity assessments should not rely solely on NDT results. Destructive testing, such as core drilling, is strongly recommended for definitive reinforcement evaluation and structural verification.

Scan Data and Supplementary Images

Migrated GPR Data

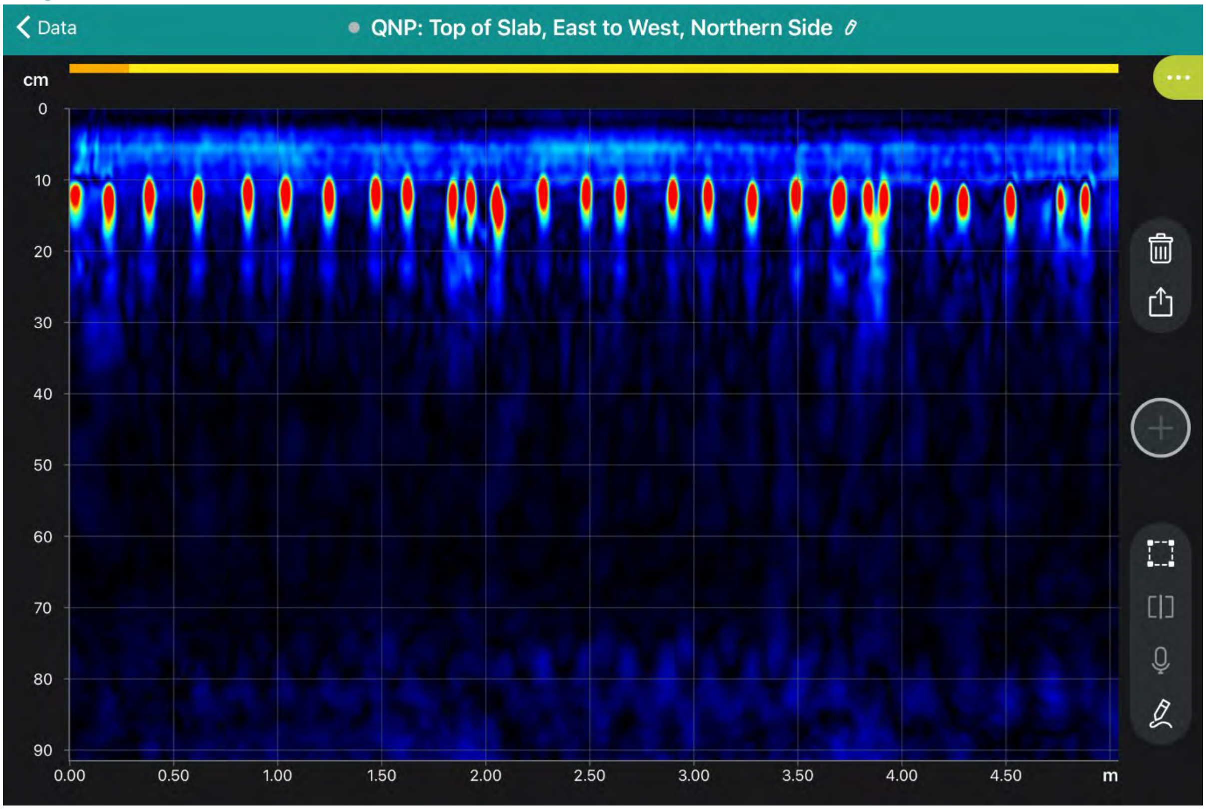


Figure 1: top of slab, east-to-west orientation.

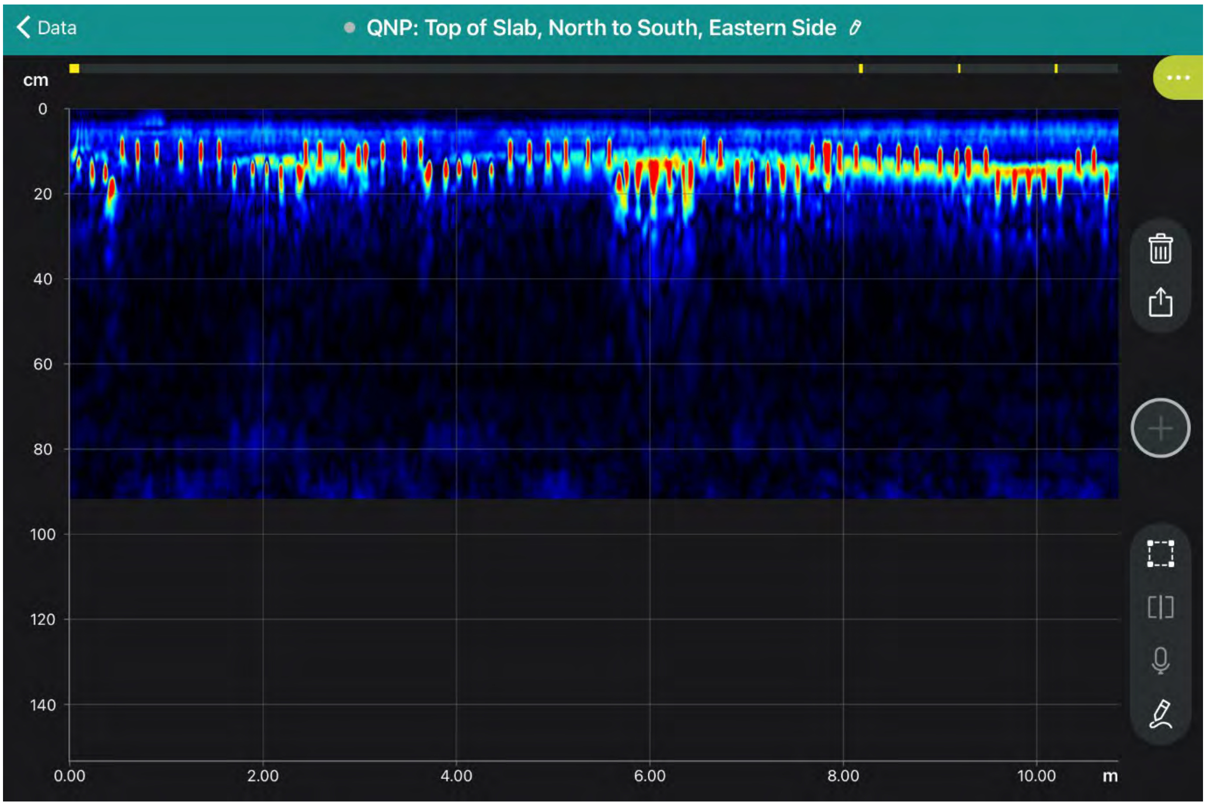


Figure 2: Top of slab, north-to-south orientation.

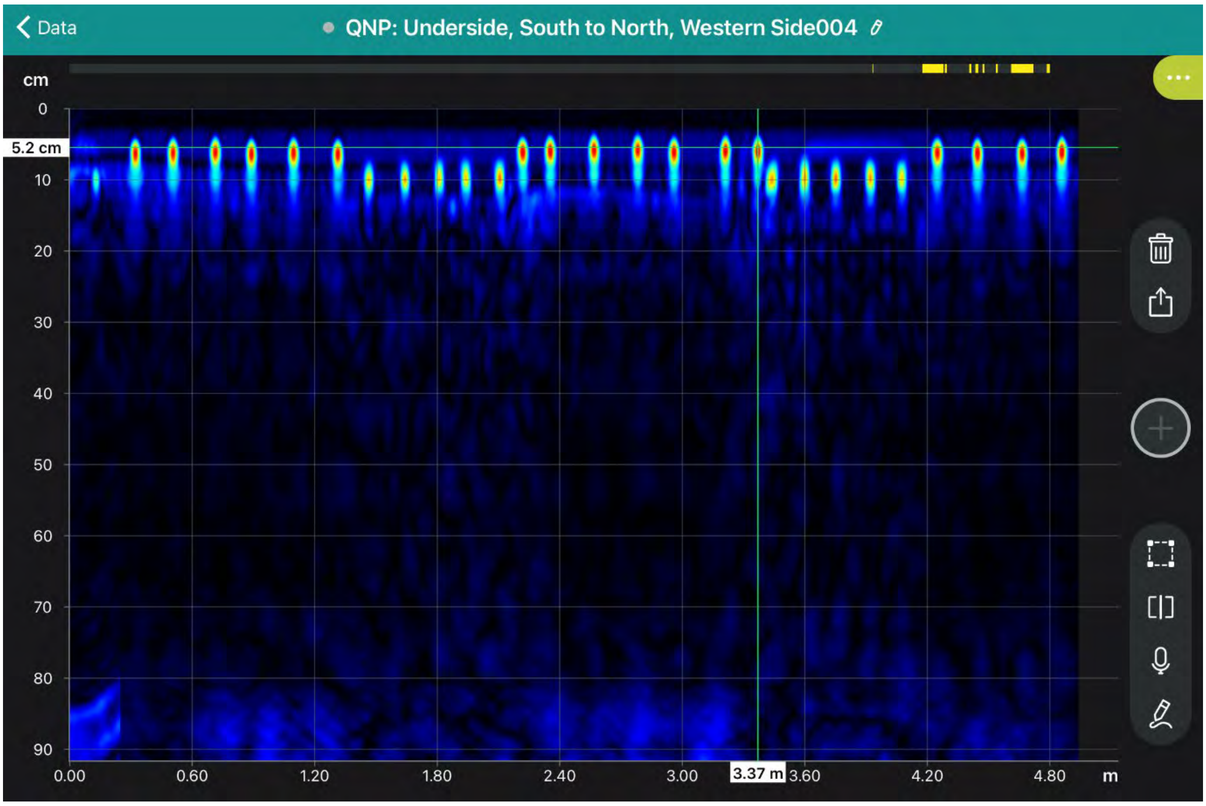


Figure 3: underside of slab, north-to-south orientation.

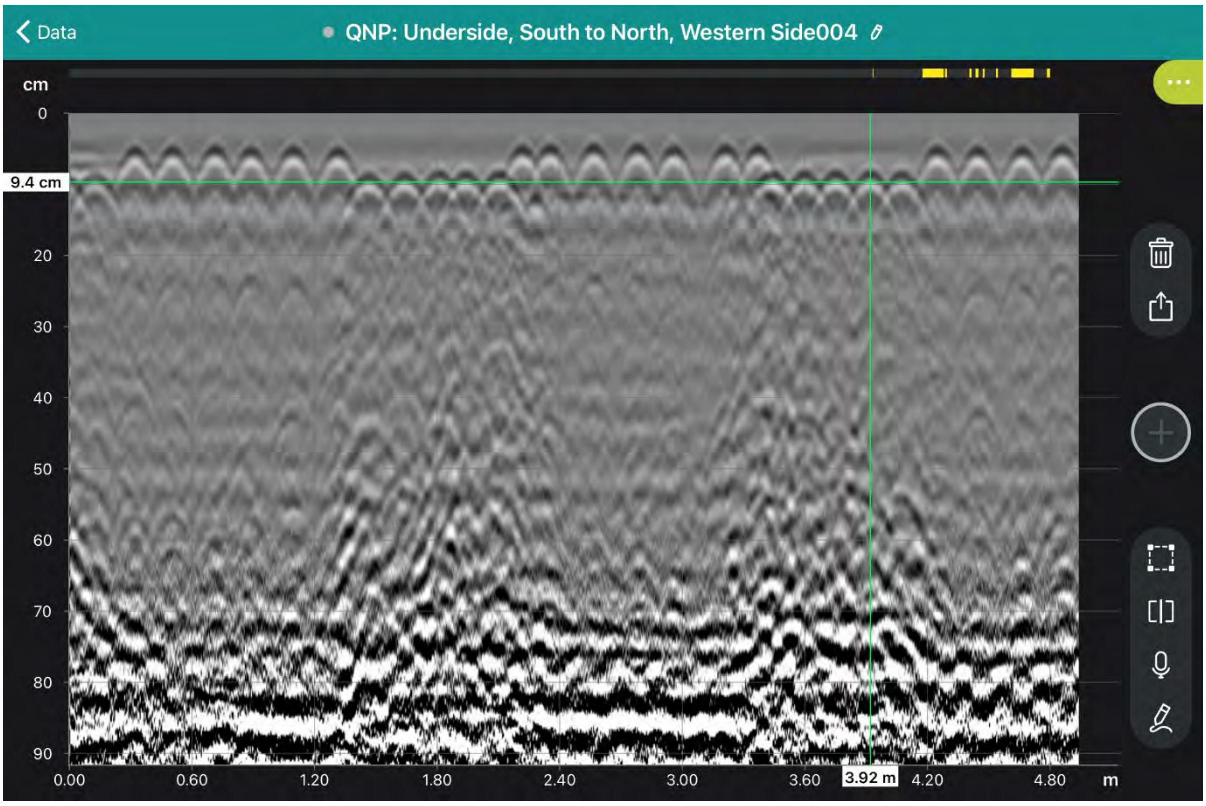


Figure 4: underside of slab, north-to-south orientation (unmigrated data showing hyperbolic readings).

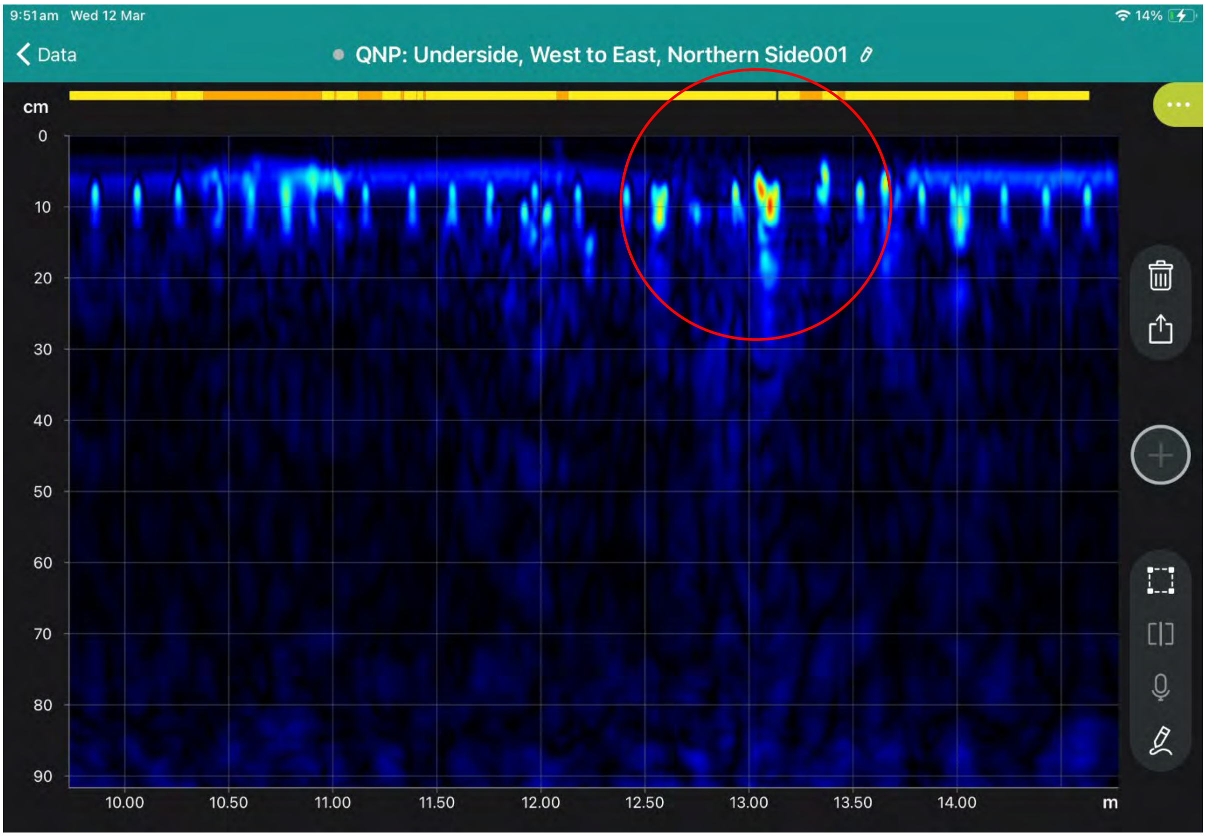


Figure 5: underside of slab, east-to-west orientation. Note that the bars overlap, indicated by the red circle.

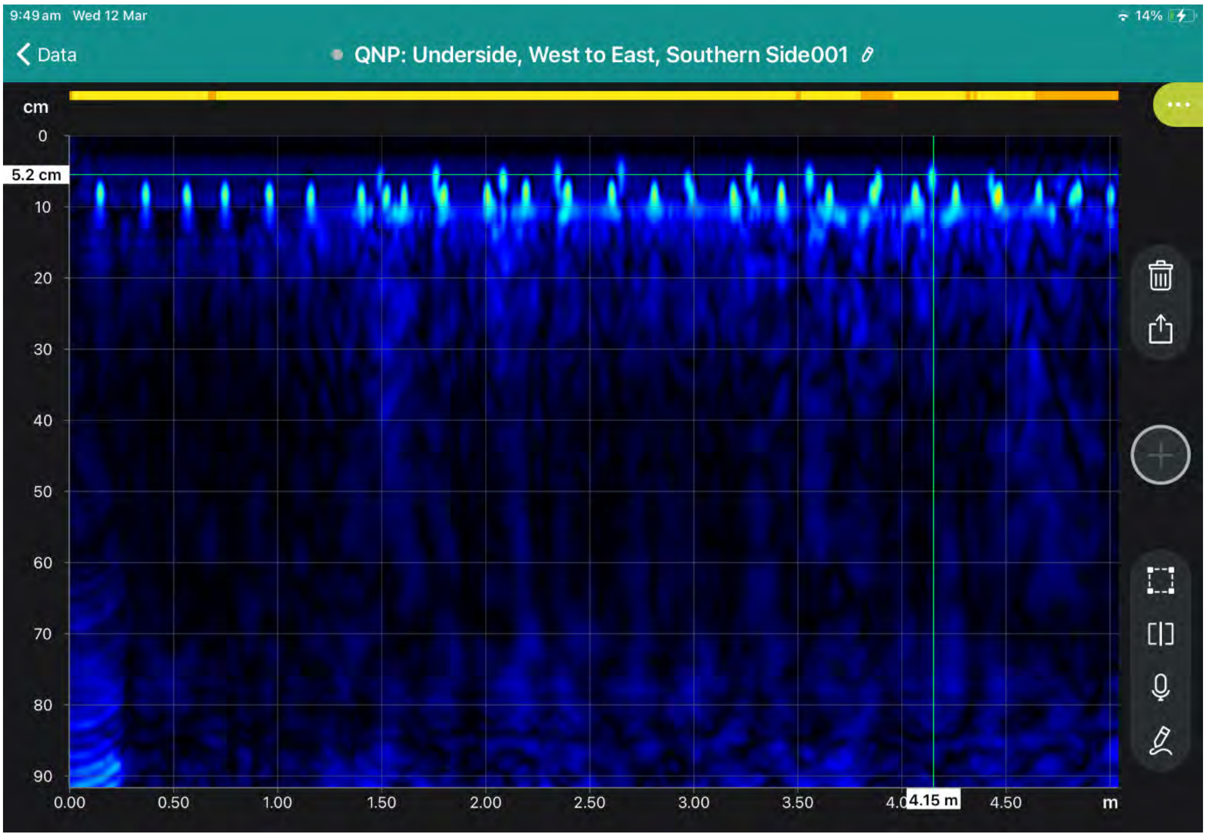


Figure 6: underside of slab, east-to-west orientation. Note the double layers of reinforcement.

Proceq Profometer PM8000 Reinforcement Bar Diameter Estimates

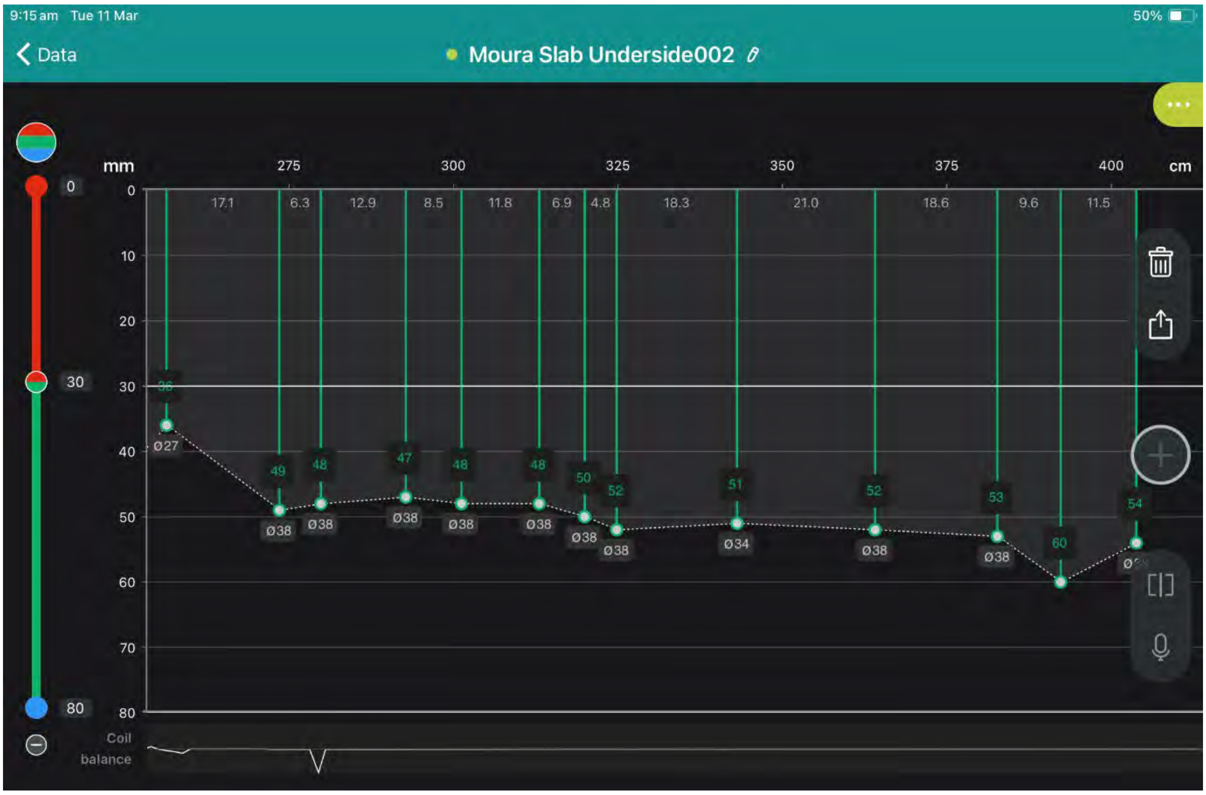


Figure 7: A range of 27mmØ to 38mmØ, indicating a likely diameter of 36mm.

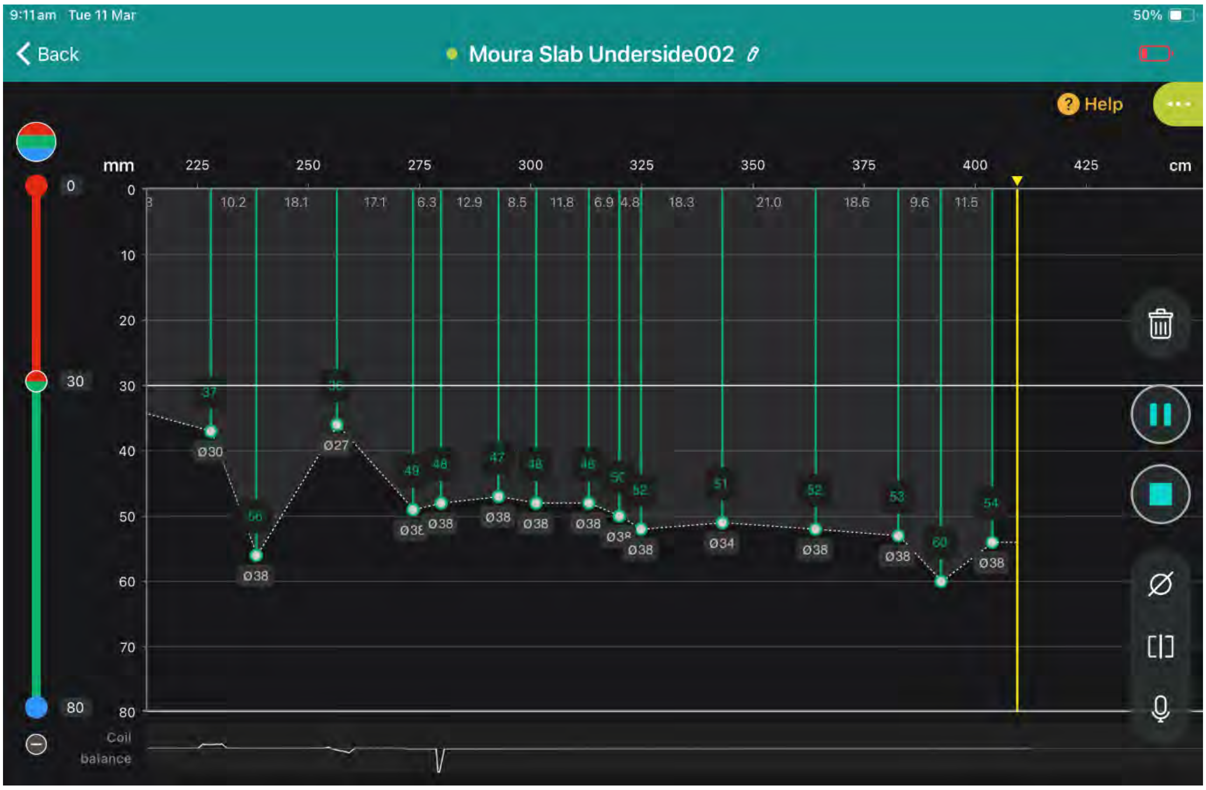


Figure 8: Average reading of 38mmØ, indicating a likely reinforcement diameter of 36mmØ when accounting for bar overlap, calibration, and Australian reinforcement bar standard sizes.

C-scan (3D) data and modelling

C-scan images, or 3D scans, generated from ground-penetrating radar (GPR) data provide an indicative visualisation of subsurface features but are not spatially precise representations. These images rely on interpolation and signal processing techniques to approximate reinforcement layouts and structural elements, meaning variations in depth, spacing, and positioning may occur.

Due to signal attenuation, overlapping reflections, and data migration, C-scan images should be interpreted as a qualitative tool rather than a definitive spatial map. Direct GPR scans, cross-sectional analysis, and verification through destructive testing are recommended for accurate reinforcement placement and measurements.

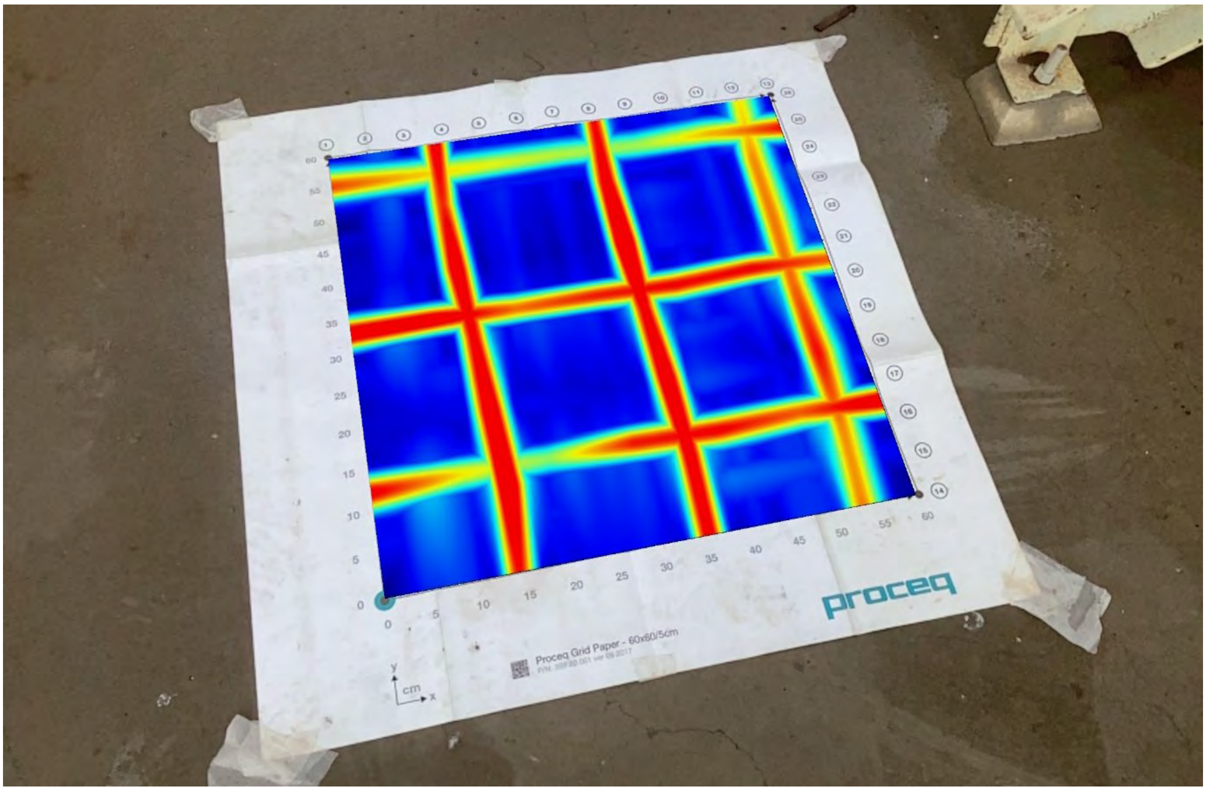


Figure 9: Top of slab, near slab edge, confirming B-scan (2D) findings of 200mm x 200mm squares. This image is a heat map generated by combining multiple 2D scan images.

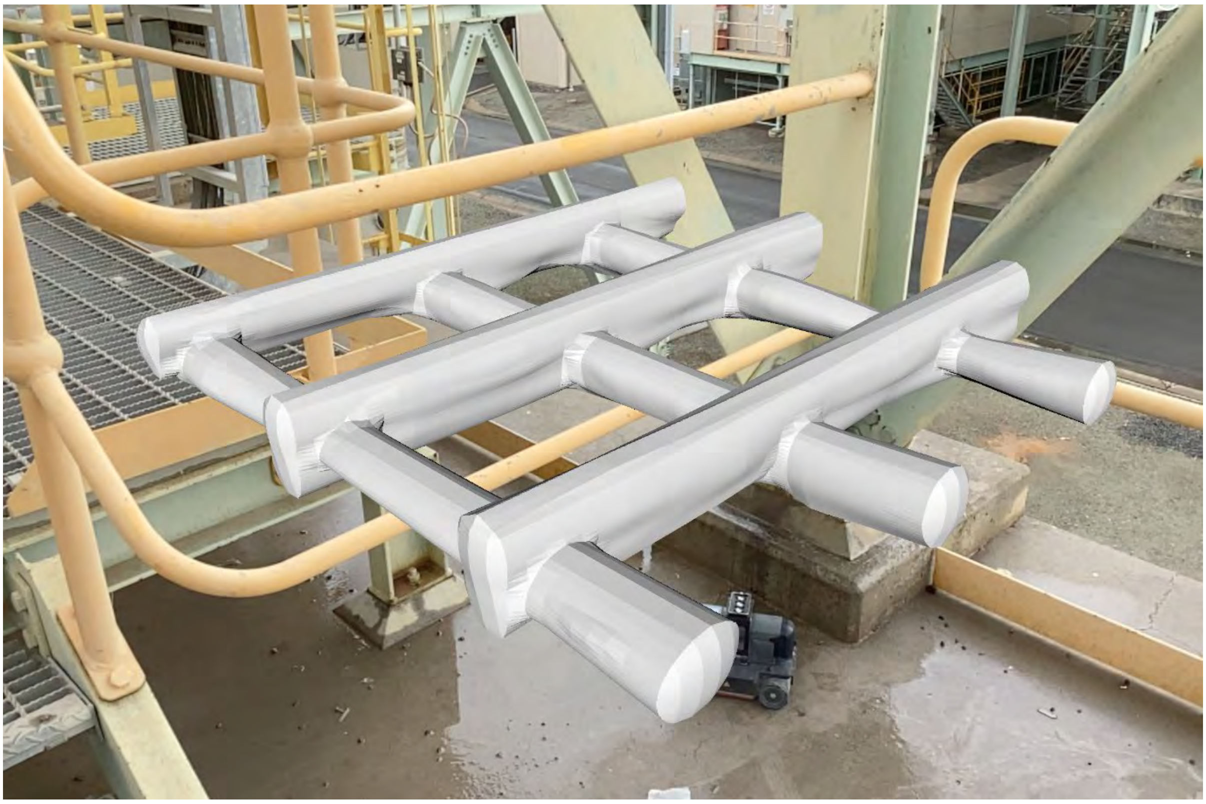


Figure 10: 3D visualisation of the scan data procured for Figure 9 above, confirming the overlap of the bars, including the placement of the east-to-west bars over the north-to-south bars.

Figure 11: 3D visualisation of the scan data procured for Figure 9 above, confirming the overlap of the bars, including the placement of the east-to-west bars over the north-to-south bars (alternate angle)

Figure 12: 3D visualisation of the scan data procured for Figure 9 above, confirming the overlap of the bars, including the placement of the east-to-west bars over the north-to-south bars (bars in place of scan over grid paper).

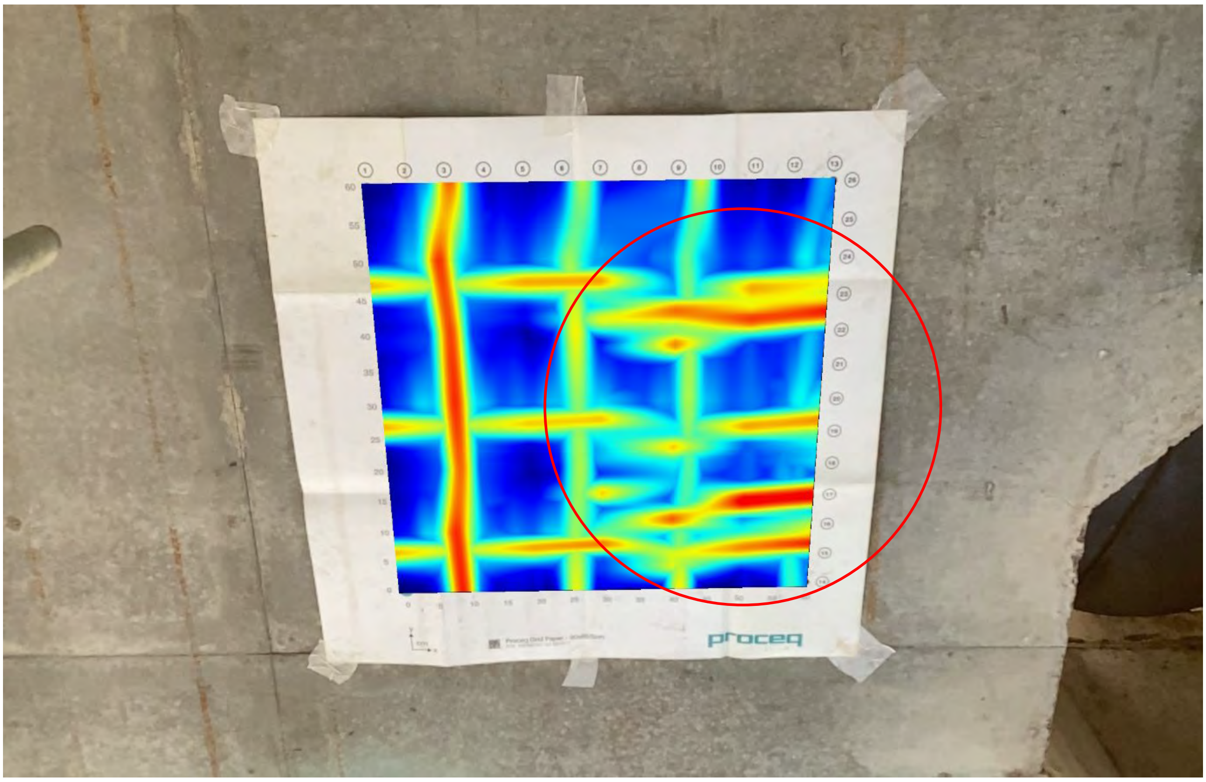


Figure 13: 3D visualisation of the slab underside, confirming the additional bar placements on the right of the image, strengthening the slab's centre in place of trimmer bars (see red circle).

Figure 14: 3D visualisation of the slab underside, confirming the additional bar placements on the right of the image, strengthening the slab's centre in place of trimmer bars. The overlap of the multiple bars is visible.

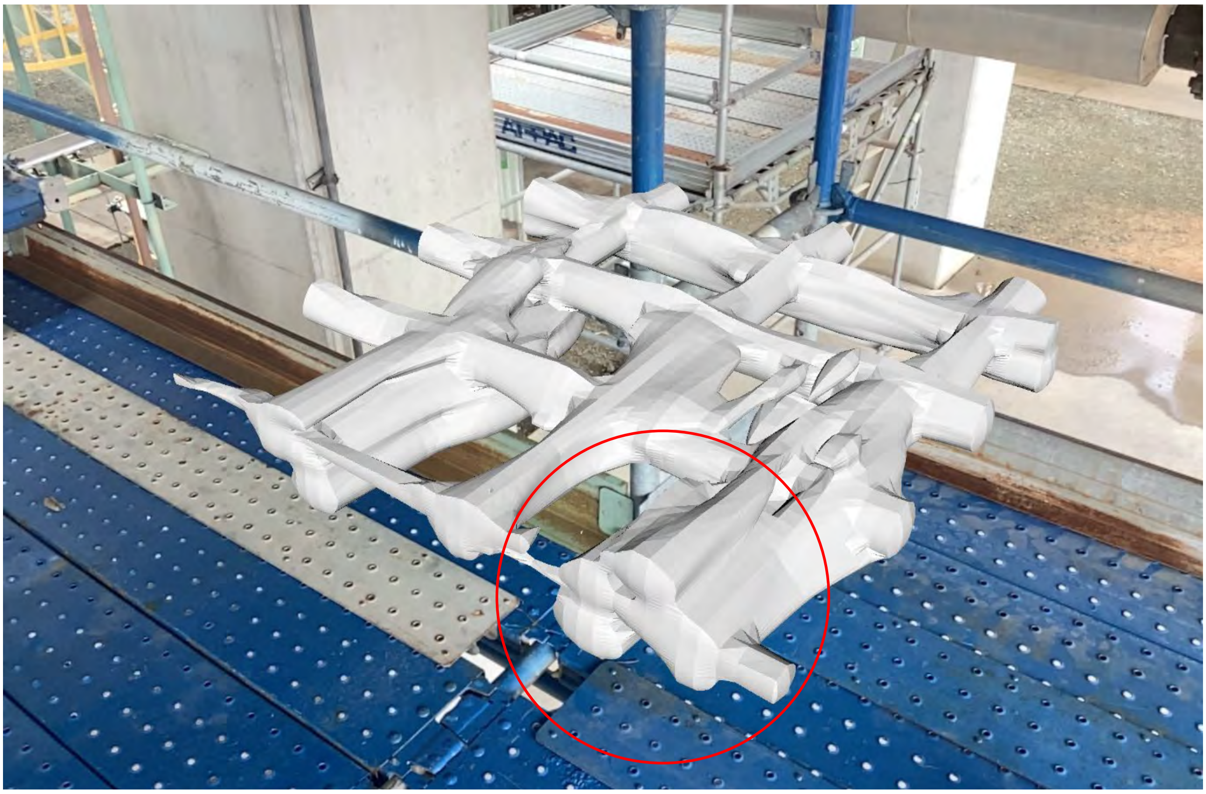


Figure 15: The data from Figure 14 viewed from an alternate angle. Note the cluster of four reinforcement bars inside the red circle.

Appendix 1: Bolt Penetrations in Plinths

Figure 16: Bolt penetrations detected using GPR scanning on the side of the pipeline plinths. The penetrations extended to approximately 450mm, placed in the centre of the plinth with ~200mm of concrete cover.

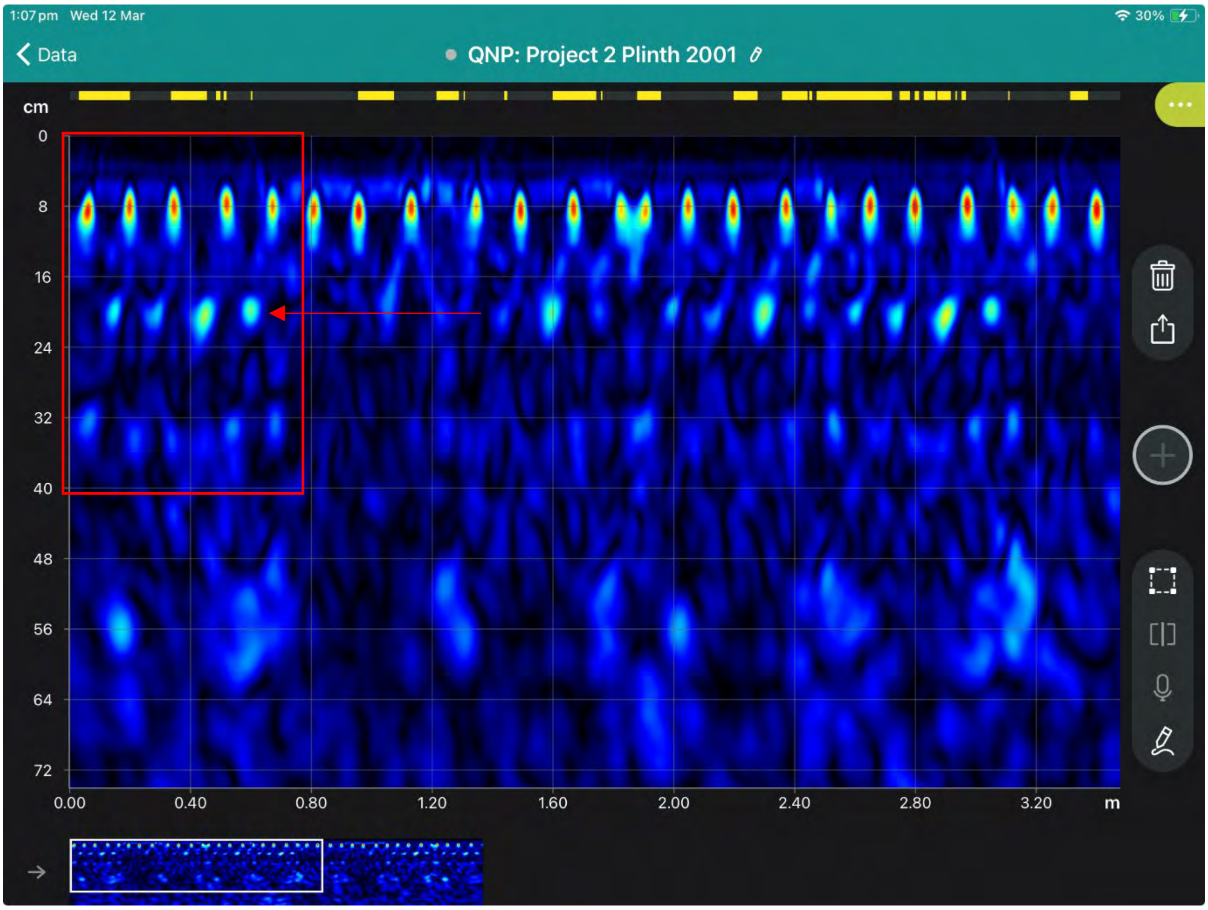
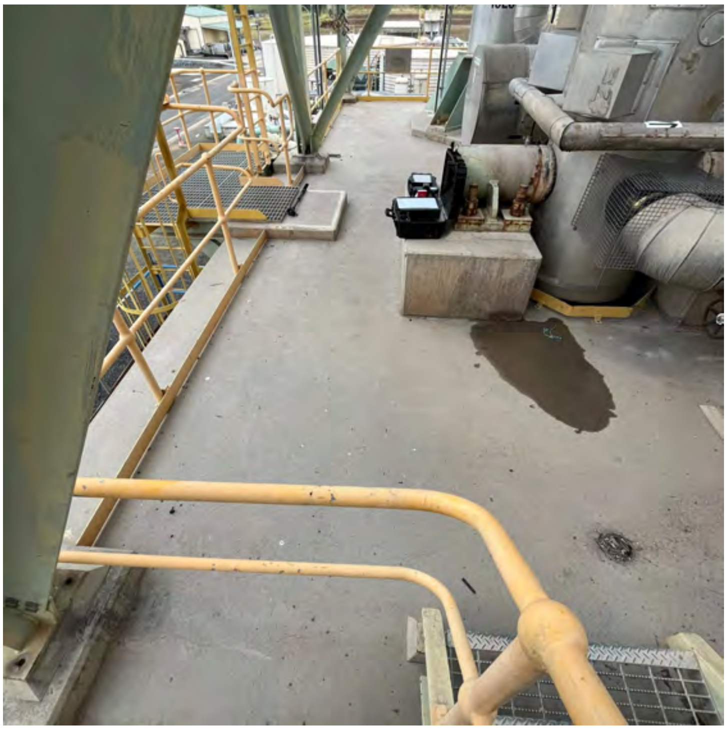


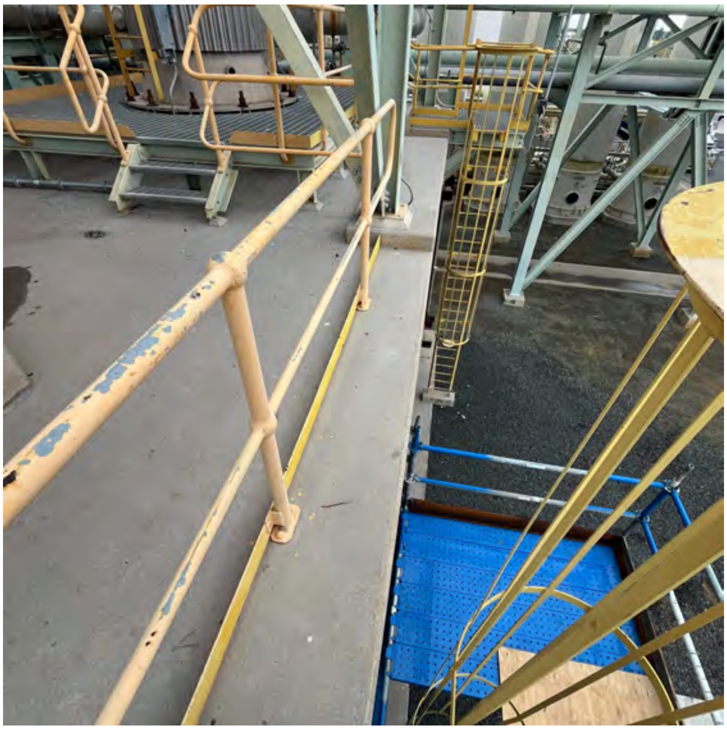
Figure 17: Confirmation of the bolts inside the rectangle. This boundary represented the width of the column, with the arrow indicating the placement of the bolts.

Appendix 2: Site Photographs

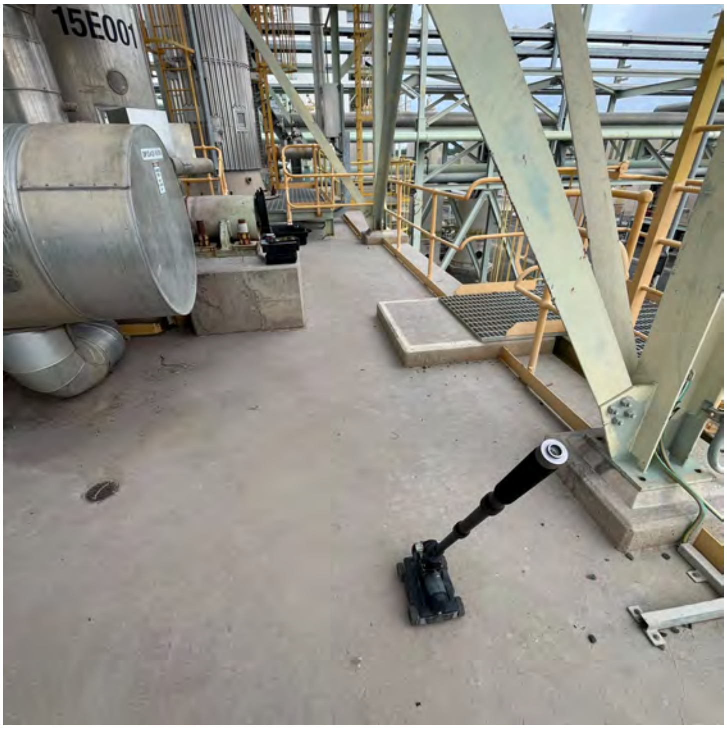

Site photo 1


Site photo 2

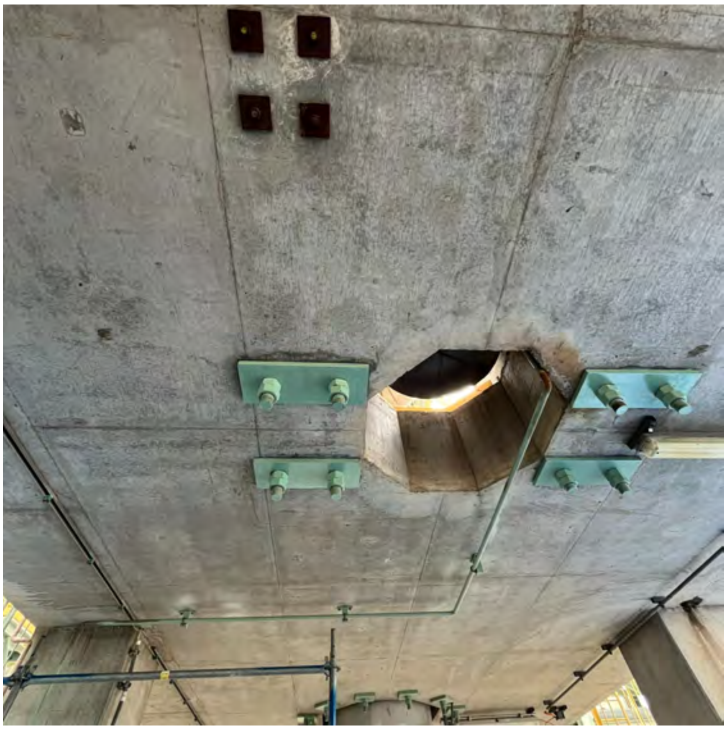

Site photo 3


Site photo 4

Site photo 5



Site photo 6



Site photo 7

Site photo 8


Site photo 9


Site photo 10


Site photo 11


Site photo 12

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If you require further information, access to GPR data, or have questions about the contents of this report, please do not hesitate to get in touch.

Kind regards,