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1 Introduction

Asbestos cement pipes have been widely utilized in water distribution and sewage systems due to their inherent strength, durability, and corrosion-resistant properties. However, as these pipes age, exposure to environmental factors, particularly water, can trigger calcium leaching within the cement matrix. The gradual depletion of calcium compounds compromises the structural integrity of asbestos cement pipes, leading to potential failures and water contamination risks. Non-destructive testing methods, such as ultrasound and computed tomography (CT) scan, offer promising solutions for evaluating calcium leaching in these critical infrastructure components.

This report aims to provide a comprehensive comparison of ultrasound and CT scan techniques to quantify and visualize calcium leaching in asbestos cement pipes. Through an analysis of the strengths and limitations of each method, we seek to offer valuable insights into their applicability and effectiveness in assessing the condition and remaining service life of asbestos cement pipelines.

2 Method

2.1 Sample and procedure

Three DN100 asbestos cement pipes have been selected as samples for this test. The following procedure has been followed to obtain the necessary results for the comparison:

1. The samples are scanned using the PipeScanner of Acquaint (using ultrasound) while still in operation. The measurements are analysed using **leaching analysis**, patented by Acquaint.
2. The samples (pipes) are removed from the network.
3. CT scans are conducted in a laboratory environment.

2.2 CT scan

Computed tomography (CT) scan, renowned for its high-resolution cross-sectional imaging capabilities, has found increasing application in non-destructive testing of various materials. In the context of asbestos cement pipes, CT scan technology provides detailed 3D visualization of the internal structure, enabling precise quantification and spatial mapping of calcium leaching. This technique offers an unparalleled level of accuracy, allowing the identification of even subtle changes in material composition. While CT scans require more sophisticated equipment and longer processing times, their ability to provide comprehensive data makes them invaluable for in-depth evaluations.

Typical CT scan results are slices along the longitudinal axis of the pipe as shown in Figure 1. Based on the measured intensity, these slices are converted to unaffected wall thickness. The wall thickness can then be mapped as function of circumferential and longitudinal position on the pipe. An example is shown in Figure 2.

Figure 1 CT scan slices

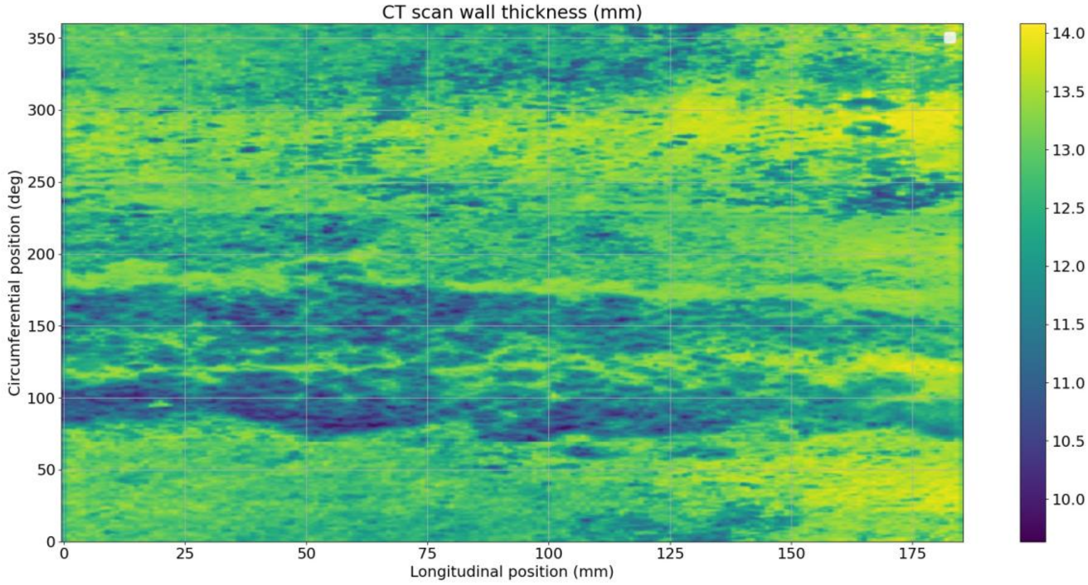

Figure 2 CT scan unaffected wall thickness heat map

2.3 Ultrasound

Ultrasound has emerged as a prominent non-invasive tool for assessing the internal condition of various materials, including asbestos cement. By transmitting high-frequency sound waves through the pipe wall, ultrasound allows us to detect changes in the material's internal structure caused by calcium leaching. The received echoes are analyzed to quantify the extent of calcium depletion, providing real-time data without causing any damage to the pipe. The portability and ease of use make ultrasound an attractive option for field inspections and routine assessments.

For each sample, the ultrasound measurements have been carried out using a couple of longitudinal lines on the pipe and a line on the circumferential of the pipe in field, while the pipes were still operational.

Figure 3 a field measurement using ultrasound

3 Analysis

In order to compare the result of CT scan research with the results of ultrasound measurements, the scanned lines from the ultrasound measurements have been extracted from the heatmap of the CT scan. IN the following paragraphs, the direct comparison of the samples are shown. At the end of this chapter (paragraph 3.2) the results are discussed.

3.1 Results

3.1.1 Sample1

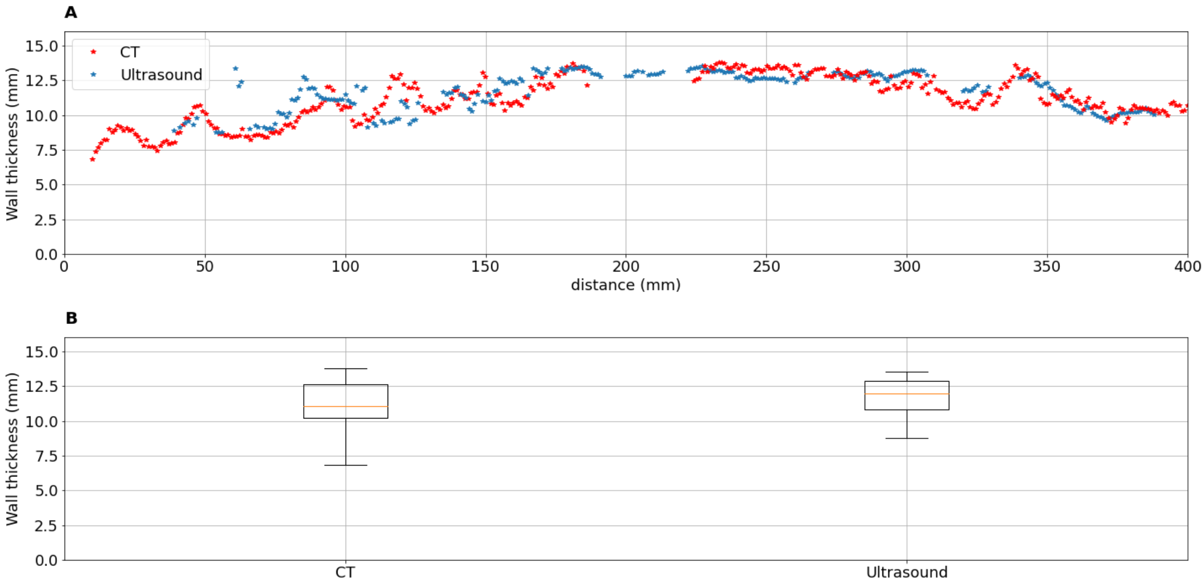

Figure 4 Sample 1, longitudinal scan 1

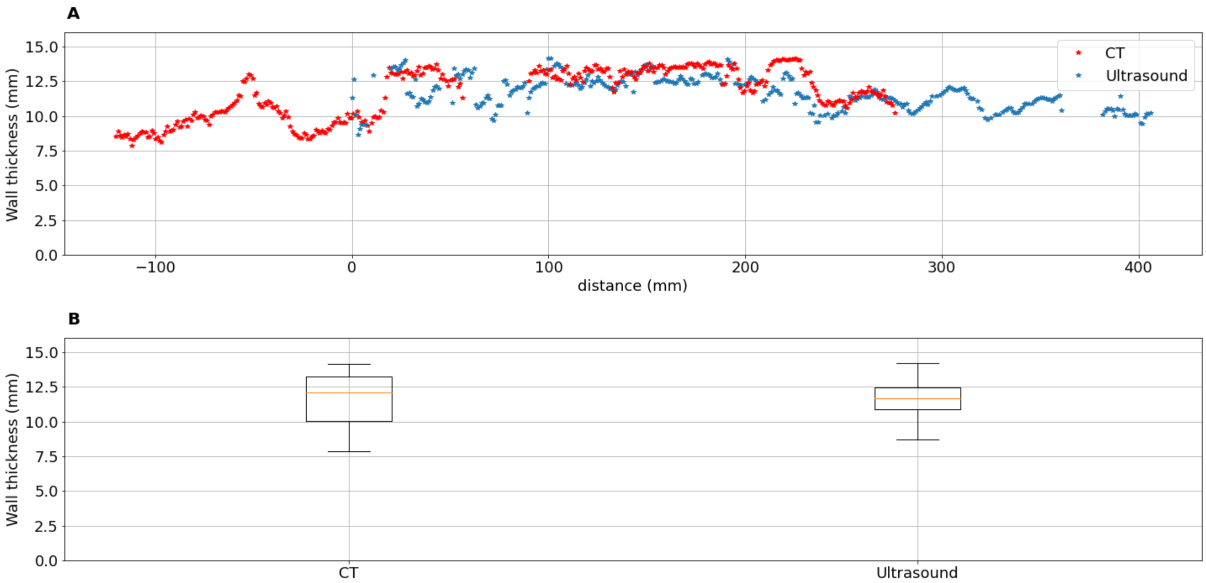

Figure 5 Sample 1, longitudinal scan 2

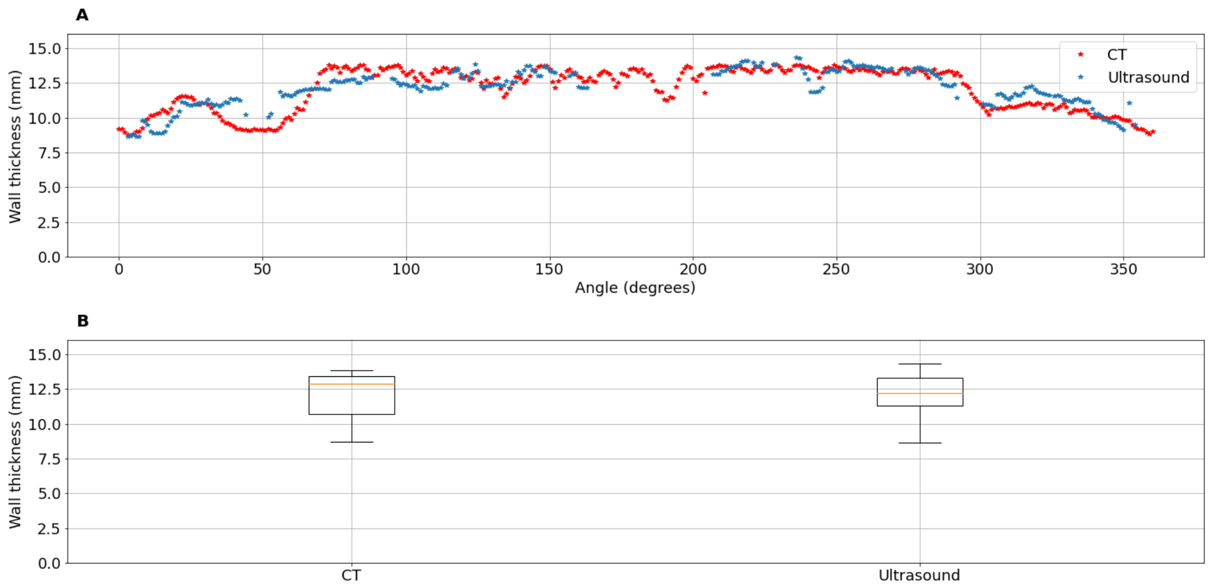

Figure 6 Sample 1, circumferential scan

3.1.2 Sample 2

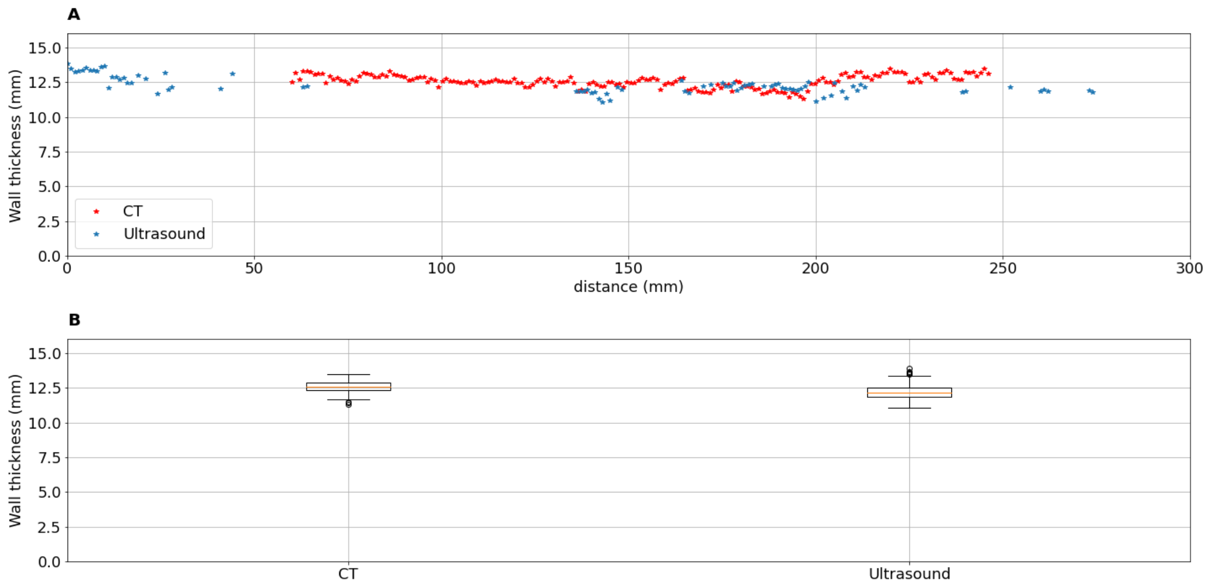

Figure 7 Sample 2, longitudinal scan 1

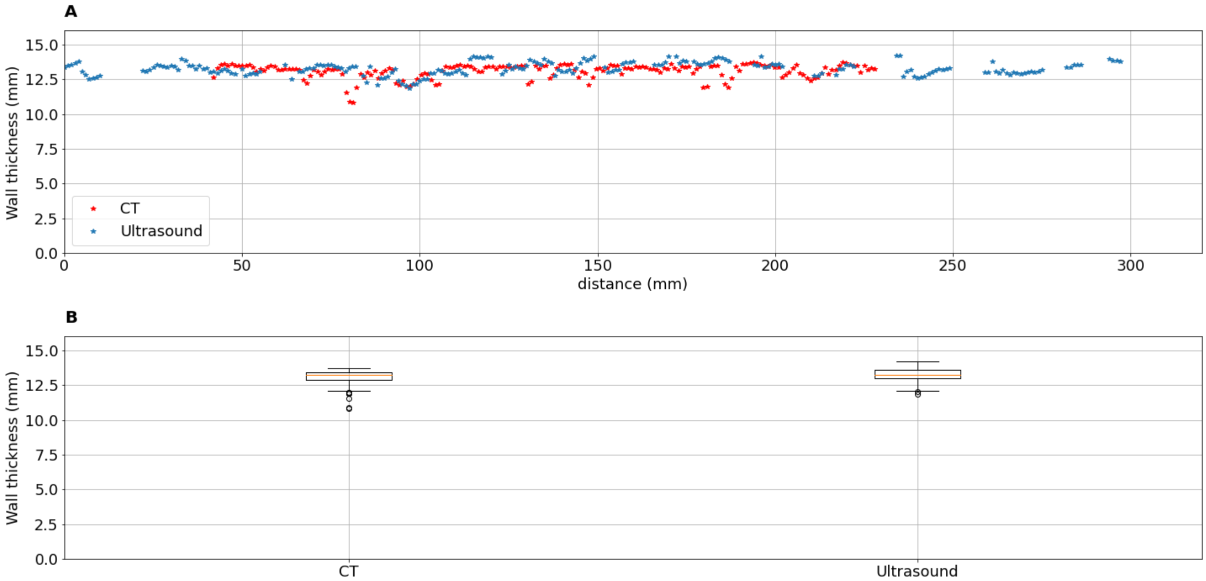

Figure 8 Sample 2, longitudinal scan 2

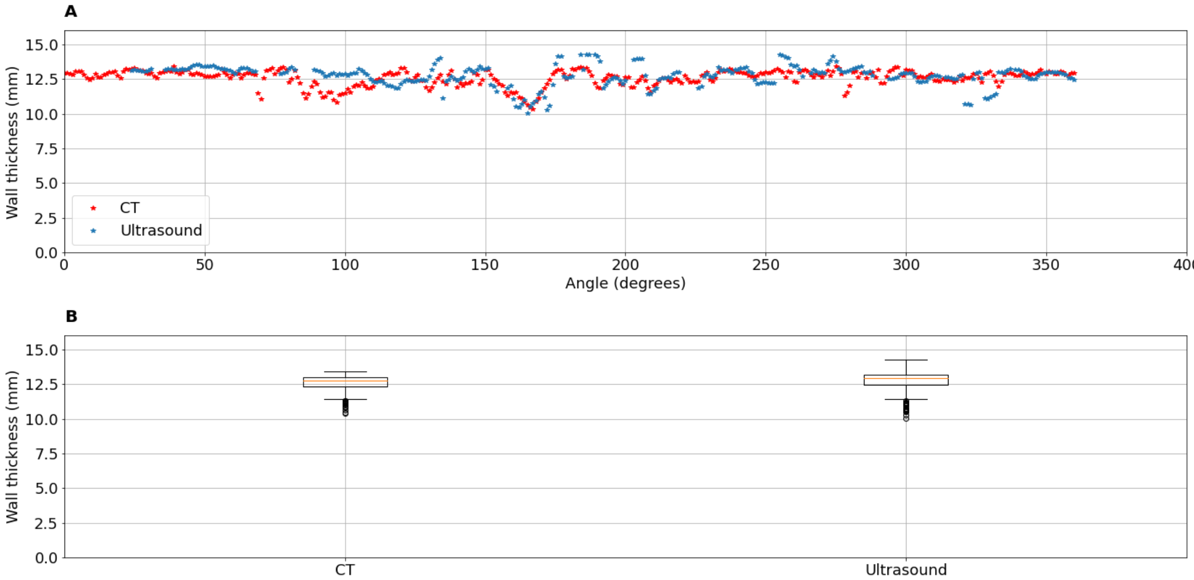

Figure 9 Sample 2, circumferential scan

3.1.3 Sample 3

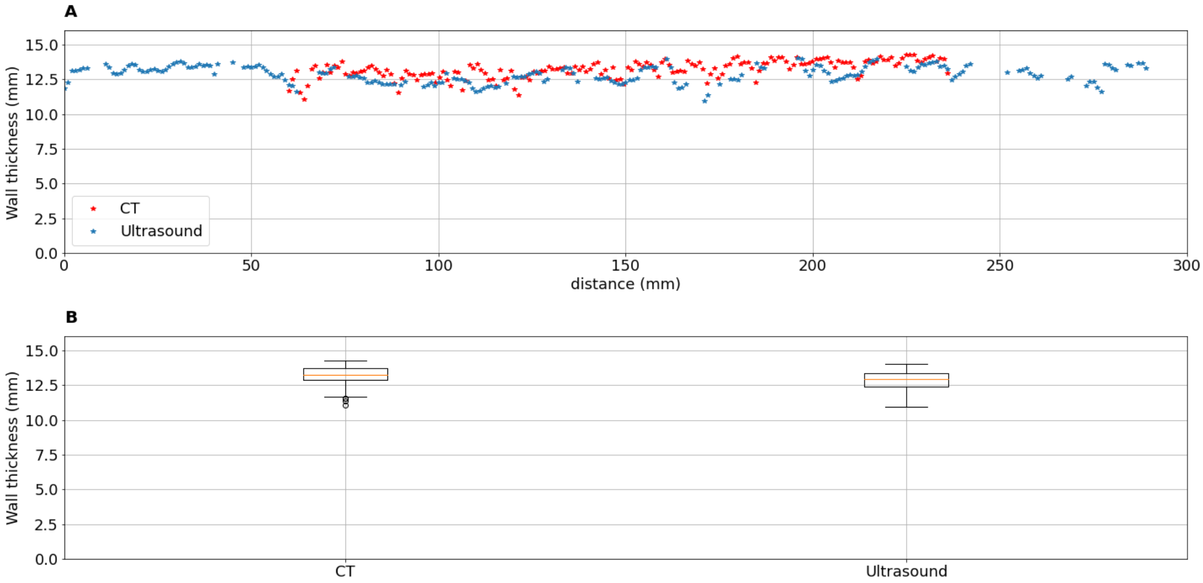

Figure 10 Sample 3, longitudinal scan 1

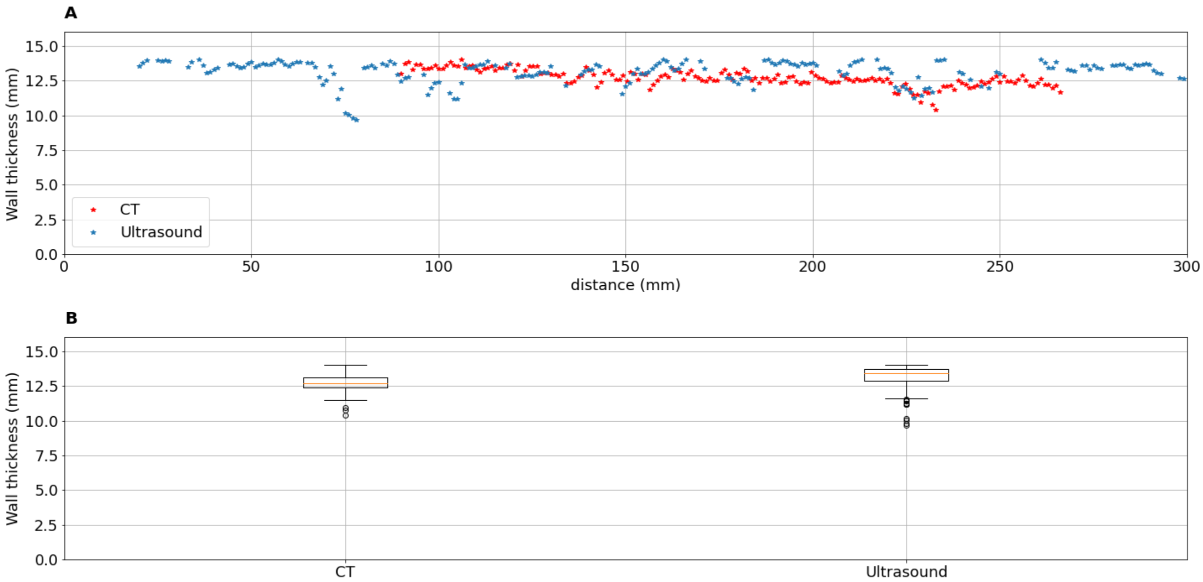

Figure 11 Sample 3, longitudinal scan 2

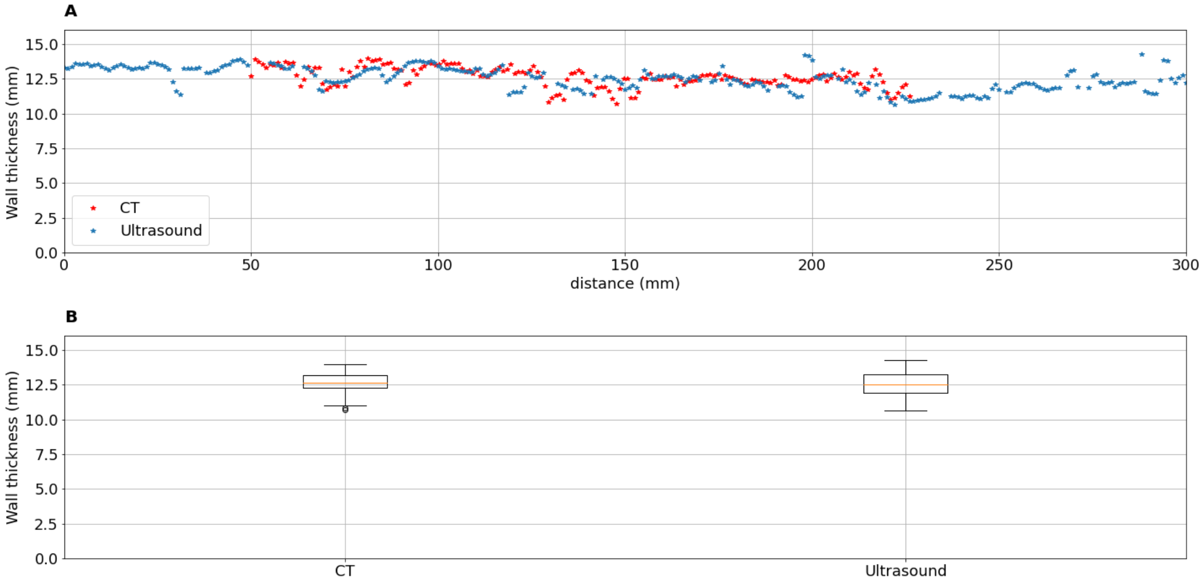

Figure 12 Sample 3, longitudinal scan 3

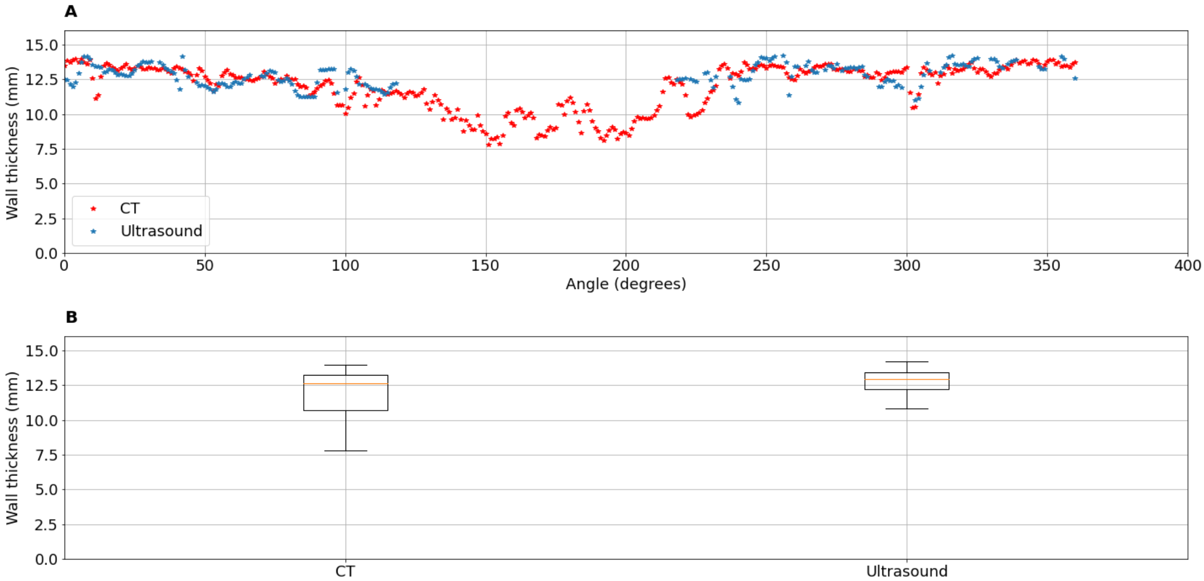

Figure 13 Sample 3, circumferential scan

3.2 Comparison and discussion

Ultrasound measurements demonstrated satisfactory sensitivity in detecting calcium leaching within asbestos cement pipes. The technique successfully identified areas of the material where calcium compounds had been depleted, indicating potential weakening. However, ultrasound's ability to precisely quantify the extent of calcium leaching looks to be limited compared to CT scan imaging as ultrasound measurements look to be slightly averaging over area due to sensor sizing limitations.

On the other hand, CT scan imaging exhibited exceptional accuracy and sensitivity in detecting even minor changes in the internal structure of asbestos cement pipes. The high-resolution cross-sectional images allowed for a comprehensive evaluation of calcium leaching, providing precise measurements of the affected areas.

Ultrasound measurements showed a consistent performance across different asbestos cement pipe samples. The real-time data acquisition and ease of use made it a reliable option for inspections and field assessments.

Statistical analysis revealed very similar distributions between the results obtained from ultrasound and CT scan measurements. This suggests that while the two methods may differ in their precision and capabilities, both can be used as an accurate tool for condition assessment.

4 Conclusion & Recommendations

In conclusion, both ultrasound and CT scan are valuable non-destructive testing methods for evaluating calcium leaching in asbestos cement pipes. Ultrasound's real-time data acquisition and portability make it well-suited for initial inspections and routine assessments. However, CT scan imaging stands out for its high-resolution 3D visualization and precise quantification capabilities, making it indispensable for in-depth evaluations and spatial mapping in laboratory environments.

For practical applications, where inspections are conducted in field, ultrasound in combination with the unique leaching analysis patented by Acquaint, offers a viable and accurate technique for assessment of calcium leaching.