ALTERNATIVE APPROACHES TO ASSESSING ASBESTOS CEMENT PIPE & CRITICAL ASSETS INSITU

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ABSTRACT

This investigation is focused on the current technological limitations in the condition assessment of critical water distribution assets and how they can be overcome with new technologies entering into the market. Previously there has been no method that can be utilised to measure the wall thickness at a pin point location of asbestos cement pipes insitu, commonly this has been undertaken exsitu with a medical CT scanner. Emerging innovative technologies such as back scatter CT scanning can now analyse asbestos cement pipe insitu and under normal operating conditions which was previously not possible. Digital radiography is also proving to be valuable when applied to other key components of the water distribution system such as large valves. The advantage of using digital radiography is the ability to scan critical asset insitu such as a large valve in the field without the need to remove the asset. The speed at which data can be obtained in the field with digital radiography can significantly increase the number of critical assets that can be scanned in a single day.

Keywords

Insitu Asset management, Innovation, Back Scatter CT

PRESENTER PROFILE
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A researcher with a focus on pipeline condition assessment technologies. Mason has undertaken testing internationally with various types of pipeline condition assessment tools. He commonly tests over 300km a year of pipeline of various materials which gives him insight to technical gaps within industry.

MICHAEL WELK

Michael has been Employed by Goulburn Valley Water since 2008 and is currently holding the position of a Senior Engineer - Asset Optimisation. He is, beside other duties, responsible for the introduction of new technologies into the Corporation. Further, Michael was recently appointed as a Program Manager - Asset Management and Optimisation for the Victorian Intelligent Water Networks Program investigating new technologies and innovations to meet common challenges for the Victorian Water Industry.

1 INTRODUCTION

Water distribution networks are composed of a range of pipes of varying ages and materials. Some of the older pipes are coming to the end of their design life but vary significantly in their condition. Some will need immediate replacement while others can have their useful life extended. Corrosion and tuberculation are common problems in iron pipes but the extent and presence is often very difficult to predict. From 1926 until around 1990 asbestos cement pipes were used for both water supply and wastewater pipe systems. While this pipe type does not suffer from corrosion if does suffer from leaching and biocorrosion from bacteria where the cement matrix that forms the wall of the pipe is lost leaving the effective pipe wall significantly reduced. This results in an apparent softening and decrease in mechanical strength (Wang et al., 2011a). The aging of the

Australian water distribution is leading to an estimated that 19,000 breaks occurring yearly in water transmissions mains with a resultant loss of 265 gigalitres of water. Currently maintenance regimes are determined by the age and burst event history of nearby and similar pipelines and this approach may result in the replacement of pipes that are in good condition. An alternative approach is to undertake proactive condition assessment of the network with a combination of tools to determine the remaining life of a pipeline and prevent the early removal of pipe which is in satisfactory operating condition.

Asbestos cement pipes (AC) were popular in the 1960-80s and have been extensively used for both water supply and wastewater pipe systems (Hu and Hubble, 2007, Matti and Al-Adeeb, 1985, Wang et al., 2011a). Due to the age and life expectancy of this pipe material which is reported to be around 50-70 years, it is the cause of numerous pipe failures and may increase as time goes on. Currently, to assess the condition of an AC pipe it needs to be excavated and either hot tapped to remove a coupon from a point of interest, or a complete cut of the pipe which requires the pipeline to be isolated. Both these methods are highly intrusive and involve working with an asbestos material.
Within this study we demonstrate the use of a new technology, back scatter CT scanning (Inversa, Canada), which utilises an insitu method that can obtain the same results from an exsitu CT scan. In addition this investigation will also examine a new solution for critical pipe elements condition assessment, such as valves/pumps/joints. It will be demonstrated that digital radiography can image key parts of valves such as seal, spindles, gear boxes, and housing. Digital radiography will allow us to assess a key asset within the field and provide an image of that asset almost instantly. This will allow asset managers to rapidly make key decisions in regard to replacing an asset or determining its remaining life.

2 METHODS

2.1 SAMPLE COLLECTION

The asbestos cement pipe sample was obtained from Goulburn Valley Water, Shepparton Victoria. The sample is a 200 mm sewer rising main that burst. At the location of the burst a short sample was taken of the whole pipeline. This sample was wrapped in protective wrapping to prevent contamination and damage to the sample.

2.2 COMPUTER TOPOGRAPHY SCAN AND BACK SCATTER CT SCANNING

The samples were stored in thick plastic asbestos safety bags that ensured the samples where safe to handle. All samples were stored in additional rigid plastic sample containers to prevent any objects penetrating the bag during transportation. The samples where then placed into a medical CT scanner and scanned at a resolution of 200 microns. In comparison, a back scatter CT scanner developed by Inversa, Canada, was used to analyse the same asbestos cement sample. The sample was shipped to the Inversa trial facility and scanned within their laboratory using their back scatter CT scanner. As seen by comparing Figure 1 and Figure 2 the size of the back scatter CT scanner is significantly smaller than the medical CT scanner, this provides it the ability to be used within the field.

Figure 1, The back scatter CT scanner developed by Inversa, Canada.

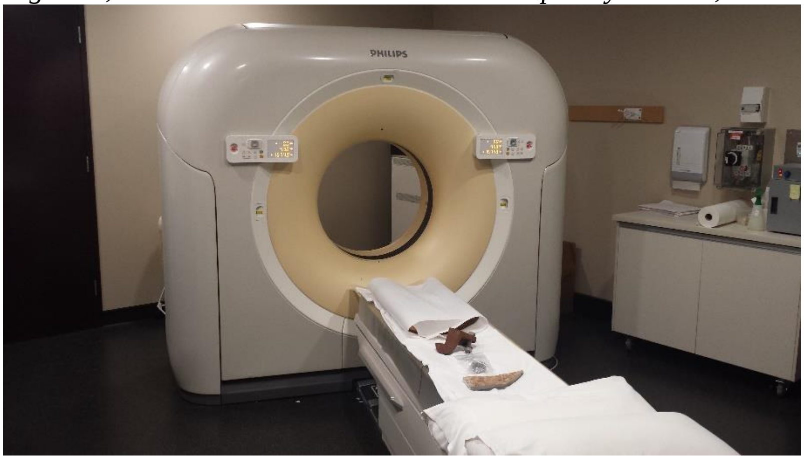

Figure 2. The CT scanner used to analyse the asbestos cement pipeline.

2.3 RESULTS AND DISCUSSION

The objective of this investigation was to observe how effective the use of innovative technologies such as back scatter CT scanning can be to assess AC pipeline within the field. The variation in the density observed in Figure 3 is due to the presence of sulphur within the sewer pipe that has caused the AC pipe to leech calcium out of the cement matrix (Matti and Al-Adeeb, 1985). Once the calcium leaches out it only leave the cement matrix behind, therefore the density of the material is reduced and in turn the strength is reduced (Matti and Al-Adeeb, 1985, Wang et al., 2011a, Wang et al., 2011b). A distribution of the density is shown in figure 5, 1500HU represent pipe that has undergone little to no degradation and still has a high amount of calcium present in the cement matrix, while a majority of the pipe is found to be ~1000HU which has leeched calcium and reduced in density, this indicates that a majority of the pipeline has leeched the calcium from the cement matrix. Therefore, the pipeline was highly susceptible to a burst which could have been caused by a number of factors.

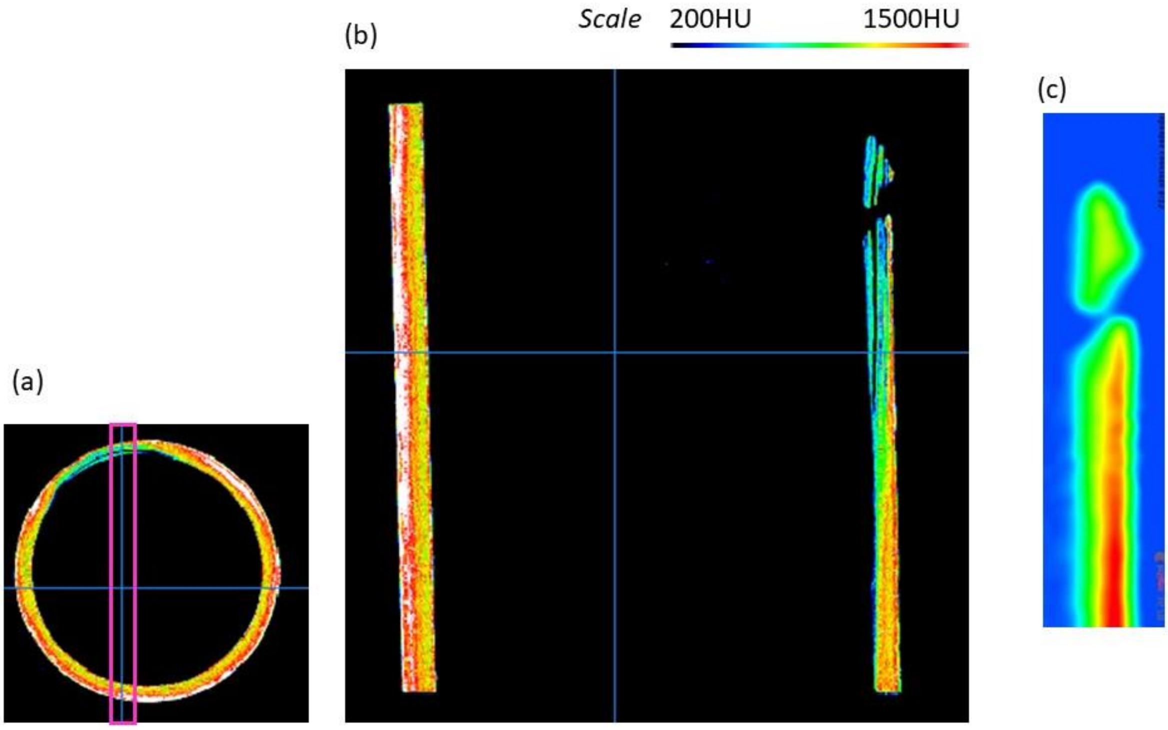

Figure 3, (a) represents the slice from where a comparison between a medical CT scanner and the back scatter CT scanner will be compared. (b) the medical CT scanners image of the AC pipe. (c) the back scatter CT scanners image of the left side of the pipe.

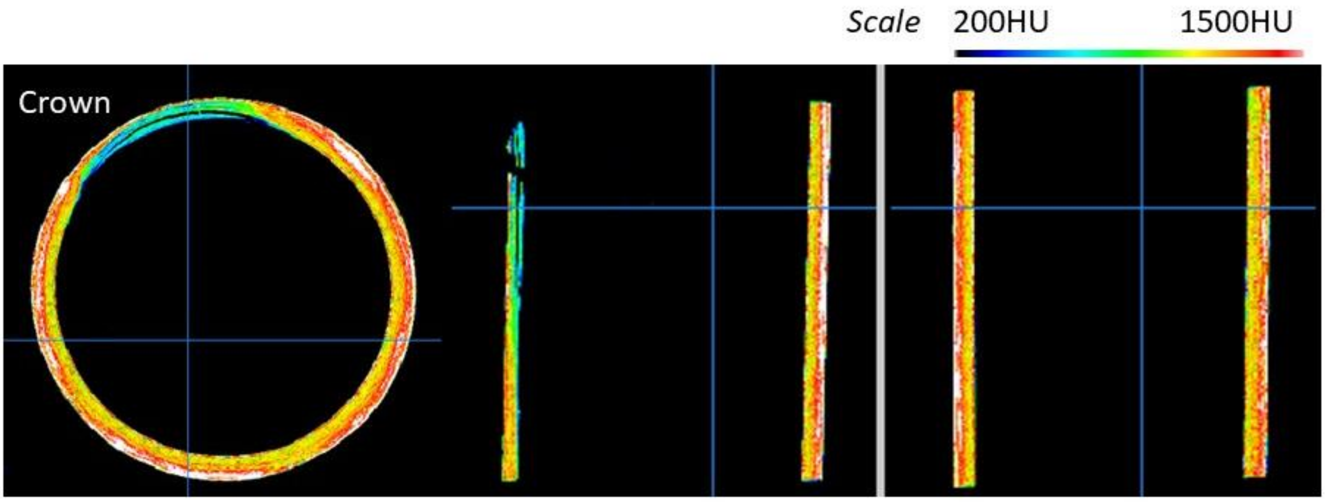

Figure 4, CT data the AC 200mm sewer pipe.

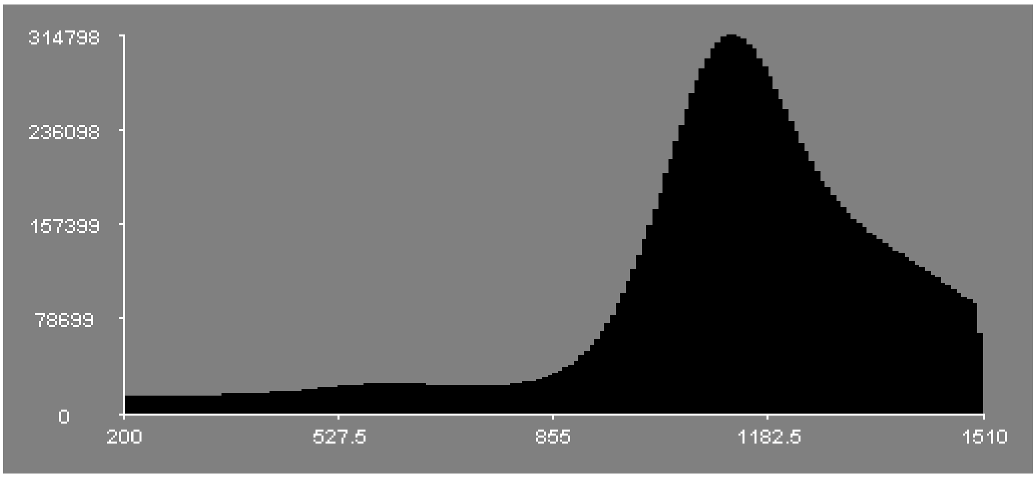

Figure 5. The distribution of density (Hounsfield) of the sewer AC pipeline.

It was observed that the back scatter CT scanner is an effective tool for assessing AC pipeline. Figure 3 displays a comparison between the two technologies (medical CT scanner and back scatter CT) on the same AC pipeline. The degradation of the AC pipe is similar in each image indicating that the backs scatter CT scanner can produce the same results obtained from a medical CT scanner. The crown of the pipe suffered from sulphur attack, as well the bottom of the pipeline appeared to have a much lower density due to potential loss of calcium, this is commonly observed in other sewer pipelines where acidic sediment is found (Wang et al., 2011a, Hu and Hubble, 2007, Matti and Al-Adeeb, 1985). The wall thickness was originally 16mm though in the burst location it is completely gone, other areas on the crown where it is still intact clearly show a low density (~1000HU) due to high degradation.

The medical CT scanner was observed to have a higher resolution and more detailed result when compared to the back scatter CT scanner, the resolution achieved by the medical CT scanner was 200 microns. The resolution of the back scatter CT scanner was lower in comparison to the medical CT scanner, though it clearly showed the remaining effective wall thickness of the AC pipeline. Therefore we can suggest that the resolution of a back scatter CT scanner is sufficient to determine the remaining wall of an AC pipeline.

Additionally, the overall scan volume that was achieved by the medical CT scanner was much greater in comparison to the back scatter CT scanner. The back scatter CT scanner is only capable to scan a slice at a time, therefore multiple locations will have to be scanned while in the field to achieve a representative result of the pipe. The benefit of the back scatter CT scanner compared to the medical CT scanner was its ability to scan the pipe on site and under normal operating conditions, this cannot be achieved by the medical CT scanner which is a disadvantage.

Medical CT scanning requires the pipeline to be tapped to remove a core sample, or to shut the pipeline down completely to take a full cut segment of the pipeline. Taking small core samples does allow operators to sample their pipeline wall thickness without interrupting the pipeline operational conditions, though observed in figure 4, the sample on the crown of the AC pipeline is very different to the other areas of the pipe. Therefore, taking coupon samples from certain locations on the pipe can only represent that location as the degradation is not uniform around the circumference of the pipe.

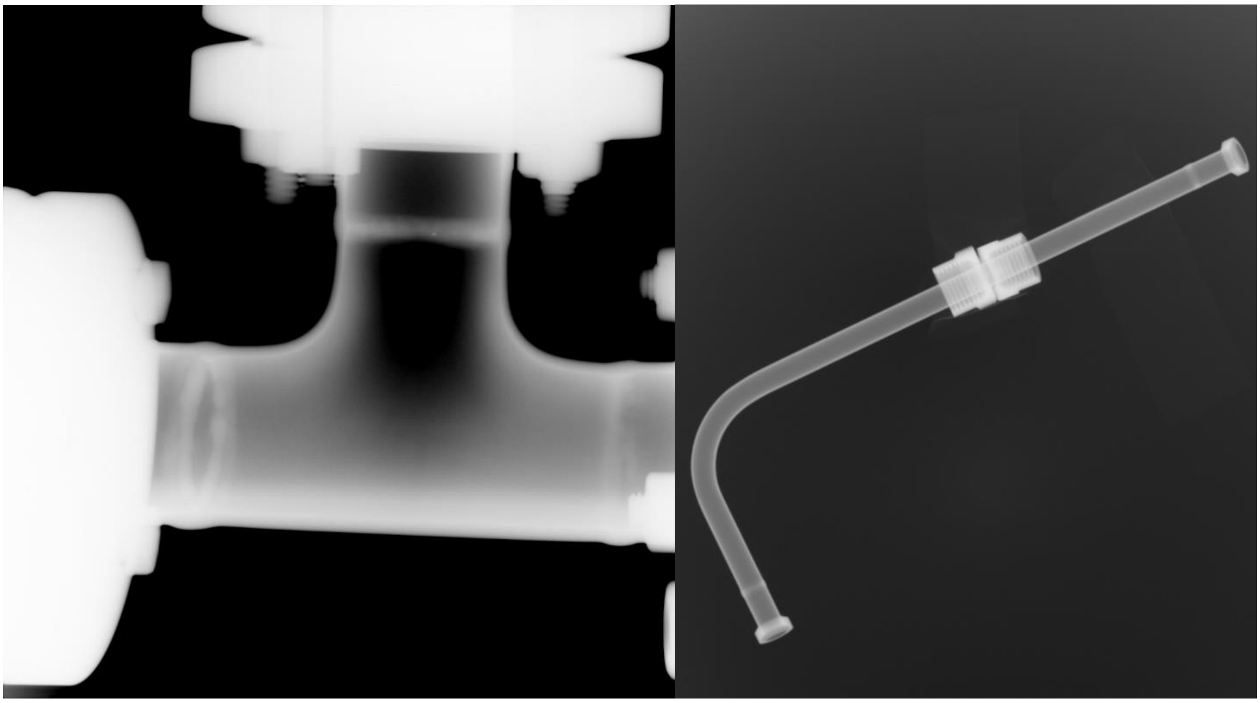

Figure 6. Adapted from Vidisco, Israel, on the left is a tee piece with three flanges, and on the right is a titanium pipe with a coupling in the center.

Another aspect of this investigation is the application of digital radiography for the insitu analysis of critical assets. Shown in Figure 5, we can examine all the internal components within the tee piece and pipe, this can be used to clearly indicate the internal issues within the pipe and what its future life expectancy. Ideal assets for this technology are large valve gear boxes, split case pumps, and pipe joints. Large valve gear boxes are commonly broken due to over torqueing and corrosion, this technology is capable of entering the pit and scanning the valve gear box assembly within five minutes and instantly have the data available for analysis. Pincu 2008 displayed the rapid ability for digital radiography to collect data within a process plant, one key part of the investigation was a steam cooler pipe with a diameter of 250mm and wrapped with insulation, the material of the pipe was 10CrMo, and a wall thickness of 40 mm, the scan took 50 seconds in total to obtain an image (Pincu, 2008). Split case pumps commonly suffer from erosion of the impeller and the casing, to assess a split case pump you would remove the pump and open it which poses the risk of damaging the pump during inspection. Digital radiography provides operators a key initial step of inspection prior to opening the casing of the split case pump. Joint failure of pipelines is an ongoing issue, this can be observed commonly with rubber joints and electro coupling, this tool provides the opportunity to scan these pipe joints during construction to assess the possibility of future joint failure.

An example of how this can be applied is the water treatment plant in Shepparton, Victoria, which consists of six low lift Pumps. The condition assessment of an individual pump has been estimated at AUD$10,000, which is based on a historical evidence. The works involved to assess a pump is to firstly lift the pump up and then dismantle the casing, this is a lengthy process. Using digital radiography would allow operators to potentially assess all the pumps on one day at a cost of approximately AUD$10,000. Digital radiography can be used as an initially screening to determine which pumps should undergo further assessment. Studies have shown that losses of up to 10% on pipes can be identified using radiography, this indicates that the use of digital radiography can be valuable within the water sector (Edalati et al., 2006).

3 CONCLUSION

In conclusion, the use of a medical CT scanner and back scatter CT scanning is an effective tool for assessing the remaining wall thickness of AC pipeline. The AC pipeline displayed a highly variable wall thickness around the circumference of the pipe. The use of back scatter CT scanning to analyse the wall thickness within the field is a cost effective and innovative way forward to assess AC pipelines. The use of digital radiography for asset management in the water industry can be highly useful for its capability to image internal parts without the removal of the asset from the field.

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