

# Material characterization of PVC pipes by means of nonlinear ultrasound

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## Introduction

Unplasticised Polyvinyl Chloride (uPVC) pipes have been used extensively in the Dutch water distribution network since mid-sixties. Physical ageing is known to cause embrittlement of uPVC; therefore it is favourable to monitor the PVC pipes service lifetime to avoid unnecessary replacements of pipe network which is costly and labour intensive [1]. Water pipe condition monitoring systems range from simple visual inspection to various non-destructive methods like ultrasound inspection. Characterization of material behaviour of aged PVC by nonlinear ultrasound has good potential to predict residual lifetime of PVC pipes.

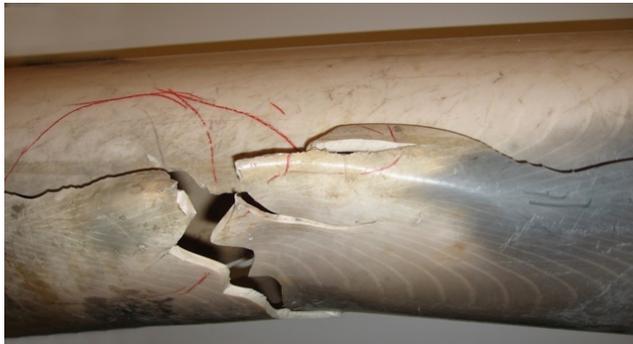


Figure 1: Brittle fracture pattern of PVC pipe

## Objectives

The aim of this research is to develop an experimental and numerical method which can predict the lifetime of PVC water pipes based on ultrasound. Previous research revealed that linear ultrasonic method is not sensitive to physical ageing of PVC. Nonlinear ultrasonic methods are much more sensitive to material changes than linear ultrasonic methods. The initial phase of the research is focused on the sensitivity of different nonlinear techniques.

## Method and Results

Experiments were performed by through-transmission measurements. The phenomenon of higher harmonic generation is related with the nonlinearity parameter  $\beta$  in the elastic behaviour of materials as shown in Fig 2.

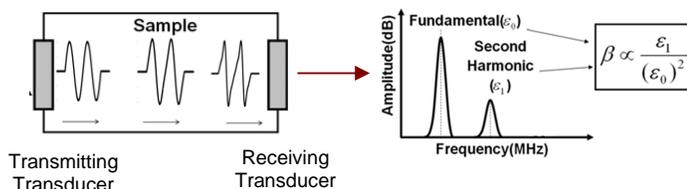


Figure 2: Harmonic generation and Fourier spectrum of received signal

The nonlinearity parameter  $\beta$  is the second order based non-linear parameter and is determined by fundamental and second harmonic amplitudes.

Fig.3 shows the experimental set up.

A comparison between the nonlinearity parameter for young and aged PVC specimens of 3mm thickness through 50mm length of samples is shown in Fig 4.

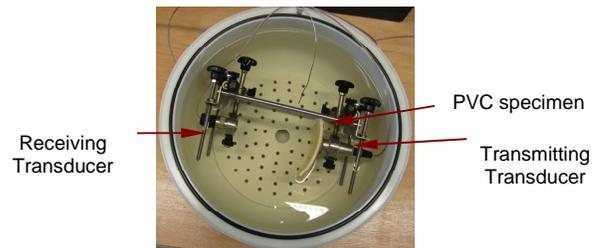


Figure 3: Experimental set up

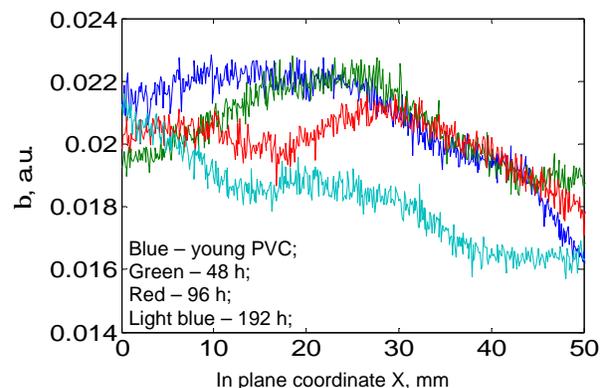


Figure 4: Nonlinear parameter vs position

## Conclusions

No substantial difference between young and aged PVC was found in the PVC specimens tested.

Future research is going to be directed towards more generalized nonlinear techniques which have the advantages of using low power ultrasonic techniques and elimination of surrounding influence by focus on longitudinal and shear wave propagation through PVC.

## References

[1] The influence of physical aging on yielding and failure of uPVC pipes. H.A.Visser, T.C.Bor, M.Wolters

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