Saf. Nucl. Waste Disposal, 2, 67–67, 2023
https://doi.org/10.5194/sand-2-67-2023

SaND
Safety of Nuclear Waste Disposal
Open Access

Advanced analysis of ultrasonic investigations at sealing structures

Vera Lay[1], **Christoph Büttner**[2], **Stefan Buske**[2], **and Ernst Niederleithinger**[1]

[1]Non-destructive Testing for Civil Engineering, Bundesanstalt für Materialforschung und -prüfung, 12205 Berlin, Germany
[2]Institute for Geophysics and Geoinformatics, Technische Universität Bergakademie Freiberg, 09599 Freiberg, Germany

Correspondence: Vera Lay (vera.lay@bam.de)

Received: 31 March 2023 – Accepted: 25 May 2023 – Published: 6 September 2023

Abstract. Engineering barrier systems are a crucial part of the safe underground disposal of radioactive waste, particularly with salt as a host rock. Sealing structures made of tailored concrete are being tested at various sites in Germany. To characterise the material properties of the concrete and potentially also the bonding to the host rock as part of the necessary subsurface structures, we apply non-destructive testing, making use of advanced geophysical imaging methods.

Ultrasonic investigations have been carried out at underground concrete structures in the Teutschenthal mine in Germany. Here, we show results from two distinct constructions produced in a shotcrete procedure. Our goal is to analyse the performance of ultrasonics to be used as quality assurance for sealing structures made from shotcrete. First, a ~ 10 m long shotcrete structure is investigated with the help of a unique large aperture ultrasonic system (LAUS), allowing for depth penetration of > 9 m. We perform measurements at the front and from the side of the construction. Second, we obtain results from a 1 m thick shotcrete body containing several artificial defects (width up to 8 cm). Ultrasonic testing data were acquired using a commercial multi-static device. Additionally, a new device measuring with 3D mode instead of line mode is applied, and preliminary results will be shown.

Generally, the acquired ultrasonic data are analysed by a synthetic aperture focusing technique that is commonly applied in non-destructive testing. As a result, reflectors in the analysed shotcrete structures are imaged. Individual reflections from internal features and particularly the opposite wall are identified. An unexpected delamination wider than 30 cm is clearly imaged and later verified by boreholes. Thus, the method is – in general – suitable to serve as a quality measure. However, particularly the small and deep artificial defects can hardly be identified in the resulting images. Thus, we use advanced geophysical imaging methods to further enhance the quality of the obtained images. The recorded ultrasonic energy is focused on the physically reflective origin in the analysed volume. First results clearly show that we successfully improve the image quality regarding noise level and artefacts and hence facilitate the detection of objects.

Therefore, we present a valuable experiment under realistic conditions for underground sealing structures made from shotcrete, where the locations of artificial reflectors are partly known. This experiment serves as a unique basis to analyse the performance of advanced analysis methods to obtain high-quality images of the structure's interior. Hence, the developed ultrasonic testing and analysis schemes can serve as a part of quality assurance that will help to enable safe sealing structures for nuclear waste disposal.

Published by Copernicus Publications on behalf of the Federal Office for the Safety of Nuclear Waste Management (BASE).