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Author

Viridiana Borjas Padilla

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Ontario Tech University – Oshawa, ON

Title

Emission Laminography for Radiological Assessment of Concrete Slabs

Abstract

Concrete is widely used as a radiation shielding material. Due to its high density and hydrogenous composition, it facilitates the absorption and scattering of particles. This material is versatile, cost-effective, and structurally stable, making it a preferred choice in nuclear facilities and repositories that store high-radiation substances. Thus, concrete structures may become activated or contaminated. In such cases, characterization of the internal activity distribution is required for safety assessment, decommissioning planning, and waste classification. Non-destructive techniques (NDT), such as, emission tomography allows internal activity profiles while maintaining structural integrity. However, large concrete structures impose geometric and accessibility constraints that may interfere with traditional tomography scanning techniques. These constraints can lead to limited angular sampling, non-uniform sensitivity and, thus, reconstruction artefacts. Therefore, this work considers an emission tomography system based on a modified limited-angle approach. Because for large concrete structures, object motion is impractical or impossible, an alternative laminographic configuration is implemented by rotating the detector system about an axis parallel to the concrete surface. The experimental configuration of this imaging system is simulated using Geant4, an object-oriented program for simulation of the passage of particles through matter. While the acquired projection data is processed and reconstructed using the Maximum-Likelihood Expectation-Maximization (MLEM) algorithm in MATLAB. The reconstructed activity distributions are expected to demonstrate depth sensitivity within the concrete slab, despite the restricted angular coverage. Thus, supporting the feasibility of detector-motion-based emission laminography as a non-destructive tool for radiological characterization of concrete structures in nuclear facilities.