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Fast neutron studies on concrete used in the nuclear industry

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Concrete is extensively within just about all nuclear facilities for its structural and shielding properties. In a re used actor facility, for example, the concrete will be subjected to high neutron and gamma-ray fluxes for the lifetime of the reactor (60+ years), and must retain is mechanical integrity and shielding properties at an acceptable level until decommissioning. Beyond the typical structural properties, there are three key properties that are required of any shielding material used in reactor conditions: attenuation of neutron flux; attenuation of gamma-ray flux; and well-known activation properties post irradiation. South Africa does not have a standard procedure for quantifying these properties for concrete, and other materials for the nuclear industry. The aim of this project is to develop and demonstrate proof-of-principle of a standardized measurement technique for quantifying radiation shielding properties of nuclear grade concrete.
We are establishing the first fast neutron beam reference facility in South Africa for the non-destructive testing of concrete (and in principle other materials used in the nuclear industry). We will initially focus on developing methods to measure overall shielding properties to fast neutrons, and the consequences of aging, where effects of radiation damage on both the structural integrity and shielding capability of concrete is of significant interest. The measurements are also being used to benchmark results from simulations using radiation transport codes. An additional area of interest is the development of methods for the independent verification of the alignment to regulatory codes of the constituent materials used in concrete mixes for nuclear facilities, both existing and planned. We present our methods and examples of illustrative analyses from typical measurements.

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