ASSESSMENT OF RADIATION SHIELDING PROPERTIES OF INNOVATIVE CONCRETE WITH OIL SHALE ASH AND BASALT-BORON FIBER ADDITIVES

ANDRIUS SLAVICKAS[1,*], MINDAUGAS VAIŠNORAS[1], ALGIRDAS KALIATKA[1]

[1]Lithuanian Energy Institute, Breslaujos g. 3, LT-44403, Kaunas, Lithuania

** Corresponding author email: andrius.slavickas@lei.lt; mindaugas.vaisnoras@lei.lt, algirdas.kaliatka@lei.lt*

Because of their low cost and radiation shielding properties, cement-based concretes are used for radioactive waste management. However, Oil Shale Ash (OSA), the by-product of energy production, is overlooked as a supplementary cementitious material in concrete production to promote the circular economy. In addition, basalt-boron fibers (BBF) to improve neutron shielding were considered in this study, too. The study focuses on assessing the radiation shielding properties of concrete with OSA and BBF additives. Radiation shielding properties were estimated by simulating particle transports in innovative concrete mixtures using the SCALE code.

The overpack containers for nuclear waste used at Ignalina Nuclear Power Plant (NPP) for the short-lived, low and intermediate-level liquid waste were chosen to demonstrate radiation shielding properties for concrete mixtures with additives against realistic low-level emissions. The cemented grout, used for waste drums immobilization within the container, is changed with the concrete with OSA and BBF to evaluate the radiation shielding properties of concrete. Concrete recipes with innovative additives resulted in 11% lower dose rates in comparison with the traditional cement paste.

The CONSTOR RBMK-1500/M2 cask used for the interim storage of spent nuclear fuel (SNF) at Ignalina NPP was chosen to demonstrate radiation shielding properties for innovative concrete mixtures against high-level emissions. A special heavy concrete (CONSTORIT) is used for the radiation shielding in the CONSTOR cask. In this study, CONSTORIT was replaced with innovative concrete mixtures. It was found, that new concrete composite materials can be an excellent solution for SNF storage facilities, since on the one hand they increase neutron radiation shielding properties through the use of BBF in concrete, a gamma radiation shielding properties are provided by simply replacing coarse aggregate with heavier ones like ferric oxide.

The study was inspired by the ICONDE project, which was successfully finished in 2024. Institutes from Latvia, Lithuania, Estonia and Norway started a cooperation project – Innovation in CONcrete DEsign for hazardous waste management applications (ICONDE) – to develop innovative concrete composite materials for the safe disposal of hazardous waste, including radioactive waste. The project promoted a circular economy by using OSA as a supplementary cementitious material in concrete production.

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