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Authors: Yuxiang Jing, Yunping Xi

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Long-term neutron radiation levels in distressed concrete biological shielding walls

Yuxiang Jing[a] and Yunping Xi[a,*]

[a]Dept. of Civil, Environmental and Architectural Engineering, University of Colorado Boulder, Boulder, CO, 80309, USA

* Corresponding author

Email addresses: yunping.xi@colorado.edu(Y. Xi)

Highlights

- Neutron and thermal transport properties of distressed concrete are variable.
- Concrete damage due to neutron radiation and elevated temperature is considered.
- Coupled Radio-Thermo analysis of neutron radiation and thermal field was performed.
- Considerable increases of neutron flux/fluence in distressed concrete bioshield.

Abstract

Neutron radiation can deteriorate mechanical properties of the concrete materials, and thus it is questionable that neutron transport properties of concrete can remain unchanged during the life span of biological shielding walls. one-speed neutron diffusion equation and heat conduction equation were used as governing equations for prediction of neutron radiation and thermal field in concrete, respectively. The potential variations of transport properties due to neutron radiation and elevated temperature were estimated. A simplified example of a typical concrete biological shielding wall was analyzed up to 80 years, and the results were discussed. The radiation damage and radiation heating lead to minor changes of the temperature profile in the concrete. However, neutron radiation and elevated temperature can result in considerable increases of neutron flux and fluence in the concrete. The damage of concrete induced by neutron radiation and elevated temperature can considerably accelerate the penetration of neutron radiation into the concrete. This work is the first attempt to deal with the degradation of neutron and heat transport properties of concrete and its effect on neutron fluence distribution in concrete, and provides a possible way to determine the long-term neutron and thermal fields in concrete biological shielding walls.

Keywords