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Numerical Investigation of Gas Leakage in RCSW-Soil Combinations

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Abstract : Fukushima nuclear accident (Japan 2011) has drawn attention to the issue of gas leakage from hazardous facilities through building boundaries. The rapidly increasing investments in nuclear stations have made the ability to predict, and prevent, gas leakage a rather crucial issue both environmentally and economically. Leakage monitoring for underground facilities is rather complicated due to the combination of Reinforced Concrete Shear Wall (RCSW) and soil. In the framework of a recent research conducted by the authors, the gas insulation capabilities of RCSW-soil combination have been investigated via a lab-scale experimental work. Despite their accuracy, experimental investigations are expensive, time-consuming, hazardous, and lack for flexibility. Numerically simulating the gas leakage as a fluid flow problem based on Computational Fluid Dynamics (CFD) modeling approach can provide a potential alternative. This novel implementation of CFD approach is the topic of the present paper. The paper discusses the aspects of modeling the gas flow through porous media that resemble the RCSW both isolated and combined with the normal soil. A commercial CFD package is utilized in simulating this fluid flow problem. A fixed RCSW layer thickness is proposed, air is taken as the leaking gas, whereas the soil layer is represented as clean sand with variable properties. The variable sand properties include sand layer thickness, fine fraction ratio, and moisture content. The CFD simulation results almost demonstrate what has been found experimentally. A soil layer attached next to a cracked reinforced concrete section plays a significant role in reducing the gas leakage from that cracked section. This role is found to be strongly dependent on the soil specifications.

Keywords : RCSW, gas leakage, Pressure Decay Method, hazardous underground facilities, CFD
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