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2. AUTHOR(s)

G.I. Ofoegbu, R.V. Kazban, S. Painter, and C. Manepally

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A Technique for Modeling Thermally Induced Progressive Degradation of an Underground Opening

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Persistent thermal loading from the decay heat of nuclear waste disposed underground could cause progressive degradation of the underground opening because of the effects of thermally induced rock stress. The resulting rock rubble accumulations could mechanically damage the engineered barrier components, such as waste packages and drip shields proposed for a potential U.S. nuclear waste disposal. The accumulated rubble, however, could reduce heat flow to the roof area of the opening and, as a result, potentially reduce the roof thermal stress enough to terminate degradation. The authors developed a continuum finite element modeling approach for coupled analysis of (i) thermally induced progressive degradation of a heated underground opening; (ii) rubble accumulation; and (iii) heat flow through the rubble, degrading opening, and surrounding rock. The approach relies on a geometric zonation of the model domain based on *a priori* understanding of the general shape and size of potential surfaces for thermally induced rock failure. Such zonation permits incrementally changing the boundaries of the rock mass, air space, and rubble to simulate progressive degradation and rubble accumulation without changing the finite element mesh. This technique was applied to examine potential contributions of thermally induced roof spallation to the postclosure degradation of drifts used for nuclear waste disposal. The host rock above the drift roof was divided into thin layers based on a previous study (Ofoegbu, et al., 2006) that indicates a thin zone of a few decimeters thick at the roof of the opening could be subjected to stress conditions favorable to spallation. The drift air space also was divided into thin layers. Spallation modeling was based on the Mohr-Coulomb failure criterion and removing overstressed rock layers one at a time. Heat flow through a progressively degrading opening was simulated by changing the thermal properties of failed rock layers from rock to air and the properties of equivalent air layers in the floor from air to rubble. The analysis indicates that thermally induced spallation of the roof-wall rock could be an important drift degradation mechanism, because the driving stress tends to increase as roof spallation progresses and is sustained by a long-persisting far-field temperature distribution.

References

Ofoegbu, G.I., Dasgupta, B., Smart, K.J. "Assessing Effects of Thermal Loading on the Stability of Emplacement Drifts." Proceedings of the 11th International High-Level Radioactive Waste Management Conference, Las Vegas, Nevada, April 30–May 4, 2006. La Grange Park, Illinois: American Nuclear Society. 2006.

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