Impact of Rock Bolts on Seepage

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Research Objectives

Characterization of seepage into drifts in unsaturated fractured tuff is a key factor for assessing the long-term viability of the proposed high level nuclear waste repository at Yucca Mountain. Rock bolts are among the methods proposed for ground control in the emplacement drifts. They may provide a conduit whereby percolating water that would otherwise bypass the drift will seep into the drift (see Figure 1). The objective of this study is to assess the impact that the use of rock bolts may have on seepage.

Approach

The impact of rock bolts on seepage is studied using a numerical model that is finely discretized around the rock bolt. There are several sources of uncertainty and variability with respect to the flow system around the drift and rock bolt. There is uncertainty about the capillary strength of the fractures around the drift. There is also uncertainty about how the permeability and capillary strength of the grout used to cement the steel rock bolts into the bolt holes will change over time. There is variability expected in the percolation rates incident upon the drifts depending on location. The uncertainty and variability of these parameters are approached by evaluating the rock bolt impact over a range of values for several model parameters. It is also important to consider where the last fracture capable of carrying flow away from the rock bolt intersects the rock bolt. Three models are used where the last fracture is 0, 10 and 50 cm above the drift.

Accomplishments

When the rock bolt and grout are much less permeable than the surrounding fractures, as they are expected to be for several hundred years after installation, they should not enhance seepage because water will preferentially flow in the more permeable fracture system. At much later times, when the grout has degraded, the effectively open rock bolt hole will form a capillary barrier and again the water will preferentially flow in the fracture system (i.e., the greater capillary strength of the fracture system will keep water from entering the rock bolt hole). For the cases where the permeability and capillary strength of the rock bolt and grout system are on the same order as that of the fracture system, the model indicates that the rock bolts do not enhance seepage, which is reasonable considering the small volume occupied by the rock bolts.

Significance of Findings

A simpler model that was previously developed to study this problem indicated that for the planned rock bolt spacing of 1.5 m, seepage would be enhanced by as much as 40%.

The results of this more detailed study will allow the amount of seepage predicted to enter the drifts to be reduced for the Total System Performance Assessment (TSPA) for Yucca Mountain. These results also reduce uncertainty about the amount of seepage and thus will reduce uncertainty about TSPA results.

Related Publications

Ahlers, C.F., Y.S. Wu, Q. Hu, G. Li, H.H. Liu, J. Liu, L. Pan, Unsaturated Zone Flow Processes and Analysis, MDL-NBS-HS-000012 REV00, LBNL, Berkeley, California, CRWMS M&O, Las Vegas, Nevada, in prep.

Acknowledgments

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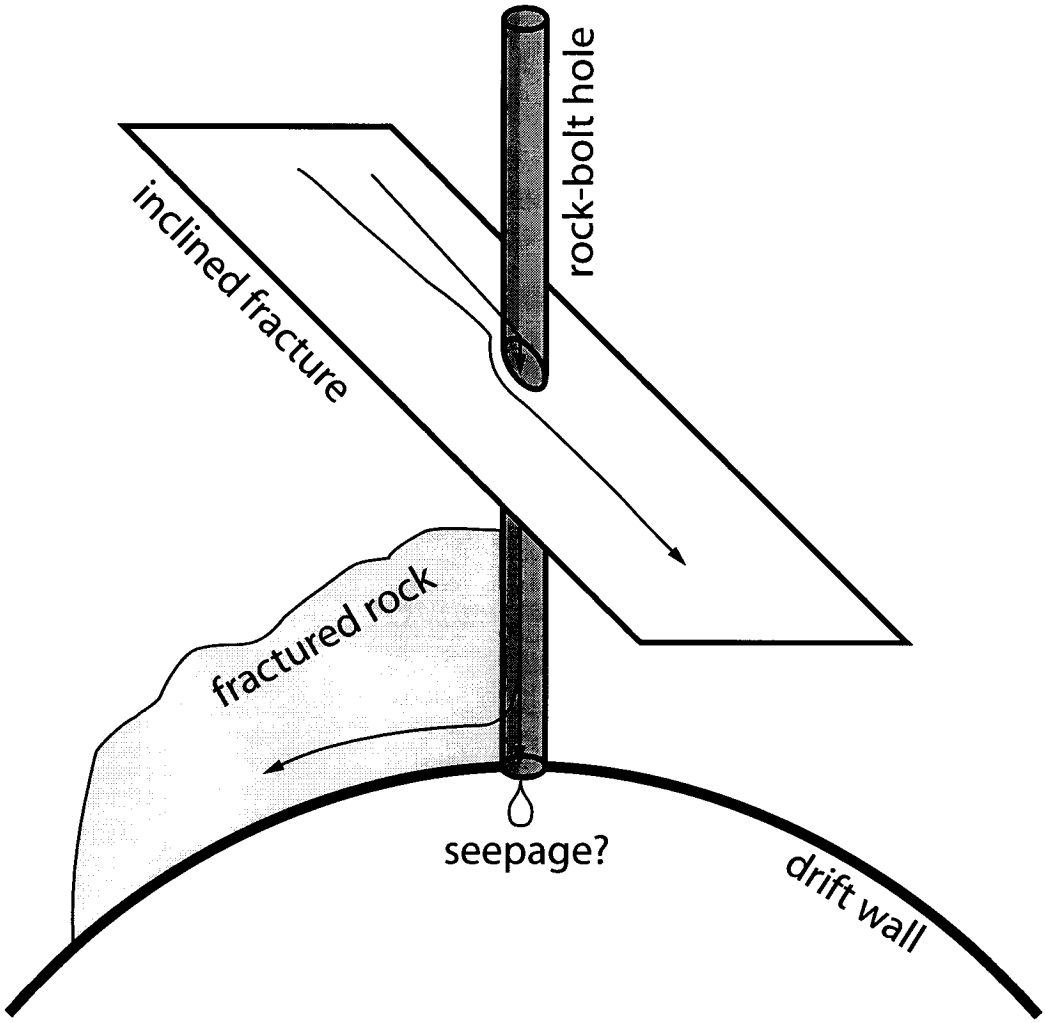
Figure 1. Schematic of rock bolt interaction with percolation through unsaturated fractured tuff.


rock-bolt hole
inclined fracture
fractured rock
seepage?
drift wall