

NUMERICAL MODELING OF NUCLEAR WASTE DISPOSAL IN ARGILLITE AT THE NEVADA TEST SITE. R. S. Stein and A. R. Lippin, Sandia Laboratory, Albuquerque, NM 87185.

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Assessing the feasibility of underground nuclear waste disposal requires the development of computational models to determine the thermo-mechanical response of the geologic media to the placement of waste. Of primary importance is the reliable extrapolation of the predictive models to in-situ depths and geologic time scales. The present study compares the mechanical modeling of nuclear waste disposal at depth in argillite, a highly plastic, splined shale, within the Bleene formation at the Nevada Test Site.

Through laboratory testing on core sample specimens, the mechanical constitutive model has been defined in terms of a uniaxial stress-strain law, a multi-planar failure surface, and a strength reduction parameter that accounts for expansion coefficients. Modeling in compression, the argillite exhibits nonlinear elastic behavior and a finite crush strength, followed by strain softening at larger deformations. Argillite exhibits deformation in, however, highly jointed with numerous joint systems of approximately 5-10 cm near surface. At depth, joint spacing may be up to 30 cm or more. The joints are multi-directional, and result in a rock composed entirely of small irregular blocks of intact rock in contact with each other. It is thus apparent that argillite rock mass possesses little tensile strength in situ. Also, the rock mass contains varying amounts of expansion clays and clays. Upon heating, to near the local boiling point of water, the clays dehydrate and subsequently contract. The rock mass containing them. Laboratory heating tests on argillite at ambient pressure have shown a contraction of 1% between temperatures of 75°C and 125°C, followed by a small expansion at higher temperatures.

Upon subjecting argillite in-situ, the effect of the negative thermal coefficient is a net expansion of volumetric contraction covering the portion of the argillite above approximately 85°C, and a net contraction of not more than 1 atm. Since the argillite rock mass will not support tension, the deformation mechanism of interest in this zone is not fracture, but rather the contraction of intact joint blocks and the opening of present long joints.

Numerical calculations for a near surface heater experiment in argillite conducted at the Nevada Test Site were performed using the finite element code ADINA assuming a two-dimensional axisymmetric strip. The existence and extent of the region

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of tensional opening of joints surrounding the heater, predicted by the mechanical model, were confirmed by posttest borehole inspection, permeability measurements, and drillback. Extrapolation of near surface heater model to repository depths reveals the necessity for prior knowledge of the mechanical properties and state of stress in-situ. The extent of the joint opening zone, for example, is not altered by changes in the elastic modulus at the near surface, but is significantly decreased beyond certain depths depending upon the in-situ elastic modulus. Results of these calculations are presented.

To further define the behavior at depth, and place bounds on the extent of the zone, far-field calculations were performed for a generic repository in arcillite. Both spent fuel and high level waste heat sources were considered at different burial densities and depths. Results of a parametric study are presented in which the mechanical properties, in-situ stresses, and waste heat sources were varied.