Bulk and Mechanical Properties of Paintbrush Tuff From Yucca Mountain, NV

ABSTRACT: A comprehensive suite of bulk and mechanical properties were measured on specimens of the Paintbrush tuff recovered from boreholes at Yucca Mountain, NV. The measurements included: dry bulk density, saturated bulk density, unconfined compression to failure, indirect tensile strength, and compressional and shear wave velocities. In addition, for each specimen designated for unconfined compression, a CT scan was performed.

EXPERIMENTAL PROCEDURE

An integral part of the licensing procedure for the potential nuclear waste repository at Yucca Mountain, NV involves prediction of the *in situ* rheology for design and construction of the facility for emplacement of canisters containing radioactive waste. In support of this effort, a comprehensive suite of bulk and mechanical properties measurements were carried out. The measurements and number of specimens tested are listed below.

Test	*Number*
Average grain density	567
Unconfined compression	220
Indirect tensile strength	160

Measurements were performed on ground right circular cylinders 50.8 mm in diameter prepared from cores recovered from boreholes. Specimens tested in unconfined compression were 101.6 mm in length; those designated for indirect tension tests were 38.1 mm in length.

The measurements were carried out according to applicable ASTM and ISR recommended procedures. The data have been synthesized in a series of reports available through NER.

LITHOLOGY

The measurements were conducted on the Tiva Canyon, Pah Canyon, and Topopah Spring Members of the Paintbrush Tuff. Most obvious lithologic divisions are between welded and nonwelded tuffs. The nonwelded tuffs are glassy or vitric and retain significant porosity. Lithologic intervals rarely coincide with stratagraphic boundaries since the upper and lower layers of the erupted units are typically non-welded while the interiors of the units are welded.

The stratigraphy has been subdivided into thermal/mechanical units were included in this study. Taw2, the potential repository horizon, is crystal poor and lithophysal rich; the most emphasis was placed on this unit.

Pumice is a major component of all the tuffs. In the non-welded specimens, it appears in its primary textural state volcanic glass with abundant gas bubbles present as pores. In the welded specimens pumice is generally present as fragments which have been flattened during welding. The porosity of these specimens decrease significantly during welding. The average porosity for each unit is:

T/M Unit	Member	Porosity, %
TCw welded	Tiva Canyon	15.2
PTn non-welded	Pah Canyon	46.7
TSw1 welded	Topopah Spring	15.9
TSw2 welded	Topopah Spring	11.3

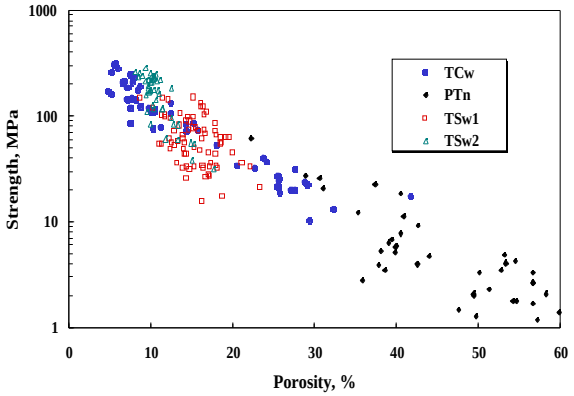
RESULTS

Since porosity is a significant variable in the baseline measurements, the data are presented as a function of porosity. Price and Bauer (1985) noted that there was a strong correlation between porosity and the mechanical properties and elastic constants of the tuff. Unconfined compressive strength and tensile strength decrease with increasing porosity. However, at each porosity there is substantial scatter in the data. Variations of a factor of two are common at the same porosity.

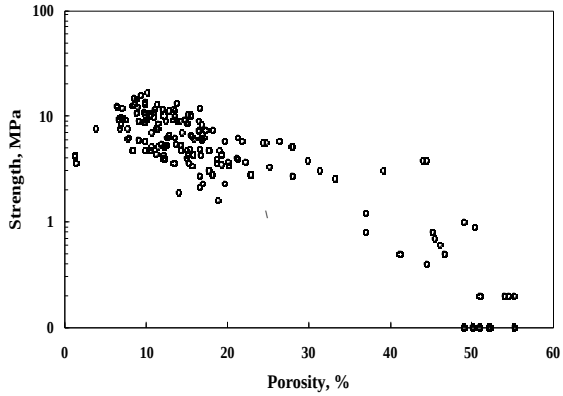
Similarly, the elastic properties (Young's modulus and P and S wave velocities) show a dependence on porosity. With increasing porosity, the values decrease. Poisson's ratio exhibited no apparent correlation with porosity.

Anisotropy was observed in some specimens. In general, seismic wave velocities measured in the bedding plane were faster than those normal to it. For the most part, anisotropy was less than 5% and only in several specimens did the anisotropy exceed 10%. The anisotropy is a result of the welding process; oriented elliptical pores and flattened lithic fragments are observed parallel to bedding in the CT scans.

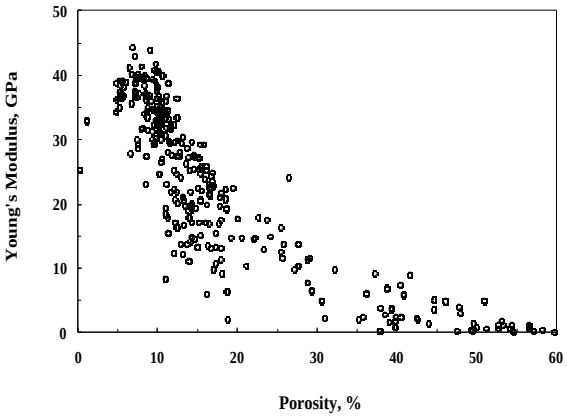
Unconfined Compressive Strength



Indirect Tensile Strength



Unconfined Compression



Dry Compressional and Shear Wave Velocities