24th U.S. Symposium
on Rock Mechanics
June 1983

THE DESIGN AND CONSTRUCTION OF A BLOCK TEST IN CLOSELY JOINTED ROCK

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ABSTRACT

The Basalt Waste Isolation Project, under the auspices of Rockwell Hanford Operations and the U.S. Department of Energy, is currently evaluating the Columbia River basalts as a potential site for a high-level nuclear waste repository. As a part of this project a field testing program is currently being conducted in a basalt flow at the Near Surface Test Facility (NSTF) on the Hanford Site. The purpose of this program is to develop and demonstrate the testing and analytical techniques which will allow the characterization of the temperature and pressure dependent deformational and thermal properties of the closely jointed basalt rock mass. A major component of this testing program is a large scale Block Test currently underway at the NSTF.

The Block Test essentially involves the isolation of a volume of the rock mass from the in situ stress field through the drilling of four slots perpendicular to the tunnel wall. A two meter cube of basalt was determined to be of sufficient volume to contain the structural discontinuities which would make its deformational response representative of the rock mass.

The construction of a geomechanical test of this size is quite complicated in itself, but several unique design features and systems have increased the complexity of the project significantly. These design features include:

- *Location of the test block 1.5 meters back from the tunnel face to avoid blast damage.*
- *Installation of flatjacks in grout boxes to allow removal and replacement in case of failure.*
- *Use of a 275 ton capacity cable anchor system to allow loading perpendicular to the tunnel face.*
- *Installation of an electro-optical deformation measurement system capable of measurements with a precision of ±30 microns.*

To allow the proper installation or construction of these items, most of the techniques used were specifically developed and adapted from conventional methods to meet the difficult requirements of the tasks.

The actual construction sequence consisted of five major phases, including the drilling of the cable anchor and instrument boreholes, the drilling of the slots, installation of the cable anchor tendons

and jacks, installation of grout boxes and flatjacks, and installation of the borehole instrumentation and the optical deformation measurement system.

The slot cutting operation was clearly the most critical and difficult component of the Block Test construction effort. Great care and precision were required in the set-up and percussion drilling of the overlapping boreholes to ensure the proper alignment of the slots, while preventing the unraveling of the jointed rock into the opening. The drilling sequence and several special techniques developed during the slot cutting were essential to the successful completion of this phase of the project.

The installation of the cable anchor system was also a rather difficult and sensitive operation. Although the installation of cable anchors is fairly common in the construction and mining industries, two modifications to the conventional system increased the complexity of the operation significantly. The first complicating factor was the use of the high strength (425 ton ultimate strength) "dyform" cable. Due to the high strength and the method of fabrication, the cable is unusually stiff and heavy, making handling very cumbersome. The second problem was due to limitations in the size of the tendon boreholes through the test block which allowed a diameter of only 3 5/8 inch. The cable bundle, consisting of twelve 0.6 inch diameter strands, was three inches in diameter, including grout and vent tubes. In typical applications, a cable bundle of 3 inch diameter would be placed in a borehole two to three times the allowable size, but to minimize the induced porosity of the test block, the smaller borehole diameter was necessary. The completed cable anchor system included eight units, each with a maximum loading capability of 275 tons. The cable tendons were anchored over a grouted length of 36 feet beginning 28 feet behind the test block. Although several packer assemblies were damaged during the insertion of the bundles down-hole, all tendons were successfully grouted at the desired depth. A series of performance tests were conducted to confirm the design and installation of each unit.

The installation of the grout boxes and flatjacks went fairly well, although two of the vertical grout boxes failed during the cutting of the top horizontal slot due to the redistribution of stresses around the newly created opening.

The flatjack installation also went well with only minor problems, while the instrument installation went very smoothly, which allowed the construction effort to be completed on schedule.

The experience gained during the Block Test construction effort is unparalled in closely jointed rock and will undoubtedly prove invaluable during future tests of this type. The slot cutting techniques as well as several design modifications of the flatjack-grout box system will probably be most useful in the further characterization of the Columbia River Basalts.