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Abstract This document outlines the tests, procedures, and results of an evaluation program for Dowell's "Chemical Seal Ring." The testing reported here deals with the physical properties of density, compression, tensile strength, elongation, and a push-out/bond strength test. Dowell's "Chemical Seal Ring" is proposed as a gasket-like seal between grout layers in the annulus around the Exploratory Shaft steel liner.				DOE-RL R. Southworth Fed Bldg/700																																							
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PHYSICAL PROPERTIES OF DOWELL
CHEMICAL SEAL RING

H. L. Benny

July 1985

Basalt Waste Isolation Project
Rockwell Hanford Operations
Richland, Washington 99352

Testing Performed at:
Pittsburgh Testing Laboratories
Pittsburgh, Pennsylvania
Contract No. SA-371

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1.0 INTRODUCTION

The Basalt Waste Isolation Project (BWIP) has planned the construction of an exploratory shaft (ES) to provide detailed in-situ hydrologic and geologic data from the candidate repository horizon for a nuclear waste repository in basalt (NWRB).

The ES will consist of a 6 foot diameter steel liner grouted within a 10 foot diameter drilled shaft. One of the primary safety concerns during construction of the ES is the rate of water inflow (Rockwell, 1982a). Water inflow will be largely controlled by the grout seal placed in the liner/rock annulus. A proprietary seal material, Dowell's "Chemical Seal Ring" has been proposed as a gasket-like material between grout layers for sealing off the aquifers penetrated by the ES. The seal material is to be used as a backup for the grout. The physical properties of Dowell's "Chemical Seal Ring" were appraised by this investigation. The actual testing was conducted by Pittsburgh Testing Laboratories, Pittsburgh, Pennsylvania, under subcontract SA-371. All materials to be tested were supplied by Dowell. Basalt cores used for the pushout tests were derived from monoliths of Elephant Mountain basalt and cored in the Basalt Materials Research Laboratory (BMRL), BWIP.

2.0 EXPERIMENTAL PROGRAM

The experimental program as defined in Rockwell, 1984, was divided into two parts. The first part was a program to measure the physical properties of the seal material; the second part was to study the seal's ability to absorb water and swell, thus sealing off the annulus. The first part, or a measure of the material's physical properties, is reported here.

2.1 SAMPLE PREPARATION

Dowell's "Chemical Seal Ring" is an organic polymer, with the cured consistency of a very fine pored sponge. The seal material was prepared and mixed according to the following procedure, supplied by Dowell.

1. Place component A in mixer
2. Prepare M6 solution from Tables 1 and 2

3. Add M6-water to component A
4. Add J279
5. Mix
6. Pump or pour to place.

TABLE 1. Field Units

Materials Yielding Approximately One Gallon of "Chemical Seal Ring" Slurry

<u>Material</u>	<u>Amount</u>
J279	3.45 lbs
M6	0.017 lbs
Mixing Fluid	0.69 gallons

TABLE 2. Laboratory Test Units

Materials Yielding Approximately 378 cc of "Chemical Seal Ring" Slurry

<u>Material</u>	<u>Amount</u>
J279	157 gms
M6	0.77 gms
Mixing Fluid	261 cc

The material was then used to cast specimens for the individual tests.

2.2 TENSILE STRENGTH AND ELONGATION

The test method for determination of the tensile strength and elongation properties of the material was ASTM D-412-80, "Test Method for Rubber Properties in Tension." A slab of material approximately 1/8" thick was prepared and 15 specimens were stamped out using a dumbbell shaped die. The dumbbell specimens were marked and measured according to the referenced procedure. The specimens were then placed in the grips of a testing machine and pulled to failure.

2.3 COMPRESSION TEST

The material was prepared by casting specimens in standard 2 inch grout cube molds. The specimens were then tested in accordance with ASTM D-695-80, "Compressive Properties of Rigid Plastics." The specimens were measured and conditioned as required in the referenced procedure. Specimens were then placed in a compression tool, or jig, and loaded in a compression machine. The compression tool is constructed so that loading is axial and applied through surfaces that are flat and parallel. A plot of load versus deformation was produced and the compressive strength at 5%, 10%, and 25% deformation was determined.

2.4 DENSITY

Specimens of the seal material were prepared by casting the material in a 2 inch diameter by 2 inch high mold. Density was measured according to ASTM D-1622-63, "Apparent Density of Rigid Cellular Plastics."

2.5 PUSH-OUT BOND TESTS

Push-out bond tests were performed on seal material cast into 2 inch diameter holes cored in Elephant Mountain basalt monoliths. This test was designed to give a measure of the bond strength of the seal material to basalt rock. A disk, approximately the size of the cored hole, was placed on the top of the material. The rock was supported so that the material could be pushed out of the bottom.

3.0 EXPERIMENTAL RESULTS

Experimental results detailed in this section were obtained from Pittsburgh Testing Laboratory Report No. 852745, November 1984, under Subcontract No. SA-371.

3.1 TENSILE STRENGTH AND ELONGATION

A total of 16 specimens were tested, all cut from the same sheet of seal material. The data are listed in Table 3. The average of the values obtained were 16.92 psi tensile strength and 467 percent elongation.

TABLE 3. Tensile Strength and Elongation of
Dowell's "Chemical Seal Ring"

Specimen Number	Width In.	Thick In.	Area Square In.	Maximum Load Lbs.	Tensile Strength PSI	Elongation In 1 In.	Elongation %
1	.250	.211	.0528	0.71	13.45	4.80	380
2	.250	.202	.0505	0.86	17.03	6.30	530
3	.250	.213	.0533	0.91	17.07	6.10	510
4	.250	.213	.0533	0.90	16.86	6.26	526
5	.250	.218	.0545	0.99	18.17	6.00	500
6	.250	.214	.0536	0.80	14.93	5.40	440
7	.250	.227	.0568	0.81	14.26	5.21	421
8	.250	.217	.0543	0.90	16.58	5.66	466
9	.250	.204	.0510	0.72	14.12	5.12	412
10	.250	.201	.0503	0.90	17.89	5.80	480
11	.250	.167	.0418	0.88	21.05	6.60	560
12	.250	.203	.0508	0.98	19.29	5.84	484
13	.250	.183	.0458	0.66	14.41	5.54	454
14	.250	.196	.0490	0.91	18.57	6.12	512
15	.250	.195	.0488	1.15	23.57	5.30	430
16	.250	.201	.0503	0.68	13.52	4.72	372
Average:					16.92 psi		467%

3.2 COMPRESSION TESTS

A total of 16 specimens were tested in compression. Table 4 (on page 10) lists the compression load and stress required for a 5, 10, and 25% deflection in the specimen. Figure 1 is a plot of load versus deflection for sample 1. The shape of this plot is typical of all specimens. The average value for compressive strength at 5% deformation is 0.58 psi; at 10% deformation is 1.38 psi; and at 25% deformation is 4.41 psi.

3.3 DENSITY MEASUREMENTS

A total of 5 specimens were measured for density calculations. The density measurements and calculated results are shown in Table 5. The average density was 75.74 lbs/cubic foot.

TABLE 5. Density of Prepared Dowell's "Chemical Seal Ring" Specimens

<u>Specimen Number</u>	<u>Diameter Inches</u>	<u>Height Inches</u>	<u>Volume Cu.In.</u>	<u>Weight Grams</u>	<u>Density Lbs./Cu.Ft.</u>
1	2.038	2.065	6.7363	134.45	75.84
2	2.056	2.070	6.8724	138.08	76.35
3	2.035	2.040	6.6351	132.35	75.80
4	2.018	2.105	6.7326	133.70	75.46
5	2.025	2.095	6.7472	133.60	<u>75.24</u>

Average: 75.74

3.4 PUSH-OUT BOND TESTS

A total of 5 specimens were prepared and tested for push-out bond strength. The push-out bond test data and calculated results are shown in Table 6. The average strength was 22.25 psi.

TABLE 6. Push-Out Bond Test For Dowell's "Chemical Seal Ring" Cast in Basalt Monoliths

<u>Specimen Number</u>	<u>Length Inches</u>	<u>Diameter Inches</u>	<u>Shear Area Sq.In.</u>	<u>Load Pounds</u>	<u>Push-Out PSI</u>
1	5.60	2.320	39.09	850	21.75
2	5.62	2.320	39.23	810	20.64
3	5.50	2.320	38.39	795	20.71
4	5.55	2.320	38.74	775	20.05
5	5.35	2.320	37.35	1,050	<u>28.11</u>

Average: 22.25

TABLE 4. Compression Test Data for Dowell's "Chemical Seal Ring"

Specimen Number	Length-Width-Height Inches			Area Square Inches	Load 5%	Compressive Strength PSI	Load 10%	Compressive Strength PSI	Load 25%	Compressive Strength PSI
1	2.093	2.081	2.073	4.356	2.50	0.57	5.80	1.33	18.45	4.24
2	2.132	2.103	2.158	4.484	2.60	0.58	6.00	1.34	19.95	4.50
3	2.126	2.082	2.090	4.426	2.55	0.58	6.00	1.36	19.00	4.29
4	2.063	2.084	2.097	4.299	2.90	0.68	6.45	1.50	20.0	4.65
5	2.050	2.102	2.123	4.309	2.55	0.59	6.00	1.59	19.40	4.50
6	2.051	2.082	2.101	4.270	2.65	0.62	6.50	1.52	20.60	4.82
7	2.056	2.091	2.119	4.299	2.45	0.57	5.90	1.37	19.10	4.44
8	2.064	2.082	2.101	4.297	2.45	0.57	6.45	1.50	19.00	4.42
9	2.095	2.159	2.048	4.523	2.60	0.58	6.20	1.37	19.70	4.36
10	2.175	2.122	2.060	4.615	2.60	0.56	5.95	1.29	19.65	4.26
11	2.064	2.080	2.173	4.293	2.55	0.59	5.95	1.39	19.00	4.43
12	2.121	2.136	2.165	4.531	2.05	0.45	5.20	1.15	18.55	4.09
13	2.075	2.096	2.064	4.349	2.80	0.64	6.10	1.40	19.80	4.55
14	2.122	2.049	2.023	4.348	2.45	0.56	5.50	1.27	18.80	4.32
15	2.078	2.098	2.082	4.360	2.51	0.58	5.50	1.26	18.55	4.26
Average:						0.58 psi		1.38 psi		4.41 psi

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Figure 1. Plot of Load Versus Deflection for
for Specimen 1, Compression Tests

4.0 DISCUSSION/CONCLUSIONS

The test data generated from this testing program when combined with the results of the absorption study will allow the evaluation of Dowell's "Chemical Seal Ring" as a backup to the liner grout. The physical test data compare fairly well with data listed in Dowell literature, indicating that the material was prepared correctly and tested in an acceptable manner. The only conclusion that can be made at this time is that the material bonds fairly well to basalt and is easy to mix and work with. The bond to basalt will be reevaluated after the specimens are exposed to in-situ moisture and temperature conditions.

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