EVALUATION OF KAOLITE-20
INSULATING CASTABLE

N. C. Davis

MAY 1968

AEC RESEARCH &
DEVELOPMENT REPORT

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EVALUATION OF KAOLITE-20
INSULATING CASTABLE

By

N. C. Davis
Materials Process Development
Materials Department

FIRST UNRESTRICTED
DISTRIBUTION MADE

JUL 25 '68

May, 1968

Battelle Memorial Institute
Pacific Northwest Laboratory
Richland, Washington

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INSULATING CASTABLE

ABSTRACT

A program was conducted to evaluate Kaolite-20, a Babcock and Wilcox Company insulating castable. This program concentrated on determining the physical integrity of the material by use of compressive strength tests made after various environmental conditioning which simulated the conditions of the proposed service in a radioactive waste storage tank installation.

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EVALUATION OF KAOLITE-20 INSULATING CASTABLE

INTRODUCTION

The Materials Process Development Unit of Battelle-Northwest was requested by the Hanford Engineering Services (Vitro) to provide technical assistance in evaluating Kaolite-20, a refractory castable. This material is being considered by Vitro for an application in the construction of storage waste tanks for the Atlantic Richfield Hanford Company (ARHCO).

The compressive strength and physical integrity of Kaolite-20 subjected to various environmental conditions, typical of the proposed application, is of major concern in this evaluation. Test results and pertinent observations are reported for the consideration of the Vitro and ARHCO engineering design of the waste storage facility. These test results are applicable to laboratory scale experiments that attempt to simulate environmental conditions of the proposed use, and shall not be considered as final engineering judgment of use of the material in the manner or service being considered.

SUMMARY

Kaolite-20, a refractory castable manufactured by the Babcock and Wilcox Company, has been evaluated to determine the optimum mixture of water and Kaolite-20. This mixture, as determined in small test specimen (2 in. cubes), is approximately 70% by weight water to dry Kaolite-20. However, larger samples indicate that a large scale placement of this material would require less water and would agree more closely to the manufacturer's recommendation of 62.5 to 67%.

A series of both 2 in. cubes and 3 in. diameter by 6 in. long cylinders were cast, cured, and subjected to compressive strength tests after environmental conditioning. These conditions included temperatures of 350 °F, 500 °F, and 1100 °F; soaking and pressure conditioning (18 psi) in water; and soaking in substitution tank slurry. The small cubes were basically stronger than the cylinders with failures greater than 700 psi in the case of some cubes and as low as 240 psi in the case of the cylinders. This extremely wide spread is due to the two types of specimens as well as the many varied special environmental conditions. The 550 psi cold crushing strength as published by the manufacturer is achieved under controlled curing conditions.

This extremely porous material (70% porosity) was found to expel moisture when subjected to rapid heat without any apparent effect on the material's integrity. However, the material will fracture if it is allowed to become wet while any of the heat is retained.

The thermal insulation properties of this material were demonstrated in a simple test which applied 1100 °F temperature to one end surface of a cylinder of the cured material while the remainder of the cylinder exposed to ambient conditions. The temperature recorded in the Kaolite-20 material 4 in. from the hot face was 145 °F; at 8 inches it was only 85 °F after reaching thermal equilibrium.

Small cylinders of Kaolite-20 were cast, cured, and irradiated to a total radiation dose of 10^8 R. This irradiation did not indicate any visual effect on the samples and they were crushed indicating again very similar physical integrity to the identical non-irradiated samples.

DISCUSSION

Optimum Mix Ratio

A mix ratio of water to Kaolite-20 castable was developed to provide the apparent maximum compressive strength practical and applicable to field conditions for placing concrete. The Kaolite-20 manufacturer, Babcock and

Wilcox Company, recommended 62.5% water (30 quarts water per 100 lbs. of K-20) on their data sheet. This was revised upward to 67.5% water (13 quarts per 40 lb. bag) on personal contact with the manufacturer representative. On the basis of this information 62.5% and 67.5% (water percentage to dry, as received material) the optimum workable versus strength mixture was determined to be in the upper range as high as 70% in the case of the small 2 in. cube samples.

The Kaolite-20 material was thoroughly dry-mixed prior to addition of water. A representative sample of Kaolite was mixed with water (percent moisture based on the dry weight of Kaolite) using ASTM method C-305 as a guide, by the hand-method of mixing. Six (6) different percentages of water ranging from 62.5% to 80% were used to determine the most desirable mixture based on the resulting strengths and workability.

Approximately forty (40) 2 in. cubes (Figure 1) were cast following the procedure for Molding Test Specimens described by ASTM method C-109-64. The Kaolite specimens were molded in four layers to insure complete consolidation and the samples were left projecting slightly above the mold surface to allow for drying shrinkage. The curing cycle as recommended by manufacturer was followed: (1) Twenty-four hours in the mold at room temperature (74 °F), (2) remove cubes from the mold, trim, and immerse in water for twenty-four hours, (3) remove from water and dry at room temperature for the remainder of the curing cycle. Seven (7) days minimum curing was recommended by the manufacturer to obtain maximum strength. Tests were conducted at the end of 5, 7 and 9 day intervals as shown on Table I. The cubes were sanded to plane surfaces, measured for cross-sectioned area computation and subjected to the test for compressive strength of cement mortars, as per ASTM designation C-109-64, procedure 12 (b) and (c). The total maximum load indicated by the testing machine was recorded and the compressive strength in pounds per square inch was calculated.

All observations in relation to workability, molding, appearance, resulting strengths, and type of fracture of the compression specimen indicates a mix ratio of approximately 70% moisture, based on dry weight of Kaolite, is preferable. As table II, Curve of Strength Versus Water, indicates, the precise quantity of moisture is not very critical to provide samples with strengths in excess of the 550 psi noted on the manufacturers data sheet.

The high values of compressive strength in respect to the published data raised the question regarding the specimen cube size. Inasmuch as larger cubes were not available, 3 in. diameter x 6 in. long cylinders were cast in accordance with provisions for cylinders in ASTM specifications 495, Light Weight Insulating Concrete. As was expected compressive strength values for these cylinders were less than those of the cubes. These cylinders (Figure 2) were cast using the 70% optimum water mix and were factored throughout the testing program for comparison purposes.

Kaolite-20 Compressive Strength Test Specimen Size

A 4 in. cube was believed to be the most desirable size specimen to be used for compressive testing of Kaolite-20. Standard molds of this size were not available when the program was started. Two in. cubes (Figure 1) were used (No. 1 through 42) to make the optimum water-Kaolite-20 mix determination. These were acceptable from known specifications, however as the program progressed 3 in. diameter x 6 in. long cylinders (Figure 2) were obtained and approximately 30 of these were factored into the program for comparison. As was expected, the increased length to cross-section ratio resulted in reduced strengths (see Graph II). According to concrete specifications in relationship to length to diameter ratio, a 1:1 ratio would be expected to be 20% stronger than the 1:2 ratio. This factor could be an indication to explain the difference, however known data regarding concrete should not be considered completely applicable in the case of this Kaolite material.

GRAPH I

Optimum Water/K-20 Curve*

PSI

900

850

800

750

700

650

600

550

500

62.5

65

70

75

78

80

Water Percentage

70% considered optimum due to workability
versus strength

*PSI noted on curve is average of total 7 and 9 day tests.
5-day tests are not shown.

GRAPH I
Optimum Water/K-20 Curve*

Table I
Kaolite-20 Test Data
Optimum Water/Kaolite-20 Mix Ratio

Size of specimen 2 inch cubes $\pm 1/32$
Curing room temperature drying $73^{\circ}\text{F} \pm 10^{\circ}$
Hours air cure 24 (in mold)
Hours water cure 24
Days air cure noted below

Cube No.	Percent Water	Maximum Load 4 Sq. In.	PSI		
			5-days	7-days	9-days
1	62.5	2300	573		
2	62.5	2050	510		
3	62.5	2400		600	
4	62.5	2400		600	
5	62.5	3500			880
6	62.5	3600			900
7	63	Reject			
8	65	Reject	(see series 25 through 30)		
9	65	Reject			
10	65	2440		610	
11	65	2120			530
12	65	2160			540
13	70	3200	800		
14	70	2600	650		
15	70	3000		760	
16	70	3000		750	
17	70	2550			660
18	70	2850			710
19	75	2150	540		
20	75	2050	520		
21	75	2200		550	
22	75	2450		610	
23	75	2500		630	
24	75	3000		750	
25	65	2400	600		
26	65	2900	730		
27	65	3300		830	
28	65	3350		840	
29	65	3750			940
30	65	3300			830
31	78	2200	560		
32	78	2250	580		
33	78	2700		680	
34	78	2400		600	
35	78	2600			650
36	78	2550			638
37	80	1800	450		
38	80	1500	380		
39	80	2150		538	
40	80	2150		538	
41	80	2200			550
42	80	2200			550

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PNL 0681528

Figure 1. Test specimen 2 inch cube

PNL 0681485-3

Figure 2. Test specimen 3 inch x 6 inch cylinder

Table II
Compressive Strengths of Kaolite-20
(See Graph-II for Comparison
and Special Environmental Conditions)

Sample No.	Type		Condition	Maximum Load	PSI Strength
	Cube	Cyl.			
43	X		A	2275	570
44	X		A	2275	570
45	X		A	2300	580
1		X	A	2875	410
2		X	A	2750	390
3		X	A	2525	360
49	X		B	2100	520
74	X		B	1850	463
26		X	B	2350	332
27		X	B	2250	318
28		X	B	2425	342
51	X		C (350)	2250	562
52	X		C (350)	2350	587
6		X	C (350)	2950	417
7		X	C (350)	2950	417
62	X		C (500)	2350	587
63	X		C (500)	2175	544
12		X	C (500)	3975	562
13		X	C (500)	3925	555
68	X		C (1100)	2125	531
69	X		C (1100)	2325	531
18		X	C (1100)	3250	460
50	X		D (350)	2250	563
59	X		D (350)	2875	719
8		X	D (350)	2400	339
9		X	D (350)	2600	367
64	X		D (500)	2050	513
65	X		D (500)	2275	569
14		X	D (500)	3675	509

1-28 Cylinders 3" diameter x 6" long.

1-42 Cubes - 2" optimum mix determination (See Table I).

43-77 Cubes - Included in this table except 46, 47 and 48 not tested.

Table II (Continued)

Sample No.	Type		Condition	Maximum Load	PSI Strength
	Cube	Cyl.			
15		X	D (500)	3475	491
70	X		D (1100)	1925	481
71	X		D (1100)	1950	488
19		X	D (1100)	2700	382
60	X		E (350)	2225	556
61	X		E (350)	2025	506
10		X	E (350)	2000	283
11		X	E (350)	2850	403
66	X		E (500)	2200	550
67	X		E (500)	2125	531
16		X	E (500)	2425	343
17		X	E (500)	2650	375
72	X		E (1100)	1500	375
73	X		E (1100)	1400	350
20		X	E (1100)	1700	240
4		X	F	2950	417
5		X	F	2675	378
21		X	F	3600	509
22		X	F	3550	502
57	X		G	2900	725
58	X		G	2623	656
53	X		H (So1-1)	1950	487
54	X		H (So1-1)	2350	637
55	X		H (So1-2)	2550	637
56	X		H (So1-2)	2200	550
75	X		I	2250	562
76	X		I	2075	518
77	X		I	2075	518
23		X	I	3850	545
24		X	I	3850	545
25		X	I	3850	545

PSI

700

650

600

550

500

450

400

350

300

250

200

A B C C C D D D E E E F G H I
 350° 500° 1100° 350° 500° 1100° 350° 500° 1100°

GRAPH II KAOLITE-20
COMPRESSIVE STRENGTH

- Condition A Seven (7) day cure of 70% water/K-20 mix (standard)
 Condition B Seven (7) day cure - soaked in water tested wet
 Condition C Heated sample and tested at temperature indicated
 Condition D Heated sample to temperature indicated and allowed to cool to room temperature and tested
 Condition E Heated sample to temperature indicated and allowed to cool, then soaked in water and tested
 Condition F Heated to 1100 °F from one end only, allowed to cool to room temperature and tested
 Condition G Seven (7) day cured samples, pressurized 5 days 18 PSI and tested wet
 Condition H Seven (7) day cured sample, soaked in substituted tank slurry for 5 days and tested wet
 Condition I Fourteen (14) day cure (standard)

● = Cube 2 x 2 x 2 x = Cylinder 3 x 6 (See Table II for itemized results.)

Special test specimens (see Appendix A, page 6) were made using various sized conventional concrete molds. Results varied as much as mold sizes, with a standard 6 in. diameter x 12 in. long cylinder (used routinely with concrete) yielding compressive strength as low as 214 psi when used with the Kaolite material.

Sufficient samples were run in both the 2 in. cube and the 3 in. diameter x 6 in. long cylinder to provide meaningful results. The 4 in. cube molds have been received and a sample run of compressive strength results are shown below:

Cubes 4 Inch Test Results

<u>Sample No.</u>	<u>Age Days</u>	<u>Percent Water</u>	<u>Test Condition</u>	<u>Maximum Load</u>	<u>Lb. Per Sq. Inch</u>
1	9	67.5	Dried	8550	530
2	9	67.5	Wet	6450	400
3	9	67.5	Dried	8250	515
4	9	67.5	Wet	6650	450
5	8	70	Dried	9350	625
6	8	70	Wet	6450	400
7	8	65	Dried	1200	750
8	8	65	Wet	9150	570

Kaolite-20 Porosity

The porosity of this material is listed as 70% by manufacturer's data sheet. A close-up view, Figure 3, indicates the macro surface porosity of this material. When broken the voids, appearing on this surface, were representative of visual appearance throughout the cylinder. It was noticeable that the amount of water used in the mix could have an effect on the final dried or fired porosity. In the case of the low water ratio, (65% and lower) excessive kneading was required to minimize the large pores,

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SNL-77

PNL 0681324-3

Figure 3. Close-up surface porosity of Kaolite-20

consequently the compressive strength was very similar to the optimum mixture. The other extreme of surplus water (70% and above) apparently created porosity which caused the resultant strength to reduce (Graph I). The samples produced using 65 to 70% water resulted in porosity of approximately 70% as listed by the manufacturer. All these determinations were made in the final fired (1100 °F) condition; prior to this firing, in the as dried form, the sample retains approximately 8% moisture by weight.

Mock-Up Thermal Test

To simulate the 1100 °F stress relieve heat treatment planned for the proposed storage tank and to observe the insulating qualities as well as the effect this temperature would have on the Kaolite-20 castable material, a mock-up test was performed. A cylinder of Kaolite-20 was cast 6 in. diameter and 9 in. long. The completed cylinder was placed on end over a furnace opening. Heat was applied and controlled by thermocouple to this bottom surface through a 1/4 in. steel plate. Temperature was recorded at the middle location as well as the top of the cylinder, Figure 4. These temperature measurements (Graph III) indicate a high degree of thermal insulation in this material and this data may be of importance in determining the insulation characteristics in the proposed application. Visually no ill effects were noted during, or as a result of, this thermal gradient type heating. Compressive strength results of heating from one side of cylinder were noted as condition F, Graph II.

Substitution Tank Slurry

The chemical composition of stand-in waste was supplied by ARHCO for current and stored waste. Slurries of these compositions were prepared by the Battelle Chemical Standards Laboratory in quantities sufficient to submerge samples of the Kaolite-20 insulating material. In both cases the slurries were approximately 50% by volume sediment after standing for a few minutes. One test sample was completely covered by this sludge

GRAPH III

Kaolite-20 Refractory Castable Time-Temperature Curve

Temperature °F

SEMI-LOGARITHMIC 358-71
KEUFFEL & ESSER CO. MADE IN U.S.A.
1 CYCLE X 10 DIVISIONS

Note: 6" Diameter x 8" Long
Cylinder-Heat Applied
To 1/4" Steel Plate At
Bottom-TC Recorded
3 Positions

-16-

DNHL-797

PNL 0631485-1

Figure 4. Mock-up thermal test

while the other was partially clear. Four samples were allowed to remain in the slurry five (5) days and then compressive tested wet; the samples were severely discolored, however the strength results were very similar to samples that had been soaked in water. This comparison is shown as condition H on Graph II with strength results ranging from 487 psi to 637 psi.

Shock Testing

Kaolite-20 cylinders and cubes were subjected to a simple thermal shock test to determine the integrity of the material under severe shock conditions. Water soaked samples were placed directly into a 1100 °F furnace to drive out the moisture in the form of steam in a matter of a few minutes. Apparently, this did not effect the material. However, if the material were heated first, and any heat was retained in the sample when soaked, the sample would crack. This was observed on samples that were cooled several hours and appeared cool (room temperature) to the touch, but apparently had some heat remaining in the center, causing it to crack when submerged in water. The low compressive strength results noted under condition E, Graph II, may have been caused by unobserved micro cracks induced by this procedure, although these specimen were cooled 6 to 7 hours prior to soaking and testing.

Irradiation Testing

A cursory type examination of this Kaolite-20 material was made after irradiation. Apparently some concern exists regarding the possible presence of organics in this insulating material. Samples were prepared approximately 1 in. diameter x 2 in. long from the same material used for compressive tests. Four (4) of these samples were subjected to radiation in the Co⁶⁰ gamma facility. They received a dose rate of 2×10^7 r/hr. for five (5) hours. After irradiation they were compared visually with the cylinders that were not tested. (Figure 5, the four on the right were irradiated.) In their appearance, no significant difference was noted.

These miniature samples were broken by compressive tests as noted below. Again, the integrity of the material after irradiation apparently is very similar to the non-irradiated material.

	Compressive Strength psi
Irradiated sample 1	318
Non-irradiated sample 2	382
Irradiated sample 3	382
Non-irradiated sample 4	350

PRL 0681400-0

Figure 2. Visual comparison of samples irradiated and non-irradiated

ACKNOWLEDGEMENT

The cooperation of the U. S. Testing Company, Richland, Washington, for suggesting appropriate procedures in casting and curing this material is appreciated. The contributions of Mr. Harry Waltenbaugh and William Alexander are especially acknowledged by the inclusion of their test analysis report as Appendix A in this document. The Battelle Chemical Standards Sub-Unit (767C) is credited with formulating the simulated tank slurry from the specifications provided by ARHCO. These specifications are included as Appendix B as well as the recommended sampling and testing procedures supplied by Mr. Samuel P. Maimone, Castable Specialist of the Babcock and Wilcox Company. Special recognition is due Mr. R. E. Woodley of Battelle's Materials Compatibility Unit for his scheduling of the use of the Co⁶⁰ gamma facility.

APPENDIX A

TEST ANALYSIS REPORT

U. S. TESTING COMPANY

COMMENTS AND OBSERVATIONS

TEST DATA AND SHEETS

UNITED STATES TESTING COMPANY, INC.
2800 George Washington Way
Richland, Washington

TEST ANALYSIS REPORT

KAOLITE - 20

REFRACTORY CASTABLE

Manufactured By:

The Babcock and Wilcox Company
Refractories Division
Augusta, Georgia

Client:

Mr. N. C. Davis
Battelle Northwest
P. O. Box 999
Richland, Washington

Contract No. AT-(45-1) 1815
Work Order No. B-06332

Data Tested and Compiled By:

Harry Waltenbaugh
Materials Technician
Engineering Department
United States Testing Company, Inc.

Date: May 3, 1968

Approved By:
William A. Alexander
Supervisor
Engineering Department
United States Testing Company, Inc.

(a) Recommended Methods for Application

- (1) Cast or Rammed
- (2) Plaster
- (3) Gunned

(B) Pounds required to place one cubic foot - - - - - 48

(C) Required water, U.S. quarts/100# (casting & rodding) - - - - - 30

(D) Recommended use limit - - - - - 2,000 degrees F.

(E) Melting point - - - - - -2,490 degrees F.

(F) Density, lbs./cu.ft.

- (1) Molded - - - - - 80
- (2) Dried - - - - - 55
- (3) Fired - - - - - 48

(G) Modulus of rupture, P.S.I.

- (1) Dried 18-24 hrs. - - - - 220 degrees F. - - - - -200
- (2) Fired 5 hrs. - - - - -1000 degrees F. - - - - - 70
- - - - -1500 degrees F. - - - - -170
- - - - -2000 degrees F. - - - - -120

(H) Cold crushing strength, P.S.I.

- (1) Dried 18-24 hrs. - - - - 220 degrees F. - - - - -550
- (2) Fired 5 hrs. - - - - -1000 degrees F. - - - - -370
- - - - -1500 degrees F. - - - - -400
- - - - -2000 degrees F. - - - - -300

(I) Permanent linear shrinkage

- (1) Cured to dried - - - - - 0.1
- (2) Dried to fired - - - - -1000 degrees F. - - - - - 0.4
- - - - -1500 degrees F. - - - - - 0.7
- - - - -2000 degrees F. - - - - - 0.8

(J) Porosity, fired - - - - - -70%

(K) Thermal conductivity, k BTU/sq.ft./hr./in./degrees F. - - - - - 1.55

(L) Chemical analysis, %, (fired basis)

- Silica - - - - - 42.3
- Alumina - - - - - 29.8
- Ferric Oxide - - - - - 1.1
- Titania - - - - - 1.0
- Calcium - - - - - 24.9
- Magnesia - - - - - 0.3
- Alkalies, As - - - - - 0.6

100.0%

TRIAL DESIGN PROCEDURES USED FOR KAOLITE-20

(A) Preparation prior to tests

- (1) The submitted samples of Kaolite were dry-mixed prior to test.
- (2) A moisture content determination of the Kaolite, as received, was made and free water was not lost under prescribed drying procedures.

(B) Casting

- (1) A representative sample of Kaolite was mixed with water (percent moisture based on the dry weight of Kaolite), using ASTM method C-305 as a guide.
- (2) A mechanical mixer was not available and the hand method of mixing was used.
- (3) Varying percentages of water were used to determine the most desirable mix ratio based on the resulting strengths and workability.
- (4) The "Determination of Flow" was performed in accordance with ASTM method C-109-64.
- (5) A set of six 2" x 2" cubes were cast following the procedure for "Molding Test Specimens" described by ASTM method C-109-64.
- (6) The Kaolite specimens were molded in four layers to insure complete consolidation and the samples were left projecting slightly above the mold surface to allow for drying shrinkage.

(C) Curing

- (1) During the first twenty-four hours of the curing cycle, the specimens, covered with glass, were left at room temperature
- (2) The temperature of the room during the course of this cycle ranged from 72 to 74 degrees F.
- (3) The cubes were then trimmed to a plane surface, removed from the mold, weighed and immersed in water, where they remained for twenty-four hours.
- (4) At the end of this period, a saturated weight was obtained and the cubes remained at room temperature for the remainder of the curing cycle.
- (5) The temperature of the water during the immersion period was +68 degrees F.

(D) Compressive Tests

- (1) The cubes were then sanded to plane surface, weighed, measured for cross-sectional area computation, and subjected to the Test for Compressive Strength of Cement Mortars, as per ASTM designation C109-64, Procedure 12(b) and (c).
- (2) The total maximum load indicated by the testing machine was recorded and the compressive strength in pounds per square inch was calculated.
- (3) The type of fracture and appearance of the concrete following each test was recorded.
- (4) The age of the specimen being subjected to the compressive strength determination was recorded.

SUMMATION AND COMMENTS APPLICABLE:

All data noted in relation to workability, molding, appearance, resulting strengths, and type of fracture of the compression specimens indicates a mix ratio of approximately seventy percent moisture, based on the dry weight of Kaolite, is preferable.

A precise quantity of moisture is not mandatory to meet strength requirements, as acceptable strengths were obtained with all ratios tested (62 to 80 percent).

The mix, using the lower moisture contents is dry and workability and consolidation more difficult to obtain.

When consolidation is obtained, free water appears on the surface of the specimen.

The molds or forms, to contain the mix, must be watertight or mixing water will be lost.

This type of water loss would invite an excess of void spaces.

A kneading-type compactive effort was applied in the laboratory for consolidation of the Kaolite-water mixture: (ASTM Method C-109-64).

CASTING PROCEDURES FOR KAOLITE-20

(A) Sampling

- (1) A sample of Kaolite-20 was thoroughly dry-mixed prior to use in tests.
- (2) A moisture content determination was made and no weight loss was noted under the prescribed drying procedure.

(B) Casting of 3" x 6" Test Specimens

- (1) A representative sample of Kaolite-20 was mixed with percentages of moisture based on dry weight, using ASTM method C-305 as a guide.
- (2) A 70 percent moisture content was determined as the best design from the previous casting of the 2" x 2" test cubes.
- (3) The mold was filled in five equal layers and each layer was consolidated by "kneading" with an oval wooden tamper. The tamping was distributed evenly and until free water was exposed to the surface of each layer.
- (4) After the mold was filled, leaving some excess material on top for shrinkage, the mold was externally vibrated to fill any remaining voids.
- (5) The top was then struck off with steel bar stock, on edge, using a "sawing" motion.
- (6) The exposed surface was "slicked" or finished by placing an oiled glass or sheet metal plate on top of the molded specimen to prevent evaporation during the first twenty-four hour curing period.
- (7) The complete operation of filling the molds was not more than five minutes.

(C) Determination of Flow Value

- (1) The flow test was performed in accordance with ASTM method C-109-64.

REMARKS:

The base diameter of the molded specimens remained unchanged during varying moisture contents between 62 percent and 80 percent. With 75 percent moisture, the upper portion of the molded specimen became a near cylindrical shape. At 80 percent moisture, the slumped, upper portion of the specimen "capped" the lower portion.

CONCLUSION:

The flow determination of Kaolite-20 is of little value in determining mix design qualities, as the flow value is insignificant.

RESULTS OF SPECIAL TEST SPECIMENS

- (A) One 6" x 12" cylinder was cast, using 80% moisture content and our standard casting method.

(1) Date Cast:	April 8, 1968
(2) Date Tested:	April 25, 1968
(3) Age (days):	17
(4) Wet Wt. (lbs.):	15.88
(5) Area (sq. in.):	28.3
(6) Maximum Load (lbs.):	6,000
(7) Lbs./sq. inch:	214

It is our opinion that a specimen of these dimensions does not give accurate test results as a representative test on this material.

- (B) One 4" x 4-1/2" cylinder was cast, using 78 percent moisture content in a standard metal mold, 1/30th cubic foot for unit weight determination. After curing, it was subjected to a compression test.

(1) Date Cast:	April 6, 1968
(2) Date Tested:	April 13, 1968
(3) Age (days):	7
(4) Wet Weight (lbs.):	2.79
(5) Dry Weight (lbs.):	1.97
(6) Area (sq. in.):	12.6
(7) Maximum Load (lbs.):	3,050
(8) Lbs./sq. inch:	243

The casting procedure used was our standard method. The calculated unit weight was 83.4 pounds per cubic foot (wet).

- (C) One 6" x 8" cylinder was cast by our standard method, using 72.5 percent moisture content on April 2, 1968. A thermocouple submitted to us by Mr. Davis was placed at a point four inches from the top and three inches in the center of the cylinder during casting. The wet weight of the unit was 10.84 pounds. After curing through our standard method, it was then submitted to Mr. Davis for his use.
- (D) Eleven plastic vials, 1" x 2" in size, were brought to us by Mr. Davis and, using our standard method, were cast with 70 percent moisture content. One set of six samples were cast on April 10, 1968. The remaining set of five were cast on April 15, 1968. After air cure, Mr. Davis picked these specimens up on April 22, 1968.

REMARKS:

Information obtained from these special test specimens:

- (1) Test specimen should be carefully consolidated for accurate results.
- (2) We recommend that ASTM standard specifications C-109-64 be used as a guide for quality in preparing test specimens. Other methods should be well-analyzed before considering them for use.
- (3) Moisture content could be varied between 62 percent and 70 percent to provide workability.
- (4) A plane test surface is very difficult to achieve with test specimens of this size.

KAOLITE TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington.

Date: 4-4-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 3-26-68 % Moisture by Dry Weight: 62.5

Type of Consolidation: Kneading

Remarks:

Specimen No.	1	2	3	4	5	6
Age-Days	5	5	7	7	9	9
Date Tested	3-31	3-31-68	4-2-68	4-2-68	4-4-68	4-4-68
Wet Wt./Grams	179.0	177.5	176.0	177.0	178.0	179.5
Dry Wt./Grams						
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2300	2050	2400	2400	3500	3600
Lbs./sq.inch	575	510	600	600	880	900
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: H. Haltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEETClient: Battelle NorthwestDate: 4-9-68Address: Richland, WashingtonProject: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox CompanyDate Cast: 3-31-68 % Moisture by Dry Weight: 65Type of Consolidation: Kneading

Remarks:

Specimen No.	7	8	9	10	11	12
Age-Days	5	5	5	7	9	9
Date Tested	4-5-68	4-5-68	4-5-68	4-7-68	4-9-68	4-9-68
Wet Wt./Grams	177.0	175.5	177.0	176.5		
Dry Wt./Grams				119.0	113.0	117.0
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	1300	1750	1200	2625	2100	2150
Lbs./sq.inch	330	440	300	610	530	540
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks: Cubes no'd. 7, 8 & 9 were broken prematurely at 2-days.
Also cube no. 7 was "capped" in establishing a test procedure, which did not prove useful.

Inspected By: J. G. Haltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington

Date: 4-10-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-1-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	13	14	15	16	17	18
Age-Days	5	5	7	7	9	9
Date Tested	4-6-68	4-6-68	4-8-68	4-8-68	4-10-68	4-10-68
Wet Wt./Grams						
Dry Wt./Grams	121.0	124.5	122.1	123.2	123.0	122.0
Voids	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	3200	2600	3000	3000	2550	2850
Lbs./sq.inch	800	650	760	750	660	710
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube _____ Cylinder _____

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: H. Staltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE TEST DATA SHEET

Client: Battelle Northwest,
 Address: Richland, Washington.

Date: 4-11-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-2-68 % Moisture by Dry Weight: 75

Type of Consolidation: Kneading

Remarks:

Specimen No.	19	20	21	22	23	24
Age-Days	5	5	7	7	10	10
Date Tested	4-7-68	4-7-68	4-9-68	4-9-68	4-11-68	4-11-68
Wet Wt./Grams	172.7	169.1	169.1	167.2	168.1	171.0
Dry Wt./Grams	113.0	112.0	114.0	116.0	114.5	116.0
Voids	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2150	2050	2200	2450	2500	3000
Lbs./sq.inch	540	520	550	610	630	750
Size-inches ⁺ 1/32	2x2	2x2	2x2	2x2	2x2	2x2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: J. Shaltembaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEETClient: Battelle NorthwestDate: 4-13-68Address: Richland, WashingtonProject: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox CompanyDate Cast: 4-4-68 % Moisture by Dry Weight: 65Type of Consolidation: Kneading

Remarks:

Specimen No.	25	26	27	28	29	30
Age-Days	5	5	8	8	9	9
Date Tested	4-9-68	4-9-68	4-12-68	4-12-68	4-13-68	4-13-68
Wet Wt./Grams	171.2					
Dry Wt./Grams	130.0	131.0	124.0	124.0	123.3	122.8
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2400	2900	3300	3350	3750	3300
Lbs./sq.inch	600	730	830	840	940	830
Size-inches ⁺ 1/32	2x2	2x2	2x2	2x2	2x2	2x2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: H. StaltenbaughEngineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

KAOLITE MO TEST DATA SHEET

Client: Battelle Northwest,
 Address: Richland, Washington.

Date: 4-15-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-6-68 % Moisture by Dry Weight: 78

Type of Consolidation: Kneading

Remarks:

Specimen No.	31	32	33	34	35	36
Age-Days	6	6	7	7	9	9
Date Tested	4-12-68	4-12-68	4-13-68	4-13-68	4-15-68	4-15-68
Wet Wt./Grams	166.0	170.0	169.5	169.5	172.0	169.5
Dry Wt./Grams	119.0	124.0	117.7	116.3	114.5	112.5
Voids	None	None	None	None	None	None
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2200	2250	2700	2400	2600	2550
Lbs./sq.inch	560	580	680	600	650	638
Size-inches ⁺ 1/32	2x2	2x2	2x2	2x2	2x2	2x2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: J. Haltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington

Date: 4-17-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-8-68 % Moisture by Dry Weight: 80

Type of Consolidation: Kneading

Remarks:

Specimen No.	37	38	39	40	41	42
Age-Days	5	5	7	7	9	9
Date Tested	4-13-68	4-13-68	4-15-68	4-15-68	4-17-68	4-17-68
Wet Wt./Grams						
Dry Wt./Grams	120.5	121.9	113.5	112.5	110.9	110.6
Voids	None	None	None	None	None	None
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	1800	1500	2150	2150	2200	2200
Lbs./sq.inch	450	380	538	538	550	550
Size-inches ^{+1/32}	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: H. Haltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington

Date: 4-17-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-10-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	43	44	45	46	47	
Age-Days	7	7	7			
Date Tested	4-17-68	4-17-68	4-17-68			
Wet Wt./Grams	174.4	173.4	174.8	174.6	173.3	
Dry Wt./Grams	120.0	119.0	119.0			
Voids	> 1/32"	> 1/32"	> 1/32"			
Area/sq.in.	4.0	4.0	4.0			
Maximum Load	2275	2275	2300			
Lbs./sq.inch	570	570	580			
Size-inches [±] 1/32	2 x 2	2 x 2	2 x 2			

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks: Cubes no'd 46 & 47 were submitted to Mr. Davis.

Inspected By: D. Staltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington.

Date: 4-28-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-11-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	48	49	50	51	52	53
Age-Days		14	17	16	16	
Date Tested		4-25-68	4-28-68	4-27-68	4-27-68	
Wet Wt./Grams	178.5	178.5	177.0	175.5	177.0	176.5
Dry Wt./Grams		165.0	117.5	116.5	117.6	
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load		2100	2250	2250	2350	
Lbs./sq.inch		520	563	562	587	
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Cube no. 49 (dry) was immersed in water for 10 minutes: wet weight = 165.0 grams.

Remarks: *Cubes no'd 48 & 53 were submitted to Mr. Davis.*

Inspected By: J. Shaltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest,
Address: Richland, Washington.

Date: 5-1-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-15-68 % Moisture by Dry Weight: 65

Type of Consolidation: Kneading

Remarks:

Specimen No.	54	55	56	57	58	59
Age-Days	16	16	16	16	16	13
Date Tested	5-1-68	5-1-68	5-1-68	5-1-68	5-1-68	4-28-68
Wet Wt./Grams	188.0	188.3	186.5	186.8	186.3	186.7
Dry Wt./Grams	—	—	—	—	—	128.9
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2550	2550	2200	2900	2625	2875
Lbs./sq.inch	637	637	550	725	656	719
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks: Cubes nos 54 thru 58 were submitted to Mr. Davis.

Inspected By: H. Shultenbaugh

Engineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest,
Address: Richland, Washington.

Date: 4-28-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-15-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	60	61	62	63	64	65
Age-Days	13	13	12	12	13	13
Date Tested	4-28-68	4-28-68	4-27-68	4-27-68	4-28-68	4-28-68
Wet Wt./Grams	181.3	182.2	180.1	179.7	178.1	179.6
Dry Wt./Grams	119.8 170.0	120.6 170.5	119.6 114.7	119.8 114.1	117.6 113.2	118.9 114.3
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2225	2025	2350	2175	2050	2275
Lbs./sq.inch	556	506	587	544	513	569
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

#60 & 61: Heated to 350°F. for 7-hours; cooled 5 1/2 hours; immersed in water 13-hours; tested.
#62 & 63: Heated to 500°F. for 5 1/2 hours; tested while hot.
#64 & 65: Heated to 500°F. for 7 hours; Cooled 20-hours; tested.

Remarks:

Inspected By: J. Haltenbaugh

Engineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest,
Address: Richland, Washington

Date: 4-28-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-16-68 % Moisture by Dry Weight: 70

Type of Consolidation: KNEADING

Remarks:

Specimen No.	66	67	68	69	70	71
Age-Days	12	12	11	11	12	12
Date Tested	4-28-68	4-28-68	4-27-68	4-27-68	4-28-68	4-28-68
Wet Wt./Grams	181.3	182.4	182.1	181.7	131.0	131.4
Dry Wt./Grams	122.5 170.0	122.9 171.2	122.8 172.8	120.9 170.5	119.4 162.6	120.4 161.7
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	2200	2125	2125	2325	1925	1950
Lbs./sq.inch	550	531	531	581	481	488
Size-inches ⁺ 1/32	2x2	2x2	2x2	2x2	2x2	2x2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

#66 & 67: Heated to 500°F for 7-hours; cooled 6-hours; Soaked in water 13 hours; Tested.
#68 & 69: Heated to 1100°F for 3-hours; Tested; hot.
#70 & 71: Heated to 1100°F for 3-hours; cooled 20 1/2 hours; tested.

Remarks:

Inspected By: J. Skaltenbaugh

Engineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

Client: Battelle Northwest,
Address: Richland, Washington.

Date: 5-1-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-17-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	72	73	74	75	76	77
Age-Days	11	11	14	14	14	14
Date Tested	4-28-68	4-28-68	5-1-68	5-1-68	5-1-68	5-1-68
Wet Wt./Grams	182.0	184.0	183.0	182.0	181.0	181.0
Dry Wt./Grams	116.7	118.4				
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"
Area/sq.in.	4.0	4.0	4.0	4.0	4.0	4.0
Maximum Load	1500	1400	1850	2250	2075	2075
Lbs./sq.inch	375	350	462	562	519	519
Size-inches ⁺ 1/32	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2	2 x 2

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: H. Haltenbaugh

Engineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

KAOLITE TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington.

Date: 5-1-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-10-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	1	2	3	4	5
Age-Days	7	7	7	14	14
Date Tested	4-17-68	4-17-68	4-17-68	5-1-68	5-1-68
Wet Wt./Grams	929.0	938.0	938.0	935.0	932.0
Dry Wt./Grams	633.0	634.5	623.5		
Voids	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"
Area/sq.in.	7.07	7.07	7.07	7.07	7.07
Maximum Load	2875	2750	2525	2950	2675
Lbs./sq.inch	410	390	360	417	378
Size-inches ^{±1/32}	3 x 6	3 x 6	3 x 6	3 x 6	3 x 6

Type Specimen: Cube _____ Cylinder ✓

Environmental Conditions Prior to Tests:

Remarks: Specimen No. 1: From sample sack no. 1.
Specimens no'd. 2 thru 20: From sample sack no. 2.
Specimens no'd. 21 thru 30: From sample sack no. 3.

Inspected By: L. Haltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington

Date: 4-28-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-11-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	6	7	8	9	10
Age-Days	16	16	17	17	17
Date Tested	4-27-68	4-27-68	4-28-68	4-28-68	4-28-68
Wet Wt./Grams	931.5	928.0	931.0	935.0	934.0
Dry Wt./Grams	591.0 574.0	588.0 569.5	590.0 575.5	591.0 575.5	595.0 559.0
Voids	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"
Area/sq. in.	7.07	7.07	7.07	7.07	7.07
Maximum Load	2950	2950	2400	2600	2000
Lbs./sq. inch	417	417	339	368	283
Size-inches ⁺ 1/32	3 x 6	3 x 6	3 x 6	3 x 6	3 x 6

Type Specimen: Cube _____ Cylinder ✓

Environmental Conditions Prior to Tests:

#6 & 7: Heated to 350°F. for 7 hours: tested while hot.

#8 & 9: Heated to 350°F. for 7 hours: Cooled 19 1/2 hrs.

#10: Heated to 350°F. for 7 hours: Cooled 5 1/2 hours; Soaked in water 13 hours.

Remarks: Sample of "Kaolite": from sack #2.

Inspected By: H. Waltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest,
Address: Richland, Washington.

Date: 4-28-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-15-68 % Moisture by Dry Weight: 65

Type of Consolidation: Kneading

Remarks:

Specimen No.	11	12	13	14	15	
Age-Days	12	12	12	13	13	
Date Tested	4-27-68	4-27-68	4-27-68	4-28-68	4-28-68	
Wet Wt./Grams	961.0	969.0	960.5	953.5	959.5	
Dry Wt./Grams	$\frac{637.0}{878.5}$	$\frac{641.0}{601.0}$	$\frac{637.0}{595.0}$	$\frac{628.5}{598.5}$	$\frac{632.0}{602.0}$	
Voids	$> \frac{1}{32}$ "	$> \frac{1}{32}$ "	$> \frac{1}{32}$ "	$> \frac{1}{32}$ "	$> \frac{1}{32}$ "	
Area/sq.in.	7.07	7.07	7.07	7.07	7.07	
Maximum Load	2850	3975	3925	3675	3475	
Lbs./sq.inch	403	562	555	510	491	
Size-inches ^{±1/32}	3x6	3x6	3x6	3x6	3x6	

Type Specimen: Cube _____ Cylinder ✓

Environmental Conditions Prior to Tests:

11 : Heated to 350°F. for 7 hours : Cooled 5 1/2 hours : Soaked in water for 13 hours. Tested.

12 & 13 : Heated to 500°F. for 5 1/2 hours : Tested while hot.

14 & 15 : Heated to 500°F. for 7 hours : Cooled 20 hours : Tested.

Remarks:

Inspected By: J. Daltenburgh

Engineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington

Date: 4-28-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-15-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	16	17	18	19	20
Age-Days	13	13	12	12	13
Date Tested	4-28-68	4-28-68	4-27-68	4-27-68	4-28-68
Wet Wt./Grams	972.0	997.0	951.0	965.0	954.0
Dry Wt./Grams	634.5 876.0	654.5 895.5	617.0 557.0	622.0 563.0	617.0 559.0
Voids	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"
Area/sq.in.	7.07	7.07	7.07	7.07	7.07
Maximum Load	2425	2650	3250	2700	1700
Lbs./sq.inch	343	375	460	381	240
Size-inches ⁺ 1/32	3x6	3x6	3x6	3x6	3x6

Type Specimen: Cube _____ Cylinder ✓

Environmental Conditions Prior to Tests:

#16 & 17: Heated to 500°F for 7 hours; Cooled 5 1/2 hours; Immersed in water 13 hours; Tested
 #18 & 19: Heated to 1100°F for 3 hours; #18 tested while hot (#19 cooled 14 1/2 hours); Tested
 #20: Heated to 1100°F for 3 hours; Cooled 1 1/4 hrs.; immersed in water; cracked in water; wet weight = 893.0 grams

Remarks:

Inspected By: J. Hattenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Washington

Date: 5-1-68

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox Company

Date Cast: 4-16-68 % Moisture by Dry Weight: 70

Type of Consolidation: Kneading

Remarks:

Specimen No.	21	22	23	24	25
Age-Days	15	15	15	15	15
Date Tested	5-1-68	5-1-68	5-1-68	5-1-68	5-1-68
Wet Wt./Grams	953.0	952.0	959.0	954.0	953.0
Dry Wt./Grams	627.5	632.5	632.0	633.5	639.5
Voids	> 1/32"	> 1/32"	> 1/32"	> 1/32"	> 1/32"
Area/sq.in.	7.07	7.07	7.07	7.07	7.07
Maximum Load	3600	3550	3850	3850	3850
Lbs./sq.inch	509	502	545	545	545
Size-inches ⁺ 1/32	3x6	3x6	3x6	3x6	3x6

Type Specimen: Cube _____ Cylinder ✓

Environmental Conditions Prior to Tests: Cylinders 21 & 22: Conditioned by Mr. Davis

Remarks:

Inspected By: H. Haltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest,
 Address: Richland, Washington.

Date: 5-1-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 4-17-68 % Moisture by Dry Weight: 70%

Type of Consolidation: Kneading

Remarks:

Specimen No.	26	27	28	29	30	
Age-Days	14	14	14			
Date Tested	5-1-68	5-1-68	5-1-68			
Wet Wt./Grams	950.0	951.0	950.0	955.0	950.0	
Dry Wt./Grams	639.5	634.0	638.0			
Voids	> 1/16"	> 1/16"	> 1/16"	> 1/16"	> 1/16"	
Area/sq.in.	7.07	7.07	7.07	7.07	7.07	
Maximum Load	2350	2250	2425			
Lbs./sq.inch	332	318	343			
Size-inches ⁺ 1/32	3x6	3x6	3x6	3x6	3x6	

Type Specimen: Cube _____ Cylinder ✓

Environmental Conditions Prior to Tests:

Remarks: Cylinder numbers 29 & 30 are being held for Mr. Davis.

Inspected By: H. Waltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client: Battelle Northwest
 Address: Richland, Wn.

Date: 5-13-68

Project: Test Design Analysis of Kaolite 20
 Manufactured by the Babcock & Wilcox Company

Date Cast: 5-5-68 % Moisture by Dry Weight: 65%

Type of Consolidation: Kneading

Remarks:

saturated
in water

Specimen No.	7				8	
Age-Days	8				8	
Date Tested	5-13-68				5-13-68	
Wet Wt./Grams	1495				1503	
Dry Wt./Grams	1102				1089/1382	
Voids	> 1/32"				> 1/32"	
Area/sq.in.	16.0				16.0	
Maximum Load	12,000				9150	
Lbs./sq.inch	750				570	
Size-inches ⁺ 1/32	4x4				4x4	

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: J. Waltenbaugh

Engineering Inspection
 United States Testing Company, Inc.
 2800 George Washington Way
 Richland, Washington

KAOLITE 20 TEST DATA SHEET

Client:

Date: 5-13-68

Address:

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox CompanyDate Cast: 5-4-68 % Moisture by Dry Weight: 67.5%Type of Consolidation: KneadingRemarks: 4" Cuts in water

Specimen No.	1	3			2	4
Age-Days	9	9			9	9
Date Tested	5-13-68	5-13-68			5-13-68	5-13-68
Wet Wt./Grams	1382	1474			1432	1404
Dry Wt./Grams	976.5	1053			1020/1295	990/1266
Voids	> 1/8"	> 1/8"			> 1/8"	> 1/8"
Area/sq.in.	16.0	16.00			16.25	15.87
Maximum Load	8550	8250			6450	6650
Lbs./sq.inch	530 +	515 +			400 -	450
Size-inches ^{±1/32}	4x4"	4x4"			4x4"	4x4"

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: H. WaltenbaughEngineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

KAOLITE 20 TEST DATA SHEET

BNWL-797

Client:

Date: 5-13-68

Address:

Project: Test Design Analysis of Kaolite 20
Manufactured by the Babcock & Wilcox CompanyDate Cast: 5-5-68 % Moisture by Dry Weight: 70.0%Type of Consolidation: KneadingRemarks: 4' cube -saturated
in water

Specimen No.	<u>5</u>				<u>6</u>	
Age-Days	<u>8</u>				<u>8</u>	
Date Tested	<u>5-13-68</u>				<u>5-13-68</u>	
Wet Wt./Grams	<u>1444</u>				<u>1512</u>	
Dry Wt./Grams	<u>984</u>				<u>1059/1314</u>	
Voids	<u>> 1/32"</u>				<u>> 1/32"</u>	
Area/sq.in.	<u>15.0</u>				<u>16.0</u>	
Maximum Load	<u>9350</u>				<u>6450</u>	
Lbs./sq.inch	<u>625</u>				<u>400</u>	
Size-inches ^{+1/32}	<u>3 7/8 x 3 7/8</u>				<u>4.0 x 4.0"</u>	

Type Specimen: Cube ☒ Cylinder ☐

Environmental Conditions Prior to Tests:

Remarks:

Inspected By: D. WaltenbaughEngineering Inspection
United States Testing Company, Inc.
2800 George Washington Way
Richland, Washington

APPENDIX B

SUBSTITUTION TANK SLURRY

RECOMMENDED SAMPLING AND TESTING PROCEDURE

FOR BABCOCK AND WILCOX COMPANY KAOLITE-20

INSULATING CASTABLE

BABCOCK AND WILCOX COMPANY

April 11, 1968

To: W. C. Armstrong
Facilities Engineering

From: W. C. Schmidt

Subject: CHEMICAL COMPOSITION OF B-PLANT
STORED BOILING WASTE

The compositions of current B-Plant stored boiling waste are listed in Table I. These compositions are based upon the present chemical flowsheets. These flowsheets will change as processing experience is gained but it is believed that they are sufficiently accurate for representing the slurry in the tank on a current basis.

Radiation decomposes the organics to sodium carbonate and a nitrogen-carbonaceous material which have not been identified. It also reduces the nitrate ion to a nitrite ion. Upon standing for a period of time the slurry in the tank will have the chemical composition shown in Table II.

It is recommended that the insulating concrete for the AY Tank Farm be evaluated in both slurries.

Attachment
WCS:jas

cc: P. Hatch
GC Oberg
PW Smith
File 354
LB

<u>Chemical</u>	Table I Current Boiling Waste Composition	Table II Stored Boiling Waste Composition
	<u>M</u>	<u>M</u>
Fe	0.10	0.10
Al	0.12	0.12
Na	1.2	2.0
Cr	0.005	0.005
Ni	0.002	0.002
Ca	0.001	0.001
Zr	0.02	0.02
SiO ₂	0.25	0.25
NO ₃	1.0	0.20
NO ₂		0.80
SO ₄	0.20	0.20
CO ₃	0.14	0.54
OH	0.05	0.05
F	0.02	0.02
Tartrate	0.013	
NTA	0.10	
Hydroxyacetate	0.18	
HEDTA	0.10	

Note from Standard Laboratory:

Foreign Ions: Table I

K⁺ 0.645 M

Table II

K⁺ 1.08 M

Cl⁻ 0.651 M

THE BABCOCK & WILCOX COMPANY
REFRACTORY DIVISION
AUGUSTA, GEORGIA

TECHNICAL DEPARTMENT
QUALITY CONTROL SECTION

SUBJECT: RECOMMENDED SAMPLING AND TESTING PROCEDURES FOR B&W
KAOLITE-20 INSULATING CASTABLE.

A. SAMPLING AND MOLDING TEST SPECIMENS FOR COMPRESSIVE STRENGTH

a. SAMPLING

On large jobs where samples are desired for testing the compressive-strength of the castable being used, the following procedure is recommended:

It would be almost an impossibility to check each and every batch of the castable being poured on large jobs. Random checking of the material being placed is desirable.

It is recommended, perhaps, that two random checks be made during each 8 hours of pouring; one check being made sometime during the first 4 hours and the second being made sometime during the last 4 hours of each shift.

b. MOLDING TEST SPECIMENS

Immediately after mixing as the mixer is being emptied, begin filling the molds, using a scoop to cut into the batch so as to get a good section, and half-full each 4" x 4" x 4" mold cavity. Consolidate the material in the half-filled mold cavities by spading at close intervals, with a scraper knife (3-1/2" width of blade), across each mold cavity. After spading the half-filled cavities, fill the cavities full with an excess on top and at 90 degrees to the direction of the first spading, spade the filled mold. After the second spading with an excess of material on top

externally vibrate completely around the outside of mold causing the castable to flow to insure filling any voided areas. Using a strike-off bar (steel bar stock, 16 inches long x 1-1/2 inches width x 3/16 inch thick) on edge, with a sawing motion to remove the excess mix, then slick the exposed surface with a steel cement finishing trowel (approximately 14" long x 4" width x 1/32 thick) with the minimum amount of troweling. The complete operation of filling the 6 cavity mold shall be completed in not more than 5 minutes. Cover the exposed surface of the specimens with a flat smooth-surface oiled sheet metal or polyethylene sheet to prevent evaporation of the mix water.

c. CURING TEST SPECIMENS

Store the filled and covered molds at a temperature between 75 and 85 degrees F for a minimum of 24 hours.

d. DRYING TEST SPECIMENS

Following the mold curing, remove the specimens from the mold and place in an oven and dry in a circulating air at 220 to 230 degrees F until all free moisture has been removed from the specimens (until the specimens reach a constant weight). Drying the specimens would normally require approximately 24 hours in a good laboratory dryer designed to take care of a heavy load because of the high moisture content of insulating castables.

COMPRESSION OR CRUSHING STRENGTH INSULATING CASTABLES

APPARATUS

a. TESTING MACHINE

A hydraulic compression testing machine with a sensitivity of at least 100 lbs. in range of 0 to 20,000 lbs.

b. SPHERICAL BEARING BLOCK

The plane bearing surface of the spherical bearing block shall have an area that will cover the 4" x 4" surface of the test specimen.

TEST SPECIMENS

The test specimens shall consist of thoroughly dried pieces measuring approximately 4" x 4" x 4" with test surfaces being approximately parallel planes.

PROCEDURE

- a. The load shall be applied to the top 4" x 4" surface, as molded, of the test specimen.
- b. The bearing block shall be used on top of the test specimen and shall be placed so that the center of the sphere is in alignment with the vertical axis of the specimen.
- c. The testing machine shall be adjusted to apply the load at a rate of 7000 lbs. per minute, $\pm 10\%$.

CALCULATION AND REPORT

- a. The crushing or compression strength shall be calculated as follows:

$$S = \frac{W}{A}$$

Where: S = crushing strength in pounds per square inch,
W = total maximum load in pounds at visible failure, and

A = average of the gross areas of the two 4" x 4"
faces of the specimen in square inches.

- b. The report shall state the average crushing strength of each of the two random checks made for each 8 hours of castable placement.

H.L.C.

11/11/67

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