MR-126-01

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
~~REGION 1~~
Area VIII

ALASKA OFFICE OF
MINERAL RESOURCES

P. O. BOX 2688
JUNEAU, ALASKA

May 10, 1966

X 126-8

Mr. James A. Williams, Director
Division of Mines and Minerals
Alaska Department of Natural Resources
Box 1391
Juneau, Alaska 99801

Dear Jim:

Enclosed are copies of the data sheets giving pozzolan test results on the sample of Katmai pumice submitted by your office in the fall of 1963.

Also enclosed is a copy of the ASTM Pozzolan-test specifications and correspondence regarding the work and related matters--including reasons for the delay in completing the tests.

I hope these data will be of some use in furthering the eventual utilization of the Katmai deposits.

Sincerely yours,

J. A. Herdlick
Area Director
Area VIII Mineral Resource Office

Enclosures

J 5-17

004.4
Katmai

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
Spokane Office of Mineral Resources

REC'D. JUNEAU
MAY 11 1966
Div. Mines & Minerals

North 1430 Washington Street
Spokane, Washington 99201

May 5, 1966

JS-17

AIR MAIL

Memorandum

To: J. A. Herdlick, Area Director, Area VIII Mineral Resource Office, Juneau, Alaska

From: David P. King, Pozzolan Project Leader, Spokane Office of Mineral Resources, Area VII

Subject: Test Results on Katmai National Monument Pumice Sample

Your letter was promptly forwarded to me for reply by Mr. Magill. I have had the test results on your sample for nearly a month now. I had planned to send the results on to you in June after my project report was completed, and as a part of a general systematic distribution effort. Actually, tests were not begun on your sample until sometime in September 1965, so actual testing has taken considerably less than a year as anticipated. At the time we agreed to test your sample, we were guaranteed ten times the allocation of tests that we eventually ended up with. Consequently, while at first we were almost desperate for samples, we ended up with 34 first-priority Area VII samples that we were unable to get tested. We want you to know we were pleased to share our quota with you. On the other hand, if we have appeared to be casual in our handling of your sample, please understand that with so many samples in process and people waiting for test results, we have had to resort to routine-handling on all samples wherever possible to avert excessive and chaotic bookkeeping problems.

I have enclosed three dossiers on test-work that has been done on Alaskan pozzolanic materials. Only Dossier No. 1 deals with test-work on the sample you sent to Mr. Magill in May 1964. The other dossiers deal with pozzolanic materials tested by U.S. Bureau of Reclamation on behalf of the U.S. Geological Survey in 1950, 1951, and 1952. Dossier No. 2 contains test and location data on rhyolite flow deposits at Polychrome Pass, McKinley National Park, and opposite the mouth of Wells Creek on the Nenana River. Dossier No. 3 contains test and related information on a pumice from Katmai

National Monument. From studying the data it appears that the deposit you sampled may be the same as that tested by Reclamation in Dossier No. 3. Moreover, it appears that Mr. Tom L. Pittman, Laboratory Services, Area VIII Mineral Resources, possibly may have some additional data in his files on this deposit, dating back to 1951, when the now defunct Metallurgical Division performed some chemical tests on the sample on behalf of the U.S.G.S.(?). Records in this dossier suggest that your office might actually have been the shipper of the two sacks of pumice that Reclamation tested.

Also attached are a set of ASTM Pozzolan-test specifications that the Bureau of Mines followed in its tests of sample P-18 in Dossier No. 1 and a set of pozzolan specifications and a set of test-methods that the U.S. Bureau of Reclamation used on the samples it tested in Dossiers No. 2 and No. 3. These may be useful in evaluating and comparing test results.

Our tests on sample No. P-18 (Dossier #1) indicate that this material is a good pozzolan, possibly an excellent one. All of the ASTM pozzolan tests, except the mortar-bar expansion test, exceed specifications. The low water requirement and low dry-shrinkage test results are very encouraging. The lime-pozzolan and portland cement-pozzolan compressive strength tests were good but not outsanding since it is desirable to have some strength leeway to accommodate dilution and other problems. However, one set of tests does not ordinarily reflect the optimum strength possibilities of the sample. Finer or coarser grinding possibly could improve the strength. The material is about average or better in its grinding characteristics as compared with other pumices. Grinding is a significant cost in the preparation of pozzolan; however, pumicites and pumices generally are among the most economical pozzolans to grind.

The mortar-bar expansion test is an optional ASTM requirement. Satisfactory fulfillment of this specification requirement would normally not be required, except in cases where reactive aggregates were to be used, and the difficulty was specified to be corrected by the pozzolan rather than by using a low-alkali cement, which is the most common solution. Reclamation requires only a 60% reduction minimum versus the 75% that ASTM requires. Alkali-reactive aggregates are in the minority and perhaps, 75% of those that are could be neutralized by P-18. In any event, very few pumices or pumicites meet the mortar-bar specifications of either Reclamation or ASTM, and sample P-18 is 49% better than ordinary portland cement in this respect.

If I can be of any further help to you regarding this sample, or on any other matter related to pozzolan, I would be glad to help.

David P. King

Report No. 71

POZZOLAN TESTS ON KUKAK BAY PUMICE
Katmai National Monument
Alaska

SOURCE: Area VIII Mineral Resource Office

SAMPLE NO.: P-13(Spokane)
C-2213(Magill's No.)
D-716(Denver USBM No.)

TESTED BY: Area VII - U. S. Bureau of Mines

Note: Only one sample, but referred to by various number designations, because it was processed by several different Labs, each of whom assigned its own number along the way.

DOSSIER #1

ALASKA USBM(MCGILL) C 2213 Ka

Mineral Resource Area VII

Sample No. P-18

Laboratory No. D-716

BUREAU OF MINES POZZOLANIC MATERIALS PROJECT
Denver Pozzolan Testing Laboratory

Results of physical tests on raw or calcined natural pozzolan for use as an admixture in portland cement concrete (ASTM Specifications C402-63T)

Test material Pumice

Source Alaska

Special instructions Do not calcine this material. Grind to required fineness only.

Mineral composition, percent		Chemical analysis, percent	ASTM specs.	Test mat'l.
Active: Volcanic glass	80-90			
n=1.490		$SiO_2+Al_2O_3+Fe_2O_3$	70.0 min.	
		MgO.....	5.0 max.	
		SO_3.....	3.0 max.	
Other: Feldspar	10-18	L.O.I.....	10.0 max.	
Ferromagnesian silicates	1	Moisture.....	3.0 max.	
Magnetite	<1			

Sample preparation: Calcining none °F for ____ hours in ____

Grinding 40 minutes with 12 x 14-inch laboratory ball mill

Physical Test Data	ASTM specs.	Test mat'l.
Specific gravity 2.46		
Fineness:		
Mean particle diameter.....microns	9.0 max.	4.4
Material retained on No. 325 sieve.....percent	12.0 max.	6.4
Pozzolanic activity index:		
Compressive strength with portland cement @ 28 days.....percent of control	75 min.	79
Compressive strength with lime @ 7 days.....psi	600 min.	999
Water requirement.....percent of control	115 max.	103
Change in drying shrinkage of mortar bars @ 28 days.....percent	0.03 max.	0.00
Soundness: Autoclave expansion or contraction....percent	0.50 max.	0.05
Reactivity with cement alkalies:		
Reduction of mortar expansion @ 14 days.....percent	75 min.	49

REC'D JUNEAU

MAY 1 1 1966

Div. Mines & Minerals

Does test material meet specifications? Yes, in all critical tests

Remarks or comments: ____

(Use other side if necessary)

Alaska USBM Mineral C 2213 Ra

Mineral Resource Area VII

Sample No. P-18

Laboratory No. D-716

BUREAU OF MINES POZZOLANIC MATERIALS PROJECT
Denver Pozzolan Testing Laboratory

Results of physical tests on raw or calcined natural pozzolan for use as an admixture in portland cement concrete (ASTM Specifications C402-63T)

Test material Pumice

Source Alaska

Special instructions Do not calcine this material. Grind to required fineness only.

Mineral composition, percent		Chemical analysis, percent	ASTM specs.	Test mat'l.
Active: Volcanic glass	80-90			
n=1.490		$SiO_2+Al_2O_3+Fe_2O_3$	70.0 min.	
		MgO.....	5.0 max.	
		SO_3.....	3.0 max.	
Other: Feldspar	10-18	L.O.I.....	10.0 max.	
Ferromagnesian silicates	1	Moisture.....	3.0 max.	
Magnetite	<1			

Sample preparation: Calcining none °F for ____ hours in ____

Grinding 40 minutes with 12 x 14-inch laboratory ball mill

Physical Test Data	ASTM specs.	Test mat'l.
Specific gravity 2.46		
Fineness:		
Mean particle diameter.....microns	9.0 max.	4.4
Material retained on No. 325 sieve.....percent	12.0 max.	6.4
Pozzolanic activity index:		
Compressive strength with portland cement @ 28 days.....percent of control	75 min.	79
Compressive strength with lime @ 7 days.....psi	600 min.	999
Water requirement.....percent of control	115 max.	103
Change in drying shrinkage of mortar bars @ 28 days.....percent	0.03 max.	0.00
Soundness: Autoclave expansion or contraction....percent	0.50 max.	0.05
Reactivity with cement alkalies:		
Reduction of mortar expansion @ 14 days.....percent	75 min.	49

Does test material meet specifications? Yes, in all critical tests.

Remarks or comments: * After June 1965 ASTM minimum is 700 psi

(Use other side if necessary)

AREA VII MINERAL RESOURCE OFFICE

REC'D. JUNEAU MAY 11 1966 Div. Mines & Minerals

SAMPLE NO. P-18

LABORATORY NO Magill's C-2213 Raw

STATE: ALASKA

TO: R. L. Bolmer, Physical Test Coordinator
FROM: Area VII Pozzolan Project Leader
SUBJECT: Physical Tests on Pozzolan sample

PETROGRAPHIC SUMMARY & TEST INSTRUCTIONS ON POTENTIAL POZZOLANIC MATERIAL

ROCK TYPE: Pumice (Raw, uncalcined-unprocessed) SOURCE: Kukak Bay Pumice, Katmai National Monument

PHYS. CHARACTERISTICS AS REC'D: a light gray to buff unconsolidated pumice sand to small pebble size

Mineral Composition		Percent
INACTIVE MINERALS		
feldspar		10-18
ferromagnesian silicates		1
magnetite		<1
	Total	<20
ACTIVE MINERALS	Calcination Temp. Range (°F.)	
volcanic glass	1000 - 1600	80-90
Type I Index 1.49		
	Total	≤ 80

Test Instructions

Total number of Tests: 1 Special Grinding: No

At fineness "A": Test Raw? Yes Test Calcined? No (1)____°F, (2)____°F, (3)____°F

At fineness "B": Test Raw?____ Test Calcined?____(1)____°F, (2)____°F, (3)____°F

Test goals: Area VIII sample. Test raw only and hold unused sample. May test calcined should raw test fail ASTM standards.

Potential Markets:

Advice Requested?:

Signed: David P Bruns Date: June 16, 1965

June 11, 1964

Dave -

I have just received some pumice samples from Magill in Seattle for submittal to Denver for pozzolan testing.

The samples are "high grade pumice" from Kukak Bay, Katmai National Monument, Alaska; however, I don't think they should be identified as such since Area VIII is not in the pozzolan project. They should be tested for activity, though.

The samples are as follows:

Sack No.	Calcined at +
1 & 1A	Raw
2	538° C
3	650° C
4	760° C
5	871° C

+ The material in sacks, 2 through 5, was held at the temperatures noted for two hours, and allowed to cool in the furnace overnight.

Possibly only the raw samples should be submitted. A petrographic examination was done at an earlier date. They also have been analyzed chemically.

SiO_2	68.9 percent
MgO	1.94
SO_3	.18
Ammonium hydroxide group	19.6
Fe_2O_3 (by fusion)	2.38
Fe_2O_3 (ASTM page 76)	.54
Al_2O_3	17.2

This submittal would be one, at least, from Area VII. (I notice Bishop is in a hurry for samples from here.) Let me know right away what your wishes are, how you want it submitted, etc. I suppose it could wait until your first group goes.

AREA VII
Mineral Resource
Office

Seattle Nonmetallics Laboratory
215 Roberts Hall
University Campus
Seattle, Washington 98105

June 8, 1964

Memorandum

To: Larry Brown, Supervisory Geologist, Petrographic Laboratory, Area VII, Albany, Oregon

From: Supervisory Physical Scientist, Seattle Nonmetallics Laboratory

Subject: Pozzolan Sample Seattle Nonmetallics Laboratory No. C-2213

Mailed under separate cover for forwarding on to Denver is the subject sample which we have previously discussed. Test work was started, but never completed, due to equipment limitations and uncertainty of which tests were going to be standard under the pozzolan project.

Five sacks constitute the sample and they contain the following:

Sack No.	Calcined at +
1 & 1A	Raw
2	538° C
3	650° C
4	760° C
5	871° C

+ The material in sacks, 2 through 5, was held at the temperatures noted for two hours, and allowed to cool in the furnace overnight.

A partial chemical analyses of the raw sample gave:

SiO_2	68.9 percent
MgO	1.94
SO_3	.18
Ammonium hydroxide group	19.6
Fe_2O_3 (by fusion)	2.38
Fe_2O_3 (ASTM page 76)	.54
Al_2O_3	17.2

E. A. Magill

cc: Mark L. Wright
H. H. Appling

ng a spoon. Compact the mortar in measure by rodding in three layers, g a ½-in. metal or glass rod, with each being rodded 15 times. Tap the xterior surface of the filled measure 10 o 15 times with a maple rod. The measure, the maple rod, and the spoon shall e as described in Section 2(b), (j), and k) of ASTM Method C 185, Test for Air Content of Hydraulic Cement Mortar.[4]

(e) In the case of masonry mortar, the water retention test shall be made in accordance with Sections 27, 28, and 29 of ASTM Specification C 91.

(f) The report of the tests shall include:

(1) Net weight of dry, combined material in the bag determined to 0.1 lb, by subtracting the weight of the empty bag from the gross weight of the package,

(2) Amount of mixing water (W) calculated in terms of pounds per bag based on printed weight of bag (Note 4),

(3) Flow, in accordance with ASTM Method C 109,

(4) Unit weight (U) in pounds per cubic foot in accordance with ASTM Method C 138 (Note 4),

(5) ... from the unit weight in terms of cubic feet per bag, based on printed weight of bag (Note 4),

(6) Air content, if required, may be determined by either of ASTM Methods C 138, C 173, or C 231, except that only Method C 173 is applicable to lightweight mortar. The method of test shall be reported,

(7) Water retention in per cent, in the case of masonry mortar, and

(8) Compressive strength at ages specified in Table 1.

Note 4—

$$W = R_w B$$

$$U = 0.156 W_m$$

$$Y = \frac{(1 + R_w)B}{U}$$

where:

R_w = ratio of weight of mixing water to weight of dry combined material in batch of mortar calculated to three decimal places,

B = the printed bag weight, and

W_m = weight in grams of mortar in the 400-ml measure.

LATEST PUBLISHED ASTM SPECIFICATION FOR POZZOLAN →

U.S. Bureau of Mines ... testing ... the sample you ... according to these specifications ...

3-24 X

Tentative Specifications for

RAW OR CALCINED NATURAL POZZOLANS FOR USE AS ADMIXTURES IN PORTLAND CEMENT CONCRETE

ASTM Designation: C 402 – 65 T

Issued, 1957; Revised, 1958, 1962, 1963, 1965.[1]

These Tentative Specifications have been approved by the sponsoring committee and accepted by the Society in accordance with established procedures, for use pending adoption as standard. Suggestions for revisions should be addressed to the Society at 1916 Race St., Philadelphia 3, Pa.

Scope

1. These specifications cover raw or calcined natural pozzolans for use as admixtures in portland cement concrete.

Note 1.—The user should recognize that replacement of a portion of the portland cement by pozzolan may reduce early strength of the concrete. Care should be exercised to insure strength adequate for the contemplated use of the concrete.

Note 2.—Pozzolan may tend to reduce the air content of concrete. Hence, if a pozzolan is added to any concrete for which entrainment of air is specified, provision should be made to assure use of sufficient air-entraining agent to entrain the specified amount of air.

Definition

2. Pozzolan is defined by the Definitions of Terms Relating to Hydraulic Cement (ASTM Designation: C 219)[3] as a siliceous or siliceous and aluminous material which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties (Note 3).

Note 3.—The natural pozzolans that may be employed as admixtures for portland cement concrete include such materials as some diatomaceous earths, opaline cherts and shales, tuffs, and volcanic ashes or pumicites, any of which may or may not be processed by calcination; and various materials requiring calcination to induce satisfactory properties, such as some clays and shales.

Chemical Requirements

3. The pozzolan shall conform to the chemical requirements prescribed in Table I.

TABLE I.—CHEMICAL REQUIREMENTS.

Silicon dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3), min, per cent	70.0
Magnesium oxide (MgO), max, per cent	5.0
Sulfur trioxide (SO_3), max, per cent	3.0
Loss on ignition, max, per cent	10.0
Moisture content, max, per cent	3.0

[1] Under the standardization procedure of the Society, these specifications are under the jurisdiction of the ASTM Committee C-9 on Concrete and Concrete Aggregates.

[2] Latest revision accepted by the Society at the Annual Meeting, June, 1965.

[3] *1965 Book of ASTM Standards*, Part 9.

TABLE II.—PHYSICAL REQUIREMENTS.

Fineness:	
Mean particle diameter, microns, max	9.0
[A]Amount retained when wet-sieved on No. 325 (44-micron) sieve, max, per cent	12.0
Pozzolanic activity index:[a]	
With portland cement, at 28 days, min, percentage of control	75
With lime, at 7 days, min, psi	800
Water requirement, max, percentage of control	115
Change of drying shrinkage of mortar bars at 28 days, max, per cent	0.03
Soundness:[b]	
Autoclave expansion or contraction, max, per cent	0.50
Amount of air-entraining admixture in concrete,[c] ratio to control, max	2.0[d]
Uniformity requirements:	
The specific gravity of individual samples shall not vary more than 15 per cent from the average established by the ten preceding samples, or by all preceding samples if the number is less than ten, by more than, per cent	5
In addition, when air entrainment is specified for the concrete, the quantity of air-entraining admixture required to produce an air content of 18.0 per cent by volume of mortar shall not vary from the average established by the ten preceding tests, or by all preceding tests if less than ten, by more than, per cent	20
Reactivity with cement alkalies:[e]	
Reduction of mortar expansion at 14 days, min, per cent	75
Mortar expansion at 14 days, max, per cent	0.020

[a] Neither the pozzolanic activity index with portland cement nor the pozzolanic activity index with lime is to be considered a measure of the compressive strength of concrete containing the pozzolan. The pozzolanic activity index with portland cement is determined by an accelerated test and is intended to evaluate the contribution to be expected from the pozzolan to the longer strength development of concrete. The weight of pozzolan specified for the test to determine the pozzolanic activity index with portland cement is not considered to be the proportion recommended for the concrete to be used in the work. The optimum amount of pozzolan for any specific project is determined by the required properties of the concrete and other constituents of the concrete and should be established by testing.

[b] The specimen shall remain firm and hard and show no signs of distortion, cracking, checking, pitting, or disintegration when subjected to the autoclave expansion test.

[c] Applicable only if air-entrained concrete is specified. Proper air entrainment is recommended for concrete that may be exposed to freezing and thawing. The user should recognize that some air-entraining admixtures may accelerate or retard setting of the cement and rate of hardening of the concrete; these possible effects should be considered carefully.

[d] If the specified limit is exceeded, the test mixture shall meet the requirements of the Specifications for Air-Entraining Admixtures for Concrete (ASTM Designation: C 260).[4]

[e] The indicated tests for reactivity with cement alkalies are optional and alternative requirements to be applied only at the purchaser's request. They need not be requested unless the pozzolan is to be used with aggregate that is regarded as deleteriously reactive with alkalies in cement. The test for reduction of mortar expansion may be made using any high alkali cement in accordance with Section 8 (*j*) if the portland cement to be used in the work is not known, or is not available at the time the pozzolan is tested. The test for mortar expansion is preferred over the test for reduction of mortar expansion if the portland cement to be used in the work is known and available. The test for mortar expansion should be performed with each of the cements to be used in the work.

Physical Requirements

4. The pozzolan shall conform to the physical requirements prescribed in Table II.

Packaging and Marking

5. When the pozzolan is delivered in packages, the words "pozzolan for use as an admixture in portland cement concrete," the name of the producer and the brand, and the weight of the pozzolan contained therein shall be marked plainly on each package. Similar information shall be provided in the shipping invoices accompanying the shipment of packaged or bulk pozzolans.

[4] Appears in this publication.

Storage and Inspection

6. The pozzolan shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment. Every facility shall be provided the purchaser for careful sampling and inspection, either at the source or at the site of the work, as may be specified by the purchaser.

Rejection

7. (*a*) The pozzolan may be rejected if it fails to meet any of the requirements of these specifications.

(*b*) Packages varying more than 5 per cent from the stated weight may be rejected. If the average weight of the packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

Methods of Sampling and Testing

8. The pozzolan shall be sampled and the properties enumerated in these specifications shall be determined in accordance with the requirements of the Methods of Sampling and Testing Fly Ash for Use as an Admixture in Portland Cement Concrete (ASTM Designation: C 311),[4] except as indicated in Paragraphs (*a*) through (*k*). The natural pozzolan shall be used in lieu of fly ash in applicable tests under Method C 311.

(*a*) *Chemical Analysis for Combined Amounts of Silicon Dioxide (SiO_2), Aluminum Oxide (Al_2O_3), and Iron Oxide (Fe_2O_3).*—Determine the silicon dioxide (SiO_2) in accordance with Section 12 of Methods C 311. Treat the filtrate reserved from the silicon dioxide determination in accordance with Section 9(*a*), (*b*), (*c*), (*f*), and (*g*) of the Methods of Chemical Analysis of Portland Cement (ASTM Designation: C 114 - 63).[3] Reserve the combined filtrate for the determination of magnesium oxide (MgO). Calculate the combined percentage of silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), and iron oxide (Fe_2O_3) by adding the percentage of SiO_2 determined in accordance with Section 12 of Methods C 311 to the percentage of ammonium hydroxide group determined in accordance with Section 9(*g*) of Methods C 114 - 63. Report the result to the nearest 0.1.

Determine the combined percentage of SiO_2, Al_2O_3, and Fe_2O_3 on composite samples representing each 1000 tons of pozzolan to be used in the work. When the total number of tons sampled is less than 1000, make the determination on the quantity sampled.

(*b*) *Mean Particle Diameter.*—Determine the fineness of the pozzolan in accordance with the Method of Test for Fineness of Portland Cement by Air Permeability Apparatus (ASTM Designation: C 204),[3] except that the determined value for specific gravity shall be used in calculating the weight of the sample. Use the following equation to calculate the mean particle diameter of the pozzolan:

$$d = \frac{60000(1-e)\sqrt{\eta}\sqrt{e_s^3}\sqrt{T_s}}{\sqrt{e^3}\sqrt{T}\,S_s\rho_s(1-e_s)\sqrt{\eta_s}}$$

where:

- d = mean particle diameter of the test sample, in microns,
- e = porosity of prepared bed of the test sample (Note 4),
- e_s = porosity of prepared bed of standard sample used in calibration of apparatus (Note 4),
- η = viscosity of air in poises at the temperature of test of the test sample (Note 4),
- η_s = viscosity of air in poises at the temperature of test of the standard sample used in calibration of the apparatus (Note 4),
- T = measured time interval, in seconds, of manometer drop for test sample (Note 4),
- T_s = measured time interval, in seconds, of manometer drop for the stand-

ard sample used in calibration of the apparatus (Note 4),

S_s = specific surface in sq cm per g of the standard sample used in calibration of the apparatus, and

ρ_s = specific gravity of the standard sample used in calibration of the apparatus.

NOTE 4.—Values for $\sqrt{n}$, $\sqrt{n_s}$, $\sqrt{e}$, $\sqrt{e_s}$, $\sqrt{T}$, and $\sqrt{T_s}$ may be taken from Tables I, II, and III of Method C 204.

(*c*) *Amount Retained When Wet-Sieved on No. 325 (44-μ) Sieve.*—Determine the amount of the pozzolan retained when wet-sieved on No. 325 (44-μ) sieve in accordance with the Method of Test for Fineness of Hydraulic Cement by the No. 325 Sieve (ASTM Designation: C 430),[2] except that a representative sample of the pozzolan shall be used in lieu of hydraulic cement in the determination.

(*d*) *Pozzolanic Activity Index with Portland Cement:*

(*1*) *Specimens.*—Mold the specimens from a control mix and from a test mix in accordance with the Method of Test for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens) (ASTM Designation: C 109).[3] The portland cement used in the control mix shall meet the requirements of the Specifications for Portland Cement (ASTM Designation: C 150)[4] and shall be the type and, if available, the brand of cement to be used in the work. In the text mix 35 per cent of the absolute volume of the amount of cement used in the control mix shall be replaced by an equal absolute volume of the pozzolan. Make three-cube batches as follows:

Control Mix:

250 g portland cement
687.5 g graded Ottawa sand
X ml water required for flow of 100 to 115

Test Mix:

162.5 g portland cement

$$\frac{87.5 \times \text{sp. gr. of the pozzolan}}{\text{sp. gr. of the portland cement}} \text{ g of pozzolan}$$

687.5 g graded Ottawa sand
Y ml water required for flow of 100 to 115

(*2*) *Storage of Specimens.*—After molding, keep all of the specimens in the molds on the base plates and place immediately in a moist closet or moist room at 73.4 ± 3 F for from 20 to 24 hr with their upper surfaces exposed to moist air but protected from dripping water. Remove all specimens from the molds 20 to 24 hr after molding, and place in close-fitting metal or glass containers (Note 5), seal the containers airtight, and store at 100 ± 3 F for 27 days. Allow the specimens to cool to 73.4 ± 3 F before testing.

NOTE 5.—Any metal container having a capacity of three cubes may be used if it can be sealed airtight by soldering. Containers of light tinned sheet metal with inside dimensions 2½ by 2½ by 6½ in. have been found to be satisfactory. Wide-mouth Mason jars of 1-qt capacity have been found to be satisfactory, provided care is taken to prevent breakage.

(*3*) *Test Age.*—Test the three specimens of the control mix and the three specimens of the test mix at an age of 28 days.

(*4*) *Calculation.*—Calculate the pozzolanic activity index with portland cement as follows:

Pozzolanic activity index with portland cement $= \frac{A}{B} \times 100$

where:

A = average compressive strength of test mix cubes, in pounds per square inch, and

B = average compressive strength of control mix cubes, in pounds per square inch.

(*5*) *Number of Tests.*—Determine the pozzolanic activity index with portland cement on composite samples representing each 100 tons of pozzolan to be used in the work. When the total number of tons sampled is less than 100, make the determination on the quantity sampled.

POZZOLANS FOR USE AS ADMIXTURES IN CONCRETE (C 402)

(*e*) *Pozzolanic Activity Index with Lime.*—Determine the pozzolanic activity index with lime in accordance with Section 12(*n*) of the Specifications for Portland-Pozzolan Cement (ASTM Designation: C 340).[4] Designate the average compressive strength of the specimens calculated in accordance with Section 12(*n*), Item (*5*) of Specifications C 340 as the pozzolanic activity index with lime.

Determine the pozzolanic activity index with lime on composite samples representing each 1000 tons of pozzolan to be used in the work. When the total number of tons sampled is less than 1000, make the determination on the quantity sampled.

(*f*) *Water Requirement.*—Calculate the water requirement from the values for X and Y determined in accordance with Paragraph (*d*), Item (*1*), as follows:

Water requirement, percentage of control $= \frac{Y}{X} \times 100$

where:

Y = milliliters of water required for flow of 100 to 115 in the test mix, and

X = milliliters of water required for flow of 100 to 115 in the control mix.

(*g*) *Change of Drying Shrinkage of Mortar Bars.*—Determine the drying shrinkage of mortar bars in accordance with Sections 23, 24, and 25 of Methods C 311,[4] except that three mortar bars shall be molded from both the control mix and the test mix specified in Section 19 (*b*) of Methods C 311. If available, the cement to be used in the work shall be used in this determination.

For purposes of these specifications, calculate the change of drying shrin of mortar bars as follows:

Change of drying shrinkage of mortar bars, per cent = S_t

where:

S_t = average drying shrinkage of test specimens calculated in cordance with Section 25 (*a* Methods C 311, and

S_s = average drying shrinkage of control specimens calculate accordance with Section 25 (*a* Methods C 311.

Report the result to the nearest If the average drying shrinkage of control specimens is larger than the erage drying shrinkage of the test s mens, prefix a minus sign to the chan drying shrinkage of mortar bars repo

(*h*) *Amount of Air-Entraining mixture in Concrete.*—Determine amount of air-entraining admixtur concrete in accordance with Sectio of Methods C 311 on composite sam representing each 1000 tons of pozz to be used in the work. When the t number of tons sampled is less than 1 make the determination on the quan sampled.

(*i*) *Uniformity Requirements (Qua of Air-Entraining Admixture).*—To tablish conformance with the uniform requirements if air entrainment is sp fied, determine the quantity of entraining admixture required to prod an air content of 18.0 per cent by vol in mortar in accordance with the requ ments of the Method of Test for Air C tent of Hydraulic Cement Mo (ASTM Designation: C 185),[3] ex that the mortar shall contain a quan of the pozzolan under test equivalen 25 per cent by weight of the cem instead of an equal weight of the sta ard sand.

(*j*) *Reactivity with Cement Alka (Reduction of Mortar Expansion*

Determine the reduction of mortar expansion in accordance with the Method of Test for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction (ASTM Designation: C 441).[4] The cement shall conform to the requirements of the Specifications for Portland Cement (ASTM Designation: C 150)[4] for type I cement and shall contain at least 1.0 per cent total alkalies calculated as sodium oxide (percentage sodium oxide (Na_2O) + 0.658 per cent potassium oxide (K_2O)) (Note 6). Prepare two types of specimens, as follows:

(*l*) *Control Specimens.*—Prepare the control specimens in accordance with Method C 227, except that the mix shall comprise 400 g of portland cement, 900 g of aggregate composed of crushed No. 7740 Pyrex graded in accordance with Section 4 of Method C 227, and 180 ml of water.

(*2*) *Test Specimens.*—Prepare the test specimens in accordance with Method C 227, except that the mix shall comprise 300 g of the portland cement used in preparation of the control specimens (Item (*l*)), 900 g of the crushed and graded Pyrex, and a quantity of pozzolan equal in absolute volume to the absolute volume of 100 g of the portland cement used, and $180 + \frac{4}{5}(Y - X)$ ml of water (Note 7). The flow test need not be performed on either mix. Mold three specimens from each mix. Make an initial reading of length at an age of 24 ± 2 hr, and a final reading at an age of 14 days. Calculate the reduction of mortar expansion, as follows:

$$R_e = \frac{(E_c - E_t) \times 100}{E_c}$$

where:

R_e = reduction of mortar expansion, in per cent,
E_t = average expansion of bars from the test mix, and
E_c = average expansion of bars from the control mix.

NOTE 6.—If a cement of the indicated alkali content is not available, any cement meeting the requirements of Specifications C 150 for type I cement may be used, provided the average expansion of the control specimens in the test for reduction of mortar expansion is equal to or greater than 0.100 per cent at 14 days.

NOTE 7.—For definitions of X and Y, see Paragraph (*d*), Item (1). The factor $(Y - X)$ may be either positive or negative.

(*k*) *Reactivity with Cement Alkalies (Mortar Expansion).*—Determine the mortar expansion in accordance with the requirements of Method C 441 for the job mixture (see especially Sections 4(*c*) and 9(*b*) of Method C 441). Calculate the mortar expansion as the average linear expansion of the three specimens of the test mix and express in per cent, assuming an effective length of 10.00 in. for each specimen.

Tentative Method of Test for
TIME OF SETTING OF CONCRETE MIXTURES BY PENETRATION RESISTANCE[1]

ASTM Designation: C 403 – 65 T

ISSUED, 1957; REVISED, 1961, 1962, 1963, 1965.[2]

This Tentative Method has been approved by the sponsoring committee and accepted by the Society in accordance with established procedures, for use pending adoption as standard. Suggestions for revisions should be addressed to the Society at 1916 Race St., Philadelphia 3, Pa.

Scope

1. (*a*) This method provides a procedure for determining the time of setting of concrete with slump greater than zero by testing mortar sieved from the concrete mixture. The method is suitable for use only when tests of the mortar fraction of the concrete will provide the information required. Since the hardening of concrete is a gradual process, any definition of time of setting must necessarily be arbitrary. The temperature of storage of specimens employed in this test is to be selected by the user. Times of initial and final setting of concrete are determined in accordance with this method on the basis of a rate of hardening test made by means of penetration resistance needles on mortar sieved from the concrete mixture.

(*b*) The method can also be used for determining the effects of variables such as temperature, cement, mixture proportions, additions, and admixt upon the time of setting and harde characteristics of concrete. It may be used as a part of performance s fications to determine compliance specified time of setting requireme

Definitions

2. (*a*) *Time of Initial Setting.*— elapsed time, after initial contact cement and water, required for mortar sieved from the concrete reach a penetration resistance of psi.

(*b*) *Time of Final Setting.*— elapsed time, after initial contact cement and water, required for mortar sieved from the concrete reach a penetration resistance of psi.

Apparatus

3. (*a*) *Containers for Mortar Specimens.*—Rigid, watertight, nonabsorp nonoiled containers, either cylindric rectangular in cross section. The m mum lateral dimension shall be 6 in. the height at least 6 in. (Note 1).

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee C-9 on Concrete and Concrete Aggregates.

[2] Latest revision accepted by the Society at the Annual Meeting, June, 1965.