NATIONAL BUREAU OF STANDARDS REPORT

6269

QUARTERLY REPORT

ON

EVALUATION OF REFRACTORY QUALITIES OF CONCRETES FOR JET AIRCRAFT WARM UP, POWER CHECK, MAINTENANCE APRONS, AND RUNWAYS

by

W. L. Pendergast, E. C. Tuma, L. E. Mong

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS PROJECT		NBS REPORT
0903-20-4428	January 12, 1959	6269

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Sponsored by

Department of the Navy
Bureau of Yards and Docks

Reference: NT4-59/NY 420 008-1
NBS File No. 9.3/1134-C

Approved:
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QUARTERLY REPORT ON EVALUATION OF REFRACTORY QUALITIES OF CONCRETES FOR JET AIRCRAFT WARM UP, POWER CHECK, MAINTENANCE APRONS, AND RUNWAYS

1. INTRODUCTION

This phase of the project includes the determination of the cause or causes of failure that occur in concrete aprons and runways exposed to jet exhaust gases. A combustion chamber that delivers hot gases at velocities and temperatures approximating those of field conditions is being used. The approach includes instrumentation of the concrete test panels to determine the heat gradients and stresses set up during flame impingement at several locations on the test area and at varying depths below the surface.

2. ACTIVITIES

2.1 X-ray Examination of Neat Cements

X-ray examinations of three samples of Alcoa cement, after curing and exposure to a heating cycle of the bomb test, without mercury, drying at 100 and 200°C were made. The compounds, identified were the same as those appearing in N.B.S. Report 5736, Table II which were found in samples similarly treated except that those referred to in the table were exposed to the mercury used to transmit the pressure during the bomb test. The mercury is considered to be without effect on the compounds formed. Portland and Lummite cement after heating under pressure to approximately 300°C and further heating at atmospheric pressure to 800°C are being examined.

2.2 Water in Concrete During Curing and Drying

The drying, at 35% relative humidity and 77°F, of the concrete tile, 3 X 3 inches and 4 inches in depth, described in the N.B.S. Report 5855 has been continued. The correlation of the relative humidity in the mid-cavity with the water loss for the whole tile continues to be a straight line relation. The relative humidity in the cavity nearest the exposed surface of each of the five tiles is now approximately that of the humidity cabinet. The relative humidity of the mid-cavity varies among the five tiles from 46 to 48%. At the bottom cavity, the humidity ranges from 40 to 43%.

The tiles have lost from 5.0 to 5.8% in weight. Assuming this to be water, they have lost one-third of the mixing water during the year since these tests were started.

2.3 Blast Furnace Slag

In response to the request of the National Slag Association, the Bureau agreed to add blast-furnace slag to the list of aggregates included in the project. One ton of this material that was sized according to our instructions has been received. Preliminary examination has been completed on this "cold-pit" blast furnace slag. The following results were obtained.

TABLE I

Screen Analysis of Slag Aggregate

Coarse		Fine	
Sieve Size	% Passing	Sieve Size	% Passing
1 1/2	100	No. 4	100
1	78	" 8	86
3/4	48	" 16	65
1/2	30	" 30	34
3/8	15	" 50	10
No. 4	0	" 100	9

The following properties were determined on the fractions given in Table I.

		Coarse	Fine
Bulk Specific Gravity		2.19	2.73
Absorption (S-SD)		5.60	3.66
Unit Weight, lbs./ft^3	Rodded	73.19	92.44
	Jigged	73.13	95.13

The loss during the Los Angeles Abrasion Test was 34.48%.

Trial batches of concrete were mixed, specimens fabricated, cured, and the flexural strength determined. These batches were designed using the aforementioned data and information furnished by the Youngstown Laboratories of the National Slag Association. Detailed information on the properties of four fresh concretes, together with flexural strength are shown in Table II.

TABLE II, Properties of Fresh Concrete

Laboratory Identification 1/	Combined Fineness Modulus	Proportion by weight, of cement to fine to coarse	Cement Content	Vinsol Resin by weight of Cement	Water Content	W/C Ratio	Air Content 2/	Slump	Remarks on Fresh Concrete	Flexural Strength 3/	Fracture
			sacks/yd^3 of concrete	%	gal/yd^3 of concrete		%	in.		lb/in^2	
P-BF-1	5.36	1:1.59:1.59	7.91	0.01	5.40	0.48	4.25	2.75	good placeability	620	aggregate fracture pull-outs
P-BF-2	5.58	1:1.43:1.75	8.08	do	5.12	0.45	2.45	1.75	do	670	aggregate fracture few pull-outs
P-BF-3	5.80	1:1.36:2.04	7.69	do	5.11	0.45	2.57	none	Harsh but placeable; vibrated	765	mostly aggregate fracture
P-BF-4	6.03	1:1.27:2.37	7.26	do	5.12	0.45	2.82	do	Very harsch but placeable vibrated	685	aggregate fracture

1/ The first letter P = Portland, type III; the second letter BF = blast furnace aggregate; the numbers denote variation in design.

2/ Gravimetric method. 3/ Since type III Portland cement was used the flexural strength was determined after 7 days fog-room curving.

2.4 Examination of Aggregates

Three rock samples were submitted for examination by your laboratory at Port Hueneme, California. The samples (1) Napa Basalt (2) Juarez Basalt (3) Napa Quarry where submitted to determine which of the three deposits might be best for use as an aggregate in concrete designed to withstand jet exhaust gases. The results of the tests completed follows. For comparative purposes the results determined on a Virginia diabase is included in the Table.

TABLE III, Properties of Rock Samples

	Napa Basalt	Virginia Diabase	Juarez Basalt	Napa Quarry
Bulk Specific Gravity 1/	2.81	2.96	2.65	2.43
Absorption 1/	0.43	0.6	0.34	3.6
Los Angeles Abrasion 2/	15.3	15.3	16.0	31.6
Results of exposure to 3/ jet blast	Poor	Good	Good	Fair

1/ Due to the size of the samples submitted determination of Bulk Specific Gravity and Absorption were made on coarse fraction only (+ No. 4).

2/ The sample was 2500 grams instead of the 5000 grams specified in the test.

3/ Samples were (-1 +3/4 inches) retained in a steel wire basket. They were exposed to a jet blast at 1200 ft/sec at 1200°F for a period of five minutes.

In all three rocks, plagioclase was dispersed in a matrix. The matrix was crystalline feldspar and pyroxene except for Juarez Basalt which had a glassy matrix. Distinctions in mineralogical composition are given in the following results from petrographic examinations.

Sample 1

Napa Basalt. Figure 1, coarser grained than Sample 2, entirely crystalline, irregular fracture with rough surface.

Sample 2

Juarez Basalt. Figure 2, fine grained feldspar and pyroxene in a glassy matrix, no quartz, with irregular fracture, but conchoidal over small areas.

Sample 3

Napa Quarry. Figure 3, weathered porous basalt, irregular in fracture, may contain secondary quartz.

2.5 Miscellaneous

Data, from the work thus far completed in the project, is being tabulated and studied for a publication.

Figure 1. Photomicrograph of Napa Basalt (300x) (Crossed Nicols). Showing zoned Plagioclase in Matrix of Feldspar (F), Olivine or Pyroxene (O) and Magnetite Crystals.

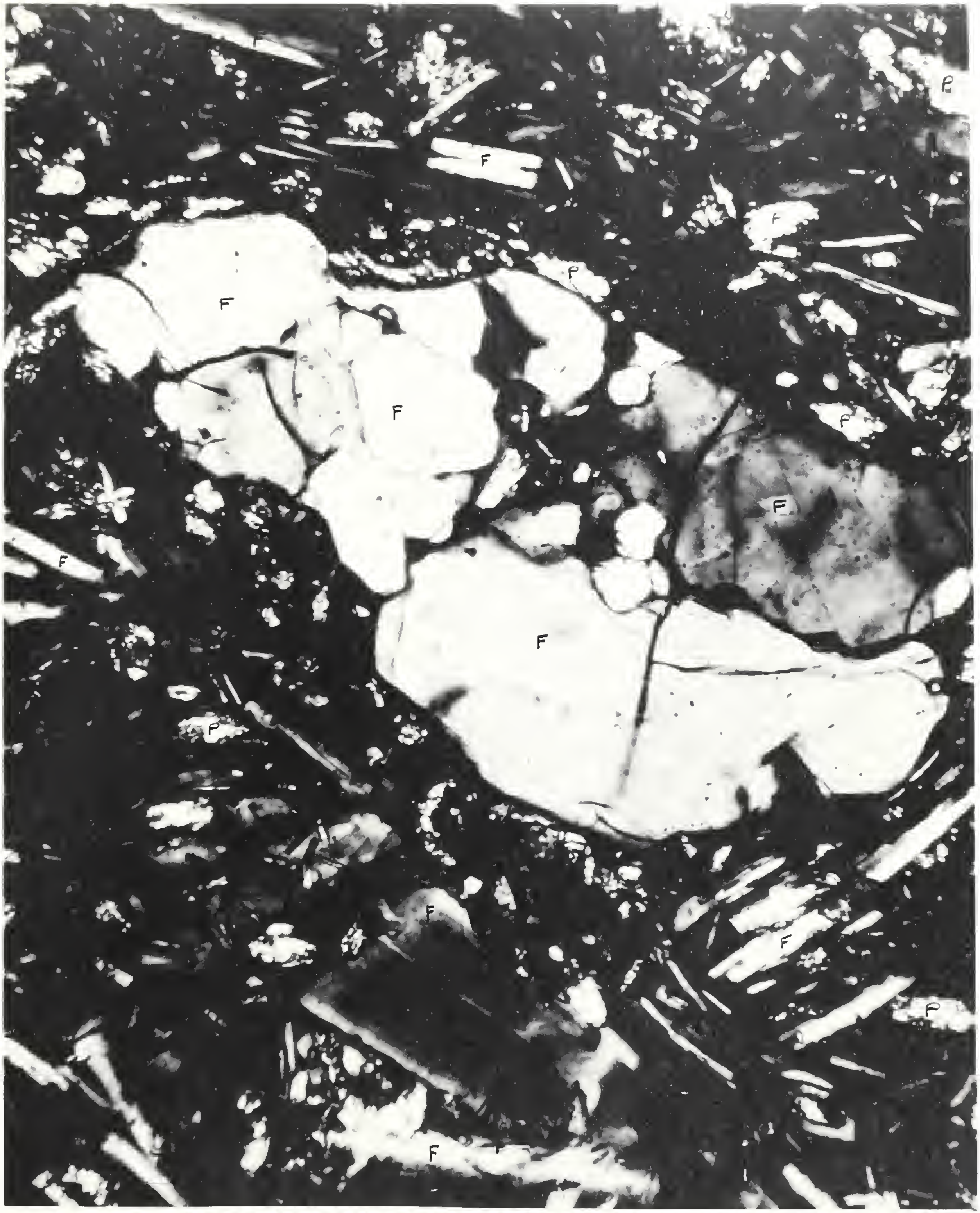

Figure 2. Photomicrograph of Juarez Basalt (300x) (Crossed Nicols). Rock consists of Plagioclase, Feldspar (F) and Pyroxene crystals (P) in a matrix of glass (dark areas). Occasional large zoned Feldspars and large Pyroxene crystals with inclined extinction. No Quartz observed.

Figure 3. Photomicrograph of Napa Quarry (300x) (Crossed Nicols). Showing zoned Plagioclase Feldspar crystals (F) in a matrix of fine feldspars and pyroxene (F & P). Secondary quartz may be present. Rock in hand specimen appears porous and altered.

U. S. DEPARTMENT OF COMMERCE
Lewis L. Strauss, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D. C., and its major laboratories in Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside front cover.

WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Anolog Systems. Application Engineering.

- Office of Basic Instrumentation.
- Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research. Ionospheric Communication Systems.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering. Radio-Meteorology.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.