# NATIONAL BUREAU OF STANDARDS REPORT

8118

Quarterly Report
on

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

by

J. V. Ryan and E. C. Tuma


U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
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# THE NATIONAL BUREAU OF STANDARDS

## Functions and Activities

The functions of the National Bureau of Standards include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications, including assistance to industry, business and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

## Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Central Radio Propagation Laboratory Ionospheric Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also seven series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, Technical Notes, Commercial Standards, and Simplified Practice Recommendations.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

# NATIONAL BUREAU OF STANDARDS REPORT

| NBS PROJECT | | NBS REPORT |
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of
CONCRETES FOR JET AIRCRAFT WARM-UP, POWER CHECK
MAINTENANCE APRONS, AND RUNWAYS

by

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Fire Research Section
Building Research Division

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## 1. Introduction

The purpose of this project is the development of criteria for the fabrication of jet exhaust resistant concretes. Concretes under development are evaluated by exposure to hot gases from a combustion chamber. The combustion chamber delivers these gases at velocities and temperatures approaching field conditions.

## 2. Present Plan of the Investigation

In an attempt to gain more understanding of the mechanism of spalling and of the factors that determine whether or not a given concrete spalls under jet impingement, specimen sizes were chosen to provide different degrees of restraint to thermal stresses and to the escape of steam from within the concrete. The instrumentation was designed to provide data on pressures and temperatures, including temperature gradients in the 1/2 in. nearest the exposed surface. In addition, electrical resistnace elements were embedded in some specimens to provide an indication of their drying. It was decided to keep some specimens in the fog room throughout their conditioning, to condition others in air at 73°F and 50% relative humidity, and to attempt to dry others thoroughly.

## 3. Activities

The specimens of blast furnace slag aggregate concrete were conditioned throughout the quarter, and observations were made of changes that occurred in the specimens.

A set of specimens in the same sizes, shapes, instrumentation, and approximate numbers as those of Di-2 and BF-2, were prepared from a concrete made with Volcanite, a lightweight aggregate from Hawaii.

The study of the feasibility of accelerated drying by conditioning in atmospheres at reduced pressures was continued.

### 3.1 Blast-Furnace Aggregate Specimens

The blast-furnace slag aggregate concrete specimens were conditioned throughout the quarter. Although the data taken on electrical resistance had indicated that the rate of moisture loss has dropped appreciably, there has been a continued change in resistance.

### 3.2 Volcanite

A shipment was received consisting of several bags of a lightweight aggregate called Volcanite plus several precast elements made of concrete containing this aggregate. The elements were of various shapes and sizes, most of which were not suitable for jet impingement tests. Three blocks, without reinforcement, were placed in 73 F 50% rh for eventual jet impingement test.

The aggregate was used in a batch of concrete, V-1, from which were cast specimens similar to those of Di-2 and BF-2, described in earlier reports, both as to sizes and instrumentation. A total of 52 specimens were cast and are being conditioned.

### 3.3 Vacuum Drying

The diabase aggregate concrete specimens (Di-3) kept at pressures near or below the vapor pressure of water (21 mm Hg at 73 F), reached electrical resistances of the same order of magnitude as those of similar specimens dried in an oven at 105 C and atmospheric pressure. Subsequent measurements indicated that the moisture content of the vacuum-dried specimens was higher than that of oven-dried specimens, but lower than that of specimens, from the same batch and of the same age, conditioned at 73 F, 50 rh, and atmospheric pressure.

The specimens dried at low pressure, and those from the same batch dried at 73 F 50 rh, were tested for flexural and compressive strength; moisture contents were measured for samples from the broken specimens. These data, and net weight loss during conditioning, are summarized in Table 1. The strength data indicate that the long period at very low pressure did not affect the strength of the concrete appreciably.

Following the removal of the Di-3 specimens from the vacuum chamber, specimens of blast furnace slag and of volcanite aggregate concretes (BF-2 and V-1) were put in. They are being subjected to the same low pressure as the Di-3 specimens.

Table 1. Effects of conditioning at vacuum (approx. vapor pressure of water) vs. air drying at one atmosphere.

| | Conditioning | |
|---|---|---|
| | Air Drying | Low Pressure |
| Modulus of rupture, psi | 925 | 850 |
| Compressive strength, psi | 9255 | 10360 |
| Weight loss during, percent | 1.97 | 3.92 |
| Moisture content after, percent | 2.97 | 1.31 |

# THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, 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 of the front cover.

## WASHINGTON, D. C.

**Electricity.** Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

**Metrology.** Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

**Heat.** Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

**Radiation Physics.** X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

**Analytical and Inorganic Chemistry.** Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

**Mechanics.** Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

**Polymers.** Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

**Metallurgy.** Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

**Inorganic Solids.** Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

**Building Research.** Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

**Applied Mathematics.** Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

**Data Processing Systems.** Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

**Atomic Physics.** Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

**Instrumentation.** Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

**Physical Chemistry.** Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

**Office of Weights and Measures.**

## BOULDER, COLO.

### CRYOGENIC ENGINEERING LABORATORY

Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

### CENTRAL RADIO PROPAGATION LABORATORY

**Ionosphere Research and Propagation.** Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

**Tropospheric and Space Telecommunications.** Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

**Radio Systems.** Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

**Upper Atmosphere and Space Physics.** Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

### RADIO STANDARDS LABORATORY

**Radio Standards Physics.** Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

**Radio Standards Engineering.** High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

**Joint Institute for Laboratory Astrophysics - NBS Group (Univ. of Colo.).**

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