NATIONAL BUREAU OF STANDARDS REPORT

8041

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

THE NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS 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 resistance 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 diabase aggregate concrete (Di-2) cast late in December, 1962 were subjected to jet impingement; companion specimens were tested for shear, flexural, and compressive strengths, and for moisture content.

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

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

3.1 Diabase Aggregate Specimens

The diabase aggregate concrete specimens included cylindrical specimens for jet impingement tests, and various prisms for strength tests, dimensional changes, and moisture content.

The jet impingement specimens were cast in three diameters, (12, 6, 3 in), two thicknesses (6 and 2 in.), and were conditioned according to three schedules. The first schedule consisted of keeping the specimens in a room at 73°F and 100 percent relative humidity, the fog room, until they were tested. The second schedule consisted of keeping specimens in the fog room for 28 days after which they were stored in an atmosphere at temperature of 73°F and relative humidity of 50 percent until tested. The third schedule consisted of keeping specimens in the fog room until they were about the same age as those in the second schedule and then drying them to constant weight at 105°C. The prism specimens for strength tests and moisture content determinations were conditioned according to the same schedules.

The results of the tests are given in Tables 1 and 2. Evaluation of these data, both as to spalled volume and as to peak pressure, showed that reduction of diameter and of thickness each resulted in decreased effect of the jet impingement on the exposed surface of the concrete. Also, the shift from fog room, to 50 percent relative humidity, to oven drying lead to marked reduction in spalling and pressure. None of the specimens oven dried at 105°C showed visible spalling.

3.2 Blast-furnace Aggregate Specimens

The specimens of blast-furnace slag aggregate concrete were conditioned throughout the quarter, following the conditioning schedules described in the preceeding section. The plot of data obtained is similar to that of figure 1 in NBS Report 7878 for the last quarter, indicating that the specimens are nearly ready to be tested.

3.3 Vacuum Drying

The results obtained to date are only for diabase aggregate concretes kept in the fog room a minimum of 28 days to allow development of strength and then conditioned at reduced pressures in an attempt to accelerate the elimination of excess moisture. As reported for the previous quarter, those specimens kept at about 0.5 atmosphere for 28 days after the fog room showed greater moisture content than duplicates kept at 1 atmosphere in 73°F/50 percent relative humidity. The second set of specimens have been kept at pressures near or below the vapor pressure of water (21 mm Hg at 73°F) for much longer time. On the basis of electrical conductivity measurements, no appreciable change was observed during the first 28 days at reduced pressure. This is despite the fact that several fluid ounces of water were removed from a trap in the vacuum system daily. Comparison with conductivity data from Di-2 specimens conditioned at 73°F/50 rh indicated the latter were drying faster for about 70 days. However, beyond that time, the specimens in reduced pressure have been at much lower (factor of 4) conductivities than attained by specimens at 73°F/50 rh in comparable times. They have not attained conductivities as low (by a factor of about 100) as attained by oven drying.

Table 1. Data Summary for Di-2 Concrete Specimens

The data are presented to show first the effect of diameter and then that of thickness

Specimen Size	Oven Dried				73°F/50% RH				Fog Room			
	Spall Volume		Peak Pressure		Spall Volume		Peak Pressure		Spall Volume		Peak Pressure	
	Avg cc	Max cc	Avg psi	Max psi	Avg cc	Max cc	Avg psi	Max psi	Avg cc	Max cc	Avg psi	Max psi
Arranged by diameter												
12 x 6	0	0	70	95	130	190	260	440	250	270	180	200
6 x 6	-	-	-	-	70	100	70	100	-	-	-	-
3 x 6	-	-	-	-	<10	<10	25	35	-	-	-	-
12 x 2	0	0	200	350	a/	90	220a/	350	110	140	260	360
3 x 2	0	0	0	0	0	0	55b/	55	<10	<10	70	100
Arranged by thickness												
12 x 6	0	0	70	95	130	190	260	440	250	270	180	200
12 x 2	0	0	200	350	a/	90	220a/	350	110	140	260	360
3 x 6	-	-	-	-	<10	<10	25	35	-	-	-	-
3 x 2	0	0	0	0	0	0	55b/	55	<10	<10	70	100

a/ Only 1 of 3 spalled; avg. pressure for 2 that did not spall.

b/ Only 2 of 3 showed pressure, average for those 2.

Table 2. Supplementary Data on Di-2

	Oven Dried		73/50		Fog Room	
	Avg	Max	Avg	Max	Avg	Max
Modulus of Rupture, Psi	795	890	795	895	830	920
Shear Strength, Psi	4380	4560	3680	3850	3670	4150
Compressive Strength, Psi	12700	13400	10500	11400	10900	11600
Moisture Content, %	-	-	3.03	3.27	5.33	5.73

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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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