~~DEP~~

10.0

NATIONAL BUREAU OF STANDARDS REPORT

7065

REPORT ON THE SOILING CHARACTERISTICS OF STRUCTURAL MASONRY UNITS

by

William C. Cullen

and

William W. Walton

Not for publication or
for reference.

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These 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. 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 work take the form of either actual equipment and devices or published papers. These papers appear 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 Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($1.50), available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT | **NBS REPORT**

1000-20-10401 | 16 January 1961 | 7065

For government use only.

REPORT ON THE SOILING CHARACTERISTICS OF STRUCTURAL MASONRY UNITS

by

William C. Cullen
and
William W. Walton

Organic Building Materials Section
Building Research Division

Not for publication or
for reference.

Sponsored by

Office of the Chief of Engineers
Department of the Air Force
Bureau of Yards and Docks

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

REPORT ON THE SOILING CHARACTERISTICS OF STRUCTURAL MASONRY UNITS

1. INTRODUCTION

In response to a request of the Office of Civil Engineering, U. S. Air Force; the Office of the Chief of Engineers, U. S. Army; and the Bureau of Yards and Docks, U. S. Navy, a study was initiated to determine the soiling and cleaning characteristics of Spectra-Glaze structural masonry units, as currently being produced by manufacturers licensed by the Burns and Russell Company, Baltimore, Maryland. This study was conducted as part of the Tri-Service Engineering Investigations of Building Construction and Equipment at the National Bureau of Standards.

Inspections of a number of installations of the older types of Spectra-Glaze units by representatives of the sponsoring agencies indicated that the material was not entirely satisfactory in regard to its soiling and cleaning characteristics. Recently, the manufacturers reported that the soiling and cleaning properties of their current product have been improved, due to a treatment of one of the essential ingredients used in the facing material. At a meeting held of 14 October 1960 with representatives of the N.B.S., the sponsoring agencies, and the Burns and Russell Company, it was requested that the N.B.S. initiate a program to determine the soiling and cleaning characteristics of Spectra-Glaze units, as currently being produced, and to compare the results with those obtained on the older type of Spectra-Glaze and glazed ceramic structural units. It was reported by the sponsors that glazed ceramic structural units have proven satisfactory in use in regard to soiling and cleaning characteristics.

The main efforts were directed toward the selection of typical stains to simulate soiling which may occur in service and toward the development of laboratory methods to numerically determine the ease with which a given stain can be removed. Soils of a greasy or oily nature were primarily used, since this type appeared to be the most difficult to remove in service.

Simulated service tests were also made on the sample under consideration. The tests consisted of accelerated aging by subjecting the specimens to elevated temperatures (110°C.) for a seven-day period. In addition, scrubbing of the specimens with a brush and mild abrasive under controlled laboratory conditions was employed to simulate repeated cleanings in service.

No attempt was made in this study to evaluate properties other than the soiling and cleaning characteristics.

2. MATERIALS

To be of value to the sponsors, it was felt that the soiling and cleaning properties of the material in question should be compared with those of products intended for the same end use, which have a satisfactory history, as well as with those that do not. With this in mind, three samples were obtained for test. Unfortunately, samples of Spectra-Glaze units produced from approximately 1949 to 1955 were not available and the units produced since 1957 were submitted in lieu of the older product. (See letter from Burns and Russell Co. in Appendix I.)

The samples submitted for the program were identified as follows:

1. Spectra-Glaze units, SG (Green). This sample represents Spectra-Glaze as currently being produced, incorporating the most recent improvement. (Appendix I.)

2. Spectra-Glaze units, Regular (Green). This material represents Spectra-Glaze as produced since 1957. (Appendix I.)

3. Natco Ceramic Glazed Vitrilite (Yellow), supplied by the Natco Company.

3. STAINS AND CLEANING AGENTS

3.1 Stains

A.	Raw Umber	4.5 g.
	Fluorescent Powder[1/]	4.5 g.
	Petrolatum	1.5 g.
	Mineral Spirits	10.0 g.
B.	Graphite	1.0 g.
	Fluorescent Powder[1/]	1.0 g.
	Oil, SAE 10	10.0 g.
	Mineral Spirits	10.0 g.
C.	Oil Soluble Dye[2/]	0.5 g.
	Lanolin	1.0 g.
	Oil, SAE 10	5.0 g.
D.	Raw Umber	2.0 g.
	Fluorescent Powder[1/]	2.0 g.
	Distilled Water	10.0 g.

(continued on next page)

E. Miscellaneous Stains

1. No. 2 Lead Pencil
2. Black Crayon
3. Magic Marker[3]
4. Lanolin and Carbon Paper[4]

[1] Zinc salt of 8-hydroxyquinoline.

[2] C.I. Solvent Orange 7, C.I. 12140.

[3] Manufactured by Speedry Products, Inc., Richmond Hill, N. Y.

[4] Described in Federal Specification TT-P-29.

3.2 Cleaning Agents

A. Cake Grit Soap (Bon Ami)
B. Liquid Detergent (Lestoil)
C. Powdered Detergent (Sparkleen)

4. TEST PROCEDURES AND RESULTS

4.1 Stain A
(Raw Umber, Fluorescent Powder, Petrolatum, Mineral Spirits)

Cleaning Agent A (Bon Ami)

The stain was applied across the specimen by brushing, and dried at room temperature for 1/2 hour, then at 110°C. for 1/2 hour. The specimens were then cleaned using the procedure described in Method 614.3, Federal Specification TT-P-141b, using cleaning agent A. The specimens were inspected visually and under black light (to indicate presence of fluorescent powder) after each 20 cycles (40 strokes) of the washability machine.

The results of the tests are given in Table 1.

4.2 Stain B
(Graphite, Fluorescent Powder, Oil, Mineral Spirits)

Cleaning Agent A (Bon Ami)

The stain was applied and the specimens treated as described in paragraph 4.1, except the specimens were conditioned at room temperature for 24 hours after the stain was applied.

The results of the tests are presented in Table 2.

TABLE 1.

Cycles	Spectra-Glaze SG Stain[1/] Vis.	Spectra-Glaze SG Stain[1/] Fluor.	Spectra-Glaze R Stain[1/] Vis.	Spectra-Glaze R Stain[1/] Fluor.	G.S.U. Stain[1/] Vis.	G.S.U. Stain[1/] Fluor.
20	3	4	0	2	0	0
40	1	3	0	1		
60	1	2	0	0		
80	0	1				
100	0	1				
120	0	1				

[1/] Numerical Rating of Stain Retention

0 - Stain completely removed.
1 - Trace.
2 - Evident.
3 - Pronounced.
4 - Very Pronounced.

TABLE 2.

No. of Cycles	Spectra-Glaze SG Stain[1/] Vis.	Spectra-Glaze SG Stain[1/] Fluor.	Spectra-Glaze R Stain[1/] Vis.	Spectra-Glaze R Stain[1/] Fluor.	G.S.U. Stain[1/] Vis.	G.S.U. Stain[1/] Fluor.
20	4	4	4	4	0	0
40	3	3	3	3		
60	1	1	1	3		
100	0	0	0	0		

[1/] Same as Footnote 1/ above.

4.3 Stain C
(Dye, Lanolin, SAE 10 Oil)

Cleaning Agents B (Lestoil) and A (Bon Ami)

The stain was applied to each specimen by pouring it on an area of approximately 1/2-in. diameter and allowing it to remain at room temperature for 4 days. The specimens were then cleaned as described in Method 614.3, Federal Specification TT-P-141b, using the brush and cleaning agent B (10% solution). The specimens were observed after 10, 20, 40, and 80 cycles. If the stain was still evident, the cleaning procedure was continued using cleaning agent A and the effects observed after 10, 20, 40, and 80 additional cycles of the washability machine.

The results are shown in Table 3.

4.4 Stain D
(Raw Umber, Fluorescent Powder, Water)

Cleaning Agent A (Bon Ami)

This stain was selected for use since it simulates a non-greasy or non-oily type of soil. The stain was applied and the specimen conditioned and treated as described in paragraph 4.1.

The results of the tests are given in Table 4.

4.5 Miscellaneous Stains

1. No. 2 Lead Pencil
2. Black Crayon
3. Magic Marker
4. Lanolin and carbon paper

Each of the above stains was applied to the test specimens and the specimens were subjected to the cleaning procedure described in paragraph 4.1 employing cleaning agents A (Bon Ami) and C (Sparkleen, 5% Solution). The specimens were continuously observed during the cleaning procedure and the number of cycles required to completely remove the soil were noted and recorded.

The results obtained with cleaning agent A are given in Table 5, while those obtained with cleaning agent C are presented in Table 6.

TABLE 3.

No. of Cycles	Specimen: Spectra-Glaze SG	Spectra-Glaze R	G.S.U.
	Vis. Stain 1/	Vis. Stain 1/	Vis. Stain 1/
10	2	4	0
20	2	4	
40	1	4	
80	1	4	
	Cleaning Agent A Used After 80 Cycles		
90	1	3	
110	1	3	
150	1	3	
230	1	3	

1/ Numerical Rating of Stain Retention

0 - Stain completely removed.
1 - Trace.
2 - Evident.
3 - Pronounced.
4 - Very Pronounced.

TABLE 4.

No. of Cycles	Specimen: Spectra-Glaze SG		Spectra-Glaze R		G.S.U.	
	Stain 1/		Stain 1/		Stain 1/	
	Vis.	Fluor.	Vis.	Fluor.	Vis.	Fluor.
10	0	1	0	1	0	0
20	0	0	0	0		

1/ Same as Footnote 1/ above.

TABLE 5.

Stain	No. of Cycles Required to Remove Stain From		
	Spectra-Glaze SG	Spectra-Glaze R	G.S.U.
Lead Pencil	10	10	5
Crayon	60	40	10
Magic Marker	+100	+100	5
Lanolin & C.P.	30	30	5

TABLE 6.

Stain	No. of Cycles Required to Remove Stain From		
	Spectra Glaze SG	Spectra-Glaze R	G.S.U.
Lead Pencil	10	20	5
Crayon	+150	140	10
Magic Marker	+150	+150	5
Lanolin & C.P.	60	50	5

5. SIMULATED SERVICE TESTS

Simulated service tests were performed on the three samples submitted for test. The conditions consisted of an oven test to accelerate aging and a scrubbing test under controlled conditions to simulate repeated cleanings in service. Of course, there has been no relation established between the simulated tests and the conditions encountered in actual service.

5.1 Accelerated Aging

Two specimens of each sample were subjected to a temperature of 110°C. continuously for a 7-day period. They were then soiled with stain A and conditioned and cleaned as described in paragraph 4.1.

The results of the test, both before and after the accelerated aging tests are shown in Table 7.

5.2 Simulated Repeated Cleanings

Repeated cleanings of the units in service were simulated by employing the cleaning procedure described in Method 614.3, Federal Specification TT-P-141b. The specimens were scrubbed using a mild abrasive (Bon Ami) for 500 cycles (1000 strokes) and allowed to dry at room temperature before Stain A was applied. The specimens were then conditioned and cleaned as described in paragraph 4.1.

The results of the cleaning operation before and after the simulated scrubbings are presented in Table 8.

6. DISCUSSION OF RESULTS

The soiling mediums, the cleaning agents, and the cleaning procedures which were selected for use in this program represented, as far as practicable, types which may be encountered in actual service. The samples which were tested included two types of Spectra-Glaze glazed structural units and a ceramic glazed structural unit.

The results of the laboratory tests indicated that the ceramic glazed structural unit was impervious to permanent soiling by all the types of stains employed in the study. Each of the stains could be readily removed by the cleaning operations to which they were subjected. The tests, which were used to simulate aging and repeated scrubbing with a mild abrasive, in service, indicated that the soiling and cleaning

TABLE 7.

No. of Cycles	Spectra-Glaze SG Fluor. Stain[1/] Before	After	Spectra-Glaze R Fluor. Stain[1/] Before	After	G.S.U. Fluor. Stain[1/] Before	After
20	4	4	2	3	0	0
40	3	3	1	2		
60	2	2	0	1		
80	1	1		0		
100	1	1				

Specimen

1/ Numerical Rating of Stain Retention

0 - Stain completely removed.
1 - Trace.
2 - Evident.
3 - Pronounced.
4 - Very Pronounced.

TABLE 8.

Specimen

No. of Cycles	Spectra-Glaze SG Fluor. Stain[1/] Before	After	Spectra-Glaze R Fluor. Stain[1/] Before	After	G.S.U. Fluor. Stain[1/] Before	After
20	4	4	2	1	0	0
40	3	1	1	0		
60	2	0	0			

1/ Same as Footnote 1/ above.

properties of this material were not materially altered due to the exposures. From the reported performance of this type of material in service, it would appear that the results of the laboratory tests corroborated the field performance in regard to soiling and cleaning.

It was reported that the staining and cleaning properties of the Spectra-Glaze units produced from 1949 to 1955 were not entirely satisfactory. However, samples of this material were not available for direct comparison with the Spectra-Glaze being currently produced, as stated in letter from the Burns and Russell Company in Appendix I. Therefore, the new Spectra-Glaze was compared with units of the type produced since 1957. It is understood that installations of units of this type have been observed by representatives of the sponsoring agencies, as indicated in Appendix I. However, it has not been established whether this material has been entirely satisfactory in service from a soiling and cleaning point of view.

The results of the experiments indicated that neither of the two types of Spectra-Glaze units were seriously soiled by the non-oily, non-greasy stains, as Stain D (Raw Umber, Fluorescent Powder, Water). This soil was completely removed from each specimen with less than 20 cycles of the washability machine.

The results of the experiments using oily or greasy soils (of petroleum origin), as Stains A and B, indicated that the regular units (Spectra-Glaze R) performed better than the SG units (Spectra-Glaze SG), in each case regardless of the cleaning procedure employed. However, the results also indicated that the stains could be completely or almost completely removed from either specimen if sufficient scrubbing was used.

The most pronounced difference in the staining properties of the two types of Spectra-Glaze units was evidenced by the degree of removal of stain C (Oil, Lanolin, Oil-Soluble Dye). The units (Spectra-Glaze SG), which are currently being produced, appeared to be superior to the regular units (Spectra-Glaze R) in regard to the ease of removal of this stain. The Spectra-Glaze SG had only a trace of the soil appearing after 80 cycles using cleaning agent B (liquid detergent) and 80 cycles using cleaning agent A (Bon Ami type), while the Spectra-Glaze R still evidenced pronounced staining after the same series of cleaning operations.

The resistance of the two types of Spectra-Glaze units to soiling by the common stains used (pencil, crayon, etc.) was approximately equal. The results of the tests indicated that the stains could be completely removed from each sample using cleaning agent A (mild abrasive).

Although the results of the accelerated aging and cleaning tests indicated that slight differences existed between the types of Spectra-Glaze in respect to the ease of removal of a given stain after exposure to the simulated service conditions, it was felt that the change was not significant enough to predict alterations in these properties which may occur in service.

Neither the contents of this report nor the fact that the study was made by the National Bureau of Standards shall be used for advertisement or promotional purposes.

USCOMM-NBS-DC

APPENDIX I.

LETTER FROM THE BURNS & RUSSELL COMPANY

P.O. Box 6063
Baltimore 31, Md.

December 15, 1960

Mr. William Cullen
Industrial Building
National Bureau of Standards
Connecticut Avenue & VanNess Street, N. W.
Washington 25, D. C.

Dear Mr. Cullen:

In response to your inquiry concerning identification of SPECTRA-GLAZE units sent to your office for evaluation, I hereby submit the following information:

1. SPECTRA-GLAZE units marked "REG." represent SPECTRA-GLAZE units as they have been produced since approximately 1957. SPECTRA-GLAZE units of this quality were supplied in buildings such as: Verwyn Heights Elementary School, Berwyn Heights Dial Center and the Kiplinger "Editors" Building. These buildings were inspected by Mr. Frank Reali, U. S. C. of E., Mr. Howard M. Williams, Chief, Specs. & Estimating Branch, U. S. C. of E., J. Glenn Whitman and John C. Morris of the Burns & Russell Company on September 16, 1960. The projects were found to be entirely satisfactory in the owners' opinion.

2. SPECTRA-GLAZE units marked "S-G" represent block incorporating our most recent improvement; namely, resistance to non-removable staining from greasy or oily substances. This particular characteristic has been a request of the U. S. C. of E.

3. SPECTRA-GLAZE units of the quality produced from 1949 to approximately 1955 which we did not claim complied with ASTM C-126, and were used in the construction of:

District Heights School, supplied - 1949
Manufactured by - General Shale Products Corporation

Hollywood School, supplied - 1951
Manufactured by - General Glaze Corporation

(continued on next page)

Continuation of Letter from The Burns & Russell Co.

Hillcrest Heights School, supplied - 1955
Manufactured by - Concrete Pipe & Products Co., Inc.

are no longer available. Therefore, samples of such units could not be provided.

I sincerely hope the above information is complete; if not, please do not hesitate to request additional information.

Very truly yours,

/s/ John A. Sergovic

John A. Sergovic
Vice-President

JAS: gb

cc: Dr. W. W. Walton

a true copy/lc

USCOMM-NBS-DC

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *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 major laboratories in Washington, D.C., and 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 of the front cover.

WASHINGTON, D.C.

ELECTRICITY. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

METROLOGY. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

HEAT. Temperature Physics. Heat Measurements. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research. Equation of State. Statistical Physics. Molecular Spectroscopy.

RADIATION PHYSICS. X-Ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

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

MECHANICS. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. 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. Constitution and Microstructure.

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

APPLIED MATHEMATICS. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

DATA PROCESSING SYSTEMS. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

ATOMIC PHYSICS. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics.

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

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

IONOSPHERE RESEARCH AND PROPAGATION. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

RADIO PROPAGATION ENGINEERING. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

RADIO STANDARDS. High frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

RADIO SYSTEMS. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Space Telecommunications.

UPPER ATMOSPHERE AND SPACE PHYSICS. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

NBS