EVALUATION OF MASONRY COATINGS

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"The opinions, findings, and conclusions expressed in this publication are those of the author and not necessarily those of the Bureau of Public Roads."

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ABSTRACT

This report describes the evaluation of five coating systems to replace the conventional Class 2 rubbed finish now required on concrete structures. The evaluation consisted of preparing test specimens with each of the five coatings and conducting absorption, freeze and thaw durability, abrasion and accelerated weathering test and comparing the results to test specimens having a Class 2 rubbed finish.

The conclusions reached from this study were that four of the five systems would be acceptable as a replacement for Class 2 rub. The only system that did not perform satisfactorily exhibited excessive scaling during the freeze and thaw tests.

The recommendations are that the four acceptable coatings be placed on an approved products list and used as alternates, and that a field installation be made using all five coating systems to confirm and supplement the laboratory findings.

INTRODUCTION

This research project was undertaken to evaluate several coating systems for concrete masonry to replace the presently used Class 2 rub. Under the existing Louisiana Department of Highways Specifications, it is required that all exterior concrete girders, and exposed faces of piers, abutments, wing walls, retaining walls, railings and parapets will be given a Class 2, Rubbed Finish. The Class 2 rub consists of rubbing the surface with a medium coarse carborundum stone, using a small amount of mortar on its face. This rubbing process eliminates form marks, projections and irregularities and fills void to obtain a uniform surface on the members. This type finish can almost be considered as a cosmetic coat as its only function is to give a neat and uniform appearance to the structure.

Due to the rising labor costs, the process of rubbing the exposed surface of structures has become quite expensive. Therefore it was decided that if an applied coating could be found that would give the same uniform appearance as a Class 2 rub and could be applied by spraying or paint brush, that the overall cost could probably be reduced and in addition a more durable coating would result.

METHODOLOGY

Five coating systems were evaluated in the study. Two of the coatings were complete systems in that no additional constituents other than water were required to be added prior to application. The other three were bonding agents used in conjunction with cement and mortar sand to produce a coating system. These five systems were compared to a conventional Class 2 rub.

The evaluation consisted of preparing test specimens of each system and performing an abrasion test, absorption test, freeze and thaw durability test and accelerated weathering in a weatherometer.

Test Procedure

The test procedures used in the study consisted of the following:

Abrasion Test - ASTM C418-64T, Abrasion Resistance of Concrete

Freeze and Thaw Test - ASTM C291-61T, Resistance of Concrete Specimens to Rapid Freezing in Air and Thawing in Water

Absorption Test - The prepared test specimens were submerged in water for 28 days and the absorption determined by weight gain.

Accelerated Weathering - Asbestos panels, 3 inch x 7 inch were coated with each system under test and placed in a Atlas XW-R Carbon Arc Weatherometer for 500 hours exposure. A comparison was then made between the weathered specimens and control specimens.

Test Specimens

The test specimens used for all tests other than the accelerated weathering, were 6 inch x 12 inch x 2 inch concrete blocks made using a 6.0 sack concrete mix. The concrete blocks were cast and then cured for 28 days prior to the application of the coating systems. The curing cycle consisted of seven days in a moist room at 73°±2°F and 100% humidity and then 21 days in a curing room maintained at 73°±2°F and 50% humidity. The test specimens for the accelerated weathering were 1/4 inch asbestos boards cut in 3 inch x 7 inch panels.

At the completion of the 28 day curing cycle, the coating systems were applied to the concrete test blocks. All coatings with the exception of one, were applied by or under the supervision of the manufacturer's representatives.

After application of the coatings, the test specimens, except the weatherometer samples, were exposed to normal atmospheric conditions outside the laboratory for 28 days prior to the start of testing. The specimens for accelerated weathering were exposed for 7 days prior to beginning the weathering cycles.

Three test specimens were made for each of the programmed tests. As mentioned previously these tests consisted of abrasion, absorption, freeze and thaw and accelerated weathering.

Description of Coating Systems

As stated previously, five coating systems were evaluated and compared to results obtained on specimens with a conventional Class 2 rub. A general description of each of the five systems is as follows:

System A - A synthetic, elastomer-polymer base, with fiberglass, absestos, perlite and mica added. Pigment is added to produce the desired colors. Material is furnished in containers pre-mixed and ready to use. Normal application is by spraying.

System B - A non reamulsifying resin binder used with a cement base powder with other special non metallic additives. Material is shipped with binder in one container, and cement base powder in separate container. Water is added to resin binder prior to mixing with cement base powder. Can be brushed or sprayed on surface.

System C - An acrylic latex base liquid (emulsion) used with portland cement and mortar sand to form a grout. Acrylic latex base is mixed with water and then added to dry mixture of portland cement and mortar sand. Prepared material is brushed on surface.

System D - A resinous water-emulsion bonding agent used with portland cement and mortar sand to form a grout. Bonding agent mixed with water and then added to dry mixture of portland cement and mortar sand. Prepared material is brushed on surface.

System E - A high polymer resin emulsion used with portland cement and mortar sand to form a grout.

System F - A Class 2 rubbed finish in accordance with LDH Specifications.

DISCUSSION OF RESULTS

Absorption Test

The results of the absorption tests are shown in Table 1. The absorption test was conducted for 28 days, and the weight gain over the original weight was used as the absorbed moisture.

TABLE 1

RESULTS OF ABSORPTION TESTS

Coating System	A	B	C	D	E	F
Absorbed Moisture - %	3.0	3.4	2.4	2.7	2.9	1.8

The results indicate that System F, which is the Class 2 rub gave the best protection against water penetration. However, there is only a 1.6% difference between the highest and lowest absorption value and it appears that all of the systems provide excellent waterproofing characteristics.

Abrasion Test

The results of the abrasion test are shown in Table 2.

TABLE 2

RESULTS OF ABRASION TESTS

Coating System	A	B	C	D	E	F
Abrasion Loss $\frac{\text{cu. cm}}{\text{sq. cm}}$	.01	.08	.11	.11	.03	.07

An analysis of the abrasion results indicate that Systems A and E are quite superior to all other Systems. Earlier work on abrasion of concrete showed that a 6.0 sack concrete mix at an age of 28 days gave a loss of .08 cu.cm./sq.cm. Therefore it appears that Systems B, C and D afford no better protection to abrasion than an exposed concrete surface, while System F, Class 2 rub, is slightly better. Figures 1 through 6 of the Appendix show the test specimens after the abrasion test.

Accelerated Weathering

The results of the accelerated weathering tests showed that all of the Systems performed very satisfactory. Figures 7 through 12 show a comparison between the weathered panels and the control panels. Panel 1 in each figure is the control specimen. The only indication of weathering was a very slight staining on some of the panels, but all Systems would be rated excellent after 500 hours of exposure.

Freeze and Thaw Tests

The results of the freeze and thaw tests are shown in Figure 13 of the Appendix. The durability factors for each system are shown in Table 3.

TABLE 3

DURABILITY FACTORS

Coating System	A	B	C	D	E	F
Durability Factor	25.6	8.4	16.0	14.4	9.0	10.8

As can be seen from the results shown in Table 3, System F, Class 2 rub, gave a durability factor of 10.8. Two of the coating systems, System B and E, gave lower durability factors than did System F. The largest durability factor was obtained from System A, with Systems C and D falling next in order respectively. Figures 14 through 19 in the Appendix show the test specimens after the freeze and thaw test.

Visual Rating

A visual inspection was used in evaluating the performance of each coating system during the freeze and thaw tests. Each time that dynamic modulus measurements were taken on the specimens, a careful visual examination was made of the surface to determine if cracks, spalls, corner breaks, or loss of bond between the coating and the concrete surface was occurring.

The following is a brief description of each coating system, noting the first evidence of distress and the final overall appearance.

System A - The only evidence of any distress was a small corner break on one specimen.

System B - Small hairline cracks developed at 38 cycles of freezing and thawing. At the completion of the tests there was numerous hairline cracks on all specimens and several small corner breaks.

System C - Scaling of the coating began at 54 cycles of freezing and thawing. At the completion of the tests there was extensive scaling and numerous corner breaks.

System D - A corner break occurred at 109 cycles of freezing and thawing. At the completion of the tests there was several corner breaks present on two specimens.

System E - Hairline cracks appeared at 46 cycles of freezing and thawing. At the completion of the tests there was several hairline cracks and minor pop outs on the surface.

System F - Hairline cracks developed at 69 cycles of freezing and thawing. At the completion of the tests there was minor hairline cracking with several small corner breaks.

CONCLUSIONS

The results of this study warrant the following conclusions:

1. System F, the Class 2 rub, performed best in the absorption test. However, all coatings provided what would be considered a very good waterproofing.

2. None of the systems tested were affected by 500 hours of accelerated weathering in the weatherometer.

3. System A gave the best freeze and thaw durability factor.

4. Overall all systems with the exception of System C would be rated as acceptable as a substitute for Class 2 rub. The extensive scaling of System C precludes its use at this time.

RECOMMENDATIONS

It is recommended that a field installation of all of the coating systems tested be placed for observation under actual field conditions and to supplement the laboratory findings. In the meantime, it is recommended that an approved products list be established and maintained so that Systems A, B, D and E can be used on construction jobs until the completion of the field evaluation study.

APPENDIX

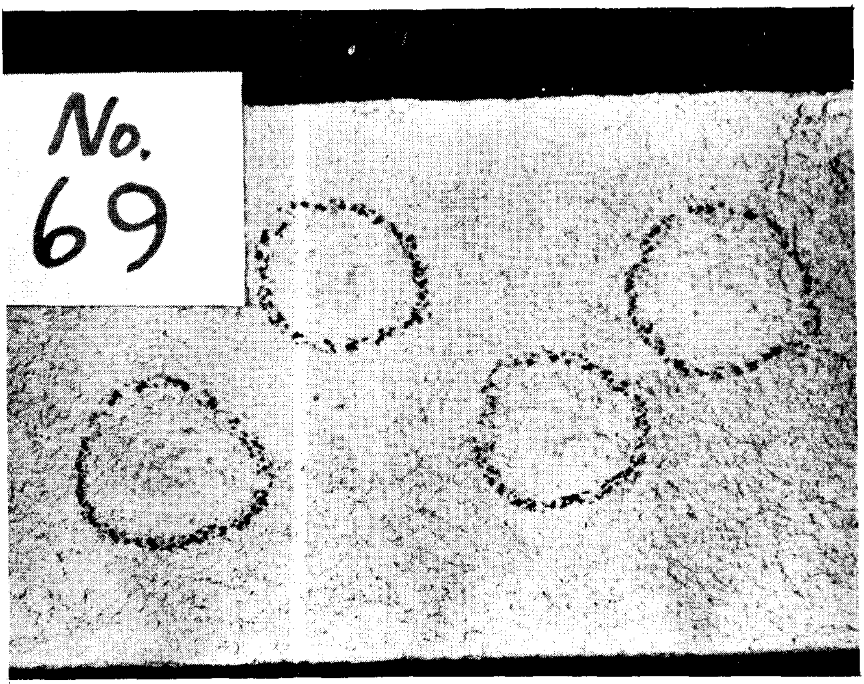

FIGURE 1 - System A After Abrasion Test

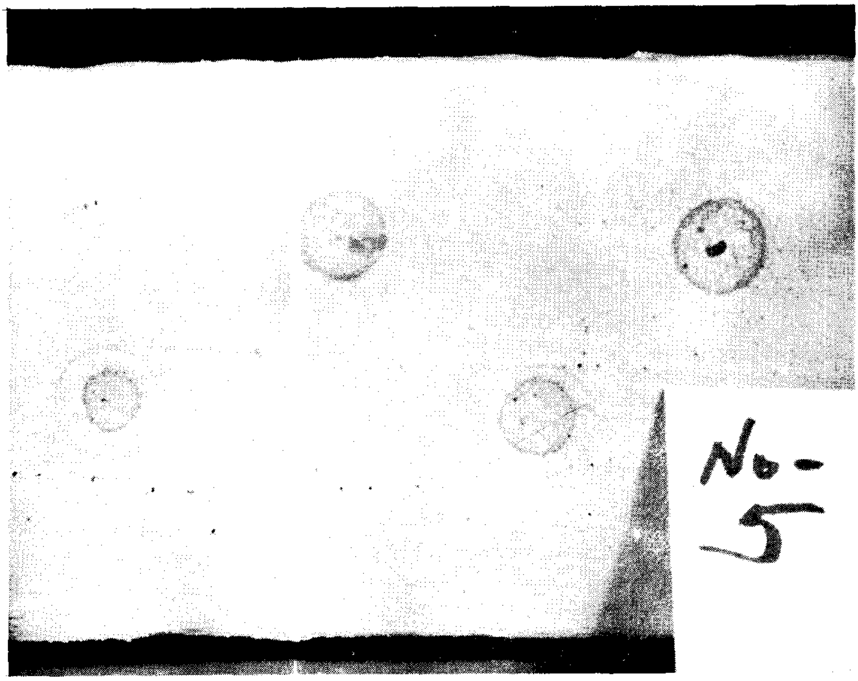

FIGURE 2 - System B After Abrasion Test

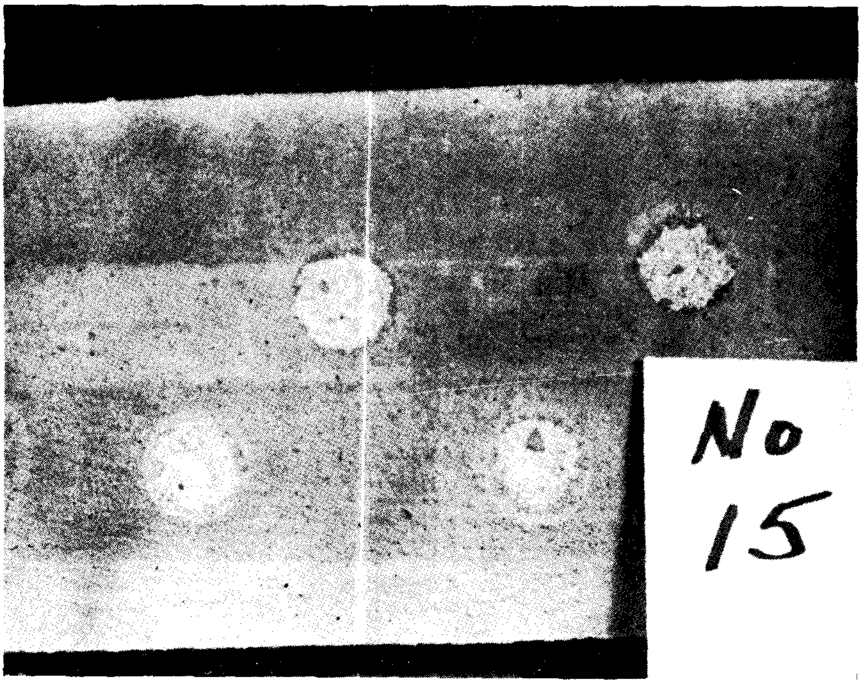

FIGURE 5 - System E After Abrasion Test

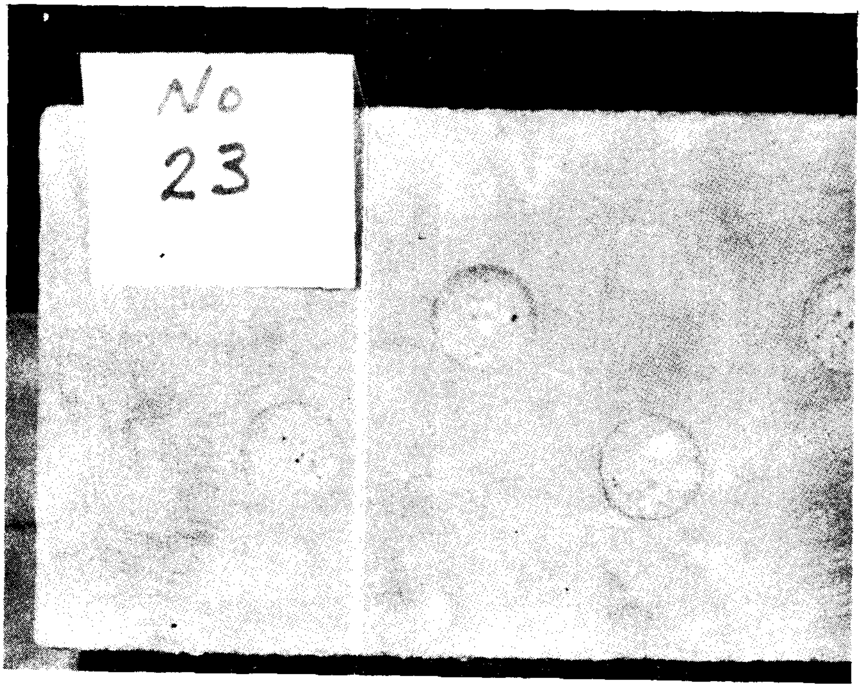

FIGURE 6 - System F After Abrasion Test

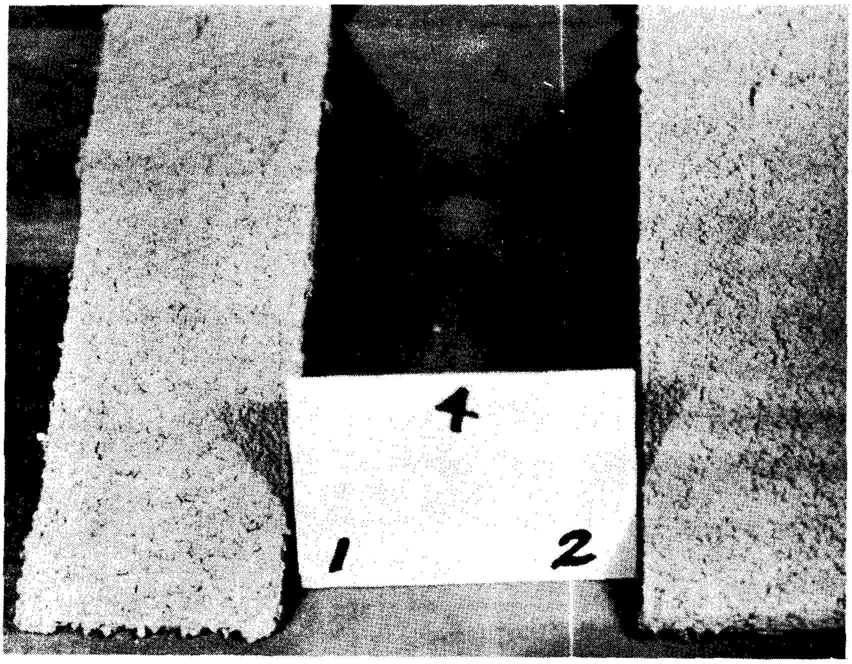

FIGURE 7 - System A After Accelerated Weathering

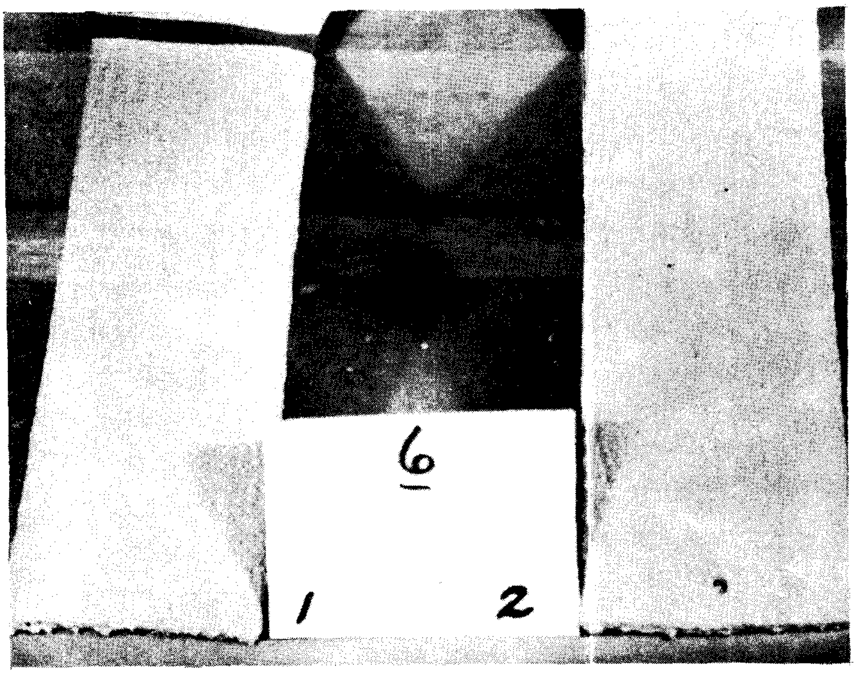

FIGURE 8 - System B After Accelerated Weathering

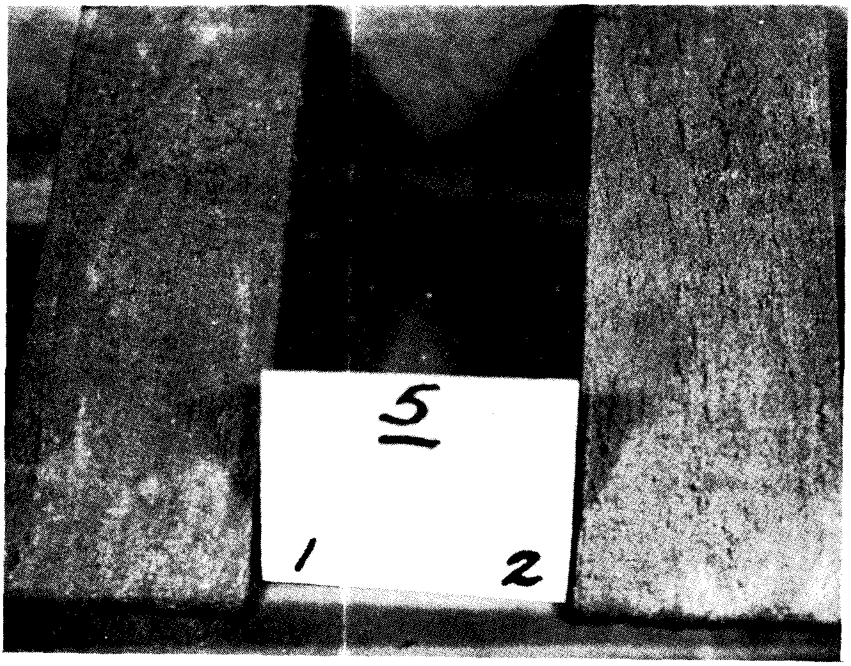

FIGURE 9 - System C After Accelerated Weathering

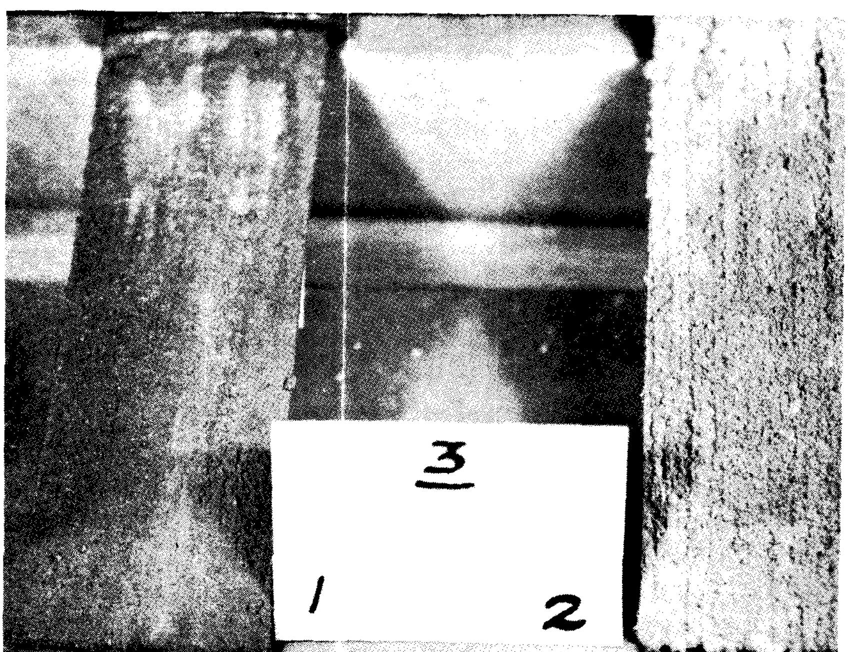

FIGURE 10 - System D After Accelerated Weathering

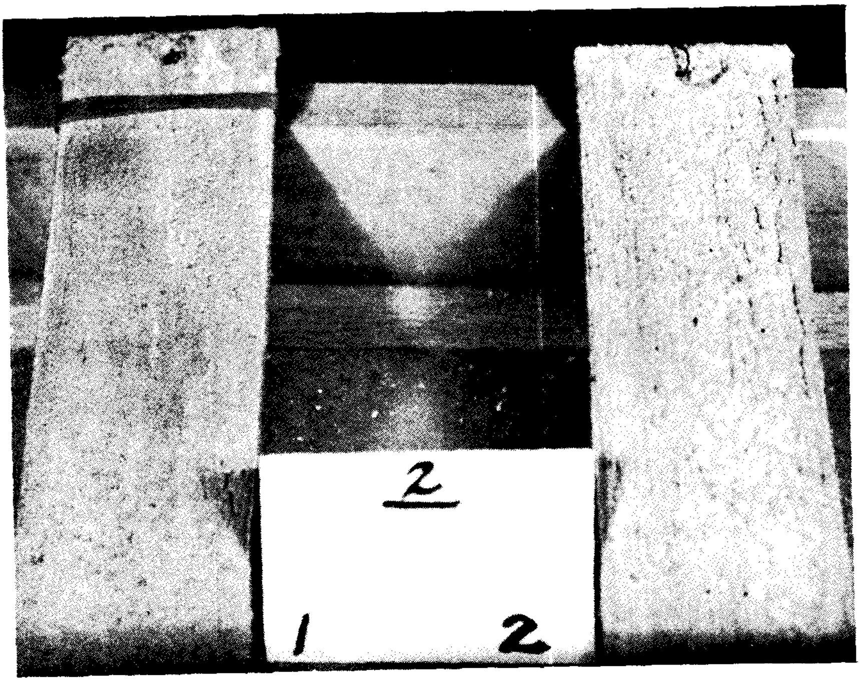

FIGURE 11 - System E After Accelerated Weathering

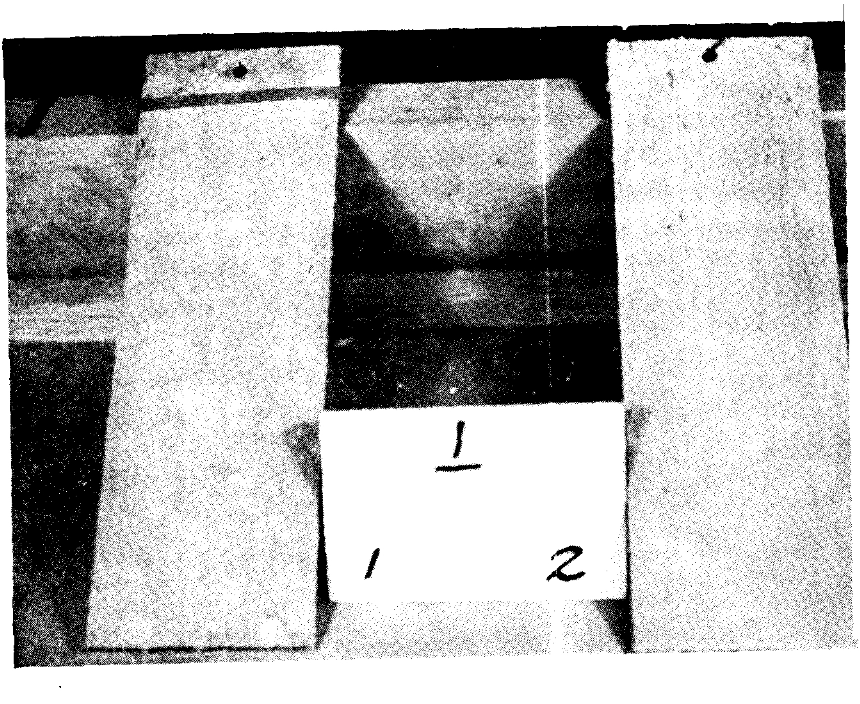

FIGURE 12 - System F After Accelerated Weathering

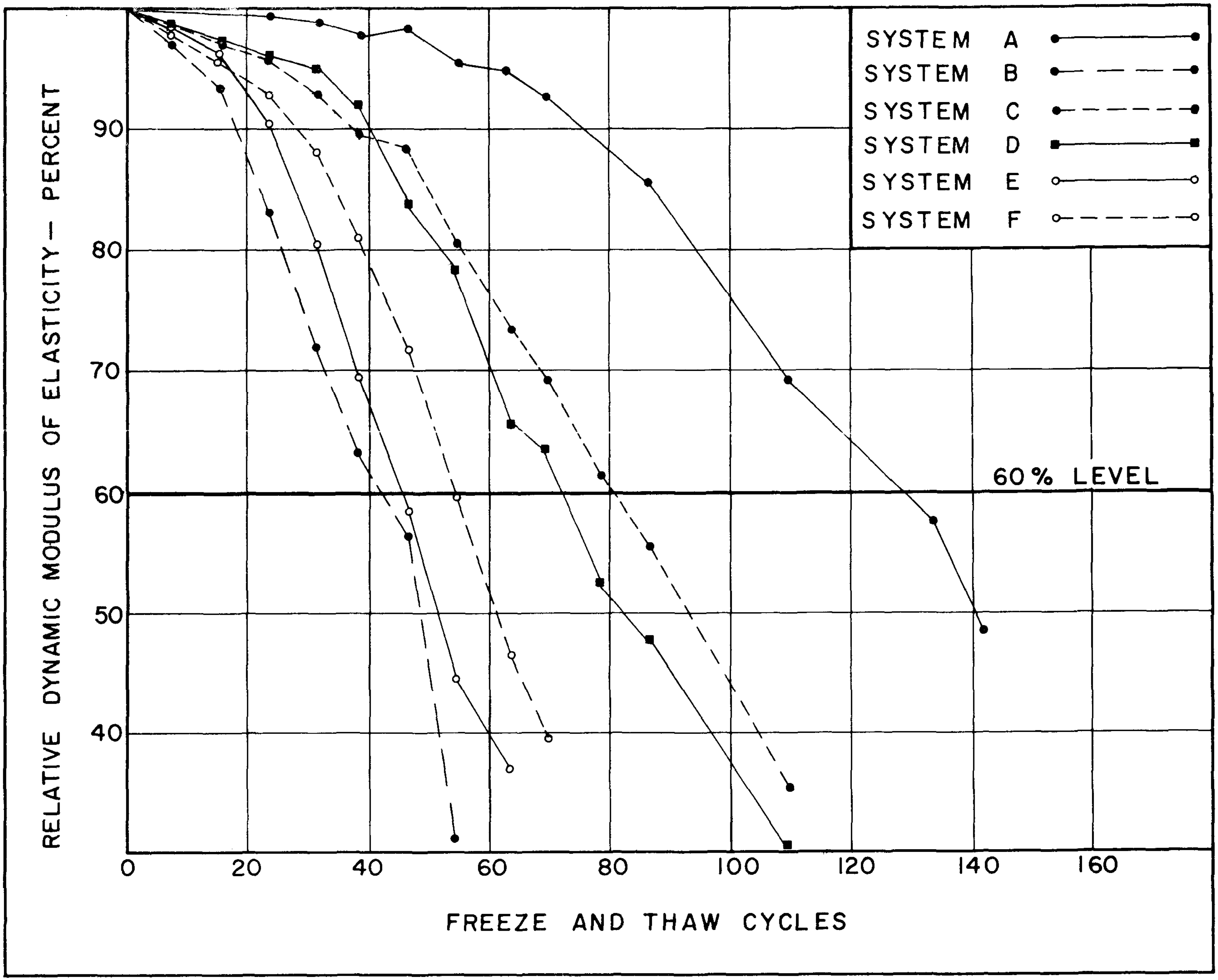

FIGURE 13 - Relative Dynamic Modulus of Elasticity vs Freeze and Thaw Cycles

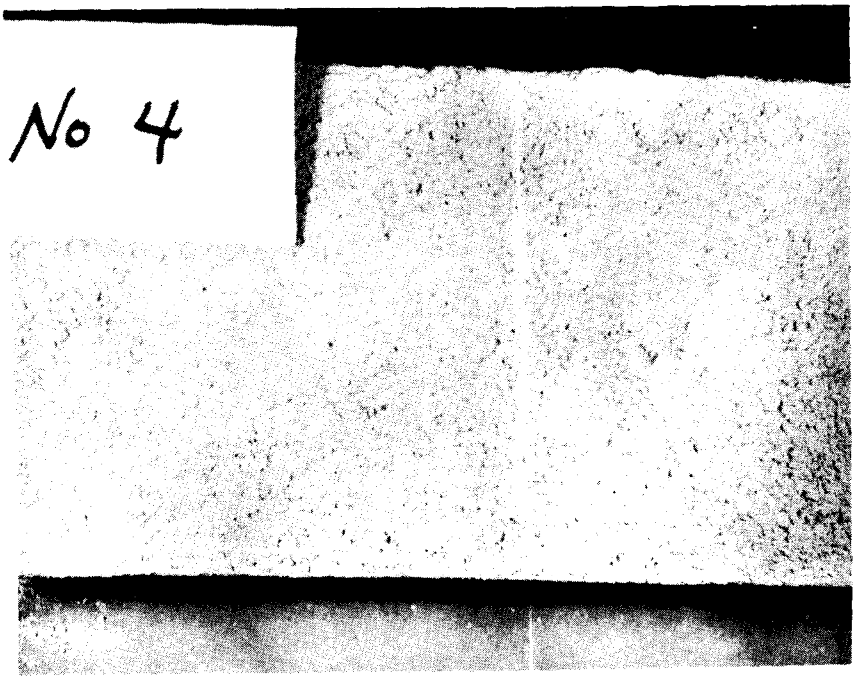

FIGURE 14 - System A After Freeze and Thaw Test

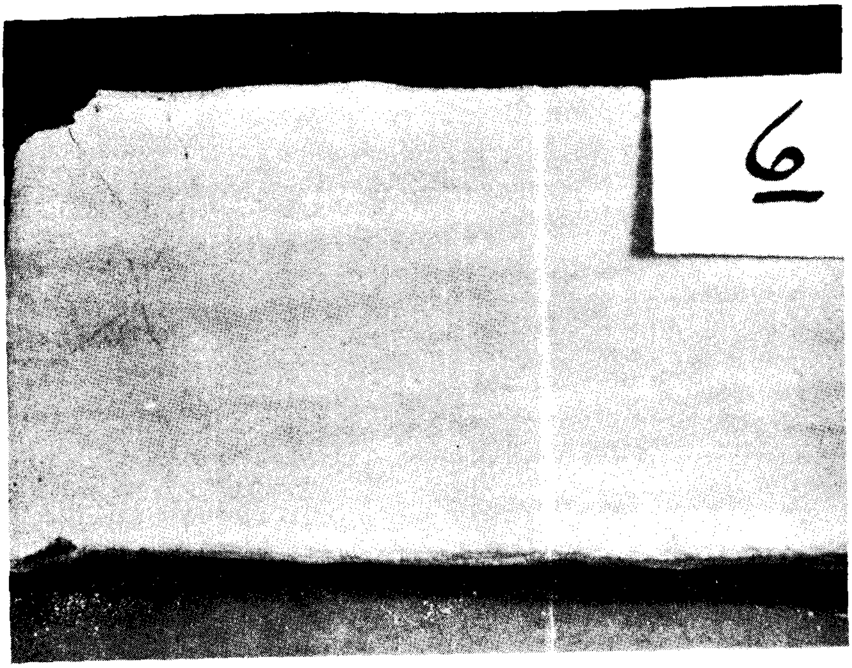

FIGURE 15 - System B After Freeze and Thaw Test

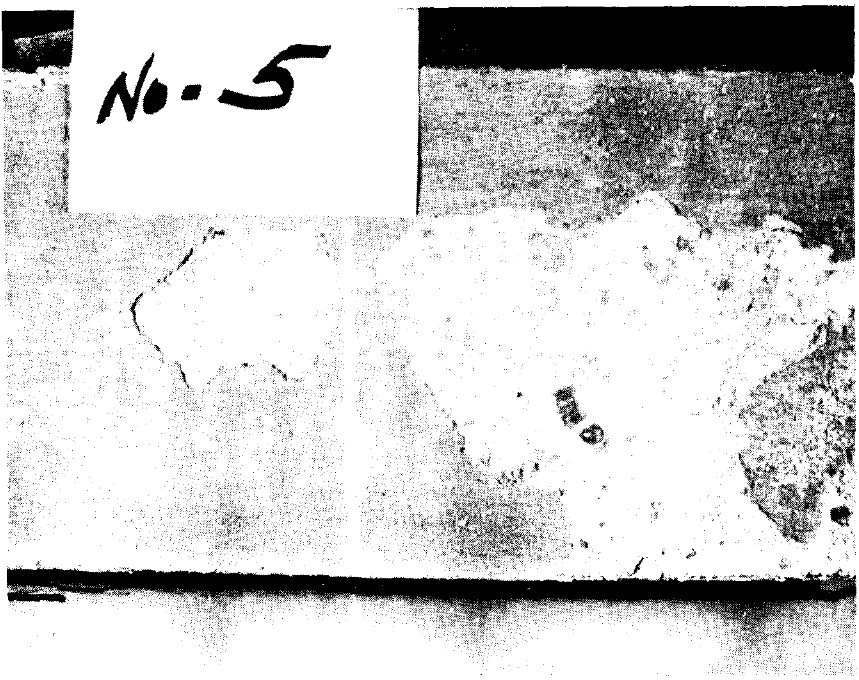

FIGURE 16 - System C After Freeze and Thaw Test

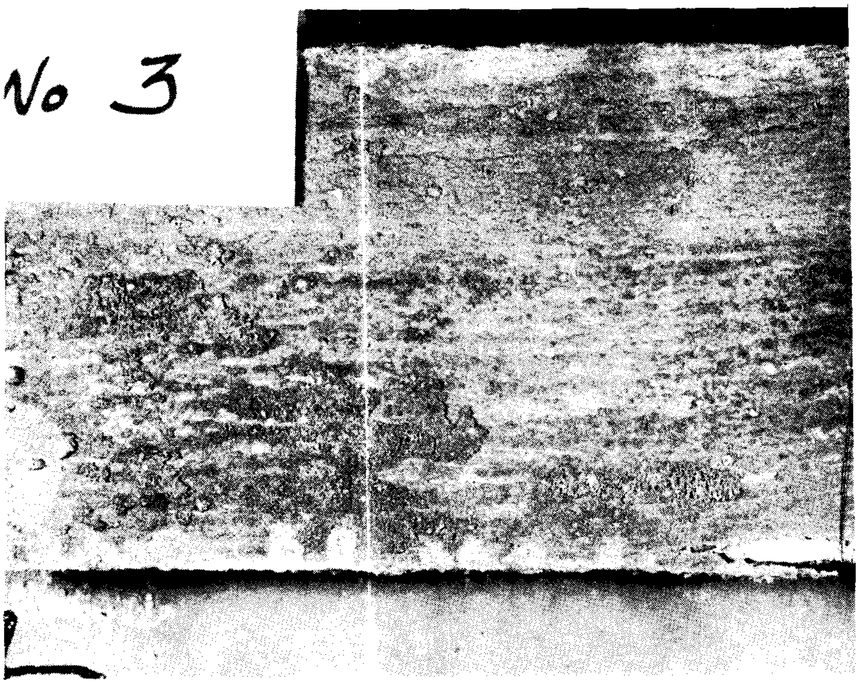

FIGURE 17 - System D After Freeze and Thaw Test

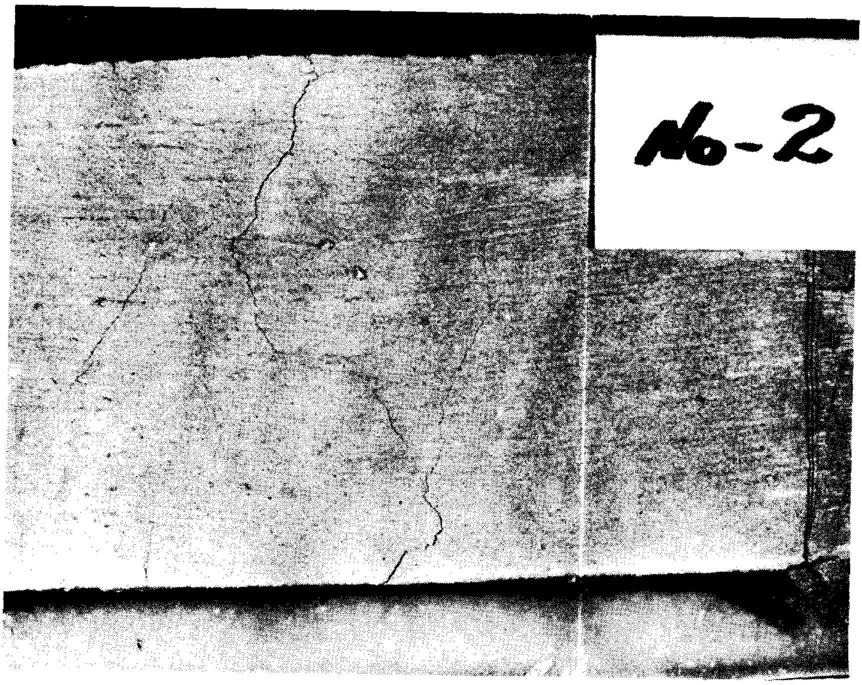

FIGURE 18 - System E After Freeze and Thaw Test

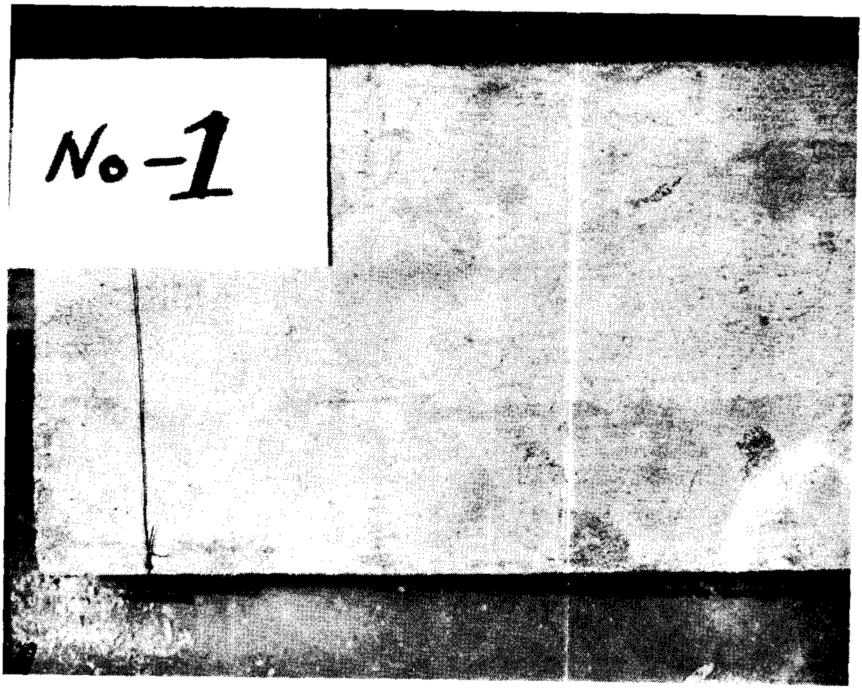

FIGURE 19 - System F After Freeze and Thaw Test