FINAL REPORT OF

EVALUATION OF MASONRY COATINGS

PHASE II

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SYNOPSIS

This research project was undertaken to evaluate several coating systems for concrete masonry to replace the presently used Class 2 rubbed finish. This is the report of Phase II, the field evaluation, of that project.

In early October 1970, application of the five coating systems to an elevated structure in the Baton Rouge area was begun. This project was completed later the same month and has been under observation for a period of one year.

The principal conclusion reached from this study is that the systems, as they are presently applied, are acceptable as a replacement for the Class 2 rubbed finish. It should be noted that the mixture in System C, which proved to be unsatisfactory under testing in Phase I, was changed by the manufacturer, and the revised System C appears to be performing as satisfactorily as the four other systems.

The recommendations are as follows. 1) that the five systems, as described herein be placed on an approved products list and used as alternates to a Class 2 rubbed finish; 2) that the present specifications be expanded to allow for a Class 2 B special coated finish and, 3) that the Department may specify a Class 2B special coated finish for which no alternate may be substituted.

IMPLEMENTATION

It is recommended that the Department revise the present specifications to allow a new heading of Class 2B Special Coated Finish to be added as detailed in this report.

INTRODUCTION

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 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. This rubbing process eliminates form marks, projections and irregularities and fills voids, thus obtaining a uniform surface on the members.

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

SCOPE

This research included five different generic types of coatings which to date is a very comprehensive coverage. There are many products available that will fall into each category. In any future acceptance, each product submitted should be evaluated by the appropriate specification contained herein, as this research is not a blanket endorsement of every coating system available.

METHODOLOGY

Five coating systems were evaluated in the study. Two of the coatings were complete systems that required no additional constituents other than water 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 rubbed finish.

Since Phase II was the field evaluation of the materials evaluated during the laboratory phase (Phase I), it was necessary to apply the materials to a structure so they could be observed in a technical and documentative manner for a given period of time. These systems were very closely observed, and observations were recorded during application and at periods of one week, two weeks, one month, two months, three months, six months, nine months and 12 months following application.

Five surface finish coating systems were applied on the outside parapets and handrails of five elevated southbound spans of Interstate I-110 between Government Street and France Street in Baton Rouge, Louisiana. The installation of coating systems was contracted by Southeastern, Inc., a division of T and T Trucking, on State Project No. 450-33-62.

The surface areas to be coated were sandblasted sufficiently to provide a sound and clean surface thus insuring a proper bond between the surface of concrete and the coating systems. All coating systems were applied in accordance with each manufacturers' recommendations.

Systems B, C, D and E were brushed on the surface by the contractor. System A was sprayed on by the manufacturer's representative.

The installation of all materials was begun on October 20, 1970, and was completed October 22, 1971, except for a section on the west side on System E (span B). A color change occurred on this section apparently due to improper mixing of the material. On November 2, 1970, the decision was reached to resandblast the west side of span B and reapply coating System E.

In addition to the field testing, samples of the materials placed on the structures were also applied to specimens at the same time as the field installation and subjected to the following laboratory analyses:

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.

Accelerated Weathering - Duplicate sets of asbestos panels, 3 inches by 7 inches were coated with each system being tested, and one set was placed in an Atlas XW-R Carbon Arc Weatherometer for 500 hours exposure. A comparison was then made between the weathered specimens and the unweathered control specimens.

Test Specimens

The test specimens used for all tests other than the accelerated weathering were 6 inch by 12 inch by 2 inch concrete blocks made from 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 percent humidity and then 21 days in a curing room maintained at 73°±2°F and 50 percent humidity. The test specimens for the accelerated weathering were 1/4 inch asbestos boards cut in 3 inch by 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 manufacturers' representative.

COATING SYSTEM MIXTURES

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

System B - is a non reemulsifying resin binder used with a cement base powder which contains other special non metallic additives. The material is shipped with the binder in one container and the cement base powder in another. Water is added to resin binder prior to mixing with the cement base powder. It can be brushed or sprayed on a surface.

One part binder is added to three parts water before the liquid can be mixed with the cement base powder to the consistency needed for brushing.

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

One part acrylic latex base emulsion is mixed with one part water for the liquid, then added to 5 parts mortar mix. The mortar mix consists of:

2 parts mortar sand,
3 parts white portland cement, and
2 parts natural portland cement

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

One part resinous water-emulsion is mixed with one part water for the liquid then added to four parts mortar mix. This produces the brushing consistency. The mortar mix consists of:

2 parts mortar sand,
3 parts while portland cement, and
2 parts natural portland cement

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

One part polymer resin emulsion is mixed with one part water for the liquid, then added to four and one-half parts mortar mix. This produces the brushing consistency mortar mix. The mortar mix consists of:

2 parts mortar sand,
3 parts white portland cement, and
2 parts natural portland cement

SPECIFICATIONS

System A

(a) Elastomer-Polymer Base:

Properties	Requirements
Solids, % min.	65.0
Volatile, % max.	35.0
Wt/Gal., lbs.	9.0 - 10.0
Infra-red Spectra	Chart 4

(b) Mixing: This product is pre-mixed by manufacturer

(c) Color: The color of the finished product, after drying, shall produce a reflectance at 550 MU between 65-75 when tested by the reflectance attachment on a Bausch and Lomb Spectronic 20 Optical Instrument.

(d) Application: The material shall be applied by spraying with heavy duty spray equipment or as recommended by the manufacturer in order to produce a good bond and provide a uniform texture and appearance.

System B

(a) Non reemulsifying resin binder:

Properties	Requirements
Solids, % min.	25.0
Volatile, % max.	75.0
Wt/Gal., lbs.	8.0 - 9.0
Infra-red Spectra	Chart 3

(b) Cement base powder with special non metallic additives:

Properties	Requirements
Silicon Dioxide, %	45-55
Iron and Aluminum Oxide, %	8-17
Calcium Oxide, %	25-35
Ignition Loss, %	0-10
Infra-red Spectra	Chart 5

(c) Mixing: The mixture shall consist of three parts of water to one part of the non reemulsifying resin binder by volume combined with the cement base powder which contains special non metallic additives in order to produce a consistency that can be brushed on the surface.

(d) Color: The color of the finished product, after drying, shall produce a reflectance at 550 MU between 65-75 when tested by the reflectance attachment on a Bausch and Lomb Spectronic 20 Optical Instrument.

(e) Application: The mixture shall be applied by brush or as recommended by the manufacturer in order to produce a good bond and provide a uniform texture and appearance.

System C

(a) Acrylic Latex Base Liquid (Emulsion):

Properties	Requirements
Solids, % min.	45
Volatile, % max.	55
Wt/Gal., lbs.	8.5 - 9.5
Infra-red Spectra	Chart 6

(b) Special Mortar Sand: The sand used shall be graded sand with 100 percent passing a No. 30 sieve.

(c) Mixing: The mixture shall consist of one part of the emulsion to two parts of water by volume combined with portland cement and mortar sand in proportions of one to three by volume in order to produce a consistency that can be brushed on the surface.

(d) Color: The color of the finished product after drying shall produce a reflectance at 550 MU between 65-75 when tested by the reflectance attachment on a Bausch and Lomb Spectronic 20 Optical Instrument.

(e) Application: The mixture shall be applied by brush or as recommended by the manufacturer in order to produce a good bond and provide a uniform texture and appearance.

System D

(a) Resinous Water-Emulsion Bonding Agent:

Properties	Requirements
Solids, % min.	50.0
Volatile, % max.	50.0
Wt/Gal., lbs.	8.8 - 9.8
Infra-red Spectra	Chart 1

(b) Special Mortar Sand: The sand used shall be graded sand with 100 percent passing a No. 30 sieve.

(c) Mixing: The mixture shall consist of three parts of water to one part of the non reemulsifying resin binder by volume combined with the cement base powder which contains special non metallic additives in order to produce a consistency that can be brushed on the surface.

(d) Application: The mixture shall be applied by brush or as recommended by the manufacturer in order to produce a good bond and provide a uniform texture and appearance.

System E

(a) High Polymer Resin Emulsion:

Properties	Requirements
Solids, % min.	50.0
Volatile, % max.	50.0
Wt/Gal., lbs.	8.8 - 9.8
Infra-red Spectra	Chart 2

(b) Special Mortar Sand: The sand used shall be a graded sand with 100 percent passing a No. 30 sieve.

(c) Mixing: The mixture shall consist of one part of the emulsion to one part of water by volume combined with portland cement and mortar sand in proportions of one to three by volume in order to produce a consistency that can be brushed on the surface.

(d) Color: The color of the finished product, after drying, shall produce a reflectance at 550 MU between 65-75 when tested by the reflectance attachment on a Bausch and Lomb Spectronic 20 Optical Instrument.

(e) Application: The mixture shall be applied by brush or as recommended by the manufacturer in order to produce a good bond and provide a uniform texture and appearance.

ANALYSIS OF DATA

I. Laboratory Results of coatings applied on Baton Rouge Interstate Route I-110 (France Street - Government Street).

During the application of each coating material, samples of the materials being used on the bridge were coated on the surface of 6 inch by 12 inch by 2 inch concrete blocks and subjected to testing as described in the Methodology of this report. The following are the results of that testing:

A. Results on Abrasion Test

TABLE 1

Coating System	A	B	C	D	E
Abrasion Loss $\frac{cu.cm.}{sq.\ cm.}$	.000	.044	.061	.038	.044

An analysis of the abrasion results indicates that System A has much better abrasion resistance than the other systems. Earlier work on abrasion of concrete indicated that a 6.0 sack concrete mix at the age of 28 days showed a loss of .07 cu.cm./sq.cm. Therefore, it appears that all systems offer more protection from abrasion than uncoated concrete surfaces. Figures 7 through 11 of the Appendix show the test specimens after abrasion testing.

B. Durability Factor

TABLE 2

Coating System	A	B	C	D	E
Durability Factor	20.6	12.3	13.0	9.3	8.7

The results of freeze and thaw test are shown in Figure 17 of the Appendix.

Although only one side of each specimen was coated with a system, there is the same trend of the durability of these materials as indicated in previous tests reported under Phase I.

C. Visual Rating

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

System A - There was no visible failure of coated surface during 110 cycles of freezing and thawing.

System B - A small flaking pop-out developed on coated surface at 102 cycles of freezing and thawing.

System C - Two small hairline cracks occurred at 60 cycles and began lenthening at 94 cycles (but remained as hairline cracks). After 110 cycles of freezing and thawing, there was a slight wearing trend.

System D - A small hairline crack developed at 60 cycles and began lenthening at 94 cycles of freezing and thawing.

System E - There was no visible failure of coated surface during 110 cycles of freezing and thawing.

II. Field Results

Observations and inspection after one year.

System A - General appearance good.

System B - General appearance good; however, slight brush overlaps remain visible after drying.

System C - General appearance fair, but coating could be applied thicker to cover blemishes and imperfections in concrete surfaces.

System D - General appearance fair. This system has less uniformity in color since some spots did lighten out after the material was applied. Coating could be applied thicker to fully cover blemishes or imperfections in surface of concrete.

System E - General appearance fair; however, material lacks thickness to fully cover blemishes or imperfections in surface of concrete.

CONCLUSIONS

The laboratory results of all systems applied to structure warrant the following conclusions:

A) All five systems as they are presently applied are acceptable.

B) System A gave the superior abrasive wear results.

C) None of the systems tested were affected by 600 hours of accelerated weathering in the weatherometer (except for a slight wear of System C). Figure 12 through 16 in the Appendix illustrate the results.

D) The durability factor by freeze and thaw testing and visual observation plus the photographs in Figure 18 through 22 will show each material withstood the test satisfactorily.

The results of the field study indicate the following:

A) All systems had some degree of streaking due to water splash from the roadway. The streaking was greater where the slope of the structure was greater.

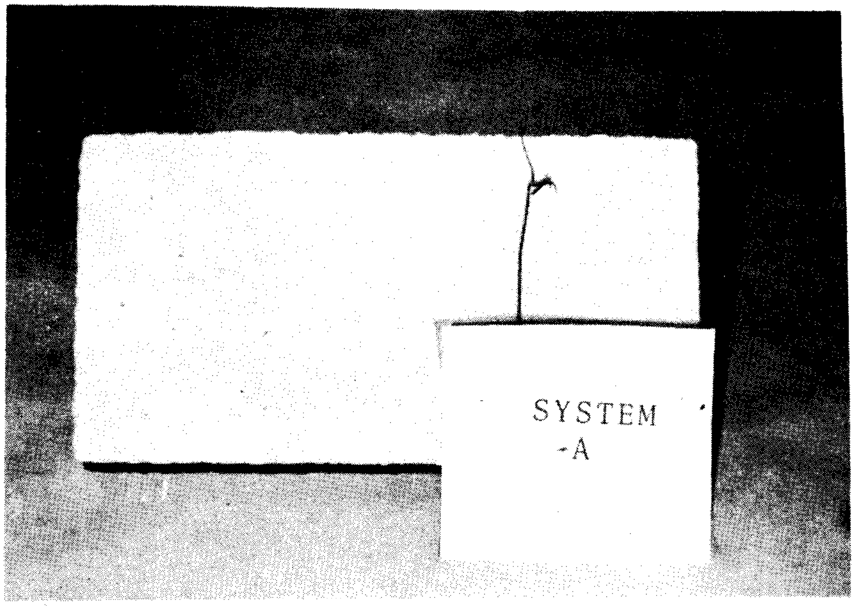
B) A careful visual inspection of all systems was made, and no flaking, cracking, spalling or loss of bond had taken place.

RECOMMENDATIONS

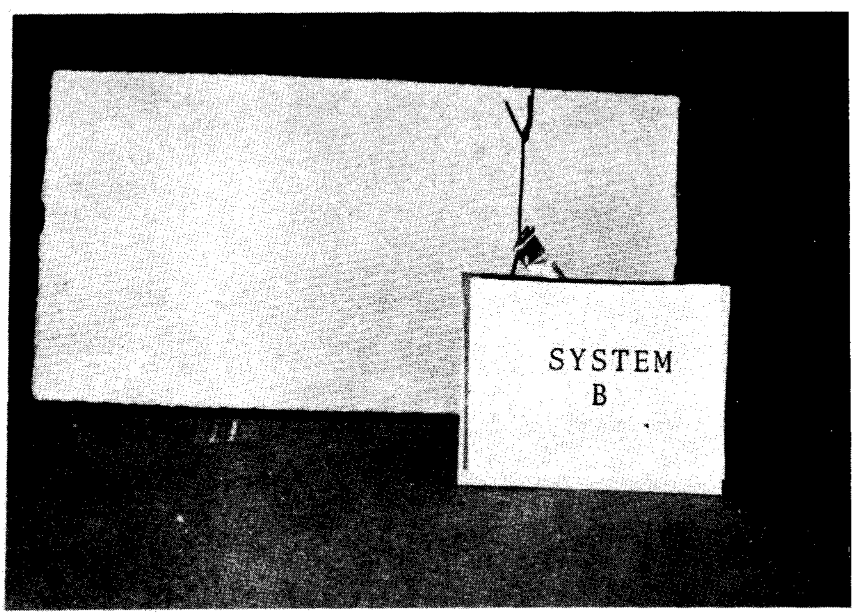
Based upon the results obtained in Phases I and II of this study, the recommendations are 1) that the five systems as described herein be placed on an approved products list and used as alternates to a Class 2 rubbed finish, 2) that the present specifications be expanded to allow for a Class 2B Special Coated Finish and, 3) that the Department should specify a Class 2B Special Coated Finish for which no alternate may be substituted.

APPENDIX

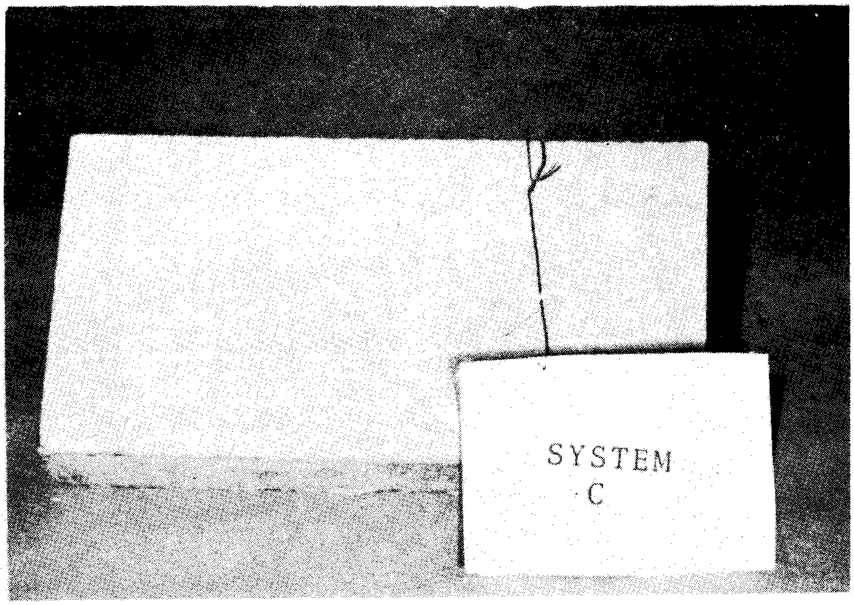
LABORATORY RESULTS



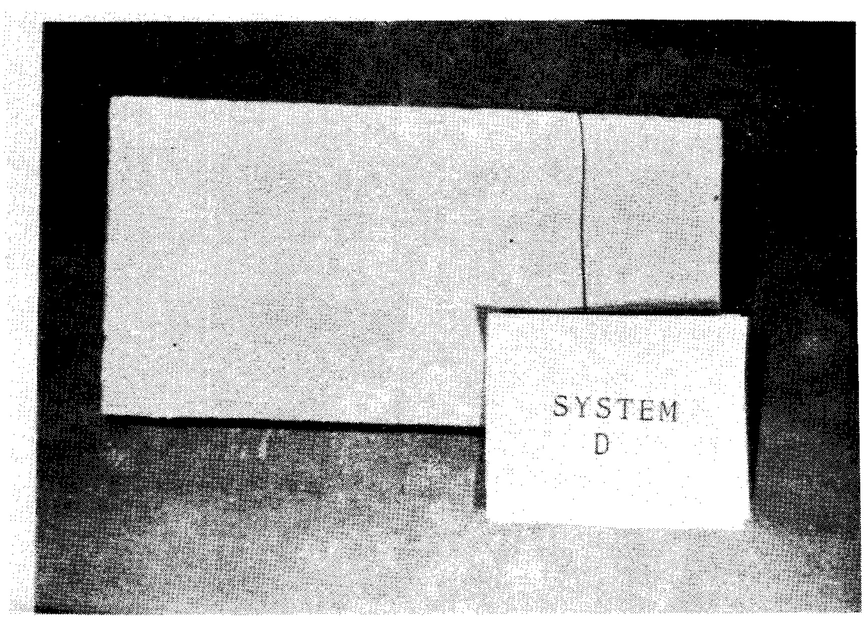
System A Prior to Testing
FIGURE 1



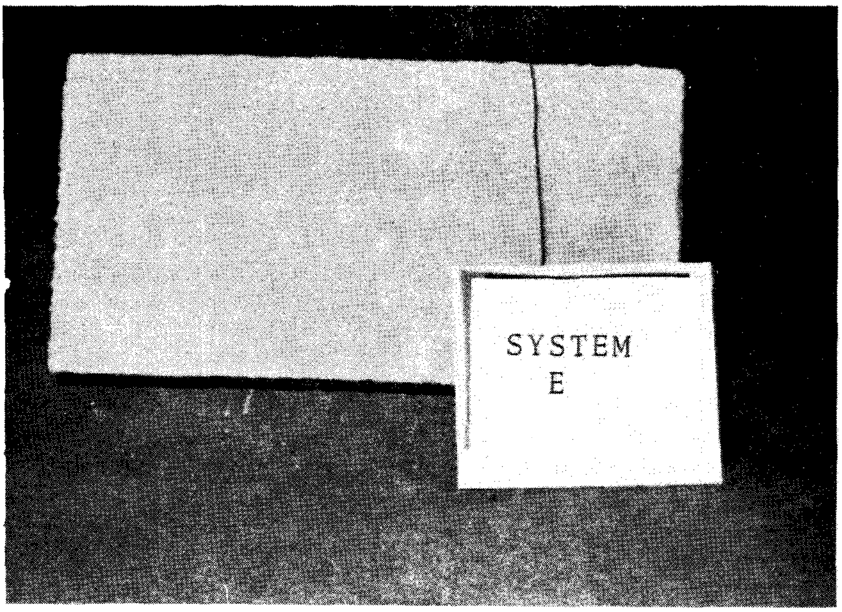
System B Prior to Testing
FIGURE 2



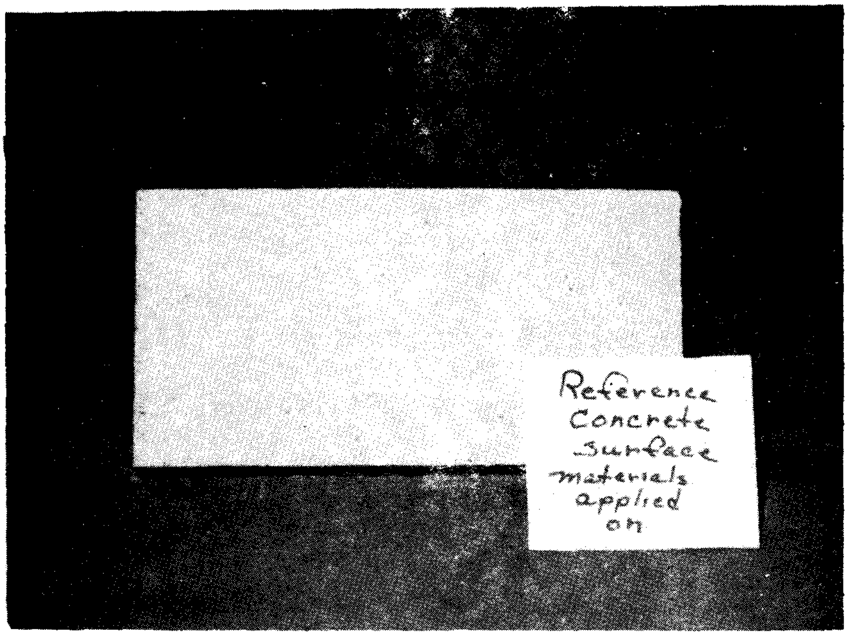
System C Prior to Testing
FIGURE 3



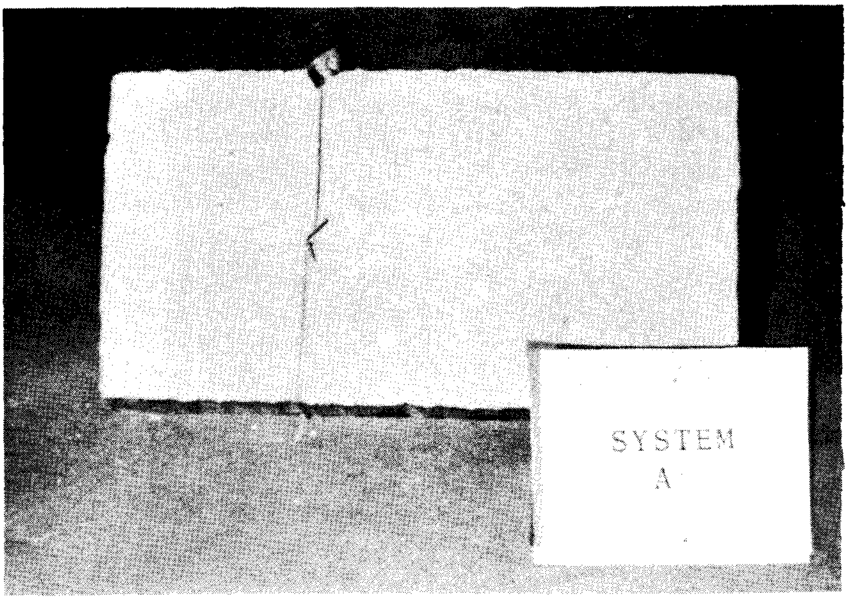
System D Prior to Testing
FIGURE 4



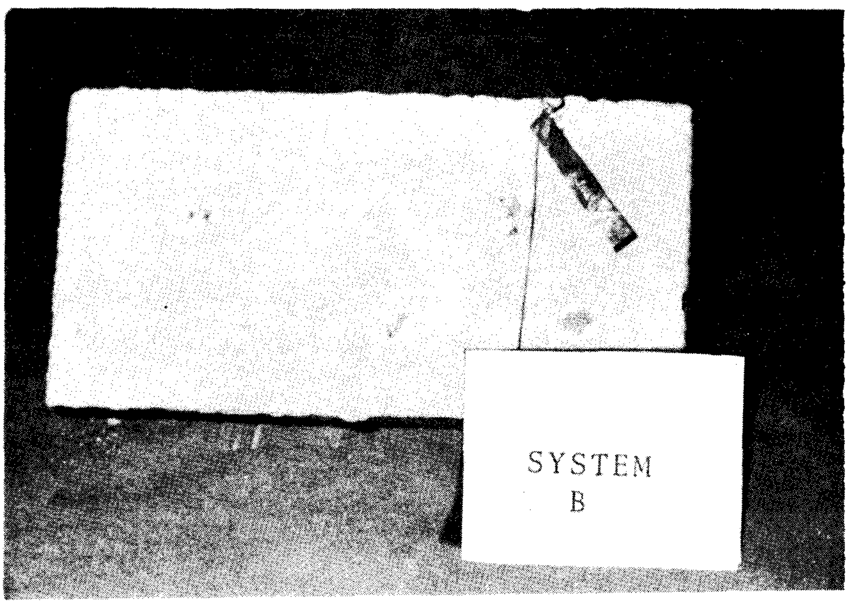
System E Prior to Testing
FIGURE 5



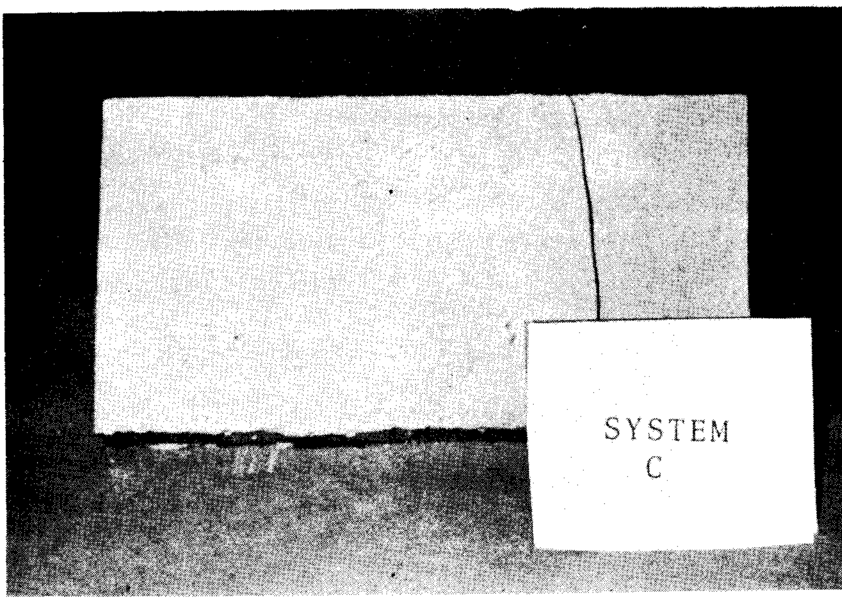
Concrete Specimen Systems Applied
FIGURE 6



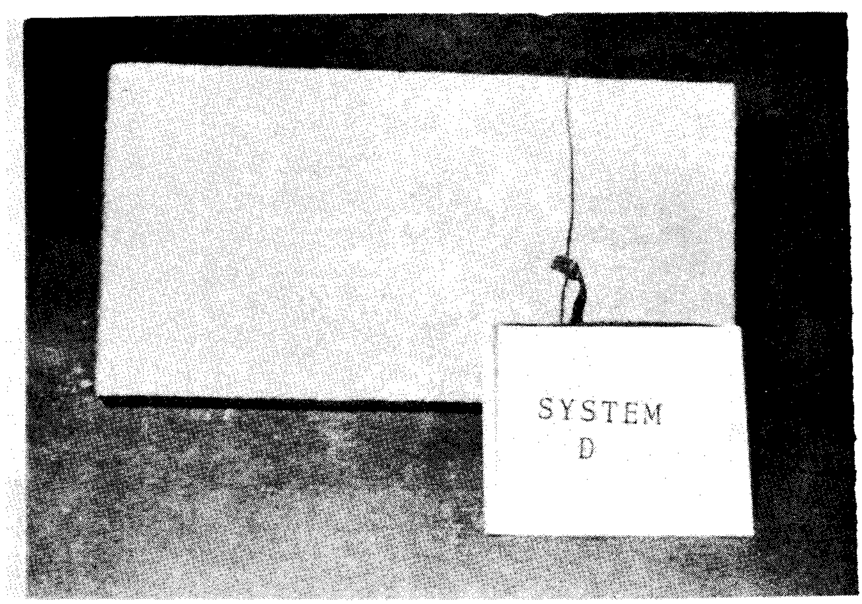
System A After Abrasion Test
FIGURE 7



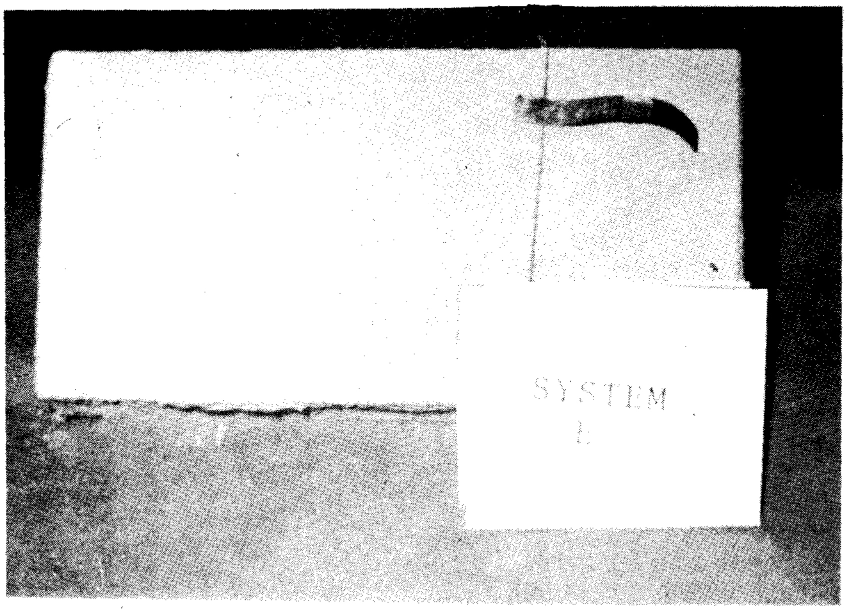
System B After Abrasion Test
FIGURE 8



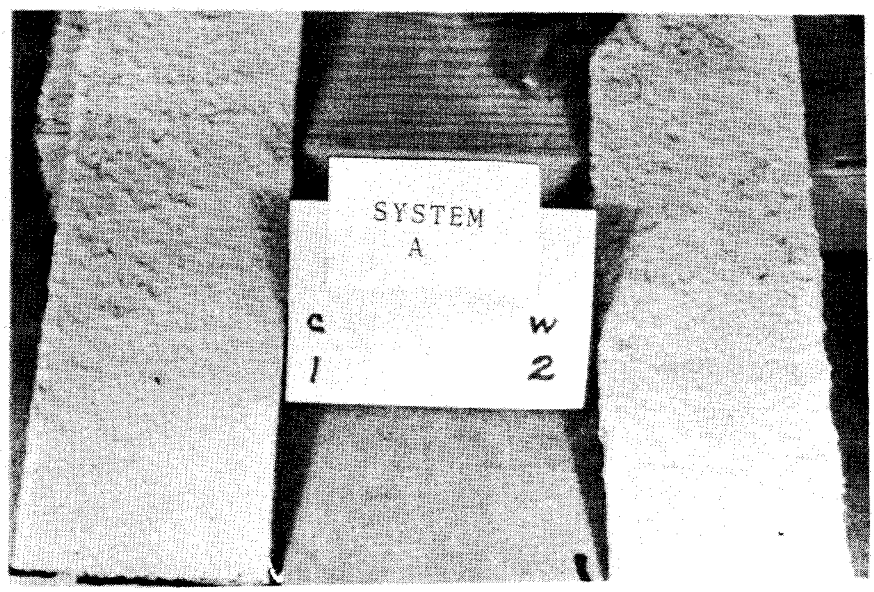
System C After Abrasion Test
FIGURE 9



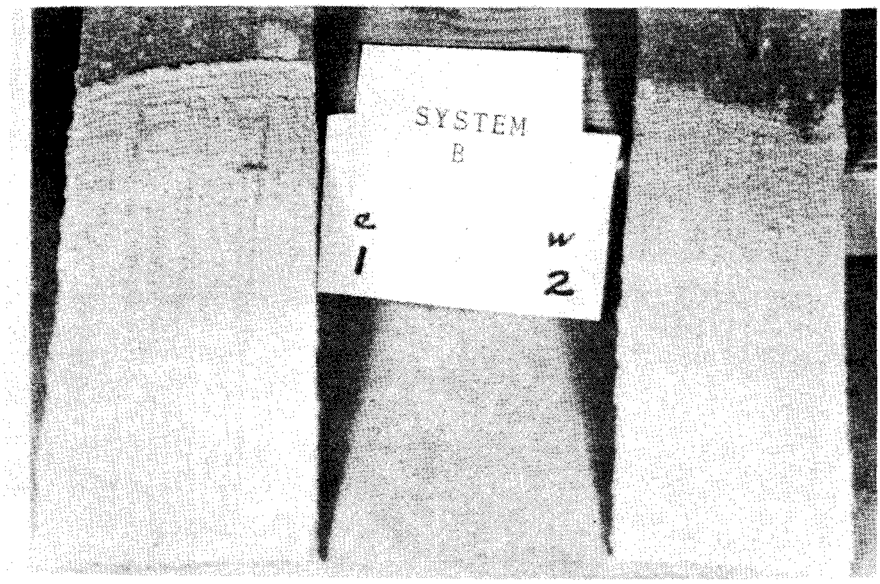
System D After Abrasion Test
FIGURE 10



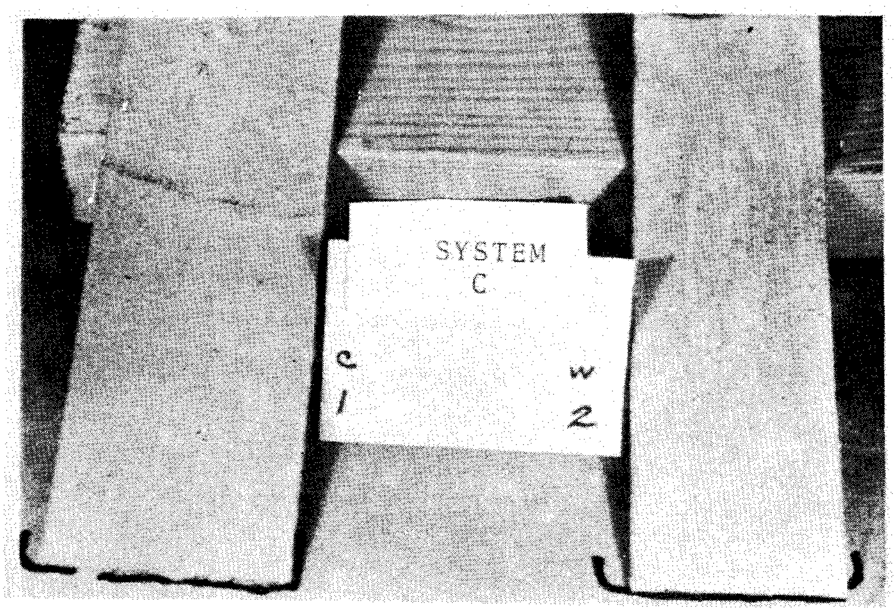
System E After Abrasion Test
FIGURE 11



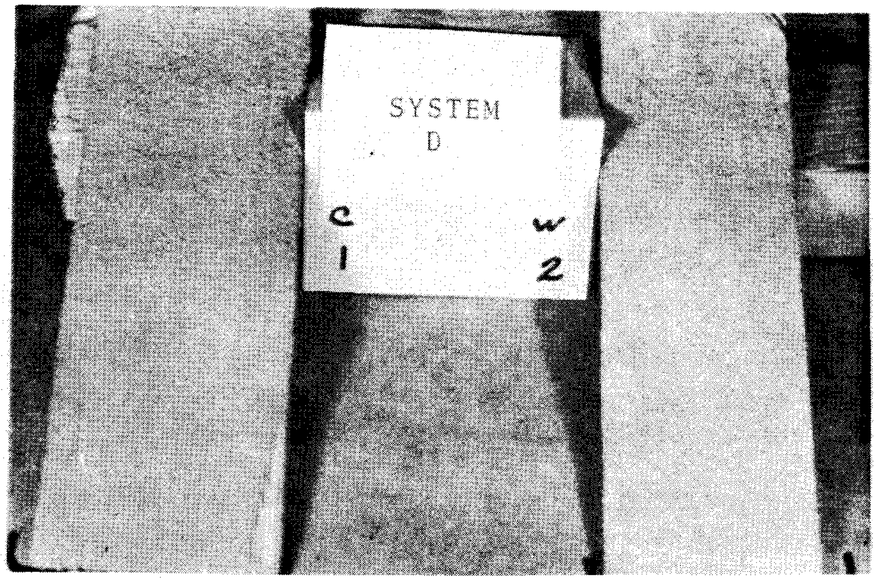
System A After Accelerated Weathering
FIGURE 12



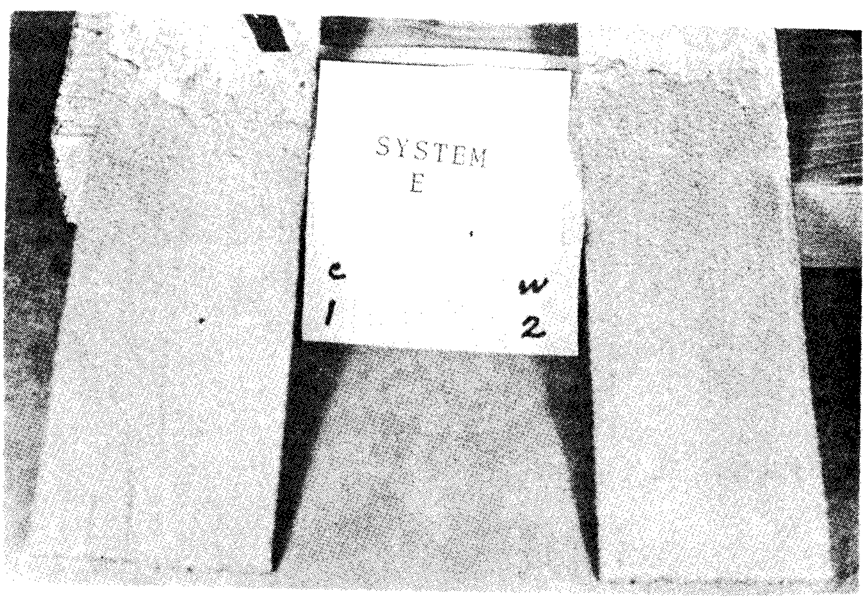
System B After Accelerated Weathering
FIGURE 13



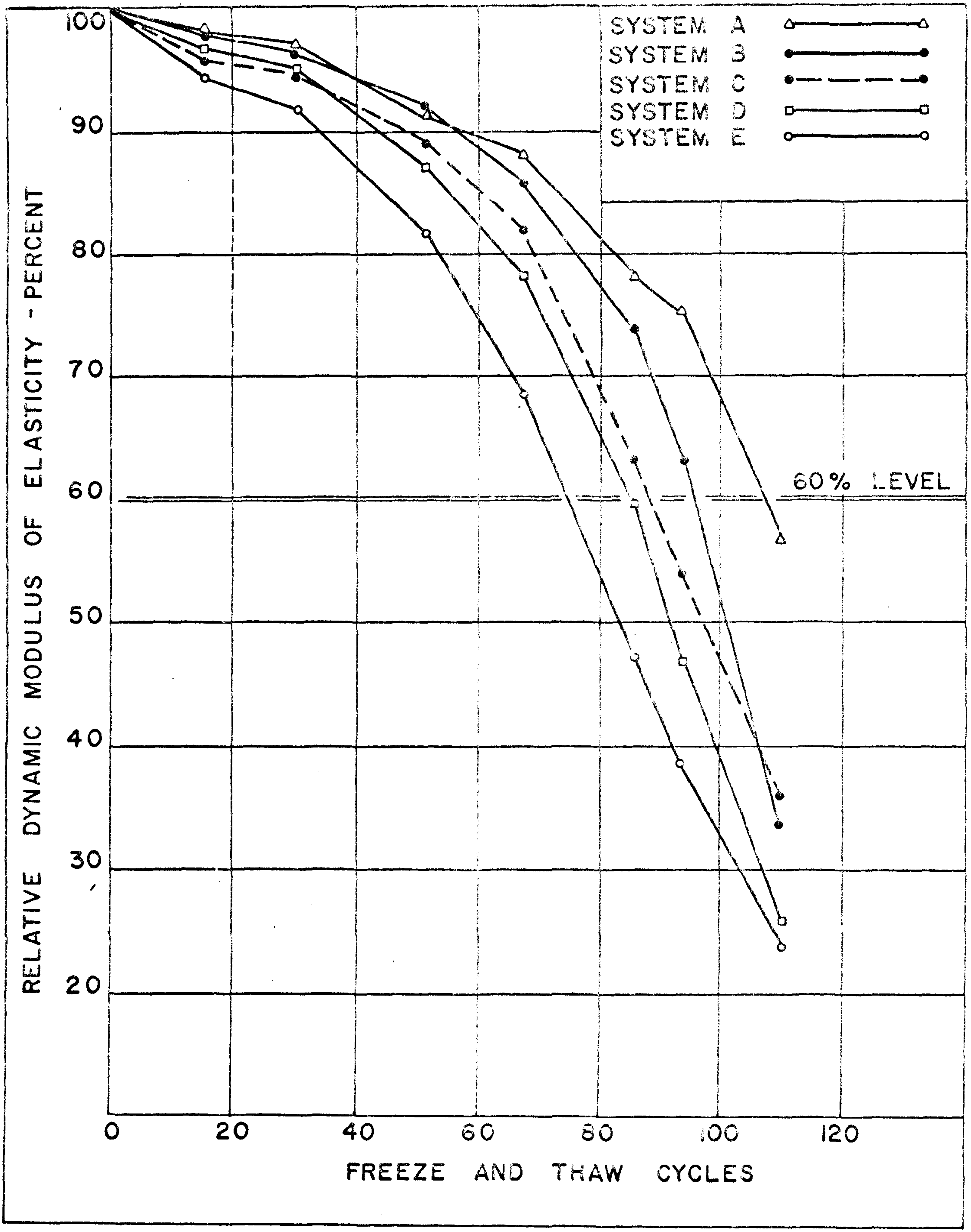
System C After Accelerated Weathering
FIGURE 14

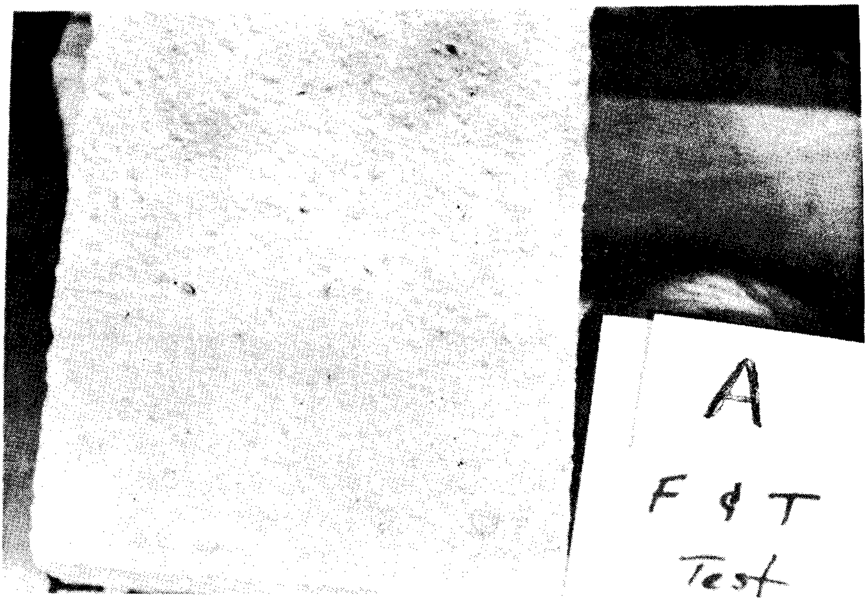


System D After Accelerated Weathering
FIGURE 15

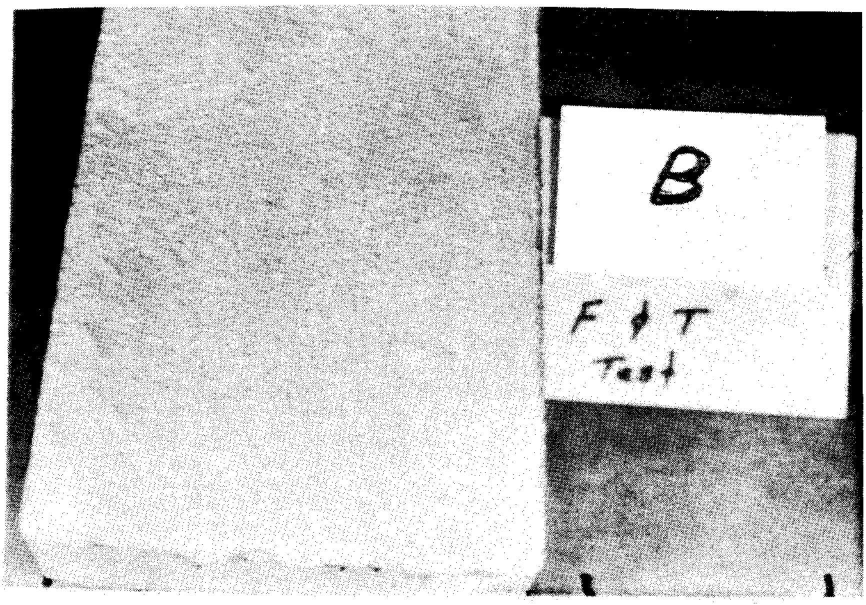


System E After Accelerated Weathering
FIGURE 16

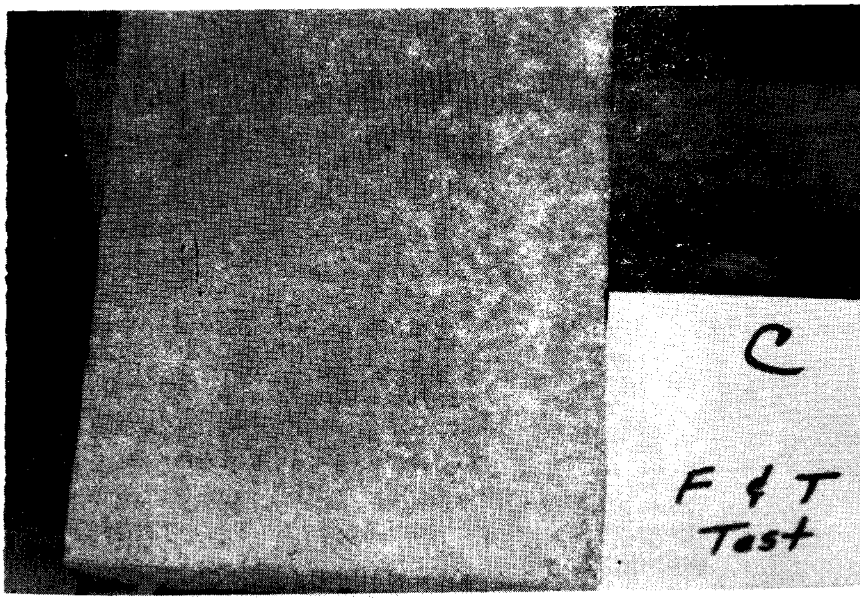

SYSTEM A
SYSTEM B
SYSTEM C
SYSTEM D
SYSTEM E
RELATIVE DYNAMIC MODULUS OF ELASTICITY - PERCENT
100
90
80
70
60
50
40
30
20
60% LEVEL
0
20
40
60
80
100
120
FREEZE AND THAW CYCLES



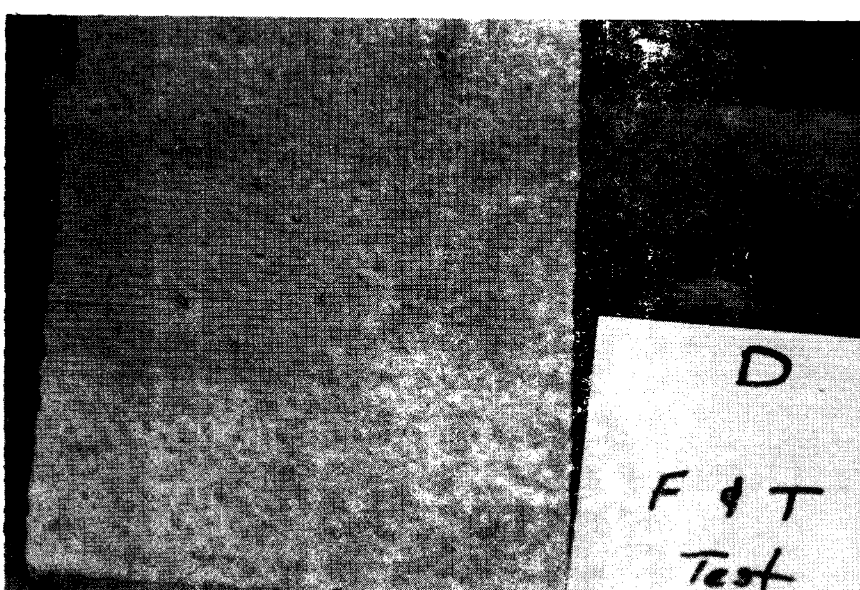
System A After Freeze and Thaw Test
FIGURE 18



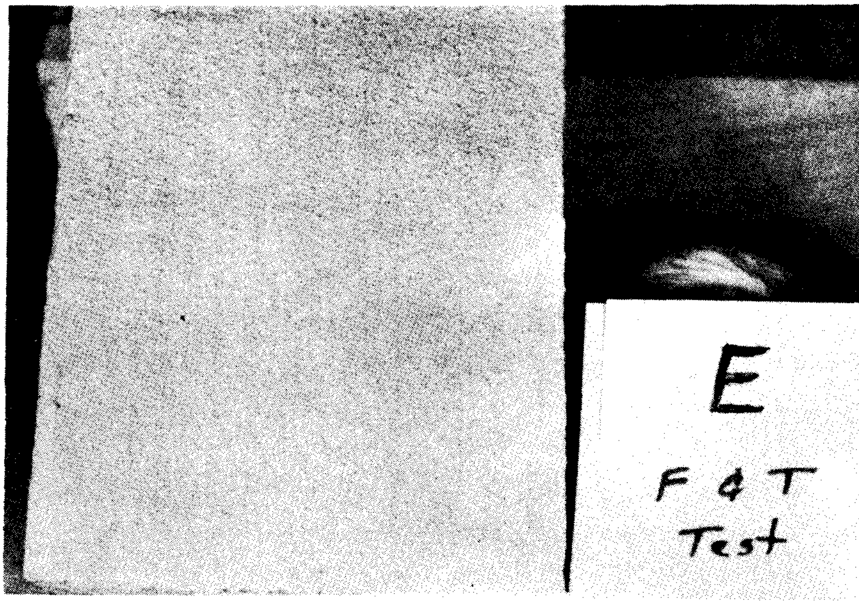
System B After Freeze and Thaw Test
FIGURE 19



System C After Freeze and Thaw Test
FIGURE 20



System D After Freeze and Thaw Test
FIGURE 21



System E After Freeze and Thaw Test
FIGURE 22