FINAL REPORT

of

EVALUATION OF ARCHITECTURAL PANELS SUBJECT TO RAPID FREEZING AND THAWING

Submitted to

Polycrete Industries
1800 N.W. 5th Street
Oklahoma City, Oklahoma

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FEARS STRUCTURAL ENGINEERING LABORATORY
School of Civil Engineering and Environmental Science
University of Oklahoma
Norman, Oklahoma 73019

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INTRODUCTION

Tests were performed at the Fears Structural Engineering Laboratory, University of Oklahoma, Norman, Oklahoma for the Polycrete Industries of Oklahoma City to determine the resistance of 4 types of 16" x 16" panels to rapid freezing and thawing. The four types of panels were cast at Polycrete Industries, 1800 N.W. 5, Oklahoma City, by the employees of Polycrete Industries under the observation of laboratory personnel. The materials for the test, as well as the design mix, were provided by Polycrete Industries. The mix weights and corresponding code numbers are given in Appendix A, Tables A.1 to A.4.

Three samples of each of the four mix designs were subjected to 154 cycles of freezing and thawing in air followed by 93 cycles of freezing and thawing while immensed in water. The samples were inspected daily for signs of wear and degradation and a photographic record of the samples was kept at regular intervals. A complete description of the testing procedure and test results follows.

TEST DETAILS

Test Specimens

The test specimens were made by applying a thin coat of the polymer-bonder to a 16" x 16" cement asbestos board on top of which an architectural rock was placed. The test specimens were allowed to cure for 24 hours at Polycrete Industries and then transported to the Fears Structural Engineering Laboratory for testing.

Test Equipment

An 18.2 cubic foot freeze-thaw cabinet manufactured by Logan Refrigeration Co., Logan, Utah, Model No. ECAM-0075-1AA was used to perform the testing. The air test specimens were placed in the cabinet on shims so that air could flow freely around the specimens. For the water test, the specimens were placed in copper pans with 1/8 in. thick shims between specimens. The stacks of specimens were completely submersed in water during the test.

The chamber is completely automatic and was set for a temperature range of $90^{o}F$ to $-5^{o}F$ throughout the testing. The cabinet cycled approximately four times per day.

TESTING PROCEDURE

Air Test. After the curing period, the specimens were photographed and weighed. The specimens were then placed in the freeze-thaw cabinet and the cycling initiated. The specimens were checked daily for sudden signs of

deterioration.

The specimens were photographed and weighed approximately every 30 cycles. At the end of the cycle prior to testing, the cabinet was opened and the specimens allowed to reach room temperature. The samples were then removed from the cabinet, photographed, weighed and returned to the cabinet.

Testing began on January 10, 1983. On February 21, 1983 with 66 cycles completed, testing was stopped. It was started again on April 10, 1984 and the air test was completed on April 30, 1984.

Water Test. Upon completion of the air test, ten of the samples were placed in two stacks of five each in copper pans. (The two remaining air test samples were not tested do to lack of space.) The samples were separated with shims and the pans filled with water. Freeze-thaw cycling was then reinitiated.

The samples were checked daily and on completeion of 93 cycles were removed from the freeze-thaw cabinet. After air-drying for 24 hours they were weighed and photographed.

TEST RESULTS

Air Test. The test data consists of weights and observations of the samples at approximately 30 cycle intervals. This data is found in Tables B.1 thru B.6. Calculated data consists of the percent of weight gain or loss at the test intervals and is given in Table B.7. (Apparent weight gain may have occurred because of moisture on the specimens or slight errors in measurements.) The 32 and 66 cycle percentages are referenced to the 0 cycle weight, Table B.1. The 96, 125 and 154 cycle percentages are referenced to the reweighed value

at 66 cycles, Table B.3b.

Samples in Series A-X lost an average of 1.6% in weight for the 154 cycles. Samples in the B-Xu series lost an average of 4.9% in weight; samples in the B-Xs series gained an average of 4.9%; and samples in the C-X series lost an average of 2.8%. These percentages are not considered significant.

The samples showed little wear after 154 freeze-thaw cycles. However, a few pieces of rock came off the panels while measurements were being made. It could not be determined if this was due to actual testing or to handling.

Water Test. The test results consist of weights and observations of the specimens after 154 cycles of air testing and 93 cycles of water testing. Results are summarized in Table C.1. The number of loose rocks increased due to the water testing, especially on samples A-1 and A-2. However, the amount of deterioration is not considered significant.

SUMMARY

Freeze-thaw tests of 16" x 16" panels epoxy matrix panels of 4 mix designs were subjected to air freeze- thaw and water freeze-thaw tests. Results indicate that the panels are capable of resisting at least 150 air freeze-thaw cycles and 90 water freeze-thaw cycles without undue deterioration.

APPENDIX A

MIX DESIGNS

Table A.1
Mix Design for Group A (AZ-900 mix)

10 lbs	Epon.
4 lbs	T-Carb.
6 lbs	Novacite
10 lbs	Sand
40 oz.	Cat. 900
2 oz.	Calidria

Table A.2
Mix Design for Group Bu (AZ-450 mix)

10 lbs	Epon.
4 lbs	T-Carb.
6 lbs	Nova
10 lbs	Sand
48 oz.	Cat.
2 oz.	Calidria

Table A.3
Mix Design for Group Bs (AZ-450 mix)

20 lbs	Epon.
8 lbs	T-Carb
12 lbs	Nova
20 lbs	Sand-Chopped Glass
6 lbs	Cat Wetting Agent

Table A.4
Mix Design for Group C (AZ-450 mix)

30 lbs	Epon
12 lbs	T-Carb.
18 lbs	Nova
30 lbs	Sand-Chopped Glass
144 oz.	Catalyst Wetting Agent
5 oz.	Caladria

Table 2
Percent of Weight Loss

Sample	0 Cycles	33 Cycles	66 Cycles
A-1	0	0	-1.3
A-2	0	1.3	3.9
A-3	0	1.3	1.3
B-1u	0	0	0
B-2u	0	1.4	0
B-3u	0	2.7	4.1
B-1s	0	0	2.8
B-2s	0	1.5	-2.9
B-3s	0	-1.4	0
C-1	0	0	0
C-2	0	1.4	2.8
C-3	0	1.4	2.8

Note: (-) indicates an increase in weight which may be due to moisture on the specimen or slight error in weighing.

APPENDIX B

RESULTS OF AIR TEST

Table B.1
Air Test
Weights and Observations of Samples at 0 Cycles

Sample	Weight (lbs)	Observations
A-1	7.8	
A-2	7.7	None
A-3	7.5	
B-1u	7.5	
B-2u	7.3	None
B-3u	7.3	
B-1s	7.2	
B-2s	6.8	None
B-3s	6.9	
C-1	6.9	
C-2	7.1	None
C-3	7.2	

Weighed January 10, 1983

Table B.2
Air Test
Weights and Observations of Samples at 32 Cycles

Sample	Weight (lbs)	Observations
A-1	7.8	-
A-2	7.6	A few small rocks came off
A-3	7.4	-
B-1u	7.5	-
B-2u	7.2	-
B-3u	7.1	-
B-1s	7.2	Small amount of deformation
B-2s	6.7	Small amount of deformation
B-3s	7.0	-
C-1	6.9	-
C-2	7.0	-
C-3	7.1	-

Weighed January 29, 1983

Table B.3a
Air Test
Weights and Observations of Samples at 66 Cycles

Sample	Weight (lbs)	Observations
A-1	7.9	
A-2	7.4	
A-3	7.4	
B-1u	7.5	
B-2u	7.3	A few small rocks fell off
B-3u	7.0	
B-1s	7.0	Small amount of deformation
B-2s	7.0	Small amount of deformation
B-3s	6.9	
C-1	6.9	
C-2	6.9	A few small rocks fell off
C-3	7.0	

Weighed February 21, 1983

Table B.3b
Air Test
Weights and Observations of Samples at 66 Cycles

Sample	Weight (lbs)	Observations
A-1	8.4	Reweighed
A-2	8.3	"
A-3	8.2	"
B-1u	7.9	"
B-2u	7.9	"
B-3u	7.9	"
B-1s	7.6	"
B-2s	7.4	"
B-3s	7.5	"
C-1	7.3	"
C-2	7.5	"
C-3	7.5	"

Weighed April 10, 1984

Table B.4
Air Test
Weights and Observations of Samples at 96 Cycles

Sample	Weight (lbs)	Observations
A-1	8.4	No apparent change
A-2	8.2	" " "
A-3	8.1	" " "
B-1u	7.6	" " "
B-2u	7.5	" " "
B-3u	7.5	" " "
B-1s	7.9	" " "
B-2s	8.0	" " "
B-3s	7.9	" " "
C-1	7.4	" " "
C-2	7.4	" " "
C-3	7.4	" " "

Weighed April 16, 1984

Table B.5
Air Test
Weights and Observations of Samples at 125 Cycles

Sample	Weight (lbs)	Observations
A-1	8.5	No apparent change
A-2	8.2	" " "
A-3	8.2	" " "
B-1u	7.5	" " "
B-2u	7.4	" " "
B-3u	7.3	" " "
B-1s	7.9	" " "
B-2s	8.0	" " "
B-3s	8.0	" " "
C-1	7.4	" " "
C-2	7.6	" " "
C-3	7.5	" " "

Weighed April 23, 1984

Table B.6
Air Test
Weights and Observations of Samples at 154 Cycles

Sample	Weight (lbs)	Observations
A-1	8.4	No apparent change
A-2	8.2	" " "
A-3	8.2	" " "
B-1u	7.6	" " "
B-2u	7.4	" " "
B-3u	7.5	" " "
B-1s	7.9	" " "
B-2s	7.8	" " "
B-3s	7.9	" " "
C-1	7.2	" " "
C-2	7.4	" " "
C-3	7.5	" " "

Weighed April 30, 1984

Table B.7
Air Test
Percent of Weight Gain or Lost

Sample	0 Cycles	32 Cycles*	66 Cycles*	96 Cycles**	125 Cycles**	154 Cycles**
A-1	0	0.0	+1.3	0.0	+1.3	0.0
A-2	0	-1.3	-3.9	-1.2	-1.2	-0.8
A-3	0	-1.3	-1.3	-1.2	0.0	0.0
B-1u	0	0.0	0.0	-3.8	-5.1	-3.8
B-2u	0	-1.4	0.0	-5.1	-6.3	-6.3
B-3u	0	-2.7	-4.1	-5.1	-7.6	-5.1
B-1s	0	0.0	-2.8	+3.9	+3.9	+3.9
B-2s	0	-1.5	+2.9	+8.1	+8.1	+5.4
B-3s	0	+1.4	0.0	+5.3	+6.7	+5.3
C-1	0	0.0	0.0	+1.4	+1.4	-1.4
C-2	0	-1.4	-2.8	-1.3	+1.3	-1.3
C-3	0	-1.4	-2.8	-1.3	0.0	0.0

Note: (+) indicates an increase in weight which may be due to moisture on the specimen or slight error in weighing.

* Reference to weight at 0 cycles.

** Reference to reweigh at 66 cycles.

APPENDIX C

RESULTS OF WATER TEST

Table C.1
Water Test
Weights and Observations of Samples at 93 Cycles

Sample	Weight (lbs)	Observations
A-1	8.8	Numerous loose rocks
A-2	8.7	Numerous loose rocks
A-3	8.6	Loose rocks
B-1u	7.9	No apparent change
B-2u	7.7	No apparent change
B-3u	—	Not tested due to lack of space
B-1s	—	Not tested due to lack of space
B-2s	8.4	No apparent change
B-3s	8.4	Loose rocks
C-1	7.4	Loose rocks
C-2	7.7	No apparent change
C-3	7.8	No apparent change

Note: Weighed 24 hours after removal from water.