NATIONAL BUREAU OF STANDARDS REPORT

9014

WATER PERMEABILITY OF LATEX EMULSION COATINGS ON CONCRETE MASONRY

by

L. F. Skoda and J. O. Bryson

Report to
Office of the Chief of Engineers
Bureau of Yards and Docks
Headquarters, U.S. Air Force

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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ABSTRACT

Three waterproofing systems applied to concrete masonry walls were tested for permeability. The object of these tests was to determine the effectiveness of waterproof coatings that require only an air dry cure. The walls treated with one-and two-coat systems of polyvinyl acetate, acrylic and styrene butadiene latex emulsions were alternately tested and allowed to weather over a period of 5 years. The range of ratings resulting from these tests varied from the one-coat styrene butadiene wall which received a very poor rating prior to weathering to the two-coat acrylic wall which received an excellent rating after over 5 years exposure to weathering.

I. INTRODUCTION

As requested by participating agencies of the Tri-Service Program, The National Bureau of Standards makes specific investigations of properties of building materials, equipment and structural assemblies. The test program for water permeability of latex emulsion coatings on concrete masonry was formulated in consultation with representatives of the Office of Chief of Engineers U. S. Army. The original test program was to include tests of one-coat and two-coat systems of polyvinyl acetate and acrylic emulsion coatings. At the request of the U. S. Air Force a third material, styrene butadiene latex emulsion, was added to the materials under study.

For the past 30 years cement based paints have been used to stop leakage of rain through concrete masonry walls. For proper application of these paints, the wall must be moistened prior to painting and the coatings must be subsequently moist cured. Under certain conditions, such as in windy and arid locations, proper moist curing is difficult to achieve. This investigation was intended to evaluate the effectiveness of sanded cement base paints mixed with polyvinyl acetate, acrylic or styrene butadiene latex emulsions when applied to masonry walls without subsequent moist cure. The use of paints which are effective in stopping leakage through concrete masonry, will result in more economical treatment of leaky walls under adverse conditions.

II. PROCEDURE

2.1 Test Walls

Six permeable concrete masonry test walls were built to accomodate the testing of the waterproofing materials. The walls were approximately 8-in. thick, 40-in. long and 50-in. high. The masonry units used in the walls were autoclaved, cinder concrete, hollow load bearing units with a nominal size of 8-by 8-by 16 inches. The mortar used contained 1:3 parts by volume of Type II masonry cement and masonry sand. The walls were constructed by an experienced mason and the workmanship used was that commonly found in a well constructed concrete masonry building.

2.2 Waterproofing Materials

Mixing liquids and finish paints were supplied in sufficient quantity to meet the needs of the test program by the following manufacturers: The Dow Chemical Company; National Starch Products Inc,; Rohm & Haas Company. The materials were tested for quantitative requirements as outlined in the Interim Federal Specifications designated TT-P-0019a, TT-P-005a and TT-P-0099a dated May 21, 1958. All material met the prescribed requirements.

2.3 Application of Coatings

Two wall specimens were used for the tests of each material. Both walls of each set received a fill coat in the proportions outlined in the Interim Federal Specifications noted above. One of the two walls in each set received an additional coating of finish paint.

The procedure used in applying the fill coat to all walls was essentially the same. The walls were thoroughly dampened one hour prior to application of the coating. The fill coat was scrubbed into the walls with an ordinary fiber bristled scrub brush. The waterproofing mixture was stirred periodically during application to insure against settlement of the cement and siliceous material.

The fill coat was allowed to air dry at 75°F and 50% R.H. for at least a week prior to application of the finish paint. The finish paint was applied with a 4-in. paint brush. The volumes and weights of all materials used were recorded before and after application so that the spreading rate could be determined.

2.4 Test Apparatus & Testing

The test apparatus simulates exposure to a heavy rain, driven by a 50-mph wind. The treated face of a test wall forms one side of a pressure chamber. Water at the rate of 40 gal/hr is applied to the top of the exposed face from a tube containing a line of small holes spaced 3/4 in. apart. Air pressure within the chamber is maintained at 10 lb/ft^2 above atmospheric pressure, equivalent to a hydrostatic head of 2 in. The test is conducted for a minimum of 24 hours and until the best possible rating is achieved.

The test sequence is the same for all walls. The initial permeability test is performed on the untreated wall. The wall is then allowed to dry to constant weight prior to application of the waterproofing material. The test is then repeated on the treated wall. Following this test the wall is moved to an outdoor exposure site for subjection to weathering. At yearly intervals the wall is returned to the laboratory, allowed to dry to constant weight and then retested. This procedure is repeated until the performance rating is significantly reduced.

2.5 Permeability Ratings

The water permeability test ratings are listed below:

Excellent (E) - No water visible on back of the wall (above the flashings) at the end of 1 day. Not more than 25 percent of the wall area damp at the end of 3 days. No leaks 1/ through the wall in 3 days.

Good (G) - No water visible on the back of the wall at the end of 1 day. Less than 50 percent of the wall damp at the end of 1 day. No leaks through the wall at the end of 1 day.

Fair (F) - No water visible on back of the wall during first 3 hours, but visible at the end of 1 day. The rate of leakage through the wall less than 1 liter/hr at the end of 1 day.

Poor (P) - Water visible on back of wall in 3 hr or less and at the end of 1 day. Rate of leakage through the wall less than 5 liter/hr at the end of 1 day.

Very Poor (VP) - Rate of leakage through the wall equal to or greater than 5 liter/hr at the end of 1 day.

Water-resistant coatings applied to permeable concrete masonry should preferably have permeability ratings of Good or Excellent.

Coatings rated as Fair may possibly be considered to have a satisfactory resistance except when subjected to rain with winds of high velocity.

Coatings rated as Poor and Very Poor would be expected to have an unsatisfactory resistance to the penetration of wind-driven rain.

1/ Leaks are defined af follows: A leak is a flow of water from one or both flashings, the combined rate of flow being equal to or greater than 0.05 liter/hr.

III. RESULTS

3.1 Spreading Rates

The spreading rates for the fill coats and finish coats of the three materials that were tested are given in Table I. The spreading rates for the polyvinyl acetate and acrylic emulsion systems are comparable for both the fill coat and finish paint treatments. The spreading rate of the fill coat for the styrene butadiene is considerably higher than the others because the liquid portion of the solution was incapable of holding the cement and sand in suspension. During application of this fill coat the solution was continuously mixed but very little of the cement and sand was brushed into the wall (No. 6). Consequently, when the finish paint was applied to wall No. 6 the spreading rate was somewhat less than that of the other materials as the finish paint had to fill voids that were not filled by the fill coat.

3.2 Permeability Tests

The results of the permeability tests are given in Table II. There was no significant difference in the tests of the untreated walls. This indicates that the materials of construction and the workmanship were the same for each wall.

The determination of visible water on the back of walls numbered 2 & 3 at 2.7 & 3.2 years exposure occurred sometime between 5 P. M. of the first day of the test and 9 A. M. of the following day. The apparatus used for the permeability test is capable of operating unattended, but visual observations were only made during the working day. The ratings of these walls were not affected by this inaccuracy because the visible water occured more than 3 hours after the start of test and no flashing leak was evident.

An examination of the rating column in Table II indicates that walls numbered 1, 2 and 5 received better ratings after a number of years of exposure than after brief periods of exposure. This phenomenon is not unusual and has been evidenced in other test programs. This improvement in rating is attributed to the accumulation of dust, dirt

and other foreign matter (as a result of weathering) on the wall surface and particularly in the voids and cracks that cause penetration and leakage of water.

3.3 Discussion of Results

Of the three materials tested, the two-coat acrylic emulsion treatment was the most successful. After more than 5 years of exposure to weathering this wall withstood the penetration of wind driven rain for 5 days with only a small area of the wall becoming damp. In every other case where the test wall received on initial acceptable rating (Fair or Good) the rating was reduced with time. The styrene butadiene treated walls had a rating of Poor at best. This is understandable in light of the relatively greater spreading rate of the fill coat of styrene butadiene.

IV. CONCLUSIONS

(1) It is possible to waterproof a highly permeable masonry wall with latex base waterproofing compounds thereby eliminating the necessity for any kind of curing other than air drying.

(2) Of the three materials tested the two coat acrylic emulsion system was superior to the other systems.

(3) All systems with initially acceptable ratings (other than the two coat acrylic) were reduced in rating after the initial exposure period.

(4) The improvement of the permeability rating after an extended period of time is attributed to the accumulation of foreign matter in the voids of the walls due to weathering.

TABLE I. SPREADING RATES

Wall No.	Water Proofing Material	Type of Coating	Spreading Rate $Ft.^2/gal$
1	Polyvinyl Acetate	Fill	64
2	" "	Fill	68
2	" "	Finish	160
3	Acrylic	Fill	60
4	"	Fill	50
4	"	Finish	171
5	Styrene Butadiene	Fill	204
6	" "	Fill	204
6	" "	Finish	137

Table II Permeability Test Data

Wall No.	Condition of wall	Duration of Test days	Time to Failure as Indicated by: Damp on Back hr	Visible Water on back hr	Flashing Leak hr	Max. Rate of Leakage L/hr	Area Damp at End of Test %	Rating
	Untreated	1	0.05	0.13	0.10	28.9	91	VP
	PVA Fill Coat	1	1.16	5.53	14.53	0.1	80	F
	1.5 yrs Exposure	1	0.33	1.05	0.73	14.4	95	VP
#1	2.7 yrs Exposure	1	0.75	1.52	None	None	85	P
	3.6 yrs Exposure	1	0.62	1.08	None	None	90	P
	4.7 yrs Exposure	1	0.40	0.80	None	None	83	P
	5.7 yrs Exposure	1	0.40	0.70	None	None	92	P
	Untreated	1	0.06	0.08	0.10	30.6	97	VP
	PVA Fill Coat & Finish Paint	5	3.00	30.00	None	None	35	G
	1.5 yrs Exposure	1	2.00	4.00	None	None	83	F
#2	2.7 yrs Exposure	1	0.51	14.5±8	None	None	80	F
	3.6 yrs Exposure	1	0.65	2.32	None	None	85	P
	4.7 yrs Exposure	1	0.57	2.70	None	None	30	P
	5.7 yrs Exposure	1	0.68	3.67	None	None	67	F
	Untreated	1	0.08	0.08	0.08	20.4	97	VP
	Acrylic Fill Coat	5	3.00	90.00	None	None	37	G
	1.1 yrs Exposure	1	1.85	7.65	None	None	63	F
#3	2.3 yrs Exposure	1	3.36	6.55	None	None	27	F
	3.2 yrs Exposure	1	3.50	14.5±8	None	None	40	F
	4.3 yrs Exposure	1	3.20	6.48	None	None	17	F
	5.4 yrs Exposure	1	3.25	6.02	None	None	40	F
	Untreated	1	0.07	0.10	0.08	26.40	98	VP
	Acrylic Fill Coat & Finsih Paint	5	72.00	None	None	None	2.6	E
	1.1 yrs Exposure	5	6.80	None	None	None	3.3	E
#4	2.3 yrs Exposure	5	22.70	None	None	None	7.0	E
	3.2 yrs Exposure	5	7.12	None	None	None	35.0	E
	4.3 yrs Exposure	5	22.90	None	None	None	23.0	E
	5.3 yrs Exposure	5	23.20	None	None	None	17.0	E
	Untreated	1	0.02	0.02	0.02	44.4	88	VP
#5	Sty. But. Fill Coat	1	0.32	0.32	0.33	31.2	90	VP
	1.2 yrs Exposure	1	0.11	0.15	0.15	1.56	95	P
	Untreated	1	0.03	0.03	0.06	44.4	90	VP
#6	Sty. But. Fill Coat & Finish Paint	1	0.48	1.13	1.30	1.2	87	P
	1.2 yrs Exposure	1	0.25	0.28	0.28	1.8	88	P


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