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NATIONAL BUREAU OF STANDARDS REPORT

6442

SEALING SYSTEMS FOR ASPHALT SHINGLES

by

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and

H. R. Snoke

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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W. C. Cullen and H. R. Snoke

Floor, Roof and Wall Coverings Section
Building Technology Division

Sponsored by

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

NBS

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NATIONAL BUREAU OF STANDARDS

SEALING SYSTEMS FOR ASPHALT SHINGLES

1. INTRODUCTION

The most frequent cause of premature failure of free-tab asphalt shingles is damage by wind. The usual mechanism of failure is that winds of moderate intensity weaken the tabs by continued flexing so that they become vulnerable to gusts of more than 50 miles per hour that are not unusual.

A method for preventing wind damage by applying a small amount of plastic cement to the under side of each shingle tab has been used effectively for a number of years. More recently, most manufacturers of asphalt shingles have applied adhesives on the surface of the shingles or underneath the tabs in the course of manufacture. With one exception, heat-sensitive adhesives that soften and seal the tabs at roof temperatures have been used. The exception used a pressure sensitive adhesive.

This report gives the results of a three-phase study of the effectiveness of factory- and on-the-job-applied adhesives of shingles from 10 manufacturers as follows:

(1) Laboratory study without wind
(2) Wind-resistance study
(3) Field observations.

Section 2 states the conclusions drawn from the three studies. Appendices I, II, and III describe the details of the three studies.

2. SUMMARY AND CONCLUSIONS

2.1 Laboratory Studies

2.1.1 Fifty percent of the shingles submitted indicated adequate sealing characteristics at moderate temperatures (100 to 120°F.), while the remainder exhibited little or no ability to seal at these temperatures.

2.1.2 All shingles indicated adequate sealing characteristics when exposed at temperatures of 140°F. to 160°F. for 16 hours.

2.1.3 Generally, the strength of the adhesive bond increased with increased area and thickness of the adhesive. This does not, of course, hold true universally since differences in types and properties of the various adhesives were evident from the laboratory study.

2.1.4 Water had no appreciable effect on the bond strength of the adhesive once sealing had occurred.

2.1.5 The initial strength of bond of shingles sealed with plastic cement was poor, apparently because of solvent retention. However, after aging for one week at room temperature, and further conditioning for 16 hours at 100°F, the bond was superior to that of the self-sealing systems.

2.2 Roof Exposures, Washington, D. C.

2.2.1 Under tab temperatures determined in July 1958, with shingles surfaced with dark granules, exceeded 160°F. and remained above 140°F. for more than 5 hours in a single day. Shingles surfaced with white granules reached a maximum of 135°F. and remained above 120°F. for more than 5 hours. These temperatures would probably be equaled in most areas of the United States.

2.2.2 All specimens of self-sealing shingles, regardless of color or manufacture, and the specimens sealed with plastic cement, exposed outdoors in Washington, D. C., in March 1958, on a slope of 4 in. in 12 in. facing south, attained an adequate seal by May 1958.

2.2.3 The adhesive bond of all shingles referred to in 2.2.2 was broken intentionally in December 1958. By March 1959 all had resealed with an adequate bond. An adequate bond indicates ability to restrain the shingle tab in winds with an average velocity of 60 m.p.h.

2.3 Wind-Resistance Studies

2.3.1 Ten samples of shingles with factory-applied adhesives, representing the products of 10 manufacturers, were conditioned at various temperatures for 16 hours and subjected to winds of 60 miles per hour for 2 hours. The results were:

(a) Two samples sealed adequately at 120°F.
(b) Five samples sealed adequately at 140°F.
(c) Three samples required a temperature of 160°F. for adequate sealing.

2.3.2 The shingles sealed with plastic cement indicated inferior performance when tested by the same procedures as the self-sealing shingles. However, when aged for one week prior to test they indicated performance as least as good as the self-sealing type.

2.4 Field Studies

2.4.1 Self-sealing shingles showed adequate bond in all areas where they were inspected, including northern New York, New England, Washington, D. C., Arkansas, Florida, Louisiana, and Texas.

2.4.2 The sealing systems examined in the field, including some that showed the poorest performance in the wind-resistance tests, indicated adequate bond strength in Northern and Southern States.

2.4.3 Adeuqate sealing was observed on roofs with slopes of 2 in. to 6 in. per foot.

2.4.4 The self-sealing systems performed adequately regardless of the direction of exposure.

2.4.5 Asphalt shingles sealed with plastic cement in the field indicated adequate bond strength.

2.4.6 Self-sealing shingles with heat-sensitive adhesives, applied in cold weather, cannot be expected to seal immediately.

2.4.7 Shingles sealed with plastic cement cannot be expected to seal immediately, because an adequate bond depends upon the evaporation of a volatile solvent. As with the heat-sensitive adhesives, development of an adequate bond will be slower in cold weather. The delay in sealing of shingles applied in cold weather is not considered to be too critical, because shingles newly applied are less likely to be damaged than weathered shingles.

2.4.8 The additional cost of self-sealing shingles or of sealing shingles with plastic cement is offset somewhat by the fact that only 4 nails per shingle are required.

2.4.9 A disadvantage of some self-sealing shingles, reported during the field survey, was sticking of shingles in the bundles when stored on a roof at elevated temperatures.

2.4.10 A disadvantage of the plastic cement method of sealing is that many tabs are not sealed through carelessness.

2.5 General Conclusions

2.5.1 From the results of the laboratory tests, wind-resistance tests, and observed behavior in the field, it can only be concluded that the development of self-sealing systems for free-tab asphalt shingles represents a major improvement in asphalt shingles by the industry.

2.5.2 While no direct comparison can be made, self-sealing systems in current use appeared to be as effective as the system using plastic cement as the adhesive.

2.5.3 Criteria for the performance of self-sealing systems should be established. From the results of these studies it would appear that self-seal asphalt shingles conditioned for 16 hours at 140°F. should be required to withstand winds of 60 miles per hour.

3. ACKNOWLEDGMENT

The authors acknowledge the assistance of the manufacturers of asphalt shingles for furnishing the location of roofs, help in making inspections, and providing samples of asphalt shingles. In addition, the assistance of Air Force, Army, and Navy personnel during the field survey is also acknowledged.

APPENDIX I. LABORATORY STUDY

1. Introduction

A laboratory study was planned to furnish background information to supplement the wind-resistance tests and the actual performance of self-sealing shingles as they were observed in the field survey. A series of tests was designed to study the variables which are necessarily present in the manufacture, application, and weathering characteristics of these materials. The study included an examination of the various sealing systems, the determination of typical roof temperatures to which asphalt shingles are exposed, and an investigation of the sealing characteristics of each system under semi-controlled conditions of outdoor exposure. In addition, a study was made of the adhesive bond after exposure to conditions similar to which they may be exposed outdoors, employing an apparatus designed and constructed for these experiments.

2. Samples and Description of Self-Sealing Systems

In response to a National Bureau of Standards letter, ten manufacturers submitted samples of self-sealing asphalt shingles. The samples submitted included shingles surfaced with white and dark colored granules. A description of the self-sealing systems and the assigned NBS numbers follow:

NBS No. 1 - Type: 210 lb. Thick Butt

Adhesive:

Type - Heat sensitive
Where applied - On front
Description - Row of 1-in. diameter spots, spaced $2\frac{1}{2}$ in. apart.
Area per tab - 4.3 in.^{2}

NBS No. 2 - Type: 210 lb. Thick Butt
210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On back
Description - Series of 4-1/4- by 3/4-in. strips, spaced 1/2-in. apart.
Area per tab - 9.0 in.^{2}

NBS No. 3 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On front
Description - Series of strips, 4- by 3/4-in., spaced in pairs, 1 in. apart, with 3-1/2 in. distance between pairs.
Area per tab - 5.5 $in.^2$

NBS No. 4 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On front
Description - Series of 3- by 1/2-in. strips, spaced 3 in. apart.
Area per tab - 3.4 $in.^2$

NBS No. 5 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On front
Description - Series of 4- by 3/4-in. strips, spaced 2 in. apart.
Area per tab - 6.0 $in.^2$

NBS No. 8 - Type: 210 lb. Thick Butt

Adhesive:

Type - Heat sensitive
Where applied - On back
Description - Two 5- by 3/4-in. strips, applied to each tab.
Area per tab - 7.5 $in.^2$

NBS No. 9 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On back
Description - Continuous strip, 3/4-in. wide across tab.
Area per tab - 8.6 in.^{2}

NBS No. 10 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On front
Description - Series of 4- by 3/4-in. strips, spaced 2 in. apart.
Area per tab - 6.4 in.^{2}

NBS No. 11 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Pressure sensitive
Where applied - On front
Description - Continuous strip, 1/2-in. wide across tab.
Area per tab - 5.8 in.^{2}

NBS No. 12 - Type: 210 lb. Uniform Thickness

Adhesive:

Type - Heat sensitive
Where applied - On front
Description - Series of 1-in. diameter spots, approximately 4 per tab.
Area per tab - 3.2 in.^{2}

3. Roof Temperatures

A knowledge of temperature and rate of change of temperature is most important not only as these variables affect the durability of roofing materials and the comfort of building occupants, but also as they influence the sealing characteristics of the factory-applied adhesives used on the self-sealing shingles. Heat-sensitive adhesives are used by all except one manufacturer. Therefore, typical temperatures which are reached at the location of the adhesive should be known. In this connection, a series of temperature determinations was made under the shingle tab of each of two different color shingles. The colors selected for the determinations were black and white, since it is felt that these colors represent the maximum and minimum in regard to their ability to absorb solar energy. The temperatures were recorded at hourly intervals on selected days using copper-constantan thermocouples. The decks were located in Washington, D. C., with the shingles facing south on a slope of 4 inches in 12 inches.

The maximum temperatures recorded on the dates indicated, as well as the temperature differences between black and white shingles, are presented in Table 1. The maximum temperature was usually recorded between 1:00 and 2:00 P.M.

TABLE 1. MAXIMUM UNDER-TAB TEMPERATURES ON TYPICAL DAYS.

Date	Ambient Temp.	Max. Temp. White Shingle	Max. Temp. Black Shingle	ΔT
12 May	79°F.	119°F.	142°F.	23°F.
9 June	86°F.	128°F.	153°F.	25°F.
11 June	94°F.	135°F.	160°F.	25°F.
30 July	92°F.	133°F.	158°F.	25°F.
21 Nov.	53°F.	72°F.	89°F.	17°F.

Figure 1. gives the typical time-temperature curves for black and white asphalt shingles as they were recorded on sunny, windless days in July and November. The curves indicate that a black shingle will rarely reach a temperature in excess of 90°F. during the winter months. On the other hand, the black shingle will reach a temperature of 160°F. during the warmer months and will remain at a temperature in excess of 120°F. for 8.5 hours and in excess of 140°F. for more than 5 hours. The white shingle will be from 17°F. to 25°F. cooler than its black counterpart, and can only be expected to reach a maximum of 140°F. during the summer. However, it will remain at a temperature in excess of 120°F. for more than 5 hours.

4. Outdoor Exposures

Twenty-two samples of self-sealing shingles, representing the products of 10 manufacturers, were exposed at Washington, D. C., on racks facing south on a slope of 4 inches per 12 inches. White shingles as well as those surfaced with dark-colored granules were exposed. Figure 2 shows views of the exposure racks.

The samples were exposed in March 1958 and were inspected periodically for evidence of self-sealing. There were great differences noted in regard to the self-sealing ability among the products of the various manufacturers and between the white and dark colored shingles. As expected, the shingles surfaced with the dark colored granules sealed in the shortest time. However, after 50 days exposure, i.e., prior to May 1958, the tabs of all specimens were sealed. Table 2 places each sample into one of three groups according to self-sealing ability. Group 1 indicates the better self-sealing characteristics.

TABLE 2. PERFORMANCE RATING - INITIAL SEALING ABILITY

Group No.	Sample No.
1	2, 8, 9, 10, 11
2	3, 4
3	1, 5, 12

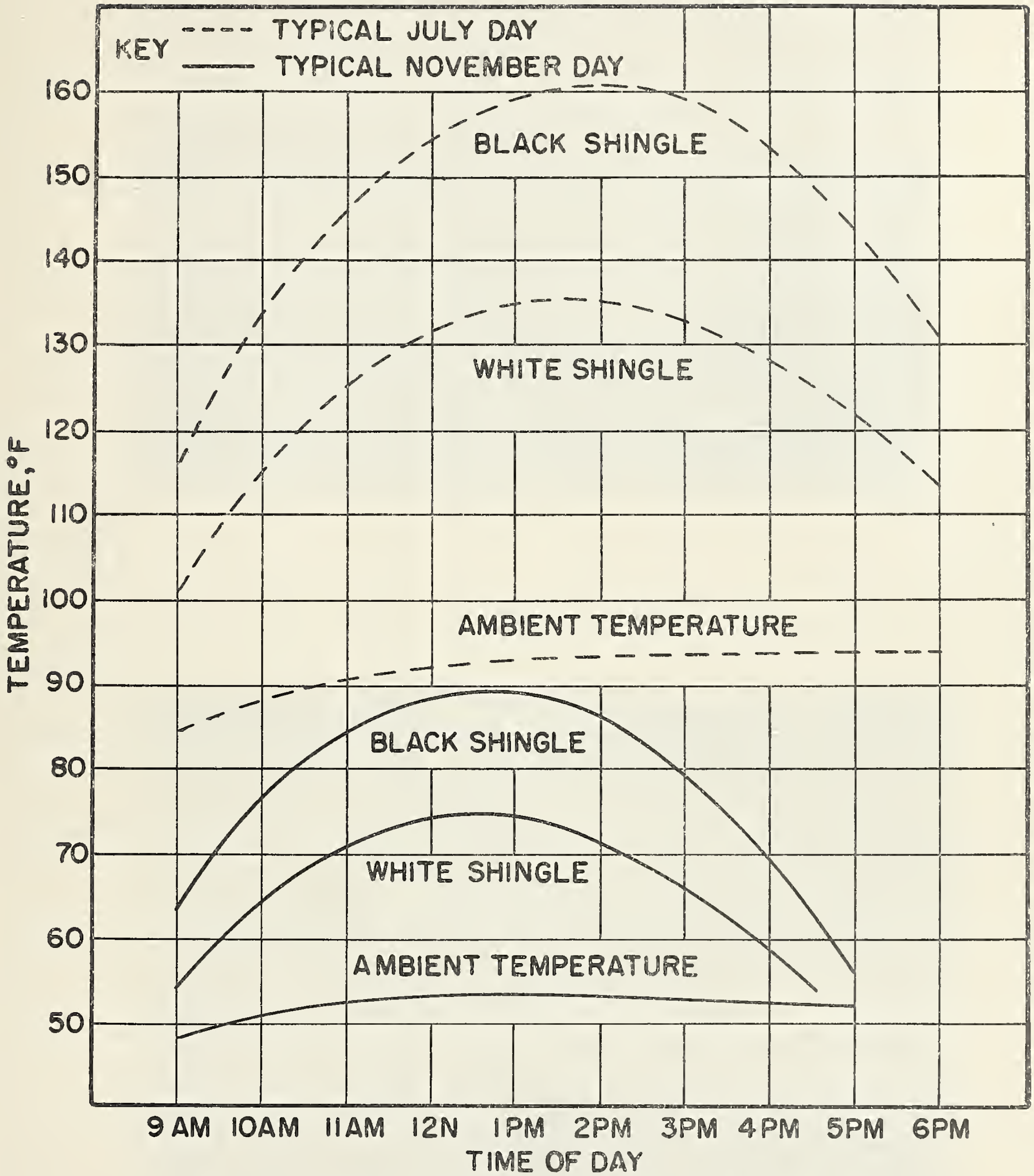
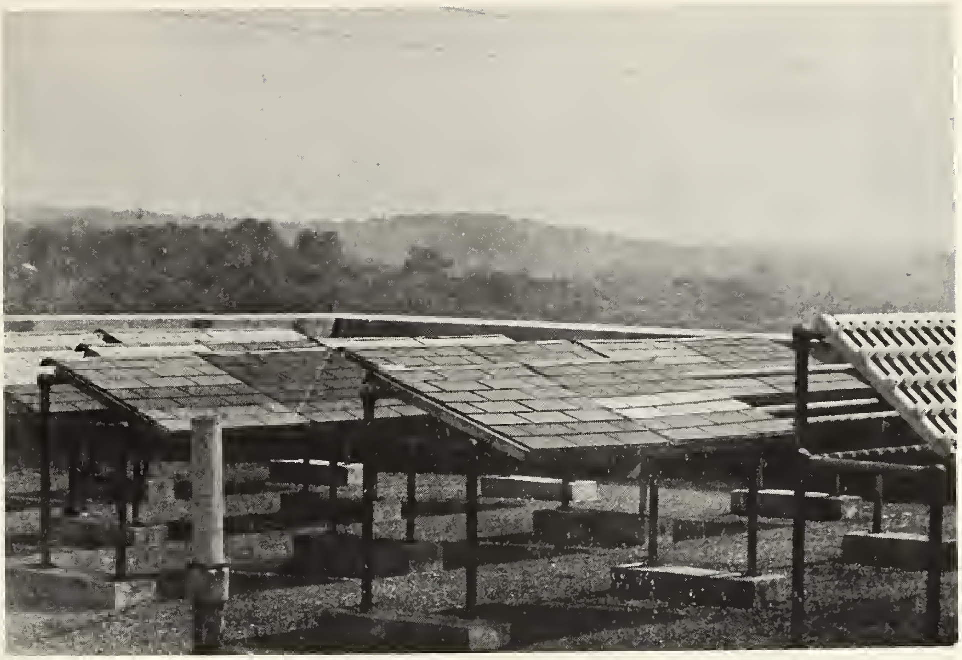


FIG. 1 – TIME–TEMPERATURE CURVES FOR BLACK AND WHITE ASPHALT SHINGLE ROOFS.



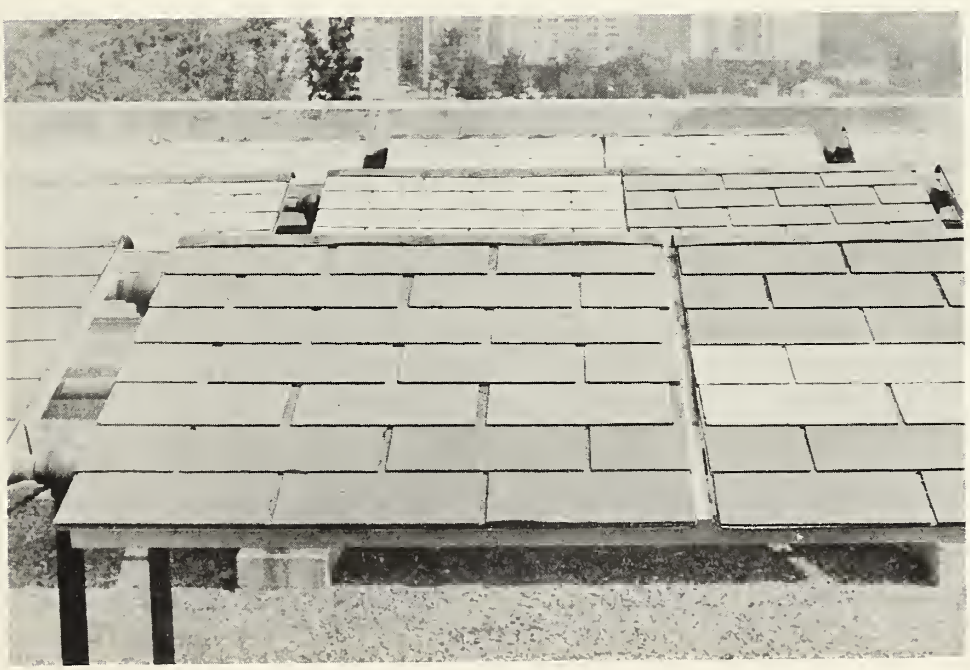


FIG. 2 - EXPOSURE RACKS.

The adhesive bond of one tab of each sample was intentionally broken in December 1958. The samples were periodically examined for evidence of resealing. By April 1959, all tabs which had the broken bonds had resealed. Table 3 places each sample into one of three groups according to its ability to reseal. The dark shingles again showed the better resealing ability when compared with their white counterparts.

TABLE 3. PERFORMANCE RATING - RESEALING ABILITY

Group No.	Sample No.
1	2, 5, 8, 11
2	4, 9, 10
3	1, 3, 12

5. Bond Strengths of the Factory-Applied Adhesives

A method was developed during the laboratory study to determine the strength of the bond of the factory-applied adhesive systems employed by the various manufacturers of self-sealing shingles. In essence, the method measures the force necessary to break the adhesive bond after the specimens had been conditioned to preselected temperatures for constant time intervals. An apparatus designed and constructed to measure the force is shown in three views in Figure 3.

5.1 Test Procedure

The test procedure consisted of clamping a previously conditioned specimen of a self-sealing shingle (a 6- by 12-in. section was sealed to a 4- by 12-in. section under controlled conditions) to the movable platform of the test apparatus. The lower edge of the top section was attached to a scale by means of a clamp, chain and pulley system as shown in the photographs in Figure 3. The platform was then put into motion at a speed of 0.2 ft. per second and the force necessary to break the adhesive bond was recorded on the scale. The photographs shown in Figure 3 were made immediately after the adhesive bond failed.

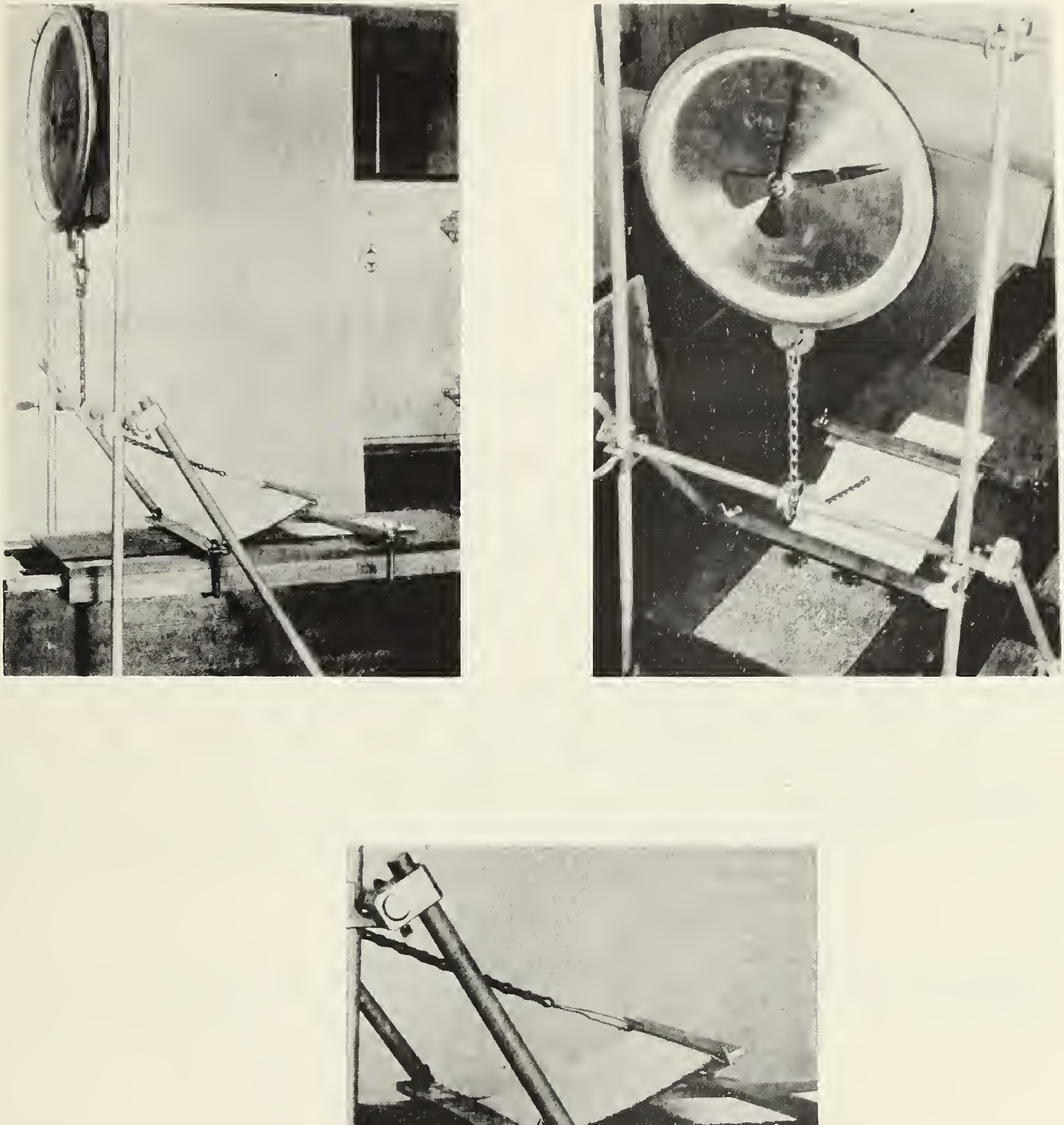


FIG. 3—APPARATUS TO DETERMINE BOND STRENGTH.

The breaking strength of the adhesive bonds was determined in triplicate, on specimens of each sample which were conditioned for periods of both 5 and 16 hours at temperatures from 100°F. to 160°F., in increments of 20°F.

5.2 Test Results

The results of the tests expressed in pounds of force required to break the adhesive bond, together with the area, thickness, and the location of the adhesive, are presented in Table 4.

6. Bond Strength of Plastic Cement When Used as an Adhesive to Seal Down Conventional Asphalt Shingles

In order to compare the performance of the self-sealing systems with a method that has proven successful in preventing wind damage in the field, a series of bond strength determinations was made with specimens of conventional asphalt shingles sealed to each other with a spot (approximately 1.8 sq. in. in area) of plastic cement.

6.1 Test Procedure

Triplicate specimens having the same dimensions as those used in testing the self-sealing adhesives were prepared by applying plastic cement at a rate sufficient to treat 6.4 roof squares per gallon of cement under the tab of each specimen. The specimens were aged for 1 week at 73°F. and at a relative humidity of 50% and then conditioned at 100°F. for 16 hours prior to testing. The breaking strength of the plastic cement bond was then determined by the method described in section 5.1.

6.2 Test Results

The results of the series of tests indicated the strength of the plastic cement bond was such that failure occurred in every case within the shingle itself, rather than in the adhesive bond.

7. Effect of Water on the Bond Strength of Adhesive Used on the Self-Sealing Shingles

It was suggested that water in the form of rain or dew may have a deleterious effect on the efficiency of the adhesives used on the self-sealing shingles once they are sealed. Therefore, to study the possible influence of water on the adhesive bond, a series of experiments was carried out.

TABLE 4. RESULTS OF BOND STRENGTH TESTS

Sample	Area of Adhesive	Thickness of Adhesive	Location of Adhesive	100°F. Hours Exposed 5	100°F. Hours Exposed 16	120°F. Hours Exposed 5	120°F. Hours Exposed 16	140°F. Hours Exposed 5	140°F. Hours Exposed 16	160°F. Hours Exposed 5	160°F. Hours Exposed 16
	$in.^2$	in.		pounds		pounds		pounds		pounds	
1	1.5	.025	Front					3.4	3.4	5.3	5.9
2	2.5	.015	Back		4.0	7.2	8.8	13.9	14.8	19.3	11.4
3	2.5	.015	Front				2.2	3.3	6.5	7.7	4.0
4	1.5	.008	Front						2.8	2.9	3.8
5	3.0	.010	Front						10.1	15.6	16.3
8	3.3	.040	Back	4.8	7.9	10.3	10.3	11.2	13.4	13.6	15.0
9	3.5	.020	Back	1.1	4.5	4.7	6.0	10.3	11.4	14.7	15.3
10	3.3	.025	Front			5.0	6.8	10.2	12.0	12.4	15.9
11	1.75	.025	Front	1.0	4.1	3.7	4.9	12.0	+20	+20	+20
12	.5	.012	Front					1.3	3.1	6.4	6.2

Five samples were selected for the tests and 10 specimens of each sample were prepared and conditioned as described in section 5.1, at 140°F. for a period of 16 hours. After they were removed from the oven and brought to room temperature, one-half of the specimens was immersed in distilled water at 73°F. for 5 hours while the other half was allowed to remain dry at 73°F for a like period. The adhesive bond strength determinations were made on both sets of specimens as described in section 5.1. The results of the test both before and after immersion are presented in Table 5.

TABLE 5. RESULTS OF EFFECT OF WATER ON THE BOND STRENGTH OF SELF-SEALING SHINGLES.

Sample No.	Bond Strength Dry	Bond Strength Wet
	lbs.	lbs.
2	13.9	12.3
8	13.6	9.9
9	12.2	14.8
10	11.1	11.5
11	21.3	20.6

APPENDIX II. WIND RESISTANCE TESTS

1. Introduction

Wind tests have been used for a number of years by roofing manufacturers, Universities and in other research laboratories to study the effects of winds on asphalt shingle roofings. Recently a method of wind testing has been proposed by the Asphalt Roofing Industry Bureau to determine the leak resistance of asphalt shingles when applied, using special precautions, on roof decks of low slope. Wind tests, like other laboratory tools, are extremely limited insofar as they approach the actual conditions produced by winds during outdoor exposure. However, these same tests may become very useful tools when they are used in conjunction with other methods of evaluation, especially a field survey.

With the limitations of the wind tests in mind, a series of tests was conducted to study the effectiveness of the adhesive systems of self-sealing asphalt shingles. The storm test machine, which was used in the series of tests, was one of several types that have been used and was selected because it was readily available. No doubt similar results could be obtained with other types of equipment.

2. Apparatus

(1) A storm test machine capable of delivering a horizontal stream of air through a rectangular opening at an average velocity of at least 60 miles per hour was employed. The apparatus was equipped with an adjustable stand to receive a test panel. An assembly drawing of the storm test machine is presented in Figure 4.

(2) Clock.

(3) Camera.

(4) Forced circulation air oven capable of receiving a 4- by 3-ft. panel on a slope of 2 in. per foot rise and maintaining a uniform temperature from 100°F. to 160°F. ±3°F. when measured with a thermocouple at the four corners and the center of the test panel.

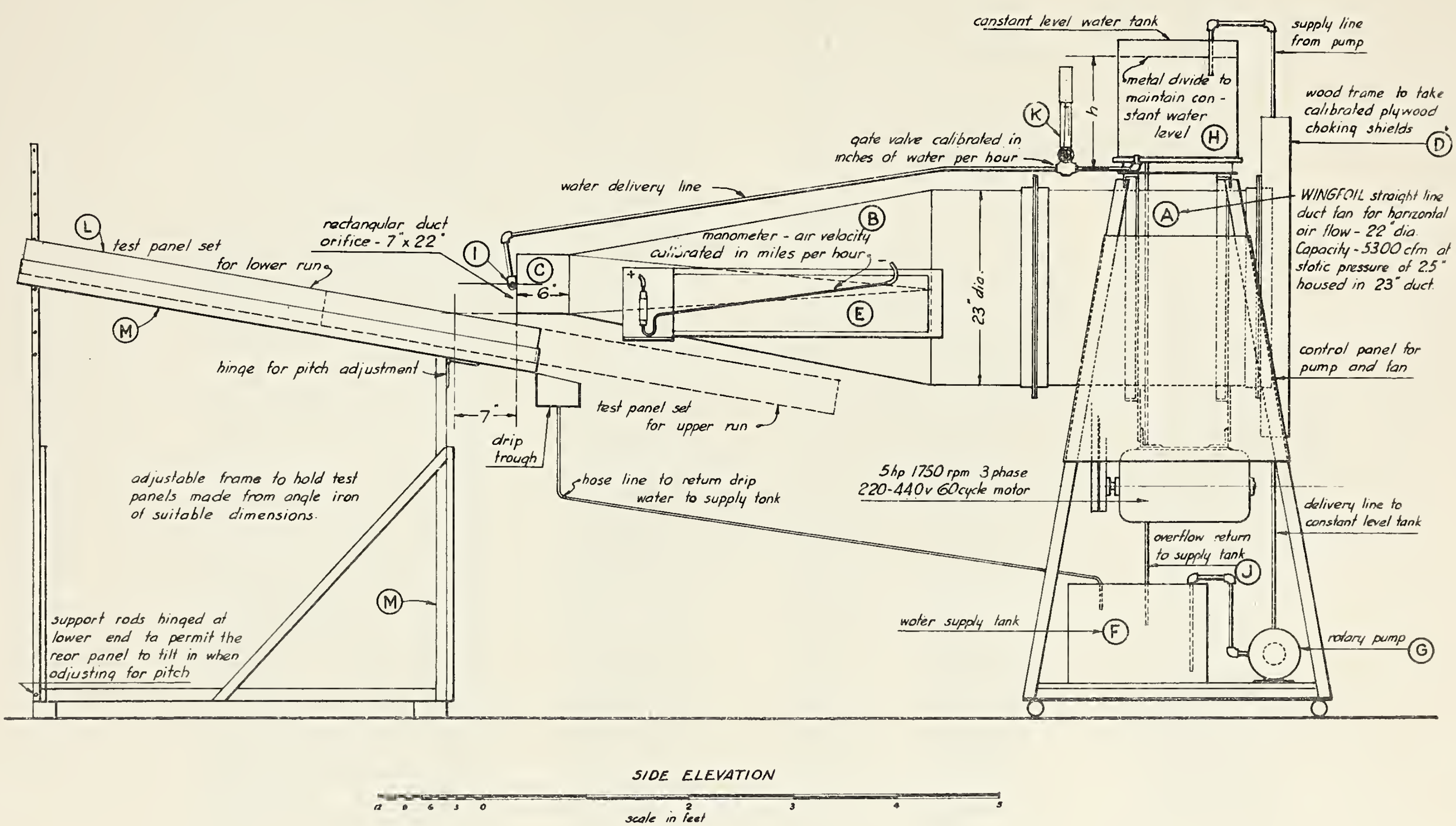


FIG. 4—STORM TEST MACHINE.

3. Test Panels

The test deck consisted of a 4-ft. by 3-ft. by 3/4-in. plywood panel on which asphalt shingles were applied in the conventional manner, parallel to the short dimension of the panel, as recommended for service conditions by the manufacturer. Four nails, properly positioned, were used to fasten each shingle and no pressure or other mechanical means was used to seal the shingle tabs.

4. Conditioning of Test Specimens

After the shingles were applied, the test panel was placed in the conditioning oven, which was maintained at the test temperature, on a slope of 2 in. per foot rise for 16 hours. The test specimen was then removed from the chamber and allowed to remain at room temperature (75 ±5°F.) for 24 hours before the wind tests were made.

The initial conditioning temperature was 120°F. However, if failure occurred during the wind test, the conditioning temperature was increased in increments of 20°F. to 160°F.

5. Test Procedure

After conditioning, the test panel was secured in place on the adjustable stand of the storm test machine as shown in Figure 4. It was exposed in such a position that the leading edge of the target tab was on the same level and 7 ±1/16 in., measured horizontally, from the lower edge of the duct orifice. The slope of the adjustable stand was maintained at 2 in. per foot rise.

When the specimen was in position, the fan was started and adjusted to produce a wind velocity of 30 miles per hour. This velocity was maintained for a period of 5 minutes, and then increased in increments of 10 miles per hour each 5 minute period, until a total time of 15 minutes had elapsed. The wind velocity was then increased to 60 miles per hour and maintained for a period of two hours. The test was stopped if failure occurred and the velocity and exposure time recorded. The end point for failure was taken as that time and velocity at which the adhesive failed to restrin one or more full shingle tabs. Photographs were taken at failure or when other significant changes were observed. The wind tests were performed at a temperature of 75 ±5°F. and no water was used during the tests.

6. Test Results

The results of the wind resistance tests of the self-sealing asphalt shingles and of one sample of conventional shingles sealed with plastic cement are presented in Table 6. This table shows that two samples, Nos. 8 and 9, were adequately sealed after 16 hours at 120°F; six samples, Nos. 2, 4, 5, 10, 11, and plastic cement, were sealed after 16 hours at 140°F., and the remaining samples, Nos. 1, 3, and 12, required exposure to 160°F. for adequate sealing.

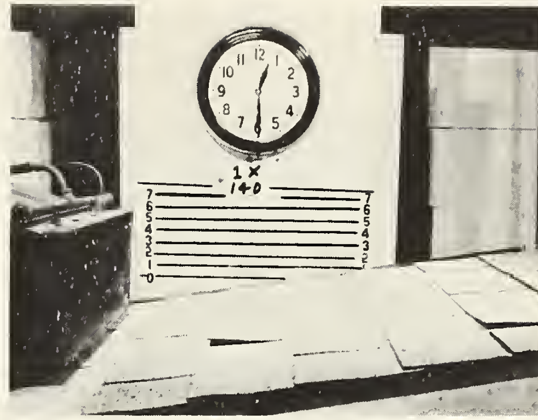
Figure 5 is a sequence of photographs presented to illustrate a typical failure which occurred during the wind test. Photograph A illustrates that the shingle was unaffected by the winds of the lower velocities. However, in Photograph B, the initiation of failure at the target tab was evident. Photographs C and D follow the progress of the failure which is completed in Photograph E after 49 minutes and 45 seconds of exposure to the wind test.

TABLE 6. RESULTS OF WIND RESISTANCE TESTS.

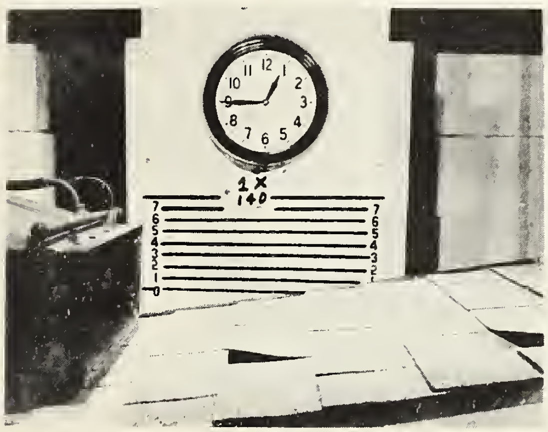
NBS No.	120°F., 16 Hours Failed at	140°F., 16 Hours Failed at	160°F., 16 Hours Failed at
1	40 mph	60 mph	Passed
2	40 mph	Passed	
3	50 mph	60 mph	Passed
4	50 mph	Passed	
5	50 mph	Passed	
8	Passed		
9	Passed		
10	40 mph	Passed	
11	60 mph	Passed	
12	30 mph	40 mph	Passed
Plastic Cement	60 mph	*Passed	

*Aged one week prior to test.

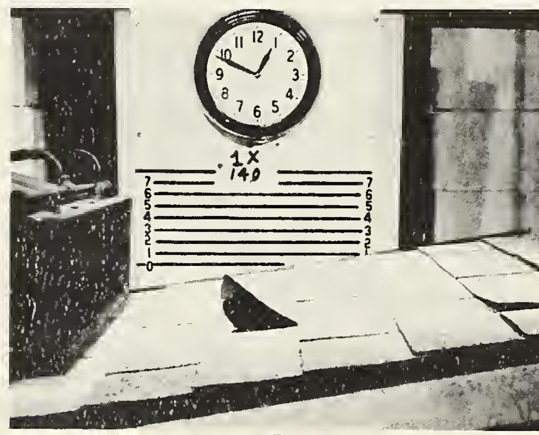
A
WIND VELOCITY – 50 M.P.H.
ELAPSED TIME –14:00 MIN.



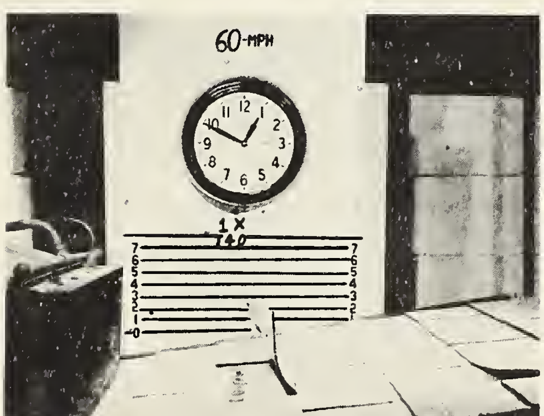
B
WIND VELOCITY – 60 M.P.H.
ELAPSED TIME – 30:00 MIN.



C
WIND VELOCITY – 60 M.P.H.
ELAPSED TIME – 45:10 MIN.



D
WIND VELOCITY – 60 M.P.H.
ELAPSED TIME – 49:12 MIN.



E
WIND VELOCITY – 60 M.P.H.
ELAPSED TIME – 49:45 MIN.

F
SHINGLE TAB AFTER FAILURE

FIG. 5 – STORM TEST SEQUENCE SHOWING FAILURE OF SELF-SEAL SHINGLES.

Photograph F is a closeup of the target tab after failure. Note the slight amount of adhesive transferred to the under side of the shingle tab, yet it was sufficient to restrain the tab for an appreciable period of time.

Figure 6 illustrates the failure which occurred on the shingles sealed with plastic cement, and without prior aging before the conditioning period, after 4 minutes exposure to 60 miles per hour. Photographs A and B illustrate the specimen prior to and immediately after failure, while Photograph C shows that the failure occurred within the adhesive itself.

Figure 7 illustrates various samples of the self-sealing systems that withstood the 60 mile per hour wind velocity for 2 hours. The bonds were broken mechanically after the tests were complete.

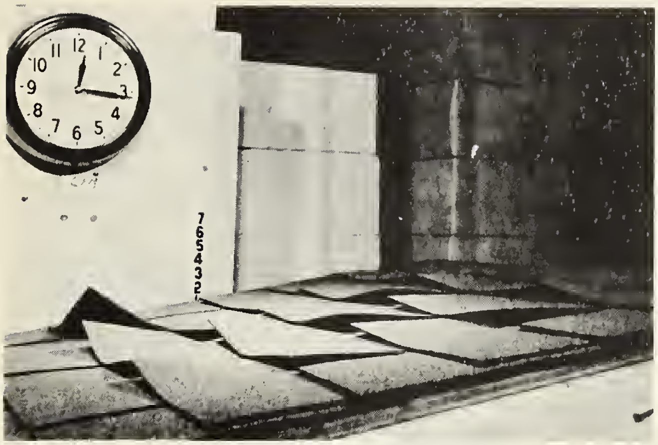
Figure 8 illustrates typical examples of specimens that failed to seal at the test temperatures.

7. Performance Ratings

The performance ratings, based exclusively on the results of the wind resistance tests, are given in Table 7. The materials can be placed in one of three groups, depending on the temperature at which they attained a seal adequate to resist a 60 mile per hour wind for 2 hours as delivered by the storm test machine.

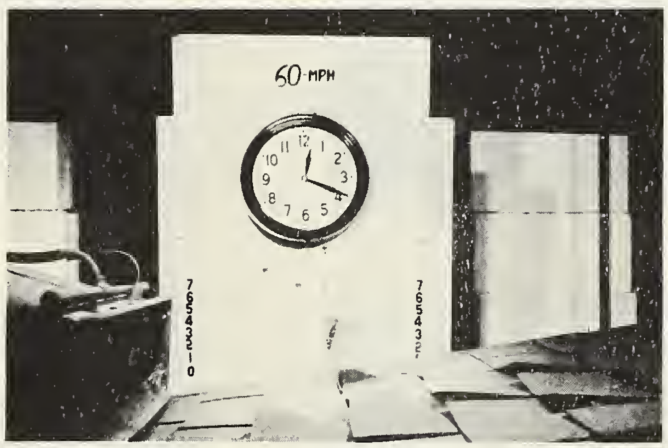
TABLE 7. PERFORMANCE RATINGS IN WIND TESTS.

Group	NBS No.
I	8, 9
II	2, 4, 5, 10, 11, Plastic Cement
III	1, 2, 12



A

WIND VELOCITY – 60 M.P.H.
ELAPSED TIME – 16:13 MIN.



B

WIND VELOCITY – 60 M.P.H.
ELAPSED TIME – 19:00 MIN.

C

SHINGLE TAB AFTER FAILURE

FIG. 6 – STORM TEST SEQUENCE SHOWING FAILURE OF SHINGLES SEALED WITH PLASTIC CEMENT.

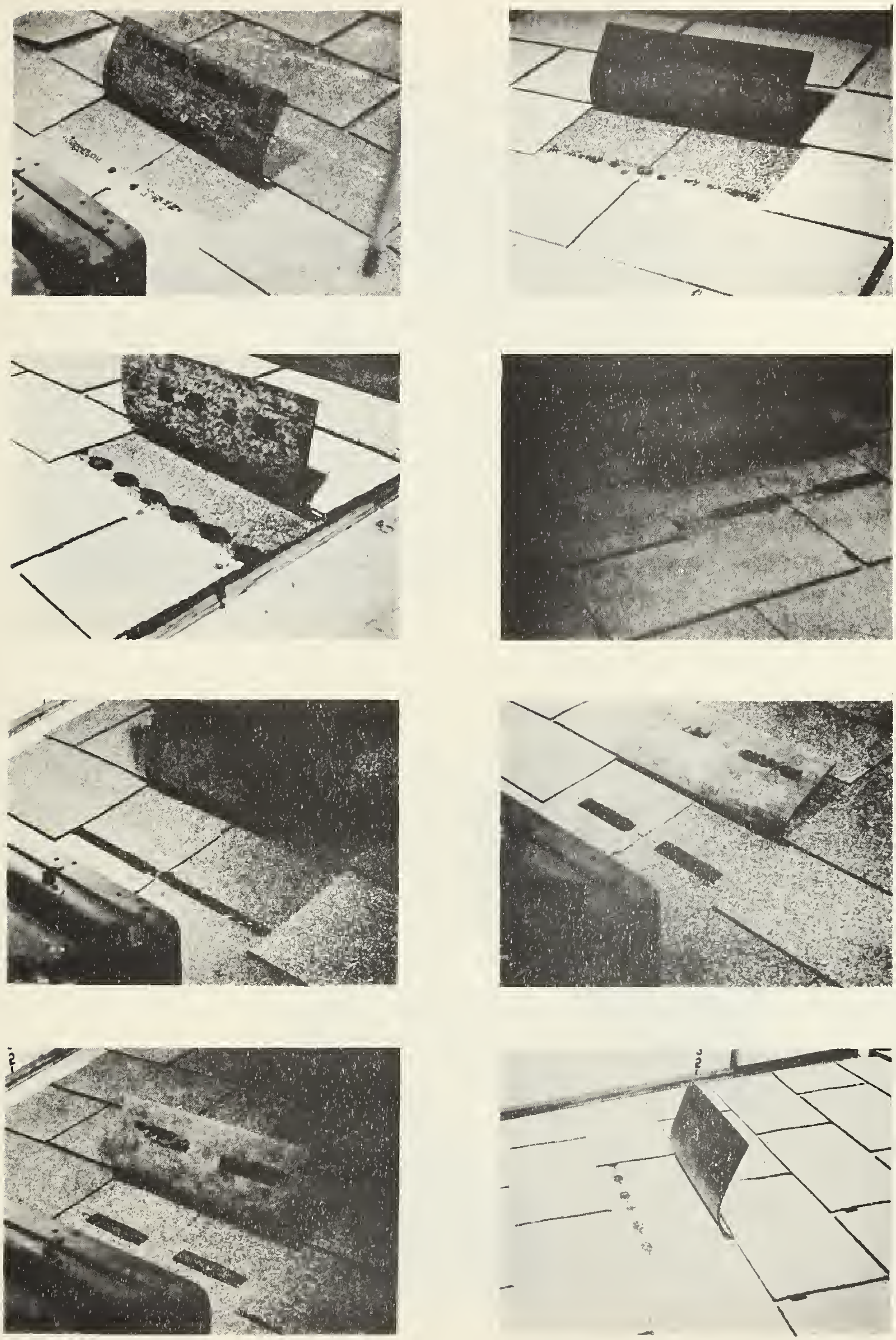


FIG. 7— SELF-SEAL SHINGLES THAT WITHSTOOD WINDS OF 60 M.P.H. FOR 2 HOURS. BONDS BROKEN MECHANICALLY AFTER TEST.

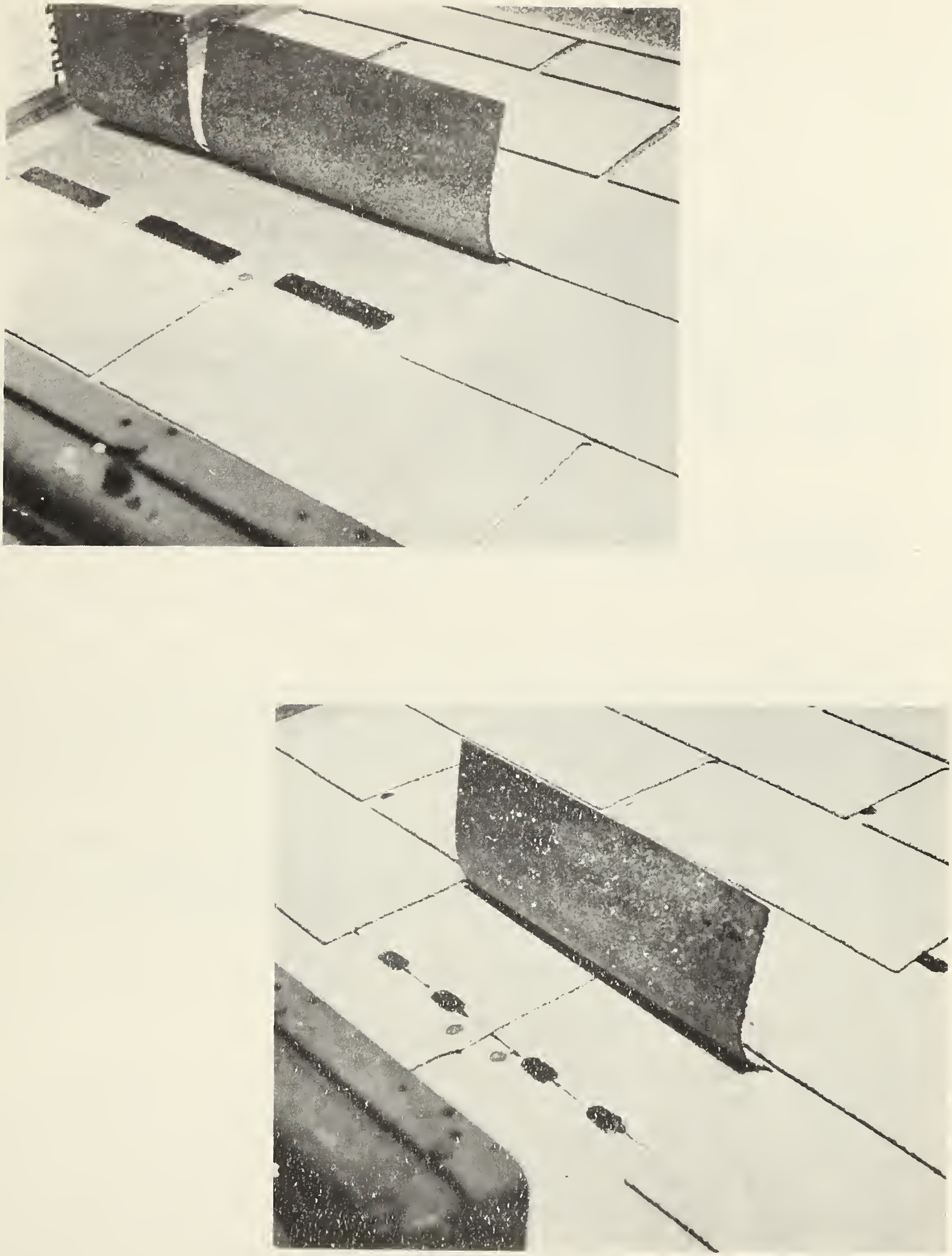


FIG. 8 - TYPICAL EXAMPLES OF FAILURE.

APPENDIX III. FIELD SURVEY.

1. Introduction

The laboratory study and the wind resistance tests have shown that certain asphalt shingles employing a factory-applied adhesive have performed adequately to seal down each shingle tab to the course below, which makes the shingle more wind resistant. The results of the tests indicated that differences existed in the adhesive bond strength of the various systems and criteria were needed to define adequate performance. To obtain these criteria a field survey was made to observe the actual performance of the respective systems under various climatic conditions. For comparison purposes, asphalt shingle roofs, on which the tabs were sealed with plastic cement, were also observed.

The roof inspections were made in Florida, Louisiana, Arkansas, Texas, Northern New York, New England, and the District of Columbia. Approximately 40 roofs were observed during the survey, representing the products of six manufacturers.

The exposure time of the shingles varied from a few days to more than 2 years and the slopes on which they were applied ranged from 2 in. to 6 in. per foot rise. Shingles, surfaced with black, green, and white granules were observed in the various locations. Many of the roofs were applied during cold weather and others during the summer months.

Generally, the shingles were applied over an underlayment of 15-pound, asphalt-saturated felt. However, in some cases, the shingles were applied over mineral-surfaced roll roofing and, in one case, over an old wood-shingle roof.

2. Observations

2.1 Self-Sealing Type Shingles

In every case, with the exception of the roof on which the shingles were applied directly over wood shingles, the performance of the self-sealing asphalt shingles was good. The inspection of the shingles applied over the old wood shingles indicated that only 80% of the tabs were sealed, apparently because of the irregularity of the deck. The photographs shown in Figure 9 illustrate typical examples of the effectiveness of the adhesives as indicated by the amount of adhesive transferred from one portion of the shingle to the other when activated by solar radiation. It should be pointed out that the percentage of

FIG. 9 – TYPICAL EXAMPLES OF ADEQUATE SEALING OBSERVED IN FIELD SURVEY.

adhesive transfer that occurred during outdoor exposure was in each case, greater than the amount transferred by similar shingles when exposed to a temperature of 140°F. for 16 hours under laboratory conditions.

The self-sealing systems of each of the 6 shingles observed performed adequately regardless of the variables usually associated with asphalt shingle roofs, such as, the slope of the deck, color of the shingle, exposure, season when applied, and the number of nails per shingle. In some cases it was reported that the roofs examined had been subjected to winds of more than 80 miles per hour during sub-freezing weather. Of course, all of these variables must remain within limits that are reasonable.

2.2 Plastic Cement Sealing Method

The system of sealing down the tabs of the conventional asphalt shingles with a spot of plastic cement is an accepted method for preventing wind damage. The observations made during the survey confirmed the previous findings, i.e., this method is effective for sealing down tabs of asphalt shingles to prevent wind damage.

3. Discussion

The results of the field survey confirm the results of the laboratory and wind-resistance tests as to the adequacy of the self-sealing systems to perform as they were intended. The systems that proved to be the least effective in the laboratory and wind tests appeared to be quite adequate when used on actual installations.

It was not possible to compare the merits of the self-sealing systems with those of the plastic cement method since each appeared to perform equally well in practical field applications.

In the course of the survey, some disadvantages of each system were evident. Those worthy of mention are as follows:

<u>Self-sealing method</u>:

Sticking of shingles in the bundle appeared to be the most critical, if precautions are not taken to keep the shingles relatively cool. At one installation in the south, one-third of a large shipment was not usable due to this deficiency. It was reported that the contractor stored the shingle bundles on the roof, as is often done during application, and due to the heat, the adhesive was activated and the shingle could not be separated without damage. It is axiomatic that if an adhesive is designed

to be effective at roof temperatures it will also become effective if the bundles are subjected to elevated temperatures during storage, transportation, or on the job site.

Plastic cement sealing method:

The main disadvantage of this method is the number of tabs which are not treated because of careless workmanship. This disadvantage, like most, can be overcome readily by adequate inspection.

U. S. DEPARTMENT OF COMMERCE
Lewis L. Strauss, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

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Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

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Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering. Radio-Meteorology.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.

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