U. S. DEPARTMENT OF COMMERCE

BUILDING MATERIALS AND STRUCTURES

REPORT BMS29

Survey of Roofing Materials in the Northeastern States

by

HUBERT R. SNOKE

and LEO J. WALDRON

NATIONAL
BUREAU OF STANDARDS

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[For list of BMS publications and how to purchase, see cover page III.]

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The National Bureau of Standards is a fact-finding organization; it does not "approve" any particular material or method of construction. The technical findings in this series of reports are to be construed accordingly.

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Foreword

This report is the second of a series issued by the National Bureau of Standards on the results of surveys of the weathering qualities and extent of use of roofing materials in sections of the country representing different climatic conditions.

The results of the first survey have been published as report BMS6, Survey of Roofing Materials in the Southeastern States. The present paper describes the results of a similar survey in 11 Northeastern States. Frequent reference is made to the first survey for the purpose of comparing conditions in the two sections of the country.

Included is a tabulation, by States, of the kinds of roofing materials used on more than 10,000 rural and small-town dwellings along approximately 1,600 miles of highway in the Northeastern States, and a summation of the kinds of roofing on more than 20,000 dwellings along more than 4,000 miles of highway in the 20 States included in the two surveys. More than 500 photographs, showing types of weathering of roofing materials, and features of design and construction of roofs, were taken in the course of this survey. Of these, 48 have been selected for publication.

Lyman J. Briggs, *Director.*

Survey of Roofing Materials in the Northeastern States

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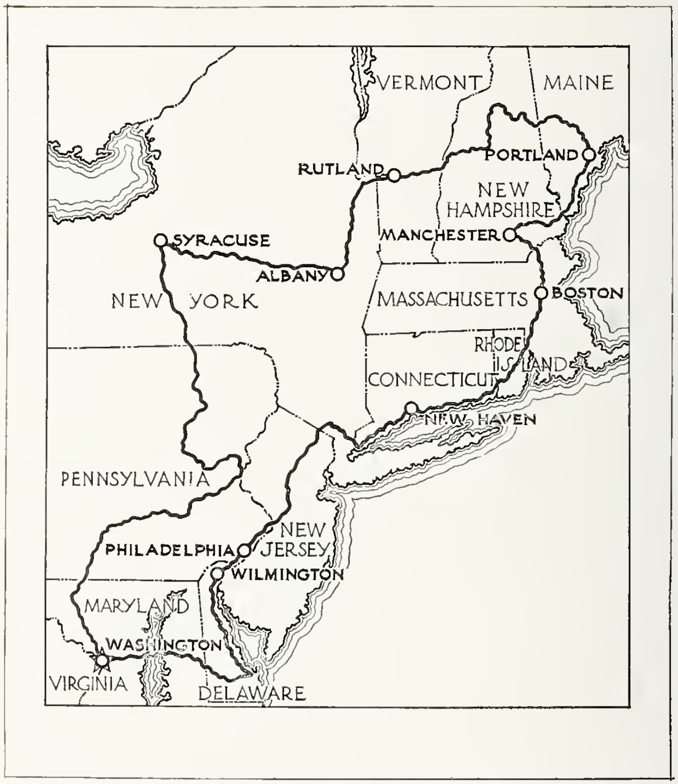


FIGURE 1.—*Northeastern States covered by survey.*

ABSTRACT

A survey of the weathering qualities and extent of use of the various roofing materials on dwellings in the Northeastern States is described, with numerous comparative references to a similar survey in the Southeastern States.

Detailed studies of roofing materials in Wilmington, Del.; Philadelphia, Pa.; New Haven, Conn.; Boston, Mass.; Manchester, N. H.; Portland, Maine; Rutland, Vt.; and Albany and Syracuse, N. Y., are reported.

A tabulation, by States, of the kinds of roofing materials used on more than 10,000 rural and small-town dwellings, along approximately 1,600 miles of highway between the cities listed above, is included; also a summary of the kinds of roofing materials used on almost 21,000 rural and small-town dwellings along 4,000 miles of highway in 20 Eastern States.

Forty-eight photographs, illustrating types of weathering of roofing materials and features of design and construction of roofs, are shown.

I. INTRODUCTION

The general research program of the National Bureau of Standards on building materials and structures includes, as part of the work on roofs and roofing materials, a comprehensive survey of the various types of roofing materials used in locations typical of widely differing climatic conditions in the country.

The first of these surveys, which was made in April 1938, included the following states: Virginia, North and South Carolina, Georgia, Florida, Alabama, Tennessee, Kentucky, and West Virginia. Results of this survey have been published as Building Materials and Structures Report BMS6, Survey of Roofing Materials in the Southeastern States.[1]

The present paper describes a similar survey in the following cities: Wilmington, Del.; Philadelphia, Pa.; New Haven, Conn.; Boston, Mass.; Manchester, N. H.; Portland, Maine; Rutland, Vt.; and Albany and Syracuse, N. Y. It includes also a report on the extent of use of the different roofing materials, classified roughly from the standpoint of appearance, on rural dwellings along the highways between the cities that were visited. This survey was made from September 12 to October 12, 1938, and included approximately 2,500 miles of travel.

[1] Price 15 cents. See cover page III.

This report, while made up primarily of observations on the weathering characteristics of roofing materials which apply only to the territory covered by this survey, also makes frequent reference to the previous survey in the Southeastern States. In this report the "Survey in the Southeastern States" is referred to as "the previous survey", for convenience.

The authors were in New Haven, Conn., at the time of the hurricane, September 21, 1938, and had an opportunity to observe the effect of winds of unusual velocity on many types of roofs.

Space is not available in this report to deal at length with the history, methods of production, composition, etc., of the various kinds of roofing materials. A list of selected references is given at the end of the report for those who wish to make a more detailed study of roofing materials. Numerals in brackets throughout the text refer to publications in this list.

II. METHOD OF MAKING THE SURVEY

The methods used in making this survey were essentially the same as those followed in the previous survey.

All travel in connection with this survey was by automobile. An actual count was made of the kinds of roofing materials used on the rural dwellings along the highways traveled. The record was kept on special forms, each covering 50 miles of highway, forms being changed at State lines to permit tabulation by States.

Local representatives of the Home Owners' Loan Corporation assisted in collecting data on roofs of different kinds and known history. Acknowledgment is made to them for their wholehearted cooperation in this work.

A short time was spent in each city in discussing the details of the investigation with representatives of the Home Owners' Loan Corporation, and then, with them, in discussing roofing practices with local roofing contractors. Actual inspections were then made of as many roofs as time would permit, followed by a general tour of the city, including long-established and new communities, to determine roughly the extent of use of the various roofing materials. It was also a regular practice to request permission to examine any roofs that looked particularly interesting.

III. EXTENT OF USE, AND APPEARANCE, OF THE VARIOUS ROOFING MATERIALS IN RURAL DISTRICTS AND SMALL TOWNS IN THE NORTHEASTERN STATES

1. Factors Which Affect the Choice of Roofing Materials in Rural Districts and Small Towns

Initial cost, relative availability of particular materials, and appearance are factors which affect the choice of roofing materials in rural districts. These factors, plus that of cost of maintenance, probably govern the choice of roofing materials in most sections. Striking evidence that the ready availability of a material is a strong factor in determining the extent of use was obtained in the slate-producing areas of Pennsylvania and Vermont, where slate roofing is used on all classes of structures.

In the rural sections of the New England States, where the house and barn are frequently connected through several intermediate buildings, it is not unusual to see three or four types of roofing materials on different sections of the structure. Occasionally two kinds of roofings of the same type are used on different sections of the same structure. Apparently failure had occurred in various sections of the roof at different times.

2. Distribution of Roofing Materials in Rural Sections and Small Towns in the Northeastern States

(a) *Villages and Small Towns*

The villages and small towns in the Northeastern States, in general, show a greater variation in the kinds of roofing materials that are used than do those in the Southeastern States. Also, the northern villages are more congested, so that any observations on the extent of use of the various roofing materials in them had to be most general. Slate is used exclusively in towns and villages adjacent to slate-producing areas; asphalt shingles have relatively wide use in most other areas, excepting Delaware, where wood shingles predominate. At present, metallic roofings have limited use. Old dwellings in some small towns in eastern Pennsylvania have mainly tin and slate roofs in about equal proportions. Cement-asbestos shingles have been used less widely than other materials. Wood shingles have had extensive use in the past and are apparently being used to a considerable extent at present.

(b) *Rural Sections*

The various kinds of rural roofs were divided roughly into two classes, "Good" and "Poor." This classification, of necessity, was based entirely on appearance and, in most cases, was made from a hasty observation of one side of a roof. For this reason, and also because it is not possible to set down the exact criteria by which a roof was judged to be good or poor, and because the various kinds of roofs have different criteria of appearance, it is realized that this classification is open to considerable criticism. It should be emphasized also that the data do not indicate the age of the roofs reported. However, it is felt that the classification as made is better than a simple census of the kinds of roofing materials that are used.

The subdivision of roofs classed as "Poor" into "Poor" and "Damaged," representing normal weathering and damage by storm in areas affected by the hurricane, excepting Connecticut, does not differentiate between roofs that were damaged badly and those that were damaged but slightly. The relative proportions of the different kinds of roofing materials must also be considered when studying storm damage to roofs. For example, only one tile roof is reported as being damaged by the hurricane, but only three tile roofs were observed in the whole rural area affected by the storm. Obviously, with such meager data, one could draw no definite conclusions.

3. Territory Covered and Routes Followed in Making the Survey

A map of the territory covered by the survey is shown in figure 1.

Table 1 lists the cities in which studies were made and the routes from city to city in the order they were traveled.

4. Extent of Use of Particular Materials in Rural Sections

Table 2 is a tabulation, by States, of the kinds of roofing materials used on dwellings in the rural sections along the routes listed in table 1.

Table 1.—*Routes traveled in making this survey*

Cities	Routes [1]
Washington, D. C., to Wilmington, Del.	50, (404), (18), (14), 13.
Wilmington, Del., to Philadelphia, Pa.	13.
Philadelphia, Pa., to New Haven, Conn.	1, 206, 202, (59), 9, Merritt Parkway, 1.
New Haven, Conn., to Boston, Mass.	1, (84), (3), 1.
Boston, Mass., to Manchester, N. H.	(28).
Manchester, N. H., to Portland, Maine	(101), 1.
Portland, Maine, to Rutland, Vt.	(207), 4, 302, 3, (25), (25a), 4.
Rutland, Vt., to Albany, N. Y.	4, (286), (22), 67).
Albany, N. Y., to Syracuse, N. Y.	20, (92).
Syracuse, N. Y., to Washington, D. C.	11, 309, (45), (946), (702), (512), (145), 222, 422, 15, 40.

[1] State routes in parentheses, all others are U. S. routes.

Table 2.—*Tabulation, by states, of the kinds of roofing materials used on rural dwellings*

State	Asphalt shingles				Wood				Slate				Sheet metal			
	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total
Maryland	138	56	-----	194	97	133	-----	230	25	2	-----	27	140	68	-----	208
Delaware	33	20	-----	53	166	199	-----	365	1	5	-----	6	17	18	-----	35
Pennsylvania	506	266	-----	772	127	95	-----	222	700	44	-----	744	283	28	-----	311
New Jersey	147	113	-----	260	83	83	-----	166	69	114	-----	183	15	2	-----	17
New York	433	264	-----	697	397	204	-----	601	267	9	-----	276	127	65	-----	192
Connecticut	100	130	(a)	230	266	95	-----	361	2	1	-----	3	3	-----	-----	3
Rhode Island	46	11	102	159	5	6	9	20	-----	-----	-----	-----	-----	-----	2	2
Massachusetts	107	44	81	232	13	13	1	27	3	-----	4	7	-----	-----	-----	-----
Maine	315	194	45	554	190	139	12	341	6	-----	-----	6	59	33	-----	92
New Hampshire	385	266	89	740	154	185	5	344	18	7	1	26	66	35	2	103
Vermont	48	52	-----	100	54	48	-----	102	253	15	-----	268	29	14	-----	43
Total	2, 258	1, 416	317	3, 991	1, 552	1, 200	27	2, 779	1, 344	197	5	1, 546	739	263	4	1, 006

State	Roll roofing				Cement-asbestos				Metal shingles				Tile				Thatched			
	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total	Good	Poor	Damaged	Total
Maryland	2	18	-----	20	14	10	-----	24	40	6	-----	46	-----	-----	-----	-----	1	-----	-----	1
Delaware	1	10	-----	11	5	2	-----	7	1	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	-----
Pennsylvania	14	60	-----	74	110	3	-----	113	16	8	-----	24	8	-----	-----	8	-----	-----	-----	-----
New Jersey	3	10	-----	13	39	12	-----	51	-----	1	-----	1	4	-----	-----	4	-----	-----	-----	-----
New York	20	76	-----	96	42	9	-----	51	35	11	-----	46	8	-----	-----	8	1	-----	-----	1
Connecticut	7	15	-----	22	3	4	-----	7	1	-----	-----	1	-----	-----	1	1	-----	-----	-----	-----
Rhode Island	1	2	2	5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Massachusetts	1	1	2	4	1	-----	-----	1	-----	-----	-----	-----	2	-----	-----	2	-----	-----	-----	-----
Maine	25	37	-----	62	9	-----	-----	9	-----	2	-----	2	-----	-----	-----	-----	-----	-----	-----	-----
New Hampshire	12	58	5	75	12	8	-----	20	-----	1	-----	1	-----	-----	-----	-----	-----	-----	-----	-----
Vermont	4	13	-----	17	-----	1	-----	1	10	2	-----	12	-----	-----	-----	-----	-----	-----	-----	-----
Total	90	300	9	399	235	49	-----	284	103	31	-----	134	22	-----	1	23	2	-----	-----	2

[a] Roofs damaged by storm were not tabulated in Connecticut

The results of the counts of rural roofs in both the Southeastern and Northeastern States are summarized in table 3.

TABLE 3.—*Summary of rural counts*

[Miles traveled: Southeast, 2,447; Northeast, 1,591. Total, 4,038]

Type of roof	Southeast	Northeast	Total
Sheet metal	3,722	1,006	4,728
Asphalt shingle	2,558	3,991	6,549
Roll roofing	1,982	399	2,381
Wood shingle	1,757	2,779	4,536
Metal shingle	366	134	500
Cement-asbestos shingle	184	284	468
Slate	64	1,546	1,610
Tile	44	23	67
Thatched		2	2
Total	10,677	10,164	20,841

Assuming that the roofs along the routes traveled were representative of the rural areas included in the surveys, this summary shows that asphalt shingles, wood shingles, and sheet metal account for approximately 76 percent of the rural roofs in the Eastern States. It is believed that in these counts the normal proportions have been somewhat upset by the fact that a considerable part of the travel was in some areas where roofing slate is locally available, and in other areas where prepared roll roofings are used almost exclusively.

IV. WEATHERING QUALITIES OF ROOFING MATERIALS IN THE NORTHEASTERN STATES

1. General Discussion

The previous report (BMS6) states that "Any discussion of the weathering qualities of roofing materials in a particular section must, of necessity, be couched in the most general terms," and then cites some of the factors which must be considered in such studies. This section of the previous report is repeated here to avoid possible misunderstandings. No two conditions of exposure are ever identical. Thus, two dwellings may be built side by side, of the same materials and design; one may remain dry throughout the building operations, whereas the wood sheathing on the other may be thoroughly soaked by several days of rain; one may be shaded by trees which protect it from the effect of sunlight but subject it to damage from falling branches, whereas the other may receive the full effect of sunlight. These roofs, in all probability, will show different weathering characteristics. The same materials on roofs of different pitch will behave differently, a fact that can be observed frequently where the same material is used for the steeply pitched main-roof sections and the porch roofs of lower pitch. The weathering of a roof is invariably less severe on the north than on the south.

Faulty workmanship probably causes more premature roof failures than faulty materials. A roof well laid with inferior materials will give good service as long as the material will withstand the effects of weathering, but a roof improperly laid with good materials will probably give poor service from the beginning.

When the materials used for roofing are considered, the problem becomes even more complicated. Materials available include: asphalt shingles in a wide variety of shapes, colors, and weights; slate in a variety of sizes, weights, and colors; and sheet metal, including "Roofing tin,"[2] galvanized steel, copper, and zinc, in either roll or shingle form. This multiplicity applies equally to other kinds of roofing materials.

Another factor which precludes definite and positive statements concerning the "life" of any particular roofing material is the difficulty of determining just when a roof has failed and exactly what constitutes a failure in a roofing material. Theoretically, a roof that does not admit water might be considered serviceable, yet roofs may be serviceable and still not be satisfactory. Appearance is a factor that is becoming increasingly important in choosing roofing materials, but it is a variable factor that cannot be weighted generally.

It can be readily understood, therefore, that no positive statement can be made concerning the probable service that a given, general type of roofing material will render in a particular

[2] Made by coating steel sheets with an alloy containing about 80 percent of lead and 20 percent of tin.

locality. However, some of the materials, as classes, do show different weathering characteristics in different locations.

Essentially the same roofing materials are used in the Northeastern States as in the Southeastern States, but the difference in climate between the two sections is reflected in differences in roofing practices. Low-pitched roofs on dwellings characterize the South, whereas in the North, roofs are usually steeply pitched, largely to prevent the accumulation of snow. Snow on a roof would not be objectionable, in fact, it would be desirable from the standpoint of preventing the loss of heat from a dwelling, if it would remain in the state it falls. It is the subsequent melting and freezing that is responsible for most of the damage to roofs by snow, particularly those laid by the shingle method. Heat from the interior of a structure and from the sun will melt some of the snow during the daytime. At night, when the temperature outside is lower and when the interior of the building is cooler, some of this melted snow will freeze to form ice dams which cause water to back up underneath the shingles and, if the shingles are laid without sufficient head lap, will cause the roof to leak. This process may result in severe breakage in roofs constructed with rigid roofing materials, such as slate and cement-asbestos shingles, if they are fastened too tightly. This form of weathering is most severe on the projecting eaves of shingle-type roofs, which are usually weathered more than other sections of the roof. It is noticeable, particularly, on wood and asphalt-shingle roofs. This effect is obviated frequently by placing a wide strip of metal or, occasionally, asphalt-prepared roll roofing at the eaves. Metal strips are usually of tin or galvanized iron, though copper is used occasionally. Figure 2 shows the methods of installing a metal eaves strip.

Snow guards are of value mainly in preventing snow from sliding from a roof in large quantities and damaging gutters, porch roofs, or shrubbery that may be placed below. In this respect they serve a very useful purpose, but, obviously, by retaining snow on a roof, they increase the possibility of damage of the type previously described.

In subsequent sections an attempt has been made to discuss and illustrate by means of photographs certain of the weathering characteristics of the roofing materials used in the Northeastern States. No attempt has been made in this discussion to differentiate between brands of roofing materials.

2. Discussion of Particular Materials

(a) *Asphalt Shingles and Roll Roofing*

In the previous survey it was determined that asphalt-prepared roofings weathered more rapidly the farther south they were exposed. Similarly, in the present survey it was apparent from many observations that normal weathering of these materials on steeply pitched roofs proceeded much less rapidly than in the southern area. Weathering proceeded more rapidly on low-pitched roofs than on steeper roofs, partly because of the tendency of snow to remain for long periods on these roofs accompanied by subsequent freezing and thawing.

The same types of weathering were observed in the Northeastern States as in the Southeastern States: namely, color changes, blistering, pitting, loss of granules, cracking, and warping. However, with the possible exception of changes in color, which are extremely difficult to evaluate, each of these types of weathering can be said to be less severe in the North than in the South when exposed for the same period The greater color changes that were observed were in certain natural green granules which after exposure became a light tan.

Blistering of asphalt shingles, observed occasionally, was negligible when compared to that observed in the Southeastern States. The longer service life of these shingles in the Northeastern States is probably due, in a large measure, to their relatively slight tendency to blister. Blisters are preliminary to pits and, in forming pits, cause loss of granules and asphalt coating, thus permitting water to enter the felts more readily.

Considerable so-called "alligatoring" of asphalt coating was observed, most noticeable on shingles with thick coatings. Figure 3 shows this condition on heavyweight asphalt shingles after 12 years of exposure in Wilmington, Del. Figure 4 is a close-up of a section of one of these shingles.

The practice of laying asphalt shingles directly over weathered wood shingles is not so prevalent in the North as in the South. Also, it is not a common practice to reroof with asphalt shingles over weathered asphalt shingles. This is, no doubt, due in part to the fact that asphalt shingles have been in general use for a period that approximates their maximum life.

Direct evidence that asphalt shingles weather less rapidly in the North than in the South is shown in figures 5 to 10, inclusive. Figure 5 shows individual shingles after 7 years' exposure in Greensboro, N. C. These shingles were laid by the hexagonal method, over wood shingles. Figure 6 shows shingles of the same type after 15 years' exposure in Manchester, N. H. Those in figure 7 had been exposed 10 years in Albany, N. Y. These roofs were of approximately the same pitch and the exposures were the same. Figure 8 represents the southern exposure of a roof of individual shingles, laid by the American method, after 13 years in Savannah, Ga. Figure 9 shows shingles of the same type on the southern exposure of a roof 22 years old in Syracuse, N. Y. Those in figure 10 were also individual shingles exposed 21 years in Portland, Maine. Figure 11 shows an asphalt-shingle roof in excellent condition after 18 years of exposure in Boston, Mass. As observed in the previous survey, the oldest asphalt-shingle roofs were invariably of individual shingles laid by the American method.

Mineral-surfaced, asphalt-prepared roll roofing is used but very little on dwellings in the Northeastern States, and smooth-surfaced roll roofing is scarcely used at all. Where mineral-surfaced roll roofing has been used, it has been laid mainly over weathered wood-shingle roofs.

No attempt will be made to estimate the probable useful life of asphalt shingles and roll roofings in the Northeastern States. Shingles are marketed in so many different weights and shapes and are subject to so many other variables that any estimate would be meaningless. However, it is apparent from evidence obtained in this survey that asphalt shingles or roll roofings exposed in the Northeastern States may be expected to give from 50 to 100 percent longer service than the same materials exposed similarly in the Southeastern States.

In any case, it is reasonable to expect that asphalt shingles that are produced at present will render longer service than those produced 20 years ago. Methods of manufacture have been improved greatly and are controlled more carefully than formerly, research has produced better felts and asphalt coatings, and the development of ceramic granules has made possible a wide variety of permanent colors and color combinations. Advancements along these lines, however, have been nullified somewhat by the constant tendency to produce shingles that require less and less material per unit area of roof. The average home owner is confused by the multiplicity of designs that are available in asphalt shingles.

(*b*) *Wood Shingles*

Work on wood shingles in this investigation is limited to such observations as are necessary for a comparison of them with other roofing materials.[3] Few wood shingles are employed in the congested sections of the cities visited, because of regulations forbidding their use within fire zones. In some places these regulations have not been enforced strictly because of recent economic conditions. Wood shingles have been used to a considerable extent in recent suburban developments of a number of cities, notably Wilmington, Del., Philadelphia, Pa., New Haven, Conn., and Syracuse, N. Y. Their use has not been confined to dwellings in the low-cost groups.

[3] Inquiries for technical information covering wood shingles should be directed to the Forest Products Laboratory, United States Department of Agriculture, Madison, Wis.

Wood shingles are applied on spaced sheathing (shingle lath) or on tight sheathing. This latter practice is quite common in some sections, no doubt, due to the fact that snow may filter through a wood-shingle roof laid on shingle lath. Wood shingles absorb a considerable amount of moisture in long-continued rains, and when laid on tight sheathing, have less opportunity to dry thoroughly than those laid on open decks. Figure 12 shows a roof of wood shingles laid on tight sheathing after 15 years' exposure in Manchester, N. H. These shingles had been stained originally. Figure 13 illustrates the extreme weathering of untreated wood shingles that had been exposed more than 40 years near Hillsboro, N. H. These shingles were laid on shingle lath. A larger section of this roof is shown in figure 14. The shingles directly beneath the chimney show less curling and general weathering than those in other sections of the roof. This condition is characteristic of hundreds of wood-shingle roofs observed. Many cases were observed where sections of asphalt and galvanized-iron roofs beneath chimneys were weathered more severely than others. See figures 15 and 16.

Menhaden oil, colloquially Pogy oil, was used formerly in certain sections of Maine for preserving wood shingles. Figure 17 shows a roof so treated after 20 years of exposure in Portland, Maine. Except for slight curling and cracking of a few shingles, this roof showed practically no weathering. The oil treatments had made these shingles quite dark in color. Shingles on this roof were laid on 6-in. sheathing spaced 2 to 3 in.

Whether or not wood shingles should be treated and the preservative value of various treatments are subjects about which there are differences of opinion among shingle experts. Results of weathering tests on treated and untreated wood shingles are given in a report of the Pennsylvania State College, School of Agriculture and Experiment Station [2 (a)].[4]

A complete study of the weathering of wood shingles in the Northeastern States would require much more time than was spent in this entire survey. An investigation of this kind should include studies of the various kinds of woods that are used, methods of laying, and exposures in different locations. It should also include a comparison of edge and flat-grain shingles of different thicknesses, with and without sapwood, both treated and untreated. Opinions vary concerning the life of wood shingles and are usually prejudiced. One may claim that they will last from 10 to 15 years and another that the average life is about 40 years. Actually, first-grade shingles of the weather-resistant woods, applied properly on roofs of sufficient pitch, will usually give excellent service. Wood-single roofs 40 and more years old are not unusual, though these roofs have probably required some patching during that time. It is also not unusual to find wood-shingle roofs that have to be replaced or recovered in less than half that time, either because the shingles were of poor quality or improperly applied. The adoption of proper grading rules by the bulk of the industry makes it possible for the individual home owner to buy wood shingles with much greater confidence than formerly.

(c) *Cement-Asbestos Shingles*

In general, cement-asbestos shingles have been used less in the Northeastern States than in the Southeastern States. They are reported to have given excellent service in that they resist normal weathering for long periods. They are quite brittle and are subject to damage by being walked upon or by heavy objects falling upon them. In industrial locations they may present a dingy appearance after long exposures, due to their tendency to collect dust and dirt. Figure 18 shows a roof after 18 years of exposure in Portland, Maine, illustrating this tendency. That not all of these roofs become dirty is illustrated by figure 19, showing cement-asbestos shingles more than 20 years old in Boston, Mass. More cement-asbestos shingle roofs were observed in Albany, N. Y., than in any other city visited. They are also used quite extensively in Syracuse, N. Y. Most of the older cement-asbestos roofs are

[4] Numerals in brackets refer to the list of selected references at the end of the report.

laid as those shown in figures 18 and 19. Many of those applied recently use shingles in attractive colors laid by the American method.

Cement-asbestos shingles show the same type of weathering in the North as in the South. After long exposure the surface is roughened somewhat, and the asbestos fibers become plainly visible. It was not possible to establish differences in the degree of weathering of cement-asbestos shingles of the same type exposed in different localities.

(*d*) *Slate*

Two areas which produce large quantities of slate for roofing purposes were visited in the course of this survey, namely, the Vermont and east Pennsylvania regions. In addition, some observations on Peach Bottom slate, made on a previous visit to Delta, Pa., and Cardiff, Md., are included.

Most of the colored slates used for roofing purposes during the past 75 years have been produced in western Vermont and eastern New York. Those from Vermont include purple; green, both fading and unfading; and the so-called variegated slates, which are mottled purple and green. The belt that produces these slates extends into eastern New York and is the only source from which appreciable quantities of red slates have been produced for roofing purposes. Quarries have been operated in this region for about 85 years, and the slates produced have an excellent record of durability. Figures 20 and 21, representing roofs in and near Fair Haven, Vt., need no explanation as regards the age of the roofs shown. In each instance the main body of the roof is of purple slate with the numerals outlined in unfading green. The color of these slates is almost identical with that of similar slates produced today.

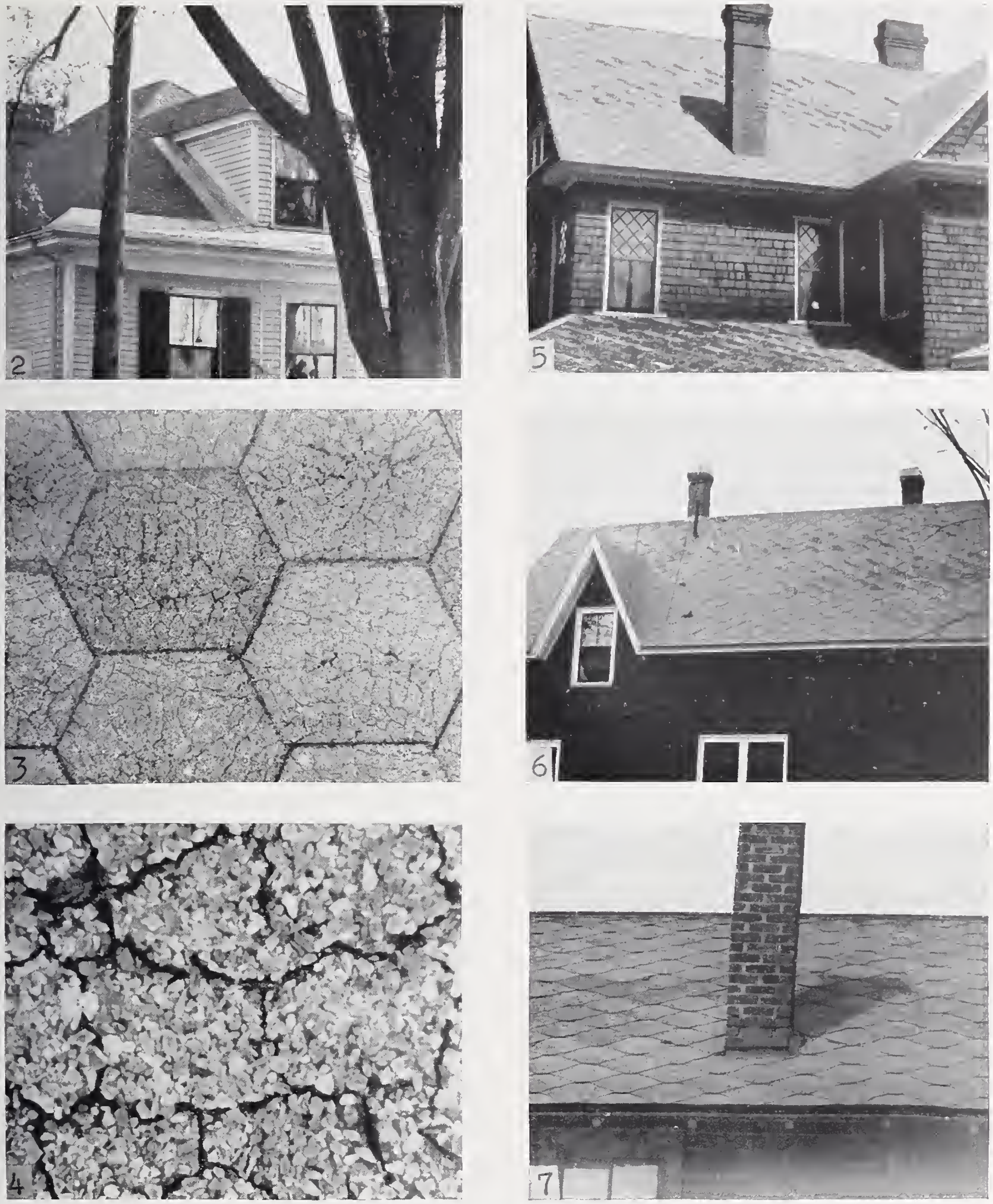
The fading green (sea-green) Vermont slates are also extremely durable, as evidenced by the roof shown in figure 22, reported to be more than 75 years old. These have weathered to a light brown and some have begun to disintegrate by scaling. This roof is failing principally through failure of the nails used to fasten the slates. The unfading and fading green slates are quarried within relatively short distances of each other and are practically indistinguishable to the layman when taken from the quarry. The fading green slate splits into thin sections more readily than the unfading variety. Experts are able to identify the fading green slates by their somewhat unctuous feel when freshly quarried. They usually show color changes within 1 or 2 years. Prolonged exposure changes them to a dark tan or light brown.

The red slates produced in eastern New York are unique in that their color becomes more intense on prolonged exposure. They are also extremely durable. Figure 23 shows a red slate roof in Rutland, Vt., more than 50 years old.

Frequently slates of different colors and thicknesses are mixed intentionally to produce a blend of colors and a pleasing architectural effect. In these cases, the larger, thicker slates are laid near the eaves to give the proper perspective.

Areas in Maine where roofing slate has been produced were not visited. In Portland, however, a number of roofs were inspected which were said to be of Maine slate. These slates were of a very dark color, almost black, and would certainly be classed as unfading. Figure 24 shows a section of one of these roofs after 38 to 40 years of exposure. Similar slates were used as a siding material on this dwelling with excellent workmanship throughout. See figure 25.

Slate for roofing purposes has been produced in Pennsylvania for about 200 years. The earliest operations were in York County, on the Maryland border, where the well-known Peach Bottom slates are still produced. This bed extends across the Susquehanna River into Lancaster County, Pennsylvania, and south into Maryland. These slates are extremely durable, figure 26 showing a roof laid recently with slates that are reported to have served previously on another roof for more than 100 years. They are dark bluish gray when quarried and retain their color on long exposure. Some that are reputed to have been in service



FIGURES 2 to 7.—*Asphalt shingles*

Figure 2, wide metal eaves strip and dormer flashing, 3 and 4, severe alligatoring, heavyweight asphalt shingles exposed 12 years in Wilmington, Del.; 5, 6, and 7, re-cover asphalt shingles; 5, exposed 7 years in Greensboro, N. C.; 6, exposed 15 years in Manchester, N. H.; 7, exposed 10 years in Albany, N. Y.

Figures 8 to 13.—*Asphalt and wood shingles*

Figures 8, 9, and 10, individual asphalt shingles, southern exposures; 8, after 13 years in Savannah, Ga.; 9, after 22 years in Syracuse, N. Y.; 10, after 21 years in Portland, Maine; 11, asphalt shingles exposed 18 years near Boston, Mass.; 12, wood shingles on tight sheathing exposed 15 years in Manchester, N. H.; 13, wood shingles more than 40 years old near Hillsboro, N. H.

FIGURES 14 to 19.—*Wood, asphalt, and cement-asbestos shingles; galvanized sheet metal*

Figure 14, wood shingles preserved below chimney, larger section of roof shown in figure 13; 15 and 16, deterioration of asphalt shingles and galvanized sheet metal below chimney; 17, treated wood sbingles exposed 20 years in Portland, Maine; 18, cement-asbestos shingles exposed 18 years in Portland, Maine; 19, cement-asbestos shingles exposed 18 years in Boston, Mass.

Figures 20 to 25.—*Slate*

Figures 20 and 21, purple Vermont slate with numerals of unfading green in and near Fair Haven, Vt.; 22, roof of fading green Vermont slate in Rutland, Vt., approximately 75 years old; 23, red slate roof in Rutland, Vt., more than 50 years old; 24 and 25, Maine slate, roofing and siding exposed 38 to 40 years in Portland, Maine.

Figures 26 to 31.—*Slate.*

Figure 26, Peach Bottom slate applied recently in Delta, Pa., after about 130 years exposure on another structure; 27, heavy Peach Bottom slate exposed more than 100 years near Delta, Pa.; 28 and 29, roofs in Slatington, Pa.: 28, 35 years old; 29, about 60 years old; 30, roof in Pen Argyl, Pa., 37 years old; 31, slates laid on slats, exposed 25 years in Wind Gap, Pa.

FIGURES 32 to 37.—*Slate and sheet metal.*

Figure 32, ribbon slates, exposed 20 years in Washington, D. C.; 33, Vermont slate laid with alternate courses of saturated felt after exposure of less than 1 year in Scarsdale, N. Y.; 34, standing-seam tin roof more than 80 years old in Reading, Pa.; 35, old standing-seam tin roof in Portland, Maine, showing lack of proper maintenance in recent years; 36, galvanized sheet-metal roof 8 to 9 years old, near Thurmont, Md.; 37, copper roof on Christ Church, Philadelphia, Pa., applied in 1749.

FIGURES 38 to 43.—*Metal roofs, flashings, and hurricane damage to asphalt shingles.*

Figure 38, dwellings with old standing-seam tin roofs in Wilmington, Del.; 39 and 40, typical chimney flashings; 41, combination valley, interlaced asphalt shingles, and wide metal strip; 42, tabs of asphalt-strip shingles blown up during hurricane; 43, hurricane damage to new asphalt shingles due to improper application.

FIGURES 44 to 49.—*Hurricane damage to roofs.*

Figure 44, old asphalt-shingle roof; 45, damage to small section of comparatively new asphalt-shingle roof laid over wood shingles; 46, old wood-shingle roof; 47, old metal roof; 48, slate blown from hips; 49, damage to tile roof.

on a number of buildings over a period of about 200 years show slight evidence of rust on the surface. Figure 27 shows a very old slate roof of heavy Peach Bottom slate. The slate that has been produced in the Peach Bottom district represents but a small proportion of the total slate production in this country.

By far the greatest quantity of slate that has been used for roofing purposes in this country has been produced in Lehigh and Northampton Counties, Pennsylvania. Quarries have been operated in these counties for about 100 years, with the principal operations at Slatington, Slatedale, Bangor, Pen Argyl, Wind Gap, Belfast, and Chapman. In this region, operations generally are on a much larger scale than elsewhere and utilize the most modern equipment, including wire saws, electric hoists, etc. Quarries 600 ft deep are not uncommon.

A thorough comparative study of the slates produced in this region was not attempted. Probably as much has been written about slate as about any roofing material, and in the bibliography at the conclusion of this report are listed a number of references to excellent treatises on slate. Reference 4 (d), "Slate in Pennsylvania," by Charles H. Behre, Jr., published by the Pennsylvania Geological Survey in 1933, is a book of 400 pages, mainly about slate from this particular region.

Many dwellings in the towns listed have slate roofs more than 50 years old. The slates from this area are classed generally as fading [4 (b)], the kind and amount varying considerably in slates produced from different quarries or, in some cases, from different parts of the same quarry. One of the most common forms of fading is shown in figure 28, where the sides and bottom of the exposed portion of the slate change to a light gray which on long exposure will spread over the entire exposed surface. The roof illustrated in figure 28 is 35 years old and is said to have never given any trouble.

After prolonged exposure many of these slates develop a tan color. The roof in figure 29, reported to be more than 60 years old, and patched in many places, showed this change. Figure 30 shows a roof 37 years old with but little fading; figure 31, one 25 years old with practically no fading. The slates in this latter roof were 12 by 24 in. in size, and were laid on slats.

All of the illustrations mentioned show roofs 25 or more years old and all are in good condition except the one in figure 29. Roofs of slate from this section may require considerable repair or even replacement in less than 25 years. Figure 32 illustrates a roof that was replaced after 20 years of exposure, and which had required extensive repairs for a number of years. These were ribbon slates,[5] though most of them would be described by producers as "No. 1 Ribbon," since the ribbons were mainly in the unexposed portions of the slates. "No. 2 Ribbon" slates are those with ribbons in the section that is exposed to the weather, and "clear" slates are those without ribbons. A number of roofs of ribbon slate have been observed where the ribbons in the unexposed portions show disintegration as great if not greater than those in the exposed section. The authors are convinced that much of the soft-vein ribbon slate should not be used for roofing purposes.

Ribbons in slates are not necessarily undesirable (see footnote 5). Some of the ribbons in hard-vein slates weather to a light-colored band. These are rough-splitting slates which are used frequently for textural effects.

It is often very difficult to distinguish, without tests, between slates of good and poor weathering characteristics, and many persons have been disappointed because a roof that was expected to last as long as the structure required frequent repairs and, in some cases, replacement in a comparatively short time. Frequently fading slates, or mixtures of fading

[5] "Bands of different color, texture, and composition in slate are commonly called ribbons. The most common ribbons are darker in color than the main part of the slate and vary in width from a fraction of an inch up to several inches." D. W. Kessler and W. H. Sligh, BS J. Research 9, 381 (1932) RP477.

"When exposed to the weather the ribbons in the 'soft-vein' slate of Pennsylvania decompose more readily than the clear stock. In sidewalks, made of ribboned slate, deep grooves have commonly resulted from the weathering of the ribbons. The ribbons in the 'hard-vein' slate of Pennsylvania resist weathering." Oliver Bowles, Bulletin 218, Bureau of Mines, United States Department of the Interior, p. 11 (1922).

and unfading slates, have been sold as unfading slates.

A number of modifications of the usual methods of laying slate roofs have been proposed. Usually these provide for less slate per unit area of the roof by substituting asphalt-saturated felt or asphalt-prepared roofing for a part of the slate. This is accomplished by introducing a strip of felt or prepared roofing between each course of slate. Because these roofs require fewer slates and, consequently, a lighter supporting structure, they may be applied more cheaply than by usual methods. One group of dwellings roofed with Vermont slate, with alternate strips of saturated felt, was examined in the course of this survey. These dwellings are located in a region where there is considerable snowfall in winter, with alternate thawing and freezing. It was reported that it was necessary to replace a number of broken slates on these roofs after each winter. Figure 33 shows a section of a roof which had been completed during the previous winter. Note the exposed felt where the slates have been broken.

(e) *Built-Up Roofing*

No detailed study was made in this survey of the weathering qualities of built-up roofs. These roofs are more commonly used on large structures, such as apartment houses, office and industrial buildings, and to a considerable extent on low-pitched, row-house roofs in cities in the Northeastern States. This use has been twofold—as a replacement for the old standing-seam tin roofs and on new construction.

It is expected that a later publication will discuss the weathering qualities of built-up roofings. Material for this report is being obtained from inspections of roofs of Government-owned buildings throughout the country by competent engineers.

(f) *Tile*

Very little tile roofing was observed in the territory covered by this survey. Where used, it was usually on the more expensive dwellings. Ceramic-shingle tiles are being used on some new dwellings, but to a very limited extent compared to the whole volume of roofing materials. A few cement-tile roofs were also observed, but not nearly as many as were seen in the Southeastern States. The severity of the winters in the northern sections limits the use of porous roofing materials of any type.

(g) *Metal*

It was found difficult to obtain accurate information concerning the durability of various metallic roofing materials. Ferrous sheet materials, unless adequately protected, suffer deterioration through corrosion, the severity of which is determined largely by the conditions of exposure.

Roofing tin when properly protected by painting gives long service. Many of these roofs are still in good condition after 40 or more years of exposure. The oldest roof of this kind of known history that was observed was more than 80 years old and had been painted regularly for more than 60 years by the same person (see fig. 34). Another standing-seam tin roof that was in good condition after 73 years of exposure was observed. The underside of the metal was unpainted and showed no rust or other evidence of corrosion. Much shorter life results if roofs of this type are not adequately maintained. Roofs covered with roofing tin are usually either good or poor; they are either well maintained and present a good appearance, even though they may have considerable age (fig. 34), or are in a poor condition due to improper maintenance (fig. 35).

A somewhat similar condition obtains in the case of galvanized sheet steel, though the life of this material may be shorter than that of roofing tin. Two conditions contribute to this: First, the zinc coating on any galvanized sheet exposed to the weather has limited life which depends on the weight of coating, character of the prevailing atmosphere, roof drainage, etc.; second, too much dependence if often placed on the coating, and galvanized roofs in many instances are never painted.

Even when painted, if proper precautions are not observed, difficulties are encountered with respect to proper adherence of the coating of paint to the metallic surface, with the result that cracking and peeling of the coating occur. In such cases, the durability of galvanized roofing depends almost entirely upon the protection offered by the zinc coating. The need for painting galvanized roofing should be strongly emphasized. Methods for pretreating the surface of galvanized-steel sheets before painting, which improve greatly the paint adherence, have been developed recently but are not in wide use as yet.

It is frequently observed, with galvanized roofs, that some sheets are rusted severely, whereas others show little or no rust, a condition indicating a lack of uniformity in the sheets. Figure 36 illustrates this condition. Information obtained from other sources indicates that this behavior prevails in other sections of the country.

The oldest metal roof (fig. 37) that was observed was the copper roof on Christ Church in Philadelphia, Pa., which dates from 1749.

3. Flashings, Valleys, Gutters, and Downspouts

It was practically impossible to secure definite information concerning the durability of these vital roofing accessories. Consequently, only general observations could be made.

It was quite evident that considerable attention is given to the correct installation of chimney flashings, valleys, and eave strips in the majority of cases that were observed. This is pronounced in the Northeast owing, perhaps, to the fact that all roofs in the northern sections of this country are subjected to loads of snow and ice which may remain in contact with the roofing material for long periods. Alternate thawing and freezing may intensify this condition. Consequently, to withstand these climatic conditions, adequate provision must be made so that all roof intersections and contacts with chimneys, vents, etc., are watertight.

(a) *Flashings*

Copper, galvanized iron, roofing tin, zinc, and lead are widely used for chimney and vent flashings. Figures 39 and 40 represent some typical installations of flashings.

Copper, zinc, and lead are used principally in those sections along the seacoast where salt atmospheres exert a deleterious effect on ferrous materials. It was found that the use of particular metals for these purposes was confined locally to given sections and was due to a combination of satisfactory service and local roofing practices. Rarely, and only on the cheapest types of construction, was roll roofing utilized as flashing material for asphalt-shingle and roll-roofing roofs.

(b) *Valleys*

Roll roofing, copper, galvanized iron, and roofing tin are used most frequently for valley flashings. The use of wide valleys, as illustrated in figure 41, is rather prevalent. Mineral-surfaced roll roofing, tin, galvanized iron, and copper are used with asphalt shingles. The practice of interlacing the butts of asphalt shingles to form continuous valleys is used to a limited extent. Figure 41 shows a valley, part of which is made by interlacing the butts of asphalt shingles with a wide metal strip forming the lower section. Copper, galvanized iron, and tin are used largely with wood shingles. Galvanized metal is used exclusively with galvanized sheet-metal roofs.

(c) *Gutters and Downspouts*

The use of these accessories on houses in the northeastern section is almost universal. Most gutters and downspouts are constructed of either copper or galvanized iron, the former material being used on houses in the higher-priced brackets, whereas the latter is used on lower-priced houses. A few of the old-type built-in gutters can be found throughout this particular territory. In some sections, wood gutters are reported to give many years of service.

V. EXTENT OF USE OF THE VARIOUS ROOFING MATERIALS IN URBAN CENTERS IN THE NORTHEASTERN STATES

1. Factors Which Affect the Choice of Roofing Materials Generally

Initial cost, cost of maintenance, fire resistance, and appearance are factors which influence the choice of roofing materials generally. Nearness to sources of supply and cost of application are strong factors in determining the initial cost. Maintenance costs must be considered as important as is the initial cost, for some roofing materials will last indefinitely if maintained regularly, while others have a more or less definite period of usefulness with little or no cost for maintenance. City regulations and fire insurance rates are factors which govern the use of the more inflammable materials. Appearance is becoming increasingly more important as a factor in the choice of roofing materials. The manufacturer of asphalt shingles and the producer of colored-slate roofings emphasize the possibilities of pleasing color effects that can be obtained with their materials. Architects strive for roofs that are individualistic and that do not repeat the same pattern on the whole surface of the roof. Wood shingles are frequently stained to give the appearance of great age. Ribbon slates are used for decorative effect. The producers of copper roofing materials emphasize the beautiful patina that will develop on copper after long exposure. There is no question but that it is possible and proper to enhance the appearance of a dwelling by choosing a pleasing roofing material, although the primary purpose of a roof should not be forgotten in the choice of the materials or the design.

2. Distribution of Roofing Materials in the Cities Included in This Survey

(a) *Asphalt Shingles and Roll Roofing*

Asphalt shingles have had comparatively wide use during the past 20 years in all cities that were visited in the Northeastern States, both for reroofing purposes over old wood shingles and on new construction. Apparently, however, they have been employed less generally than in the cities of the Southeastern States. They give much longer service in the North than in the South, so that, with the relatively short period that these shingles have been on the market, the practice of reroofing over weathered asphalt shingles with new shingles has not become a general one. Many more roofs of individual asphalt shingles, laid by the American method, are found in the North than in the South. These were the first asphalt shingles that were produced, and many of them remain after more than 20 years of exposure. The cheaper types of individual asphalt shingles laid by the Dutch-lap or hexagonal methods, used principally for reroofing purposes, have had much less use in the North than in the South.

One would judge, from the large number of comparatively new asphalt-shingle roofs that were seen, particularly those of the so-called "thick-butt" strip shingles, that the use of asphalt shingles is increasing in the territory covered by this survey.

The use of asphalt-prepared roll roofing, either smooth or mineral-surfaced, on dwellings in the Northeastern States is so slight that it may be considered negligible.

(b) *Wood Shingles*

Wood shingles are being used to a considerable extent on all classes of construction in the outlying districts of Northeastern cities. Western red cedar shingles, unstained, are used most widely, with some white cedar shingles being used occasionally. In Wilmington, Del., Philadelphia, Pa., and New Haven, Conn., recent suburban developments were observed in which wood shingles were used exclusively.

More wood-shingle roofs were found in the congested sections of cities in the Northeastern States than in the Southeastern States. Most of these were old roofs, since wood shingles are not permitted now, generally, because of fire regulations.

(c) *Cement-Asbestos Shingles*

Cement-asbestos shingles have not had very wide use in the past, through it is apparent that the use of these shingles is increasing. More cement-asbestos shingle roofs were observed in Albany and Syracuse, N. Y., than in any of the other cities.

(d) *Slate*

Slate has been employed for roofing purposes to a much greater extent in the cities of the Northeastern States than in the Southeastern States. The extent to which availability of a particular material influences its use is best illustrated by the use of slate roofing on all types of structures in the rural and urban sections near slate-producing areas. The amount of slate for roofing purposes now produced is much less than it was 35 to 40 years ago. The year of greatest production was 1902, since which time competition of cheaper materials and rising labor costs have tended to decrease production. The absence of proper specifications and a unified merchandising plan have more or less crippled the roofing-slate industry. Recently specifications which should be of considerable help to purchasers and producers of roofing slate have been adopted. [4 (e, f)].

(e) *Tile*

Very few tile roofs of any type were observed in the cities covered by this survey. Some ceramic-shingle tiles are being used on new dwellings in the higher-priced classes. Unglazed, porous tiles are not suitable for use in areas where extremes of temperature prevail.

(f) *Metal*

Metal roofing materials, as a class, are used to a lesser extent at present than formerly. In every city visited were found many row houses with comparatively low-pitched roofs which were covered originally with standing-seam tin.

Figure 38 illustrates representative installations. Galvanized-iron roofing is used but little on urban dwellings; in locations near the seacoast, practically not at all.

A few roofs of 10-oz and 3-oz sheet copper and some of crimped-copper shingles were observed in Connecticut near the cities where these materials are manufactured.

(g) *Built-Up Roofing*

Asphalt and coal-tar-pitch built-up roofs have largely superseded the standing-seam tin roofs in most cities. They are cheaper to install and give good service with but little maintenance for periods of 10 to 20 or more years, depending on the number of layers of felt and moppings of bitumen.

VI. DAMAGE TO ROOFS BY THE HURRICANE OF SEPTEMBER 21, 1938

Observations on the effects of the destructive hurricane that swept through New England on September 21, 1938, were made in New Haven, Conn., Boston, Mass., and Manchester, N. H. Damage to rural roofs in this area is reported in section III, 4, page 5.

Elsewhere in this report considerable space is devoted to a discussion of the necessity for limiting descriptions of the normal weathering qualities of roofing materials to the most general terms. It might appear, at first glance, that with but a single causative factor, such as the strong winds of a hurricane, it would be possible to discuss the relative damage to roofs of the various types more specifically; that it might even be possible to list the different kinds in the order of the damage they received. Such, however, is not the case. Roofing materials are designed and roofs are constructed to withstand winds of usual velocity. With winds of intensity sufficient to completely demolish thousands of dwellings, it was natural that numerous roofs of all types should be destroyed. To determine definitely which types were affected most under such conditions would require a census of a great many roofs with a complete history of each one. The age of any roof, regardless of the roofing material, is of great importance in studying wind damage; wood and asphalt shingles that have been exposed a number of years may be slightly curled at the butts; old asphalt shingles are more brittle than new ones; wood shingles may be weakened greatly by erosion; and all types of roofs may be rendered less resistant to high winds by the disintegration of the nails used to fasten them. Faulty application, particularly improper nailing of shingle-type roofs, is responsible for the failure of many roofs under wind conditions that are not unusual; and under winds of hurricane intensity, roofs that are not fastened properly have little chance.

The first reaction from the observations of roofs after the hurricane was one of surprise, not that the damage was so great, but that so many roofs of all types had escaped with little or no damage. The action of the wind can be described best as freakish because many instances of adjacent identical roofs were observed where one would be damaged badly and the other but little, if at all.

Figures 42 to 49, inclusive, illustrate damage to roofs by the hurricane. They have been selected, not to show the maximum damage to any type of roof or the relative amount of damage to various kinds of roofs, but rather to show damage that was typical, with several examples of damage due to improper application of the roofing material. The age of these damaged roofs was not determined; but, generally, the oldest roofs were damaged most, except where some structural weakness was at fault or where the roofing was applied improperly.

The roof shown in figure 42 was photographed during the height of the storm. The only shingles that are affected in this roof are those in the course next to the ridge. Apparently these shingles were nailed very high in order that the ridge roll would cover the nail heads, as indicated by the shingle on the extreme right. Another roof that illustrates the improper application of asphalt shingles is shown in figure 43. These were square-tab strip shingles that were each fastened with three nails, one at the center and one at each end, about 1 in. from the top.

Figure 44 shows damage that was typical of badly weathered asphalt shingles. Figure 45 shows typical damage to a small section of a comparatively new asphalt-shingle roof laid over wood shingles. Numerous asphalt-shingle roofs in the immediate vicinity of that shown in figure 11 were badly damaged.

Figure 46 shows damage to a rather old wood-shingle roof. While only a few shingles were blown from one section of the roof, another whole section was blown off entirely. Very little damage was done to roofs of wood shingles that were not curled and weathered.

The metal roof in figure 47 is probably not typical of damage to roofs of this type, because generally, when these roofs were damaged, a section of the roof or the entire roof would be, rolled up and blown clear of the structure.

The roofs shown in figures 48 and 49 illustrate damage that may occur to slate and tile roofs. It was characteristic that damage to slate roofs was usually confined to small sections of the roof. Note that the felt underlay in figure 49 has not been disturbed. Very few tile roofs were observed in the hurricane area.

VII. COSTS OF ROOFING MATERIALS, INCLUDING COST OF APPLICATION, IN URBAN CENTERS IN THE NORTHEASTERN STATES

The current price, including cost of application, per square (100 sq ft of roof surface) for each of the materials listed in table 4 was furnished by representatives of the Home Owners' Loan Corporation in Wilmington, Del., Philadelphia, Pa., New Haven, Conn., Boston, Mass., Manchester, N. H., Portland, Maine, and Rutland, Vt. The range in costs is shown in the columns marked "minimum" and "maximum." The minimum and maximum costs were distributed among the different cities and were not confined to any particular one. The average cost shown is the average for all of the cities.

Table 4.—*Costs of roofing materials, including application, per square, on a simple pitched roof with no valleys, but including chimney flashings*

[Data obtained from the Home Owners' Loan Corporation]

Materials	Weight per square	Cost per square		
		Minimum	Maximum	Average
Asphalt shingles:	lb			
Giant individual, 12 by 16 in., American method	325	$12.85	$20.00	$15.50
Standard individual, 9 by 12¾ in., American method	255	10.50	16.50	13.70
Four-tab square butt strip, 12½ by 36 in.	266	10.30	16.00	13.35
Three-tab square butt strip, 12 by 36 in. overlay	211	9.50	14.00	11.55
Two-tab hexagonal strip, 11⅓ by 36 in.	167	8.50	12.00	9.75
Individual re-cover, Dutch lap	125 to 140	7.50	12.00	9.70
Individual re-cover, hexagonal	125 to 140	7.50	12.00	9.60
Asphalt roll roofing:				
Mineral-surfaced	90	4.50	7.25	6.20
Smooth-surfaced	55	4.25	6.50	5.30
Cement-asbestos shingles (gray color only):				
American method		21.00	29.00	23.95
Hexagonal method		15.00	21.80	18.05
Dutch-lap method		15.00	24.50	19.50
Slate		13.00	28.00	21.00
Wood shingles		10.00	18.00	14.00
Metal roofing:				
Shingles (galvanized)		9.75	25.00	16.80
Five V-crimp sheets (galvanized)		7.25	22.00	14.50
Standing-seam "tin," 25 lb, unpainted		13.60	25.00	19.25
Flat lock and soldered "tin," 25 lb, unpainted		13.25	30.00	20.60
Ceramic-shingle tile		35.00	60.00	47.50
Built-up roofing:				
Five-ply coal-tar-pitch, surfaced with slag or gravel		7.25	13.00	10.10
Five-ply asphalt, surfaced with slag or gravel		8.00	12.00	9.90

VIII. SUMMARY

1. Distribution

Initial and maintenance costs, availability, and appearance largely govern the choice of roofing materials.

Asphalt shingles, wood shingles, and sheet metal (galvanized) are found on approximately 76 percent of the rural dwellings along the routes traveled in the two surveys. Sheet-metal roofs are used most frequently on low-cost rural roofs in the Southeastern States; asphalt shingles on roofs of the same class in the Northeastern States.

The villages and small towns in the Northeastern States show a greater variation, generally, in the kinds of roofing materials that are used, than those in the Southeastern States.

Slate roofs are used almost exclusively in rural sections, towns, and villages near slate-producing areas.

Few old wood-shingle roofs remain in congested areas of the Northeastern cities, but they are being used to a considerable extent in new suburban developments near some cities, notably Wilmington, Del., Philadelphia, Pa., and New Haven, Conn.

Standing-seam tin was used formerly on many low-pitched roofs in the congested areas of most cities in the Northeastern States. A number of these old roofs remain but many have been superseded by bituminous built-up roofs.

Sheet metal and metal shingles are not in wide use on dwellings in the Northeastern States.

Asphalt-prepared roll roofing has comparatively little use on dwellings in the Northeastern States.

Fewer single-coverage asphalt-shingle roofs are seen in the Northeastern States than in the Southeastern States.

Roofs in the Northeastern States are generally more steeply pitched than in the Southeastern States because of snow and ice conditions. Wide metal eaves strips are installed frequently to prevent leaks and to reduce damage by snow and ice to shingle-type roofs.

2. Weathering

Asphalt shingles and roll roofings in the Northeastern States exhibit the same types of weathering as in the Southeastern States, but weathering proceeds more slowly in the Northeastern States. In general, these roofs may be expected to render from 50 to 100 percent longer service in the Northeastern States than in the Southeastern States. The oldest asphalt-shingle roof that was examined was 22 years old, of individual shingles, which showed severe weathering on the southern exposure.

Many asphalt-shingle roofs that had been exposed for a number of years suffered damage from the hurricane. Many comparatively new asphalt-shingle roofs showed no damage, or only slight damage to small areas.

Several wood-shingle roofs were found to be in good condition after more than 20 years of exposure, also some that were in poor condition after 10 or 12 years. Some very old roofs of wood shingles (more than 40 years old) were also observed, but invariably these had been patched and showed severe weathering. Edge-grain shingles of weather-resisting woods, of proper thickness and without knots or cracks, may be expected to render long service. Old wood-shingle roofs suffered damage from the hurricane; roofs of wood shingles that had been exposed only a few years showed but little damage. In many instances, entire sections were blown off with no damage to the individual shingles.

Practically all colored slates that are used for roofing purposes in this country are produced in the Vermont-New York area. They are very durable, and the unfading varieties retain their colors during long periods of exposure. The greatest quantities of slate for roofing purposes are now, as in the past, produced in Lehigh and Northampton Counties, Pa. Slates from this area are classified as fading slates [4 (b)]. The best grades may last 60 or more years, the poorest grades may have to be replaced within 10 years. Peach Bottom slates produced in York County, Pa. and Harford County, Md. are nonfading and very durable, some that have been exposed more than 100 years still being in service. Some roofing slates are being produced in this area at present but in relatively small quantities.

Comparatively few slate roofs were observed in the area affected by the hurricane. Damage to slate roofs was confined chiefly to small sections, usually along hips or ridges.

Cement-asbestos shingles have been on the market only about 30 years, and numerous roofs that have rendered satisfactory service for more than 20 years have been examined. These shingles tend to collect dust and dirt and become unsightly after long exposure in industrial locations. Only a very few cement-asbestos roofs were observed in the hurricane area—none that showed any damage.

Tin and galvanized roofs render very long service if they are painted at regular intervals but may deteriorate rapidly if they are not painted. Galvanized sheets exposed in rural sections may remain 8 or 9 years without severe rusting; in industrial atmospheres or close to the seacoast they deteriorate more rapidly.

Sheet-metal roofs, particularly old tin roofs of standing- and soldered-seam construction, when damaged by the hurricane, were usually destroyed, many being blown free of the structure.

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