U. S. DEPARTMENT OF COMMERCE

BUILDING MATERIALS AND STRUCTURES

REPORT BMS84

Survey of Roofing Materials in the South Central States

by

HUBERT R. SNOKE
and LEO J. WALDRON

NATIONAL BUREAU OF STANDARDS

The program of Research on Building Materials and Structures carried on by the National Bureau of Standards was undertaken with the assistance of the Central Housing Committee, an informal organization of governmental agencies concerned with housing construction and finance, which is cooperating in the investigations through a committee of principal technicians.

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[For list of BMS publications and directions for purchasing, see cover page III.]

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Foreword

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

Reports published previously are: BMS6, Survey of Roofing Materials in the Southeastern States; BMS29, Survey of Roofing Materials in the Northeastern States; and BMS75, Survey of Roofing Materials in the North Central States. Frequent reference is made in this report to the reports on previous surveys.

A tabulation, by States, of the kinds of roofing materials that were found on more than 9,500 rural dwellings, along approximately 4,200 miles of highway in the South Central States, is included. There is also given a summation of the kinds of roofing found on more than 38,000 dwellings along more than 11,000 miles of highway in the 37 states covered by the four surveys.

More than 400 photographs, showing types of weathering of roofing materials, and features of the 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 South Central States

by HUBERT R. SNOKE *and* LEO J. WALDRON

CONTENTS

ABSTRACT

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

Detailed studies of roofing materials in Chattanooga and Memphis, Tenn.; Jackson, Miss.; New Orleans, La.; Houston, Dallas, San Antonio, and Amarillo, Tex.; Oklahoma City, Okla.; Little Rock, Ark.; and Louisville, Ky., are reported.

A tabulation, by States, of the kinds of roofing materials used on 9,500 rural and small-town dwellings, along approximately 4,200 miles of highway between the cities listed above, is included; also a summary of the kinds of roofing materials used on more than 38,000 rural and small-town dwellings along approximately 11,000 miles of highway in the 37 States covered by the four surveys.

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

1. 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, comprehensive surveys of the various types of roofing materials used in locations of widely different climatic conditions.

Three surveys have been made previously, in the Southeastern, Northeastern, and North Central States as follows: Southeastern States, covering Virginia, North and South Carolina, Georgia, Florida, Alabama, parts of Tennessee and Kentucky, and West Virginia, in April 1938; Northeastern States, covering Delaware, Maryland, Eastern Pennsylvania, Connecticut, Massachusetts, New Hampshire, Maine, Vermont, and New York, in September and October 1938; North Central States, covering Western

Pennsylvania, Ohio, Illinois, Michigan, Wisconsin, Minnesota, North and South Dakota, Nebraska, Missouri, and Indiana, in August and September 1940.

Results of these surveys have been published,[1] respectively, as Building Materials and Structures Report BMS6, Survey of Roofing Materials in the Southeastern States; Building Materials and Structures Report BMS29, Survey of Roofing Materials in the Northeastern States; and Building Materials and Structures Report BMS75, Survey of Roofing Materials in the North Central States.

The present paper describes a similar survey in the South Central States, with detailed studies in the following cities: Chattanooga and Memphis, Tenn.; Jackson, Miss.; New Orleans, La.; Houston, Dallas, San Antonio, and Amarillo, Tex.; Oklahoma City, Okla.; Little Rock, Ark.; and Louisville, Ky. It includes also a report of the extent of use of the different roofing materials, classified roughly by appearance on rural dwellings along the highways between the cities visited. This survey was made from April 12 to May 23, 1941, and involved approximately 5,700 miles of travel.

Reference to the reports on the previous surveys is frequently made in this report. For convenience they are referred to as "BMS6", "BMS29", and "BMS75."

Another report, Building Materials and Structures Report BMS57, Roofing in the United States—Results of a Questionnaire,[2] summarizes the replies to a questionnaire on general roofing practices and conditions throughout the entire country, furnished by representatives of the Home Owners' Loan Corporation and the Federal Housing Administration in 48 States and the District of Columbia. This report is referred to as "BMS57."

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 material. A list of selected references to the literature on roofing materials is given at the end of the report.

[1] See cover pages III and IV.

[2] See cover page IV.

II. METHODS OF MAKING THE SURVEY

The methods of making this survey are outlined only briefly here, since they are essentially the same as those previously followed.

All travel was by automobile. A list of the highways traveled is given in table 1. The frequency of use of different roofing materials on dwellings along the highways is recorded in table 2.

Local representatives of the Home Owners' Loan Corporation assisted in the work, as in the previous surveys. Many of these representatives had spent considerable time in preparing lists of roofs that included all kinds of materials.

Except in Amarillo, Tex., the offices of the Federal Housing Administration were visited. Problems and practices in the use of roofing materials on new dwellings were discussed with representatives of this organization, and new housing developments were inspected.

General roofing problems and practices were discussed with men in the Division of Agricultural Engineering at the Oklahoma A. and M. College, Stillwater, Okla., and the University of Kentucky, Lexington, Ky. The roofs of a number of dwellings in a Farm Security project at Ropesville, Tex., were also inspected.

Grateful acknowledgement is made to all who furnished assistance in this work, particularly to the representatives of the Home Owners' Loan Corporation, to whom was assigned the more difficult task of preparing for the work on weathered roofing materials. Acknowledgement is also made to the roofing contractors who assisted in this work by furnishing trucks and ladders.

III. ROOFING MATERIALS IN RURAL DISTRICTS IN THE SOUTH CENTRAL STATES

(1) General Discussion

As was true in the previous surveys, a wide variety of roofing materials is characteristic of rural dwellings in the South Central States. The availability of a material is always a

governing factor in determining the extent of its use, but in a large part of the territory covered, the climatic conditions appear to be a controlling factor.

Along the highways traversed, sheet-metal roofs predominate on rural dwellings in Virginia, Alabama, Mississippi and Louisiana. Metal shingles also are used to a considerable extent in Virginia and Tennessee. Wood-shingle roofs predominate in Texas, Oklahoma, and Arkansas. In Tennessee and Kentucky, sheet-metal and asphalt-shingle roofs are almost equal in number, and in West Virginia the same is true of roofs of sheet metal and roll roofing.

(2) Routes Followed

Table 1 lists the cities in the order in which they were visited, together with the connecting highways, and the entire territory covered is shown in figure 1.

Table 1.—*Routes traveled*

Cities	Routes [1]
Washington, D. C., to Chattanooga, Tenn	211, 11, 11E, 70, 27
Chattanooga, Tenn., to Jackson, Miss.	11, 80
Jackson, Miss., to New Orleans, La.	51
New Orleans, La., to Houston, Tex.	61, 190, 165, 90
Houston, Tex., to San Antonio, Tex.	90
San Antonio, Tex., to Dallas, Tex.	81, 77
Dallas, Tex., to Amarillo, Tex.	77, (24), 287, 70, (283), 287
Amarillo, Tex., to Oklahoma City, Okla.	66
Oklahoma City, Okla., to Stillwater, Okla.	77, (33), (40)
Stillwater, Okla., to Little Rock, Ark.	(51), 64, 65
Little Rock, Ark., to Memphis, Tenn.	70
Memphis, Tenn., to Louisville, Ky.	70, (76), 45, 60
Louisville, Ky., to Washington, D. C.	60, (4), 19, 119, 50, 340, (7)

[1] State highways in parentheses; all others are U. S. highways.

(3) Roofing Materials in Rural Sections

The kinds of roofing materials observed on rural dwellings along the highways traveled are given in table 2.

Each rural-dwelling roof was classified by its appearance as "good" or "poor." In most cases, only the side seen from the highway could be taken into consideration.

Figure 1.—*South Central States covered by the survey.*

TABLE 2.—*Roofing materials on dwellings in rural sections of States traversed*

[The general condition of the roof is indicated as "good" or "poor"]

State	Sheet metal			Wood shingles			Asphalt shingles			Roll roofing			Metal shingles			Cement-asbestos			Slate			Tile			Built-up			Total
	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total	
Virginia	592	380	972	15	28	43	320	68	388	17	63	80	120	65	185	20	1	21	32	11	43	1		1				1,733
Tennessee	191	161	352	38	116	154	259	92	351	18	52	70	49	20	69	42		42	1	1	2	24		24				1,064
Georgia	24	26	50	3	14	17	30	12	42	2	14	16	3	2	5	1		1										131
Alabama	194	222	416	13	85	98	148	44	192	15	52	67	9	4	13	1	1	2										788
Mississippi	91	158	249	11	75	86	118	28	146	26	36	62	3	1	4	1	2	3										550
Louisiana	155	209	364	54	78	132	92	19	111	11	51	62	1		1	59	11	70	1	2	3	4		4				747
Texas	112	98	210	534	272	806	56	10	66	5	19	24		1	1	13	3	16	3		3	6		6	2	1	3	1,135
Oklahoma	5	11	16	299	207	506	28	21	49	7	14	21				3		3				1		1				596
Arkansas	89	105	194	131	180	311	111	35	146	23	46	69		1	1	1		1		2	2	1		1				725
Kentucky	214	214	428	97	101	198	370	108	478	76	183	259	1		1	15		15	1	1	2	4		4				1,385
West Virginia	106	118	224	5	10	15	86	33	119	83	189	272	3	1	4	5		5	6	5	11	1		1				651
Total	1,773	1,702	3,475	1,200	1,166	2,366	1,618	470	2,088	283	719	1,002	189	95	284	161	18	179	44	22	66	42		42	2	1	3	9,505

Table 3 shows the percentages, by States, of the four principal roofing materials tabulated in the present survey. The extremes are exhibited by Virginia and Oklahoma, the former with 56.1 percent of sheet-metal and 0.2 percent of wood-shingle roofs, the latter with 2.7 percent of sheet-metal and 84.9 percent of wood-shingle roofs.

TABLE 3.—*Percentages of principal roofing materials on rural dwellings in particular States of this survey*

	Sheet metal	Asphalt shingles	Wood shingles	Roll roofing	Total
	%	%	%	%	%
Virginia	56.1	22.4	0.2	0.5	79.2
Tennessee	33.1	33.0	14.5	6.6	87.2
Alabama	52.8	24.3	12.4	8.5	98.0
Mississippi	45.3	26.5	15.6	11.3	98.7
Louisiana	48.7	14.9	17.7	8.3	89.6
Texas	18.5	5.8	71.1	2.1	97.5
Oklahoma	2.7	8.2	84.9	3.5	99.3
Arkansas	26.8	20.1	42.9	9.5	99.3
Kentucky	30.9	34.5	14.3	18.7	98.4
West Virginia	34.4	18.3	2.3	41.8	96.8

TABLE 4.—*Summary of counts of roofs in rural sections of the four surveys*

[Miles traveled: Southeast, 2,447; Northeast, 1,591; North Central, 3,014; South Central, 4,170; total, 11,222]

Type of roofing material	Southeast		Northeast		North Central		South Central		Total	
	No.	Percent [1]	No.	Percent [1]	No.	Percent [1]	No.	Percent [1]	No.	Percent
Asphalt shingle	2,558	24.0	3,991	39.3	2,318	28.4	2,088	22.0	10,955	28.5
Wood shingle	1,757	16.5	2,779	27.3	3,058	37.6	2,366	24.9	9,960	25.9
Sheet metal	3,722	34.9	1,006	9.9	789	9.7	3,475	36.6	8,992	23.4
Roll roofing	1,982	18.6	399	3.9	628	7.7	1,002	10.5	4,011	10.4
Slate	64	0.6	1,546	15.2	1,099	13.5	66	0.7	2,775	7.2
Metal shingle	366	3.4	134	1.3	55	0.7	284	3.0	839	2.2
Cement-asbestos	184	1.7	284	2.8	190	2.3	179	1.9	837	2.2
Tile	44	0.4	23	0.2	4		42	0.4	113	0.3
Built-up							3		3	
Thatched			2						2	
Total	10,677		10,164		8,141		9,505		38,487	
Average number of roofs per mile	4.4		6.4		2.7		2.3			

[1] Percentage based on the particular survey.

A summary of the counts of roofs on rural dwellings in the four surveys that have been made is given in table 4.

Asphalt shingles, sheet metal, wood shingles, and roll roofing account for 94 percent of all the roofs tabulated in the Southeastern and South Central States, with the percentages of the first two materials differing but little.

The sheet-metal roofs were mainly of galvanized iron, though many of the older ones were of standing-seam "tin".[3] The asphalt-shingle roofs were of all types, with a preponderance of hexagonal-pattern strip shingles. The wood-shingle roofs were mostly of western red cedar, with some cypress shingles. The roll roofings were of all types, both smooth- and mineral-surfaced, with a comparatively large number of decorative roofings, having the exposure edge cut to form a regular pattern.

IV. WEATHERING OF ROOFING MATERIALS IN THE SOUTH CENTRAL STATES

1. General Discussion

It is well to repeat a statement that has appeared in the previous reports that "Any discussion of the weathering qualities of roofing materials in a particular section must, of necessity, be couched in the most general terms."

Some of the more obvious factors that must be considered in studies of the weathering of roofing materials are:

(a) Weather conditions during and after construction.

[3] Commercially called "roofing ternes." Made by coating iron or steel sheets with an alloy containing approximately 80 percent of lead and 20 percent of tin.

(b) Influence of the pitch and exposure of a roof on the weathering of the roofing material.

(c) Workmanship in applying the roofing material.

(d) Varieties of materials, and variations in the design and quality of materials of the same kind.

(e) Absence of definite criteria for determining when a roofing material has failed.

With these factors, and others of lesser importance, it can be understood why it is not possible to state definitely the service life of a particular roofing material in any section. In general, the materials exhibit the same types of weathering in the various sections of the country, the differences that are apparent being mainly in the degree, rather than in the kind of weathering.

In subsequent sections, the weathering characteristics of the materials that are used principally in the South Central States are discussed and, where possible, are illustrated by means of photographs. No attempt has been made in any of these surveys to differentiate between brands of roofing materials.

2. Discussion of Particular Materials

(a) *Asphalt Shingles and Roll Roofings* [4]

Several facts concerning the weathering of asphalt-prepared roll roofings and shingles have been definitely established in the previous surveys. Among the more important of these are that (a) asphalt-prepared roofings weather more rapidly in warm humid climates with much sunshine than in cooler dry climates with less sunshine; (b) roofings that furnish the best coverage, that is, that have the greatest number of plies, resist weathering best; (c) the southern exposure of a roof weathers more rapidly than the northern exposure; and (d) asphalt-prepared roofings weather less rapidly on roofs that are steeply pitched than on low-pitched ones.

Observations in the present survey confirmed these facts. The climate in some parts is particularly severe for asphalt-prepared roofings. It has been unfortunate too that, until recently, the roofings that were used most widely were light-weight shingles that provide poor coverage. As in the previous surveys, the asphalt shingles that resisted weathering best were individual ones laid by the American method, which provides excellent coverage. The adoption by the Federal Housing Administration of a minimum weight of 210 pounds per square for asphalt shingles has raised the standard of shingles in common use on new dwellings.

The kinds of weathering to which asphalt-prepared roofings are subject are discussed in detail in BMS6. Because of the general similarity of climatic conditions in the Southeastern and South Central States, there is a great similarity in the behavior of these roofings in the two areas. One type of weathering that was observed frequently in the South Central States was that caused by hailstones. Houston, San Antonio, and Dallas, Tex., were notable in this respect. In parts of these cities practically all of the roofs could be definitely dated to the last severe hailstorm. Hailstorms are common in Oklahoma City, Okla., and Little Rock, Ark.

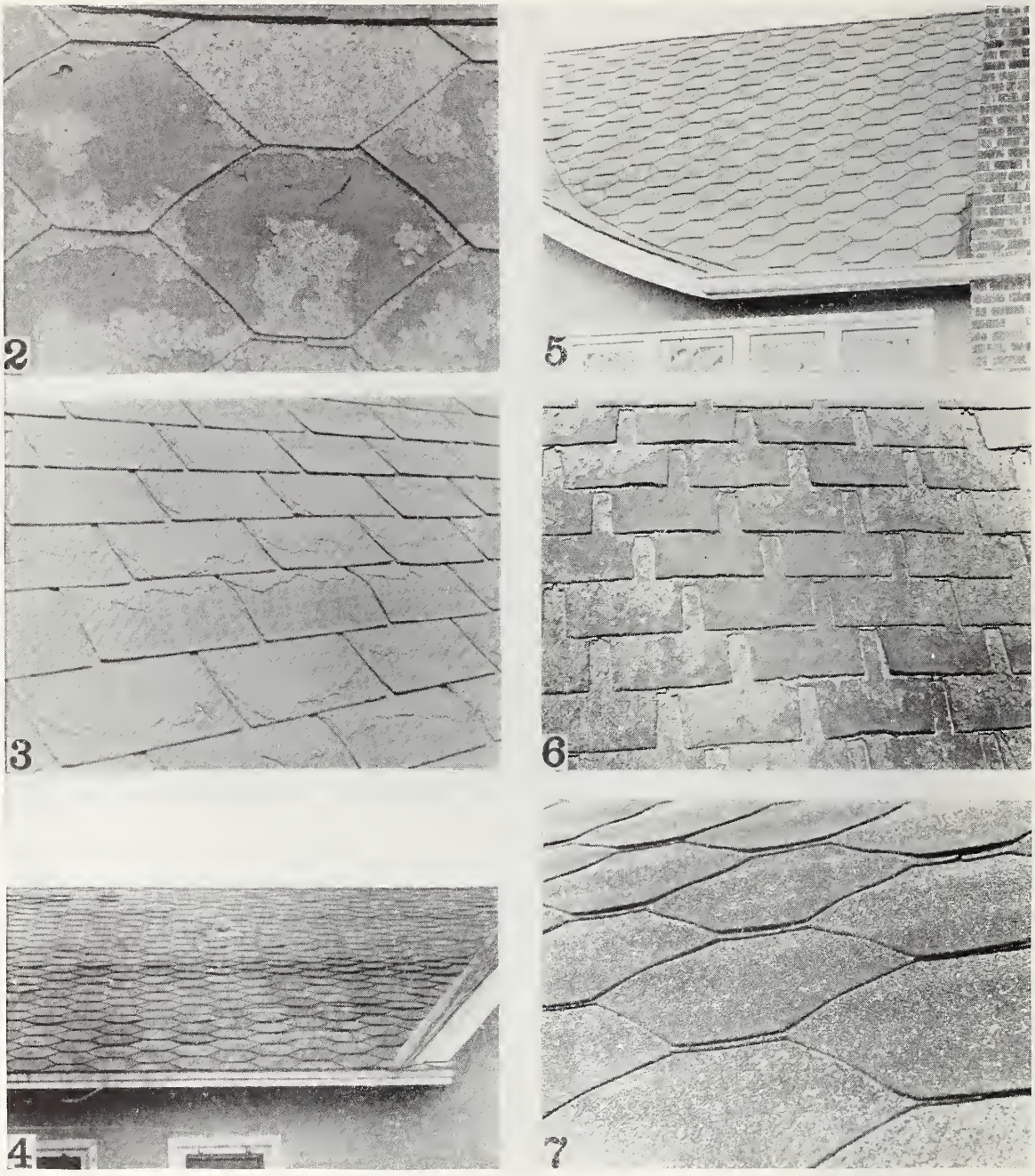
The illustrations of weathered asphalt shingles shown in figures 2 to 15, inclusive, have been selected as representing an approach to the maximum rather than the minimum service that may be expected from the particular type of shingle under the conditions of exposure.

Figure 2 shows 11⅓ by 36-inch, hexagonal-pattern strip shingles after 12 years of exposure Chattanooga, Tenn. The most severe weathering occurred in the upper-third section of each hexagon, where but a single layer of fabric is provided. The shingles illustrated were on the southern exposure of the roof. Those on the northern exposure were weathered much less. Figure 3 shows individual asphalt shingles after more than 20 years of exposure in Chattanooga. Figures 4, a low-pitched section, southern exposure, and 5, a steep-pitched section, eastern exposure, illustrate the effect of the pitch and exposure on the weathering of asphalt shingles. These are sections of the same roof after 14 years of exposure in Jackson, Miss.

Figure 6 shows 10- by 36-inch strip shingles, from the eastern exposure of a steeply pitched roof after 13 years in Houston, Tex. Figure 7 represents hexagonal pattern strip shingles pfter being exposed 9 years in San Antonio, Tex.

The shingles illustrated in figures 8 and 9 were of the same type and weight, and were

[4] Building Materials and Structures Report BMS70, Asphalt-Prepared Roll Roofings and Shingles. See cover page IV.

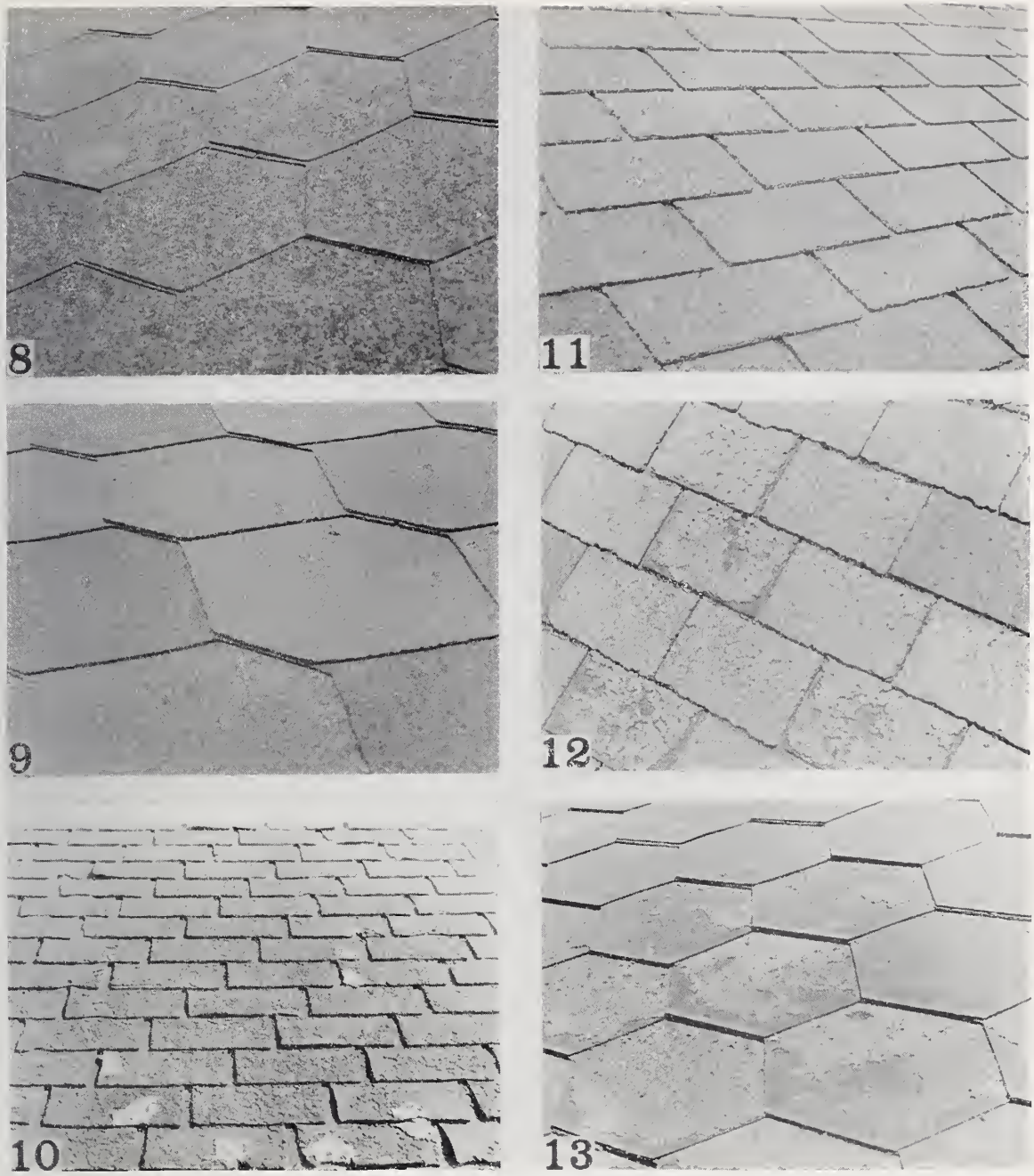


FIGURES 2 to 7.—*Asphalt shingles.*

Figure 2, hexagonal-pattern strip shingles exposed 12 years in Chattanooga, Tenn.; 3, individual shingles, American method, exposed more than 20 years in Chattanooga; 4 and 5, low-pitched southern and steep-pitched eastern sections, respectively, of a roof after 14 years of exposure in Jackson, Miss.; 6, square-tab strip shingles exposed 13 years in Houston, Tex.; 7, hexagonal-pattern strip shingles exposed 9 years in San Antonio, Tex.

exposed on roofs of the same pitch within 50 yards of each other in Dallas, Tex., for 7 and 9 years, respectively. They show that it is not possible to ascribe a definite life to a particular roofing material in any section.

Figure 10 shows individual shingles exposed 15 years in Amarillo, Tex. These shingles were damaged by hailstones, and repaired with plastic cement. In figure 11 are shown similar shingles from the northern exposure of a roof



FIGURES 8 to 13.—*Asphalt shingles.*

Figures 8 and 9, strip shingles exposed 7 and 9 years, respectively, in Dallas, Tex.; 10, individual shingles exposed 15 years in Amarillo, Tex. Note damage by hail; 11, individual shingles exposed 14 years in Oklahoma City, Okla.; 12, individual shingles exposed 18 years in Stillwater, Okla.; 13, strip shingles exposed 10 years in Little Rock, Ark.

after 14 years in Oklahoma City, Okla. Those on the southern exposure showed a considerable loss of granules and some curling.

In figure 12 are illustrated individual asphalt shingles 8 by 12 inches, that had been exposed 18 years in Stillwater, Okla. They were laid with a 5-inch exposure over smooth-surfaced asphalt-prepared roofing on a roof that was pitched approximately 12 inches to 1 foot, and had rendered excellent serivce.

Figure 13 shows hexagonal-pattern strip shingles exposed 10 years in Little Rock, Ark.

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FIGURES 14 to 19.—*Asphalt shingles, roll roofings, and wood shingles.*

Figures 14 and 15, individual shingles exposed, respectively, 18 years in Memphis, Tenn., and 12 years in Louisville, Ky. 16, wide-selvage, mineral-surfaced roll roofing; 17, diamond-point roll roofing; 18, vertical application of roll roofing; 19, cypress shingles exposed 30 years in Jackson, Miss.

Figure 14 shows individual shingles 9 by 12 inches, exposed 18 years in Memphis, Tenn. This roof was on 1 of 12 dwellings that were erected at the same time and roofed with the same kind of shingles. Seven of these dwellings were reroofed recently. The western exposure is shown in figure 14.

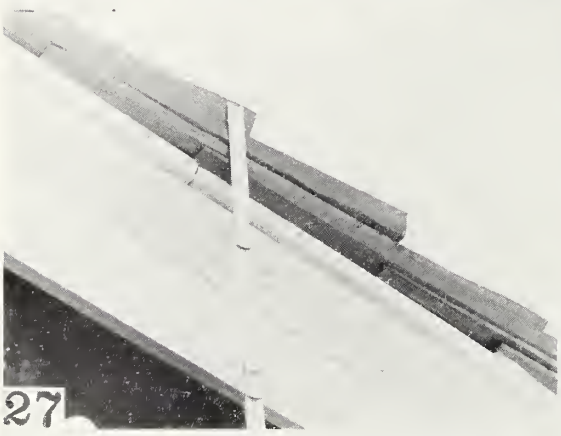
Figure 15 illustrates individual shingles in fair condition after 12 years of exposure in Louisville, Ky.

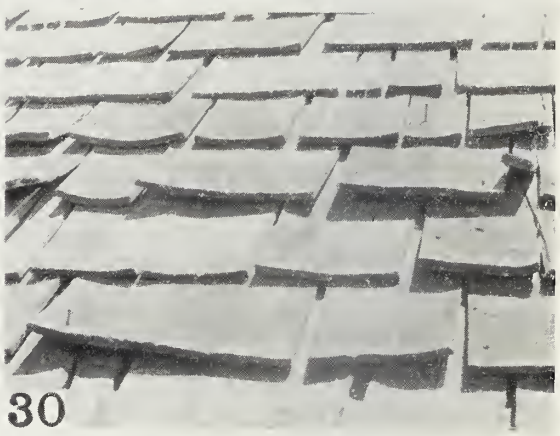
FIGURES 20 to 25.—*Wood shingles.*

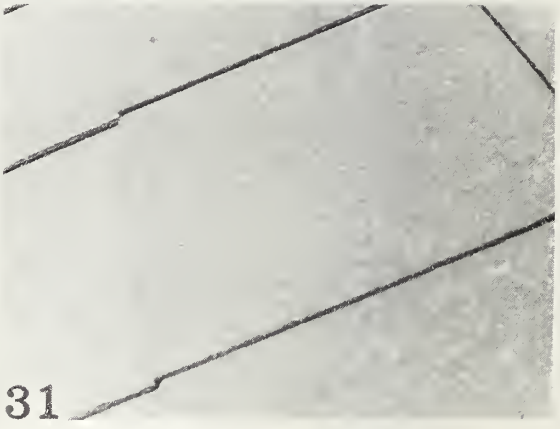
Figure 20, hand-split cypress shingles exposed approximately 50 years in New Orleans, La.; 21, cypress shingles exposed 16 years in Memphis, Tenn. 22, red cedar dimension shingles exposed 15 years in Houston, Tex.; 23, loose nails in shingles nailed through the butts; 24, and 25, red-cedar shingles exposed 37 years in Amarillo, Tex.

Asphalt-prepared roll roofings are not used to any considerable extent on dwellings in the cities covered by this survey. Where they have been used, it has been mainly for reroofing, over weathered wood or asphalt shingles.

In general the roll roofings do not render as long service as asphalt shingles, because they furnish but a single layer of fabric on the roof. Recently the so-called wide-selvage roofings, which usually consist of a 36-inch sheet with only 17 inches covered with mineral granules, have become more popular. These are laid





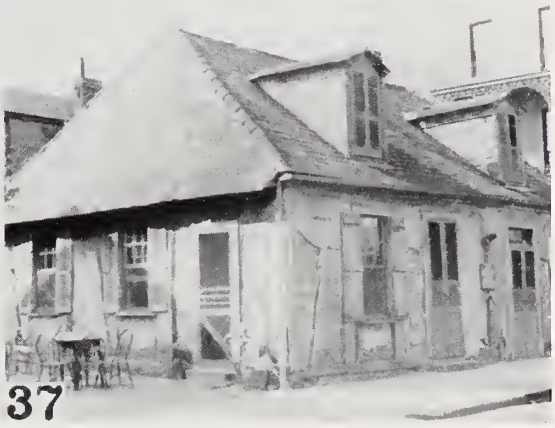


FIGURES 26 to 31.—*Wood and cement-asbestos shingles.*

Figures 26 and 27, new, hand-split, red-cedar shingles; 28, wood shingles laid to simulate the appearance of a thatched roof; 29, red-cedar shingles exposed 44 years in Perkins, Okla.; 30, poorly graded shingles after 16 years of exposure in Little Rock, Ark.; 31, cement-asbestos shingles exposed about 35 years in New Orleans, La.

shingle fashion, with a sheet lapping the one next below 19 inches, and are cemented to each other with asphalt cement, which may be applied either hot or cold. Figure 16 illustrates a roof of this type. They are particularly adapted to low-pitched roofs because of the wide, sealed laps. Another advantage is that they are laid without exposed nails.

Figure 17 shows diamond-point roll roofing, which has been used to some extent for reroofing. Figure 18 illustrates the vertical application of roll roofing over weathered asphalt shingles.



FIGURES 32 to 37.—*Cement-asbestos shingles and slate.*

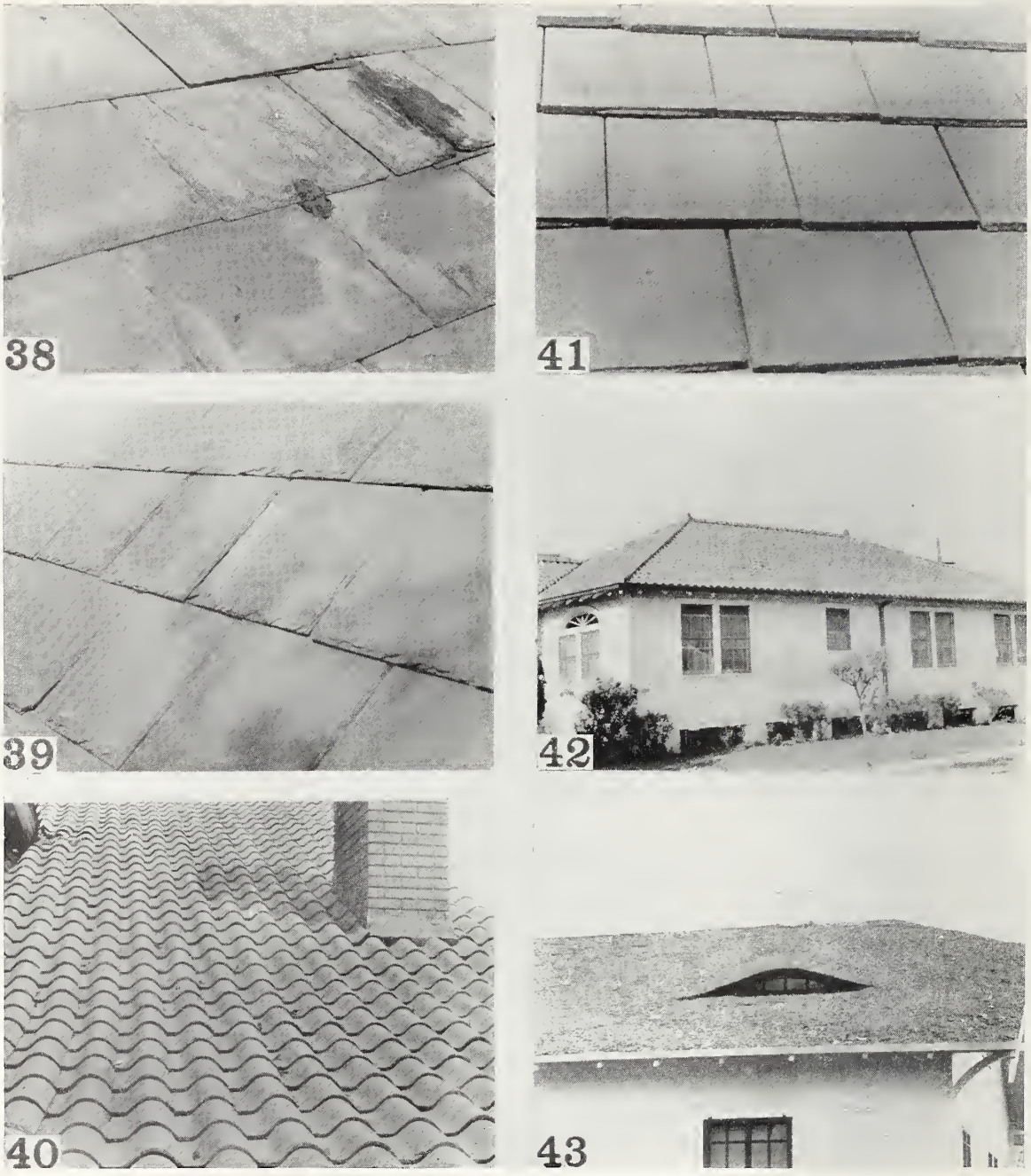
Figure 32, new cement-asbestos shingles laid by the Dutch-lap method; 33, cement-asbestos shingles exposed 35 years in Louisville, Ky.; 34, cement-asbestos shingles, American method, exposed 10 years in Little Rock, Ark.; 35, very old Welsh slate, relaid in 1940; 36, failure of nails in old slate roof; 37, typical old slate roof in the French quarter of New Orleans, La.

This roofing is surfaced with mineral granules in different colors, forming striking patterns on the roof.

(*b*) *Wood Shingles*

Originally wood shingles were used almost exclusively for roofing in cities throughout the South Central States. They are still used to a considerable extent, although most cities have adopted regulations forbidding wood shingles within certain fire zones and some forbid their use entirely within the city limits.

Red-cedar and cypress shingles are used most

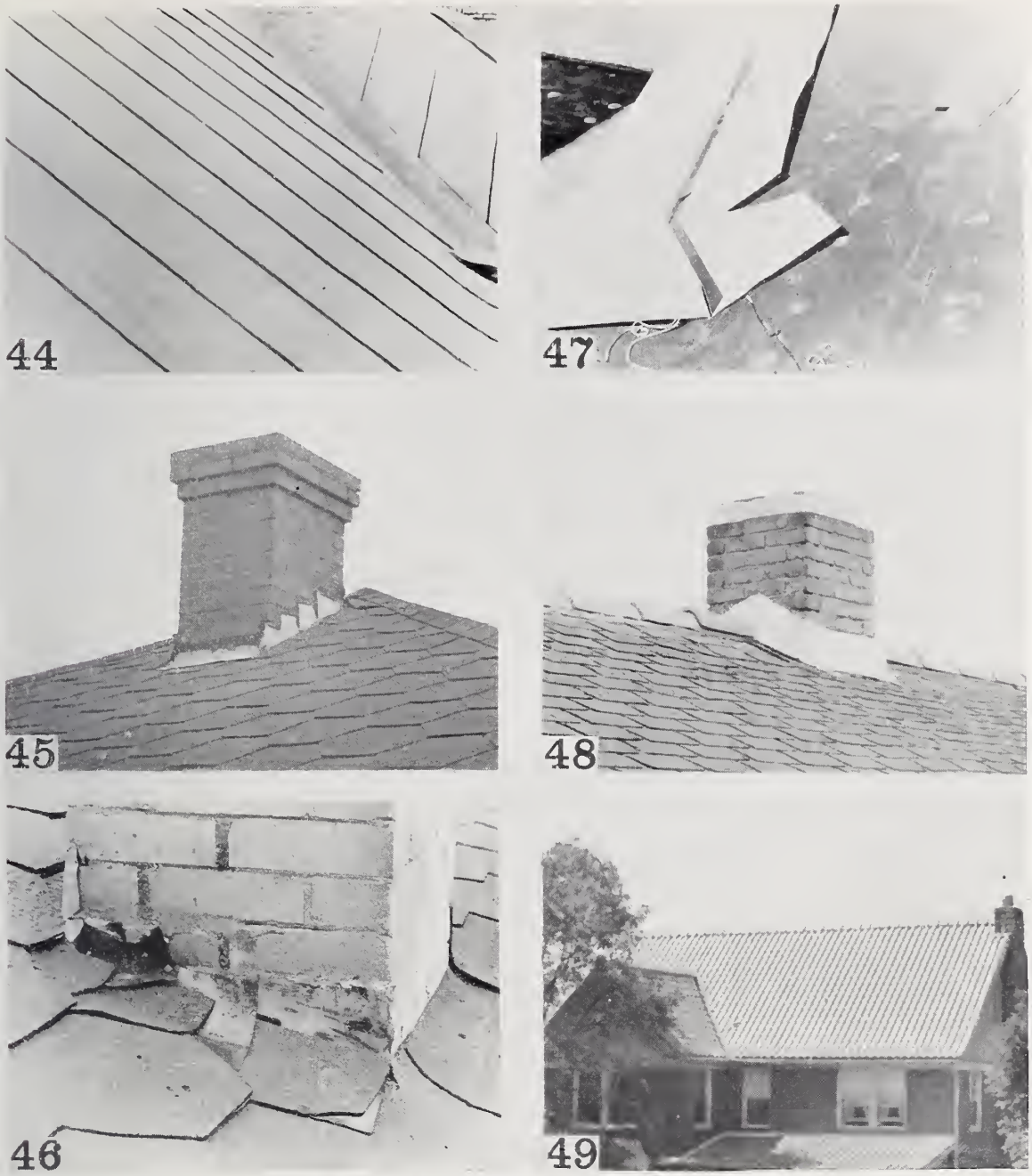


FIGURES 38 to 43.—*Slate, tile, and built-up roofs.*

Figure 38, slate from Eastern Pennsylvania after 33 years of exposure in Memphis, Tenn.; 39, Buckingham (Virginia) slate exposed 18 years in Louisville, Ky.; 40 and 41, ceramic-tile roofs, exposed 18 and 25 years, respectively, in Louisville, Ky.; 42, practically new cement-tile roof in New Orleans, La.; 43, built-up roof, Houston, Tex.

frequently at present, with the former predominating. As observed previously in the North Central States, the greatest differences that have been noted in the weathering of wood shingles have been those due to the quality or grade of the shingles rather than to the variations in climate.

The grading of wood shingles is discussed in detail in BMS75, so that only a brief outline will be given here. Commercial Standard



FIGURES 44 to 49.—*Metal roofs, flashings, and valleys*

Figure 44, terne roof after approximately 40 years of exposure in Louisville, Ky.; 45, metal chimney flashing; 46, bad chimney flashing; 47, divided metal valley; 48, mortar chimney flashing; 49, metal-tile roof in Amarillo, Tex.

CS31–38 includes red cedar, California redwood, and tidewater red cypress of the highest commercial grade. Shingles eligible to carry the Commercial Standard label must be 100-percent heartwood and strictly vertical, or edge-grained. The minimum length is 16 inches, with other standard lengths of 18 and 24 inches. The minimum width for shingles less than 24 inches long is 3 inches; for those 24 inches and longer, the minimum width is 4 inches. The minimum thickness of 16-inch shingles is 5/2, that is, five butts together must measure at least 2 inches. Shingles that comply with the Commercial Standard require-

ments also comply with No. 1 Grade shingles of the American Lumber Standards.

Figure 19 illustrates cypress shingles after 30 years of exposure in Jackson, Miss. Although some shingles were missing and the roof had required patching, it was still in fair condition when examined. Figure 20 shows a roof of hand-split cypress shingles, weathered badly, and patched in numerous places, after an exposure of approximately 50 years in New Orleans, La.

Figure 21 shows cypress shingles exposed 16 years in Memphis, Tenn. A few shingles had curled, but in other respects the roof was in good condition.

So-called dimension shingles, that is, shingles that are all the same width, are illustrated in figure 22. These were red-cedar shingles, first grade, that had been exposed 15 years in Houston, Tex. Dimension shingles may be applied more rapidly than shingles of random width, and like other materials where the units are all the same size, they present a uniform pattern on the roof.

Figure 23 furnishes proof that it is a poor practice to nail down the butts of wood shingles that have curled. The nails eventually work loose and leave holes that cause leaks. These shingles had been exposed 12 years in Dallas, Tex. The butts show considerable erosion.

Figure 24 shows a roof of red-cedar shingles after 37 years of exposure in Amarillo, Tex. It was weathered badly and had been patched in some places, but it was reported as not leaking. One reason this roof had rendered such long service was its steep pitch, 14 in./ft. Figure 25 is a close-up of a section of this roof.

Figure 26 shows heavy, hand-split, red-cedar shingles being applied on a new roof in Amarillo, Tex. These shingles were of random width, 24 inches long, and from 1 to 1¾ inches thick at the butts (see fig. 27). They were being laid over solid sheathing covered with 15-pound asphalt-saturated felt, with a strip of saturated felt, slightly narrower than the exposed part of the shingles, between each course.

Figure 28 shows the method of laying wood shingles with very small irregular exposures to simulate the appearance of a thatched roof. Roofs of this type are quite expensive, but they render excellent service. The one illustrated was 18 years old, in Dallas, Tex.

The roof shown in figure 29 was of red-cedar shingles, weathered badly after 44 years of exposure in Perkins, Okla. The roof was patched in numerous places.

Figure 30 shows a section of a roof of poorly graded shingles after 16 years of exposure in Little Rock, Ark. Ten other dwellings, erected at the same time, were roofed with the same kind of shingles. A few of these had been reroofed within the past 2 years.

(c) *Cement-Asbestos Shingles*

The weathering of cement-asbestos shingles in the South Central States is similar to that in other sections of the country. On prolonged exposure the surface is roughened somewhat and the asbestos fibers become plainly visible. As elsewhere, these shingles resist normal weathering extremely well, but they may become dingy in appearance on long exposure, particularly in industrial areas.

The percentage of cement-asbestos roofs in New Orleans, La., is probably as high as in any other city in the United States, and in this city may be found some of the oldest cement-asbestos roofs in the country. The shingles on many of the older roofs were imported from Belgium, France, or Germany. They are manufactured locally at present and are being used widely on dwellings in all price classes.

Figure 31 is a close-up of cement-asbestos shingles after approximately 35 years of exposure in New Orleans. These were exposed close to several industrial plants and had accumulated a rather hard, scale-like deposit on the surface. The pock-marked appearance of the shingles was the result of a recent severe hailstorm. Figure 32 shows cement-asbestos shingles laid by the Dutch-lap method on a typical, new, low-cost dwelling in New Orleans.

Cement-asbestos shingles laid by the hexagonal method and exposed 35 years in Louisville, Ky., are shown in figure 33.

Figure 34 illustrates cement-asbestos shingles laid by the American method, after 10 years of exposure in Little Rock, Ark. These were rather thin shingles and some of them had curled slightly.

(*d*) *Slate*

The dwellings with slate roofs in the cities included in the present survey, excepting New Orleans, La., are mainly in the higher price classes. This is the usual condition in cities that are far from slate-producing areas.

There are many roofs of very old slate in New Orleans. Some of these are of Welsh slate which was used for ballast in cargo vessels more than 100 years ago. Few, if any, of these remain on the original buildings, but many have been relaid within recent years. Slates from Pennsylvania, Vermont, and Virginia have also been used to a considerable extent.

Figure 35 shows a roof that is mainly of Welsh slates. The dwelling, which was reported to be 103 years old, was remodeled in 1940, when the slates were taken from the roof, a few defective ones replaced, and then relaid. One of the frequent causes of failure in old slate roofs is the failure of the nails.

Figure 36 illustrates this condition in a roof of Pennsylvania slate after 40 to 50 years of exposure. The slates on this roof were scaling and disintegrating badly and their conditions would not warrant relaying them.

Figure 37 is typical of many old slate roofs in the French Quarter of New Orleans. It was reported that this building was erected in 1783 and that the present roof is the original one, but this could not be verified.

Figure 38 shows slate from eastern Pennsylvania after 33 years of exposure in Memphis, Tenn. The so-called U-fading that is typical of slate from that region after long exposure is illustrated in this photograph.

The section of roof shown in figure 39 is of Buckingham (Virginia) slate after 18 years of exposure in Louisville, Ky. This roof had the appearance of a new one, the slates showing no evidence of weathering.

(*e*) *Tile*

Ceramic tile roofs, being comparatively expensive and requiring a heavy supporting structure, have their principal use in any location on the more expensive dwellings. Ceramic tiles resist normal weathering extremely well, and, except for the occasional replacement of those that have been damaged mechanically, roofs constructed of them will usually last as long as the fastenings.

Shingle-type tiles are apparently being used mostly on the newer dwellings. Considerable quantities of cement tiles, manufactured locally, have been used in the Southern States. These are also extremely heavy and are broken rather easily, but they are less expensive than ceramic tiles. Being somewhat porous, they tend to collect dirt readily.

Figure 40 illustrates a ceramic tile roof, Spanish type, after 18 years of exposure in Louisville, Ky. Figure 41 shows flat, ceramic, shingle tiles exposed 25 years in the same city.

Figure 42 shows Spanish-type cement tiles on a comparatively new dwelling in New Orleans, La.

(*f*) *Built-Up Roofing*

The use of bituminous built-up roofs on dwellings throughout the Eastern United States has been mainly confined to the comparatively flat-roofed sections of row dwellings, of which there are so many in such cities as Philadelphia, Pa., Baltimore, Md., and Washington, D. C.

Within the past 4 or 5 years built-up roofs have been used quite frequently on detached dwellings in some Texas cities. They are usually four-ply asphalt and asphalt-saturated felt roofs surfaced with crushed brick or quartz, or so-called pea-gravel. Figure 43 shows a roof of this type, surfaced with gravel, in Houston, Tex.

(*g*) *Metal*

The durability of the various metallic roofing materials is determined by so many factors other than actual weathering that it is practically impossible to state definitely their life.[5]

Selected metallic roofing, given adequate maintenance, will render satisfactory service under normal conditions of exposure. Figure 44, showing a terne roof on an old residence in Louisville, Ky., after approximately 40 years of exposure, illustrates the long service that can be expected when this type of roofing is properly cared for.

Considerable evidence was found that single V-crimp galvanized roofing was unsatisfactory,

[5] Building Materials and Structures Report BMS49, Metallic Roofing for Low-Cost House Construction. See cover page IV.

particularly in those sections subject to high winds, which blew water through the single joints.

3. Flashings, Valleys, Gutters, and Downspouts

These items are widely used on most roofs and are made principally from sheet metal. Sheet copper, galvanized iron or steel, roofing terne, and asphalt-roll roofing were found to be used. Because of the use of simple-pitched roofs, the absence of gutters and downspouts, and the simplification of chimney construction due to the small heating systems required, these accessories are not used to as great an extent in the South Central States as in other sections of the country.

Roof flashings and valleys were found to be important sources of roof failures. In many instances improper construction was the principal cause of these failures. The use of narrow valleys, particularly on low-pitched roofs, often results in leakage if the roof is exposed to driving rains.

(*a*) *Flashings*

Copper, terne, and galvanized iron or steel are all widely used for chimney and vent flashings, though galvanized metal probably predominates. Many instances of the use of asphalt roll roofing and shingles for chimney flashings were observed. The many cases where no flashings were used were mostly confined to the small, cheaper type of homes. A few mortar or concrete chimney flashings were also observed (fig. 48).

Poor construction of flashings persists occasionally in the section covered by this survey, though great improvement was noted in this respect with all types of new construction.

Typical examples of good and bad flashings are shown in figures 45 and 46.

(*b*) *Valleys*

Copper, galvanized metal, terne, and roll roofing are used for valley flashings. They are mainly of the open type, though occasionally they are divided if metal is used for their construction (fig. 47). An absence of closed, laced, or overlapped shingle valleys was noted with roofs of asphalt shingles.

Occasional streaking of galvanized metal valleys on wood-shingle roofs was observed, apparently caused by the rusting of uncoated nails used with the shingles. This effect was absent where galvanized nails were used.

(*c*) *Gutters and Downspouts*

Many of the older houses in the South Central States, particularly the smaller ones, do not use gutters and downspouts. The wide overhang of the eaves and the absence of basements lessen the necessity for such accessories. Gutters and downspouts, where used, are constructed principally of galvanized metal, though copper is used on houses in the higher priced classes.

Very few hidden or wooden gutters were found.

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

1. Factors Which Affect the Choice of Roofing Materials Generally

This subject is discussed in considerable detail in BMS6 and BMS29, so it will be treated only briefly here. Initial cost, cost of maintenance, fire resistance, and appearance are factors that influence the choice of roofing materials generally. Availability, insurance rates, and city regulations also govern the extent of use of the various materials to a considerable degree. Climate is a most important consideration, because, though most materials may be used in any location if they are applied properly and given proper care, some materials are much better suited than others for particular weather conditions.

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

In this, as in the previous surveys, it was observed that the more expensive roofing materials are found on dwellings in the higher price classes. Where the initial cost is not an important factor, it is usually the personal preference of the owner or his architect that governs the choice of the material, without regard to whether it is readily available or not.

Where the intitial cost must be considered, the choice of materials is greatly limited, and availability becomes an extremely important factor. It is obvious that the material which costs the least initially may be the most expensive on a "per year" basis, because of factors such as the cost of maintenance, higher insurance rates, and earlier replacement.

The climatic conditions in the South Central States resemble those of the Southeastern States more closely than those of other sections covered by these surveys. Comparatively mild winters, alternate periods of high and low humidity, and long periods of extremely intense sunshine characterize a large part of the territory covered by this survey. Under such conditions, one would expect a trend toward the use of inorganic roofing materials in this territory. With certain limitations that has been true, but because the less expensive metal roofings are not generally favored on city dwellings, and because other inorganic materials—such as slate, tile, and cement-asbestos shingles—are more expensive than the commonly used organic materials, such as wood shingles and asphalt-prepared roofings, this trend has not been so great.

New Orleans, La., is one city in which inorganic roofing materials are used almost exclusively. This city is unique in many respects, including several that are related to roofing practices. Although there are some extremely old roofing materials in use in this city, there are few very old roofs, because most of the roofs were damaged badly, if not destroyed, by a hurricane that swept the city in 1915. Prior to this time most of the roofs were of slate or tile, including many old ones of Welsh slate. There are still many roofs of these slates which were relaid after the hurricane. New England and Pennsylvania slates have also been used widely. Cement-asbestos shingles predominate on the roofs of the more recent dwellings. For a number of years shingles of this type were imported from France, Belgium, and Germany. At present they are manufactured locally. Cement-tile roofs are also used to a considerable extent.

Louisville, Ky., is another city where, in the past, inorganic roofings were used on most dwellings. In this case the roofs were of terne, applied by the standing-seam method. Although scarcely any roofs of this type have been applied within the past 25 years, many are still in service.

Asphalt-shingle roofs predominate in Chattanooga and Memphis, Tenn., Jackson, Miss., Little Rock, Ark., San Antonio, Tex., and probably in Louisville, Ky. They are used to a considerable extent in Houston and Dallas, Tex., and Oklahoma City, Okla. In all of these cities, asphalt shingles are being used widely for reroofing.

Wood-shingle roofs formerly predominated in most of the cities covered by this survey, and at present there are more of them than of any other kind in Houston, Dallas, and Amarillo, Tex., and Oklahoma City, Okla. Data obtained by the questionnaire method, reported in BMS57, indicate that the Mississippi River divides the country roughly into two sections as regards the present use of roofing materials on dwellings, with wood shingles predominating west of the Mississippi River and asphalt shingles east of it. This statement was verified, generally, insofar as the South Central States are concerned. Certain cities may be excepted —for example, San Antonio, Tex., where wood shingles are not permitted within the city limits, and New Orleans, La., where asphalt shingles have very slight use.

VI. ROOFING COSTS IN URBAN CENTERS OF THE SOUTH CENTRAL STATES

The prices, as of the approximate date of this survey, including cost of application per square (100 square feet of roof surface) for each of the materials listed in table 5 were furnished by representatives of the Home Owners' Loan Corporation in Chattanooga and Memphis, Tenn.; Jackson, Miss.; New Orleans, La.; Huston, Dallas, and San Antonio, Tex.; Oklahoma City, Okla.; Little Rock, Ark.; and Louisville, Ky. 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 a particular one. The average cost shown is the average for all of the cities.

TABLE 5.—*Cost 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.] [1]

Materials	Weight per square	Cost per square		
		Minimum	Maximum	Average
	lb			
Asphalt shingles:				
Giant individual, 12 by 16 in., American method	325	$10.00	$15.00	$12.00
Standard individual, 9 by 12¾ in., American method	255	7.50	12.00	9.85
Four-tab square-butt strip, 12½ by 36 in.	266	7.50	10.75	9.25
Three-tab square-butt strip, 12 by 36 in. overlay	211	6.50	10.00	8.05
Two-tab hexagonal strip, 11⅓ by 36 in.	167	5.00	7.50	6.45
Individual re-cover, Dutch lap	125 to 140	5.50	8.00	6.50
Individual re-cover, hexagonal	125 to 140	5.50	8.00	6.50
Asphalt roll roofing:				
Mineral-surfaced	90	3.25	5.50	4.00
Smooth-surfaced	55	2.00	4.50	3.20
Cement-asbestos shingles (gray color only):				
American method		13.25	25.00	17.55
Hexagonal method		10.00	18.00	13.70
Dutch-lap		11.50	18.00	14.50
Slate		18.00	30.00	23.70
Wood shingles		7.75	13.00	9.25
Metal roofing:				
Shingles (galvanized)		8.50	18.00	11.00
Five V-crimp sheets (galvanized)		5.50	12.00	7.80
Standing-seam "tin", 25 lb, unpainted		10.00	20.00	13.35
Flat lock and soldered "tin", 25 lb, unpainted		11.50	22.00	15.40
Tile roofing:				
Ceramic shingle tile		17.50	35.00	26.05
Cement tile		14.50	25.00	19.40
Built-up roofing:				
Five-ply coal tar pitch, surfaced with slag or gravel		7.50	13.50	9.40
Five-ply asphalt, surfaced with slag or gravel		7.50	10.00	8.60

[1] April–May 1941.

VII. SUMMARY

1. Distribution

In this survey, as in the previous ones, it was found that the roofing materials which cost the most initially are usually found on dwellings in the higher price classes in any location. The more expensive materials—such as slate, tile, and cement-asbestos shingles—are extremely heavy compared with such materials as wood and asphalt shingles, and consequently require a stronger supporting structure than the lighter materials.

In general, the data reported in BMS57, obtained by means of questionnaires distributed to representatives of the Home Owners' Loan Corporation and the Federal Housing Administration, are supported by this survey. With a few exceptions asphalt shingles predominate in the cities east of the Mississippi River and wood shingles in those west of it.

Roofs of asphalt shingles, wood shingles, or sheet metal were found on approximately 78 percent of the more than 38,000 rural dwellings along the routes traveled in the four surveys to date. In the present survey these three materials accounted for approximately 83 percent of all the rural dwelling roofs tabulated. Cement-asbestos, slate, and tile roofs were found on only 3 percent of the rural dwellings tabulated in this survey, approximately the same proportion as in the Southeastern States, whereas the total percentages for these three materials in the Northeastern and North Central States were 18 and 16, respectively.

More roofs of asphalt-prepared roll-roofing were tabulated than in any of the previous surveys excepting that in the Southeastern States, and the percentage of sheet-metal roofs on rural dwellings was the highest yet recorded.

2. Weathering

In general, the roofing materials in the area covered by this survey exhibit the same types of weathering as were observed in the previous surveys. Because of the general similarity of the climatic conditions in the South Central and Southeastern States, there is a great similarity in the behavior of the various materials in these two areas.

Hailstorms and strong winds, prevalent in certain sections of the South Central States, do considerable damage to roofing materials. Light-weight materials, except those of metal, and materials that have been weathered for relatively long periods are particularly susceptible to damage by hail.

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WASHINGTON, February 11, 1942.

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BMS27 Structural Properties of "Bender Steel Home" Wall Construction Sponsored by the Bender Body Co---------- 10¢
BMS28 Backflow Prevention in Over-Rim Water Supplies---------- 10¢
BMS29 Survey of Roofing Materials in the Northeastern States---------- 10¢
BMS30 Structural Properties of a Wood-Frame Wall Construction Sponsored by the Douglas Fir Plywood Association---------- 10¢
BMS31 Structural Properties of "Insulite" Wall and "Insulite" Partition Constructions Sponsored by The Insulite Co---------- 15¢

[List continued on cover page IV]

BUILDING MATERIALS AND STRUCTURES REPORTS

[Continued from cover page III]

BMS32 Structural Properties of Two Brick-Concrete-Block Wall Constructions and a Concrete-Block Wall Construction Sponsored by the National Concrete Masonry Association 10¢
BMS33 Plastic Calking Materials 10¢
BMS34 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 1 10¢
BMS35 Stability of Sheathing Papers as Determined by Accelerated Aging 10¢
BMS36 Structural Properties of Wood-Frame Wall, Partition, Floor, and Roof Constructions with "Red Stripe" Lath Sponsored by the Weston Paper and Manufacturing Co 10¢
BMS37 Structural Properties of "Palisade Homes" Constructions for Walls, Partitions, and Floors, Sponsored by Palisade Homes 10¢
BMS38 Structural Properties of Two "Dunstone" Wall Constructions Sponsored by the W. E. Dunn Manufacturing Co 10¢
BMS39 Structural Properties of a Wall Construction of "Pfeifer Units" Sponsored by the Wisconsin Units Co 10¢
BMS40 Structural Properties of a Wall Construction of "Knap Concrete Wall Units" Sponsored by Knap America, Inc 10¢
BMS41 Effect of Heating and Cooling on the Permeability of Masonry Walls 10¢
BMS42 Structural Properties of Wood-Frame Wall and Partition Constructions with "Celotex" Insulating Boards Sponsored by The Celotex Corporation 15¢
BMS43 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 2 10¢
BMS44 Surface Treatment of Steel Prior to Painting 10¢
BMS45 Air Infiltration Through Windows 10¢
BMS46 Structural Properties of "Scot-Bilt" Prefabricated Sheet-Steel Constructions for Walls, Floors, and Roofs Sponsored by The Globe-Wernicke Co 10¢
BMS47 Structural Properties of Prefabricated Wood-Frame Constructions for Walls, Partitions, and Floors Sponsored by American Houses, Inc 10¢
BMS48 Structural Properties of "Precision-Built" Frame Wall and Partition Constructions Sponsored by the Homasote Co 10¢
BMS49 Metallic Roofing for Low-Cost House Construction 10¢
BMS50 Stability of Fiber Building Boards as Determined by Accelerated Aging 10¢
BMS51 Structural Properties of "Tilecrete Type A" Floor Construction Sponsored by the Tilecrete Corporation 10¢
BMS52 Effect of Ceiling Insulation on Summer Comfort 10¢
BMS53 Structural Properties of a Masonry Wall Construction of "Munlock Dry Wall Brick" Sponsored by the Munlock Engineering Co 10¢
BMS54 Effect of Soot on the Rating of an Oil-Fired Heating Boiler 10¢
BMS55 Effects of Wetting and Drying on the Permeability of Masonry Walls 10¢
BMS56 A Survey of Humidities in Residences 10¢
BMS57 Roofing in the United States—Results of a Questionnaire 10¢
BMS58 Strength of Soft-Soldered Joints in Copper Tubing 10¢
BMS59 Properties of Adhesives for Floor Coverings 10¢
BMS60 Strength, Absorption, and Resistance to Laboratory Freezing and Thawing of Building Bricks Produced in the United States 15¢
BMS61 Structural Properties of Two Nonreinforced Monolithic Concrete Wall Constructions 10¢
BMS62 Structural Properties of a Precast Joist Concrete Floor Construction Sponsored by the Portland Cement Association 10¢
BMS63 Moisture Condensation in Building Walls 10¢
BMS64 Solar Heating of Various Surfaces 10¢
BMS65 Methods of Estimating Loads in Plumbing Systems 10¢
BMS66 Plumbing Manual 20¢
BMS67 Structural Properties of "Mu-Steel" Prefabricated Sheet-Steel Constructions for Walls, Partitions, Floors, and Roofs Sponsored by Herman A. Mugler 15¢
BMS68 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 3 15¢
BMS69 Stability of Fiber Sheathing Boards as Determined by Accelerated Aging 10¢
BMS70 Asphalt-Prepared Roll Roofings and Shingles 15¢
BMS71 Fire Tests of Wood and Metal Framed Partitions 10¢
BMS72 Structural Properties of "Precision-Built, Jr." Prefabricated Wood-Frame Wall construction Sponsored by the Homasote Co 10¢
BMS73 Indentation Characteristics of Floor Coverings 10¢
BMS74 Structural and Heat-Transfer Properties of "U. S. S. Panelbilt" Prefabricated Sheet-Steel Constructions for Walls, Partitions, and Roofs Sponsored by the Tennessee Coal, Iron, and Railroad Co 15¢
BMS75 Survey of Roofing Materials in the North Central States 15¢
BMS76 Effect of Outdoor Exposure on the Water Permeability of Masonry Walls 15¢
BMS77 Properties and Performance of Fiber Tile Boards 10¢
BMS78 Structural, Heat-Transfer, and Water-Permeability Properties of Five Earth-Wall Constructions 20¢
BMS79 Water-Distributing Systems for Buildings 15¢
BMS80 Performance Tests of Floor Coverings for Use in Low-Cost Housing: Part 4 15¢
BMS81 Field Inspectors' Check List for Building Constructions (cloth cover, 5 x 7½ inches) 20¢
BMS82 Water Permeability of Walls Built of Masonry Units 20¢
BMS83 Strength of Sleeve Joints in Copper Tubing Made with Various Lead-Base Solders 10¢
BMS84 Survey of Roofing Materials in the South Central States 15¢