

What Determines the Length
of Life of Prepared Roll
Roofings ?

June, 1933

Bulletin No. 304

What Determines the Length of Life of Prepared Roll Roofings?

BY HENRY GIESE, H. J. BARRE AND J. BROWNLEE DAVIDSON

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE AND
MECHANIC ARTS

R. M. HUGHES, Acting Director

AGRICULTURAL ENGINEERING SECTION



AMES, IOWA

SUMMARY

1. The average life of the samples of roll roofings laid on the south slope of a test roof was 10 years in contrast with over 13½ years for the same samples laid on the north slope. The life of the samples varied from 5 to 14 and 5 to 18 years on the south and north slopes, respectively.

2. The weathering tests revealed the following:

- a. The sun was the most destructive agency.
- b. The wind became very destructive once the roofing was loosened sufficiently to permit flapping.
- c. The slate and fine sand of the mineral surfacing were retained much better than the coarser sands or pebbles.
- d. The application of an asphalt roof paint prolonged the useful life of many of the roofings.

3. Pitch knots and other defects in the sheathing, and improper nailing reduced considerably the useful life of the roofings.

4. From the equation obtained by a statistical interpretation of the data from the investigation, it may be said that durability of prepared roll roofings varies:

- a. Directly with the tensile strength of felt.
- b. Inversely with the loss of weight of the original material on heating at 149 degrees F.
- c. Directly with the amount of mineral surfacing on the roofing.

What Determines the Length of Life of Prepared Roll Roofings?¹

By HENRY GIESE, H. J. BARRE and J. BROWNLEE DAVIDSON

The length of life of prepared roll roofings is a prime consideration in their selection. The durability of the various brands of roofing on the market varies widely. The useful life of a roof made of roll roofing is influenced by the degree of exposure to the weathering agencies, the condition of the sheathing and the inherent qualities of the roofing material itself. This bulletin is a summary of the results of an investigation, conducted cooperatively by the Agricultural and Engineering Experiment Stations, to determine the quality factors of three-ply prepared roll roofings as they were sold on the market at the beginning of the project in 1913.

One roll or square of each of 35 brands of prepared roll roofing which were made by 19 manufacturers was purchased on the open market and included in the experiment. This provided sufficient material for one strip to be placed on the shed for weathering tests and enough additional for laboratory tests. Table I presents some general information and data of the physical qualities of the roofing sample.

A review of literature on the subject reveals little work directly comparable with that given here other than the development of testing methods and specifications for prepared roll roofings.

EXPERIMENTAL PROCEDURE

The experimental work consisted of tests which were divided into two groups; namely, weathering tests for determining the durability of each of the 35 roofing samples by subjecting them to actual weather conditions, and laboratory tests for determining such physical and chemical qualities as were considered to be related to durability.

WEATHERING TESTS

For this group of tests the roofings were laid upon a gable roofed shed where they were subjected to actual weather conditions (fig. 1). The roofings were laid in warm weather between July 21 and 24, 1913. The axis of the shed extended east and west, giving north and south slopes to the roof. The roof which was of one-third pitch was constructed of 8-inch shiplap laid horizontally on 2 by 4-inch rafters spaced 24 inches center

¹Project 9 (old series) of the Iowa Agricultural Experiment Station. A more detailed account of the investigation is reported in Bulletin 109 "The Durability of Prepared Roll Roofings," Engineering Experiment Station, Iowa State College.



Fig. 1. Roofing samples in place for weathering tests.

to center. The sheathing contained occasional knots, some of which were rather pitchy.

One strip of each roofing sample 28 feet 8 inches long was laid from eave to eave with a 3-inch lap to form the joint with the adjacent samples.

The samples were inspected, usually once each year until nearly all of them had failed. Most of the failures were repaired to maintain the serviceability of the roof.

In 1920, an asphalt roof paint was applied to a strip 3 feet wide on the south slope of the roof located near the eaves and extending lengthwise of the building. This treatment was made to determine its influence upon the life of the roofing. Painting at regular intervals was specified for one brand of roofing by the manufacturer.

LABORATORY TESTS

The laboratory tests consisted of analyses to determine the chemical and physical properties of the samples which might have a relation to durability. There were few precedents to follow in making these tests because prepared roll roofings at the time the investigation was initiated were a comparatively new material. A part of each roofing sample was kept in reserve for the making of additional tests. Tests were made of the principal constituents of the roofings, namely, the bitumen, felt and mineral surfacing.

TABLE 1. GENERAL DATA OF ROOFING SAMPLES.

Roofing and name of manufacturer	Weight of roll packed, lb.	Weight of roll unpacked, lb.	Unrolled length, ft. & in.	Total width, in.	Weight per square foot, lb.	Thickness, inches	Laying width, in.	Square feet laid	Number of ply	Cost per roll, dollars	Color	Kind of surface	Flexibility
1 Heavy Galvanite, Ford Mfg. Co.	71	68	41-8	32	0.61	0.125	29	69.5	3	2.50	Silver gray	Mica	Medium
2 Pyramid, Ford Mfg. Co.	62	58	42-8	32	0.51	0.078	29	69.5	3	1.75	Orange gray	Smooth	Medium
3 Durable, McHenry-Millhouse Mfg. Co.	50	47	39-8	32	0.42	0.078	29	69.5	3	1.50	Yellow gray	Very Fine Sand	Medium
4 Verbest, McHenry-Millhouse Mfg. Co.	51	48	40-8	32	0.44	0.078	29	69.5	3	1.75	Blue gray	Smooth	Very flexible
5 Mica Flake, McHenry-Millhouse Mfg. Co.	51	47	42-8	32	0.41	0.172	29	69.5	3	1.75	Orange gray	Alligator	Very flexible
6 Alligator, Langan Bros. Co.	58	55	40-8	32	0.51	0.109	29	69.5	3	1.50	Orange gray	Alligator	Very flexible
7 Higrado, Langan Bros. Co.	62	59	43-4	32	0.52	0.078	29	69.5	3	1.70	Orange gray	Alligator	Medium
8 Woven Asphalt, Langan Bros. Co.	86	83	39-8	32	0.79	0.141	29	69.5	3	2.85	Yellow gray	Fine Sand	Stiff
9 Reliance, Sall Mt. Asbestos Mfg. Co.	53	50	41-8	32	0.45	0.078	29	69.5	3	2.25	Blue gray	Fine Mica	Very flexible
10 Asbestos, Sall Mt. Asbestos Mfg. Co.	56	52	40-8	32	0.48	0.078	29	69.5	3	2.75	Blue gray	Fine Mica	Very flexible
11 Aduro-Rubber, Sall Mt. Asbestos Mfg. Co.	49	46	40-8	32	0.42	0.109	29	69.5	3	1.40	Yellow gray	Smooth	Very flexible
12 Monarch, Stowell Mfg. Co.	54	51	40-8	32	0.47	0.078	29	69.5	3	1.90	Blue gray	Fine Sand	Very flexible
13 Eureka, Stowell Mfg. Co.	55	51	36-8	36	0.50	0.141	33	70.0	3	1.60	Orange gray	Alligator	Very flexible
14 Rubberite, The Heppes Co.	67	53	36-8	36	0.52	0.078	33	79.0	3	1.50	Yellow gray	Smooth	Stiff
15 Flexo, The Heppes Co.	61	58	35-11	36	0.59	0.141	33	79.0	3	1.50	Yellow gray	Fine Sand	Medium
16 Ebonite, The Heppes Co.	81	77	40-8	32	0.71	0.141	29	69.5	3	1.50	Blue gray	Fine Sand	Stiff
17 Tia-best, The Eastern Granite Roofing Co.	51	48	35-8	36	0.49	0.078	33	79.0	3	2.00	Yellow gray	Alligator	Very flexible
18 Granite, The Eastern Granite Roofing Co.	154	140	40-8	32	1.28	0.234	29	69.5	3	2.50	Orange gray	Fine Grooved	Very stiff
19 Protection, Asphalt Ready Roofing Co.	98	85	40-8	36	0.76	0.141	30	71.8	3	3.00	Yellow gray	Coarse Sand	Stiff
20 Arrow, Asphalt Ready Roofing Co.	123	118	40-8	32	1.08	0.172	29	69.5	3	2.75	Yellow gray	Fine Grooved	Very stiff
21 Compo-Rubber, General Roofing Mfg. Co.	55	52	39-8	32	0.49	0.109	29	69.5	3	1.50	Yellow gray	Very Fine Sand	Very flexible
22 Genasco (smooth), Leighton Supply Co.	53	50	40-2	32	0.47	0.078	29	69.5	3	2.30	Orange gray	Alligator	Medium
23 Genasco (sanded), Leighton Supply Co.	Spe	clme	n not	received									
24 Parlette, The Amer. Asphaltum & Rubber Co.	62	58	38-2	32	0.57	0.109	29	69.5	3	1.90	Orange gray	Very Fine Sand	Very flexible
25 Majeatic, J. D. Street & Co.	54	51	40-2	32	0.48	0.155	29	69.5	3	1.67	Orange gray	Alligator	Medium
26 Best-of-all, Sears Roebuck & Co.	56	53	43-8	32	0.46	0.078	29	69.5	3.5	1.60	Blue gray	Fine Mica	Stiff
27 Composition Rubber, Sears Roebuck & Co.	53	50	41-2	32	0.46	0.141	29	69.5	3.5	1.10	Blue gray	Coarse Sand	Medium
28 Flint-Surface, Sears Roebuck & Co.	82	78	42-8	32	0.68	0.172	29	69.5	3.5	1.70	Blue gray	Coarse Sand	Stiff
29 Everlastic, Barrett Mfg. Co.	54	49	36	36	0.45	0.089			3	1.75	Yellow	Alligator	Flexible
30 Oriental, Sears Roebuck & Co.	77.5	72.5	41	32	0.68	0.112				2.25	Slate	Fine Slate	Medium
31 Neponset Paroid, J. W. Bird & Son	52	49	36-6	36	0.45	0.084			3	3.75	Gray	Very Fine Sand	Medium
32 Asbestos, H. W. Johns-Manville	60	53	40-8	36	0.49	0.057			3	3.50	White	Asbestos	Medium
33 Ruberoid, Standard Rfg. Co.	53	50.5	36-4	36	0.46	0.105			3	3.75	Light gray	Alligator	Flexible
34 Amazon, Barrett Mfg. Co.	50	45	37-4	36	0.40	0.086			3	2.25	Light gray	Alligator	Flexible
35 Old Process, W. J. Burton Co.	57	53.5	36-4	36	0.49	0.100			3	2.50	Yellow gray	Alligator	Flexible
36 Protecto, W. J. Burton Co.	55	52	40	32	0.49	0.095			3	1.50	Yellow	Alligator	Stiff

EXPERIMENTAL RESULTS

WEATHERING TESTS

Extended observations were made of the effects of weathering upon the roofings which may be roughly classified for the sake of discussion as major and minor effects.

Major Effects of Weathering

The weathering tests revealed that the durability of the various samples of roofings varied widely. Furthermore, the durability of the test samples was, in general, greatly reduced when they were placed on the south slope of the roof. It was difficult to determine just when a sample of roofing had failed, since no definite method was available for measuring just when it ceased to give adequate protection to the building. A sample, however, was considered to have failed when it was sufficiently perforated to permit leakage, which in these tests occurred in the five following ways:

1. Holes in roofing due to pitch knots and nail holes caused by pulling away from joints.
2. Open joints due to contraction of material.
3. Holes due to parts of roofing being torn loose or blown away by wind.
4. Holes worn through the surface.
5. Cracks in the roofing due to the breaking of roofing.

Figure 2 presents the observations concerning the number of kinds of failure which occurred on each slope of the roof after 14 years of weathering. It should be noted that the failures of the samples on the south slope were two and one-half times as numerous as those on the north slope. There were 30 failures on the south slope as compared with 12 on the north. The samples on the south slope were exposed more directly to

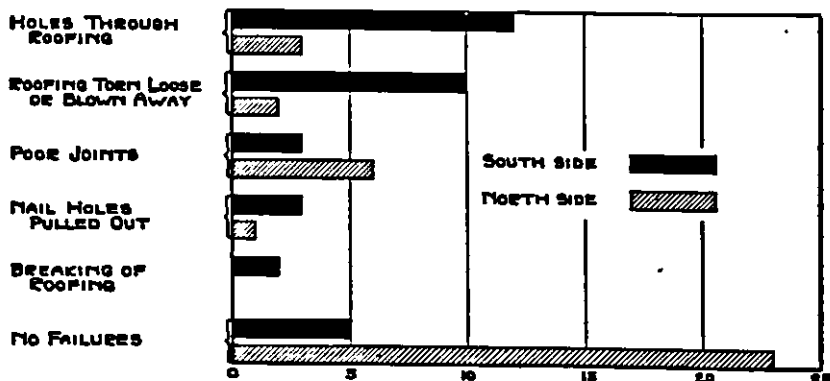


Fig. 2. Kind and number of failures observed in the weathering tests.

TABLE II. GROUPING OF SAMPLES ACCORDING TO DURABILITY.

Last year intact	Durability, years	Samples on south side	Samples on north side
1918	5	2, 5, 26, 27	12
1919	6		
1920	7	12, 18, 21, 32	5, 17
1921	8	3, 25, 28, 29	8, 11, 24
1922	9		
1923	10	8, 9, 10, 11, 24, 31	32
1924	11	1, 6, 13, 15, 17, 35, 36	9, 29
1925	12	19, 20	21
1926	13	14, 16, 30	2, 13
1927	14	4, 7, 22, 33, 34	3, 6, 15, 22, 25, 26, 27, 28, 33, 34, 36
1930	17	All samples replaced	18, 19, 20, 31
1931	18		1, 4, 7, 10, 14, 16, 30, 35

the sun which undoubtedly accounts for the differences in the number of failures.

“Holes through roofing” was the most common type of failure, caused principally by pitch in the knots in the sheathing. The excessive amount of pitch in the knots in two boards of the sheathing caused a very rapid deterioration in samples Nos. 25, 26, 27, 28 and 29 which were placed over these boards. Other holes were caused by loosened nails and unevenness in the sheathing.

The action of the wind, on account of the character of the building, was unusually severe, and was perhaps the next most important factor in the failures. After the roofing stretched and loosened, the wind caused much flapping. The wind eventually tore several of the roofing samples and removed a portion altogether. Poor joints and cracks in roofing were common types of failures.

In table II the samples on both sides of the shed are grouped with respect to durability. In determining the durability of a particular sample, one year was deducted from the time that a sample was reported to have failed. For example, a sample which was reported to have failed after 7 years of weathering was considered to have lasted 6 years.

The average durability of the samples, as shown in table II, is exactly 10 years for the south slope and a little over 13½ years for the north slope. Although the range in durability is only 4 years greater on the north, the higher average is due to the larger number of samples failing near the termination of the weathering tests. The failures on the south slope were well distributed.

Minor Effects of Weathering

The accompanying illustrations (one-fourth natural size), figs. 3, 4, 5, 6, 7 and 8, show some of the typical effects of weathering upon the representative samples of roofing used in the investigation. An examination of the illustrations shows, as indicated in

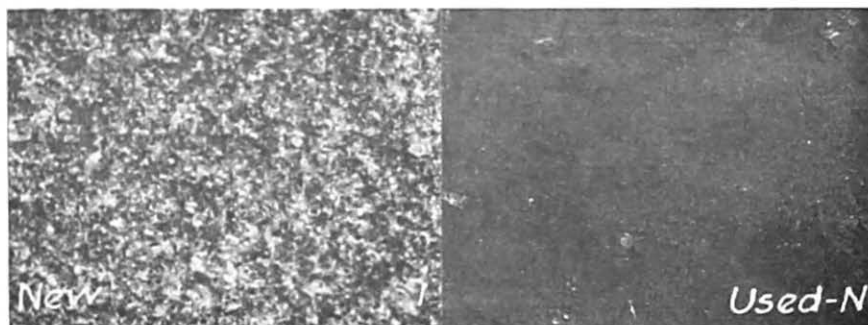


Fig. 3. On the left is new "mica" roofing and on the right the same roofing after it had been used on the north side of the building. The observations of the condition of the roofing on the north and south sides are recorded below for the various years.

SOUTH SIDE		NORTH SIDE	
1915	Condition good. Gray color. Some mica gone.	1918	Condition good. Gray color. Mica partly gone.
1916	Few bulges.	1924	Surface in fair condition. About 30 percent of mica gone.
1918	Condition fair. Dark gray color. Mica two-thirds gone in many places.	1925	About 50 percent of mica gone.
1921	Gray color. About one-half of mica gone.	1926	About 80 percent of mica gone.
1923	Mica surfacing badly weatherworn.	1927	Mica practically all gone.
1924	Surface in fair condition.	1931	Condition fair.
1925	One hole 4 inches in length. About 75 percent of mica gone.		
1926	About 80 percent of mica gone.		
1927	Mica practically all gone.		

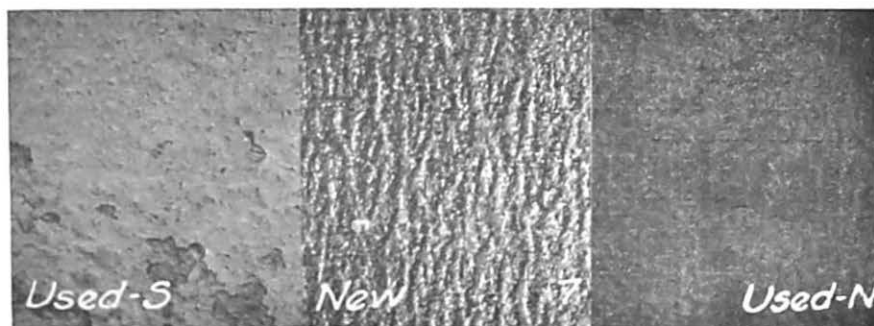


Fig. 4. Alligator roofing—new sample is shown in the center, that used on the south side of the building at the left and the sample from the north side at the right. Below are the observations of the condition on each side of the building.

SOUTH SIDE		NORTH SIDE	
1915	Condition good. Brown color. Surface bitumen partly gone. Surface appeared smooth.	1918	Condition good. Gray color. Mica mostly gone.
1916	Condition good. Black color. Surface pliable.	1921	Mica practically all gone.
1918	Dark gray color. Most of mica gone.	1927	No apparent change in condition.
1919	Condition fair. Slightly weatherworn.	1931	In fairly good condition.
1921	Mica entirely gone.		
1922	Dusty brown color. Appearance fair.		
1923	Surface appearance dusty.		
1924	Top ply gone in spots. Dirty brown color.		
1927	About 25 percent of top ply gone.		

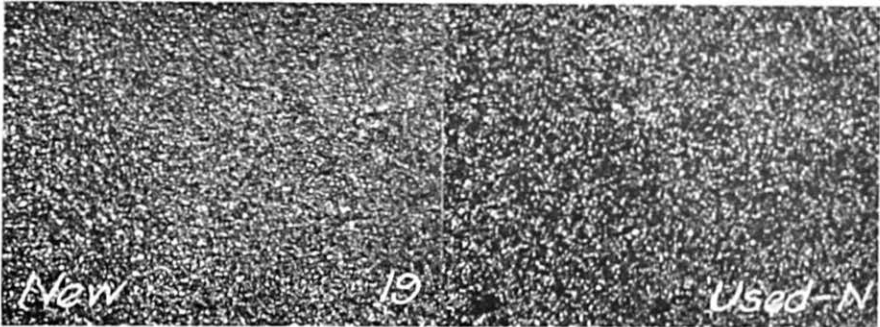


Fig. 5. New and used roofing with fine sand finish. The condition on the north and south sides of the building for the various years are recorded below.

SOUTH SIDE		NORTH SIDE	
1915	Condition fair. Dark gray color. Some surface bitumen gone.	1918	Condition good. Gray color. Some sand gone. Surface ply broken in one place.
1916	Black color, with fine white sand. Surface dry and stiff and covered with smooth coarse sand.	1921	Light gray color.
1918	Light color. Surface bitumen hard and brittle, and gone in spots.	1927	Surface appeared weatherworn.
1919	Gray color. Nearly one-half of sand gone.	1931	Condition poor.
1922	Surface badly weatherworn.		
1923	Sand 85 percent gone. Paint no apparent value.		
1925	Surface ply broken badly except where painted.		
1926	About one-half of roofing gone.		

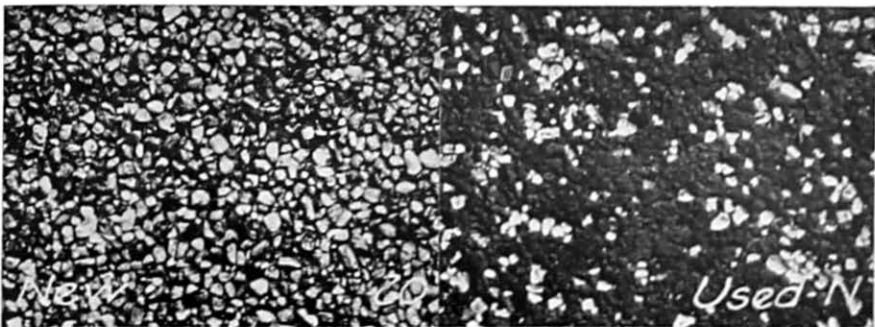


Fig. 6. Roofing surfaced with pebbles—new on the left, used right. Observations for the various years are recorded below.

SOUTH SIDE		NORTH SIDE	
1915	Condition good. Pebble color. About one-third of pebbles gone. Bitumen brittle.	1918	Condition good. Gray color. Some pebbles gone.
1916	Black color with white pebbles. About one-half of pebbles gone.	1919	About 40 percent of pebbles gone.
1918	Light color. Two-thirds of pebbles and much bitumen gone.	1921	About 70 percent of pebbles gone.
1919	Gray color. Remaining bitumen lifeless.	1922	About 75 percent of pebbles gone.
1921	Pebbles 90 percent gone.	1923	About 80 percent of pebbles gone.
1922	Surface badly weatherworn. Paint of no apparent value.	1924	About 90 percent of pebbles gone.
1923	Pebbles 95 percent gone with slightly less removed on the painted area.	1925	Condition fair.
1925	Surface ply broken in places.	1927	Pebbles 95 percent removed.
1926	About one-half of roofing gone.	1931	Condition poor.

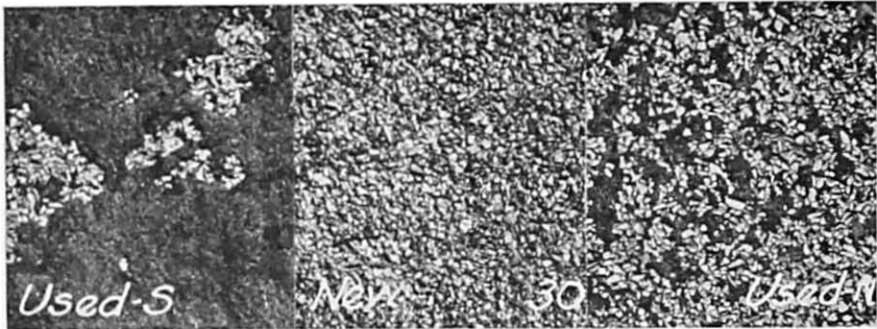


Fig. 7. Slate covered roofing. New sample is shown in the center, that used on the south side of the building at the left and on north side at the right. Observations for each side at different years are recorded below.

SOUTH SIDE

- 1916 Condition very good. Slate color.
 1916 Condition good. Pliable. Some slate gone.
 1918 Remaining slate firmly in place.
 1921 Edge curled slightly.
 1922 Some slate removed near edge. Paint retained slate.
 1923 Paint of little apparent value.
 1924 About 20 percent of surfacing gone except where painted.
 1925 About 30 percent of surfacing gone except where painted. Surface good except near east joint.
 1927 Holes near ridge.

NORTH SIDE

- 1918 Condition good. Slate color.
 1922 Slate surfacing firmly in place but appeared somewhat weatherworn. Joint fair.
 1924 About 5 percent of slate surfacing gone.
 1925 About 10 percent of slate gone. Surface in poor condition near edge.
 1927 No apparent change in condition.
 1931 Condition fair.

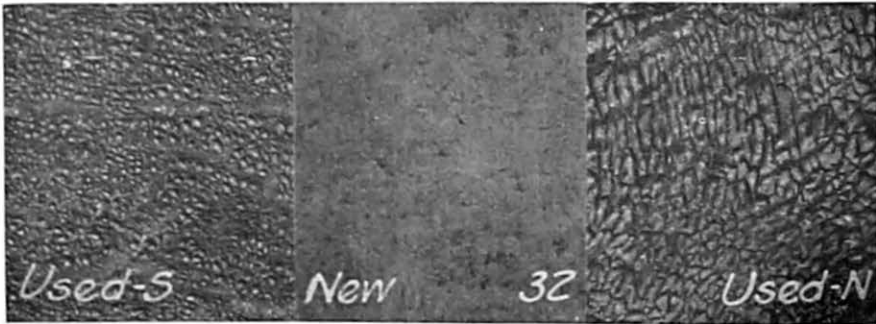


Fig. 8. "Asbestos" roofing is shown above—new sample in the center, that used on the south and north sides of the building are shown, respectively, on the left and right. Observations on the condition are recorded below.

SOUTH SIDE

- 1915 Condition good. White color. Top ply badly scuffed.
 1918 Light color.
 1919 Light gray color. Asbestos top ply checked and weatherworn.
 1921 Condition fair. Some breaks in top asbestos ply. Joint poor.
 1922 Asbestos top ply badly broken and weatherworn. Paint renewed slightly.
 1927 No apparent change in condition.

NORTH SIDE

- 1918 Condition good. Light color. Asbestos nearly gone.
 1919 Gray color. Some breaks in asbestos ply.
 1921 Light gray color.
 1923 Asbestos surface scarred.
 1924 Asbestos top ply badly broken and weatherworn. Joint poor.
 1927 No apparent change in condition.
 1931 Replaced.

the reports below each, that the shedding of the mineral surfacing was one of the first weathering effects noticed, especially on those roofings which were surfaced with mica and coarse sand. The finer sand particles and slate were retained much better than the coarser sands. One of the first noticeable weathering effects in the smoothly surfaced samples was the hardening and scaling of the bitumen, which left the surface ply exposed. Sample 32, which had a felt consisting of 2 plies of asbestos, soon lost its light color because bitumen oozed through the surface layer and then hardened leaving the material very stiff and brittle.

Other minor weathering effects, together with those mentioned above, are summarized in fig. 9. Reports on "bitumen running" caused by the heat of the sun, were more frequent for the samples on the north slope. The effect of the heat on the south slope was apparently sufficient to dry the bitumen.

The burlap layer in sample 8 deteriorated rapidly, due to its exposure from failure to retain the asphalt.

The effect of the asphalt roof paint applied on the roofings after 7 years of weathering was, in general, very marked. It was reported that 22 samples were "renewed" by the paint while 7 were not. In a few samples the paint also aided in retaining over 20 percent more of the mineral surfacing than was held on the unpainted areas. In the sample with the burlap layer, the paint aided in keeping the burlap in place after its failure to retain the asphalt had left it exposed. It seems logical to assume that the application of a suitable asphalt roof paint over areas which have partially deteriorated because of pitch knots would materially reduce the effect of the pitch and delay failure.

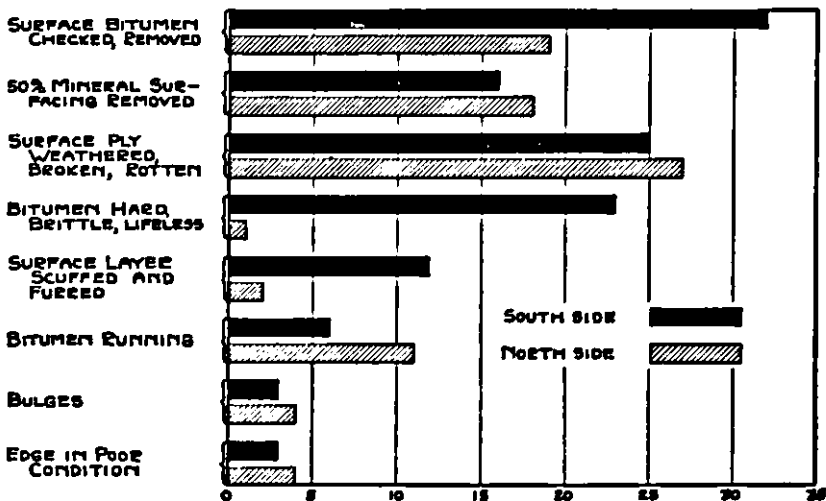


Fig. 9. Kind and number of minor effects observed in the weathering tests.

TABLE III. CHANGES IN WEIGHT AND THICKNESS OF TEST SAMPLES

Sample No.	Weight, lb. per sq. ft.		Weathering loss, weight		Thickness, inches		Weathering loss, thickness	
	New	Used	Lb. per sq. ft.	Percent	New	Used	Inches	Percent
1	0.633	0.497	0.136	21.5	0.130	0.102	0.028	21.5
2	.525	.420	.105	20.0	.107	.080	.027	25.2
3	.450	.369	.081	18.0	.097	.089	.008	8.2
4	.474	.377	.097	20.4	.087	.072	.015	17.2
5	.502				.101			
6	.456	.395	.061	13.4	.112	.085	.027	24.1
7	.500	.460	.040	8.0	.105	.097	.008	7.6
8	.787				.144			
9	.449	.382	.067	14.9	.101	.085	.016	15.8
10	.499	.392	.107	21.4	.102	.091	.011	10.8
11	.421	.346	.075	17.8	.092	.079	.013	14.1
12	.457	.329	.128	28.0	.107	.102	.005	4.7
13	.472	.404	.068	14.4	.102	.099	.003	2.9
14	.518	.436	.080	15.5	.095	.091	.004	4.2
15	.533	.362	.171	32.1	.100	.088	.012	12.0
16	.749	.567	.182	24.3	.131	.117	.014	10.7
17	.464	.360	.104	22.4	.103	.099	.004	3.9
18	1.260	.858	.402	31.9	.220	.199	.021	9.5
19	.728	.456	.272	37.4	.123	.098	.025	20.3
20	1.168	.514	.654	56.0	.188	.169	.029	15.4
21	.463	.402	.061	13.1	.105	.115	-.010	-9.5
22	.441	.314	.127	28.8	.110	.102	.008	7.3
24	.492				.117			
25	.614	.440	.074	14.4	.110	.111	-.001	-0.9
26	.462	.370	.082	18.1	.097	.088	.014	14.5
27	.473	.263	.210	44.4	.094	.065	.029	30.8
28	.709	.479	.230	32.4	.128	.114	.014	10.9
29	.451				.098			
30	.621	.670	.051	8.2	.121	.121	0	0
31	.438	.407	.031	7.1	.095	.091	.004	4.2
32	.416				.065	.060	.005	7.7
33	.459	.435	.024	5.2	.111	.120	-.009	-5.1
34	.406	.344	.062	15.3	.083	.084	-.001	-1.2
35	.482	.423	.059	12.2	.106	.106	0	0
36	0.493	0.437	0.056	11.3	0.099	0.093	0.006	6.0

The losses in weight and changes in thickness of the samples which were removed from the north side after 14 years of weathering are given in table III. Samples of four roofings were not obtained as they had been replaced and therefore do not occur in the table. The significant changes are the extremely wide range of the loss in weight and the actual increase in thickness of four samples. The large part of losses in weight for most samples was due to the loss of mineral surfacing. Sample No. 30, however, with its large amount of slate suffered a loss of only a little over 8 percent which is far below the average of those samples with mineral surfacing. This indicates that the flat particles are retained much better than the larger round pebbles.

Much of the reduction in thickness may be accounted for in the same way as the loss of weight explained above. The increase in thickness of the four samples, which were without mineral surfacing, was due to a swelling of the felt.

Laboratory Test Data

The data of all of the laboratory tests have been summarized

in table IV. A majority of the data represent the mean of several observations. The thickness of the felts represents the combined average thickness of the individual layers. Similarly the values of the tensile strength of the desaturated felts represent the combined average of those samples with more than one layer.

The composition of the felts, as to the kind of fiber, has been determined for several of the roofings which represent a wide range of durability: The tests on the balance of the samples were not made because the tests of the representative samples showed no significant difference in their composition.

STATISTICAL ANALYSIS OF EXPERIMENTAL RESULTS

Statistical methods were used in analyzing the experimental data pertaining to the qualities influencing durability. The multiple correlation method,² which is a method commonly used and understood, was found very useful in making this study.

The results of the analysis show that durability is associated chiefly with the following qualities: (1) The tensile strength of the felt, (2) the loss in weight of the roofing on heating, and (3) the weight of the roofing. The following tabulation is presented to show the increase in the length of life of the roofings with the variation of these qualities.

Durability increases:

0.164 of a year per pound increase of the tensile strength of a 1-inch strip of felt.

0.160 of a year per gram decrease of the loss on heating of a square yard of original material at 149 degrees F.

0.038 of a year per pound increase in weight per 108 square feet of original material.

These results also indicate that the length of life of similar roofings, similar to those represented by the test samples, may be estimated with a fair degree of accuracy.

These conclusions are supported more definitely by the durability data for the roofing samples exposed on the north slope, although the data for the south slope indicate a similar relationship. The weight of some of the roofings is determined in part by the amount of mineral surfacing, which would indicate that the latter also has some influence on durability.

CONCLUSIONS AND RECOMMENDATIONS

A prepared roll roofing is essentially a felt saturated with a bituminous material. Usually, a protective coating of asphalt is applied to both sides of the saturated felt. Mineral surfacing is often added to the top side for protection.

² Wallace, H. A., and Snedecor, G. W. Correlation and machine calculation. Iowa State College of Agriculture and Mechanic Arts. Official Bul. 30. 71p. June, 1931.

The life of prepared roll roofings is determined largely by: (1) the quality of the materials, (2) the degree of exposure to the weathering agencies (sun, rain and wind), (3) the condition of the sheathing and roof framing, and (4) frequency of inspection and repairs.

A good roll roofing should include the following desirable qualities: a felt with high tensile strength, a low loss in weight of the original material when it is subjected to heat at 149 degrees F. and a moderate amount of mineral surfacing in the form of sand or slate. With the exception of the latter, these qualities cannot be determined except by laboratory tests which require special equipment. The mineral surfacing should either be a sand or slate, since these are likely to be retained much better than the larger, round particles.

The degree of exposure of the roofings to the weathering agencies, namely, the sun, rain and wind, are important factors in the serviceability of the roof. A roofing placed on a north slope of a roof can be expected to last from 3 to 4 years longer than one which is subject to the direct rays of the sun. The effect of the wind is reduced considerably when the roof is well protected by surrounding buildings and trees.

The pitch in the sheathing, especially where it is concentrated, as in knots, has a very serious deteriorating effect upon the roofing. The bitumen or asphalt in the roofing is dissolved by the turpentine in the pitch, and the remaining felt soon deteriorates. Pitchy knots may be covered readily with a coat of shellac to prevent the pitch from coming directly in contact with the roofing, and the larger knot holes can be covered with small pieces of sheet metal.

Unnecessary strains on the roofing, due to sagging of the roof, can be prevented by adequately framing and bracing the structure. Care in nailing and cementing the joints at the time when the roofing is laid is important. The laying of the roofing should preferably be done in warm weather since it is more pliable at higher temperatures. Roofing is easily injured by cracking when handled while cold. The possible wrinkling and bulging will be reduced if laid while warm, flexible and expanded. Care should be exercised in securing a firm hold for each nail. Loose nails are frequently the cause of leaks.

The life of a roll roofing can, under most circumstances, be prolonged by making frequent repairs. Regular inspections every 6 to 12 months should be made to determine the condition of the joints, especially with respect to loose nails, and to note areas which seem to have deteriorated. The application of asphalt roof paint to the deteriorated areas will replace or supply a part of the asphalt which has sealed off or volatilized and will hold the mineral surfacing in place.