What Determines the Length of Life of Prepared Roll Roofings?
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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

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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.
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>
<thead>
<tr>
<th>Roofing and name of manufacturer</th>
<th>Weight of roll packed, lb.</th>
<th>Weight of roll unpacked, lb.</th>
<th>Thickness, in.</th>
<th>Color</th>
<th>Kind of surface</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Heavy Galvanite, Ford Mfg. Co.</td>
<td>67</td>
<td>41-8</td>
<td>0.61</td>
<td>Silver gray</td>
<td>Mica</td>
<td>Medium</td>
</tr>
<tr>
<td>2 Pyramid, Ford Mfg. Co.</td>
<td>52</td>
<td>42-8</td>
<td>0.51</td>
<td>Orange gray</td>
<td>Smooth</td>
<td>Medium</td>
</tr>
<tr>
<td>3 Durable, McHenry-Millhouse Mfg. Co.</td>
<td>50</td>
<td>39-8</td>
<td>0.42</td>
<td>Very Fine Sand</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>4 Verbeek, Patent-Millhouse Mfg. Co.</td>
<td>51</td>
<td>40-8</td>
<td>0.44</td>
<td>Very Fine Sand</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>5 Mica Flake, McHenry-Millhouse Mfg. Co.</td>
<td>51</td>
<td>41-8</td>
<td>0.41</td>
<td>Yellow gray</td>
<td>Fine Sand</td>
<td>Stiff</td>
</tr>
<tr>
<td>6 Alligator, Langan Bros. Co.</td>
<td>55</td>
<td>40-8</td>
<td>0.51</td>
<td>Alligator</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>7 Tungsten, Langan Bros. Co.</td>
<td>52</td>
<td>39-8</td>
<td>0.42</td>
<td>Alligator</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>8 Woven Asphalt, Langan Bros. Co.</td>
<td>56</td>
<td>39-8</td>
<td>0.39</td>
<td>Yellow gray</td>
<td>Fine Sand</td>
<td>Stiff</td>
</tr>
<tr>
<td>9 Reliance, Salt Mt. Asbestos Mfg. Co.</td>
<td>53</td>
<td>41-8</td>
<td>0.41</td>
<td>Fine Mica</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>10 Asbestos, Salt Mt. Asbestos Mfg. Co.</td>
<td>56</td>
<td>40-8</td>
<td>0.40</td>
<td>Fine Mica</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>11 Aduro-Rubber, Salt Mt. Asbestos Mfg. Co.</td>
<td>49</td>
<td>40-8</td>
<td>0.39</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>12 Monarch, Stowell Mfg. Co.</td>
<td>54</td>
<td>40-8</td>
<td>0.40</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>13 Eureka, Stowell Mfg. Co.</td>
<td>55</td>
<td>58-8</td>
<td>0.50</td>
<td>Silver gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>14 Rubberite, The Heppes Co.</td>
<td>67</td>
<td>38-8</td>
<td>0.50</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>15 Fleso, The Heppes Co.</td>
<td>61</td>
<td>58-8</td>
<td>0.50</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>16 Ebonite, The Heppes Co.</td>
<td>87</td>
<td>48-8</td>
<td>0.40</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>17 Titalust, The Eastern Granite Roofing Co.</td>
<td>54</td>
<td>38-8</td>
<td>0.49</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>18 Granite, The Eastern Granite Roofing Co.</td>
<td>154</td>
<td>40-8</td>
<td>1.26</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>19 Protection, Asphalt Ready Roofing Co.</td>
<td>56</td>
<td>40-8</td>
<td>0.56</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>20 Arrow, Alligator Roofing Co.</td>
<td>123</td>
<td>118-8</td>
<td>1.20</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>21 Compo-Rubber, General Roofing Mfg. Co.</td>
<td>55</td>
<td>38-8</td>
<td>0.40</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>22 Genasco (smooth), Leighton Supply Co.</td>
<td>53</td>
<td>40-8</td>
<td>0.41</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>23 Genasco (sanded), Leighton Supply Co.</td>
<td>53</td>
<td>40-8</td>
<td>0.41</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>24 Parriette, The Amer. Asphaltum &amp; Rubber Co.</td>
<td>62</td>
<td>58-8</td>
<td>0.50</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>25 Majestic, J. D. Street &amp; Co.</td>
<td>54</td>
<td>50-8</td>
<td>0.48</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>26 Best-of-all, Sears Roebuck &amp; Co.</td>
<td>56</td>
<td>40-8</td>
<td>0.46</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>27 Composition Rubber, Sears Roebuck &amp; Co.</td>
<td>53</td>
<td>40-8</td>
<td>0.44</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>28 Flint-Surface, Sears Roebuck &amp; Co.</td>
<td>52</td>
<td>42-8</td>
<td>0.50</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>29 Keverlast, Barrett Mfg. Co.</td>
<td>54</td>
<td>50-8</td>
<td>0.46</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>30 Oriental, Sears Roebuck &amp; Co.</td>
<td>56</td>
<td>40-8</td>
<td>0.46</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>31 Neponset Portland, J. W. Bird &amp; Son</td>
<td>52</td>
<td>38-8</td>
<td>0.48</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>32 Asbestos, H. W. Johns-Manville</td>
<td>60</td>
<td>40-8</td>
<td>0.46</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>33 Ruberoid, Standard Mfg. Co.</td>
<td>53</td>
<td>36-8</td>
<td>0.46</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>34 Amason, Barrett Mfg. Co.</td>
<td>50</td>
<td>40-8</td>
<td>0.45</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>35 Old Process, W. J. Burton Co.</td>
<td>57</td>
<td>36-8</td>
<td>0.49</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
<tr>
<td>36 Protec, W. J. Burton Co.</td>
<td>55</td>
<td>52-8</td>
<td>0.49</td>
<td>Yellow gray</td>
<td>Very flexible</td>
<td>Medium</td>
</tr>
</tbody>
</table>
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
TABLE II. GROUPING OF SAMPLES ACCORDING TO DURABILITY.

<table>
<thead>
<tr>
<th>Last year intact</th>
<th>Durability, years</th>
<th>Samples on south side</th>
<th>Samples on north side</th>
</tr>
</thead>
<tbody>
<tr>
<td>1918</td>
<td>5</td>
<td>2, 5, 26, 27</td>
<td>12</td>
</tr>
<tr>
<td>1919</td>
<td>6</td>
<td>12, 18, 21, 32</td>
<td>5, 17</td>
</tr>
<tr>
<td>1920</td>
<td>7</td>
<td>9, 25, 28, 29</td>
<td>8, 11, 24</td>
</tr>
<tr>
<td>1921</td>
<td>8</td>
<td>8, 9, 10, 11, 24, 31</td>
<td>32</td>
</tr>
<tr>
<td>1922</td>
<td>9</td>
<td>1, 6, 13, 15, 17, 35, 36</td>
<td>9, 29</td>
</tr>
<tr>
<td>1923</td>
<td>10</td>
<td>19, 20</td>
<td>21</td>
</tr>
<tr>
<td>1924</td>
<td>11</td>
<td>14, 16, 30</td>
<td>2, 18</td>
</tr>
<tr>
<td>1925</td>
<td>12</td>
<td>4, 7, 22, 33, 34</td>
<td>3, 6, 15, 22, 25, 26, 27, 28, 38, 34, 36</td>
</tr>
<tr>
<td>1926</td>
<td>13</td>
<td>All samples replaced</td>
<td>18, 19, 20, 31</td>
</tr>
<tr>
<td>1927</td>
<td>14</td>
<td></td>
<td>1, 4, 7, 10, 14, 16, 20, 35</td>
</tr>
<tr>
<td>1930</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1931</td>
<td>18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 uneveness 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**

1915 Condition good. Gray color. Some mica gone.
1918 Gray color. About one-half of mica gone.
1921 Mica surfacing badly weatherworn.
1923 Condition fair. Dark gray color. Mica gone.
1925 Surface in fair condition.
1926 About 50 percent of mica gone.
1927 Mica practically all gone.

**NORTH SIDE**

1918 Condition good. Gray color. Mica partly gone.
1924 Surface in fair condition. About 30 percent of mica gone.
1925 About 60 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**

1918 Dark gray color. Most of mica gone.
1919 Condition fair. Slightly weatherworn.
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.

**NORTH SIDE**

1921 Mica practically all gone.
1927 No apparent change in condition.
1931 In fairly good condition.
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**
- **1915** Condition fair. Dark gray color. Some surface bitumen gone.
- **1916** Black color, with fine white sand. Surface dry and stiff and covered with smooth coarse sand.
- **1918** Light color. Surface bitumen hard and brittle, and gone in spots.
- **1919** Gray color. Nearly one-half of sand gone.
- **1922** Surface badly weathered.
- **1923** Sand 85 percent gone. Paint no apparent value.
- **1925** Surface ply broken badly except where painted.
- **1926** About one-half of roofing gone.

**NORTH SIDE**
- **1918** Condition good. Gray color. Some sand gone. Surface ply broken in one place.
- **1921** Light gray color.
- **1927** Surface appeared weathered.
- **1931** Condition poor.

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

**SOUTH SIDE**
- **1916** Black color with white pebbles. About one-half of pebbles gone.
- **1918** Light color. Two-thirds of pebbles and much bitumen gone.
- **1919** Gray color. Remaining bitumen lifeless.
- **1921** Pebbles 90 percent gone.
- **1922** Surface badly weathered. Paint of no apparent value.
- **1923** Pebbles 95 percent gone with slightly less removed on the painted area.
- **1925** Surface ply broken in places.
- **1926** About one-half of roofing gone.

**NORTH SIDE**
- **1918** Condition good. Gray color. Some pebbles gone.
- **1919** About 40 percent of pebbles gone.
- **1921** About 70 percent of pebbles gone.
- **1922** About 75 percent of pebbles gone.
- **1923** About 80 percent of pebbles gone.
- **1924** About 90 percent of pebbles gone.
- **1925** Condition fair.
- **1927** Pebbles 85 percent removed.
- **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**
1915 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 20 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 plys 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.

![Chart showing various weathering effects observed in the test samples.](chart.png)

Fig. 9. Kind and number of minor effects observed in the weathering tests.
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
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**TABLE IV. SUMMARY OF LABORATORY TEST DATA**

- **Original Material**
- **Bitumen**
- **Felt**

**Fiber Constituents**
- Cotton
- Linen
- Chemical wool
- Mechanical wool
- Jute manila
- Wool
- Unidentified fibers

**Data Columns:**
- Weight per 100 sq. ft.
- Mineral surfacing per 100 sq. ft.
- Thickness
- Heating loss per sq. yd.
- Water absorption per sq. yd.
- Tensile strength of 1 in. strip
- Mulling point
- Weight per 100 sq. ft.
- Mulling point

**Note:** The table includes a variety of test data related to the properties of materials, such as heating loss, water absorption, tensile strength, and mulling points. Each sample is categorized by these properties, helping to evaluate the material's performance under different conditions.
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, 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.

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 in-
spection 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 de-
grees 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 fac-
tors 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 roof-
ing. 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 roof-
ing, 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 struc-
ture. 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 scaled off or volatilized and will hold
the mineral surfacing in place.