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AN APPARATUS FOR MEASURING THE RELATIVE
WEAR OF SOLE LEATHERS, AND THE RESULTS
OBTAINED WITH LEATHER FROM DIFFERENT PARTS OF A HIDE

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I. INTRODUCTION

The quality of sole leather is affected by many factors, such as the breed of the animal, its mode of life, the time of killing, the method of preserving the hide, and the kind of tannage. A very important factor which influences the durability of any particular sole is the part of the hide from which it is cut. It is a difficult problem to measure the wear of sole leather and generally it is accomplished by actual service tests on individuals. Such a method takes considerable time, and the value of the results obtained is often uncertain on account of the many uncontrollable variables occurring in the types of service and among the individuals wearing the soles. The development of a simple method for quickly determining the durability of sole leather seemed desirable, and this paper discusses a laboratory apparatus designed for this purpose and also presents the results of tests made to date to determine the relative wear of leather from different parts of a hide.

II. WEARING-TEST MACHINE

A machine has been developed at the Bureau for testing the durability of sole leather with the idea of subjecting the leather to shearing action during the wear similar to that occurring in service on shoes and at the same time accelerating the actual wearing away of the material so that an indication of the durability of the specimen might be obtained in about 24 hours. The

machine as first designed (Fig. 1) embodied a cam of clover-leaf shape, to which the samples were attached, and which rested on a horizontal disk having an abrasive surface of cement. The difficulties with this design were that the samples were submitted to a bumping action which caused the wear of each sample to be so localized that it was often worn through on one end before the other end showed appreciable wear, that no means was provided for removing the material worn away, and that the abrasive material soon wore smooth which caused a longer time to be necessary for a test. The machine (Fig. 2) as later developed and as now used is described as follows:

A wheel of 15-inch diameter carries on its face 12 test pieces. The wheel revolves at the rate of 30 revolutions per minute about a horizontal axis with its bearings in two parallel metal bars which are pivoted at one end, the other end being free. The wheel carrying the weight of the bars (and any additional weight that may be suspended from their free ends), rests on a horizontal disk of 16-inch diameter, the point of contact being $5\frac{1}{2}$ inches from the axis of the disk. This disk has a surface of carborundum, and rotates about a vertical axis on which is a brake wheel provided with a brake strap, by means of which any desired resistance to rotation may be secured by the application of dead-weight. The wheel is driven by a chain and in turn drives the horizontal disk with which the test pieces are in contact. The apparatus is designed with the view of subjecting the test piece to (1) a driving (shearing) action under pressure, and (2) a slight abrasive action resulting from the circular path of contact between the wheel and disk. The conditions of pressure and shear may be adjusted as desired. A circular brush is shown resting on the carborundum disk. This brush in connection with a small exhaustor tends to keep the surface of the wearing disk clean.

A test usually consists of 40 000 revolutions of the wheel which corresponds with 40 000 steps, or approximately 40 miles of walking.

The substitution of a wheel for the cam eliminated the bumping action but retained the shearing action and resulted in a more even and smoother operation. The use of a wheel allowed more specimens to be tested at one time, the entire surfaces of which were subjected to the wearing action. By using carborundum for an abrasive, a material was obtained which did not become dull or smooth quickly and which could be resurfaced with an emery-wheel dresser.

FIG. 1.—Wearing test machine as first used

FIG. 2.—Wearing test machine as used at present

FIG. 3.—A bend marked off for machine wearing test

A small suction fan and circular brush were added to the equipment in order to remove the dust caused by abrasion. These improvements permitted the wearing conditions to be more uniformly maintained.

III. METHODS

Sole leather is generally sold in the form of bends. A bend is a half of a hide with the shoulder and belly portions trimmed off, the remaining portion being suitable for soles. In the tests conducted samples of leather from different locations on a bend were used to determine their relative durability or resistance to wear. When a whole bend was tested the general scheme was to divide it into blocks, as illustrated in Fig. 3. Each block was stamped with a code number, which fixed its location on the bend. When using the clover-leaf-shaped cam for holding the samples, test pieces approximately 24 by 5 cm were required and they were attached to the cam by a clinching device. Test pieces for use with the wheel were about half as long and were attached by means of four countersunk screws. In either case the samples were first weighed and then placed on the machine. After the test was completed the samples were again weighed and the loss in weight determined. The relative durability was obtained by determining the loss in volume from the loss in weight and the specific gravity. The sample showing the greatest loss in volume was considered as the least durable.

A small sample adjacent to the test specimen was used in determining the specific gravity. Since only the grain portion was worn away during the test, it was thought desirable to use the specific gravity value for the grain portion only. Accordingly the flesh portion of the sample was removed and the grain portion was then coated with cellulose nitrate to render the sample waterproof. The determinations were then made using a direct-reading gravitometer (Fig. 4).

IV. RESULTS OF TESTS

Test No. 1.—This series of tests was conducted on an oak-tanned bend using the machine with the clover-shaped cam to carry the samples and an abrasive disk of cement. The length of the test was 40 000 revolutions except that in some cases one of the test pieces was entirely worn through before the 40 000 mark was reached; in these cases the machine was stopped and the results figured on a proportional basis.

The four pieces tested at the same time were all taken from the same column across the bend and equidistant from each other so that each run gave an indication of the relative wear across the bend. The exact location of each test piece is shown in Fig. 3.

The results show that in general the resistance to wear is greater at the backbone edge and decreases gradually toward the belly edge of the bend. This is shown in Fig. 5. In studying these results it should be remembered that the best wearing portions of the bend are represented by the lowest points on the curves. In

FIG 4.—Direct reading gravimeter

diagrams *B*, *C*, and *D* the results of each individual run may be distinctly seen as one continuous curve, and the general tendency in regard to the wear as stated above is shown in each case. In diagram *A*, all the points in the other three diagrams are plotted, which gives a broken curve, showing that tests of practically the same material made at different times did not check. This failure of the machine to check itself caused the changes previously discussed to be made.

Test No. 2.—A scoured oak bend was used in this series of tests. The samples in this case were 10 by 5 cm. in size, and when placed

FIG. 5.—Results of test No. 1 (ordinates indicate loss in wearing tests)

on the wheel were made to an apparent even thickness by backing the thinner ones with sheets of metal so that the outer circumference of the wheel, after all the test pieces were in place, presented a smooth surface. Twelve pieces were tested at one time. The same general scheme of placing the samples on the machine for this test was carried out as in Test No. 1.

The results of the tests are given in Fig. 6 and show that the best wearing portions of the bend are along the backbone edge and

FIG. 6.—Results of test No. 2 (ordinates indicate loss in wearing tests)

over the kidney. The resistance to wear decreases as the belly edge is approached and also toward the shoulder end of the bend.

Test No. 3.—Test No. 3 differs from the preceding test mainly in the fact that the leather was of hemlock tannage instead of oak tannage, and that the conditions of pressure and shear were changed, so that no comparison can be made between the relative wear of the oak and hemlock tannages. The tests were made along the bend with samples of composition material placed alternately on the machine with the leather. The general tendency of the decreasing resistance to wear as the belly edge and the shoulder end

FIG. 7.—Results of test No. 3 (ordinates indicate loss in wearing tests)

are approached is shown in Fig. 7. This test also shows that the portion on the extreme butt end near the tail is inferior in wearing quality.

1	11	21	31
2	12	22	32
3	13	23	33
4	14	24	34
5	15	25	35

FIG. 8.—Method of dividing a bend for service and machine tests

Test No. 4.—Several bends of sole leather were divided into blocks as shown in Fig. 8. From each block a sole was cut which was used in an actual service test. A sample for the wearing-test

FIG. 9.—Chart showing relation between actual service tests and laboratory machine tests in test No. 4

machine was also secured from each block adjacent to the toe end of the sole. A comparison of the results obtained in service and on the machine is shown in Fig. 9.

The upper curve represents the average wear in days per iron¹ for all the soles from each location. The lower curve represents the wear as indicated by the machine tests expressed as the average loss in volume of the test pieces as compared with a standard specimen of composition material, a sample of which was tested with each group of six samples of leather. The two curves show the same general tendency as regards wearing quality with the exception of location No. 31. No cause can be assigned for this apparent discrepancy, but it is expected that subsequent investigations will correct this difference.

V. CONCLUSIONS

The results of these tests show that the machine indicates a decided difference in the wearing quality of leather taken from different parts of the hide, the portion near the back and over the kidneys having the best wearing quality and those portions near the belly edge, shoulder end, and extreme butt end having considerable less durability. These indications are in accord with the opinion and experience of many tanners and leather manufacturers. The results obtained on the machine in Test No. 4 also agree quite closely with those obtained in service tests.

In view of these facts it seems reasonable to believe that the machine may properly be used to indicate the relative resistance to wear of different leathers.

WASHINGTON, May 26, 1919.

¹ The iron is a unit of measure used in the leather trade to designate the thickness or gage of leather and is equal to approximately one-half millimeter in the metric scale, and equal to one forty-eighth inch in the English scale.