COMPARATIVE WEARING QUALITIES OF PIMA AND ORDINARY COTTON USED IN MAIL BAGS

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ABSTRACT

The general characteristics of Pima cotton are discussed, together with the reasons for attempting to find new uses for this type. The purpose of this investigation was to compare mail bags made from Pima cotton with those made from ordinary cotton in the regular catcher-pouch service. The details of the organization used for making the yarn is given. The tests and results are described and discussed. The conclusion from this investigation is that Pima cotton mail bags stand the service wear decidedly better than ordinary cotton bags.

CONTENTS

I. INTRODUCTION

1. GENERAL CHARACTERISTICS OF PIMA COTTON

Pima cotton is a special variety of cotton which has been developed in the production of the Egyptian type of cotton in Arizona. It has been found that Pima is better adapted to the Arizona and California conditions than any of the imported Egyptian varieties.

The acreage used in growing Pima cotton underwent a very rapid expansion—from 275 acres in 1916 to approximately 250,000 acres in 1920. However, on account of the general depression, this decreased to about 75,000 acres in 1921 and 1922. This rapid expan-

sion in acreage introduced several factors which reduced to some extent the uniformity of the product. These factors were, first, the additional acreage required included some which was not well suited to producing regular uniform crops, and, second, many people with no previous experience undertook the raising of this cotton often under unfavorable conditions.

This lack of uniformity is noticeable in the staple length, which varies to a marked extent. Poor ginning and handling of the crops has resulted in some objection to the use of this type of cotton by causing a higher waste factor. In manufacturing it has been noticed that neps occur. These also occur in Sakellaridis, but not to as large an extent as in Pima.

The diameter of the fiber of Pima cotton is about the same as Sakellaridis. In spirality of fiber it averages higher than Sakellaridis, Sea Island, or Peruvian varieties.

2. USES FOR PIMA COTTON

In its early development Pima cotton had been used almost exclusively for tire yarns and fabrics. Prior to 1921 its use in the manufacture of fine goods was very limited.

The continued use of the bulk of this cotton in the tire-goods trade resulted in several undesirable conditions. First, the spinners of fine yarns were aware of the ever-increasing demand for tire yarns and fabrics, and, realizing the rather limited supply of Pima cotton, they were reluctant to buy it because they could not be assured of additional lots after going to the expense of setting machines for this staple. Second, the demand for Pima fluctuated with the demand for tires which were made from high-grade material, and this was markedly reflected in the price. Third, the requirements for the tire trade as to waste and as to methods of handling in relation to the production of clean, smooth staple uniform in length and strength are not as exacting as those for the fine-goods trade.

The second condition has been altered by the competition of cheaper grades of Egyptian and American 1¼-inch staple in the tire trade because of the demand for lower prices for tires.

The last of these conditions will probably be remedied by the growers themselves, for they realize the importance of uniform quality in the production of fine yarns.

3. REASONS FOR THIS INVESTIGATION

The competition of lower grades of cotton in the tire industry had resulted in the accumulation of large amounts of Pima for which new uses were needed. It was suggested that this material could be used by the Government in the manufacture of mail bags for the Post Office Department. It was realized that these would cost more than

the regular service bags, but it was considered that the increase in the life of the bags might justify its use.

The type of mail bag which was selected for test was the catcher pouch. The reasons for this choice were, first, that the kind of treatment the catcher pouches receive provides a more severe test and shortens the service period, and, second, catcher pouches can be traced and recalled from service by the Post Office Department much more easily than ordinary mail pouches. In order to make the results more marked it was decided to use No. 8 duck instead of No. 5, which is usually used for catcher pouches. These fabrics are the same type, but No. 8 is a lighter duck and would show the effect of service more than No. 5.

No. 8 cotton duck has a higher strength in the warp direction than in the filling. This is a desirable feature, for it is considered that a fabric equally balanced in regard to strength would have no advantage in the service for which this is intended. This service is to a large extent abrasive, so a well-covered filling will prolong the life of the fabric to a greater extent than if the warp count were reduced in order to increase the filling strength by increasing the filling count.

II. PURPOSE

The purpose of the investigation was (*a*) to develop a suitable mill organization for the manufacture of yarn from Pima cotton, and (*b*) to compare the length and performance in service of mail bags made from this yarn with the mail bags now being used by the Post Office Department.

III. PROCEDURE

1. MATERIAL USED

For this investigation there were furnished four bales of cotton by cooperative growers' associations and commercial organizations in the Salt River valley. The bales were taken from the stock of one of the cotton growers in that locality. The cotton was classed as No. 2 American Egyptian fully equal to Middling Upland in grade. The average staple length was 1⅝ inches. The ordinary mail bag duck was manufactured from 1″ Middling cotton to meet Post Office specifications.

2. MANUFACTURING DETAILS

(*a*) Through Yarn State.—After the wrapping and soiled cotton were removed the bales were "opened" and the cotton exposed to atmospheric conditions in the mill for several days. The relative humidity in the mill ranged from 60 to 70 per cent throughout the manufacturing operations. The cotton was then run through the mill processes, using the organization given in full in Table 1.

TABLE 1.—*Full organization used on Pima cotton for yarn for mail bag canvas*

[Automatic feeder to vertical opener 530 r. p. m.]

PICKERS	
Breaker:	
Type of beater	Kirschner.
Number of blades	3
Speed of beater—r. p. m.	1,050
Blows per minute	3,150
Blows per inch	39
Weight of lap—ounces	14.4
Settings—	
Beater to feed rolls—inch	3/8
Intermediate and finisher:	
Type of beater	Kirschner.
Number of blades	3
Speed of beater—r. p. m.	870
Blows per minute	2,610
Blows per inch	79
Weight of lap—ounces	11.5–11.6
Settings—	
Beater to feed rolls—inch	5/16
CARDS	
Saco-Lowell:	
Cylinder speed—r. p. m.	170
Doffer speed—do	7 1/2
Licker-in speed—do	465
Draft	101.67
Sliver—grains	44.5
Settings—	
Feed plate to licker-in	10/1,000
Mote knife—	
Top	29/
Bottom	17/
Licker-in to cylinder	10/
Back knife plate cylinder	29/
Flats to cylinder—	
Back	10/
Front	9/
Doffer to cylinder	7/
Cylinder screen—	
Back	29/
Middle	58/
Front—inch	3/16
Licker-in screen—	
Blank	29/
Nose—inch	1/8
Front knife plate	29/
Whitin:	
Cylinder speed—r. p. m.	160
Doffer speed—do	7 1/2
Licker-in speed—do	405
Draft	98.91
Sliver	45.5

Settings—

Feed plate to licker-in	10/1, 000
Mote knife—	
Top	22/
Bottom	17/
Licker-in to cylinder	10/
Back-knife plate	29/
Flats to cylinder—	
Back	10/
Front	9/
Doffer to cylinder	7/
Cylinder screen—	
Back	29/
Middle	58/
Front inch	3/16
Licker-in screen—	
Blank	29/
Nose inch	1/4
Front-knife plate	29/

DRAWING

	First	Second	Third
Sliver fed grains	45. 5	46	46
Sliver delivered do	46	46	46
Draft	6	6	6

Front roll speed, 350 (Saco-Lowell); 310 (Whitin).

Settings (rolls):

Between centers—	
First to second inches	1 13/16
Second to third do	1 1/4
Third to fourth do	1 15/16

Diameters:	Saco-Lowell	Whitin
Front roll inches	1 3/8	1 1/4
Second roll do	1 1/8	1
Third roll do	1 1/8	1 1/8
Fourth roll do	1 3/8	1 1/8

SLUBBER—INTERMEDIATE

Stock fed	46 grains sliver	1. 04 hank
Draft	5. 83	5. 0
Hank delivered	1. 04	2. 6
Twist per inch	. 91	1. 47
Twist multiplier	. 9	. 9
Spindle speed	745	990
Front roll speed	230	193

Settings:

First to second rolls inches	1 3/4	1 3/4
Second to third rolls do	1 7/8	1 7/8
Diameters:		
Front do	1 1/8	1 1/8
Middle do	1	1
Back do	1	1

SPINNING FOR 7S YARN

Stock fed	hank	1.04
Number of ends		1
Draft		7
Count delivered		7.13
Twist per inch		11.87
Twist multiplier		4.48
Diameter of ring	inches	2½
Diameter of front roll	do	1
Diameter of back roll	inch	⅞
Traverse	inches	7½
Traveler		No. 12
Spindle speed	r. p. m.	6,240
Cylinder speed	do	813
Front roll speed	do	170

SPINNING FOR 13S YARN

Stock fed	hank	2.6
Number of ends		2
Draft		10.97
Count delivered		13.12
Twist per inch		16.27
Twist multiplier		4.51
Diameter of ring	inches	1¾
Diameter of front roll	inch	1
Diameter of back roll	do	⅞
Traverse	inches	6½
Traveler		No. 7
Spindle speed	r. p. m.	9,100
Cylinder speed	do	1,170
Front roll	do	178

The same organization was used for both sizes of yarn until it reached the spinning frame, where the changes necessary to spin 7s and 13s yarn were made.

In selecting a proper twist multiple for spinning number 7s yarn inquiry failed to ascertain one which would give the best strength qualities. Accordingly, it was thought advisable to make yarn of varying twists and study its characteristics.[1] From a consideration of these results it was decided to use the twist factors given in Table 1.

(*b*) MANUFACTURE OF FABRIC.—Because the experimental cotton mill in which the yarn was made was not equipped with the weaving facilities necessary to weave the duck, the yarn was shipped to a duck mill, where it was made into ply yarn and woven into material 22 inches wide.

(*c*) MANUFACTURE OF CATCHER POUCHES.—After the fabric had been manufactured it was sent to the Post Office Mail Equipment Shops, where catcher pouches were made from it in accordance with their usual procedure. These were put into regular service.

[1] See forthcoming B. S. Tech. paper, entitled "Effect of Twist on the Physical Properties of a Number 7s Yarn."

IV. TEST METHODS AND RESULTS

1. LABORATORY TESTS ON ORIGINAL FABRIC

In Table 2 is shown the results of physical tests on the fabric manufactured from Pima cotton and ordinary cotton duck used for mail bags.

TABLE 2.—*Results of physical tests on Pima cotton fabric and ordinary cotton duck used for mail bags*

Type	Threads per inch		Ply		Yarn size		Breaking strength grab (1 by 1 by 3)		Weight per square yard
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	
							Pounds	*Pounds*	*Ounces*
Pima duck	36½	24	3	4	7	13	470	245	17.7
Ordinary mail bag duck	36½	24	3	4	7	13	285	224	18.2

All laboratory tests were made after conditioning the material for at least four hours in a normal atmospheric condition of 65 per cent relative humidity at 70° F.

For obtaining breaking strength results the 1 by 1 by 3 inch grab method was used. Ten test specimens 6 inches long by 4 inches wide were cut, 5 in the direction of the warp and 5 in the direction of the filling, respectively (see fig. 1). Care was taken that no two test specimens included the same threads, except for retest as specified below. No sample for testing was taken at less than 8 inches from either selvage.

The machine used was of the inclination balance type having a maximum capacity of 800 pounds. The lower or pulling jaw traveled at a uniform rate of 12 inches per minute under no load. The distance between jaws was 3 inches at start of test. The inside half of each jaw was 2 inches in width; the other half was 1 inch in width. The jaws had a smooth, flat surface with edges slightly rounded to prevent cutting. The results of the test in each direction were averaged. If a specimen slipped in the jaw, broke in the jaw, broke at the edge of the jaw, or for any reason due to faulty operation the result fell markedly below the general average, the result was disregarded, another specimen taken from the same threads, and the result of this break included in the average.

2. SERVICE TEST ON FABRIC

Four hundred catcher pouches—200 made from Pima cotton and 200 of the kind usually used by the Post Office Department—were put into service at the same time. These were marked with a special mark in order to make it possible to recall them when desired.

The service which these pouches undergo is extremely rigorous. In addition to the usual service which mail bags are given, these bags are subjected to severe treatment when they are picked up by a rapidly moving express train. The manner in which this is

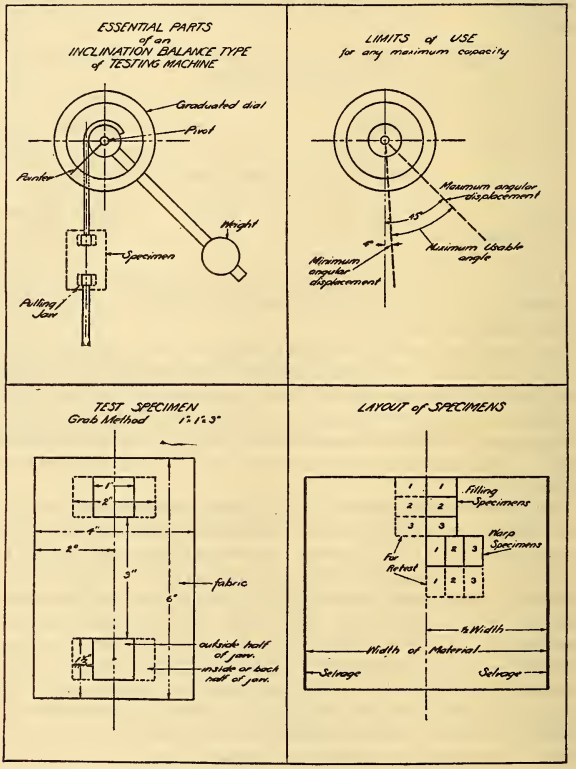

FIG. 1.—*Type of breaking strength machine, layout and dimensions of specimen for 1 by 1 by 3 inch grab method*

done is shown by Figure 2. These bags are strapped at the bottom and in the middle. They are held to the stationary holding device by metal rings. The arm on the moving train strikes the bag at the middle strap and holds it until it is removed by the operator.

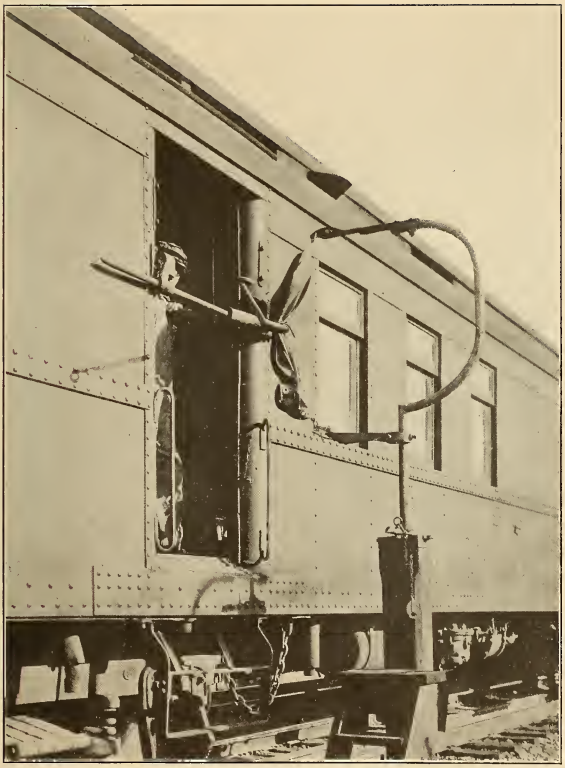

FIG. 2.—*Mail crane picking up catcher pouch*

FIG. 3.—*Character of the tears in catcher pouches*

After the pouches had been in service one year a recall order was issued so that they could be examined and tested. Only 43 pouches were located—33 ordinary bags and 10 Pima cotton bags—but it was thought that this number would be sufficient for comparison.

The bags showed evidence of service, such as soiled areas, punctures, and tears. The soiled areas result from the ordinary conditions of the service. The punctures seemed to have been caused by sharp-pointed projections, such as nails or similar sharp instruments, and may occur in any mail bag, new or old. The tears,

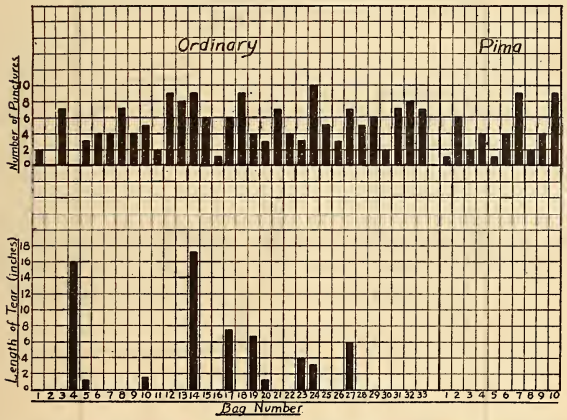

FIG. 4.—*Number of punctures in Pima cotton and ordinary cotton catcher pouches after one year in service (above). The occurrence and length of tears in these types of pouches is shown below. No tears occurred in Pima bags*

however, are caused in the majority of instances by a weakness of the fabric when subjected to a load. Figure 3 shows the character of these tears. These bags had been mended and put back into service.

A comparison of the number of tears and punctures occurring in the two types of pouches under consideration is shown in Figure 4. The number of punctures per bag were smaller in the case of the Pima pouches. Pima cotton pouches averaged 4.2 punctures per bag, while the ordinary cotton pouches averaged 5.1. This difference is slight and may be accidental. On the other hand, it may be that they indicate that the Pima fabric is more difficult to puncture.

In the case of the tears, the superiority of the Pima cotton bags is unmistakable. None of the bags of this material had been torn, while 10 of the 33 ordinary bags had tears of various lengths, ranging from 1 to 17 inches.

3. LABORATORY TESTS ON FABRIC AFTER SERVICE PERIOD

The same laboratory procedure was followed in testing the pouches after a year of service that had been used in testing the original fabric, except the layout of the sample which is shown in Figure 5.

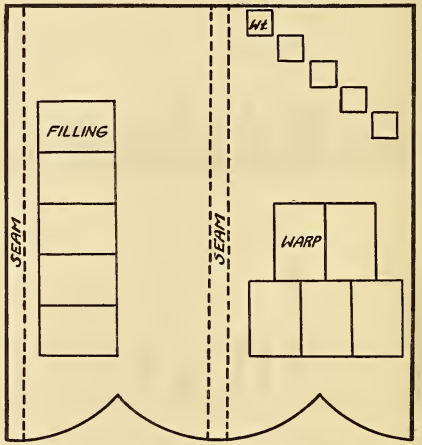

FIG. 5.—*The layout of the sample after the service period for the breaking strength specimens (1 by 1 by 3 grab method) and for the weight specimens*

The specimens were selected from portions of the fabric which have not been torn or punctured. The results of these tests obtained on two pouches of each type selected at random from the lot are shown in Table 3.

TABLE 3.—*Results of physical tests on Pima cotton and ordinary cotton catcher pouches after one year service*

Type	Threads per inch		Yarn count		Weight per square yard	Breaking strength 1 by 1 by 3 inch grab	
	Warp	Filling	Warp	Filling		Warp	Filling
					Ounces	*Pounds*	*Pounds*
Pima	37.0	25.7	6.8	12.5	19.8	430	228
Ordinary	36.7	24.5	6.9	11.9	19.6	281	184

The increase in weight per square yard over the results of the original fabric is probably caused by some shrinkage, which is also evidenced by the thread count and by the dirt which was picked up. The breaking strength shows a natural decrease after a year of service, but the Pima cotton fabric is much stronger than the ordinary fabric used for the purpose.

V. CONCLUSIONS

In this investigation a suitable mill organization is developed for making Pima cotton duck for mail bags on a commercial basis. The results of the laboratory and service tests show that catcher pouches made from Pima cotton duck will give better service than ordinary cotton duck.

While it was not the purpose of this investigation to determine which of these materials would be the most economical purchase, the following points may be of interest. It would seem logical that since the manufacturing costs enter largely into a material of this kind, both fabric costs and bag-making costs, the longer the material would remain in service the more efficient would be the system. It has been shown that the Pima fabric withstood tearing strains incident to the service a great deal better than the fabric usually used. This forms an item in operating expense, for torn or otherwise damaged bags are out of service for a time in addition to the expense of repairing.

WASHINGTON, June 6, 1924.

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